APPENDIX D

ECONOMICS

APPENDIX D

ECONOMIC ANALYSIS

GENERAL METHODOLOGY

Purpose and Scope

The principal purpose of this economic analysis was to identify the extent of the flood problem and comparably evaluate solutions to reduce flood losses. As part of these activities, a field survey was conducted to identify the numbers and types of property, and the value of the investment affected by flooding. Calculations were done to develop estimates of the damages and benefits assignable to the various flood protection plans investigated. This analysis was conducted following procedures and guidelines as set forth in the Water Resources Council's Principles and Guidelines (July 1983) and current implementing regulations.

Due to its complexity, the plan formulation for this reevaluation occurs in three stages - 1991-1993, 1993-1996, and 1996-1997. The results of the first two stages are summarized with the final array presented in detail. Annual benefits were determined by subtracting residual flood losses from the without project losses. Significant future changes in hydrology and increased urbanization in the flood plain areas are anticipated in this study, however equivalent average annual damages were assessed for with and without project conditions only in the final stage (1996-1997) of the analysis.

The prevailing price, level of development and the Federal interest rate were documented and applied accordingly. Final estimates of the total array of the plans flood damages and benefits presented herein reflect January 1997 prices and level of development, and a Federal interest rate of 7.375 percent. The Recommended and the Locally Preferred plans were updated to reflect the Fiscal Year 1998 interest rate of 7.125 percent. This rate was also applied to convert first costs and undiscounted future damages and benefits to average annual equivalent values.

Flood Profiles and Delineations.

A full range of water surface profiles, based on existing stream conditions, was developed for this study. These profiles were used to delineate the flood plain limits and determine the relationship of damageable properties to both elevation and frequency of flood occurrence. The satisfactory development of the hydraulic model in each reach was a multistage iterative process, with the reasonableness of the resulting economic effects being used to help in refining the hydraulic models used.

Probabilities of Flood Events

USACE policy (as per ER 1105-2-101) states, "The estimate of NED benefits and costs will be reported as single expected value and on a probabilistic basis for each planning alternative." This requires the classical nomenclature describing the relative risk of given flood events to be changed to reflect the actual probability, rather than the average recurrence interval, of flood events.

For example, the commonly used term "100-year frequency flood", meaning that flood which stands a one percent chance of being equaled or exceeded in any given year period will hereafter be described as the "1 percent annual chance exceedance (ACE) flood". For convenience, the new probabilistic nomenclature will be abbreviated as "1 percent ACE flood".

The classical terminology and the equivalent current terminology for this report is shown below

Classic Terminology	*Current Terminology*
1-Year Flood	<100 Percent Annual Chance Exceedance Flood
2-Year Flood	50 Percent Annual Chance Exceedance Flood
5-Year Flood	20 Percent Annual Chance Exceedance Flood
10-Year Flood	10 Percent Annual Chance Exceedance Flood
25-Year Flood	4 Percent Annual Chance Exceedance Flood
50-Year Flood	2 Percent Annual Chance Exceedance Flood
100-Year Flood	1 Percent Annual Chance Exceedance Flood
500-Year Flood	.2 Percent Annual Chance Exceedance Flood
800-Year Flood	.125 Percent Annual Chance Exceedance Flood

Damage Categories.

Damageable property and costs associated with flooding are divided among five damage categories. Flood damages are calculated in terms of structure and content damage and loss, damage to infrastructures, costs to the public in subsidizing flood insurance, and the cost to combat floods and provide emergency management. These categories are detailed in table D-1.

Data Collection.

In May 1991, an inventory was made of the floodplain lands along the subject streams to identify existing flood plain development. Due to the large size of the floodplain, residential structure data for this inventory was collected in aggregates of city blocks. It included enumeration of the numbers and types of structures within the SPF limit. Existing damageable properties were classified into the major damage categories. This inventory was field-checked and extensively supplemented in June 1992. Surveys were also taken of individual homes within a sample residential city block. Statistical relationships between the sample residential data and the original aggregated data for the same blocks were used to calibrate the aggregated residential data set as a whole. Individual surveys of all nonresidential properties were taken.

A determination was made of the value of flood plain investment (structures and contents) for each major damage category, based on data provided by the Dallas County Tax Appraisal District. These data, which were reviewed by Real Estate Division personnel in Fort Worth District, represent the depreciated replacement value of each structure, net of the value of associated lands. The value of existing residential contents was assumed to be 50 percent of the structure value. The values of contents for the other damage categories were based on direct field observation and interviews with property owners, and the relationships between structure value and content value observed in previous studies of similar areas.

Table D-1
Major Damage Categories

Damage Category	Activity Description
Residential	Single and multifamily dwellings
Commercial & Industrial	Retail and wholesale businesses
Public	Public and quasi-public buildings
Flood Insurance Admin.	Costs to the public of flood insurance program administration
Other:	
Transportation	Streets, highways, and bridges
Communications & Utilities	Electrical, gas, telephone, sewerage, and water supply facilities and buildings
Public Health and Relief	Flood-fighting and related emergency management activities

Flood Damage Programs

The STDMA program, written in the Memphis District in 1977, was originally developed in to avoid certain analytical simplifications common to flood damage computer models of the time. Namely, that within a given reach all properties are at the same stream station and all flowlines are parallel. The program also improved the manipulation of multiple sets of hydraulics data. Since the start of its use in Fort Worth District, the program and its input data sets have been modified to incorporate ongoing field survey findings concerning depth-damage relationships for various kinds of property. More recently, the program has been expanded to provide automatic computation of expected annual benefits for flood proofing every structure to one, two and three feet above the finished floor, and other enhancements.

The STDMA program was used in this analysis to facilitate data tabulation, aggregation and segregation by reach and flood zone. Single-event damage estimates were extracted and entered in the HEC-FDA program to derive depth-damage curves. Average annual damage estimates per structure were used to evaluate nonstructural alternatives.

The NexGen Hydrologic Engineering Center-Flood Damage Assessment Program (HEC-FDA) was developed to facilitate the plan formulation and evaluation of flood damage consistent with federal and Corps of Engineer (COE) policy regulations (ER 1105-2-100 and ER 1105-2-101). The program integrates hydrologic engineering and economic analysis through application of the Monte Carlo simulation, a technique that computes expected value of damage while accounting for uncertainty in the basic value. This program was used to calculate stage-damage-uncertainty information at damage reach index locations and to compute equivalent annual damage.

Depth-Damage Relationships

The original depth-damage curve file was adapted, at the time STDMA was created, from the one used by the older 761-F5-M3020 flood damage computer program and was based on data from the U.S. Flood Insurance Administration. Current files were supplemented and modified based on the findings of numerous subsequent economic field surveys of flood plain properties in Fort Worth District, considering such factors as the design of the structure and nature of the structure contents. The depth-damage relationships determine damages after a comparison of flood elevation with the elevation of the finished floor of each structure. A finished floor – the lowest occupied floor of a building – is generally higher than the local ground elevation by an amount that varies with the structure (typically 0.5 to 1.5 feet above the ground for most detached residences and commercial establishments and 3 feet for mobile homes). For a vehicle, "finished floor" refers to the bottom of the engine block and the floorboard of the passenger compartment, and is assumed to be one foot above the ground.

Residential Vehicles

Formidable practical difficulties are directly related to field-surveying the number and value of residential vehicles in a flood plain at the various times that a flood might occur. Damages for residential automobiles were therefore estimated considering the average number of vehicles per residence characteristic of the study area, and their probability of being present at the time of a flood. An analysis was conducted of registered motor vehicles per occupied housing unit for counties within Metropolitan Statistical Areas in Texas (MSA), using data from the U.S. Census and the Texas State Department of Highways and Public Transportation. The number of registered vehicles per occupied housing unit in MSA counties clusters closely around a mean value of 2.48. However, not all registered motor vehicles are associated with private homes, and not all housing units are occupied. For simplicity, it was assumed that an average of 2.0 vehicles per gross residence exists, about 1.5 of which would be present during non-work hours (128 hours per week) and about 0.5 would be present during work hours (40 hours per week). The expected number of vehicles present at any given time that a flood might occur would therefore be

$$((128/168)*1.5)+((40/168)*0.5)$$

or 1.26 expected vehicles per residence. The exact number would vary depending on the assumptions made, but for further simplicity, and conservatism, it was assumed that one expected vehicle exists per residence, which would be present at the time of a flood. This vehicle was assumed to be at the same location as the structure with which it is associated, with the same stream station and ground elevation values. (As noted above, damages start when flooding reaches one foot above the ground elevation.)

It should be noted that this calculation of the expected number of vehicles that would be present in the flood plain at the time of a flood has nothing to do with the warning time flood plain residents would have. A flood affects only those vehicles present at the time of a flood, While a vehicle is usually the single-most valuable item of personal property, and by definition the most mobile, the overwhelming majority of urban floodplain users experience flooding with little or no warning time. This is either because of a steep flood hydrograph, a lack of a warning system, or both, and substantial vehicle damages are typically observed. In any case, the effects of increased flood warning time would take the expected number of flood plain vehicles as its baseline.

A strong positive correlation would be expected between the value of a residential structure and the value of the vehicles associated with it, based on general field observation. The relationship is not simply proportional, since an extremely low-value structure can have a vehicle worth as much as the structure itself, while the most affluent residence would have

vehicle worth not much more than a tenth of the value of the structure. Plausible average vehicle values result by assuming the following relationship for detached single-family residences:

$$V = (0.1*S)+1000$$

where V is the vehicle value and S is the value of the residential structure. The typical residence, with a structure value between $40,000 and $60,000, would have a vehicle worth $5,000 to $7,000. This is in good agreement both with field observation, the observed average age of the private vehicle stock (on the order of five years), the corresponding depreciation (about 50 percent), and the average vehicle cost when new (on the order of $10,000 to $15,000). An exception to this general formula is made for mobile homes, which have a much lower structure value relative to the economic status of the residents (which is the basic determinant of the value of their personal property, including vehicles). The assumed relationship for mobile homes is

$$V = (0.2*S)+1000$$

While each of these calculated vehicle values is assumed rather than empirical, varying them does not greatly affect the resulting assumed average vehicle value or the vehicular flood damages that result from using them. The above set of assumed relationships, although hypothetical, are considered realistic and a sufficient basis for planning purposes.

Flood Insurance Administrative Costs

A public cost is incurred for each flood insurance policy, reflecting the administrative costs of the national flood insurance program. The average cost per policy is $131 per year, which is applied to all structures within the 1 percent ACE (100-year) floodplain.

Other Damages

Damages associated with transportation, communications, and public utilities facilities, and with flood-fighting and public health and relief activities, are estimated based on historical data collected from the City of Dallas Public Works Department. Data includes documented costs submitted to FEMA following major flood events.

Frequency-Damage Calculations

Using the appropriate water surface profiles, the depth of water at each structure within the study area was calculated for the 0.00125, 0.002, 0.01, 0.02, 0.04, 0.1, 0.2, and 1.0 percent ACE flood events. These depths were combined with the damage susceptibility factors and estimated values to estimate damages. Damages to the various activities were accumulated by frequency to produce a frequency-damage function. Estimates of expected annual damages were calculated through an integration process using frequency-damage data. Generally, this involved aggregating the multiplication of the mean damage between each pair of flood events by the difference in exceedance probabilities for that pair of events, repeated over the entire range of flood events for each category of damageable property. These calculations were facilitated by the HEC-FDA program.

Magnitude and Extent of the Flood Problem

Descriptive information on the existing flood problem along the Trinity River is provided below. This includes field survey data and follow-up office analysis to ascertain the severity of the flood hazard, including:

- o Enumeration and estimates of existing flood plain properties.
- o Estimates of single occurrence flood losses for various events.
- o Estimates of average annual flood losses to existing properties.
- o Estimates of risk associated with selected flood events
- o Estimates of equivalent annual flood losses based on significant future changes in hydrology and urbanization.

STUDY AREA DESCRIPTION

Socioeconomic Conditions

The Bureau of the Census reports the population for the city of Dallas as 904,100 persons in 1980 and 1,007,600 persons in 1990. These figures account for more than 80 percent of the population in Dallas County. These figures also show an annual growth rate of over 10 percent. The 1996 population was estimated at 1,039,100.

Employment in the service industry highlights the significant shift from a manufacturing-based economy to a service related economy. Over the 10-year period service industry employment increased almost 50 percent. Between 1990 and 1994 non-farm employment figures increased almost 4 percent. The construction industry lead the job growth figures in 1994 with an increase of over 10 percent.

The Texas Workforce Commission reported area unemployment 1994 at 5.3 percent. In 1996 the unemployment decreased to 3.9 percent and is currently reported by the commission at 3.6 percent. The employment rate continues to be lower than the state and the nation. Per capita income for 1995 was estimated at $18,180 with an average salary of about $30,000.

Dallas is a major hub for hundreds of rail routes. The major railroads that serve the Dallas area include: Burlington Northern, Cotton Belt, Kansas City Southern Lines, Santa Fe Railway, Southern Pacific and Union Pacific. Many of these lines traverse the study area. The city also provides public transportation with a net work of local and suburban bus routes, light rail, and High Occupancy Vehicle lanes.

Reach Determination

The study area is located along the Trinity River in the southern sector of the city of Dallas. The initial area of investigation can be defined as that portion of the Trinity River between the confluence of Five Mile Creek, near Interstate-20 (I-20) downstream and the terminus of the existing Dallas Floodway Levee System upstream. However, preliminary analysis revealed significant hydraulic correlations between the extension area and the existing levee system upstream. Specifically, implementation of flood control projects in the extension area significantly influences the performance of the Dallas Floodway Levee System. Subsequently, about eight miles of the Dallas Floodway Levee System was included in the study area. To facilitate the analysis of benefits and inducements in both locations the study area was divided

accordingly. The Dallas Floodway Extension is referred to as the Primary Study Area and the Dallas Floodway Levee System as the Secondary Study Area.

The primary study area was surveyed in 1991 and included all properties identified within the standard project flood (SPF) floodplain along the Trinity River and the White Rock Creek Tributary between station 499+14 and station 954+04. This area was considered the primary study area. The secondary study area includes all properties protected by the Dallas Floodway Levee System between station 1083+80 and 1180+00. The reach extends from the terminus of the levee system to the confluence with the West Fork of the Trinity River. These primary and secondary study areas were further subdivided into reaches based on concentrations of damageable properties. The reach boundaries are shown in table D-2.

Table D-2
Study Area Reach Boundaries

Reach	Reference Name	Station Range	Index	Bank
Primary Study Area				
Reach 1	Sleepy Hollow	499+14 to 823+61	768+24	Both
Reach 2	White Rock Creek	823+61 to 859+16	859+16	Both
Reach 3	Rochester Park	859+16 to 998+01	998+00	Left
Reach 4A	Lamar Street	895+27 to 1083+80	998+00	Left
Reach 4B	Oakland Channel	895+27 to 1083+80	998+00	Left
Reach 5	Cadillac Heights	998+00 to 1083+80	1011+38	Right
Reach 6	Treatment Plant	954+04 to 1011+38	1011+38	Right
Secondary Study Area				
Reach 7	East Levee	1083+80 to 1180+00	1083+80	Left
Reach 8	West Levee	1083+80 to 1180+00	1083+80	Right

Detailed Reach Description

Primary Study Area: This area begins at the Atchison, Topeka and Santa Fe Railroad (AT&SF) upstream and extends southwesterly to the river crossing at I-20. The study area also includes floodplain lands along the White Rock Creek Tributary from I-30 to its confluence with the Trinity River. Under existing conditions the .125 percent ACE floodplain encompasses over 10,400 acres and the 1 percent chance exceedance flood over 9,200 acres. A map of the total study area is presented in the main report. To facilitate the analysis the study area was separated into the following reaches:

Reach 1 (Sleepy Hollow): Extends from the confluence of White Rock Creek south eastward to the confluence of 5-Mile Creek. The reach is bounded by I-20, the MKT Rail Road, and Linfield and Riverwood Roads. This reach includes the Sleepy Hollow Golf Course located near the river and Loop 12. The land use includes commercial, industrial, residential, and public facilities. The McCommas Bluff and Linfield landfill sites are located in this reach.

