APPENDIX G

ENVIRONMENTAL RESOURCES

Including Section 404(B)(1) Analysis

ENVIRONMENTAL SETTING

Description of Study area

Location

The ecological study area is located adjacent to the business district of downtown Fort Worth, Tarrant County, Texas, on the floodplains of Clear and West Forks of the Trinity River (see Figure 3-4, "Ecosystem Improvement Reaches" in Main Report). The initially identified study area lies along the Clear Fork downstream of Interstate Highway 30, downstream of University Drive on the West Fork and extends to a point just upstream of Riverside Drive. During 2004, it was determined that it was necessary to expand the detailed study area to include resources upstream of University Drive on the West Fork. The natural resources of the area have been significantly modified by past flood damage reduction activities. The entire study reach has been channelized and levees have been constructed along the area to protect large areas of former flood plain. Sumps in some areas near the Clear and West Fork confluence are not well defined, but the overall study area offers a unique opportunity to consider merits of preserving and restoring a large area of riparian woodlands along the West Fork of the Trinity and an upland community that has remnant vegetation including both native prairie and riparian stringers.

Ongoing activities of others in area

New construction adjacent to the study area has moved forward during recent months. A new business campus is under construction in the west side of downtown Fort Worth along the banks of the Clear Fork. The campus setting was partially designed to take advantage of the potential aesthetic, recreational and other benefits of the Trinity River within the study area. Tarrant Regional Water District as part of its ongoing operation and maintenance of the flood damage reduction project has recently completed some shoreline stabilization near the upper end of the study area on the Clear Fork and is proceeding with modification of existing low water dams to facilitate recreational canoe and kayak navigation. Tarrant County College has purchased lands adjacent to the West Fork near Main Street and is developing plans to build a downtown campus that may lie on both sides of the channel and may include an enclosed pedestrian crossing over the River that includes classrooms or other campus facilities.

Climate

The Upper Trinity River watershed is located in a region of temperate mean climatological conditions, experiencing occasional extremes of temperature and rainfall of relatively short duration. According to the National Oceanic and Atmospheric Administration (NOAA 1997) Station at Fort Worth, Texas, the 30-year mean rainfall amount is 33.7 inches per year with the most recent ten-year (1987-1996) average being 37.88 inches. The extreme annual rainfall values since 1887 are a maximum of 53.54 inches occurring in 1991 and a minimum of 17.91 inches occurring in 1921. The maximum precipitation in a 24-hour period was 9.57 inches in September 1932. Precipitation is distributed fairly uniformly throughout the year, with the exception of a slight peak in the spring and a low in mid-to-late summer. The mean relative humidity is 65 percent and the average temperature is 65.8^{o}F. Recent temperature extremes range from -1^{o}F in December 1989 to 115^{o}F in June 1980. The average freeze dates are March 23, which is the last in spring and November 13, which is the first to occur in the fall. The temperature falls below freezing an average of 41 days a year, but this drop is usually followed by daily thaws. The length of the growing season is approximately 235 days.

- The major storms experienced in the study area are produced by heavy rainfall from frontal-type storms that generally occur in the spring and summer months, but major flooding can also be produced by intense rainfall associated with localized thunderstorms. These thunderstorms may occur at any time during the year, but they are more prevalent in spring and summer months.

Aquatic Resources

Water Quality

General

The water project area is located within the general confluence area of the Clear Fork and West Fork of the Trinity River and extending downstream on the main stem West Fork. The water quality in the project area is primarily influenced by base flows from upstream Lake Benbrook and Lake Worth releases, urban runoff from upstream adjacent watershed areas, and the check dams at various locations along the watercourse. Below the major lakes, upstream of the immediate project area, there are only two relatively minor point source industrial discharges requiring National Pollutant Discharge Elimination System (NPDES) permits.

Designated Water Quality Uses

Texas Commission on Environmental Quality (TCEQ) charged with the responsibility of maintaining and enhancing the waters in the state, has divided surface waters in the state of Texas into numbered segments for the purpose of organizing water quality data and designating water uses and classifications. The immediate study area is located in stream segments *0806 West Fork Trinity River below Lake Worth* and *0829 Clear Fork Trinity River below Benbrook Lake*. West Fork Segment 0806 extends from the Lake Worth dam in west-central Tarrant County downstream to the confluence of Village Creek in east-central Tarrant County. Clear Fork Segment 0829 is located in Fort Worth

and extends from Benbrook Lake dam in southwest Tarrant County, downstream to the confluence with the West Fork Trinity River. Figure 2-4 of the Main Report displays the locations of these two stream segments. TCEQ has set water quality standards and designated the water use for these stream segments where the project area is located. According to TCEQ use designations, the immediate study area is designated for aquatic life use, contact recreation use, general use, fish consumption use, and public water supply use (TNRCC, 2000a).

Contributing Upstream Reservoirs

Immediately upstream from the proposed project area are major water supply reservoirs, Lake Benbrook and Lake Worth. Lake Benbrook (TCEQ *Stream Segment 0830*) is a reservoir upstream of the project area on the Clear Fork. Lake Worth (TCEQ *Stream Segment 0807*) is a reservoir upstream of the project area on the West Fork upstream of the Clear Fork confluence. Lake Benbrook and Lake Worth trap sediment and prevent the natural downstream migration of a sizable portion of suspended material.

Discharges from Lake Benbrook are released from a multi-level intake outlet structure. As a result, water can be selectively drawn from various lake depths during summertime thermal stratification to optimize lake release quality. Benbrook Lake releases are conducted such that a minimum Clear Fork flow of at least one (1) cubic feet per second (cfs) is maintained downstream at Interstate Highway 20 crossing marker, except when the lake surface elevation is 690 feet mean sea level or above during the months of April through August. When the lake elevation is above 690 feet mean sea level, releases are operated so that average flow at the marker is not less than 8 cfs during May, 5 cfs during June, and 2 cfs during the months of April, July, and August. TCEQ has designated Lake Benbrook as "fully supporting" intended uses of aquatic life, recreation, fish consumption, public water supply, general, and overall use (TCEQ, 2004).

Discharges from Lake Worth are primarily uncontrolled releases over the spillway. Lake Worth surface water level is dependent on Eagle Mountain Lake releases. Lake Worth is essentially a water supply holding reservoir for upstream releases from Eagle Mountain Lake immediately upstream. TCEQ has designated Lake Worth as fully supporting its public water supply use, but not supporting fish consumption because of the presence of polychlorinated biphenyls (PCBs) in fish tissue (TCEQ, 2004).

Upstream Land Use and Non-point Sources of Pollution

Segments 0829 and 0806 drain a 188,666 acre watershed below Benbrook Lake and Lake Worth dams. Based on a 1999 Texas Natural Resources Conservation Commission (TNRCC) report, the watershed was then 62 percent urban and 34 percent agricultural/undeveloped. The city of Fort Worth accounts for most of the watershed area and 74 percent of the population (TNRCC, 2000b).

The land uses in the contributing watershed areas upstream and in the immediate vicinity of the project area influence the existing stream water quality. Over-application of fertilizers, herbicides, and pesticides on residential and commercial lawns prior to significant rainfall events would result in increased runoff pollutant loads. Road debris and street litter are subject to be picked up with storm water run-off. The use of road de-icing agents (sand and salt) during infrequent sleet events also is a possible contributing source of stream contamination though not to be considered significant. Various commercial/industrial activities may have raw material in open storage yards exposed to rainfall and

subsequent storm water pick-up. Sheet flow over parking lots and roadways are anticipated to contribute runoff containing vehicle or factory exhaust particulates, oils and greases, and other materials. In addition, impervious surfaces create higher storm water velocities that tend to increase erosion in downstream earthen channels.

Water Quality and Check Dam System

Existing check dams along the watercourse slow stream velocities and create watercourse morphology that is similar to a chain of small lakes. Suspended sediment settles much more readily in the existing watercourse environment than the previous unmodified natural state. At certain times in the summer months, portions of the stream may thermally stratify in impounded areas and dissolve oxygen concentrations will decrease with water depth. In addition, a process known as eutrophication is subject to occur with the presence of excess nutrients. Eutrophication is a condition whereby an over abundance of nitrogen and phosphorus nutrient loads over-stimulate the growth of near-surface algae which later settle, decompose, and further reduce dissolved oxygen at lower lake levels. It is also important to note that dissolved oxygen tends to decrease at night as aquatic plant life ceases to produce dissolved oxygen. Most lakes within Texas are eutrophic.

Thermal stratification is more pronounced in larger lakes than what would be expected in the smaller water bodies impounded by the check dams along the Clear Fork and West Fork. These smaller impoundments are subject to rapid water quality changes with varying stream flow due to shallower depths and lower retention times.

Point Source Discharge

Active NPDES discharge permits in the region of the project area include those outfalls for TXU Generation Company (Permit TX0001155), Chevron USA, Inc. (Permit TX0120120), and Reagent Chemical and Research (Permit TX0100315). All of these outfalls discharge into Segment 0806 of the West Fork, and there are no active permit discharges reaching the contributing watershed of Segment 0829 (Clear Fork). TXU Generation and Chevron USA, Inc. are located in the immediate project vicinity, while Reagent Chemical and Research discharge into Little Fossil Creek, a downstream tributary of the West Fork River (TCEQ, 2005a). Discharge parameters from TXU Generation include temperature, pH, copper, iron, flow, chlorine, oil and grease, total suspended solids, and total dissolved solids. It is important to note that though this facility is permitted, it has not produced an external discharge since September 30, 2002 (based on records through September 30, 2004). Discharge parameters from Chevron USA, Inc. include pH, total organic carbon, benzene, petroleum hydrocarbons (total recoverable), and flow. Chevron has been compliant and with no enforcement actions taken based on data from July 31, 2001 through November 30, 2004 (USEPA, 2005). Since discharges from Reagent Chemical and Research outfall (reporting parameters are flow and oil and grease) are downstream and do not reach the project location, this effluent does not affect the existing waters in the project area. The flows from Reagent Chemical and Research are relatively infrequent and of small quantity compared to West Fork mainstream flow where they are received far downstream.

Designated Uses and Existing Water Quality

Public Water Supply and General Use.

In the Draft 2004 Texas Water Quality Inventory Status of All Waters, TCEQ has designated segments 0806 (based on data from 03/01/1998 to 02/28/2003) and 0829 (currently based on 03/01/1996 to 02/28/2001) as fully supporting their designated use for public water supply and general use (which includes parameters of pH, chlorides, sulfates, and total dissolved solids). Table G-1 below displays a relative comparison between Texas Surface Water Standards for public water supply and general use and available test data of samples taken in year 2002, year 2003 and portion of 2004 at a representative monitoring station in West Fork Segment 0806, but below Clear Fork confluence and in the downstream portion of the project area.

Table G-1.

Comparison of Selected Surface Water Criteria for General Use and Public Water Supply and Sample Test Results from the TCEQ 4th Street Station

Parameter	Criterion *	2002 Samples **	2003 Samples **	2004 Samples (Jan-May only)**
pH, Absolute Maximum Limit	9.0	8.5	8.7	8.7
pH, Absolute Minimum Limit	6.5	7.3	7.3	8.0
Chlorides, Annual Average, mg/L	100	28.4	14.0	12.3
Sulfates, Annual Average, mg/L	100	58.6	30.1	50.1
Total Dissolved Solids (TDS), mg/L	500	***	***	***

* Criteria taken from the Texas Surface Water Quality Standards (TNRCC, 2000a)

** Samples taken at TCEQ Station 17368 at 4th Street (TCEQ, 2005c)

*** No samples tested for TDS during this period.

Based on the data comparison shown in Table G-1 above, surface water quality has been generally good for water supply and general use in the proposed project area.

Fish Consumption.

TCEQ has designated the lower mile of Segment 0829 and the lower 22 miles of Segment 0806 as not supporting their recommended use for fish consumption primarily because of the presence of chlordane and PCBs in fish tissue which does not support the fish consumption use (TCEQ 2004). As a result of the past presence of chlordane, the Department of State Health Services (DSHS) has issued advisories against the consumption of fish from portions of Segments 0829 and 0806 (advisory issued in January 1990) (TNRCC, 2000b). Fishing is not prohibited, but State law prohibits the possession of fish from water bodies with consumption advisories (TAC § 436.011), so any fish caught must be released.

Contact Recreation.

Contact recreation designated use refers to aquatic recreational activities such as swimming where there is direct water contact with a significant risk for water ingestion. The basic concern in the assessment of surface water is the ingestion of pathogenic microorganisms. Though these project waters are designated for contact recreation use, the presence of high bacteria concentrations in the lower 22 miles of Segment 0806 has not supported contact recreation (TCEQ, 2004). *Escherichia coli* (or *E. coli*) bacterium is a representative microorganism used as an indicator of pathogenic conditions and is used as the primary basis by TCEQ to determine suitability for contact recreation. Table G-2 below displays a relative comparison between Texas Surface Water Standards for contact recreation and available test data of samples taken in year 2002, year 2003 and portion of 2004 at a representative monitoring station in West Fork Segment 0806, but below Clear Fork confluence and in the downstream portion of the project area.

Table G-2.

Comparison of Selected Surface Water Criteria for Contact Recreation and Bacterial Test Results from the TCEQ 4th Street Station

Parameter	Criterion *	2002 Samples **	2003 Samples **	2004 Samples (Jan-May only)**
E. coli, Geometric Mean, colonies per 100 ml	126***	66†	39†	18††
E. coli, Absolute maximum, colonies per 100 ml	394	>2419	201	128

* Criteria taken from the Texas Surface Water Quality Standards (TNRCC, 2000a).

** Samples taken at TCEQ Station 17368 at 4th Street (TCEQ, 2005c)

*** According to TCEQ (2005b), the criterion is meant to be applied on at least 10 samples over a 2-year period for a geometric mean calculation with at least one month taken between samples

† Represents that geometric mean was calculated based on 15+ bacterial samples taken within the year.

†† Represents that geometric mean was calculated based on only 6 bacterial samples

> Represents "greater than".

As shown above, there have been episodic occurrences of high bacteria concentrations in 2002. Although there has been no preliminary indication of bacterial concerns in 2003 and 2004, further investigation should be conducted before contact recreation is allowed. Currently, portions of the watercourse have been open to other non-contact recreation activities such as recreational boating where there is limited body contact incidental to shoreline activity.

Another concern for primary contact recreation is water clarity for potential swimmers, waders, and/or bathers. Based on Secchi disk readings from March 12, 2002 through March 24, 2004, depth of view from the water surface ranges from 0.3 to 0.8 meters, which is relatively shallow and would be a concern for small children under water. Though there is some concern with organochlorines in fish tissue, these toxic substances are most likely associated with sediment and fish, and not anticipated to be in significant concentrations in the water column to be of concern for accidental human ingestion of stream water.

Aquatic Life Use and Water Quality.

TCEQ has designated stream segments 0829 (Clear Fork) and 0806 (West Fork, 33 miles below Lake Worth) for high aquatic life use (TNRCC, 2000a). Based on information taken from the Draft 2004 Water Quality Inventory prepared by TCEQ, portions of these segments were deemed fully supporting of a high aquatic life use, but other portions were not assessed in this last inventory.

Table G-3 below displays a relative comparison between Texas Surface Water Standards (2000a) and test data of samples taken in year 2002, year 2003 and portion of 2004 at a representative monitoring station (TCEQ Station 17368 at 4th Street in Segment 0806) in the downstream portion of the project area.

Table G-3 Comparison of Texas Surface Water Standards at TCEQ Station 17368

Parameter	Criterion	2002 Samples	2003 Samples	2004 Samples (Jan-May only)
DO, Minimum Average over 24-hr period, mg/L	5.0	7.0*	5.9*	No Value**
DO, Allowable Daily Minima for not extending beyond an 8-hr period, mg/L	3.0	2.3*** (at 0.3 Meter depth)	0.1*** (low value at 4 Meter depth)	No Value**
Temperature, Maximum, degrees Celsius	33.9	30.9	30.0	23.4

Note: Criteria taken from Texas Surface Water Quality Standards (TNRCC, 2000a). Due to the lack of corresponding flow data and samples for DO within given sampling timeframes for direct criterion comparison, values for this analysis are shown to depict relative water quality conditions and not compliance.

* Only one grab sample was taken at the same depth within any given 8-hr or 24-hour period. Values are average of all sample events taken in the warmer months of June through September, when DO is typically lower. When multiple samples are taken at different depths during one event, an average value is determined for that event then averaged with the other events for this review.

** No DO values computed since no samples were reported between June through September 2004 at the time the data was acquired.

*** Lowest DO value shown for a single grab sample regardless of depth taken from surface.

Based on the above comparison of maximum water temperature readings with the Texas Surface Water Standard of 33.9° C (or 93° F), water temperatures appeared to be of no concern in the downstream portion of the project area.

Although there are insufficient samples shown in Table G-3 above to determine actual compliance with the state DO standards, fish diversity in the Clear and West Forks is generally good and this tends to indicate that DO conditions are not a significant concern. A stable fish population depends on the maintenance of healthy instream dissolved oxygen levels. The Texas surface water standards to support a high aquatic life designation are a 24-hour mean concentration of at least 5.0 mg/L of dissolved oxygen (DO) and a daily minimum of 3.0 mg/l DO, not to extend beyond 8 hours per 24-hour day. Figure 1 in Tab G.3 *(TM-ECO-4)* depicts a profile of recorded DO concentrations along various locations within the Clear and West Forks.

Nutrient and algae production are important factors in DO levels. Based on 2002 assessment report data in the Draft 2004 Water Quality Inventory, TCEQ identified that there would be no nutrient enrichment concern for the lower 22 miles of West Fork Segment 0806 based on past water tests for ammonia nitrogen, nitrite + nitrate nitrogen, orthophosphorus, and total phosphorus. However, chlorophyll a for the same stream reach was considered a concern. Based on historical data (see sampling dates in Table 1 of Tab G.3 *(TM ECO-4*), Figures 2, 3, and 5 in Tab G.3 *(TM ECO-4)* display graphically changes in nutrients (total phosphorus and nutrient contributing total Kjeldahl nitrogen or TKN) and chlorophyll concentrations along the watercourse in the general study area. Figure 4 in Tab G.3 *(TM ECO-4)* displays a graph of past range and median concentrations of ultimate carbonaceous biological oxygen demand (CBOD) of the upstream reservoirs, Lake Benbrook and Lake Worth.

Organochlorine Concerns.

