Economic Appendix

Draft

October 2011

THE STUDY AREA

The study area for the economic analysis is the Harris, Galveston, and Brazoria County portions of the Clear Creek watershed impacted by the estimated median 0.2 percent annual exceedance probability (AEP) flood event on the main stem and five of its tributaries as defined by the most likely future 2070 hydrology without runoff controls. This area, extends from Galveston Bay to the Brazoria County-Fort Bend County boundary, and includes the main stem of Clear Creek, Mud Gully and Turkey Creek in Harris County, and Marys, Cowart, and Chigger Creeks in Brazoria and Galveston Counties, as shown in Figure 1.

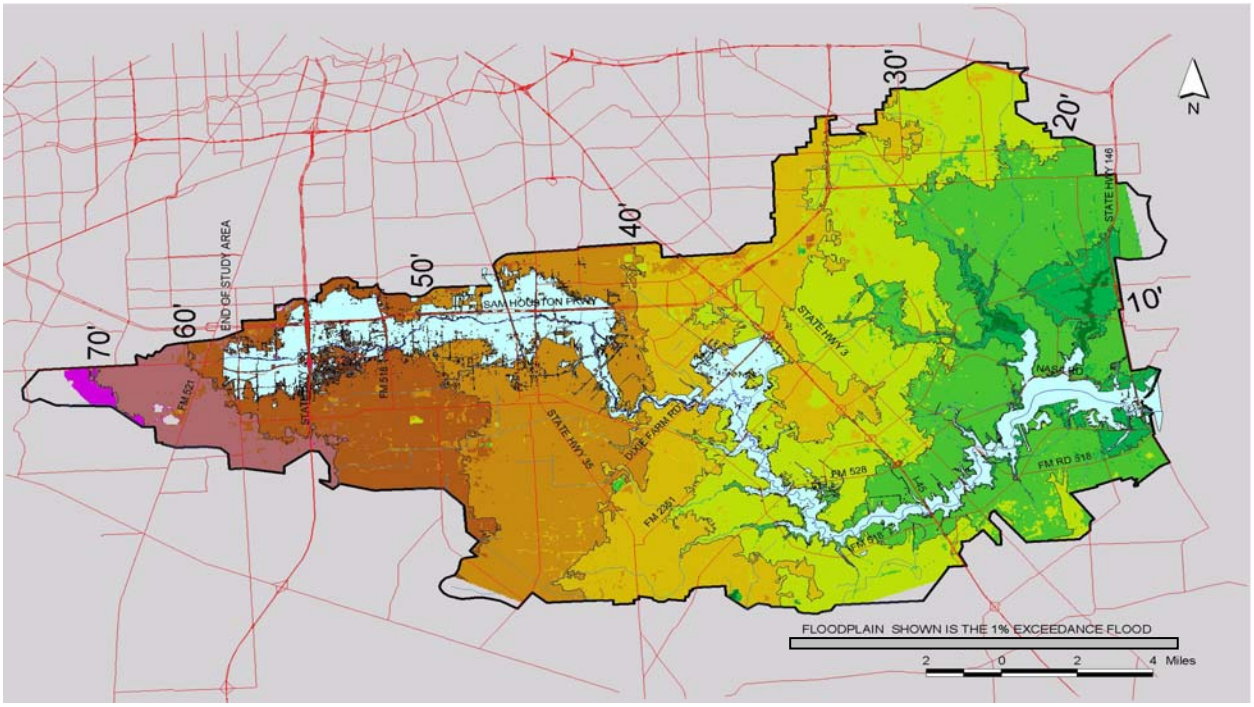

Figure 1. Clear Creek Watershed, 1% AEP Floodplain (light blue) and Associated Land Surface Elevations, Main Stem

Flooding of residential and commercial developments situated near Clear Creek and its tributaries is the principal problem within the watershed. As a result of rapid expansion and urbanization in recent years, the capacity of the existing channels has been exceeded on an increasingly frequent basis, even with runoff from moderate rainfalls. The present extent of flooding from the 100-year flood plain in Galveston, Harris, and Brazoria Counties is now restricted by land use regulations adopted by these counties to qualify for the National Flood Insurance Program.

THE PERIOD OF ANALYSIS, INTEREST RATE, AND PRICE LEVEL

The period of analysis begins in the year 2020, the first year in which a project would become operational. Therefore, the base year is defined as 2020. The period of analysis extends 50 years in the future to the year 2070, in accordance with ER 1105-2-100, Appendix D-6(a) (3), dated June 30, 2004. The most probable future condition reflects changes in hydrologic conditions from anticipated development within the watershed tempered by runoff restrictions imposed by local authorities over the period of analysis, 2020 to 2070. This assumption is consistent with current guidance.

For the purpose of plan comparison, a uniform period of analysis is required to incorporate the time value of money. Guidance requires that all project benefits be reported as average annual equivalent values (AAEV) which involve calculating benefits over the entire 50-year period of analysis, discounting those benefits to the base year, the first year the project is fully operational, and then amortizing them over 50 years using a mandated interest rate. The interest rate for discounting is set each fiscal year in accordance with Section 80 of Public Law 93-251. The U.S. Army Corps of Engineers (USACE) obtains the rate from the U.S. Treasury Department, which computes it as the average yield on interest-bearing marketable securities of the United States having 15 or more years to maturity. The computed rate is effective as of October 1of each year. The interest rate for Fiscal Year 2011 (FY11) is 4.125 percent and is applied to the final analysis.