Reach 2 (White Rock): Includes a portion of the White Rock Creek Tributary from I-30 upstream to its confluence with the Trinity River near Linfield Street. The reach is further bounded by Pemberton Road, I-30, the Southern Pacific Railroad and the Rochester Park Levee. Land use includes single and multi-family residential, commercial and industrial properties.

Reach 3 (Rochester Park): This reach is located near the center of the study area and is predominately enclosed along its southern border by the Rochester Park Levee. The reach is further bounded by Hwy. 175 (Hawn Freeway), and Hwy. 310 (Central Expressway). The land use is predominately single and multi-family residential and a few commercial and public properties.

Reach 4A (Lamar): This reach (initially combined with reach 4B) is located within the SPF floodplain limits along the east bank of the Trinity River. Beginning near the intersection of Lamar Street and Hwy. 175 and continuing northerly upstream to the AT & SF railroad. The reach is bounded on the east by Hwy. 310 (Central Expressway). The major land use categories include residential, commercial and industrial facilities.

Reach 4B (Oakland Channel): This reach (initially combined with reach 4A) is located parallel and to the east of Reach 4A. It is bounded by Hwy. 310 and Second Avenue. The Oakland Channel, which flows into White Rock Creek is located within this reach. The primary land use categories are single and multifamily residential and some commercial facilities.

Reach 5 (Cadillac Heights): Located on the West Bank of the Trinity River, the SPF limit of this reach extends from I-45 to the AT&SF Railroad at the end of the existing Dallas Floodway. This area includes single-family residential, commercial, industrial and public properties.

Reach 6 (Treatment Plant): This reach is located downstream of Reach 5 and consists solely of the Central Wastewater Treatment Plant facility. This public facility represents the greatest single investment in the study area.

Secondary Study Area: Property protected by the east and west levees between the floodway terminus and the confluence of the West Fork of the Trinity River is included in the secondary study area. The total investment behind these levees was estimated at over $5.7 billion.

Reach 7 (East Levee): This reach, located upstream of the primary study area, encompasses the SPF flood plain limits protected by the East Levee of the existing Dallas Floodway System. The area includes the Central Business District and a mixture of all land use categories. Commercial facilities dominate the reach (69 percent) with almost 1982 structures. A total of 2,885 structures was identified with an estimated value of over $4.8 billion.

Reach 8 (West Levee): This reach, located upstream of the primary study area, encompasses the SPF flood plain limits protected by the West Levee of the existing Dallas Floodway. The area includes all land use categories- residential and commercial and industrial and public facilities. Residential structures make up over 90 percent of the land use in this reach with over 6,900 identified. A total of 7,700 structures was identified with an estimated value of over $934 million.

Key Assumptions

- o Investigations through 1993 utilized the hydrological model developed for the original 1989 Upper Trinity River Reconnaissance Study, existing two foot topography maps and expected probability water surface elevations.

- o Property values, based on the Dallas County Appraisal District data, were adjusted to reflect depreciated replacement value.

- o Floodway extension is considered a modification to the existing floodway project. The benefits attributable to restoring the level of protection should be claimed and are not considered incidental benefits. The cost of the extension needs to be incrementally justified.

- o In accordance with PGL 26, Benefit Determination Involving Existing Levees benefits were based on Probable Failure Points (PFP) and Probable Non-Failure Points (PNP).

- o The chance exceedance flood event for the Rochester Park levee was estimated at the .68 percent ACE level and the Central Wastewater Treatment Plant at the .7 percent ACE level.

- o Prevailing interest rate of 8 percent for analysis conducted before fiscal year 1993.

- o 1993 analysis used standard frequency models and STDMA to determine benefits. Included benefits\disbenefits for overtopped levees upstream in existing Dallas Floodway.

- o Design grade is assumed for benefit and damage calculation. The height of the existing Federal Dallas Floodway Levee System was estimated to stand at the .23 percent ACE flood level based on the design grade. The Dallas Floodway System has settled in some areas and is not currently at design grade.

Structures and Investment Identified

Table D-3 displays the numbers and estimated total values of properties (structures and contents) identified within the Primary study area surveyed. A total of 2,640 structures was identified within the .125 percent ACE (SPF) flood limits, of which about 90 percent are located above the confluence of White Rock Creek. The total flood plain investment within the .125 percent ACE floodplain limit of the primary study area was valued at over $740 million based on June 1993 prices and level of development.

About 90 percent of the structures, representing about 11 percent of the value of floodplain investment, are residential. These are nearly all one or two-story detached residences, with an average structure value of about $26,000. Commercial and industrial properties represent 9 percent of the total number of structures and 10 percent of the total floodplain investment value. Although only 26 public structures are identified, they constitute 78 percent of the floodplain investment value.

Preliminary estimates of the investments protected by the Dallas Floodway Levee System were extracted from the 1989 Dallas Floodway Reconnaissance Report. Investments

of over $5.0 billion were identified within the SPF floodplain. The majority of these investments are commercial and industrial in nature.

Single-Occurrence Flood Losses

Cumulative single-occurrence flood losses by reach and flood zone under with and without-project conditions are presented in Table D-4. Within the primary study area, under without-project conditions, damages begin at the 50 percent ACE discharge in reach 4 for railroad facilities. A 10 percent ACE event could produce damages totaling $4.8 million. The 4 percent ACE flood discharge could produce damages that exceed $12.0 million. The 1 percent ACE event could produce losses totaling over $40.0 million. A significant increase in loss occurs with the .2 percent ACE event that could produce over $296.0 million in damage. This would represent about 48 percent of the floodplain investment. It was estimated that a .125 percent ACE event could cause direct structure and content damage of about $374.0 million based on June 1993 prices. A flood of this magnitude would destroy about 50 percent of the total investment in the primary study area. Estimates of flood losses for different single-occurrence flood events by reach, are presented in table D-4.

Single-event damages in the secondary study area were based on data used in the 1989 Dallas floodway Section 215 Reconnaissance Report. The preliminary investigation assumed the entire levee system to be at risk. The single-event damages for the levee system were reported as follows:

East Levee (E):	$7,247 billion
West Levee (W):	$1,550 billion
North West Levee (NW):	$ 388 billion

and tabulated based on a weighted-average of the damages occurring behind the three levees where,

Weighted Average = NW+(E+W+(E+W))/3,

which yields weighted average damages of $6,253 billion. These damages were updated to the prevailing price level based on an October 1988 index of 4555.4 and an October 1993-estimated index of 5208.8. The calculated factor of 1.43 was applied to yield total single-event damages of $7.15 billion for the secondary study area.

Table D-3
Total Floodplain Investments by Reach
(June 1993 Prices and Level of Development)
(1,000's $)

	Single-Family Residential		Multi-Family Residential		Commercial\ Industrial		Public		Total Structure Investment		Vehicles	Rail	Total Investment
	No.	*Value*	*No.*	*Value*	*No.*	*Value*	*No.*	*Value*	*No.*	*Value*	*Value*	*Value*	*Value*
Primary Study Area													
1	73	1,672.9	0	0.0	26	21,601.3	3	2,420.8	102	25,695.0	182.5	4,204.2	30,081.7
2	68	4,105.9	3	450.5	19	1,615.6	0	0.0	90	6,172.0	407.7	0.0	6,579.7
3	247	6,114.8	112	8,736.0	8	188.3	4	34,675.0	371	49,714.1	1,483.2	0.0	51,197.3
4	1,641	39,580.2	6	361.4	131	40,669.8	3	107,013.2	1,781	187,6247.6	2,295.2	6,682.2	196,602.0
5	215	6,025.5	0	0.0	66	17,035.2	0	0.0	281	23,060.7	661.7	1,535.5	25,257.9
6	0	0.0	0	0.0	0	0.0	15	434,133.0	15	434,133.0	0.0	0.0	434,133.0
	Area Total												
	2,244	$57,499.3	121	$9,547.9	250	$81,110.2	25	$578,242.0	2,640	$824,141.1	$3,732.9	$13,129.9	$743,851.6
%	85.0%	8.0%	5.0%	1.0%	9.0%	11.0	1.0%	71.0%	100.0%		1.0%	2.0%	100.0%

Table D-4
Cumulative Single-Event Damages

% ACE Event	1	2	3*	4	5	6*	Total
<100	$0	$0	$0	$13,129	$0	$0.0	$13,129
50	$6,083	$0	$0	$43,596	$22,479	$0.0	$72,158
20	$30,070	$365,150	$0	$243,976	$477,256	$0.0	$1,116,452
10	$317,055	$639,283	$0	$1,470,734	$2,470,518	$0.0	$4,897,590
4	$565,731	$687,813	$0	$6,750,943	$4,041,161	$0.0	$12,045,648
2	$834,462	$747,697	$0	$12,129,761	$5,895,266	$0.0	$19,607,186
1	$3,326,273	$1,116,522	$2,230,000	$24,671,859	$8,367,142	$24,489,000.0	$64,200,796
.2	$14,021,172	$3,448,877	$14,038,560	$91,586,716	$14,902,354	$158,841,900.0	$296,839,579
.125	$16,802,385	$4,001,853	$18,400,480	$102,406,626	$16,167,014	$216,891,800.0	$374,670,158

**Reach 3 assumes 148-year Rochester levee and reach 4 assumes 142-year Treatment Plant levees.*

1991-1993 INVESTIGATED PLANS

Expected Annual Damages

Estimates of expected annual damages under existing conditions were calculated through integration of frequency-damage data. Generally, this involved multiplication of the mean damages between each pair of flood events by the difference in exceedance probabilities for that pair of events. The process was repeated over the entire range of flood events for each category of damageable property. Incidental damages (comprising transportation, communications, and utilities' facilities, and public health and relief operations) were estimated based on the historical information submitted by the local sponsor documenting FEMA claims.

The total expected annual flood losses in the primary study area were estimated at over $4.1 million, based on June 1993 prices and level of development. Table D-5 details this information by reach and damage category. As detailed, damage to structures, contents and vehicles account for over 87 percent of the annual damages. Collectively, commercial and industrial, and public properties suffer the greatest financial loss. Losses to commercial and industrial properties contribute to about 30 percent of the total damages and public properties about 33 percent of the total damages.

Based on the water surface elevation occurring at stream station 165.71 just upstream of the AT and SF railroad, it was assumed that a breach could occur one-half foot below the top of the levee. This translates to a flood event with a .00226 probability of occurrence (442-year). Direct application of this probability to the single-event damages of $7.15 billion yields expected annual damages of $16,176,470 for the secondary study area.

Aggregated expected annual damages for both portions of the study area were tabulated as:

Primary Study Area	$ 4,160,516
Secondary Study Area	$16,176,471
Total	**$20,336,987**

Nonstructural Plans Investigated

General

Several nonstructural measures were evaluated during the plan formulation stage. Specifically, evacuation, relocation, and raising-in-place alternatives were investigated. Permanent evacuation within the primary study area was selected for detailed evaluation based on finished floor elevations. The accuracy of the following nonstructural evaluation was supported by estimates obtained from AWARE House and Structural Movers of Fort Worth, Texas for other nonstructural projects currently under investigation. The company described costs and problems associated with the demolition, relocation and raising of the flood prone structures consistent with those found in the Dallas Floodway Extension study area.

Table D-5
Existing Conditions Expected Annual Damages
(June 1993 prices and level of development)

Total Expected Annual Direct Damages							Total Expected Annual Incidental Damages						
Reach	*Res.*	*Comm/Ind*	Public	Vehicles	Rail	Primary Subtotal	Roads	Utilities	Emergency Aid	Clean-Up	Flood Insurance	Incidental Subtotal	Total Damages
1	$10,449	$117,682	$2,356	$1,702	$55,352	$187,541	$992	$1,567	$8,579	$3,039	$2,148	$16,324	$203,865
2	$23,328	$163,241	$0	$7,972	$0	$194,541	$3,443	$5,441	$18,985	$10,550	$1,499	$39,917	$234,458
3	$45,331	$658	$33,995	$8,016	$0	$88,000	$1,559	$2,464	$39,416	$4,778	$0	$48,217	$136,217
4	$200,432	$510,740	$323,497	$47,601	$346,038	$1,428,308	$15,867	$25,076	$161,375	$48,622	$26,124	$277,064	$1,705,372
5	$114,283	$481,849	$0	$19,692	$103,109	$718,933	$8,500	$13,433	$70,250	$26,045	$9,790	$126,018	$846,951
6	$0	$0	$1,033,143	$0	$0	$1,033,143	$66	$104	$139	$201	$0	$509	$1,033,652
TOTAL	$393,823	$1,274,170	$1,392,991	$84,983	$504,499	$3,650,466	$30,426	$48,085	$298,743	$93,235	$39,560	$510,049	$4,160,516
%	9.5%	30.6%	33.5%	2.0%	12.1%	87.7%	0.7%	1.2%	7.2%	2.2%	1.0%	12.3%	100.0%

Nonstructural Benefit Methodology

As stated in ER 1105-2-100, and IWR Report 88-R-2, page IX-12, benefits for removing individual structures from the flood plain are limited to the sum of:

annualized residual value of the vacated land, *or* average annual recreation benefits for the land

plus:

reduction in annual flood insurance subsidies:

agency cost:

average annual damages to the structure and its contents,

plus:

agent fees (at 15 percent of the estimated premium), and other administrative costs (at $131 per policy)

minus:

policy holders' cost:

estimated annual insurance premium (at $0.55 per $100 of structure value for the first $45,000 and $0.17 per $100 thereafter, plus $0.65 per $100 of contents value for the first $15,000 and $0.30 per $100 thereafter),

annual deductible ($500 each for structure and contents per flood occurrence, times the probability of a flood in a typical year), and

annual uninsured losses (5 percent of the structure value per flood occurrence, times the probability of a flood in a typical year)

plus:

average annual public damages prevented (that is, damages to communications and public utilities facilities, and costs for flood fighting and public relief) based on actual FEMA claims.

Nonstructural Analysis Results

Floodplain evacuation involves the acquisition and removal or demolition of frequently flooded structures from the flood plain. This alternative was initially evaluated for the evacuation of structures within the 10 percent ACE flood event according to the nonstructural economic criteria previously outlined. Eligibility under the evacuation alternative rests primarily with the economic criteria and the frequency of flooding. The structural integrity of the structure was not a factor in determining feasibility as in other nonstructural plans. Reaches 2 and 5 contain commercial and industrial structures within the 50 to 20 percent ACE flood events, which meet these nonstructural economic criteria. Table D-6 presents a summary of the economic analysis for the evacuation of eligible structures in reaches 2 and 5. The cost estimates include land acquisition, demolition and disposal, and the remediation of asbestos, lead based paint, and other hazardous non-CERCLA contaminants.