In April 2004, U.S. Fish and Wildlife Service completed a supplemental report on pesticide contaminated fish tissue taken from the project area. Specimens collected for this study were taken in July 2003 (USFWS, 2004). Analysis was conducted on 13 fish specimens and one mussel taken form 5 locations within the immediate study area. All fish tissue samples indicated the presence of pesticide residual. Contaminant concentrations were compared to fish tissue criteria established by U.S. Environmental Protection Agency (USEPA), U.S. Food and Drug Administration (USFDA), and TCEQ. The study data indicated that 12 of the 13 fish had contaminants in excess of one or more criteria set by these agencies. Contaminants of primary concern in fish tissue included chlordane, DDE, dieldrin, and toxaphene. The study further stated that the fish in this area appear to be accumulating these contaminants from sediments and sequestering them into their body tissues. It was further stated that this might be due to the consumption of contaminated sediments and/or the consumption of contaminated prey items. It was also noted that no detectable levels of organochlorine pesticide contaminants were measured in the freshwater mussel collected and that this might be attributed to the fact that mussels are filter feeders that absorb nutrients directly from the water column; whereas, the organochlorines detected in fish typically adsorb to the sediments and do not readily remain suspended in the water column (USFWS, 2004).

It is important to note that chlordane, DDT, DDE, Dieldrin, and PCBs are part of a group known as legacy pollutants. Legacy pollutants are chemicals that have been banned or severely restricted, but which persist in the environment. TCEQ has established the total maximum daily load (TMDL) allowable for these contaminants as "zero" (TCEQ, 2001). With regulation and enforcement, it is

anticipated that the presence of these chemicals will reduce in fish tissue to a degree that TDH fish consumption bans will be lifted in the distant future.

Historical Fish Kills.

Three notable recent fish kills occurred in Segment 0806 of the West Fork of the Trinity River. One occurrence in August 1996 at Beach Street and downstream included the lost of 18 fish and was believed to be the result of low dissolved oxygen. In July 1998, 237 fish were killed in downstream tributary at Colleyville, Texas. Another smaller fish kill of 13 occurred in April 2000 in another downstream tributary in Euless, Texas. Each of these occurrences were located downstream of the proposed project area.

Future Urban Development and Watershed Water Quality Planning.

There is a normal tendency for water quality to deteriorate with uncontrolled urban development. Removal of vegetation and replacement with paved impervious parking lots tend to degrade runoff water quality. The local governments in North Texas recognize this trend and are promoting a careful systematic planning approach through the *integrated* Storm Water Management (iSWM) program to improve water quality and reduce flood control risks. The implementation of iSWM practices with careful subdivision planning and watercourse modification along with best management practices would tend to improve water quality as development occurs.

Aquatic Habitat

The types of aquatic systems that are in the overall Upper Trinity River drainage area include wetlands, shallow ponds, oxbow lakes or their remnants, flooded sand and gravel quarry operations, and larger river systems such as the Trinity River. The aquatic habitat within the heart of the study area is best described as a channelized river with almost vertical channel banks. Several low water dams have been installed that provide a slack water environment except during flood flow events. Siltation and accumulation of organic material along the channel edges is common on the West Fork.

Most flows up to the 100-year events are contained within the channel banks, thereby decreasing interaction between the stream and overbank areas. Recruitment is minimal except for some minor streams that feed the area. Marine Creek, which enters the study area from Northwest Fort Worth, has pools and riffles that provide recruitment into the study area.

Sumps or interior drainage areas drain rapidly thereby minimizing the quantity and quality of these ephemeral aquatic areas.

- Physical features in an aquatic system that yield high aquatic habitat values are those which either directly or indirectly support some aspect of an aquatic organism's life history. Examples of these are features or objects that provide spawning substrate, shelter, food, or improve the water quality. Specific aquatic features include overhanging vegetation, stable stream banks with irregular features, silt-free, gravel or sandy bottoms and in-stream structures.

- Common in-stream structural habitat features of aquatic systems in the study area include: overhanging grassy vegetation; low water dams; bridge pilings; concrete slabs; and areas where floating debris, mainly litter transported by urban runoff, accumulate.

- The U. S Fish and Wildlife Service conducted fisheries studies with assistance from Texas Parks and Wildlife Department and the Corps of Engineers at 5 sample sites within the study area during the summer of 2003. The purpose of the studies was to gather baseline information on the general quality of aquatic habitat in the study area as demonstrated by the fish assemblage present in the system. Notes on depth, substrate and general water quality were also taken. The Service provided planning aid letters detailing the results of that study in October 2003 and incorporated those results into a revised planning aid letter addressing both terrestrial and aquatic resources in June 2004. The report shows a relatively high quality fisheries community considering the level of past alterations to the study area and when considering that the area is closed to fish possession due to elevated chlordane in fish tissues.

- Electroshocking and seining during the study resulted in the collection of over 4600 fish comprising 11 families and 30 species. The fish were identified to species and numbers of each were determined. Using these data, the fish communities were identified based upon such parameters as percent tolerant individuals, percent omnivores, percent non-native individuals and percent anomalies of individuals. These metrics were used to determine a fish-community degradation index. Additional metrics were used to determine regional and statewide indices of biotic integrity.

- The fish assemblages within the study area were characterized as moderate to high. The West Fork above the confluence with Clear Fork demonstrated moderate community degradation and a statewide intermediate aquatic life use value. On a regional basis, this site was classified as high use value. Other sites exhibited low degradation and high aquatic life use values in statewide and regional indices, with the exception of site 1 which was located within the West Fork upstream of the new fourth street dam. This site was characterized as having high aquatic life values using both the statewide and regional indices.

- Additional surveys were conducted in January and April 2005 to determine the baseline fish community structure of Marine and Lebow Creeks, tributaries to the West Fork. Further evaluation will be conducted to validate the analysis conducted on these streams as the analysis methodology is normally conducted during summer months.

- The drainage area of Marine Creek encompasses approximately 25 square miles resulting in perennial flow within the study reach. The confluence of Marine Creek with the West Fork is located near Samuels Avenue. The reach extends from the confluence to just below Exchange Avenue, a distance of 4329 feet. Within this reach, pool habitat was identified to cover a total of 2985 linear feet, riffle habitat covered 2280 linear feet and run habitat was identified on about 164 linear feet. Two sites were intensively sampled by electrofishing to represent the habitats within the

study reach evaluated. Site 1 was located in a shallow riffle-pool complex within the vicinity of the Southern Pacific Rail Road Bridge about 1250 feet upstream of the confluence. Within this site the stream averaged 0.8 feet in depth and 50 feet in width. Its upstream boundary was strongly demarked by a waterfall at the downstream edge of a long section of relatively flat bedrock. Water cascades from the bedrock into a deep pool. Substrate within the site varied from gravel to cobble. The stream bank was lined with large rock and scrap concrete to reduce erosion.

- Site 2 was located approximately 3000 feet upstream of the confluence with the center of the site located near 23rd Street Bridge. The site was also characterized as a riffle-pool complex, however the average water was deeper (1.5 feet) and narrower (23 feet) than at Site 1. Substrate varied from large cobble to bedrock.

- The drainage area of Lebow Creek is estimated to be about 3 square miles. Flow appears to be intermittent, however, during wetter years, a small quantity of water may flow for longer periods of time. The study reach for Lebow Creek extended from the confluence with West Fork to Brennan Avenue. Site 1 extended approximately 300 feet from the confluence to an outcrop of limestone that produced a small waterfall. Within this reach habitat consisted of a deep pool just below the waterfall and a shallow riffle-pool complex. Stream width varied from approximately 38 feet at the confluence to 25 feet at the upstream limit of the reach. Water depth averaged about 0.7 feet. Site 2 was located about 1000 feet upstream of the confluence and incorporated shallow riffle-pool sequences. Stream width varied from three feet to 10 feet. The water averaged 0.4 feet in depth at this reach. Stream flow on the date of sampling was approximately 1.4 cubic feet per second. Substrate varied but generally consisted of large cobble and bedrock in the upper reaches (Site 2) and, cobble and bedrock silt, sand and gravel within Site 1.

- Ham Branch is a tributary to the West Fork of the Trinity that originates from the bluff line on the northeast side of downtown Fort Worth. The small size of the basin below this bluff would indicate that the stream would ordinarily only have seasonal flow, but low flow of approximately 0.5 cfs has been observed flowing from outfalls draining downtown Fort Worth for several years. Testing by the City of Fort Worth indicates that this base flow does not originate from leakage of either potable or wastewater lines and therefore it appears that this base flow is from isolated seeps, irrigation and return flows into the subsurface drainage system, and therefore would be expected to continue into the future. The stream width averages approximately 1.5 meters or 5 feet in width. A narrow riparian corridor exists along part of the channel, and existing activities associated with nearby informal practice fields have resulted in erosion of areas of stream bank . Fisheries studies were conducted on Ham Branch in May 2005 to determine baseline conditions in order to establish potential for improving fisheries as a means to mitigate impacts to Marine and Lebow Creeks.

The Index of Biotic Integrity (IBI) for each site on the West Fork, Clear Fork, Marine Creek, Lebow Creek and Ham Branch was utilized to determine a habitat suitability index following a mathematical process utilized in previous Corps of Engineers studies. The regional IBI was divided by the theoretical maximum regional stream related IBI (55) and used in decimal format. This approximates the traditional concept of the development of HSI values where

the theoretical maximum HSI value of 1.0 would reflect the value accredited to best habitat that could be expected within a regional area. Existing aquatic habitat quality and quantity are displayed in Table G-4. Acreages of stream aquatic habitat in each study reach were determined from information developed based upon hydraulic modeling of existing conditions, on the Clear Fork and West Fork. Data based upon measurements conducted by US Fish and Wildlife Service was used for Marine Creek, Lebow Creek and Ham Branch.

Table G-4. Aquatic (Riverine) Habitat Based FWS Fisheries Data for Study Area

Study Reach	Regional IBI	Calculated HSI	Surface Area*	Habitat Units
West Fork				
Fourth St dam to TRWD Dam	50	0.91	105.62	96.02
TRWD dam to Nutt Dam	48	0.87	23.55	20.55
Nutt Dam to Rockwood Park	45	0.82	39.7	32.48
Clear Fork				
Confluence to 1st Dam	46	.84	19.6	16.39
1st Dam to 2nd dam	46	.84	4.3	3.60
Marine Creek				
Plunge pool and riffles downstream of waterfall	51	.93	1.72	1.60
Waterfall to Exchange Ave	41	.75	1.49	1.12
Lebow Creek				
Confluence to bedrock shelf	49	0.89	0.23	0.20
Shelf to Brennan Ave.	47	0.85	0.36	0.31
Ham Branch				
Levee to Railroad	33	0.60	0.41	0.25

- * Surface area of West and Clear Fork based upon HECRAS Estimates, Surface Areas for Marine, Lebow Creek and Ham Branch based upon field measured average widths of segments.

- The IBI and HSI data do not tell the complete story for the riverine reaches studied, however, the higher values associated with the lower segment of Marine Creek and the most downstream reach of the West Fork are associated with better

overall habitat conditions. The lower Marine Creek site contained three species of darters that are associated with clean water, perennial streams characterized by riffles and pools as noted in Marine Creek. Only one species of darter was collected from Lebow Creek and significantly less species and numbers of fish were identified in the Lebow Creek, reflecting the differences in basin size, flow characteristics and channel bottom differences. However, based upon the criteria used for scoring, Lebow Creek had a Regional IBI of Exceptional for Site 1 and High for Site 2. The lower segment of the West Fork was recently modified by the addition of an in-channel dam that inundated areas of grass and herbaceous vegetation that serve as spawning and hiding areas for fisheries. In addition, the substrate contains more areas that are sandy and lacks the silt layers that have accumulated in upstream sites.

- During the sampling effort to evaluate fisheries conditions within the West Fork and Clear Fork, several fish were retained and were evaluated for organochlorine levels in tissues. This effort was done to determine if conditions were improving over time. The results of that analysis, presented in (Tab G.4) Fish and Wildlife Coordination, indicates that elevated levels of contaminants in fish tissues is still of concern.

- As evidenced within Table G-4, Fish and Wildlife sampling did not cover the entire study area as emphasis changed during the course of the study to include areas much further upstream. Corps of Engineers reassessed the existing aquatic habitat associated with the West Fork, Clear Fork and Marine Creek. The entire area is totally influenced by low water dams as shown in the following Table G-5. Utilizing the previously provided information by USFWS, the Corps conducted an analysis that showed that within this entire study area there are 292 acres of quasi-riverine habitat at normal flows with an existing habitat value of 252 HU.

Table G-5.

Influence of In-channel Dams on Riverine Habitat in Study Area

Dam	Crest Elevation	Station Location	Influences River In Study Area
WEST FORK			
Beach Street	494.5	217982	Riverside Drive (222947) to Fourth St. Dam
Fourth Street	500	229428	TRWD to Nutt Dam
TRWD	505	247157	Nutt
Nutt	520	252041	To Clear Fork 1 and Tucker Dam
Tucker	523.5	West Fork 281821	To Upstream study limit(289275)
CLEAR FORK			
Clear Fork 1	523.0	Clear Fork 6707	To Clear Fork 2

Clear Fork 2	525.8	Clear Fork 8243	To Clear Fork 3
Clear Fork 3	527.1	Clear Fork 9566	To Clear Fork 4
Clear Fork 4	529.4	Clear Fork 10956	To Upstream study limit (Station 12075)

Land Uses

A vegetation cover and land use map was developed for the study area (Figure G-1). Most of the area is undeveloped due to its tendency to flood. However, the area shows modifications resulting from the flood damage reduction channel, low water weirs, highways, and past agricultural uses. Within the environmental study area, land use based upon vegetative cover was determined on about 5300 acres.

Terrestrial Resources

The area of the West Fork from upstream of Riverside Drive in Fort Worth to the Lake Worth Dam has been channelized and leveed as a part of the Fort Worth Floodway project. The vegetation in this area is more reminiscent of manicured parkland than that of a bottomland hardwood community. More trees are found within the study area near I-30 on the Clear Fork. Very little understory or herbaceous vegetation is present over most of this forested area because of its use as parkland. Tree species within this area are generally burr oaks, pecan and cedar elm. Since the trees generally don't have to compete for resources with other species and the seedlings and saplings that would be found in more natural riparian corridors, they tend to be larger in size.

The West Fork within the study area has a few tributaries that are typically bordered by a narrow fringe usually less than 100 feet wide of riparian woodlands composed of oaks, green ash, cottonwood, black willow, and a dense understory of greenbriar, immature hardwoods, and invader shrubs. Forblands are scattered throughout the floodplain on drier sites that have developed in old fields.

Wildlife.
The river channel, wetlands, open water areas, and bottomland hardwood forests support a variety of wildlife species for cover, food, and den or nesting sites. Bird species which were observed or have been reported in the area include migratory warblers, sparrows, meadowlark, mourning dove, crow, red-tailed hawk, red-shouldered hawk, American kestrel, herons, egrets, mallard, wood duck, blue-winged teal, green-winged teal, lesser scaup, grackle, scissor-tailed flycatcher, kingbird, logger-head shrike, black bird, swallows, blue jay, chickadees, downy woodpecker, red-belly woodpecker, and barred owl. Amphibians, reptiles, and mammals common to the area include frogs, toads, snakes, turtles, cottontail rabbit, cotton rat, field mice, opossum, raccoon, bobcat, beaver, nutria, and coyotes.

Quality of existing terrestrial habitat was conducted by utilizing the Habitat Evaluation procedures developed by the U.S. Fish and Wildlife Service. Representatives of the Service, Texas Parks and Wildlife Department and the U. S. Army Corps of Engineers participated in selection of wildlife models to use for the evaluation and participated in the collection of field data beginning during late spring 2003. Additional work was done during late summer 2004 to determine existing conditions on the expanded study area that extended upstream of University Drive on West Fork to include the area adjacent to sumps 7, 8 and 9.

Based upon the field data collected, the Service provided habitat suitability indices for each wildlife habitat evaluated in the study area. These quality indicators were based upon numerous sites within each vegetative cover type in the study area Acreages of each habitat type displayed in Table G-6 were determined by the Corps of Engineers and reviewed by the Service. Figure G-1 is a map that displays the existing vegetative cover of the entire Central City study area, including the expanded study area upstream of University Drive.

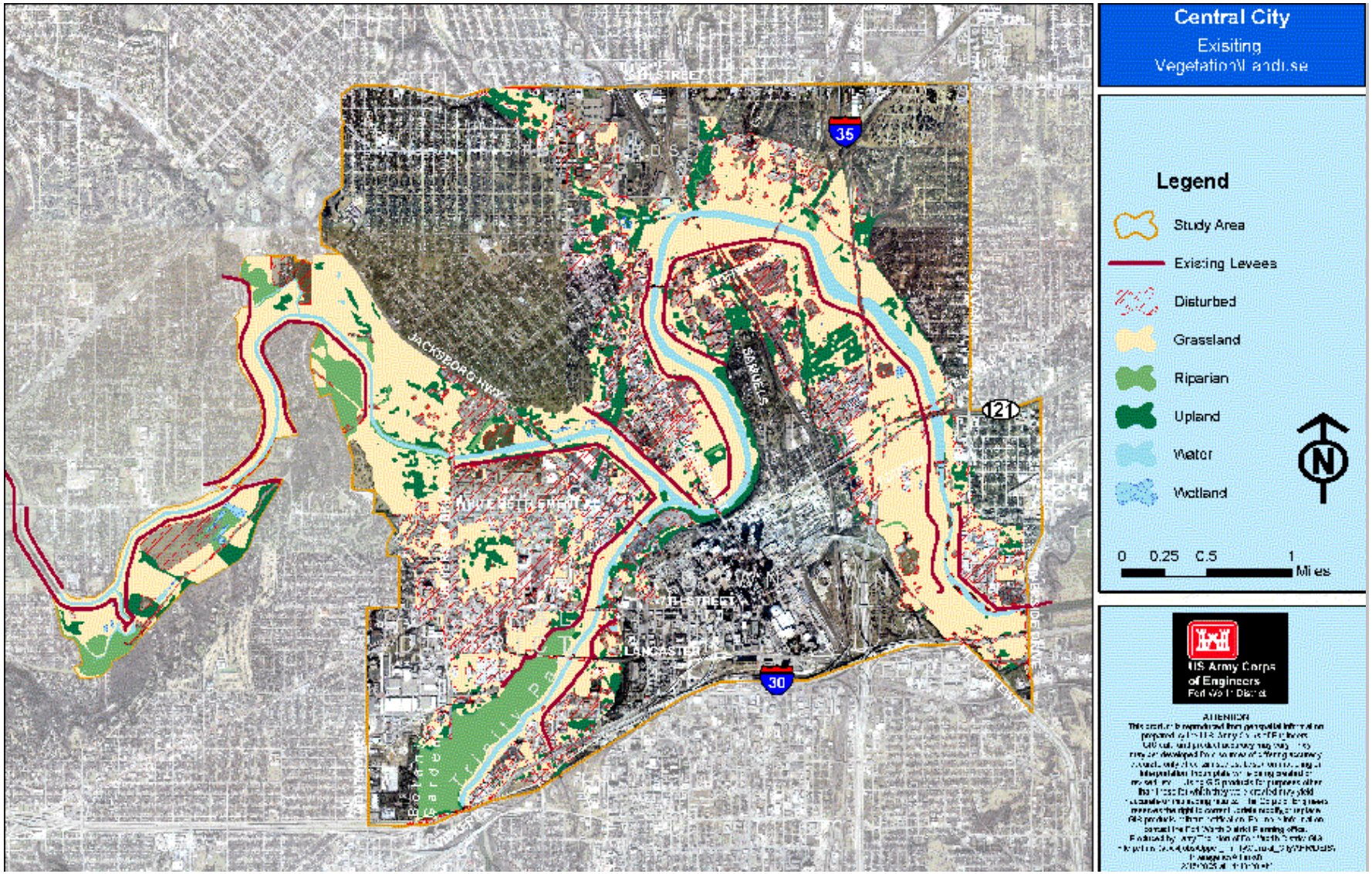

Figure G-1. Existing Vegetation and Land Use for the Central City Study Area

Table G-6.
Summary of Existing Wildlife Habitat and Habitat Units

Study Zone	Riparian Forested			Upland Forest			Emergent Wetland			Grassland			Water*	Disturbed/Urban	
	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU	Acres	HSI	HU	Acres	Acres	
Clear Fork West	187.5	0.62	116.25	80.70	0.56	45.19	0.0	0.0	0.0	402.5	0.48	193.20	39.4	589.8	NA
Clear Fork East	0.0	0.0	0.0	41.9	0.50	20.95	0.0	0	0.0	102.2	0.35	35.77	21.9	162.3	NA
North Main	11.6	0.62	7.19	145.6	0.56	81.54	2.9	0.30	0.87	404.1	0.48	193.96	52.5	407.7	NA
WestFork North	3.2	0.60	1.92	77.1	0.41	31.61	0.0	0	0.0	308.1	0.35	107.83	59.0	188.9	NA
West Fork South	2.6	0.30	0.78	126.0	0.50	63.00	2.6	0.19	0.49	665.7	0.35	233.0	75.8	345.1	NA
WestFork Riverbend/Rockwood	118.1	0.53	62.59	51.6	0.80	41.28	8.8	.44	3.87	480.4	0.40	192.16	51.0	104.6	NA
TOTALS	**323.0**		**188.74**	**522.9**		**283.57**	**14.3**		**5.23**	**2363.0**		**955.92**	**299.6**	**1798.4**	**NA**

*See Aquatic Section for discussion of quality. Also note that there is additional water identified with this analysis as compared to the aquatic analysis, which only considered the river and adjacent tributaries affected by the rivers.