In reach 2 about $154,300 in annual damages would be eliminated with the permanent evacuation of 5 commercial structures. The first cost for this plan was estimated at about $874,800. The annual costs and claimable annual benefits are $75,800 and $145,600, respectively with a resultant benefit-to-cost ratio of 1.8 to 1.0 and excess benefits of about $66,000.

In reach 5 an estimated $419,000 in annual damages could be eliminated with the evacuation of only 2 commercial structures. First cost for this plan was estimated at about $580,300. The annual costs and claimable annual benefits are $50,800 and $410,800, respectively with a resultant benefit-to-cost ratio (BCR) of 7.6 and excess benefits of about $357,000. The benefits derived signal the need for a more detailed investigation to obtain empirical flooding evidence associated with the contents in these structures for this reach.

In summary, the permanent evacuation plans were economically feasible for 7 commercial structures. Total damages would be reduced damages by 12 percent in the immediate study area. The combined plans would have an estimated project first cost of $1,455,100. The total annual benefits and costs would be $556,400, and $133,400, respectively. The resultant BCR would be 4.2 to 1.0 with excess benefits of $423,100.

The Uniform Relocation Assistance Program requires that displaced property owners be compensated for losses attributable to evacuation. A maximum of $22,000 was allowed for residential structures to cover moving expenses, temporary lodging, and the cost to obtain housing in accordance with Federal guidelines. Maximum relocation expenses have not been set for commercial/industrial structures. These costs would be 100 percent non-Federal.

The local sponsor needs recreational facilities, however, a specific recreation design was not considered at this point since the BCR exceeds 1.0, and the structures are randomly located throughout the flood plain. It is recognized that individual structures may be selected for evacuation in conjunction with other flood control measures.

Table D-6
Summary of Estimated Benefits and Costs of Investigated Evacuation Plans
(October 1993 prices, 8.0 percent interest rate)
(in thousands of dollars)

Reach	Number of Structures	Total First Costs	Annual Costs	Annual Benefits	Benefit to Cost Ratio	Annual Net Benefits
Reach 2	5	$874.8	$75.8	$145.6	1.8	$ 66.0
Reach 5	2	$580.3	$50.8	$410.8	7.6	$357.0
Combined	7	$1,455.1	$125.1	$556.4	4.2	$423.0

Channel Plans Investigated

The preliminary design features a 5-mile channel extending from the downstream end of the existing Dallas Floodway upstream to Loop 12. The channel would be a grass-lined trapezoid with 3' horizontal to 1' vertical side slopes. Between the existing floodway upstream and continuing just below I-45 with alignment along the West bank of the Trinity River. At I-45 the channel would veer to the east and cross the river to the East bank, rejoining the natural channel at the center of the large oxbow and continue along the East bank to I-20. The channel was aligned to preserve at least 1 side of the river bank. Bottom width sizes investigated for this alignment included the 250', 200', 150', and 100'. The results of the analysis are shown in table D-7.

Project first costs' range from about $37.0 million to $75.0 million. Each plan would be feasible with B/C ratios ranging from 1.7 to 2.8. The optimum bottom width would be 150'. All four designs would increase the level of protection provided by the existing levees in the primary and secondary study portions of the study area and reduce damages in the unprotected primary study area by 50 to 75 percent. However, due to an unfavorable public acceptance, plans with fewer environmental impacts were evaluated.

Table D-7
Summary of Channel Alternatives
(Millions of Dollars)
(June 1993 prices and level of development, 8.0% interest)

Option	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
100' BW	$38.9	$3.6	$11.1	2.8	$6.5
150' BW	$52.1	$5.0	$11.9	2.4	$6.9
200' BW	$74.2	$6.3	$12.5	2.0	$6.2
250' BW	$78.3	$7.6	$13.2	1.7	$5.6

Levees Investigated

Levee designs for the 1 percent and .125 percent ACE flood events, were investigated for the left and right banks of the Trinity River between the existing Dallas Floodway Levee System and Hwy. 75 (Central Expressway).

Lamar Street Levee: Constructed along the left bank with an average height of about 27' with 3.5v on 1h side slopes and a length of about 2.5 miles. A 1 percent ACE levee would consist of a series of small levees with a typical height of about 15' and an aggregate length of about 13,200'.

Cadillac Heights/Treatment Plant Levees: Constructed along the right bank of the Trinity river between the Cedar Creek confluence and Hwy. 75. The levees are referred to as the Cadillac Heights Levee (Reach 5) and Wastewater Treatment Plant Levee (Reach 6). The design of each was based on the permitted design plan developed by the engineering firm of Halff Associates. The average height would be about 25' for the .125 percent ACE levee and 15' for the 1 percent ACE levee. The total length is about 1.3 miles.

As shown in table D-8, annual levee costs are supported by the annual benefits. It was not considered practical to construct single levees along the East or West bank of the Trinity because inducements would occur along the opposite bank. However, as a system, inducements to the existing floodway produced negative net benefits.

Table D-8
Summary of Levee Alternatives
(Millions of Dollars)
(June 1993 prices and level of development, 8.0% interest)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
100-Year Lamar	$9.0	$.8	$1.5	1.9	$.7
100-Year Cadillac	$9.1	$.8	$1.2	1.5	$.4
SPF Lamar	$14.6	$1.3	$2.2	1.7	$.9
SPF Cadillac\Treatment Plant	$29.3	$2.6	$2.8	1.1	$ .2
ALL 100-Year Levees	$18.2	$1.6	$2.6	1.6	($1.1)
All SPF Levees	$43.9	$3.9	$1.8	0.5	($2.1)

Vegetation Management

This plan would clear non-endangered species underbrush from the downstream end of the existing Dallas floodway to Loop 12. The width of the clearing would extend approximately 1,000' from each side of the centerline of the river leaving an overstory of tree cover from 20' upward and a 200' corridor of existing vegetation along the natural channel. Although some selective clearing and pruning may be required, an attempt to leave a buffer zone 100' wide for a riparian habitat along both sides of the river channel. Small parcels of the understory (shrubs and other vegetation of approximately 3-5 acres in size) left in existing state dotted throughout the 2,000 foot area. All remaining understory vegetation would be removed. Hydraulic performance of this alternative demonstrated the significant impact of vegetation on the water surface elevations. The alternative was removed from consideration due to the requirement for expensive, intense maintenance. However, hydraulic findings initiated development of the swale plan.

Swale Plans Investigated

An economic analysis was conducted to ascertain the performance of overbank swales. Bottom width (BW) sizes investigated include an average of 300', 500', 600' 900', 1,200' and 1,500' with both swales in place. The swale plan would clear the site of all non-endangered species vegetation. A description of these swales is given below.

Lower Overbank Swale: Extends from Hwy. 75 (Central Expressway) upstream beginning at least 100' from the edge of the east bank and continues downstream to about 2,000' below Loop 12, for a total length of 17,300' or 3.3 miles. The lower swale was designed with a slope of .0005 ft/ft.

Upper Overbank Swale: To maximize channel relief, this grass-lined, overbank swale was designed to work in conjunction with the lower overbank swale to maximize channel relief. The length of the Upper Swale is about 7,800' or 1.5 miles and extends from the confluence of Cedar Creek upstream to the river crossing of I-45.

The Multi-Objective Management (MOM) Approach was used to design the swales to avoid and minimize environmental impacts. The wider swales impact the higher quality habitat to a greater extent than the 300' BW to 500' BW swales. Fragmentation was unavoidable and will require significant mitigation. Approximately 3,200 acres of land would be required to offset the environmental impacts. Each size swale was determined to be economically feasible. Benefits

range from $9.0 million to $15.3 million, without future discharges. greatest net benefits between all the swale plans and among all the alternatives evaluated in the 1991 to 1993-period. The plan captured 75 percent of the floodplain damages. Further, investigations of the 1200' BW swale were not conducted during this period of analysis.

Table D-9
Economic Summary of Swale Alternatives
(Millions $, June 1993 prices and level of development, 8.0% interest)

Option	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
300' BW	$15.2	$1.4	$ 9.3	6.6	$ 7.8
600' BW	$23.7	$2.3	$11.8	5.2	$ 9.5
900' BW	$31.9	$3.1	$12.7	4.1	$ 9.6
1200' BW	$43.6	$4.4	$15.3	3.5	$11.0
1500' BW	$54.8	$5.4	$15.7	2.9	$10.2

Swale and Levee Combination Plans Investigated

An economic analysis was conducted to determine the benefits of placing a single levee along the eastbank of the river. Specifically, either 100-year or SPF levees along Lamar. The results of the analysis are shown below. These plans show significant net benefits, but would not be practical for implementation since damages to reaches 5 and 6 along the opposite bank would be incurred. The investigation showed that individual placement would not induce damages to the secondary study area. Table D-10 summarizes the results of this investigation.

Table D-10
Economic Summary of Various
Swale and Lamar Levee Combination Alternatives
(Millions $, June 1993 prices and level of development, 8.0% interest)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
300' BW & SPF	$27.5	$2.6	$ 8.4	3.2	$ 5.8
500' BW & SPF	$29.6	$2.8	$12.4	4.4	$ 1.8
600' BW & SPF	$30.6	$2.9	$14.1	4.9	$ 2.4
300' BW & 100-Yr	$24.2	$2.2	$ 8.9	4.0	$ 6.7
500' BW & 100-Yr	$26.1	$2.4	$17.8	7.4	$15.4
600' BW & 100-Yr	$27.6	$2.5	$21.4	8.4	$18.9

Recreation Plan

Benefits for the initial recreation plan were derived based on Region 4 facility needs and carrying-capacity factors extracted from the Texas Outdoor Recreational Plan (TORP). The TORP does not identify a net need for picnic facilities therefore, initial benefits were only calculated for the trail system. This project would generate at least $1.0 million in annual recreation benefits. The total estimated project first cost for the recreation plan is about $8.9 million, with a resulting BCR of 1.2 to 1.0. This plan could be adapted to either of the proposed swale alternatives. See Recreation Appendix for plan details.

Summary of 1993 Preliminary Analysis

The most cost effective plan from each category of investigated alternatives is summarized in table D-11. As shown, the optimized 1200' BW upper and lower east bank swales provide the greatest net benefits (not including recreation). This plan was therefore identified as the NED plan.

Table D-11
Economic Analysis of Most Cost Effective Alternatives

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
Non-Structural	$ 1.5	$0.13	$ 0.6	4.2	$ 0.4
150' BW Channel	$52.1	$5.0	$11.9	2.4	$ 6.9
100-Yr Lamar Levee	$ 9.0	$0.8	$ 1.5	1.9	$ 0.7
1200' BW Swale	$43.8	$4.4	$15.3	3.5	$11.0

1994-1996 INVESTIGATED PLANS

Key Assumptions

Adjusted hydraulic model to reflect computed probability water surface elevations.

Incorporated Trinity River hydrology models and topography from the Upper Trinity Study, which incorporated the effects of extending the 100-foot benched channel and raising the levees in the existing floodway levee system.

Updated structure files to current price level and level of development.

Used prevailing Federal interest rate of 7.63 percent.

Integrated Risk Based Analysis with Palisade @RISK model.

Estimated cost of plans were updated for price level and increased haul distance of excavated materials.

Updated Expected Annual Damages

Expected annual Damages under baseline conditions were revised to reflect current price level and changes in the development. The results also reflect the integration of the Upper Trinity River hydraulic model (refer to Appendix B) and the use of the risk based approach to damage assessment. Table E-12 shows the resulting expected annual damages by reach.

Table D-12
Updated Expected Annual Damages
Under Baseline Conditions

Reach	Annual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$338,200	$35,200	$373,400	Below White Rock
2	$58,400	$6,100	$64,500	White Rock
3	$168,000	$17,500	$185,500	Rochester Park
4	$1,853,800	$192,800	$2,046,600	Lamar Area
5	$986,000	$102,500	$1,088,500	Cadillac Heights
6	$1,254,200	$130,400	$1,384,600	Treatment Plant
Subtotal	$4,658,600	$484,500	$5,143,100	Primary Study Area
7	$12,131,000	$1,261,600	$13,392,600	East Levee
8	$1,102,400	$114,700	$1,217,100	West Levee
Subtotal	$13,233,400	$1,376,300	$14,609,700	Secondary Study Area
Total	$17,892,000	$1,860,800	$19,752,800	

Realigned Swale Alternative

The community's environmental concerns with regard to the impacts of the 1200' BW swales prompted the city to request an evaluation of a west bank alignment for the lower swale paired with the 300' BW upper swale from the original analysis. The Corps presented two alignment options-one through the Linfield Landfill and the other through the Joppa community. The selected alignment would be the basis for the Chain of Wetlands alternative. A description of the preliminary alignments and the selected alternative is shown below.

Linfield Bypass Swale: In conjunction with the 300' BW upper swale this alignment would place a 500' Channel between Loop 12 at the golf course, and the Linfield landfill. The maximum depth would be about 30 feet, with a minimum depth of about 9 feet. HTRW investigations showed manageable levels of contaminants within the landfill.

Joppa Bypass Swale: This plan would place a 500' BW Channel between Loop 12 at the golf course, and the Joppa neighborhood. This alignment would avoid the Linfield landfill and instead go through the Joppa neighborhood. This alignment would displace approximately 17 residents and impact about 68 properties. The alignment would also traverse a large pond, which was previously a gravel pit and a parcel of S&P railroad property that, has been cited as an illegal dumping area. This neighborhood is located outside the floodplain.

Chain of Wetlands: The resulting alignment consists of an undulating swale with connecting wetlands and pockets of sparsely treed areas within an open grassy area. The average depth is about 2 feet and the wetland areas are approximately 2 to 4 feet in depth. Vegetated areas would contain about 10 trees per acre.

Both alignments reduce damages within the study area by more than 30 percent and in the existing floodway by about 12 percent. Costs associated with the Linfield alignment were on par with the cost to relocate and abate contaminated areas associated with the Joppa alignment. Therefore, both plans were considered cost effective. The cost difference was insignificant and HTRW concerns were minimal for the two alignments. However, the residents in the Joppa neighborhood are not situated in the floodplain. Therefore, the plan formulation team used the Linfield alignment to develop the Chain of Wetlands alternative. The final design served to double the preliminary economic benefits. Overall, the economic analysis of the Chain of Wetlands design shows a reduction of damages in the primary study area by over 30 percent with net benefits of $4.1 million. A summary of the economic analysis is presented in table D-13.

Table D-13
Summary of Revised Swale Alternatives
(Millions of Dollars, 7.63 interest, Oct' 1995 prices)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
Linfield Swale	$35.0	$2.9	$7.2	2.5	$4.4
Joppa Swale	$33.4	$2.8	$6.3	2.3	$3.5
Chain of Wetlands	$50.6	$4.2	$9.4	2.2	$5.2

Evaluation of Combination Plans

The three plans considered above were combined with either the 1 percent ACE (100-year) or .125 percent ACE (SPF) levee to determine the economic efficiency of providing a higher level of protection and facilitate the local sponsor in selecting a plan. Each plan was combined with adding .125 ACE levees to both the East and West banks or adding an .125 ACE height east levee and extending the existing 1 percent ACE levee height around the treatment plant to include the Cadillac Heights neighborhood. The results of this analysis are presented below. As shown in table D-14 the plan with the greatest net benefits is the 1200' BW swale. This plan, not including recreation generates net benefits of $8.6 million and was designated as the NED plan. However, the Chain of Wetlands along with SPF Lamar and Cadillac Heights levees is preferred by the local sponsor. Accordingly, the final array of alternatives to be investigated in detail includes the Authorized Plan (for comparison purposes), the 1200' Swale (NED), the Chain of Wetlands (COW), and the COW plus SPF levees.

Table D-14
Summary of NED Plan Determination
(Millions of Dollars)
(Oct 1995 prices and level of development, 7.63% interest)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit to Cost Ratio	Net Benefits
Authorized Plan*	$166.7	$6.3	$10.2	1.6	$4.0
1200' BW Swale	$47.5	$4.3	$12.8	3.0	$8.6
Chain of Wetlands	$50.6	$4.2	$9.4	2.2	$5.2
Chain of Wetlands w\SPF Levees	$82.6	$7.2	$11.5	1.6	$4.3

*Based on interest rate of 3.25 percent.

INVESTIGATED STRUCTURAL PLANS 1996-1997

Key Assumptions and Methodology

Without project conditions assume the locally constructed levees are not in-place. The Rochester Park Levee (reach 3) and the Central Wastewater Treatment Plant Levee (reach 6) each offer a 0.0067 percent ACE flood level. Both levees were constructed by the city of Dallas during the study investigation. The WRDA 1996 document grants the city of Dallas credit for the portions of these levees that are compatible with the authorized plan. Therefore, the revised without project conditions reflect the pre-1991 floodplain (no Rochester levee and the treatment plant at a 2 percent ACE levee height).

Supplemented the structure file data gathered through survey and Dallas County Appraisal District with information from Upper Trinity Study.

Further divided Reach 4, located in the primary study area into reaches 4A and 4B to account for unique hydrological characteristics.

Further divided Reach 7, located in the secondary study area into reaches 7 and 8 to account for unique hydrological and economic characteristics.

Interest rate of 7.375 percent.

Revised Investment Value

Table D-15 displays the numbers and estimated total values of properties (structures and contents) located within the primary study area after applying the revised hydrology model. A total of 2,550 structures was identified within the SPF limits. As shown, the total flood plain investment within the SPF limit of the primary study area was valued at over $840.0 million based on January 1997 prices.

Table D-15
Total Floodplain Investments by Reach
Under Existing Conditions
(January 1997 Prices and Level of Development)
(1,000's $)

Reach	Single-Family Residential		Multi-Family Residential		Commercial\ Industrial		Public		Total Structure Investment		Vehicles	Rail	Total Investment
	No.	*Value*	*No.*	*Value*	*No.*	*Value*	*No.*	*Value*	*No.*	*Value*	*Value*	*Value*	*Value*
Primary Study Area													
1	73	1,768.3	0	0.0	26	22,876.1	3	2,558.8	102	27,203.2	192.9	4,443.8	31,839.9
2	68	4,339.9	3	476.1	19	1,707.7	0	0.0	90	6,523.7	430.9	0.0	6,954.6
3	247	6,463.4	112	9,234.0	8	199.0	4	36,651.5	371	52,547.9	2,021.0	0.0	54,568.9
4A	107	2,715.3	6	382.0	68	34,194.2	0	0.0	181	37,291.5	345.3	7,063.1	44,699.9
4B	1,432	34,189.1	0	0.0	61	5,102.8	4	177,768.0	1497	217,059.9	0.0	0.0	217,059.9
5	228	6,630.1	0	0.0 6	66	18,006.2	0	0.0	294	24,636.3	742.8	1,623.0	27,002.1
6	0	0.0	0	0.0	0	0.0	15	458,878.6	15	458,878.6	0.0	0.0	458,878.6
	Area Total												
	2,155	$56,106.1	121	$10,092.1	248	$82,086.0	26	$675,856.9	2,550	$824,141.1	$3,732.9	$13,129.9	$841,003.9
%	84.5%	6.7%	4.7%	1.2%	9.7%	9.8%	1.0%	80.4%	100.0%		0.4%	1.6%	100.0%
Secondary Study Area													
7	869	75,871.6	3	1,691.3	1,982	4,553,940.5	31	$220,968.8	2,885	$4,852,472.2	$5,058.1	N/A	$4,857,530.3
8	6,493	$297,262.5	474	$110,933.0	642	$440,403.4	94	$58,497.6	7,703	$907,096.5	$27,221.7	N/A	$934,318.2
	Area Total												
	7,362	$373,134.1	477	$112,624.3	2,624	$4,994,343.	125	$279,466.4	10,588	$5,759,568.7	$32,279.8	$0.0	$5,791,848.5
%	69.5%	6.4%	4.5%	1.9%	24.8%	86.2%	1.2%	4.8%	100.0%		0.6%	0.0%	100.0%
Total Investment													
	9,517	$429,240.2	598	$122,716.4	2,872	$5,076,429.	151	$955,323.3	13,138	$6,583,709.8	$36,012.7	$13,129.9	$6,632,852.4

Risk Assessment Assumptions and Values

In the evaluation of levee projects an element of risk is associated with levee failure. Damage calculations and risk assessment require integration of hydrological, hydraulic and economic data. Table D-16 details each element of data used to assess damages with the FDA program.

Calculations of potential flood losses were extracted from the STDMA model and used to approximate property damages by depth in the primary study area and transferred to the HEC-FDA program to calculate average annual and equivalent annual damages. Hydrological input values included a 40-year period of record for the stream gauges.

The GIS database for the Upper Trinity River was used to estimate potential flood losses in the secondary study area. The estimates were calculated based on water surface elevations with one foot increments. The Dallas Floodway Levee System was constructed to Federal standards. However, failure of the East Levee could occur first since the lowest point is at an elevation of 423', while the West Levee's lowest elevation is 428'.

The hydraulic rating curve was combined with the economic damages to derive the depth-damage curves with a 10 percent margin of error. Since the risk approach was integrated late into the study effort, primary damages were not disaggregated by category.

Table D-17 summarizes the parameters used to model the effects of each levee by condition and plan of improvement. Geotechnical investigations concluded that the top of the levee and the potential failure and non failure points were equal. This conclusion was based on the assumption that all levees were constructed to Federal standards.

Table D-16
Hydrologic, Hydraulic and Economic Parameters by Reach and Elevation

Idx # 76824 (134200)	Sleepy Hollow Area	
	Reach 1	SD1
392.0	$10,710	$1,071
393.7	$15,960	$1,596
396.1	$245,110	$24,511
398.2	$362,347	$36,235
400.3	$580,205	$58,021
402.3	$1,542,677	$154,268
404.2	$4,216,900	$421,690
409.8	$16,255,577	$1,625,558
413.1	$19,786,841	$1,978,684
419.7	$30,135,850	$3,013,585

Idx # 85916 (143280)	White Rock Creek Area	
	Reach 2	SD2
395.7	$0	$0
398.0	$0	$0
400.3	$0	$0
401.4	$16,482	$1,648
403.6	$130,545	$13,055
405.7	$346,016	$34,602
407.6	$662,373	$66,237
413.0	$3,309,568	$330,957
416.3	$4,209,974	$420,997
423.2	$6,579,634	$657,963

Idx # 99800 (157060)	Rochester Park Area	
	Reach 3	SD3
400.4	$0	$0
402.0	$15,231	$1,523
404.6	$273,530	$27,353
406.4	$1,549,743	$154,974
408.9	$7,005,213	$700,521
410.7	$10,297,280	$1,029,728
412.7	$14,523,630	$1,452,363
418.6	$33,622,060	$3,362,206
422.2	$43,019,190	$4,301,919
429.4	$51,197,260	$5,119,726

Idx # 99800 (157060)	Lamar Street Area	
	Reach 4A	SD4
399.9	$114,255	$11,426
401.4	$180,642	$18,064
404.0	$826,621	$82,662
405.7	$2,391,595	$239,160
408.3	$7,681,784	$768,178
410.0	$10,487,711	$1,048,771
412.1	$13,511,957	$1,351,196
418.1	$23,889,189	$2,388,919
421.8	$26,680,326	$2,668,033
429.1	$37,636,890	$3,763,689

Idx # 99800 (157060)	Oakland Channel Area	
	Reach 4B	SD4
399.9	$0	$0
401.4	$0	$0
404.0	$0	$0
405.7	$2,269	$227
408.3	$210,268	$21,027
410.0	$433,059	$43,306
412.1	$1,287,991	$128,799
418.1	$27,358,890	$2,735,889
421.8	$58,756,050	$5,875,605
429.1	$177,768,100	$17,776,810

Table D-16 Continued
Hydrologic, Hydraulic and Economic Parameters by Reach and Elevation

Idx # 101138 (158420)	Cadillac Heights Area	
	Reach 5	SD5
400.4	$26,410	$2,641
402.0	$61,761	$6,176
404.6	$1,468,049	$146,805
406.4	$2,491,248	$249,125
408.9	$4,396,107	$439,611
410.7	$6,209,722	$620,972
412.7	$8,108,719	$810,872
418.6	$14,237,124	$1,423,712
422.2	$16,934,474	$1,693,447
429.4	$25,568,600	$2,556,860

Idx # 101138 (158420)	Central Wastewater Treatment Plant	
	Reach 6	SD6
400.4	$0	$0
402.0	$0	$0
404.6	$0	$0
406.4	$0	$0
408.9	$0	$0
410.7	$39,432,230	$3,943,223
412.7	$52,375,320	$5,237,532
418.6	$167,461,000	$16,746,100
422.2	$286,604,600	$28,660,460
429.4	$434,133,000	$43,413,300

Idx # 108380	Dallas Floodway East Levee	
Elev	Reach 7	SD 7
423.0	$ 3,485,628	$348,563
424.0	$3,961,690	$396,169
425.0	$4,299,849	$429,985
426.0	$4,381,467	$438,147
427.0	$4,476,384	$447,638
428.0	$4,591,795	$459,180
429.0	$4,684,571	$468,457
430.0	$4,802,384	$480,238
433.0	$5,155,962	$515,596

Idx # 118000	Dallas Floodway West Levee	
Elev	Reach 8	SD 8
427.0	$618,269	$61,827
428.0	$683,911	$68,391
429.0	$732,957	$73,296
430.0	$777,231	$77,723
431.0	$806,637	$80,664
432.0	$842,322	$84,232
433.0	$886,892	$88,689
434.0	$924,980	$92,498
438.0	$1,034,088	$103,409

PMF Values based on total zone value.
SD band assumed to be =/- 10%.
Numbers in () are DFE original stations and index points
Reach 7 and 8 calculated using GIS

Table D-17
Summary of Levee Assumptions
by Condition and Alternative

Levee	Existing (Pre '91)			Current (Post '91) NED Chain of Wetlands			COW+SPF+SPF			COW+SPF+100-Yr		
	Top	PFP	PNP	Top	PFP	PNP	Top	PFP	PNP	Top	PFP	PNP
Rochester Park				415.00	415.00	413.00	421.02	421.02	421.02	421.02	421.02	421.02
Treatment Plant	413.40	413.40	412.40	415.00	415.00	415.00	415.00	415.00	415.00	415.00	415.00	415.00
Lamar 4A							421.02	421.02	421.02	421.02	421.02	421.02
Lamar 4B												
Cadillac Heights							421.85	421.85	421.85	418.00	418.00	418.00
East Levee	423.00	423.00	423.00	423.00	423.00	423.00	425.20	425.20	425.20	425.20	425.20	425.20
West Levee	428.00	428.00	428.00	428.00	428.00	428.00	428.00	428.00	428.00	428.00	428.00	428.00

Expected Annual Damages

Expected annual damages were tabulated for the final plan formulation phase based on the aforementioned assumptions. The NexGen FDA program was utilized to perform these calculations. Incidental damages (comprising transportation, communications, and utilities facilities, and public health and relief operations) were added to the results to obtain the total expected annual damages by reach for the primary and secondary study areas.

Damages for two without-project conditions were calculated. The existing conditions model assumes a pre-1991 scenario (prior to construction of the Rochester Park and CWWTP levees). The current conditions model assumes that both local levees are in-place. The expected annual damages are shown in table D-18

Under pre-1991 conditions the annual damages were estimated at $19.7 million. Under current conditions the annual damages would be about $18.5 million. Raising the CWWTP levee reduced damages by $1.1 million and construction of the Rochester levee about $.2 million. As shown, these levee improvements produced a negative impact in the secondary study area by increasing the expected annual damages to the area by $222,000. This equates to a 2 percent increase compared to damages before construction. In either case the level of protection in the secondary study area remained above the .25 percent ACE (400-year) flood event.

Economic Analysis of Local Levees

An evaluation of the local levees was conducted to determine the hydraulic impacts to the primary and secondary study areas and the economic effectiveness of the projects. The projects were evaluated assuming a 50-year project life and an interest rate of 7.38 percent. The result of the economic analysis is shown in table D-19. Total benefits include floodplain user benefits as described in a later section.

From an economic standpoint, construction of the Rochester Park levee was not feasible. The $574,900 in annual benefits to the primary study area were significantly reduced by inducements of $417,000 in the secondary study area. Initial evaluation of this project only included the primary study area which showed a benefit-to-cost ratio of .6 to 1.0. After inclusion of the affects on the Floodway Levee System the ratio fell to 0.2 to 1.0.

The second construction phase of the local levees raised the level of protection for the CWWTP from a 2 percent ACE (50-year) event to a 1 percent ACE (100-year+3') event. The design of the levee raise also included mitigation swales that offset some of the negative impacts to the Floodway Levee System. The benefit to cost ratio was 1.02 to 1.0. As a combined project the levees produce a BC ratio of 0.55 to 1.0.

The inclusion of about $400,000 in floodplain user benefits would improve the benefit cost ratio for the Rochester levee, but it would remain below unity. Intangible benefits derived from the improvements include a significant reduction in the potential for loss of life and mental and financial stress to over 600 residents in the Rochester Park area. Additional benefits from the treatment plant levee raise are generated from the financial costs incurred from environmental fines. These fines are levied by the Environmental Protection Agency when a levee is not constructed to the 1 percent ACE (100-year) flood event.