All HSI data updated as provided by FWS via electronic mail on March 17, 2005

NA Habitat Quality for Urban and Disturbed habitat not quantified.

Threatened and Endangered Species.
U. S. Fish and Wildlife Service (USFWS) records indicate that the following threatened (T), endangered (E), proposed threatened (PT), and candidate (C) species have been documented, or are known to occur in Tarrant County: There is no designated critical habitat for listed species in Tarrant County.

interior least tern (*Sterna antillarum*) - E
whooping crane (*Grus americana*) - E
bald eagle (*Haliaeetus leucocephalus*) - T
mountain plover (*Charadrius montanus*) - PT

The endangered interior least tern (*Sterna antillarum*) nests in colonies on bare to sparsely vegetated sandbars along rivers and streams in Texas, from May through August. Nesting areas are ephemeral, changing as sandbars form, move and become vegetated. Because natural nesting sites have become sparse, interior least terns have nested in atypical/non-natural areas, which provide similar habitat requirements (e.g., the colony which has been nesting for several years at the Southside Wastewater Treatment Plant in Dallas). Non-natural nesting sites include sandpits, exposed areas near reservoirs, gravel levee roads, dredged islands, gravel rooftops, and dike-fields. In recent years, terns have been utilizing artificial habitat more frequently within the Dallas-Fort Worth Metroplex area with small colonies being established in highly developed areas. Ground disturbance related to construction activities near the Trinity River may incidentally create areas that are attractive to least terns for use as potential nesting sites.

Endangered whooping cranes (*Grus americana*) may be encountered in any county in north central Texas, including Tarrant, during migration. Autumn migration normally begins in mid-September with most birds arriving on the wintering grounds at Aransas National Wildlife Refuge between late October and mid-November. Spring migration occurs during March and April. Whooping cranes prefer isolated areas away from human activity for feeding and roosting, with vegetated wetlands and wetlands adjacent to cropland being utilized along the migration route. Food usually includes frogs, fish, plant tubers, crayfish, insects, and waste grains in harvested fields.

Bald eagles (*Haliaeetus leucocephalus*) are considered winter and possible spring residents of Tarrant County. Bald eagles nest, roost, and perch in tall trees near water and feed primarily on fish and waterfowl. Winter habitat includes reservoirs, lakes, playas, rivers, and marshes. The project areas and/or adjacent lands contain large trees suitable for perching and nesting by bald eagles. Nesting bald eagles have been documented at Lake Worth. Most wintering bald eagles migrate north from February through March; however, nesting eagles either stay throughout the entire year or migrate late in the summer.

The mountain plover (*Charadrius montans*) was proposed for listing as threatened in February 1999. Mountain plovers migrate in small numbers throughout northwestern and north-central Texas from early March to mid-May and from early August to late October. Preferred habitat consists of expansive flats of shortgrass prairie where grasshoppers, beetles, crickets and flies are available for the birds to feed upon. In areas of tall grasses, the plover is closely associated with prairie dog towns. Nesting plovers appear to prefer areas that have been intensively grazed by livestock.

Air Quality

This proposed project is located within the Environmental Protection Agency (EPA) Air Quality Control Region (AQCR) 215 for the state of Texas. Air Quality Control Region 215 consists of 19 counties including Dallas, Denton, Collin, and Tarrant counties, Texas. The EPA uses six "criteria pollutants" as indicators of air quality and has established a maximum concentration for each of them above which adverse effects on human health may occur. These threshold concentrations are referred to as the National Ambient Air Quality Standards (NAAQS). The areas of the country where air pollution levels persistently exceed the standards may be designated 'nonattainment'. Areas of the country where the air pollutant concentration meets the national primary air quality standard are designated as in "attainment". An "unclassifiable" designation is ascribed to areas of the country that cannot be classified based on available information. A subclassification may be ascribed by the EPA to areas that are currently in nonattainment. This classification describes the level of a particular air pollutant as being Severe 17, Severe 15, Serious, Moderate, Marginal, Submarginal, Section 185A, or Incomplete (no data). Criteria air pollutants, the existing air quality conditions, historical trends, and the relationship of these parameters to NAAQS and state standards are discussed in the following paragraphs.

Ozone.
Ozone (O_3) is a photochemical oxidant and the major component of smog. Ozone is not emitted directly into the air but is formed through chemical reactions between precursor emissions of volatile organic compounds (VOC) and oxides of nitrogen in the presence of sunlight. These reactions are stimulated by high temperatures so that elevated concentrations of O_3 are typically detected during the warmer months. Precursors for O_3 are emitted by transportation, industrial, and biogenic sources.

The NAAQS threshold value for ozone is 0.12 parts per million (ppm) or 125 parts per billion (ppb), measured as one-hour average concentration. A new eight-hour average concentration standard of 0.08 ppm or .85 ppb was established in 1997. The EPA is phasing out and replacing the previous one-hour standard with the new eight-hour standard to protect public health against longer exposures to the air pollutant. The previous one-hour standard still applies to communities that were not in attainment of that standard in July 1997. Once these communities meet the one-hour standard, the EPA will evaluate them by the new eight-hour standard. This will allow the EPA to use the 3 years of the most available data to make their determination. Air Quality Control Region 215 is classified as a non-attainment area for ozone, and as of February 1998 the status of ozone in this region was reclassified from moderate to serious status.

Tarrant County is classified as an attainment area or unclassified for all other criteria pollutants (Air Quality Assessment Report Fort Worth Central City Project, Fort Worth Texas, February 2005).

Noise

The study area is generally located adjacent to the downtown area but is generally buffered from the main urban traffic noises Portions of the study area near the Riverbend and Rockwood study zones, farther from the downtown area are more shielded from urban and industrial noises.. Localized low speed traffic crosses the study area on, 7th street, Henderson and Main streets. Ongoing construction near the Central City area has temporarily increased the background sound level. Traffic conditions vary but generally are more intense during morning and evening rush hour periods. Traffic on IH-30 and IH-35 generally travels at higher speeds and often consists of trucks in addition to automobiles. The Central City study area lies within the southern flight path of Fort Worth Meacham International Airport and is east of the Naval Air Station Joint Reserve Base Fort Worth.

Light

The study area has areas of direct lighting from business activities and from street lighting. Evening baseball games at the renovated Graves stadium generate additional lighting of the area. There are several special events held outdoors each year within the study area. Many of these events include evening activities. Residential lighting is the primary source of existing night light sources farther away from the downtown area.

Aesthetics

The study area has mixed aesthetics resulting from the man made features including the channels, levees, low water dams, manicured grasses of the floodway and the high-rise downtown buildings visible from multiple view points along the study area contrasting with the more natural features associated with the Trinity Park area and riparian woodland stringers associated with Marine Creek and other tributaries to the study area. Water surface, elevated by the newly constructed Beach Street dam, the riffle area immediately downstream of the dam, and the natural West Fork channel flowing through Gateway Park add to the aesthetic values. Views from the site include roads and some of the urban features associated with downtown Fort Worth.

Aesthetics of the water course depend on water appearance, odor, and taste (if a drinking source). The water color and clarity in the general vicinity of the project area is similar to other portions of the Trinity River. Stream water at times will exhibit turbid light brown following heavy rainfall events. During extended dry winter periods with low rainfall and low or no wind conditions, the water course may appear to be relatively clear as suspended material settles. Algae at certain times of the summer months may be visible. In deeper impoundment areas of the stream, the water may stratify in late summer and subsequently lead to notable odor changes in late fall as water in stream impoundments cool and overturn. It should be noted that the TCEQ report "Draft 2004 Texas Water Quality Inventory" (TCEQ, 2004) documented that algal growth was of "no concern" in a relatively large portion (about 9 of 14 miles) of the Clear Fork below Benbrook Lake (TCEQ Stream Segment 0829) based on 1996-2001 chlorophyll *a* water sample test data and that remaining portion of this stream segment was not assessed for algal growth. In the same report, water in the West Fork in an 11-mile reach below Lake Worth was not assessed for algal, but water below this reach (lower 22 miles of TCEQ Stream Segment 0806) was identified as an algal growth "concern" based on a 2002 algal assessment. Based on this information, the existing water in the vicinity of the project area will have probable episodes of algal growth in late spring-summer months. On such occasions, water color may take on a green cast, but significant floating algal mats are not known to occur. Water upstream of the immediate project areas is currently used as a public water supply source. The City of Fort Worth draws water from the Clear Fork above the project area for treatment to drinking water standards at the City's Holly facility. No taste or odor problems have been identified from this water source. On the whole, the aesthetic appeal is expected to be similar to the shallow lake fringes of Benbrook Lake and Lake Worth.

ECOSYSTEM PROBLEMS AND OPPORTUNITIES

U.S Fish and Wildlife Service, Texas Parks and Wildlife Department, and U.S. Army Corps of Engineers performed Field evaluations. A review of existing and anticipated future conditions in the study area coupled with coordination with representatives of the project sponsor and City of Fort Worth led to the identification of several problems in the overall condition of existing ecosystem quality.

Problems

Terrestrial.
The existing flood damage reduction project features including the channelized Clear Fork and West Forks of the Trinity River largely influence the study area. In addition, required maintenance of most of the flood plain and levees keeps existing vegetation restricted to mowed grasses. Recreational trail and maintenance roads extend along all segments of the channels in the study area.

Within the riparian woodlands and emergent wetlands, effects of urbanization have disturbed the overall quality for natural resource uses. Problems identified during the study for terrestrial resources include:

- Riparian and bottomland hardwood forest now total only about 6.1 percent of the Central City study area that was formerly predominately floodplain.

- Most stands are dominated by non-mature trees resulting in poor conditions for cavity production for bird nesting, mast production, hiding cover and general forest stability.

- Non-native invaders including Chinaberry, Ligustrum (privet and gloss leaf), and honeysuckle within the riparian woodlands are diminishing habitat quality by causing extensive areas of dense understory plants. The Ligustrum species and honeysuckle are extremely hardy and resistant to cold weather, thereby gaining a competitive advantage to native wildlife beneficial forbs and shrubs.

- Remnant stands of riparian woodlands generally are located in areas with little interspersion with wetlands or standing waters, greatly reducing brood rearing capabilities for wood duck.

- Erosion and slumpage of soils along the intensively managed floodway reduce grass coverage and introduce sediment to the aquatic environment. The entire floodway is mowed several times per year as part of the federally required maintenance regime to restrict natural succession that would result in development of shrubs and trees that could adversely impact the projects purpose of providing flood damage reduction.

Wetlands.
Wetlands within the study area are generally small and poor in quality. They generally occur adjacent to maintained drainages associated with the existing flood damage reduction project, therefore they are ephemeral in nature, assimilate limited nutrients that is converted to biomass usable by wildlife. Perch sites for birds adjacent to or overhanging the wetlands are also limited.

Aquatics.
The flood damage reduction channels of the Clear Fork and West Fork dominate the aquatic environment of the study area. Tributaries other than Marine Creek are ephemeral and are characterized by limited riparian zones.

Clear and West Forks are inundated by a series of low water dams that have changed the overall character of the system which now displays a more lacustrine or lake like appearance. The channelized and impounded reaches also function more as lakes during low flow periods. Substrate

may be gravelly or clay but generally even gravels are covered with silt over most of the area. Although no specific sampling was conducted to determine abundance, low numbers of invertebrates was noted during site investigations within the areas inundated by in-channel dams. Lack of in-channel structure diversity and the continued presence of contaminants in fish tissues at levels that caused the State of Texas to prohibit possession of fish taken from waters within the Clear Fork below 7th street and the West Fork below the confluence appear to be the most significant problems. The low water dams provide long term fisheries habitat, however there is likely some impediment of fisheries movements attributable to the West Fork dams due to their height.

Opportunities

Opportunities to improve the ecosystem within the study area vary from modification or physically altering existing landforms and structures to development of management strategies to foster resource improvement.

Terrestrial.
Riparian woodlands can be improved by selective clearing of non-native invaders and adding mast trees and shrubs that provide consistent food supplies for wildlife of the area. In addition, riparian woodlands could be expanded in the shape of stringers to provide travel routes along the major river corridors and linkage to the isolated pockets of woodlands within the study area.

Grasslands are abundant within the study area and will be present in future scenarios due to the need to maintain flood flow conveyance within the project. Maintenance as currently conducted greatly restricts wildlife usage of this vegetative cover. Site specific prescriptions for grassland management as opposed to treating the entire federal floodway with the same intensive mowing regime could provide opportunities to increase habitat diversity, provide opportunities for ground nesting birds to successfully clutch and provide year round habitat for small mammals. Reduced mowing could also reduce use of non-renewable energy and reduce erosion on steep sloped banks adjacent to the channel. Periodic removal of hard stemmed vegetation might partially offset the energy savings however, wildlife resources could benefit from a change in management.

Wetlands.
Natural and man made low lying areas could be excavated to provide a more permanent source of water to extend the period that adjacent soils are saturated. Connecting existing remnant oxbow scars to the river channel provides another opportunity to improve water circulation and improve wetland habitat diversity. Reconnection of oxbows that already have existing overhanging vegetation would provide benefits to perching and shorebirds that feed upon aquatic insects and small fish with wetlands. Planting additional shrubs and trees to improve perching quality would also benefit habitat values of wetlands.

Aquatics.
Minor improvements in aquatic habitat could be derived within the Clear Fork and West Fork channels by addition of structures that would improve hiding cover and food production. Techniques suitable for large streams such as those found in the study area would be those that could be stabilized against a variety of flow conditions. Consideration of restoring channel meandering and removal of existing in-channel dams to restore the geomorphic characteristics of the channel to the extent possible while maintaining existing flood control function was identified as an opportunity to evaluate.

CONSTRAINTS

During the course of plan formulation, differing degrees of known constraints were identified that effected selection of types, sizes, and location ecosystem measures could be considered for further cost effectiveness.

Although suggested by a team of interagency biologists during early plan formulation stages of the study, it was determined soon thereafter, that removing or breaching of existing levees to restore floodplain to include its initial with its associated ecosystem values, was not practical due to the high costs of acquisition of real estate protected by the levee against flooding. In addition, current agency policy favors restoring aquatic based ecosystems or those adjacent habitats having a strong connection to riverine, riparian or wetland communities. Therefore, plan formulation that would result in restoration of native grasslands and upland forests were not pursued beyond initial screening.

In addition, some riparian grasslands associated with the existing floodway could be restored in a manner that would benefit the aquatic habitat and would derive their own values directly from the close physical association with the aquatic habitat. However, resistance from the public and Corps of Engineers management strategies for the existing floodway project present formidable obstacles to restoring native grasslands adjacent to the riverine component of the system.

These constraints led to the conclusion during plan formulation, that measures considered during final plan formulation for the federal ecosystem restoration plan must be compatible with the federal flood control system as it would be restored to meet Standard Project Flood conditions with a 4 foot freeboard. Incremental analysis and cost effectiveness processes coupled with engineering constraints of the area greatly reduced the ability to restore riparian woodlands within much of the study area.

ECOSYSTEM RESTORATION OBJECTIVES

The planning objectives for ecosystem restoration of the Central City study area were defined early in the study and then refined based upon additional information that was derived. The objectives are listed below.

- Restore, improve and diversify aquatic habitat associated with Clear Fork and West Forks of the Trinity River for native aquatic organisms

- Improve and increase quantity of emergent wetland habitat for migratory birds of ecological importance

- Establish continuity and connectivity within and between regionally and nationally significant ecosystems

- Protect and improve existing pockets of high quality bottomland hardwoods adjacent to the river system.

Plan Formulation

NER.

Ecosystem Restoration measures were evaluated for the study area with the constraints identified. An initial plan was drawn that incorporated features that an Interagency team of ecosystem specialists believed should be considered. No constraints were used during this plan formulation phase. During the second phase of planning for the NER, concepts from the Interagency team plan were further developed and constrained based upon new information developed during the plan formulation. For example, real estate costs in areas currently protected by the existing Fort Worth floodway are sufficiently high that it was deemed unreasonable to consider measures recommended by the Interagency team that would require acquisition of these protected areas. Other concepts such as removal of existing in-channel dams, re-establishing channel configuration to simulate the riverine system conditions that existed prior to the floodway development, development of and improvement of existing riparian woodlands and development of and improvement of existing wetlands was carried further for evaluation.