Table D-18
Expected Annual Damages
Under Without Project Conditions

Pre-1991 Conditions

Reach	Annual Damages			Description
	Direct	Incidental	Total	
1	$294,200	$54,721	$348,900	Below White Rock
2	$50,800	$9,449	$60,200	White Rock
3	$431,500	$80,259	$511,800	Rochester Park
4A	$1,350,000	$251,100	$1,601,100	Lamar Area
4B	$741,100	$137,845	$878,900	Oakland Area
5	$1,085,700	$201,940	$1,287,600	Cadillac Heights
6	$1,696,300	$162,845	$1,859,100	Treatment Plant
Subtotal	$5,649,600	$898,159	$6,547,600	Study Area
7	$10,054,700	$1,870,174	$11,924,900	East Levee
8	$998,500	$185,721	$1,184,200	West Levee
Subtotal	$11,053,200	$2,055,895	$13,109,100	Upstream Levees
Total	$16,702,800	$2,954,054	$19,656,700	

Current Conditions w\Rochester Park & CWWTP Levees

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$294,200	$54,721	$348,900	$0
2	$49,700	$9,244	$58,900	$1,300
3	$102,700	$19,102	$121,800	$390,000
4A	$1,180,100	$219,499	$1,399,600	$201,500
4B	$724,000	$134,664	$858,700	$20,200
5	$912,700	$169,762	$1,082,500	$205,100
6	$1,150,300	$110,429	$1,260,700	$598,400
Subtotal	$4,413,700	$717,421	$5,131,100	$1,416,500
7	$10,232,100	$1,903,171	$12,135,300	($210,400)
8	$1,008,700	$187,618	$1,196,300	($12,100)
Subtotal	$11,240,800	$2,090,789	$13,331,600	($222,500)
Total	$15,654,500	$2,808,210	$18,462,700	$1,194,000

Pre-1991 Conditions w\CWWTP Raised to 100-yr+3'

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$294,200	$54,721	$348,900	$0
2	$50,800	$9,449	$60,200	$0
3	$385,600	$71,722	$457,300	$54,500
4A	$1,192,800	$221,861	$1,414,700	$186,400
4B	$724,000	$134,664	$858,700	$20,200
5	$923,400	$171,752	$1,095,200	$192,400
6	$1,119,800	$107,501	$1,227,300	$631,800
Subtotal	$4,690,600	$771,670	$5,462,300	$1,085,300
7	$9,982,000	$1,856,652	$11,838,652	$86,248
8	$994,300	$184,940	$1,179,240	$4,960
Subtotal	$10,976,300	$2,041,592	$13,017,892	$91,208
Total	$15,666,900	$2,813,261	$18,480,192	$1,176,508

Pre-1991 Conditions w\Rochester Park Levee

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$294,200	$54,721	$348,900	$0
2	$52,700	$9,802	$62,500	($2,300)
3	$107,500	$19,995	$127,500	$384,300
4A	$1,333,400	$248,012	$1,581,400	$19,700
4B	$724,000	$134,664	$858,700	$20,200
5	$1,049,600	$195,226	$1,244,800	$42,800
6	$1,595,700	$153,187	$1,748,900	$110,200
Subtotal	$5,157,100	$815,608	$5,972,700	$574,900
7	$10,387,200	$1,932,019	$12,319,200	($394,300)
8	$1,017,600	$189,274	$1,206,900	($22,700)
Subtotal	$11,404,800	$2,121,293	$13,526,100	($417,000)
Total	$16,561,900	$2,936,900	$19,498,800	$157,900

Table D-19
Economic Analysis of Local Levees

Project Alternatives	Rochester Park Levee	CWWTP Levee	Combined Local Levees
INVESTMENT			
ESTIMATED FIRST COST	$12,738,000	$14,220,000	$26,958,000
ANNUAL INTEREST RATE	0.0738	0.0738	0.0738
PROJECT LIFE (years)	50	50	50
CONSTRUCTION PERIOD (months)	24	24	24
COMPOUND INTEREST FACTOR	25.77523	25.77523	25.77523
CAPITAL RECOVERY FACTOR	0.0759135	0.0759135	0.0759135
INTEREST DURING CONSTRUCTION	$0	$0	$0
INVESTMENT COST	$12,738,000	$14,220,000	$26,958,000
ANNUAL CHARGES			
INTEREST	$939,428	$1,048,725	$1,988,153
AMORTIZATION	$27,559	$30,765	$58,324
OPERATION/MAINTENANCE ($/year)	$50,000	$75,000	$125,000
REPLACEMENTS	$0	$0	$0
TOTAL ANNUAL CHARGES	$1,016,986	$1,154,490	$2,171,500
ANNUAL BENEFITS			
INUNDATION REDUCTION	$574,900	$1,085,300	$1,416,500
EXISTING DALLAS FLOODWAY	($417,000)	$91,208	($222,500)
TOTAL BENEFITS	$157,900	$1,176,508	$1,194,000
NET BENEFITS	($859,100)	$22,000	($977,500)
BENEFIT-TO COST-RATIO	0.16	1.02	0.55

INVESTIGATED NONSTRUCTURAL PLANS 1996-1997

An additional aggregated evaluation of the acquisition and removal of frequently flooded structures was conducted for the primary study area. This generalized approach was used to determine feasibility of a 1 percent chance exceedance flood buyout plan for the entire study area. The evaluation used finished floor elevations and included the 50 to 1 percent ACE flood frequency zones. Eligibility is dependant on economic criteria and flood frequency. The results of this analysis are shown in table D-20.

As shown, no structures were identified in the 50 percent chance exceedance flood zone. In the 20 percent chance exceedance flood frequency zone 13 structures were identified. The first cost was estimated at about $13.0 million with a BCR of 0.8 to 1.0. Both plans result in negative net benefits. Although these negative benefits could be offset with the incorporation of a recreation plan, the identified structures are scattered throughout the floodplain and a recreation plan could not be designed to meet the study area needs. Implementation of this plan would not significantly reduce damages in the study area.

The evaluation of the 10 percent and 1 percent ACE flood zones also resulted in negative net benefits. Development of an economically feasible plan would require a recreation plan expected to increase the first cost of the plan alternative by more than 50 percent while the maximum annual benefits would be limited to the total flood control benefits claimed. Further, removal of the 1 percent ACE flood zone would eliminate about 20 percent of the study area property. The majority of which are of commercial use. This plan could have a significant negative economic impact on the community. Non-structural measures may be more beneficial on a last added basis.

Table D-20
Investigated Evacuation Plans
(October 1996 prices, 7.65 percent interest rate)
(in thousands of dollars)

Flood Frequency Zone	Number of Structures	Total First Costs	Annual Costs	Annual Benefits	Benefit to Cost Ratio	Annual Net Benefits
0-2	0	$0.0	$0.0	$0.0	0.0	$0.0
0-5	13	$13,000.0	$1,075.2	$880.0	0.8	($ 195.2)
0-10	37	$24,000.3	$2,005.0	$1,230.0	0.6	($ 775.0)
0-100	508	$60,000.3	$125.1	$1,275.0	0.2	($4,499.0)

Residual expected annual damages and the resulting annual benefits for each are presented in table D-21 by reach. The plans include the:

- National Economic Development Plan
- Chain of Wetlands Only
- Chain of Wetlands with SPF Lamar and 100-Year Cadillac Heights Levees
- Chain of Wetlands with SPF Lamar and SPF Cadillac Heights Levees
- Chain of Wetlands with SPF Lamar Levee
- Chain of Wetlands with SPF Cadillac Heights Levee

Benefit-to-Cost Analysis

A comparison of the results of the economic analysis shows the 1200' BW swale provides the greatest net benefits and remains to be the NED plan. Among the combination chain of wetland alternatives, construction of the chain of wetlands along with SPF Lamar Levee would provide the greatest net benefits. The ranking of each alternative is shown in table D-22 below. A complete economic analysis of the alternatives is shown in table D-23.

Table D-21
Expected Annual Damages and Benefits
(January 1997 prices, 7.375% interest, 50-year period of analysis)

1200' East Bank Swale (NED)

Reach	Annual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$209,600	$38,986	$248,600	$100,300
2	$20,500	$3,813	$24,300	$35,900
3	$32,300	$6,008	$38,300	$473,500
4A	$524,500	$97,557	$622,100	$979,000
4B	$306,600	$57,028	$363,600	$515,300
5	$384,400	$71,498	$455,900	$831,700
6	$361,100	$34,666	$395,800	$1,463,300
Subtotal	$1,839,000	$309,555	$2,148,600	$4,399,000
7	$2,544,900	$473,351	$3,018,300	$8,906,600
8	$433,300	$80,594	$513,900	$670,300
Subtotal	$2,978,200	$553,945	$3,532,200	$9,576,900
Total	$4,817,200	$863,500	$5,680,800	$13,975,900

Chain of Wetlands Only

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,000
2	$29,800	$5,543	$35,300	$24,900
3	$47,400	$8,816	$56,200	$455,600
4A	$631,200	$117,403	$748,600	$852,500
4B	$420,300	$78,176	$498,500	$380,400
5	$459,200	$85,411	$544,600	$743,000
6	$538,400	$51,686	$590,100	$1,269,000
Subtotal	$2,396,000	$397,200	$2,793,200	$3,754,400
7	$4,449,800	$827,663	$5,277,500	$6,647,400
8	$602,700	$112,102	$714,800	$469,400
Subtotal	$5,052,500	$939,765	$5,992,300	$7,116,800
Total	$7,448,500	$1,336,965	$8,785,500	$10,871,200

Chain of Wetlands w\SPF Cadillac Heights

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,000
2	$27,700	$5,152	$32,900	$27,300
3	$47,400	$8,816	$56,200	$455,600
4A	$631,200	$117,403	$748,600	$852,500
4B	$420,300	$78,176	$498,500	$380,400
5	$9,800	$1,823	$11,600	$1,276,000
6	$538,400	$51,686	$590,100	$1,269,000
Subtotal	$1,944,500	$313,221	$2,257,800	$4,289,800
7	$4,449,800	$827,663	$5,277,463	$6,647,437
8	$602,700	$112,102	$714,802	$469,398
Subtotal	$5,052,500	$939,765	$5,992,265	$7,116,835
Total	$6,997,000	$1,262,986	$8,260,065	$11,466,635

Chain of Wetlands w\SPF Lamar Street Levee

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,000
2	$27,700	$5,152	$32,900	$27,300
3	$15,200	$2,827	$18,000	$493,800
4A	$17,100	$3,181	$20,300	$1,580,800
4B	$132,200	$24,589	$156,800	$722,100
5	$467,400	$86,936	$554,300	$733,300
6	$574,200	$55,123	$629,300	$1,229,800
Subtotal	$1,503,500	$227,973	$1,731,500	$4,816,100
7	$3,158,800	$587,537	$3,746,300	$8,178,600
8	$671,000	$124,806	$795,800	$388,400
Subtotal	$3,829,800	$712,343	$4,542,100	$8,567,000
Total	$5,333,300	$940,316	$6,273,600	$13,383,100

Table D-21 Continued
Expected Annual Damages and Benefits
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Chain of Wetlands w/SPF Lamar & Cadillac Heights Short Option

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,000
2	$29,800	$5,543	$35,300	$24,900
3	$16,600	$3,088	$19,700	$492,100
4A	$18,400	$3,422	$21,800	$1,579,300
4B	$132,200	$24,589	$156,800	$722,100
5	$13,800	$2,567	$16,400	$1,271,200
6	$688,900	$66,134	$755,000	$1,104,100
Subtotal	$1,169,400	$155,507	$1,324,900	$5,222,700
7	$4,737,000	$881,082	$5,618,082	$6,306,818
8	$873,900	$162,545	$1,036,445	$147,755
Subtotal	$5,610,900	$1,043,627	$6,654,527	$6,454,573
Total	$6,780,300	$1,199,135	$7,979,427	$11,677,273

Chain of Wetlands w\SPF Lamar & 100-Year Cadillac Levees

Reach	Residual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,000
2	$27,700	$5,152	$32,900	$27,300
3	$15,200	$2,827	$18,000	$493,800
4A	$17,100	$3,181	$20,300	$1,580,800
4B	$132,200	$24,589	$156,800	$722,100
5	$82,700	$15,382	$98,100	$1,189,500
6	$574,200	$55,123	$629,300	$1,229,800
Subtotal	$1,118,800	$156,419	$1,275,300	$5,272,300
7	$3,158,800	$587,537	$3,746,300	$8,178,600
8	$671,000	$124,806	$795,800	$388,400
Subtotal	$3,829,800	$712,343	$4,542,100	$8,567,000
Total	$4,948,600	$868,762	$5,817,400	$13,839,300

Table D-22
Alternative Rankings
Based on Net Benefits
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Rank	Alternative	Net Benefits
1	National Economic Development Plan	$7,446,300
2	Chain of Wetlands with SPF Lamar	$6,008,300
3	Chain of Wetlands+SPF Lamar & 100-Year Cadillac Levees	$5,134,600
4	Chain of Wetlands	$4,661,300
5	Chain of Wetlands with SPF Cadillac Heights Levee	$4,057,500
6	Chain of Wetlands+SPF Lamar & SPF Cadillac Levees	$2,929,600

Table D-23
Economic Analysis of Flood Control Benefits
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Project Alternatives include	Authorized	Authorized	1200' Swale	Chain Of Wetlands	Chain Of Wetlands & SPF Levees	Chain Of Wetlands & SPF Lamar	Chain Of Wetlands & SPF Cadillac	Chain Of Wetlands & SPF\100 Levees
	(original rate)	(FY 97 rate)						
ESTIMATED FIRST COST	$194,108,302	$194,108,302	$50,022,200	$46,889,300	$76,780,800	$64,520,500	$61,149,600	$67,225,000
ANNUAL INTEREST RATE	0.0325	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738
PROJECT LIFE (years)	100	50	50	50	50	50	50	50
CONSTRUCTION PERIOD (months)	36	36	36	24	36	24	24	24
COMPOUND INTEREST FACTOR	37.75981	40.15579	40.15579	25.77523	40.15579	25.77523	25.77523	25.77523
CAPITAL RECOVERY FACTOR	0.0339	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759
INTEREST DURING CONSTRUCTION	$9,617,320	$22,274,403	$5,740,170	$3,649,820	$8,810,785	$4,816,764	$4,565,110	$5,016,668
COST OF LOCAL LEVEES			$26,958,000	$26,958,000	$23,120,000	$23,120,000	$26,958,000	$26,958,000
INVESTMENT COST	$203,725,622	$216,382,705	$82,720,370	$79,497,120	$108,711,585	$92,457,264	$92,672,710	$99,201,668
INTEREST	$6,621,083	$15,958,225	$6,100,627	$5,862,913	$8,017,479	$6,818,723	$6,834,612	$7,316,123
AMORTIZATION	$281,854	$468,144	$178,966	$171,992	$235,198	$200,031	$200,497	$214,623
OPERATION/MAINTENANCE ($/year)	$250,000	$250,000	$250,000	$175,000	$495,000	$356,000	$314,000	$370,000
REPLACEMENTS	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	$7,152,937	$16,676,369	$6,529,593	$6,209,905	$8,747,677	$7,374,754	$7,349,110	$7,900,746
INUNDATION REDUCTION	$11,372,400	$11,372,400	$4,399,000	$3,754,400	$5,222,700	$4,816,100	$4,289,800	$4,245,800
EXISTING DALLAS FLOODWAY			$9,576,900	$7,116,800	$6,454,600	$8,567,000	$7,116,800	$8,789,500
TOTAL BENEFITS	$11,372,400	$11,372,400	$13,975,900	$10,871,200	$11,677,300	$13,383,100	$11,406,600	$13,035,300
NET BENEFITS	$4,219,500	($5,304,000)	$7,446,300	$4,661,300	$2,929,600	$6,008,300	$4,057,500	$5,134,600
BENEFIT-TO-COST RATIO	1.59	0.68	2.14	1.75	1.33	1.81	1.55	1.65

Incremental Cost Analysis

Although all of the structural plans are feasible, an incremental analysis was done to determine the added benefits for the addition of each portion of the plan. The results of adding SPF levees to the Chain of Wetlands plan are presented in table D-24. Costs do not include the cost of the local levees. The incremental analysis reveals that the addition of the SPF Lamar levee is incrementally justified. However, the addition of the SPF Cadillac Heights Levee as a first or a last-added piece is not incrementally justified. This addition is not justified as a first-added piece due because the additional annual costs are not offset by inundation reduction benefits to the primary study area. The addition is not justified as a last-added due to the $2.1 million decrease in benefits to the secondary study area as well as the disproportionate amount of benefits to cost in the primary study area.

The results of adding the 1 percent ACE (100-year) Cadillac Heights levee to the Chain of Wetlands plan are presented in table D-23. The analysis shows that the addition is incrementally justified with net benefits of $96,600. The analysis shows that construction of the 1 percent ACE (100-year) Cadillac levee will not reduce the benefits to the secondary study area derived from the chain of wetlands and SPF Lamar Levee.

Table D-24
Incremental Analysis of
Chain of Wetlands
and
SPF Lamar and SPF Cadillac Heights Levees

(January 1997 prices, 7.375% interest, 50-year period of analysis)

Description	Chain of Wetlands Added	Chain of Wetlands Cadillac Levee	Incremental	Chain of Wetlands Lamar Levee	Incremental	Chain of Wetlands Both Levees	Cadillac Heights Last Added
PROJECT COSTS							
Estimated First Cost	$48,889,300	$61,149,593	$12,260,293	$64,520,500	$15,631,200	$76,780,782	$12,260,282
Annual Interest Rate	0.073750	0.07375	0.07375	0.073750	0.073750	0.073750	0.073750
Project Life (years)	50	50	50	50	50	50	50
Construction Period (months)	24	24	24	24	24	36	36
Compound Interest Factor	25.77523	25.77523	25.77523	25.77523	25.77523	40.15579	40.15579
Capital Recovery Factor	0.0759135	0.0759135	0.0759135	0.0759135	0.0759135	0.0759135	0.0759135
Interest During Construction	$3,649,820	$4,565,110	$915,290	$4,816,764	$1,166,944	$8,810,783	$3,994,019
Investment Cost	$52,539,120	$65,714,703	$13,175,583	$69,337,264	$16,798,144	$85,591,565	$16,254,301
ANNUALIZED COSTS							
Interest	$3,874,760	$4,846,459	$971,699	$5,113,623	$1,238,863	$6,312,378	$1,198,755
Amortization	$113,668	$142,174	$28,505	$150,011	$36,343	$185,177	$35,166
O&M ($/year)	$50,000	$189,000	$139,000	$231,000	$181,000	$370,000	$139,000
Replacements	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	$4,038,428	$5,177,633	$1,139,205	$5,494,634	$1,456,206	$6,867,555	$1,372,921
ANNUAL BENEFITS							
Inundation Reduction	$2,727,900	$3,263,300	$535,400	$3,789,600	$1,061,700	$4,196,200	$406,600
Existing Dallas Floodway	$7,339,300	$7,339,300	$0	$8,789,500	$1,450,200	$6,677,100	($2,112,400)
TOTAL BENEFITS	$10,067,200	$10,602,600	$535,400	$12,579,100	$2,511,900	$10,873,300	($1,705,800)
BENEFIT/COST RATIO	2.49	2.05	0.47	2.29	1.72	1.58	-1.24
NET ANNUAL BENEFITS	$6,028,800	$5,425,000	($603,800)	$7,084,500	$1,055,700	$4,005,700	($3,078,700)

Table D-25
Incremental Analysis of
Chain of Wetlands and
SPF Lamar and 100-Year Cadillac Heights Levees

(January 1997 prices, 7.375% interest, 50-year period of analysis)

Description	Chain of Wetlands	Chain of Wetlands SPF Lamar Levee Added	Increment	Chain of Wetlands SPF\100 Levees	Cadillac 100-Year Last Added
PROJECT COSTS					
Estimated First Cost	$48,889,300	$64,520,500	$15,631,200	$67,225,000	$2,704,500
Annual Interest Rate	0.073750	0.073750	0.073750	0.073750	0.073750
Project Life (years)	50	50	50	50	50
Construction Period (months)	24	24	24	24	24
Compound Interest Factor	25.77523	25.77523	25.77523	25.77523	25.77523
Capital Recovery Factor	0.0759135	0.0759135	0.0759135	0.0759135	0.0759135
Interest During Construction	$3,649,820	$4,816,764	$1,166,944	$5,018,668	$201,904
Investment Cost	$52,539,120	$69,337,264	$16,798,144	$72,243,668	$2,906,404
ANNUALIZED COSTS					
Interest	$3,874,760	$5,113,623	$1,238,863	$5,327,970	$214,347
Amortization	$113,668	$150,011	$36,343	$156,299	$6,288
O&M ($/year)	$50,000	$231,000	$181,000	$370,000	$139,000
Replacements	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	$4,038,428	$5,494,634	$1,456,206	$5,854,270	$359,635
ANNUAL BENEFITS					
Inundation Reduction	$2,727,900	$3,789,600	$1,061,700	$4,245,800	$456,200
Existing Dallas Floodway	$7,339,300	$8,789,500	$1,450,200	$8,789,500	$0
TOTAL BENEFITS	$10,067,200	$12,579,100	$2,511,900	$13,035,300	$456,200
BENEFIT COST RATIO	2.49	2.29	1.72	2.23	1.27
ANNUAL NET BENEFITS	$6,028,800	$7,084,500	$1,055,700	$7,181,000	$96,600

Cadillac Heights Nonstructural Analysis

An evaluation of reach 5 was conducted with a focus on the feasibility of nonstructural plans. The results of the evaluation are shown in table D-26. In plans 2 and 3 nonstructural measures are evaluated on a last added basis. Plan 1 assumes current hydrologic and economic conditions with a total of 235 structures identified within the 1 percent ACE flood zone. As shown, 6 structures were identified in the 50 percent chance exceedance flood zone, 9 structures in the 20 percent ACE flood zone and 17 structures within the 10 percent ACE flood zone. A permanent evacuation plan would be feasible up to the 10 percent ACE event. Within the 4 percent ACE flood zone a buyout of 117 structures would yield a benefit to cost ratio of 0.8 to 1.0 with ($216,800) in net benefits. The economic cost to permanently evacuate the 1 percent ACE flood zone is estimated at almost $24.0 million or $1.9 million annually. This plan generates estimated benefits of about $677,000 which results in a BCR of 0.4 to 1.0. As shown, implementation of Plan 1 is only feasible up through the 10 percent ACE flood zone which a BCR of 1.4 to 1.0.

In Plan 2 construction of the chain of wetlands and Lamar Street is assumed. Following construction, about 160 structures would remain within the 1 percent ACE flood zone. The economic cost to permanently evacuate the area is estimated at almost $16.0 million or $1.3 million annually. Comparatively, benefits are estimated at about $404,900, resulting in a BCR of 0.3 to 1.0. As shown in table D-26, implementation of Plan 2 is feasible up through the 4 percent ACE flood zone which has a BCR of 1.1 to 1.0 and would evacuate 24 of the structures remaining in the 1 percent ACE flood zone.

Plan 3 evaluates the feasibility of permanent evacuation to remaining structures following construction of the chain of wetlands, the Lamar Street levee, and a 1 percent ACE Cadillac Heights levee. The plan would remove over 85 percent of the threatened structures from the 1 percent ACE flood frequency zone. Under this scenario 32 structures would remain in the 1 percent ACE flood plain. The remaining structures are located near Moore Park with several located southwest of the CWWTP. The lowest structures begin to receive damages with less than a 4 percent ACE flood event. The analysis for the purchase of these structures results in a BCR below unity for each flood zone. Therefore, as a last added measure, Plan 3 is not economically feasible.

Table D-26
Analysis of Cadillac Heights (Reach 5) Permanent Evacuation
(January 1997 prices, 7.375% interest, 60-year period of analysis)

	Hydrologic Condition		
Flood Frequency	Plan 1 *Cadillac Heights Buyout (Stand-Alone)*	Plan 2 *COW+SPF Lamar Levee & Cadillac Heights Buyout (Buyout Increment Only)*	Plan 3 *COW+SPF Lamar & Cadillac Levees & Moore Park Buyout (Buyout Increment Only)*
0-2 Zone			
# of Strs.	6	0	0
Annual Costs	$146,500	N\A	N\A
Annual Benefits	$538,900	N\A	N\A
Eco. Costs	$1,810,100	N\A	N\A
Fin. Costs	$372,100	N\A	N\A
Total Costs	$2,182,200	$0	$0
BC Ratio	3.7	N\A	N\A
Net Benefits	$392,400	N\A	N\A
0-5 Zone			
# of Strs.	9	3	0
Annual Costs	$362,900	$79,100	N\A
Annual Benefits	$594,600	$194,100	N\A
Eco. Costs	$4,502,200	$977,500	N\A
Fin. Costs	$688,300	$198,500	N\A
Total Costs	$5,190,500	$1,176,000	$0
BC Ratio	1.6	2.5	N\A
Net Benefits	$231,700	$115,000	N\A
0-10 Zone			
# of Strs.	17	7	0
Annual Costs	$451,100	$165,300	N\A
Annual Benefits	$638,600	$179,700	N\A
Eco. Costs	$5,577,300	$2,041,200	N\A
Fin. Costs	$1,131,700	$421,900	N\A
Total Costs	$6,709,000	$2,463,100	$0
BC Ratio	1.4	2.1	N\A
Net Benefits	$187,500	$179,700	N\A
0-25 Zone			
# of Strs.	117	24	3
Annual Costs	$946,300	$334,900	$5,332
Annual Benefits	$729,500	$365,900	$1,200
Eco. Costs	$11,447,600	$4,105,000	$57,200
Fin. Costs	$3,143,800	$947,700	$66,000
Total Costs	$14,591,400	$5,052,700	$123,200
BC Ratio	0.8	1.1	0.23
Net Benefits	($216,800)	$31,000	($4,132)

Table D-26 continued

Flood Frequency	Hydrologic Condition Plan 1 *Cadillac Heights Buyout (Stand-Alone)*	Plan 2 *COW+SPF Lamar Levee & Cadillac Heights Buyout (Buyout Increment Only)*	Plan 3 *COW+SPF Lamar & Cadillac Levees & Moore Park Buyout (Buyout Increment Only)*
0-50 Zone			
# of Strs.	164	126	17
Annual Costs	$1,264,346	$823,600	$60,529
Annual Benefits	$746,500	$401,100	$4,700
Eco. Costs	$15,270,300	$9,887,000	$702,500
Fin. Costs	$3,608,000	$2,964,600	$374,000
Total Costs	$18,878,300	$12,851,600	$1,076,500
BC Ratio	0.59	0.5	0.08
Net Benefits	($517,846)	($422,500)	($55,829)
0-100 Zone			
# of Strs.	235	160	32
Annual Costs	$1,942,410	$1,311,230	$107,724
Annual Benefits	$752,700	$404,943	$5,900
Eco. Costs	$23,512,600	$15,868,000	$1,244,800
Fin. Costs	$5,170,000	$3,520,000	$704,000
Total Costs	$28,682,600	$19,388,000	$1,948,800
BC Ratio	0.39	0.3	0.05
Net Benefits	($1,189,710)	($906,287)	($101,824)

ECONOMIC ANALYSIS UNDER WRDA '96

General

The structural plans previously evaluated were revised to reflect project conditions under the authority of WRDA'96. Under this authority portions of the costs to construct the local levees would be credited to the local sponsor. Therefore, the baseline conditions of the analysis of various plans were revised. Table D-27 shows the expected annual damages for the NED and Chain of Wetlands plans along with improvement to the CWWTP levee. The remaining plans include all the costs for the CWWTP and the compatible portion of the Rochester Park Levee. All the benefits associated with the Rochester levee are included because the levee would be an integral part of the Lamar Street levee design and therefore cannot be separated.

Floodplain User Benefits

Implementation of either plan would produce an annual savings in administration of the flood insurance program operating expenses. The current average operating cost per policy is $131.00. The annual benefit that would accrue to each plan is determined by multiplying the number of structures removed from the 1 percent ACE flood frequency zone by the operating cost per policy. Under without project (pre-1991) conditions 794 structures were identified within the 1 percent ACE flood zone. The amount of the benefit was determined by subtracting the number of structures remaining in the 1 percent ACE zone from the number assuming pre-1991 conditions. The total estimated flood insurance savings attributable to each alternative are shown in table D-28.

Table D-27
Economic Analysis of Flood Control Benefits
(January 1997 prices, 7.375% interest, 50-year period of analysis)
(Existing Conditions as Baseline)

					Includes Benefits From All Local Levees***			
	AUTHORIZED PLAN (original rate)	*AUTHORIZED PLAN* (FY 97 rate)	*1200' SWALE & CWWTP***	*CHAIN OF WETLANDS & CWWTP***	*CHAIN OF WETLANDS & SPF LEVEES*	*CHAIN OF WETLANDS & SPF LAMAR*	*CHAIN OF WETLANDS & SPF CADILLAC*	*CHAIN OF WETLANDS SPF\100 LEVEES*
INVESTMENT								
ESTIMATED FIRST COST	$199,214,200	$199,214,200	$50,022,200	$48,889,300	$76,780,800	$64,520,500	$61,149,600	$67,225,000
ANNUAL INTEREST RATE	0.0325	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738
PROJECT LIFE (years)	100	50	50	50	50	50	50	50
CONSTRUCTION PERIOD (months)	36	36	36	24	36	24	24	24
COMPOUND INTEREST FACTOR	37.75981	40.15579	40.15579	25.77523	40.15579	25.77523	25.77523	25.77523
CAPITAL RECOVERY FACTOR	0.0339	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759
INTEREST DURING CONSTRUCTION	$9,870,297	$22,860,317	$5,740,170	$3,649,820	$8,810,785	$4,816,764	$4,565,110	$5,018,668
COST OF LOCAL LEVEES			$14,220,000	$14,220,000	$23,120,000	$23,120,000	$23,120,000	$23,120,000
INVESTMENT COST	$209,084,497	$222,074,517	$69,982,370	$66,759,120	$108,711,585	$92,457,264	$88,834,710	$95,363,668
ANNUAL CHARGES								
INTEREST	$6,795,246	$16,377,996	$5,161,200	$4,923,485	$8,017,479	$6,818,723	$6,551,560	$7,033,070
AMORTIZATION	$289,268	$480,458	$151,407	$144,433	$235,198	$200,031	$192,194	$206,319
OPERATION/MAINTENANCE ($/year)	$250,000	$250,000	$250,000	$175,000	$495,000	$356,000	$314,000	$370,000
REPLACEMENTS	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	$7,334,515	$17,108,454	$5,562,607	$5,242,918	$8,747,677	$7,374,755	$7,057,754	$7,609,390
ANNUAL BENEFITS								
INUNDATION REDUCTION	$13,016,900	$13,016,900	$4,014,700	$3,370,100	$5,222,700	$4,816,100	$4,289,800	$5,272,300
EXISTING DALLAS FLOODWAY			$9,576,900	$7,116,800	$6,454,600	$8,567,000	$7,116,800	$8,567,000
TOTAL BENEFITS	$13,016,900	$13,016,900	$13,591,600	$10,486,900	$11,677,300	$13,383,100	$11,406,600	$13,839,300
NET BENEFITS	$5,682,400	($4,091,600)	$8,029,000	$5,244,000	$2,929,600	$6,008,300	$4,348,800	$6,229,900
BENEFIT-TO-COST RATIO	1.77	0.76	2.44	2.00	1.33	1.81	1.62	1.82

**Includes construction costs for CWWTP Levee.
***Include construction costs for Compatible Rochester and CWWTP Levees.

Table D-28
Flood Insurance Savings
By Alternative

Investigated Plan	Structures No Longer at 1 Percent ACE Flood Risk
NED+CWWTP	403
COW+SPF Lamar & Cadillac Levees	719
COW+SPF Lamar\1% Cadillac Levees	719
COW	511
Rochester Levee	278
COW+CWWTP	233

Recreation Benefits

Benefits for the recreation plan developed for the final array of alternatives were derived using the unit day value method. This method of benefit calculation was selected based on the criteria set forth in ER 1105-2-100. Specifically, the regional model available is more than seven years old, annual visits are not expected to exceed 750,000, and recreation costs are not expected to exceed 25 percent of the total project costs.