Features and measures identified in this step were then evaluated by hydraulic and civil engineers to incorporate as much of the desired habitat improvement while further considering existing obstacles that would be unduly expensive to modify. For example, stream meanders were modified such that existing bridge crossings could remain to be utilized. A significant plan formulation limitation was a requirement to restrict features of the ecosystem restoration plan to those compatible with the NED plan that was developed during this study. Also, some areas of riparian restoration were removed or the density that trees could be planted were reduced in order to maintain compliance with existing floodway performance criteria based upon Pamphlet No. 1150-2-1, U.S. Army Corps of Engineers, Fort Worth District, dated October 31, 2003.

Incremental Analysis

The guidelines in the Evaluation Investments Procedures Manual (Robinson et al., 1995) and Cost Effectiveness (CE) / Incremental Cost Analysis (ICA) procedures were used to analyze restoration alternatives. Proposed restoration alternatives were evaluated in terms of average annual habitat units (AAHUs) and average annual cost. The CE / ICA procedure evaluated the multiple combinations of restoration measures to develop alternatives that are cost effective and efficient in production (i.e.-best-buy plans). Best-buy alternatives were then evaluated using tabular and graphical summaries to determine the National Ecosystem Restoration (NER) plan for the study. Tabular and graphical summaries are included in Tab G.6.

Due to the large number of restoration measures and scales considered for formulation of alternatives using ICA, the "build cost-effective and edit" approach was utilized within the program. Over 1.6 billion possible combinations were analyzed culminating with 158 "cost-effective" alternatives. Cost-effective plans are those that produce a particular level of output at the least cost. Of these, ICA identified 22 plans or alternatives that were the most cost-effective, including the "no action" alternative. These are often referred to as "best buy" plans because they provide the lowest cost per unit of additional habitat output. Costs included those related to: lands, easement, right-of-ways, relocation, and disposal areas (LERRDS); construction; contingency; and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R). Output was measured in AAHU's as assessed using the HEP analysis techniques.

These 22 plans were then evaluated further for cost-effectiveness. A summary of the restoration components in each of the 22 plans is outlined below. Each summary contains a reference to Figure G-2, which should be utilized to locate the restoration features described. Because the "no action" plan does not have an associated cost, it is identified as the first plan in the comparison sequence. Total Output, Total Cost, Incremental Cost, Incremental Output, Incremental Cost per Unit of Output,

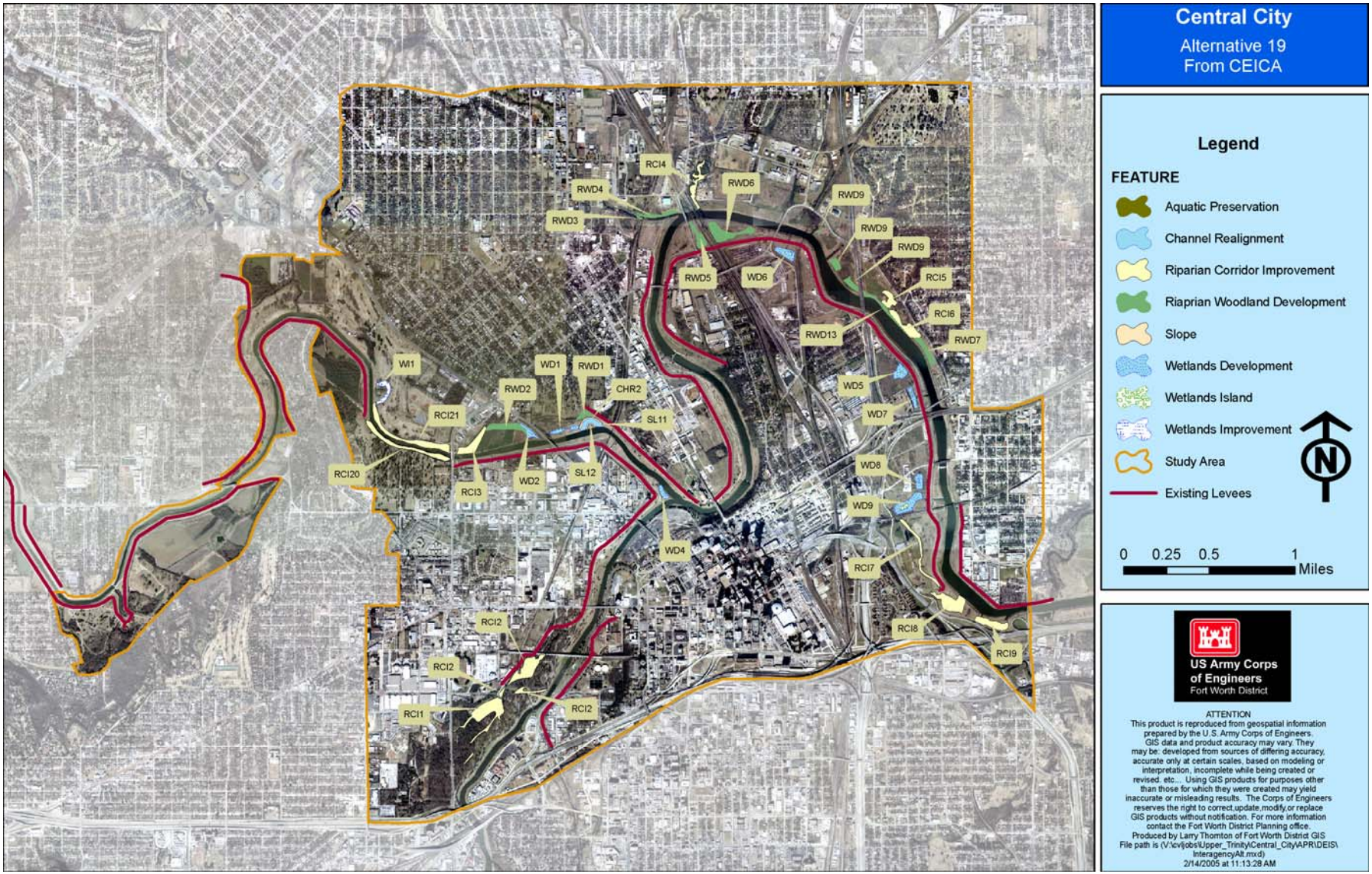

Figure G-2. Location and Description of Restoration Features Included in National Ecosystem Restoration Plan.

and Average Cost per Average Annual Habitat Unit can be found in the (see "Is it Worth It?" Tab G.6.) Figure G-3 shows a graphical representation of Total Output and Incremental Cost per Incremental Output for all of the 22 plans.

Plan 1 – The "no action" alternative or future without project alternative. Under this alternative, none of the proposed restoration alternatives would be implemented. Study area conditions would likely remain in their degraded status and existing habitats would provide approximately 247.63 AAHUs over the project life.

Plan 2 – This plan would consist of riparian corridor improvements (RCI 2) as indicated on Figure G-2. These improvements would be made excluding the channel realignment proposed in the same area. Riparian corridor improvements would consist of planting five to ten trees and shrubs per acre consisting of hard mast and fruit bearing natives. Some minor thinning of non-native invaders would also be done with the intent of trying to restore a "true" forest. Implementation of this measure would increase AAHUs from 247.63 to 269.84.

Plan 3 – Would include implementation of Plan 2 with additional riparian corridor improvements (RCI 5 and 6) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 3 would increase AAHUs from 247.63 to 272.61.

Plan 4 – Would include implementation of Plan 3 with additional riparian corridor improvements (RCI 4) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 4 would increase AAHUs from 247.63 to 275.44.

Plan 5 - Would include implementation of Plan 4 with additional riparian corridor improvements (RCI 7, 8, and 9) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 5 would increase AAHUs from 247.63 to 279.13.

Plan 6 - Would include implementation of Plan 5 with wetland improvements (WI 1) as indicated on Figure G-2. Wetland improvements would involve the planting of aquatic plants only within the existing footprint of the existing wetlands. Implementation of Plan 6 would increase AAHUs from 247.63 to 281.34.

Plan 7 - Would include implementation of Plan 6 with additional riparian corridor improvements (RCI 21) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 7 would increase AAHUs from 247.63 to 285.74.

Plan 8 - Would include implementation of Plan 7 with additional riparian corridor improvements (RCI 3) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 7 would increase AAHUs from 247.63 to 287.97.

Plan 9 - Would include implementation of Plan 8 with wetland development (WD 4) as indicated on Figure G-2. Wetland development would involve the clearing of sediment, contouring, and wetland planting in the aquatic zone only. Implementation of Plan 9 would increase AAHUs from 247.63 to 289.24.

Plan 10 - Would include implementation of Plan 9 with additional riparian corridor improvements (RCI 20) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 10 would increase AAHUs from 247.63 to 291.93.

Plan 11 - Would include implementation of Plan 10 with additional wetland development (WD 5, 6, 7, 8, and 9) as indicated on Figure G-2. Wetland development would involve the clearing of sediment, contouring, and wetland planting in the aquatic zone only. Implementation of Plan 11 would increase AAHUs from 247.63 to 306.98.

Plan 12 – Would include implementation of Plan 11 with riparian woodland development (RWD 1 and 2) as indicated on Figure G-2. Riparian woodland development (RWD 1) is very restricted due to hydrologic and hydraulic constraints. Therefore, the plantings in RWD 1 will be limited to the plantings of hard and soft mast trees (no shrubs allowed) at 50 foot on center spacing, no closer than 50 feet from top of bank, and 50 feet from toe of levee. Riparian woodland development (RWD 2) is not restricted and therefore can be planted / restored with much more dense plantings (625 seedlings, 10 containerized trees and 40 containerized shrubs per acre). Implementation of Plan 12 would increase AAHUs from 247.63 to 316.30. Additional benefits are realized with this plan due to the creation of a continuous riparian corridor through this area.

Plan 13 - Would include implementation of Plan 12 with additional riparian woodland development (RWD 5 and 6) as indicated on Figure G-2. Again, riparian woodland development is very restricted due to hydrologic and hydraulic constraints. Restoration in this area would be limited to the plantings of hard and soft mast trees (no shrubs allowed) at 50 foot on center spacing, no closer than 50 feet from top of bank, and 50 feet from toe of levee. Implementation of Plan 13 would increase AAHUs from 247.63 to 321.22.

Plan 14 - Would include implementation of Plan 13 with additional riparian corridor improvements (RCI 1) as indicated on Figure G-2. These improvements would be the same as described in Plan 2. Implementation of Plan 14 would increase AAHUs from 247.63 to 324.36.

Plan 15 - Would include implementation of Plan 14 with additional wetland development (WD 1) as indicated on Figure G-2. Wetland development would involve the clearing of sediment, contouring, and wetland planting in the aquatic zone only. Implementation of Plan 15 would increase AAHUs from 247.63 to 325.85.

Plan 16 - Would include implementation of Plan 15 with additional riparian woodland development (RWD 3 and 4) as indicated on Figure G-2. Again, riparian woodland development is very restricted due to hydrologic and hydraulic constraints. Restoration in this area would be limited to the plantings of hard and soft mast trees (no shrubs allowed) at 50 foot on center spacing, no closer than 50 feet from top of bank, and 50 feet from toe of levee. Implementation of Plan 16 would increase AAHUs from 247.63 to 326.75.

Plan 17 - Would include implementation of Plan 16 with additional wetland development (WD 2) as indicated on Figure G-2. Wetland development would involve the clearing of sediment, contouring, and wetland planting in the aquatic zone only. Implementation of Plan 17 would increase AAHUs from 247.63 to 328.51.

Plan 18 - Would include implementation of Plan 17 with a channel realignment (CHR 2) and associated slope restoration along the banks (SL 11 and 12) as indicated on Figure G-2. Channel realignment would involve the restoration of two historic meanders prior to the channelization project in this area. Slope restoration would involve dense plantings of shrubs (80 to 100 shrubs per acre) to help protect and restore the new channel slopes that would result from the restoration of the meanders. Implementation of Plan 18 would increase AAHUs from 247.63 to 334.16.

Plan 19 - Would include implementation of Plan 18 with additional riparian woodland development (RWD 7, 9, and 13) as indicated on Figure G-2. Again, riparian woodland development is very restricted

due to hydrologic and hydraulic constraints. Restoration in this area would be limited to the plantings of hard and soft mast trees (no shrubs allowed) at 50 foot on center spacing, no closer than 50 feet from top of bank, and 50 feet from toe of levee. Implementation of Plan 19 would increase AAHUs from 247.63 to 337.41.

Plan 20 - Would include implementation of Plan 19 with an additional channel realignment (CHR 1A) and associated slope restoration along the banks (SL 13 and 14). Channel realignment would involve the restoration of an historic meander prior to the channelization project in this area. Slope restoration would involve dense plantings of shrubs (80 to 100 shrubs per acre) to help protect and restore the new channel slopes that would result from the restoration of the meanders. Implementation of Plan 20 would increase AAHUs from 247.63 to 341.23.

Plan 21 - Would include implementation of Plan 20 with an additional channel realignment (CHR 1B) and associated slope restoration along the banks (SL 15 and 16). Channel realignment would involve the restoration of an historic meander prior to the channelization project in this area. Slope restoration would involve dense plantings of shrubs (80 to 100 shrubs per acre) to help protect and restore the new channel slopes that would result from the restoration of the meanders. Implementation of Plan 21 would increase AAHUs from 247.63 to 345.29.

Plan 22 - Would include implementation of Plan 21 with an additional channel realignment (CHR 1C) and associated slope restoration along the banks (SL 18 and 19). Channel realignment would involve the restoration of an historic meander prior to the channelization project in this area. Slope restoration would involve dense plantings of shrubs (80 to 100 shrubs per acre) to help protect and restore the new channel slopes that would result from the restoration of the meanders. Implementation of Plan 22 would increase AAHUs from 247.63 to 355.69.

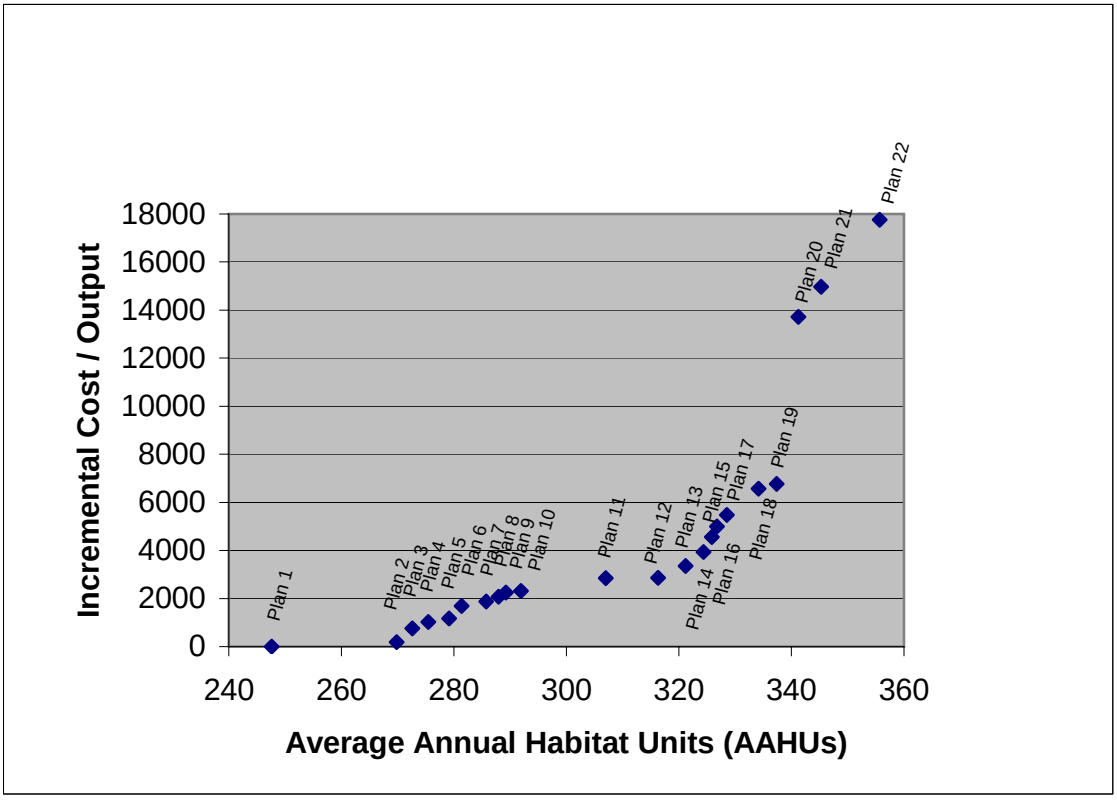

Figure G-3. Average Annual Habitat Units (AAHUs) and Incremental Cost / Output for Best-Buy Plans.

RECOMMENDED PLAN SELECTION

Is it Worth It Questioning Process

Beginning with Plan 1, the "no action" plan, each successive plan requires additional cost over the previous plan. In order to identify the NER plan, the question "Is it worth it?" should be asked of each plan in relation to the previous plan. When compared to Plan 1, Plan 2 provides an additional 22.21 AAHUs at an incremental cost per incremental output of $192.70 (see "Is it worth it?" Tab G.6). These additional AAHUs would come from gains in barred owl, Carolina chickadee, raccoon, fox squirrel, red-tail hawk, and wood duck habitat provided by the riparian corridor improvements described above. Thus, the PDT determined that "Yes, 22.21 AAHUs is worth an incremental cost / output of $192.70." This questioning process was followed for each successive plan, until the "Is it worth it?" question had been answered for all 22 plans.

While there are no set rules for selecting the NER plan, decisions are generally made based on output targets, output thresholds, cost limits, or curve anomalies. Cost limits and output thresholds were not used in the decision making process because there was no maximum or minimum output threshold or cost limit for this analysis. However, output targets and curve anomalies were utilized to guide the decision process. Using these criteria helps focus the "Is it worth it?" questioning process on plans that incur abrupt changes in incremental cost, such as those seen in Figure G-3, and on those plans that include output targets, such as aquatic restoration that first appears in Plan 18 (addition of CHR 2) described above.

Two such curve anomalies can be seen in Figure G-3. One occurs at the transition between Plan 13 and Plan 14, and the other between Plan 19 and Plan 20. Plans 13 and 14 both include very similar restoration features including riparian woodland development, riparian corridor improvements, wetland development, and wetland improvements. However, neither plan contains aquatic restoration features, which is one of the planning objectives, nor output targets identified for this study. Therefore, in the "Is it worth it?" questioning process, the PDT decided that "Yes, it is worth it to move beyond this curve anomaly because neither plan contains aquatic restoration features."

The next curve anomaly occurs at the transition between Plans 19 and 20. Both Plans 19 and 20 contain very similar restoration features, which now includes aquatic restoration (CHR 2) that was incrementally added in Plan 18. This satisfies the output target criteria of having aquatic restoration included in the restoration effort. Now, the decision-making criterion is again focused on curve anomalies (Figure G-3). As stated above, this occurs between Plans 19 and 20. Plan 20 includes the addition of more aquatic restoration (CHR 1A). The addition of this feature only increases AAHUs by 3.82, while the incremental cost / output jumps from $6,770 (Plan 19) to $13,710 (Plan 20) (see "Is it Worth It?" Tab G.6). Therefore, in the "Is it worth it?" questioning process, it was decided by the PDT that "No, it is not worth 3.82 AAHUs provided by Plan 20 for the incremental cost / output of $13,710." Therefore, Plan 19 is identified as the National Ecosystem Restoration plan for this study based on output targets and curve anomalies.

Acceptability, Completeness, Efficiency, and Effectiveness

There are other criteria that must be considered during the selection of the National Ecosystem Restoration plan. These include consideration of such factors as meeting planning objectives and constraints, reasonably maximizing environmental benefits while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness.

To determine if an ecosystem restoration plan is acceptable, there should be support from State and Federal resource agencies, the local government, and the non-Federal cost sharing partner. Resource agencies were involved early on in the formulation of the restoration measures that were evaluated during the formulation of the NER plan. It is believed therefore that Plan 19, as identified above, would be supported by State and Federal resource agencies. The local study and cost share sponsor also expressed an interest in pursuing the ecosystem

restoration features ultimately identified in the NER plan. However, development of the local plan strongly emphasizes economic development requiring land acquisitions for hydrologic and hydraulic (H&H) mitigation. The H&H mitigation area provides a cost effective opportunity to do extensive restoration that is more favorable to the non-Federal sponsor and local government than the NER plan. However, the USACE believes that if this were a stand-alone ecosystem restoration project, the NER would have received support from both of these entities.

To determine if an ecosystem restoration plan is complete, it must provide and account for all investments or other actions needed to ensure the realization of the planned restoration outputs. The necessary investments as well as the restoration outputs were discussed and taken into consideration in the Incremental Analysis section of this report. Investments including: lands, easements, rights-of-way, relocations, and disposal areas (LERRDS); construction; contingency; and operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) were all considered. Ecosystem restoration outputs (AAHUs) were also accounted for utilizing the Habitat Evaluation Procedures data gathered within the study area.

To determine if an ecosystem restoration plan is efficient, it must represent a cost effective means of addressing the restoration problem or opportunity. Problems and opportunities were documented earlier in this document and were used to formulate restoration measures and then restoration alternatives. This criterion has been satisfied and discussed above in the Incremental Analysis section of this report.

To determine if an ecosystem restoration plan is effective, it must make a significant contribution to addressing the specified restoration problems or opportunities. As mentioned above, many restoration problems and opportunities were identified and discussed earlier in this document. All restoration measures included in the NER were developed with the specific intent of addressing the restoration problems and taking advantage of the identified opportunities that exist within the study area.

Significance of Restoration Outputs.

Along with information from cost effectiveness and incremental cost analyses, as well as information about acceptability, completeness, efficiency, and effectiveness, information on the significance of ecosystem outputs will help determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended. The significance of restoration outputs is recognized in terms of institutional, public, and / or technical importance, which are discussed below.

Significance based on institutional recognition means that the importance of an environmental resource is acknowledged in the laws, adopted plans, and other policy statements of public agencies, tribes, or private groups. One example is the 1988 amendment to the Fish and Wildlife Conservation Act that mandates the U.S. Fish and Wildlife Service (USFWS) to "identify species, subspecies, and populations of all migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973." The *Birds of Conservation Concern 2002* (*BCC 2002*) report is the most recent effort to carry out this mandate. The overall goal is to accurately identify the migratory and non-migratory bird species (beyond those already designated as Federally threatened or endangered) that represent our highest conservation priorities and draw attention to species in need of conservation action.

The USFWS has divided North America into 37 regions known as Bird Conservation Regions (BCRs). Using Figure G-4, as well as consultation with USFWS, it was determined that the project area for this study lies within Bird Conservation Region 21 (Oaks and Prairies). According to the report, there are 23 species (Table G-7**)** in BCR 21 that are likely to become candidates for listing under the Endangered Species Act of 1973 without additional conservation actions. Of those 23 species, eleven are known to occur in the riparian and floodplain habitats associated with the Upper Trinity watershed. Included amongst these eleven species are nine species that are of national concern due to their downward population status trends.

Table G-4.

Species Listed in Bird Conservation Region 21 according to USFWS *Birds of Conservation Concern 2002*, those Known to Occur in Upper Trinity Riparian Habitats, and those of National Concern.

Species	Species Known to Occur in Upper Trinity Riparian Areas	Species of National Concern
Little Blue Heron*	X	X
Northern Harrier	X	X
Peregrine Falcon		
American Golden-Plover		
Long-billed Curlew		
Hudsonian Godwit		
Buff-breasted Sandpiper		
Red-headed Woodpecker	X	
Scissor-tailed Flycatcher	X	X
Loggerhead Shrike*	X	X
Bell's Vireo	X	X
Sprague's Pipit	X	X
Prothonotary Warbler	X	X
Worm-eating Warbler		
Swainson's Warbler		
Kentucky Warbler		
Field Sparrow	X	
Henslow's Sparrow		
Le Conte's Sparrow		
Harris's Sparrow		
Smith's Longspur		
Chestnut-collared Longspur	X	X
Painted Bunting*	X	X

* *Note* - species that met the rigorous criteria for statistically significant (P< or= 0.1, N>or =100), long-term (1966-2000) populations declines of > or = to 2.5 percent annually, both in the United States and survey-wide, using breeding bird survey data.

The ecosystem restoration measures identified above in the NER, including riparian corridor improvement (RCI), riparian woodland development (RWD), wetland improvement (WI), channel realignments (CHR), and wetland development (WD), could all serve to improve the riparian and floodplain habitats within the study area. This could benefit those species listed within in the *BCC 2002* and known to occur in the Upper Trinity watershed. Based on this information, it is clearly evident that ecosystem outputs gained from the NER are significant at the institutional level.

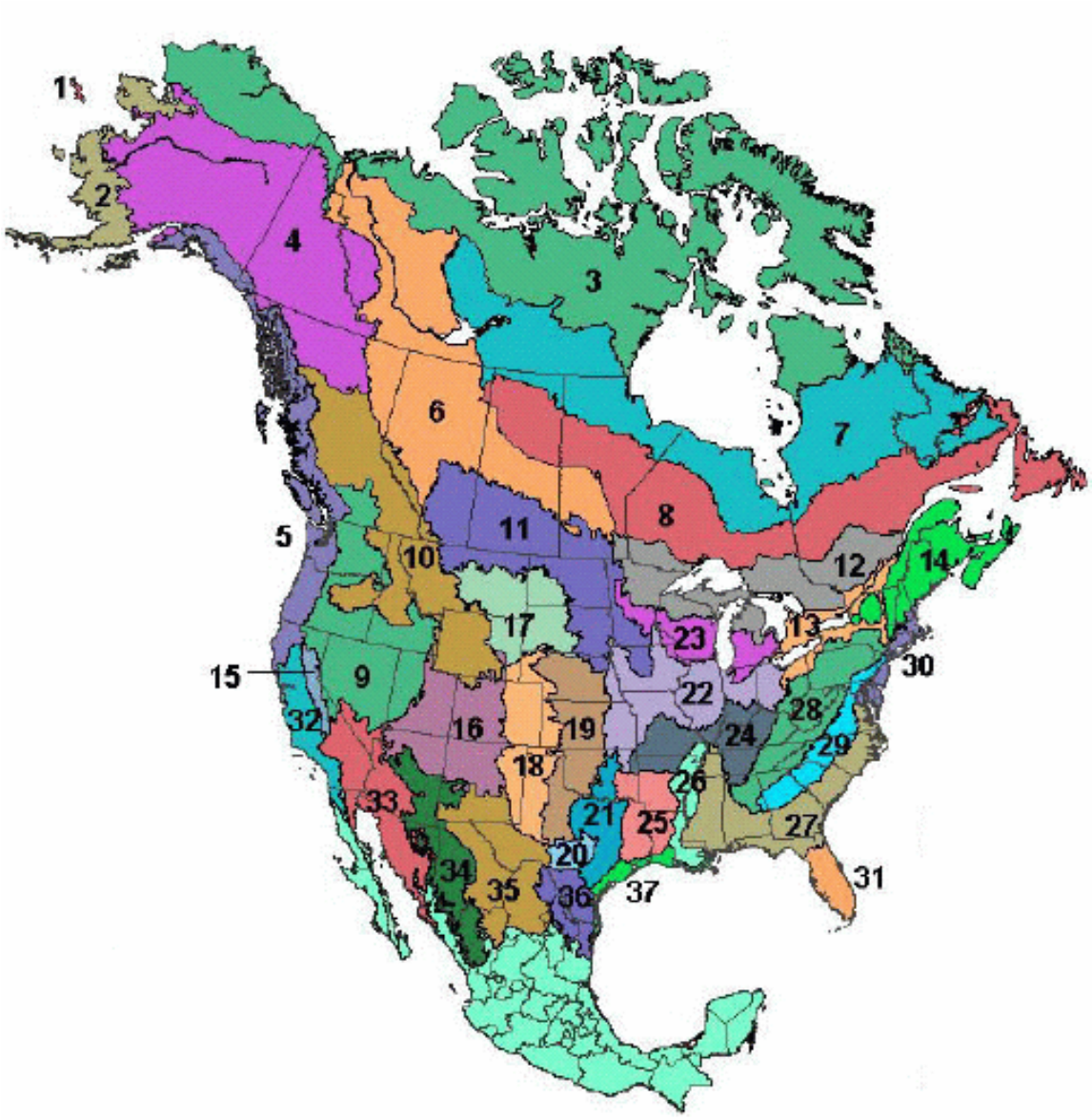

Figure G-4. Map of the Bird Conservation Regions (BCRs) of the United States.

Significance based on public recognition means that some segment of the general public recognizes the importance of an environmental resource, as evidenced by people engaged in activities that reflect an interest or concern for that particular resource. This may involve membership in an organization, financial contributions to resource-related efforts, providing volunteer labor, and correspondence regarding the importance of the resource.

An example of public recognition exists within the Trinity River Vision Master Plan which was commenced in August 2000 by the Tarrant Regional Water District (TRWD) and the architecture / planning firm Gideon Toal. A kick-off meeting was held in February 2001 followed by a total of 10 public meetings between April and June 2001. The purpose of these meetings was to gather information from the public on things they liked, disliked, were concerned about, and their vision of the river's future. Concepts were created and then taken back to the public in a series of meetings during January 2002. These meetings were held to ensure that all of the previous ideas, thoughts, and concerns were addressed and captured in the concept plans. Among the many goals

identified by the public during this process for the Central City segment of the Trinity River Vision Master Plan, expanding wildlife habitat and improving water quality were both identified. Measures within the NER, such as riparian corridor improvement (RCI), riparian woodland development (RWD), and slope restoration (SL) could all serve to expand and improve wildlife habitat within the study area. Other measures, such as wetland development (WD), wetland improvement (WI), and channel realignment (CHR) could serve to improve the water quality within the study area as well. The general public has identified and recognizes the importance of wildlife habitat and water quality within the study area. All measures included within the NER could serve to address these concerns and improve the environmental resources the public has deemed important.

Significance based on technical recognition means that the resource qualifies as significant based on its "technical" merits, which are based on scientific knowledge or judgment of critical resource characteristics. Technical significance is generally described in terms of one or more of the following criteria or concepts: scarcity, representativeness, status and trends, connectivity, critical habitat, and biodiversity.

Considering the multiple resources targeted for restoration within the NER, the technical significance of the development (RWD) and improvement (RCI) of the riparian woodlands in terms of its status and trends can best be described. In describing the status and trends of a technically significant resource, an evaluation of the occurrence and extent of the resource over time, how it has changed, and why, should all be considered.

Riparian forests, including bottomland hardwood forests, especially those occurring in the South, were designated by Noss et al. in 1995 as a nationally threatened ecosystem. There has been an 84% decline in riparian forests on a national scale since early settlement (Noss et al., 1995). The bottomland hardwood ecosystem in Texas prior to European settlement once extended over 6.5 million hectares; it is estimated that less than 40% of this original extent still remains (Frye, 1986), with only a few small and isolated patches of old growth scattered amongst the floodplains of the eastern third of the state. Losses of intact bottomland hardwoods in the past 50 years have at times been greater than 120,000 ha per year (Barry and Knoll, 1999). For the most part, factors such as urbanization, channelization, timber harvest, agriculture, and the introduction of exotic species have all contributed to the degradation and declining trend of riparian forests. Classification of the habitat types within the study area indicates that only six percent of the area is riparian forest habitat. This number is very low considering that the study area is limited to the floodplain of the Clear and West Forks of the Trinity River. Specific measures such as riparian woodland development (RWD) and riparian corridor improvements (RCI) could directly serve to increase the acreage and improve the health of the riparian forest habitat located within the study area.

Identification of the NER plan has undergone a rigorous selection process involving many different selection criteria. These criteria include: using a questioning process of "Is it worth it?" with data from CE / ICA to identify the NER; determining if the NER plan satisfies the acceptability, completeness, effectiveness, and efficiency criteria; and showing that the NER plan restoration outputs are significant at the institutional, public, and technical levels. It was determined that Plan 19 satisfies the above criteria and has been identified as the NER plan for this study.

NED.

Following traditional Corps of Engineers procedures a National Economic Development Plan based upon providing flood damage reduction benefits was developed. Several alternatives were evaluated but eliminated from further consideration. The plan consists of levee raising, construction of a small length of flood wall and provision of flood gates at areas that currently are not sufficiently high enough to provide standard project flood protection. Levee raise alternatives consisted of those that would restore Standard Project Flood (SPF) protection with various levels of freeboard. The SPF + 4 (with four feet of freeboard) alternative was selected as the NED Plan.

The levee replacing the Main Street Floodwall would have a crest elevation of 550.7', a base width of 110', a length of 700', and have a total volume of 14,490 cubic yards. The Tarantula Railroad has a bridge crossing the West Fork Trinity River approximately 2880 feet upstream of the confluence of the West Fork and the Clear Fork Trinity Rivers. Breaches at the Tarantula Railroad would be closed by use of permanent five-foot high-hinged gate that can be closed during peak flows with a winch.

In addition, Henderson Street crosses the levee loop in two locations. Along the left bank of the Clear Fork Trinity River the road profile for Henderson Street does not meet the SPF +4 flood criteria elevations. In order to correct this breach, a gated structure would be required. This structure is envisioned to consist of double swing gates that can be closed by a winch. The third structure required to meet the SPF flood control levels would be along 7th Street on the left bank of the Clear Fork Trinity River. The structure would be similar to the Henderson Street gated structure. Both structures would be two feet in height.

Improvements would be required to two low sections of the levee loop (along the Right Bank of the West Fork Trinity River and the Left bank of the Clear Fork Trinity River). The total amount of fill required for this construction would be approximately 180,700 cubic yards. Due to raising segments of the levee loop in the areas mentioned above, the new fill material would be placed on the riverside of the levee in order to stay within the current right-of-way limits and not disturb sump areas and private property. This placement of material is, in turn, subject to compliance with Corridor Development Certificate criteria. Hydraulic mitigation to meet CDC criteria consists of an 18-acre site excavated to an average depth of 6 feet and 1V:3H side slopes.

P&G BASED ALTERNATIVE

During the course of plan formulation, congressional action resulted in the authorization of a plan based upon a master plan developed and included in a report dated April 2003. As a result of this authorization, it was subsequently determined that a combination of the cost effective ecosystem restoration NER and NED plans developed by the Corps of Engineers would be referred to as the Planning and Guidance Based Alternative (P&G Based Alternative).

Community Based Alternative.

The Community Based Alternative within the area currently being referred to as the Uptown area includes hydraulic mitigation at several sites to meet criteria developed to reduce direct and cumulative increases in floodwater surface elevations in adjacent areas. At the Riverbend area of the West Fork, hydraulic mitigation incorporates levee breaching and relocation to enlarge the 100-year floodplain, along with borrow and fill to increase valley storage. Just downstream of Riverbend within the Rockwood Park area, two relic channels of the West Fork would be reconnected to the river to restore valley storage and to improve aquatic habitat.

The Community Based Alternative includes the benefits of extensive design, planting and maintenance of an ecosystem improvement area within the Riverbend/Rockwood study area. Table G-8 provides the benefits of the Riverbend/Rockwood area, but to capture the overall balances of habitat losses and benefits, please see Table G-12 which compares the Community Based Alternative and Community Based Alternative with Trinity Uptown Features to the no action alternative.

Table G-8. Benefits of the Riverbend/Rockwood Ecosystem Improvement Area of the Community Based Alternative		
Resource	**Community Based Alternative Ecosystem Improvement**	
	Acres	**AAHU**
Riparian Woodlands	139.01	66.34
Emergent Wetlands	15.02	13.78
Oxbow	5.1	4.3
Grassland	42.4	34.95
Upland Forest	58.8	27.59

Community Based Alternative with Trinity Uptown Features.
The intent of the Community Based Alternative construction is to foster intensive land us changes within the area identified as the Uptown area. A model illustrating one possible scenario of development has been developed. City planners are continuing to consult with urban designers to complete master planning, zoning and ordinance development for this area. Development of this area may take many years and the ultimate footprint of these developments is still undefined, however due to the strong intent to invest and develop this area, it was determined for this analysis that the Trinity Uptown Features would ultimately convert all existing resources within the zone to urban/disturbed conditions.

General Without Project Trends

Environmental conditions in the study area are likely to change over time even without the influences of construction or management alterations that might result from a Corps of Engineers plan. The fringe vegetation of the study area will tend to mature, and slight alterations in ongoing maintenance might periodically occur. The changes that will occur within this heavily urbanized study area will be associated with man made modifications and as a result of habitat deterioration associated with non-native plant invaders into sensitive riparian and upland woodlands. See Table G-9 for a summary of without project conditions for fish and wildlife resources.