A score of 40 points was assessed for the plan based on the professional judgement of both Federal and local recreation planners. Applying the Planning Guidance Memorandum, a score of 40 points converts to $5.00 per visitor day, at April 1998 price levels, for quantifiable features. The complete recreation master plan would provide 50 miles of trails and 7 picnic pavilions. However, benefits were derived based on those portions located on project lands. Specifically, 31.5 miles of trails and 34 picnic type sites are proposed. Refer to Appendix I for complete details on the recreation plan. Table D-29 details the benefits calculated for the recreation plan by feature. The participation rate in the Dallas-Fort Worth area for multipurpose trails and pavilions exceeds the facility capacity. Therefore, it is assumed that participation equals capacity and a value of one was applied. Annual visitors per miles of equestrian and nature trails were adjusted by the participation rate for the local area.

Table D-29
Dallas Floodway Extension Recreation Benefits
Unit Day Value Method
(April 1998 price levels, 7.125% interest, 50-year period of analysis)

Feature	Amount	Participation Rate	Visitors	Rate	Annual Benefits
Hike\Bike Trail	18 miles	1.0	57,662	$5.00	$5,189,580
Equestrian Trail	8.5 miles	0.2	6,999	$5.00	$59,492
Nature Trail	5 miles	0.6	7,402	$5.00	$111,030
Pavilions	6 sites	1.0	1,665	$5.00	$49,950
Picnic Tables	34 sites	1.0	1,575	$5.00	$267,750
				Total Benefits	$5,677,802

CHANNEL REALIGNMENT PROPOSAL AT IH-45 BRIDGE

During the Environmental Impact Statement (EIS) scoping process, the Texas Department of Transportation (TxDOT) submitted a proposal to realign the Trinity River at IH-45 as a part of the Dallas Floodway Extension project. TxDOT provided documentation that the bridge at IH-45 was constructed in 1972 to complement the authorized navigation channel of the Dallas Floodway Extension portion of the Trinity River Project. The bridge, which consists of 23 spans, varying in length from 78' to 480' was constructed with the longer spans to be located over the proposed navigation channel. Currently, three of the shorter 78 foot spans span the existing Trinity River at the IH-45 location. In the years following construction, the constricted flows through the existing 78 foot spans have resulted in a blockage due to debris and subsequent damage to the existing piers. TxDOT cited a 1984 flood event in which massive accumulations of driftwood precipitated a fracture in one of the bridge columns within the existing Trinity River channel. The narrow bridge span was cited as the cause of the debris blockage.

TxDOT's proposal was to relocate a section of the existing Trinity River to a new site beneath a 1,120 foot plate girder structure that was originally designed and constructed for the river in anticipation of a federal navigation channel. This 1,120 foot continuous plate girder unit which consists of two 320 foot end spans and a 480 foot center span have considerably stronger columns and drill shafts designed specifically for lateral forces in anticipation of possible boat or debris impacts.

ALTERNATIVES

Three alternatives were investigated to determine the economic feasibility of a solution to the problem. Federal participation was not addressed. The alternatives were:

- No Action
- Columns/Piers Armoring existing
- River Realignment

"No Action" Plan

In the absence of a project to reroute the Trinity River, the "no action" plan alternative, TxDOT indicated that the three 78 foot spans spanning the existing river would be replaced by a single 320 foot span which would span the existing river in its entirety. This would be done at a future date in a planned replacement scenario, or as a reaction to a catastrophic or partial failure of the bridge during a flood event. This is to remove the possibility of loss of lives due to bridge failure, extensive and expensive repairs if the bridge experiences partial failure, and the significant costs associated with rerouting of traffic and lost of potential wages due to delays should the this major thoroughfare between Dallas and Houston require lengthy maintenance. The cost associated with traffic rerouting was estimated to be $1.3 million. The first cost was estimated to be about $12.4 million with an annualized cost of about $1.0 million.

Columns/Piers Armoring

In lieu of replacing the 78 foot spans to a wider 320 foot section, a less costly alternative of providing additional protection to the existing columns against impacts similar to the 1984 occurrence. This alternative would involve armoring the six sets of columns in the existing Trinity River with concrete. The first cost of this alternative was estimated to be about $4.9 million with an annualized cost of $454,700. There exists an element of risk associated with this alternative. It would still be possible to have a large flood event carrying sufficient debris to cause the bridge to fail.

River Realignment

The third alternative investigated would involve rerouting a portion of the existing Trinity river to a new site beneath the adjacent 1,120 foot plate girder bridge. This location would follow the original authorized navigation channel project location and would provide the needed cross-sectional area under the bridge to avert potential damage from high debris flows. This alternative was estimated to have a first cost of $1.9 million and an annualized cost of $154,900.

IH-45 Economic Analysis

An economic analysis of this proposal was performed, using the "No Action" Plan as the basis for project benefits. This analysis assumes that in time, with no changes in annual maintenance of the existing bridge, the bridge will fail or be damaged to such an extent as to require complete replacement. The results of this analysis is presented in table D-29. As shown, the alternative which involved armored protection of existing columns was economically feasible, with net benefits of about $588,900 million, and a BCR of 2.30 to 1.0. The alternative providing maximum net benefits, however, was determined to be the rerouting of the river to an adjacent span. This River realignment alternative yielded about $888,600 in net benefits, with a BCR of 6.74 to 1.0. The general layout of this plan is shown in Appendix C.

Table D-29
Economic Analysis of IH 45 Proposal
(April 1998 price levels, 7.125% interest, 50-year period of analysis)

	No-Action Plan	Column/Pier Armoring	River Realignment
INVESTMENT			
ESTIMATED FIRST COST	$12,449,132	$4,874,132	$1,935,100
ANNUAL INTEREST RATE	0.0713	0.0713	0.0113
PROJECT LIFE (years)	30	30	50
CONSTRUCTION PERIOD (months)	6	6	6
COMPOUND INTEREST FACTOR	6.08977	6.08977	6.08977
CAPITAL RECOVERY FACTOR	0.0816007	0.0816007	0.0736071
INTEREST DURING CONSTRUCTION	$216,668	$84,831	$33,679
INVESTMENT COST	$12,665,800	$4,958,963	$1,968,779
ANNUAL CHARGES			
INTEREST	$902,438	$353,326	$140,275
AMORTIZATION	$131,100	$51,329	$4,641
OPERATION/MAINTENANCE ($/year)	$10,000	$50,000	$10,000
REPLACEMENTS	$0	$0	$0
TOTAL ANNUAL CHARGES	$1,043,538	$454,656	$154,916
ANNUAL BENEFITS			
Annual Cost Reduction	$1,043,538	$1,043,538	$1,043,538
TOTAL BENEFITS	$1,043,538	$1,043,538	$1,043,538
NET BENEFITS	$0	$588,883	$888,622
BENEFIT-TO-COST RATIO	1.00	2.30	6.74

Equivalent Annual Damages of Investigated Plans

Equivalent annual damages (EAD) were calculated for the recommended plan to account for future changes in urbanization and hydrology. The analysis was performed over a 50 year period (2000 to 2050) using April 1998 prices and level of development with an interest rate of 7.125 percent. Table D-30 summarizes the damages under existing conditions and the residual damages for the federally supportable and locally preferred plans. Table D-31 summarizes the number of structures remaining in each flood zone under the investigated alternatives. The total benefits derived for each plan are shown in table D-32. Tables D-33, D-34, and D-35 show the project performance of the NED Plan, the Chain of Wetlands Plus SPF Lamar Levee and 100-Year Cadillac Heights Levee Plan, and the Recommended Plan, respectively. Finally, the cumulative single event damages with minimum facility sumps for the Lamar Street levee is shown in table D-36.

Table D-30
Equivalent Annual Damages and Benefits
(April 1998 Prices and Level of Development)

Reach	2000 Existing Annual Damages			Description
	Direct	Incidental	Total	
1	$294,200	$54,721	$348,900	Below White Rock
2	$50,800	$9,449	$60,200	White Rock
3	$431,500	$80,259	$511,800	Rochester Park
4A	$1,350,000	$251,100	$1,601,100	Lamar Area
4B	$741,100	$137,845	$878,900	Oakland Area
5	$1,085,700	$201,940	$1,287,600	Cadillac Heights
6	$1,696,300	$162,845	$1,859,100	Treatment Plant
Subtotal	$5,649,600	$898,159	$6,547,600	Study Area
7	$10,054,700	$1,870,174	$11,924,900	East Levee
8	$998,500	$185,721	$1,184,200	West Levee
Subtotal	$11,053,200	$2,055,895	$13,109,100	Upstream Levees
Total	$16,702,800	$2,954,054	$19,656,700	

Reach	2080 Existing Annual Damages			Equivalent Annual Damages
	Direct	Incidental	Total	
1	$324,000	$60,264	$384,300	$357,800
2	$54,600	$10,156	$64,800	$61,400
3	$454,500	$84,537	$539,000	$518,700
4A	$1,398,400	$260,102	$1,658,500	$1,615,600
4B	$807,000	$150,102	$957,100	$898,700
5	$1,116,600	$207,688	$1,324,300	$1,296,900
6	$1,856,400	$178,214	$2,034,600	$1,903,400
Subtotal	$6,011,500	$951,063	$6,962,600	$6,652,500
7	$11,264,800	$2,095,253	$13,360,100	$12,287,500
8	$1,135,900	$211,277	$1,347,200	$1,225,400
Subtotal	$12,400,700	$2,306,530	$14,707,300	$13,512,900
Total	$18,412,200	$3,257,593	$21,669,900	$20,165,400

Table D-30 continued
Equivalent Annual Damages and Benefits

2000	COW+SPF Lamar+100-Yr Cadillac Residual Damages				2050	COW+SPF Lamar+100-Yr Cadillac Residual Damages				
Reach	Direct	Incidental	Total	Annual Benefits	Reach	Direct	Incidental	Total	Annual Benefits	Equivalent Annual Benefits
1	$269,700	$50,164	$319,900	$29,000	1	$298,200	$55,465	$353,700	$30,600	$29,400
2	$27,700	$5,152	$32,900	$27,300	2	$30,200	$5,617	$35,800	$29,000	$27,700
3	$15,200	$2,827	$18,000	$493,800	3	$18,600	$3,460	$22,100	$516,900	$499,600
4A	$17,100	$3,181	$20,300	$1,580,800	4A	$20,000	$3,720	$23,700	$1,634,800	$1,594,400
4B	$132,200	$24,589	$156,800	$722,100	4B	$148,800	$27,677	$176,500	$780,600	$736,900
5	$82,700	$15,382	$98,100	$1,189,500	5	$91,100	$16,945	$108,000	$1,216,300	$1,196,300
6	$574,200	$55,123	$629,300	$1,229,800	6	$646,200	$62,035	$708,200	$1,326,400	$1,254,200
Subtotal	$1,118,800	$156,419	$1,275,300	$5,272,300	Subtotal	$1,253,100	$174,919	$1,428,000	$5,534,600	$5,338,500
7	$3,168,800	$587,537	$3,746,300	$8,178,600	7	$3,634,000	$675,924	$4,309,900	$9,060,200	$8,393,800
8	$671,000	$124,806	$795,800	$388,400	8	$778,600	$144,820	$923,400	$423,800	$397,300
Subtotal	$3,829,800	$712,343	$4,542,100	$8,567,000	Subtotal	$4,412,600	$820,744	$5,233,300	$9,474,000	$8,796,100
Total	$4,948,600	$868,762	$5,817,400	$13,839,300	Total	$5,666,700	$995,662	$6,661,300	$15,008,600	$14,134,600

2000	COW+SPF Lamar & Cadillac Residual Damages				2050	COW+SPF Lamar & Cadillac Residual Damages				
Reach	Direct	Incidental	Total	Annual Benefits	Reach	Direct	Incidental	Total	Annual Benefits	Equivalent Annual Benefits
1	$269,700	$50,164	$319,900	$29,000	1	$298,200	$55,465	$353,700	$30,600	$29,400
2	$29,800	$5,543	$35,300	$24,900	2	$30,200	$5,617	$35,800	$29,000	$25,900
3	$16,600	$3,088	$19,700	$492,100	3	$18,600	$3,460	$22,100	$516,900	$498,400
4A	$18,400	$3,422	$21,800	$1,579,300	4A	$21,500	$3,999	$25,500	$1,633,000	$1,592,900
4B	$132,200	$24,589	$156,800	$722,100	4B	$148,800	$27,677	$176,500	$780,600	$736,900
5	$13,800	$2,667	$16,400	$1,271,200	5	$16,100	$2,995	$19,100	$1,305,200	$1,279,800
6	$688,900	$66,134	$755,000	$1,104,100	6	$773,400	$74,246	$847,600	$1,187,000	$1,125,000
Subtotal	$1,169,400	$155,507	$1,324,900	$5,222,700	Subtotal	$1,306,800	$173,459	$1,480,300	$5,482,300	$5,288,300
7	$4,737,000	$881,082	$5,618,100	$6,306,800	7	$5,374,200	$999,601	$6,373,800	$6,986,300	$6,478,500
8	$873,900	$162,645	$1,036,400	$147,800	8	$997,400	$185,516	$1,182,900	$164,300	$152,000
Subtotal	$5,610,900	$1,043,627	$6,654,500	$6,454,600	Subtotal	$6,371,600	$1,185,118	$7,556,700	$7,150,600	$6,630,500
Total	$6,780,300	$1,199,135	$7,979,400	$11,677,300	Total	$7,678,400	$1,358,576	$9,037,000	$12,632,900	$11,918,800

Table D-31
Number of Structures By Flood Zone
For Selected Alternatives

	Cumulative Flood Zone								
	0-1	0-2	0-5	0-10	0-25	0-50	0-100	0-500	0-SPF
Pre-1991 Conditions	0	2	30	112	334	504	794	1804	2550
NED	0	0	3	16	56	221	391	1250	1970
Chain of Wetlands (COW)	0	0	2	10	57	201	283	1542	2232
COW+SPF & 100-Year Levees	0	0	1	7	21	48	75	1036	2046
COW +SPF Levees	0	0	1	7	21	48	75	1232	1862

Table D-32
Benefits of Levee Plans
(April 1998 Prices and Level of Development)
(Based on Equivalent Annual Damages)

Benefit Type	Chain of Wetlands SPF Lamar & 100-Yr Cadillac Levees	Chain of Wetlands SPF Lamar & SPF Cadillac Levees
Inundation Reduction	$5,338,500	$5,288,300
Insurance Subsidy	$94,200	$94,200
Existing Dallas Floodway	$8,796,100	$6,630,500
Total Flood Reduction	$14,228,800	$12,013,000
Restoration	$5,854,100	$5,854,100
Recreation	$5,677,800	$5,677,800
IH-45 River Realignment	$1,043,500	$1,043,500
TOTAL BENEFITS	$26,804,200	$24,588,400