Table G-9. Without Project Conditions		
Resource	**Future Without Project**	
	Acres	**AAHU**
Riparian Woodlands	323	179.07
Emergent Wetlands	14.3	1.92
Oxbow	0.00	0.00
Grassland	2088.6	876.74
Upland Forest	418.3	232.68

ENVIRONMENTAL EFFECTS

Since the mid 1970's the Corps has strived to improve analysis of existing wildlife and fisheries habitat conditions by incorporation of standard methodologies that determine quality of suitable habitat from field measurements of structural components of the habitat being evaluated. In this study, the methodology utilized was the US Fish and Wildlife Services Habitat Evaluation Procedures. An adaptation of the methodology was utilized for assessing existing quality of riverine and stream habitat. The methodology compares existing habitat conditions against optimum habitat conditions with the ecoregion being assessed. Models developed by the Service and

Wetlands

Without Project.
Based upon methodologies utilized, only 14.3 acres of existing wetlands were identified in the entire study area. Of this total 8.8 acres were located within the Riverbend/Rockwood zone of the West Fork. The wetlands had a combined value of 5.23 habitat units. It was estimated that due to the overall poor quality of wetlands observed for wildlife usage and due to the continued maintenance and other encroachment into around these wetlands that deterioration of values would continue over the 50- year study period. It was assumed that for wetlands, that existing values would diminish to one half of their current value by year 10 and to the point of having no value by year 50. The estimated future without a project habitat value would be only 1.92 average annual habitat units (AAHUs).

P&G BASED ALTERNATIVE .

Table G-10 provides a summary of values of all resources that would occur if the (P&G) were implemented.

Table G-10.
Without Project Conditions and P&G Conditions

Resource	Future Without a Project		P&G Plan	
	Acres	AAHU	Acres	AAHU
Riparian Woodlands	323	179.07	397.4	217.6
Emergent Wetlands	14.3	1.92	33.7	23.7
Oxbow	0	0.00	2.54	2.2*
Grassland	2008.6	876.74	1926.6	863.9
Upland Forest	418.3	232.68	418.3	232.7

*excludes minor additional value (1.7aahu) to be added to existing Riverine aquatic ecosystem

The P&G BASED ALTERNATIVE would improve wetland habitat conditions by increasing acreages and quality of emergent wetlands within existing sumps and associated drainages. The P&G BASED ALTERNATIVE plan would result in a net gain of 22.22 AAHUs over the without a project condition.

Community Based Alternative.

The Community Based Alternative including all constructed features, consideration of the pool raise and the effects of adding land contouring to obtain required H&H mitigation was evaluated in its entirety for effects to wetland habitat. All impacts identifiable to wetlands from this plan occur as a result of the H&H mitigation and all of those impacts were identified to occur within the Riverbend/Rockwood area. The initial construction of the Community Based Alternative would impact wetlands (Table G-11), including an initial loss of 8.8 acres having

an existing value of 3.87 habitat units. See Table G-12 for a comparison of the analysis of total project conditions for environmental resources evaluated for the Community Based Alternative and Community Based Alternative with Trinity Uptown Features conditions.

Table G-11.
Initial Community Based Alternative Impacts to Wetland Resources

Planning Zone	Acres Impacted	HSI	HU
Riverbend/Rockwood	8.8	.44	3.87
Total Initial Impact	**8.8**		**3.87**

Table G-12.
Without Project Conditions and Community Based Alternative Conditions

Resource	Future Without Project		Community Based Alternative With Ecosystem Improvements		Community Based Alternative and Trinity Uptown Features with Ecosystem Improvements	
	Acres	AAHU	Acres	AAHU	Acres	AAHU
Emergent Wetlands	14.3	1.92	20.52	14.39	20.52	14.39
Riparian Woodlands	323	179.07	408.33	221.24	407.15	220.54
Upland Forest	418.3	232.7	414.92	216.04	398.56	199.28
Grassland	2088.6	876.74	2063.31	843.39	1891.76	774.01
Oxbow	0	0.00	5.1	4.30*	5.1	4.3*

*Excludes minor additional gain attributed (2.2AAHUs) to existing riverine system.

A goal of the Community Based Alternative was to provide improved wildlife habitat where practical and economically reasonable within the study area. The modifications of the area for H&H mitigation near existing sumps 7, 8 and 9 within the Riverbend area provided a unique opportunity to meet this goal. Although there are initial losses to wetland within this H&H mitigation area in addition to losses due to construction of other project features totaling 8.8 acres having a 1.31 AAHU value, wetlands that would be developed at the Riverbend site would be incorporated into a regime that includes better hydrology and opportunities for long-term maintenance. The Ecosystem improvements would restore 15.02 acres of wetlands having 13.78 AAHUs. As a result of these wetland improvements the total study area would have 20.52 acres of wetlands having a total of 14.39 AAHUs. These wetland improvements provide substantially more benefits (net gain of 6.22 acres and 12.47 AAHUs over the without a project condition. Since the Community Based Alternative and the Community Based Alternative with Trinity Uptown Features with the Ecosystem improvements at Riverbend as proposed provides a net gain of wetlands resources including functional values for wildlife resources, no additional mitigation for wetland resources is required.

Community Based Alternative with Trinity Uptown Features.
Since there are no existing wetlands within the Trinity Uptown Features area of influence the consequences to wetlands is the same as for the Community Based Alternative alone.

Terrestrial Habitat

Woodlands

Within the study area, broadleaf deciduous trees and shrubs dominate the woodlands. Native evergreens are present but density is low. Non-native species of trees and shrubs continue to invade the woodlands, particularly within the river bottom zones. Species and location with respect to elevation and distance from tributaries and the main stem rivers in the study zones was utilized to distinguish upland woodlands from riparian woodlands.

Riparian Woodlands

The largest area of riparian woodlands (187.5 acres) within the study area are located within the Clear Fork West zone mostly associated with existing parks managed by the City of Fort Worth for recreational use. An additional 118.1 acres was identified within the Riverbend/Rockwood area. No riparian woodlands were identified in the Clear Fork east zone and only 17.4 acres total were identified within the other 3 zones.

Without Project.
Due to the location of the riparian woodlands within the floodplain, and nationally recognized significance of this resource, it was determined that sufficient protection exists and public interest is sufficient to encourage conservation of existing acreages of riparian resources. While some areas could be impacted, new areas could be either intentionally developed or allowed to redevelop. Within the more actively maintained zones, no new forest would be allowed to develop however. Management to maintain or improve the values of riparian woodlands is currently limited or nonexistent. Therefore, it was determined that for planning purposes, the acreage of riparian woodlands would not change over the 50 year period for the without project condition, however, it was estimated that due to the lack of active management, continued invasion by non-native shrubs and trees would continue to diminish habitat values. It was estimated that values would decrease to 97.5% of existing value by year 10 and to 90 percent of existing values by year 50. As a result it was determined that the existing 323 acres having existing value of 188.74 habitat units would produce 179.07 AAHUs for the without a project condition.

P&G Based Alternative
The P&G plan would provide for management of existing riparian woodlands and development of additional stringers of riparian woodland spread throughout the entire study area, with exception of the Riverbend/Rockwood area. The NER plan would provide for a total value of 217.6 AAHUs which would represent a net gain of 38.53 AAHUs over the without a project condition.

Community Based Alternative.
The Community Based Alternative including the H&H mitigation necessary for the project would result in the loss of 35 acres having immediate impact of 16.33 HUs (Table G-13). However the project losses when annualized amounts to 34.51 acres and 17.67 AAHUs as compared to the without a project condition. As was found for the wetlands, the majority of the losses to riparian resources would occur in the Riverbend/Rockwood zone (30.81 acres and 15.50 AAHUs) and are directly associated with the need to provide valley storage mitigation.

Table G-13. Community Based Alternative Initial Impacts to Riparian Woodland Resources			
Planning Zone	**Acres Impacted**	**HSI**	**HU**
Riverbend/Rockwood	30.81	0.53	16.33
North Main	3.7	0.62	2.29
Clear Fork West	0.46	0.62	0.29
Clear Fork East	0	0	0
West Fork North	0	0.6	0
West Fork South	0.03	0.3	0.01
Total Initial Impact	**35**		**18.92**

The Community Based Alternative related ecosystem improvements s to riparian woodlands would all occur within the Riverbend/Rockwood area associated primarily with the floodplain modification at Sumps 7, 8 and 9. Additional riparian woodlands improvement would also occur in conjunction with reconnection of two remnant oxbows to the existing West Fork within the Rockwood park area. Riparian habitat values would be gained by management to improve habitat value on about 19.17 acres and reforestation on 119.84 acres. These ecosystem improvements total 51.99 AAHUs at Riverbend/Rockwood area thus providing a total of 408.33 AAHUs within the project area, presenting a net gain of 42.17 AAHUs over the without a project condition.

Since this is a resource of recognized national significance, 17.67 AAHU's of the riparian woodlands ecosystem improvements should be designated as environmental mitigation with the remaining 24.5 AAHUs attributable to ecosystem restoration.

Community Based Alternative with Trinity Uptown Features.
A slight additional loss of riparian woodlands is expected to occur as development of the Uptown
Area progresses. A loss of 1.18 acres and 0.69 AAHUs is projected to occur following implementation of the Trinity Uptown Features. After consideration of the total project including ecosystem improvements at Riverbend/Rockwood area, there would still be a net gain of 41.47 AAHUs attributable to this action over the without a project condition.

Upland Forest

The Corps of Engineers policies do not normally allow for restoration or require that these resources be mitigated, however, it is well established that these resources provide significant values to multiple wildlife species that also utilize riparian woodlands. These resources can also provide valuable cooling in urban areas and some studies indicate that all forests can provide air quality benefits. Therefore the effects of project alternative were considered for this resource.

Without Project.
Existing upland forest is more evenly distributed throughout the study area than is the riparian woodlands. The largest areas are within the Norm Main and the West Fork South zones. Similar to the evaluation for riparian woodlands, management of upland woodlands was found generally lacking within the area. Also, these resources are more vulnerable to development since they generally are located at higher elevations and within zone less susceptible to flooding conditions. As a result planning assumptions for this resource was that there would be a loss of 20% of the existing acreage and 10% of existing habitat suitability over the planning period. As a result it was determined that the initial 522.9 acres of existing upland forest would diminish to 418.32 acres at the end of the study period providing 232.68 AAHUs for the without a project condition.

P&G BASED ALTERNATIVE Plan.
No specific measures were considered to directly improve existing upland forests. There were also no modifications proposed that would negatively impact upland woodlands.

Community Based Alternative.
The Community Based Alternative would have impacts to upland forests within all six study zones (Table G-14).

Table G-14.
Community Based Alternative Initial Impacts to Upland Forest Resources

Planning Zone	Acres Impacted	HSI	HU
Riverbend/Rockwood	38.27	0.8	30.62
North Main	14.09	0.56	7.89
Clear Fork West	3.85	0.56	2.16
Clear Fork East	2.06	0.50	1.03
West Fork North	2.37	0.41	0.97
West Fork South	3.76	0.50	1.88
Total Initial Impact	**64.4**		**44.54**

Initial direct impacts to upland forest would be to 64.4 acres and 44.54 existing habitat units. However, considering that there was estimated to be a 20 percent loss in upland forest acreage and a loss of 15 percent of habitat in the study area even without a project, there would be a net loss of 51.54 acres of upland woodlands and a net loss of 34.58 AAHUs as compared to the acreage and habitat value that would occur over the project evaluation period.

Within the Riverbend/Rockwood H&H mitigation area, proposed ecosystem improvements include management of 13.3 acres of existing upland forest and replanting and development of 45.5 acres of new upland forest. These ecosystem improvement s would provide a total of 27.59 AAHUs over the study period. As a result there would be a net loss of 3.4 acres of upland forest with a net loss of 16.64 AAHUs of upland forest habitat attributable to the Community Based Alternative with the ecosystem improvements in place.

Community Based Alternative with Trinity Uptown Features.
Development believed to be likely to occur within the Uptown area would impact an additional 16.36 acres and result in the loss of an additional 14.24 AAHUs. There would be a net loss of 19.76 acres of upland forest and a net loss of 33.40 AAHUs attributable to the Community Based Alternative and Trinity Uptown Features, including the ecosystem improvements at Riverbend/Rockwood area.

Combined forest habitat values when considering both riparian and upland hardwood forest habitat values are increased with project conditions for the Community Based Alternative with Trinity Uptown Features and ecosystem improvements (419.82 AAHUs) over the total forest value for the without a project condition (411.75 AAHUs).

US Fish and Wildlife Service has identified upland forests within this study area as being of significance for migratory birds and indicated that the bird species that utilize the upland forest vary from those that utilize the adjacent riparian forest. Corps of Engineer policy generally requires environmental mitigation for impacts to significant resources should the project on whole have unmitigated impacts. As indicated there is a net loss of upland forest habitat value for both the Community Based Alternative and for the Community Based Alternative when considering Trinity Uptown Features. However, when considering the overall project including the ecosystem improvements with combined riparian and upland forest habitat values , there are more fish and

wildlife habitat related values for forest related habitat values with the project than for the without a project condition. Fish and Wildlife Service has indicated the upland as well as the riparian forest habitat is a Resource Category 4, which has according to the Service's policy, a mitigation goal of minimizing loss of habitat value due to project implementation.

Grasslands

Without Project.
Within the overall study area, grasslands are the predominant terrestrial vegetation type. Most of the grasslands are mowed and manicured as would be expected in the urban environment. Some areas of grassland would be converted by others urban or disturbed habitat in the future without a project condition. However a large amount of the area lies within the existing federally authorized flood damage reduction project therefore limiting the amount that would be modified by projects of others. Within the urban environment little to no maintenance changes can be foreseen. As a result, no changes to future habitat quality of grasslands in the study area are anticipated. However it is anticipated that a minimal of 15 % of grassland vegetation would be lost during the 50-year planning period. Based upon that assumption, after 50 years for the without a project condition there would be 2008.6 acres of grassland in the study area having an average annual habitat value of 858.17.

P&G BASED ALTERNATIVE
The P&G BASED ALTERNATIVE would temporarily impact grassland as a result of the levee raises. However, the disturbed areas would be replanted to the same type of grasses currently onsite and would be maintained in its present manner. An 18 acre area of grasslands would also be excavated within the North Main study reach to offset valley storage losses attributed to the project. It is also anticipated that this area would be contoured to drain and would also be replanted to grassland. Initial impacts would be about 8.64 Habitat Units of grassland habitat that is low significance. No mitigation would be required for this initial loss as is also anticipated that this area would be contoured to drain and would also be replanted to grassland immediately after excavation, resulting in no net losses of grassland value.

Some conversion of grassland (96.37 acres) within the study area to riparian woodlands and grasslands would occur. The remaining grasslands would benefit in value due to the presence of these improved woodlands and wetlands. Any initial impacts due to the establishment of these forests would be quickly overcome and therefore the impacts are considered insignificant.

Community Based Alternative.
The Community Based Alternative including the ecosystem improvements at the Riverbend location would convert about 271.3 acres as compared to the future without a project scenario resulting in a net loss of 81.76 AAHUs (Table G-15).

Table G-15.
Community Based Alternative Initial Impacts to Grassland Resources

Planning Zone	**Acres Impacted**	**HSI**	*HU*
Riverbend/Rockwood	172.68	0.4	69.07
North Main	50	0.48	24
Clear Fork West	28.24	0.48	13.56
Clear Fork East	1.19	0.35	0.42
West Fork North	83.77	0.35	29.32
West Fork South	37.0	0.35	12.95
Total Initial Impact	**372.88**		**149.31**

The ecosystem improvements would provide a buffer zone of native grasses adjacent to riparian forest within the Riverbend H&H mitigation area. These buffer grasses would cover about 42 acres having an AAHU of 34.95. Grassland resources of the type found within the study area are abundant within this ecoregion. The resource lacks significance for wildlife habitat on a regional, state or federal scale and therefore the impacts disclosed are considered insignificant and do not merit consideration for compensatory mitigation.

Community Based Alternative with Trinity Uptown Features.
Trinity Uptown Features associated with the Community Based Alternative would induce an additional impact to an estimated 122.87 acres having an AAHU of 63.64. Including the other effects both positive and negative, of the Community Based Alternative, the net result from this total action would be a loss of 394.19 acres of grassland having an average annual habitat value of 145.39. As discussed for the Community Based Alternative effects, the grassland impacts are considered insignificant and do not merit compensatory mitigation.

Water Quality

General.

Water quality is subject to considerable variability. Frequently, the most notable changes occur during project implementation (construction). Though these changes have the potential to be dramatic, they are typically temporary. Temporary and long-term water quality impacts for alternatives are discussed in the following paragraphs.

Temporary Term Water Quality Impacts

No Action Alternative.

The No Action Alternative will not undergo any watercourse or construction activities and therefore will not change in resulting water quality.

Planning and Guidance Based Alternative

The construction of the Planning and Guidance Based Alternative will cause temporary adverse water quality impacts. The construction of the raised levy and its associated features (riparian woodland restoration, wetland restoration, slope restoration, and recreation) will generate the production of dust and temporarily subject the watercourse to turbidity conditions. These turbidity conditions are expected to be temporary and have no long term after effects to the watercourse. These conditions will be further lessened with the implementation of storm water controls and best management practices during construction.

Community Based Alternative.

Like the Planning and Guidance Alternative, the construction of the Community Based Alternative will cause also temporary adverse water quality impacts. The construction of the channel/impoundment features (bypass channel, Samuel Avenue Dam, isolation gates, pump station, interior impoundment feature, recreation, bridge modification, H&H mitigation, and ecosystem restoration) will generate the production of dust and temporarily subject the watercourse to turbidity conditions. Direct construction in the watercourse will especially mix sediment into the water column. These turbidity conditions are expected to be temporary and have no long term after effects to the watercourse. These conditions will be further lessened with the implementation of storm water controls and best management practices during construction as required by TCEQ storm water permit requirements.

Long Term Water Quality Impacts

No Action Alternative

There are no long-term water quality effects for the No Action Alternative.

Planning and Guidance Based Alternative

Raising the levees will not have a long-term water quality effect. The project wetland restoration feature will provide a slight water quality improvement for the long-term. Wetlands provide a mechanism to partially remove excess nutrients through plant life uptake and retain or filter sediments and other suspended solids. Wetlands are often used in many wastewater treatment systems as final polishing treatment measure. Riparian woodlands restoration feature will not have a direct affect on the water. The proposed tree plantings are not immediately adjacent to the stream and will not provide beneficial shading for lowering summertime water temperatures. The construction of recreation features (trails, etc.) for the P&G Based Alternative will have no long-term water quality effects. Overall, the P&G Based Alternative will have a slight beneficial long-term benefit due to the implementation of the wetland restoration feature.

The Planning and Guidance Based Alternative will have little environmental impacts to stream aesthetic appeal. The only noticeable change in water aesthetics will be a temporary adverse impact associated with stream turbidity during project construction as existing levee and channel conditions are modified. As a result of these construction activities, some sediment material and fugitive dust will become suspended in the stream water column. However, much of construction dust and sediment will be retained onsite and prevented direct release to the watercourse due the implementation of the required storm water controls (erosion controls, silt fences or hay bales, and onsite best management practices). After construction, the visual aesthetic quality of the stream water will return to conditions similar to existing stream conditions. Other aesthetic appeal parameters for odor and taste for the P&G Based Alternative are not expected to differ from existing stream conditions.

Community Based Alternative.

The Community Based Alternative with its various features and varying operating schemes is subject to more water quality variability than the Planning and Guidance Alternative. The basic plan involving linear impoundments for the main pass-through and bypass channel, isolation gates, and pump station is operationally more complex.

The Samuels Avenue Dam feature of the Community Based Alternative is a larger structure than the existing check dams along the watercourse, but unlike the upstream Benbrook Lake and Lake Worth dams, it has much greater flexibility in the quality of its downstream releases. The dam is predominantly composed of a series of large leaf (drawbridge-like) gates and smaller sluice gates. The large leaf gates lower to allow release water flow-over. Water spilling over these leaf gates would tend become aerated. The gates can also be operated in a raised position to hold water for longer retention times than check-dam impoundments. This would be the most likely operational scenario during low flow conditions to maintain a constant water surface elevation (as near to 525 feet as practicable). During late summer, the water upstream of the dam would tend to stratify if water is held for longer detention times. As identified in existing conditions during late summer, impounded water under this condition would tend to have higher levels of dissolved oxygen near the surface as algae growth occurs, but lower concentrations of DO at the greater depths.

As discussed in Technical Memorandum ECO-5 (Tab G.3), flow augmentation will be necessary to offset evaporative losses from Community Based Alternative during low flow conditions. Potential augmenting flow sources include the use of reclaimed wastewater, additional surface water releases from upstream reservoirs (requiring additional surface water rights or use of flow-through of raw drinking water supply), and groundwater. Groundwater tends to contain higher concentrations of dissolved minerals than surface waters. Therefore,

groundwater use may slightly increase the overall dissolved mineral content of project waters. The reclaimed water would be wastewater that has undergone treatment approved by TCEQ. The treatment measures used would dictate the quality of the reclaimed water. Surface water augmentation with upstream reservoirs is not expected to significantly alter project impoundment water quality, since these waters are a major portion of the existing base flows. Each of these sources of make-up water is expected to have a slight difference in water quality, but is not expected to appreciably alter the overall water quality for its designated uses.

Algal growth is currently a slight concern in the existing stream as documented in the existing conditions discussion. It is also considered to be a slight concern for the Community Based Alternative. Though algal growth can increase the DO content near the water surface, it can also cause DO depletion near the impoundment floor. Nutrients like phosphorus and nitrogen are the direct cause of these algal blooms. Measures are being proposed with the alternative to locally control algal growth through minimizing the use of fertilizer, harvesting nutrients through periphyton gardens, or chemically treating water to limit algae growth or settle for decomposition.

Sedimentation as result of the Community Based Alternative is not expected to significantly change since the existing system of check dams tends to similarly retard the downstream migration of sediment. Also floatable material like litter and other debris are expected to be similar to the existing conditions. Additional best management practices (frequent grounds pickup of litter, etc) may be required if development increases the incidence of floatable material.

Water odor is also considered an aesthetic concern during fall turnover when cooler water sinks at the onset of the fall season. During this event, unpleasant odors are often brought to the surface. Possible measures for the Community Based Alternative have been proposed to minimize this concern. Potential measures include increase flow through the system to help minimize stratification, use of mixing devices to break-up vertical stratification, release of impoundment water from lower depths through the flexible gate system, and maintaining depth in 8 to 10 feet in channel portions to keep temperature uniform and minimize thermal stratification.

Aesthetics and flow circulation in the Community Based Alternative is another consideration. Pool stagnation and low dissolved oxygen episodes are also important consideration during low flow conditions. Possible measures being considered to manage circulation include augmenting flow as discussed above, mechanical use of pumps, aeration devices like cascades and water fountains, and other hydraulic structures to direct flow as required. Algal growth would be a potential aesthetic concern if stream stagnation occurs as result of increased evaporation and low downstream releases. However, the Community Based Alternatives project is flexible by design and would allow flows through the system to simulate a similar flow-through condition as the existing stream. Further, the maintenance of a good aesthetic appeal of the water course is a primary proponent objective. In addition, other water quality features have been suggested by the proponent to further improve water quality aesthetics beyond the existing conditions.

The USEPA Water Quality Analysis Simulation Program (WASP) was used to model the effects of the Community Based Alternative as discussed in Technical Memorandum ECO-4 (Tab G.3),. Figures 7 through 12 in *(TM ECO-4)* Tab G.3 show the modeled results in terms of anticipated concentration variances of DO, carbonaceous biological oxygen demand, total Kjeldahl nitrogen, and chlorophyll a along the watercourse of the Community Based Alternative. Figures 13 and 14 in *(TM ECO-4)* Tab G.3 depict a relative comparison of projected DO changes anticipated between the existing conditions and the Community Based Alternative under median and low flow conditions (7-day, 2-year low flow). These latter two figures show that there are relatively minor projected differences between the existing and the Community Based Alternative conditions.

The Community Based Alternative, if implemented, may encourage more water use for non-contact recreation (incidental contact - boating, etc). It is anticipated that occasional episodes of elevated bacteria may occur as it does now. TRWD would continue to post warning notifications if such conditions were to occur.

Community Based Alternative and Trinity Uptown Features.

The development of other Trinity Uptown Features associated with the Community Based Alternative would tend to create slightly more water quality problems except for wetland restoration. Here are few of the notable changes anticipated based on connected items.

- The potential addition of more canals to the alternative would tend to create more water surface subject to evaporation. As a result, water would be held in the impounded sections for longer detention times and relatively less water would be released unless an additional make-up water supply source is provided. This condition would result in stagnation without fresh make-up water or aeration mechanisms.

- Land use intensification through real estate development in the project area would also tend to slightly degrade the water quality as impervious surfaces are increased with parking lot pavements, concrete sidewalks, hard road surfaces, and buildings. The increase in impervious surfaces near to the watercourse would increase the incidence for urban contaminants to be picked up in storm water runoff and carried directly to the watercourse. Additional concrete and pavement would also tend to become irradiated and conduct heat during the hot summertime months. During such occurrences, the stream water would have a tendency to also be heated due to close proximity of pavement and concrete structures. In addition to long-term effects, stream water turbidity will likely increase during construction of new structures. However, temporary serious adverse effects will be avoided as construction operators comply with storm water pollution prevention measures as required by TCEQ permit requirements.

- As development progresses, transportation modifications would be necessary to accommodate the increased traffic resulting in the project area. The effects of this activity are similar to land intensification discussed above. Construction of impervious road surfaces (asphalt, concrete, etc.) would also allow contaminants on these surfaces to be readily picked-up by storm water runoff. Typical contaminants lying on these surfaces include exhaust particulates, various petroleum residues (oils, greases, etc.), and street litter. Because there will be more traffic in the project area, there is also a greater risk for accidental chemical spills on bridges and ramps. Road and bridge construction will also incur temporary increases in stream turbidity.

- Levee removal will also likely temporarily increase stream turbidity during the construction activity. The use of best management construction techniques to prevent and control storm water pollution will offset most of these temporary adverse effects. Long-term effects from the removal of the levee itself are not considered to be significant and could be slightly beneficial or slightly adverse depending on the associated follow-up activity. Removal of the levee and creation of wetlands would create an opportunity to improve instream water quality. Whereas, increased urban infrastructure development in closer proximity to the watercourse because of levee removal would tend to slightly degrade the water quality.

- Wetland development, if implemented, would be a beneficial feature to the Community Based Alternative project. The wetland would serve as an excellent natural treatment mechanism to reduce stream nutrient loads. Depending on the wetland size and water retention characteristics, this feature could offset much of the slight adverse effects of the Community Based Alternative. As result of wetland implementation, less nutrients will be available in downstream waters for algae uptake and growth.

Community Based Alternative Water Quality Effects Conclusion.

There is a potential for water stagnation and algal problems to occur on a greater frequency during summer because of increased evaporation as stream water surface area is enlarged and stream water is retained. This could occur if fresh water circulation is not maintained in the project area. However, design for the Community Based Alternative is flexible and includes optional features that could produce a slightly improved water quality if operations were conducted to optimize water quality. If the system is optimized for pool elevation alone without

joint consideration of water quality management, the Community Based Alternative could incur slightly adverse impacts. With water quality monitoring, adjustments, and optional water quality improvement features (flow augmentation, recirculation, aeration, etc), the Community Based Alternative could be further improved to best jointly meet pool elevation and water quality purposes.

Overall Water Quality Comparison of Alternatives.

The P&G Alternative and the Community Based Alternative would have similar slightly adverse water quality impacts during construction. After construction, the Planning and Guidance Alternative will have a slightly beneficial impact over the existing conditions. The Community Based Alternative is subject to variability due to design features, optional features, and operations. The Community Based Alternative is anticipated to have a slightly adverse water quality impact, but could improve to having a slightly beneficial impact with optional water quality improvement features incorporated.

Aquatic Habitats

Aquatic habitats within the study area include the Clear and West Forks of the Trinity River and Marine Creek and Lebow Creek, which are tributaries to the West Fork. No detailed analysis was conducted of the aquatic habitat of the West Fork upstream of University Drive. However, this reach is similar to the reach immediately downstream and little variation is anticipated.

Without Project.
Existing conditions for the aquatic habitat associated with the rivers and tributary streams were determined by sampling of existing fisheries resources. When considering without project conditions for the study area, it is important to consider that the Clear and West Forks within the area have long been a part of a major flood damage reduction project. Maintenance to keep the channel and overbank morphology is intensive. Modifications to several in-channel dams were completed prior to the aquatic habitat studies and it is not anticipated that significant new modifications would occur for the without project condition. As a result of these past actions, the aquatic habitat within the river channels is generally more lentic than lotic and even as flood events occur, the water surface is confined to a smooth, well-manicured grass-lined channel for all but the more rare flooding events. Although not directly utilized in the assessment of existing physical habitat conditions, levels of contaminants within fish tissue have prompted a closure by the state of Texas prohibiting retention of fish from the Clear Fork below 7th street and from the West Fork downstream of the confluence through the study area. Insufficient information is currently available to predict when the ban may be removed, however, due to the persistent nature of the contaminants and the recent discovery that additional contaminants may be concentrating in fish tissue, it would be reasonable to presume that it is unlikely the ban will be removed in the near future. Therefore, the future without conditions is assumed to be the same as existing conditions.

P&G BASED ALTERNATIVE .
All P&G Based Alternative modifications would be on existing levee alignments or within adjacent grasslands and these modifications are small. No impacts to aquatic resources would occur following implementation of the P&G Based Alternative.

The P&G Based Alternative includes the construction of oxbow additions that would provide a net gain of 3.82 AAHUs to the future without aquatic habitat future conditions. This oxbow system would route local runoff through a larger habitat area, however, the most significant value would be the provision of backwater habitat for spawning and nursery habitat for the local fish population.

Community Based Alternative.
The Community Based Alternative adds approximately 118.5 acres of aquatic habitat through construction of the bypass channel and additional inundation as a result of the operation of Samuels Avenue Dam. Samuels Avenue Dam at normal flows would inundate the upstream channel to an elevation of approximately 525 feet NGVD. As

a result the immediate area upstream would be inundated by an additional 25 feet in some areas over existing conditions. The area upstream of Samuels Avenue is already strongly under the influence of a series of in channel dams and as evidenced by fisheries studies is more lotic than lentic at normal flow conditions. In general the additional acreages of impounded water would generally be considered as not providing any additional aquatic habitat to the lentic or river system.

The most significant permanent changes to the aquatic values would be related to the flooding of Marine Creek by approximately 25 feet over existing conditions. Recently conducted studies by the US Fish and Wildlife Service (see Tab G.4) indicate this stream has exceptional fish habitat as indicated by the IBI for this stream. USFWS indicated particular concern about the loss of approximately 1875 linear feet of riffle pool habitat that exists from just below the railroad to just upstream of 23rd Street. In addition, USFWS expressed concern about the proposed fill of approximately 400 linear feet of Lebow Creek as part of the plan to relocate the confluence to below Samuels Avenue Dam to avoid inundation of Lebow Creek. Table G-16 indicates the impacts that would occur to Marine Creek and Lebow Creek in terms of aquatic habitat on an annualized basis for the 50 year study period. The impacts would be immediate and permanent following inundation of Marine Creek and filling of the lower 400 feet of Lebow Creek. Future with a project condition addresses the quantity and quality of aquatic habitat that is believed to occur following construction of the project absent any mitigative measures being employed. Ham Branch would not be impacted by the project but has been included in Table G-16 as a basis for comparison of proposed aquatic mitigation features on Hams Branch that will be discussed later.

Table G-16.
Community Based Alternative Impacts to Aquatic Resources

Planning Zone	**Raw HU**	**Seasonally adjusted HU And Future Without AAHU**	**Future With AAHU**
Marine Creek			
Plunge Pool –Riffle	1.6	0.8	0
Waterfall to Exchange	1.12	0.28	0
Lebow Creek			
Confluence Area	0.2	0.1	0.1
Upstream Reach	0.31	0.16	0
Ham Branch	0.25	0.25	0.25
Total		1.59	**0.35**

Temporary impacts would occur during construction of the bypass channel, isolation gates and pump station, interior water feature and the Samuels Avenue Dam. Potential for temporary impacts would be greatest as temporary cofferdams are constructed and removed to provide dry areas to construct these features and when the plugs separating the bypass channel from the Clear Fork and West Fork (2 locations) are removed. There would also be some minor impacts to aquatic habitat associated with removal of Nutt Dam and two in-channel dams on the Clear Fork.

Community Based Alternative with Trinity Uptown Features.
The Trinity Uptown Features would not provide additional significant quantifiable impacts or benefits to the aquatic habitat over those determined for the Community Based Alternative. One concept of the master plan for the area of impact considered for the Trinity Uptown Features is that local runoff would be treated and improved through series of artificial wet areas or holding areas that could provide some improvement in storm water runoff quality. While these singular improvements are not quantifiable, they should be encouraged as cumulatively there

could be demonstrable benefits to the West Fork Trinity River aquatic habitats if more of these type runoff treatment facilities are incorporated into other proposed developments.

Ecosystem Improvements.
The wetland and terrestrial ecosystem improvements would in general result in some limited water quality benefits that could provide some aquatic habitat improvements. However, at this time, insufficient data and tools are available to quantify the restoration plans contributions to aquatic habitat improvements. The plan does include restoration of two oxbows by establishing connection to the West Fork. As a result of this connection and riparian forest improvements adjacent to them, it was determined that these oxbows in the Rockwood park area would provide 5.08 acres of aquatic habitat having an AAHU of 4.30. Additional minor but non-quantifiable benefits to the river would also likely occur from connecting these oxbows to the West Fork.

CUMULATIVE IMPACTS

P&G BASED ALTERNATIVE

Water Quality.
A water quality concern with the implementation of multiple reasonably foreseeable projects is the temporary effect associated with construction. Each foreseeable project construction site lying within the direct watershed area and exposed to precipitation events has the potential to release water pollutants directly or indirectly to the river system. Effectiveness of the ultimate introduction of these pollutants into the stream will depend on many factors including, but not limited to: onsite construction storm water control features, runoff travel distance release to nearest water conveyance, land surface permeability, intersecting vegetation strips, and size and duration of precipitation events. Projects located at great upland distances from the West Fork or its tributaries will tend to have relatively low potential for direct pollutant contribution to the watercourse. In order to comply with law, the majority of these foreseeable projects will include control features required by the Texas Commission on Environmental Quality (TCEQ) to minimize offsite storm water pollution. Although many of the foreseeable projects will have similar construction time frames, it is not anticipated that these developments are so synchronized to cause a major watercourse pollution episode as long as the proper individual construction site controls (hay bales, silt fences, etc.) are in place as required by the state. Based on these considerations, cumulative effects of the implementation of these reasonably foreseeable projects are not expected to be a significant water quality concern. However, it should be noted that each project added, incrementally increases the potential for the release of pollutants through urban runoff. Further, these projects cumulatively should not represent a major permanent land use conversion from natural areas to impervious surfaces that drastically increases urban runoff resulting in high litter/debris pick-up and elevated downstream erosion.

The P&G Based Alternative could have slight adverse impacts to water quality within the study area. Most of the proposed activities would occur directly in or along the watercourse increasing the likelihood of dust and loose sediment being released during construction. This could create temporary water turbidity problems. The cumulative effects of the reasonably foreseeable projects with the P&G Based Alternative would be slightly adverse due to cumulative sediment introduced through runoff from the various construction activities. However, it is anticipated that the sediments that could cumulate from all these activities would be very low with the implementation of storm water control features and best management practices required during construction.

Wetlands.
The P&G Based Alternative would have moderate beneficial cumulative impacts to wetlands within the study area. As identified within the future without a project conditions loss of value to wetlands in the study area will continue due to lack of regulatory requirements or general interest in maintenance of these wetlands which largely fall on private property. Substantial regulations in place would limit the loss of acreages of wetland due to direct impacts, however general deterioration would continue absent the construction and maintenance of wetlands within the framework of a project specifically oriented to maintain wetland values. The P&G Based Alternative

would provide a framework for that to occur resulting in development of wetlands and several existing sump areas that would be managed for the life of the project.

Woodlands.
Woodlands include both riparian and upland hardwoods. The P&G Based Alternative would have no impacts to upland forest and therefore there would be no cumulative benefits or impacts to upland forests from this action. The NER component of the P&G plan includes restoration of riparian forests in the area. However considering that upland woodlands and riparian woodlands are diminishing in quantity and value in the study area and considering the impacts of identified reasonably foreseeable future activities of others in the area between there would be a slight beneficial cumulative impact to woodland resources attributable to the project.

Grasslands.
Throughout the entire metropolitan area, and within areas the urban complex will likely continue to expand in, grassland of all types will be incorporated into a mosaic of landscaped and manicured lawns. The direct impacts identified from the P&G Based Alternative would be small, however these impacts when considered with the general decline in acreage and quality of grassland within the area result in a slight cumulative adverse impact to this resource.

Aquatic Habitat.
The P&G Based Alternative generally has only minor beneficial impacts to aquatic habitat, mainly related to providing spawning and rearing habitat associated with construction of oxbows. However, within the region considering the effects of others past, present and reasonably foreseeable projects, there are no identifiable cumulative effects to aquatic resources.

Air Quality.
Changes to this resource can affect a large geographical area as well as a large number of individuals. The P&G Based Alternative would have only short-term minor local impacts due to the construction equipment being utilized. The project would not intensify development nor cause additional impacts of significance. However, even these minor changes when considered with the effects of the population growth, continued reliance on use of automobiles for the mainstay of transportation, and expanding trade continues to produce slightly adverse cumulative impacts to air quality within the region.