Table D-33
Project Performance by Reach For
1200' BW Swale Alternative
(April 1998 Prices and Level of Development)

		Expected Annual Target Stage Exceedance Probability		Long Term Risk (Years)			Conditional Non-Exceedance Probability by Event					
Reach	Target Stage	Median	Expected	10	25	50	10%	4%	2%	1%	.4%	.2%
1	395.7	0.145	0.154	0.8131	0.9849	0.9998	0.1748	0.0054	0.0001	0.0000	0.0000	0.0000
2	401.9	0.031	0.039	0.3267	0.6280	0.8616	0.9801	0.6089	0.2254	0.0290	0.0054	0.0006
3	levee	0.001	0.003	0.0249	0.0611	0.1184	1.000	0.9998	0.9939	0.9180	0.7829	0.5737
4A	403.14	0.090	0.099	0.6484	0.9267	0.9946	0.5571	0.0627	0.0062	0.0002	0.0000	0.0000
4B	407.03	0.005	0.008	0.0729	0.1724	0.3152	1.000	0.9947	0.9377	0.6376	0.3868	0.1797
5	402.15	0.114	0.154	0.8125	0.9848	0.9998	0.1753	0.0055	0.0001	0.0000	0.0000	0.0000
6	levee	0.001	0.002	0.0216	0.0531	0.9998	0.1753	0.0055	0.0001	0.0000	0.0000	0.0000
7	levee	0.000	0.000	0.0028	0.0069	0.0138	1.0000	1.0000	0.9999	0.9957	0.9806	0.9313
8	levee	0.000	0.000	0.0023	0.0057	0.0113	1.0000	1.0000	1.0000	0.9965	0.9835	0.9395

Table D-34
Project Performance by Reach For
Chain of Wetlands with SPF Lamar and 100-Year Cadillac Levees
(April 1998 Prices and Level of Development)

		Expected Annual Target Stage Exceedance Probability		Long Term Risk (Years)			Conditional Non-Exceedance Probability by Event					
Reach	Target Stage	Median	Expected	10	25	50	10%	4%	2%	1%	.4%	.2%
1	395.70	0.193	0.201	0.8935	0.9849	0.9998	0.1748	0.0054	0.0001	0.0000	0.0000	0.0000
2	401.88	0.044	0.052	0.4112	0.6280	0.8616	0.9801	0.6089	0.2254	0.0290	0.0054	0.0006
3	levee	0.000	0.000	0.0721	0.0026	0.1184	1.000	0.9998	0.9939	0.9180	0.7829	0.5737
4A	levee	0.000	0.000	0.0032	0.0079	0.0157	1.0000	1.0000	0.9999	0.9952	0.9783	0.9244
4B	levee	0.005	0.007	0.0721	0.1705	0.3119	1.0000	0.9950	0.9387	0.6397	0.3867	0.1802
5	levee	0.000	0.000	0.0034	0.0085	0.0168	1.0000	1.0000	0.9999	0.9941	0.9735	0.9109
6	levee	0.002	0.004	0.0399	0.0969	0.1844	1.0000	0.9993	0.9855	0.8436	0.6451	0.4001
7	levee	0.000	0.000	0.0022	0.0054	0.0109	1.0000	1.0000	0.9996	0.9886	0.9531	0.8597
8	levee	0.000	0.001	0.0067	0.0167	0.0330	1.0000	1.0000	0.9996	0.9885	0.9524	0.8567

Table D-35
Project Performance by Reach For
Chain of Wetlands with SPF Lamar and Cadillac Levees
(April 1998 Prices and Level of Development)

		Expected Annual Target Stage Exceedance Probability		Long Term Risk (Years)			Conditional Non-Exceedance Probability by Event					
Reach	Target Stage	Median	Expected	10	25	50	10%	4%	2%	1%	.4%	.2%
1	395.70	0.193	0.201	0.8935	0.9849	0.9998	0.1748	0.0054	0.0001	0.0000	0.0000	0.0000
2	401.88	0.044	0.052	0.4112	0.6280	0.8616	0.9801	0.6089	0.2254	0.0290	0.0054	0.0006
3	levee	0.000	0.000	0.0721	0.0026	0.1184	1.000	0.9998	0.9939	0.9180	0.7829	0.5737
4A	levee	0.000	0.000	0.0032	0.0079	0.0157	1.0000	1.0000	0.9999	0.9952	0.9783	0.9244
4B	levee	0.005	0.007	0.0721	0.1705	0.3119	1.0000	0.9950	0.9387	0.6397	0.3867	0.1802
5	levee	0.000	0.000	0.0034	0.0085	0.0168	1.0000	1.0000	0.9999	0.9941	0.9735	0.9109
6	levee	0.002	0.004	0.0399	0.0969	0.1844	1.0000	0.9993	0.9855	0.8436	0.6451	0.4001
7	levee	0.000	0.000	0.0022	0.0054	0.0109	1.0000	1.0000	0.9996	0.9886	0.9531	0.8597
8	levee	0.000	0.001	0.0067	0.0167	0.0330	1.0000	1.0000	0.9996	0.9885	0.9524	0.8567

Tabl D-36
Cumulative Single-Event Damages
For Lamar Street Sumps
(without risk)

% ACE Event	1	2	3	4	5	Total
<100	$0	$0	$0	$0	$0	$0
50	$0	$0	$0	$0	$0	$0
20	$0	$0	$0	$0	$0	$0
10	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0
1	$0	$0	$0	$0	$0	$0
.4	$43,396	$11,411	$223,538	$0	$0	$278,345
.2	$60,344	$119,551	$331,458	$0	$0	$511,353

Socioeconomic Effects of Plan Implementation

The potential economic and social effects of implementation of the investigated plan on the study area comprise the value of the long-term reduction in periodic flood damages, and direct and indirect short-term income and employment impact of project construction. The permanent reduction in periodic flood damages would effectively increase the income available to flood plain property owners for other purposes, such as (for example) improvements to homes, yards or personal property. Construction of SPF levees could encourage growth of existing business and entice new business to the area. This would improve employment conditions and expand the tax base of the area.

To the extent that this additional disposable income is spent within the surrounding area, it would result in a local "multiplier effect": increases in business revenues, employment, and personal income rippling through the local economy as each new dollar brought in is spent and respent. Property values, and local tax revenues, would also be expected to increase as a general result.

Short-term impacts associated with project construction results from the temporary presence of construction workers and expenditures for construction materials and services, as well as spending by the construction work force for food and other personal needs. These expenditures would be expected to result in a positive multiplier effect on the local economy and would last for about three years. The lasting economic and social effects of project implementation would be the benefits resulting from the permanent reduction in flood damages, as described above.

Financial Capability

A financial capability analysis of the City of Dallas was conducted in accordance with ER 1105-2-100 to ascertain the community's financial condition and its ability to meet the cost sharing responsibilities for the Floodway Extension Project. The assessment involved the calculation and analysis of nine key financial indicators. A number of interrelated economic, fiscal, and management factors support a local government's capacity to finance desired capital improvement projects. Those factors include the health of the local economy, the structure of its revenue base, the management of the community's operations, and the debt history of the community.

The Municipal Fiscal Officers Association has developed a number of financial warning indicators useful in determining the financial health of a community. These indicators are used to help determine the sponsor's current debt position and financial health. Financial indicator ratings are calculated for the city of Dallas and are compared to national averages as outlined in the Environmental Protection Agency's *Financial Capability Guidebook*, dated March 1984. The financial data used to calculate these ratings were obtained from the city of Dallas Office of Budget and Management. Other relevant facts and data which play a role in the analysis include population, per capita income and property tax information. Table D-37 provides a key of the financial indicator ratings and limits. Table D-38 shows the indicator values and rating for the city of Dallas. The indicators, calculated values and corresponding rating have been updated to reflect the city's capability as of September 1997 and are summarized in table D-39.

Table D-37
Financial Indicator Rating Key

Indicator	Weak	Average	Strong
1. Annual rate of change in population	< 1%	1% to 1%	> 1%
2. Current surplus/deficit as a percent of total current expenditures	< 0%	0% to 5%	> 5%
3. Real property tax collection rate	< 96%	96% to 98%	> 98%
4. Property tax revenue as a percent of full market value of real property	> 4%	2% to 4%	< 2%
5. Overall net debt as a percent of full market value of real property	> 5%	3% to 5%	< 3%
6. Overall net debt outstanding as a percent of personal income	> 12%	4% to 12%	< 12%
7. Direct net debt per capita	> $750	$250 to $750	< $250
8. Overall net debt per capita	> $1,200	$500 to $1,200	< $500
9. Percent direct net debt outstanding due within next 5 years	< 10%	10% to 30%	> 30%

Table D-38
Current Community Financial Indicator Values
For the City Of Dallas

INDICATOR	VALUE	RATING
1. Annual rate of change in population	1.2%	Strong
2. Current surplus/deficit as a percent of total current expenditures	1.1%	Average
3. Real property tax collection rate	96.9%	Average
4. Property tax revenues as a percent of full market value of real	.5%	Strong
5. Overall net debt as a percent of full market value of real property	2.2%	Strong
6. Overall net debt outstanding as a percent of personal income	6.2%	Average
7. Direct net debt per capita	$609	Average
8. Overall net debt per capita	$1,277	Weak
9. Percent direct net debt outstanding due within next 5 years	77.0%	Strong

The annual rates of change in Dallas' population between 1980 and 1990 exhibits a strong 1.2 percent annual rate of change. The indicator stability in the economic base is useful because the economic base typically rises and falls with changes in the population. The proportion of surplus/deficit expenditures to total expenditures are also some significant indicators of the community's strength. Dallas is currently operating at a surplus with revenues exceeding expenditures by about 1.1 percent, which is in balance with the national average. The third indicator measures the efficiency of the city's tax collection system. The city is currently strong in this area reporting a 1997 collection rte of 96.9 percent. The city's reliance on tax revenue, indicator four, shows the extensiveness of property taxation and the potential for future revenue growth from this source. A value of 0.5 percent is strong and indicates that the city does not appear to tax heavily in relation to property values in this area.

Indicators' five through nine are used to assess the community's debt capacity. Indicator five compares the amount of tax-supported debt to the full market value of real property. The city of Dallas is average with a value of 2.2 percent. Personal income can be used as a yardstick to judge the city's ability to repay debt. Per Capita income for January 1990 was $20,483. Indicator six shows net debt representing about 6.2 percent of total personal income, which is average for most cities. Indicators' seven and eight represent the per capita direct debt of almost $609 and overall net debt outstanding per capita of $1,277, which indicates a weakness in this area.

Finally, indicator nine compares the percentage of direct net debt due within five years to total outstanding direct net debt. The city's situation is strong with 77 percent of the outstanding debt being paid over the next five years. The overall net debt reported in 1997 was $1,326,830,670.

Based on the national averages the overall financial condition of the city of Dallas is currently in a healthy state. The only indicator falling within the weak range was for the amount of net debt outstanding per capita. However, the calculated value only exceeded the average limits by only $77. The city of Dallas is not over extended and appears to have room to expand their debt load for new capital projects.

Table D-39
City of Dallas
Summary of Financial Capability
Dallas Floodway Extension Dallas, Texas, General Evaluation

A. BOND RATINGS	Rating	Date
General Obligation	AAA/Aaa (S&P)	Nov-96
Revenue Bonds:		
Dallas Water Utilities	AA/Aa (S&P)	
Civic Center	A/A1	Apr-98

B. DEBT

	Outstanding	Projected	Total
General Obligation Bonds	$632,940,270	0	$632,940,270
Revenue Bonds	$1,026,993,000	0	$1,026,993,000
Gross Direct Debt	$1,659,933,270	0	$1,659,933,270
Direct Net Debt	$632,940,270	0	$632,940,270
Overlapping Net Debt 1/	$693,890,000	0	$693,890,000
Overall Net Debt	$1,326,830,270	0	$1,326,830,270

C. DEBT REPAYMENT SCHEDULE (principle only)

	Existing	This Project*	Total
Year 1: 1998	$110,829,408	0	$110,829,408
Year 2: 1999	$107,821,082	0	$107,821,082
Year 3: 2000	$100,014,486	0	$100,014,486
Year 4: 2001	$86,486,881	0	$86,486,881
Year 5: 2002	$80,955,880	0	$80,955,880
			$486,107,737

* Assumes project funding at $23.7 million and included in outstanding debts. General Obligation bonds authorized as of May 1997.

D. DEBT LIMITS

Constitutional and Charter Debt Limit: Ten percent of assessed value. Article 717K, Vernon's Annotated Texas Civil Status Constitution and Laws of the State of Texas. Approximately 16.83% of debt limit will be used.

[1] Overlapping net debt is the sponsor's share of taxes owed to other taxing bodies within the community, ie., a flood district.

[2] Other debt obligations include outstanding leases, unfunded pension liabilities, and notes with a maturity.

Non-Federal Financial Planning

The purpose of strategic financial planning is to optimize the use of capital over time in response to long term financial goals. The three principal elements involved include cost recovery alternatives, if needed; selection of the preferred financing alternative; and implementation of the cost recovery approach. Although financing decisions are ultimately the sponsors', the Corps of Engineers can assist in the decision making through the provision of timely information on costs, benefits and cost recovery opportunities. The sponsor is responsible for making arrangements to finance the project sufficiently in advance of construction to enable the project schedule to be met.

Ability-to Pay Analysis

Based on ER 1165-2-121 an ability-to-pay test should be applied to all flood control projects. The test determines the eligibility of the study area to qualify for a reduction in the amount to be cost shared by the Non-Federal interest. To qualify for a reduction the results of both the benefit and income portions of the twofold ability-to-pay test must fall within the specified guidelines.

The benefits' test determines the maximum reduction, called the "benefits based floor" (BBF), in the level of non-Federal cost sharing for any project. The factor is determined by dividing the project B/C ratio by four. If the factor (expressed as a percentage) is less than the standard level of cost sharing, the project may be eligible for a reduction in the non-Federal share to this BBF. The WRDA 86 authorized cost share level for the Flood Protection project is 25 percent. The recommended plan's B/C ratio of 2.06 was divided by four to yield a BBF of .515 or 51.5 percent.

The income test determines qualification for the reduction calculated in the benefit step. Qualification depends on a measure of the current economic resources of both the project area and the State in which the project is located.

In accordance with factors released in Economic Guidance 96-4, the income index factors for the state of Texas and Dallas County are 90.81 and 102.77, respectively. The Eligibility Factor (EF) for a flood control project is calculated according to the following formula:

$$EF = a - b_1 * (\text{State factor}) - b_2 * (\text{area factor})$$

where:

$a = 15.86794$

$b_1 = 0.06771$

$b_2 = 0.13543$

Utilizing the above formula, an EF of -4.2 was calculated for the City of Dallas. An EF less than zero indicates ineligibility for a reduction in construction cost sharing. As stated previously, a BBF factor for the investigated plan was calculated at 51.5 percent. To qualify for a reduction, the BBF factor must be less than the standard level of cost sharing in accordance with ER-1165-2-121 paragraph 5a(2). The City of Dallas does not meet the criteria for a reduction in construction cost because this project meets neither test, therefore, the City of Dallas must pay the standard 25 percent level of the total project cost as authorized in WRDA 86.