Community Based Alternative plus Trinity Uptown Features

Water Quality.
The Community Based Alternative plus Trinity Uptown Features could have slight adverse impacts to water quality within the study area. Again, most of the proposed activities would occur directly in or along the watercourse increasing the likelihood of dust and loose sediment being released during construction. This could create temporary water turbidity problems. The cumulative effects of the reasonably foreseeable projects with the Community Based Alternative plus Trinity Uptown Features would be slightly adverse due to cumulative sediment introduced through runoff from the various construction activities. However, it is anticipated that the sediments that could cumulate from all these activities would be very low with the implementation of storm water control features and best management practices required during construction.

Wetlands.
The Community Based Alternative and Trinity Uptown Features would have slight beneficial cumulative impacts to wetlands within the study area. The Community Based Alternative and Trinity Uptown Features incorporates a plan to develop wetlands within a manageable area upstream of the major business districts of downtown Fort Worth. This construction would provide a framework for management to occur resulting in protected wetlands that would be managed for the life of the project. Because of the initial adverse impacts to wetlands, resulting from the other project features, however, the net cumulative impact is considered slightly beneficial.

Woodlands.
The Community Based Alternative with associated Trinity Uptown Features result in the initial removal of a significant quantity of both riparian and upland hardwoods. However, the complete plan, including ecosystem improvements, provides a net increase in woodlands resource values over the life of the project. Riparian woodlands are considered to have more significance from a regional and national level and this plan emphasizes development of riparian woodlands over upland forest. Cumulatively, the effect on woodland resources considering activities of others is slightly beneficial.

Grasslands.
As discussed for the P&G Based Alternative, grassland resources are diminishing in quantity and quality within the region. The Community Based Alternative with Trinity Uptown Features converts several acres of low quality grassland to other uses. While some grassland would be restored following construction, there would be losses. Considering the effects of other reasonably foreseeable projects, the additive effect of this alternative would result in a slight adverse cumulative effect to grassland resources.

Aquatic Habitat.
The Community and Trinity Uptown Features would increase the surface areas of lake like aquatic habitat. Within this region, abundant resources of this type have been developed, and therefore, the added area is not considered either beneficial or adverse to the existing system. The inundation of Marine Creek however does by itself constitute a significant impact to tributary stream habitat. At this point, there are ongoing considerations on appropriate means to mitigate this resource, and it appears that a solution to increase habitat values of a nearby stream and possible to Marine Creek above the area impacted by inundation would be sufficient to compensate for stream impacts. With the assumption that this stream mitigation plan is developed and implemented, the cumulative impacts to aquatic habitat would not be considered adverse.

Air Quality.
As was considered for the P& G alternative, air quality suffers as intensification of human population and attendant services occur. Therefore, it was considered that cumulative impacts from the Community Based Alternative would be slightly adverse. Studies conducted (Air Quality Assessment Report Fort Worth Central City Project Fort Worth, Texas, February 2005) have indicated that there is no concern that this intensification of development would jeopardize the ability of this region to meet air quality compliance requirements. In addition, master planning for the area that would be impacted by the Trinity Uptown Features could result in improvement of certain air quality parameters resulting from anticipated use of mass transit and the intended development of high intensity residential facilities in close proximity to work locations, thereby reducing the number of commuters utilizing transportation that is run by internal combustion engines.

ENVIRONMENTAL COMPLIANCE

Invasive Species, Executive Order 13112
The Executive Order establishes the concerns for widespread introduction of non-native plants and wildlife species to the United States and the potential for economic and environmental harm associated with those that have ability to spread relatively unchecked. This EO establishes processes to deal with this issue and among other items establishes that Federal agencies "will not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."

Invasive plants have been identified as being established and detrimental within the study area. The authorized plan would assist in the removal of invasive Ligustrum plants within the ecosystem improvement area associated with the improvement of existing riparian and upland woodlands and the long-term management of that area. No project feature would directly promote the spread of invasive species.

Section 404 of the Clean Water Act

The Corps of Engineers under direction of Congress regulates the discharge of dredged and fill material into all waters of the United States, including wetlands. Although the Corps of Engineers does not issue itself permits for construction activities that would affect waters of the United States, the Corps must meet the legal requirement of the Act. Section 404 (r) of the Clean Water Act waives the requirement to obtain a State Water Quality Certificate (Section 401) provided information on the effects of the discharge of dredged or fill material into waters of the United Sates is provided in an analysis conforming with the Section 404(b)(1) guidelines and included in the EIS and the EIS is submitted to Congress before the actual discharge takes place and prior to authorization or appropriation of funds for project construction. A Section 404 (b)(1) analysis has been completed and is presented in Tab G.2. The Corps intends to utilize the Section 404(r) exemption process. The project has been authorized; however, the EIS will be submitted to Congress prior to appropriation of funds and prior to the actual discharge of materials into waters of the United States.

Section 402 of the Clean Water Act

The construction activities that disturb upland areas (land above Section 404 jurisdictional waters) are subject to National Pollutant Discharge Elimination System (NPDES) requirements of Section 402(p) of the Clean Water Act (CWA). Within Texas, Texas Commission of Environmental Quality (TCEQ) is the permitting authority and administers the federal NPDES program through its Texas Pollutant Discharge Elimination System (TPDES) program. Construction activities that disturb one or more acres are subject to complying with TPDES requirements. Operators of construction activities that disturb 5 or greater acres must prepare a Storm Water Pollution Prevention Plan (SWPPP), submit a Notice of Intent to TCEQ, conducting onsite posting and periodic self-inspection, and accordingly follow and maintain the requirements of the SWPPP. During construction, the operator shall assure that measures are taken to control erosion, reduce litter and sediment carried offsite (silt fences, hay bales, sediment retention ponds, litter pick-up, etc.), promptly clean-up accidental spills, utilize best management practices onsite, and stabilize site against erosion before completion. The operator of Community Based Alternatives project is required to comply with these construction storm water permits requirements.

Section 176 (c) Clean Air Act

Federal agencies are required by this Act to review all air emissions resulting from Federal funded projects or permits to insure conformity with the State Implementation Plans in non-attainment areas. An analysis was conducted of the authorized plan including the likely development that would occur as a result of the Community Based Alternative development and it was determined that the project would not interfere with State Implementation Plans for this area.

Advisory Circular – Hazardous Wildlife Attractants on or Near Airports

The advisory circular provides guidance on locating certain land uses having the potential to attract hazardous wildlife to or in the vicinity of public-use airports. The circular provides guidance on wetlands in and around airports and establishes notification procedures if reasonably foreseeable projects either attract or may attract wildlife.

In response to the Advisory Circular, the United States Army as well as other Federal agencies, signed a Memorandum of Agreement (MOA) with the Federal Aviation Administration (FAA) to address aircraft-wildlife strikes. The MOA establishes procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States. The Corps of Engineers has initiated coordination with FAA providing verbal and written descriptions of the authorized project. Meacham International Airport has flight paths over the heart of the authorized project area, however no wetlands would be constructed near the within the area under or adjacent to the flight path. As of the publication date of the draft EIS, there has been no communication from FAA indicating that the project might attract hazardous wildlife into the vicinity. Communication with FAA will continue throughout the completion of the NEPA process as necessary.

Environmental Mitigation

AQUATIC

The USFWS has provided Planning Aid Letters, information that was utilized during the planning of this project, and have continued coordination with the Corps and local sponsors, to develop a plan to mitigate the impacts caused by inundating 1875 linear feet of exceptional and high quality Marine Creek lentic aquatic habitat and filling of approximately 400 linear of exceptional quality Lebow Creek aquatic habitat as result of implementing the Community Based Alternative**.**

Goal The goal of the aquatic mitigation plan is to compensate for changes in Marine Creek aquatic habitat and losses of aquatic habitat in Lebow Creek attributable to implementation of the Community Based Alternative. Construction and operation of Samuels Avenue Dam would inundate 1875 linear feet of Marine Creek of stream habitat warranting mitigation (FWS planning aid letter dated March 1, 2005. The construction of the dam would also result in the loss of 400 feet of riffle and pool habitat within Lebow Creek due to fill. Based upon studies conducted to date, approximately 1.46 average annual habitat units (AAHU) of high and exceptional quality stream habitat would be lost due to the project. Approximately 0.8 AAHU would be adversely affected within the exceptionally rated plunge pool and riffles in the lower segment of Marine Creek (Table G-4). Approximately 0.56 AAHU associated with "high" ranked fisheries habitat within the upper reach of Marine Creek would also be adversely impacted. Exceptional ranked habitat providing 0.10 AAHU would be lost in Lebow Creek. The goal of the aquatic mitigation is to mitigate these losses to the extent practicable.

Background Aquatic studies were conducted by the US Fish and Wildlife Service (Service) within the West Fork, Clear Fork, Marine Creek, Lebow Creek and Ham Branch (previously identified as an unnamed tributary within Harmon Park), to determine the existing fisheries communities and to describe the habitat within these streams. These studies were conducted on single events, the Trinity River sampling during the summer, and the tributaries during winter and spring. Study results were transmitted to the Corps of Engineers through a series of planning aid letters (Appendix G.5). The Corps has used the Regional Index of Biotic Integrity results for each site to calculate a Habitat Suitability Index (HSI) for each site evaluated and then to determine the aquatic habitat impacts within Marine and Lebow Creeks.

An initial evaluation of Lebow Creek indicated that diverting water from the pool resulting from construction of Samuels Avenue Dam to a point near Brennan Avenue, could provide improved aquatic habitat within Lebow Creek. In addition, replacement riffle and pool habitat would be constructed within the rerouted channel of Lebow Creek. An abbreviated evaluation of the proposal to change Lebow Creek from an intermitted Creek to permanent stream and to add riffle and pool features to the rerouted section would offset losses to Lebow Creek and partially mitigate aquatic losses in Marine Creek. Therefore additional aquatic mitigation was determined necessary.

The Service, Corps and TRWD initiated review of other potential aquatic habitat mitigation areas resulting in the identification of Ham Branch as a stream that could be protected and modified to provide additional stream habitat mitigation. Studies conducted by the Service indicate that Ham Branch had a Regional IBI of 33 which results in a determination that Ham Branch fish community demonstrates a limited aquatic life use value.

Ham Branch

Although separated from the West Fork of the Trinity River by the levee system, Ham Branch and adjacent low lying lands are frequently flooded from localized runoff. The main source of both continuous low flow and storm water appears to originate from the highly urbanized area of downtown Fort Worth (reference email from city of Fort Worth here). Base flow is perennial but appears to be less than one cubic foot per second. Storm water runoff surges are considerably larger but usually of short duration. Riparian corridor is limited in width and is mainly restricted to short segment near the TRE railroad. Currently it is estimated that the existing narrow riparian woodlands lying between the railroad and the levee is limited to approximately 1.4 acres.

Scant growth of understory and ground layer grasses, shrubs and vines were observed. The channel is adjacent to highly managed grasslands and recreational features such as practice fields and fenced soccer fields. Vegetation overhanging the channel is almost non existent, and scouring of the overbank and erosion of the channel banks is likely a problem during major events. Although some undercut banks, root snags, and fallen branches were identified within the channel, the predominant substrate was identified as silt and fine sand. The channel averages only 5 feet in width within the investigated reach. Two small excavated ponds adjacent to the channel have recently been connected to the creek either through man made activities or as a result of naturally occurring processes. Most fish collected in the study were within the reach adjacent to the better developed riparian woodlands and in proximity to the existing connected ponds.

Several underground utilities and one overhead utility was identified that could limit modifications to the system. The fenced soccer fields and the area immediately upstream of the levee provide limitations to the extent of resource modification that could be economically exercised.

Aquatic Mitigation Plan

The Corps of Engineers and local sponsor are committed to adequately mitigating impacts to Marine and Lebow Creeks, including developing necessary information to appropriately design the mitigation (Memorandum from TRWD). At this time, insufficient baseline information regarding seasonal flow, local topography, channel responses to alterations are known to develop the final design. This information will be developed and incorporated into a final plan that will be completed prior to impacting the aquatic habitat of Marine and Lebow Creek. In addition, following development of the final design, a monitoring and adaptive management plant will be developed and implemented to provide for compliance with the aquatic mitigation goals.

Lebow Creek

The mitigation plan for Lebow Creek includes the previously identified diversion of flows (up to 5 cfs) to provide improved aquatic habitat primarily by increasing the period of time per year that essential riffles, pool and run habitats are maintained. Additionally the 1500 linear feet of new relocated channel would be modified to include comparable riffles and pools to that which would be lost from filling 400 feet of Lebow channel. Shrubs and overhanging grasses would be included along the entire 1500 linear feet of diverted channel to provide shade and cover. A conceptual plan to provide this flow and channel

modification is shown in Appendix G, "Technical Memorandum ECO-7, Conceptual Habitat Mitigation Plan for Marine Creek Impacts". It is anticipated that these habitat improvement features if added to Lebow Creek could increase AAHU by 0.72 AAHU over without a project conditions.

Studies conducted during plans and specifications will concentrate on optimizing flow modifications by season and channel modifications within the reach between Brennan Avenue and the new confluence that would be geomorphically stable.

Ham Branch

Final design of Ham Branch mitigation features would be completed following additional studies to determine a stream configuration that is geomorphically stable based upon hydrology, sediment characteristics and slope. A typical cross section of the stream and its adjacent corridor that would be developed is shown on Figure G-5. A plan view showing the proposed configuration of the Ham Branch mitigation is shown on Figure G-6.

Development of a riparian forested buffer of 50 foot in width and at mature crown development on each side of the center line of the channel (total 100 foot width) would provide water quality and aquatic habitat improvement benefits. Contouring of the channel bank as necessary to provide appropriate interaction between the riparian vegetation and the aquatic environment would be done prior to reforestation. The Riparian plantings would include dense development of shrubs and overhanging grasses near the creek channel. Approximately 305 feet of the existing channel would be relocated to provide adequate width for riparian forest development adjacent to an existing fenced soccer field. Riparian forest would be planted on 7.4 acres and the existing 1.4 acres of riparian forest would be improved to provide a total 8.8 acres along the creek.

Within the channel, approximately 25 percent of the total length (3568 feet) of the stream segment would be modified, if determined appropriate during follow up studies, to provide 892 linear feet of rock based riffles at locations to be determined by those additional studies.

Water quality improvement, if found necessary to benefit aquatic habitat resources development, would be provided by construction of small off channel wetlands. An area has been identified that could provide approximately 0.6 acres of emergent wetlands. In addition a triangular shaped area between existing railroads at the outfall that drains the downtown Fort Worth area could be modified to develop up to approximately 0.7 acres of sediment and floating materials trap if needed.

Aquatic habitat benefits on Ham Branch would accrue on 3568 linear feet of stream channel and should provide up to 0.80 AAHU over without a project conditions. Stream habitat alternations proposed within Lebow Creek and Ham Branch should provide a combined 1.52 AAHU over without a project conditions thereby compensating for unavoidable impacts to Marine Creek and lower Lebow Creek. The benefits to mitigating within Ham Branch would go beyond the creek proper. It is anticipated that significant benefits to the water quality and fisheries within the West Fork immediately adjacent to the confluence should occur, however, current methods to quantify those benefits are unavailable. In addition, the construction of the riparian corridor adjacent to Ham Branch would provide additional

significant forest resources in the lower end of the study area, supporting resource agencies recommendations to provide resources of this type at additional locations within the study area.

Central City
Figure G - 5
Ham Branch, Proposed Typical Cross Section for Aquatic Habitat Mitigation

US Army Corps of Engineers
Fort Worth District


Sediment Pond
Wetland
Existing Ponds
Realignment
Central City
Figure G-6
Ham Branch Plan View
of Potential Aquatic
Habitat Mitigation Measures
Legend
Ham Branch
No Buffer
Buffered 50'
Aquatic Mitigation Measures
Zone
Channel
Riparian Buffer
Sediment Pond
Wetland
N
0 125 250 500
Feet
Aerial Photography Date: January 2003
US Army Corps
of Engineers
Fort Worth District
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USACE and the local sponsor in coordination with the U.S Fish and Wildlife Service have completed a compensatory mitigation plan for the Marine Creek and Lebow Creek stream habitat impacts. Additional refinement to that plan will be incorporated as appropriate based upon the results of additional studies which have already been implemented. Specialists have been also been coordinated with to identify studies needed to be conducted to incorporate stream geomorphology considerations into the aquatic mitigation design. The Corps has also committed to continue coordination with the US Fish and Wildlife Service and Texas Commission on Environmental Quality in the aquatic mitigation design process.

WETLANDS

The Community Based Alternative with Trinity Uptown Features exclusive of the ecosystem improvements proposed at Riverbend area would impact 8.8 acres of wetlands but would only impact 1.31 average annual habitat units as compared to the without a project future conditions. Approximately 15.02 acres of wetlands would be provided by addition of ecosystem improvements at Riverbend that would result in the ultimate provision of 13.78 AAHUs of wetland values. As a result, after implementation of the Community Based Alternative, Trinity Uptown Features, ecosystem improvements there would be 20.52 acres of wetlands having 14.39 AAHUs within the study area. Provided the plan is implemented completely as proposed, including the ecosystem improvements at Riverbend as described, the plan would adequately mitigate the 1.31 AAHUs of wetland lost.

WOODLANDS

Riparian Woodlands
The Community Based Plan would adversely impact 34.5 acres having 17.67 AAHUs associated with riparian woodlands. The Community Based Plan and Trinity Uptown Features would impact about 35.7 acres and 18.36 AAHUs as compared to the without a project condition. However, ecosystem improvements at Riverbend and Rockwood areas would more than offset that loss, providing a net gain of 41.47 AAHUs of riparian forest. To satisfy project goals 18.36 AAHUs of the ecosystem improvements should be designated as environmental mitigation for riparian forest.

Upland woodlands

The Community Based Plan and Trinity Uptown Features would cause a loss of 67.9 acres of upland forest and a loss of 48.82 AAHUs compared to the future without a project condition. After development of ecosystem improvements at Riverbend and Rockwood areas a net loss of 33.40 AAHUs would occur to upland forest. Upland forests in the study area were identified by the Fish and Wildlife Service having a Resource Category 4 in accordance with their mitigation policy. Consistent with that categorization, it is appropriate to consider either to mitigate out of kind or to mitigate with additional upland forest habitat development. As currently planned there are more benefits attributable to the riparian forests than are lost, and it is appropriate to consider those surplus benefits toward mitigation of upland forest losses. As there was a net gain of 41.47 AAHUs of riparian compared to the net loss of 33.40 AAHUs of upland forest, out of kind mitigation by designation of an additional 33.40 AAHUs of the riparian forest ecosystem improvement benefits is recommended as the mitigation strategy for upland forest habitat losses.

In addition to the specific average annual habitat unit mitigation goals identified, it is also proposed that a specific plan to identify the precise mitigation tract within the ecosystem improvement area for wetlands, riparian forest and upland forest would be identified during later planning phases. In addition, management plans, including monitoring and providing for adaptive management will also be developed for the identified aquatic, wetland and terrestrial mitigation objectives.

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