Current interest rates were used during the multi-year study period and applied uniformly during each phase of plan formulation. In order to avoid confusion in the presentation of alternative screening results and to remain true to the results of the plan formulation, the interest rate applicable at the time the analysis was conducted is reported where appropriate. The final results are presented in FY10 price levels.

Data collection for development of the Clear Creek main stem structure inventory began in the year 2000. Data for over 12,000 structures on the main stem were collected during 2000-2001 and data for another 12,000 structures for the tributaries were collected during the period 2002-2003. Values presented in this analysis reflect certified year 2001 tax appraisal district valuations updated and adjusted to October, 2009 depreciated replacement values. For purposes of plan formulation and initial screening of flood risk management reduction measures, the year 2001 tax valuations were used as proxy values for depreciated replacement values. For the final refinement of alternatives, prices were adjusted to reflect depreciated replacement values, as required by guidance, for the current year.

ECONOMIC REACHES

Property surveyed within the most likely future median 0.2 percent AEP floodplain (or 500-year floodplain) of the Clear Creek main stem was allocated to the nearest stream cross-section between river cross-section 0+00 and 236609+00. These cross-sections were aggregated into 19 economic reaches in order to facilitate analysis. The following Table 1 shows the aggregations of cross-sections into economic reaches with geographic or other physical descriptors. The backwater effects of the main stem on the tributaries in the study area were incorporated into the main stem analysis. Properties that lie on the tributaries, but whose hydrology was controlled by that of the main stem, were assigned to the main stem.

TABLE 1
ECONOMIC REACH DELINEATIONS FOR CLEAR CREEK MAIN STEM

REACH	LOWER XSEC	LOWER LIMIT NEAR	UPPER XSEC	UPPER LIMIT NEAR
1	0	GALVESTON BAY	7020	ROSEWOOD
2	7020	ROSEWOOD	23263	BAL HARBOR
3	23263	BAL HARBOR	37212	FM270
4	37212	FM270	46388	SH3
5	46388	SH3	55615	IH45
6	55615	IH45	73893	W BAY AREA BLVD
7	73893	W BAY AREA BLVD	90072	FM528
8	90072	FM528	95406	WHISPERING PINES
9	95406	WHISPERING PINES	103330	NEAR MARYS CRK
10	103330	NEAR MARYS CRK	112394	FM2351
11	112394	FM2351	125782	NEAR TURKEY CRK
12	125782	NEAR TURKEY CRK	143346	DIXIE FARM RD
13	143346	DIXIE FARM RD	160053	COUNTRY CLUB DR
14	160053	COUNTRY CLUB DR	170703	BENNIE KATE
15	170703	BENNIE KATE	185548	SH35
16	185548	SH35	189373	MYKAWA
17	189373	MYKAWA	205888	STONE RD
18	205888	STONE RD	223445	SH288
19	223445	SH288	236609	ALMEDA SCHOOL RD

note: All properties north of the main stem lie in Harris County; Properties in Reaches 1-12 south of the main stem lie in Galveston County; properties in Reaches 13-19 south of the main stem lie in Brazoria County

A similar procedure was followed with the five Clear Creek tributaries studied. Property improvements were surveyed and allocated to the nearer cross-sections of the respective

tributaries. Tables 2 through 6 display the economic reaches created for the tributaries to which properties were assigned. ER 1165-2-21, 30 Oct 80, describes one criterion for Federal participation in urban water damage problems as "… downstream from the point where the flood discharge of such a stream or waterway within an urban area is greater than 800 cubic feet per second (cfs) for the 10 percent flood …." This criterion was especially critical for determining the Federal interest in the Clear Creek tributaries. Hickory Slough a tributary of Clear Creek that drains part of the City of Pearland, Brazoria County, did not qualify for consideration based on this "800 cfs" criterion. Economic reaches are presented in Figure 2 along with the 0.2 percent AEP (500-year) floodplain delineation.

TABLE 2

ECONOMIC REACH DELINEATIONS FOR MUD CREEK

REACH	LOWER XSEC	LOWER LIMIT NEAR	UPPER XSEC	UPPER LIMIT NEAR
1	9960	90 DEGREE TURN SW	17833.5	HALL ROAD
2	17833.5	HALL ROAD	20262.9	BELTWAY 8
3	20262.9	BELTWAY 8	23454.6	KINGSPOINT
4	23454.6	KINGSPOINT	26578.6	UPPER 800 CFS LIMIT

note: All reaches are located in Harris County

TABLE 3

ECONOMIC REACH DELINEATIONS FOR TURKEY CREEK

REACH	LOWER XSEC	LOWER LIMIT NEAR	UPPER XSEC	UPPER LIMIT NEAR
1	13518.95	END OF BACKWATER	17666.00	NYACK
2	17666.00	NYACK	19778.71	SCARSDALE
3	19778.71	SCARSDALE	22476.28	BELTWAY 8
4	22476.28	BELTWAY 8	23604.19	SAGEDOWNE—800 CFS LIMIT

note: All reaches are located in Harris County

TABLE 4

ECONOMIC REACH DELINEATIONS FOR MARYS CREEK

REACH	LOWER XSEC	LOWER LIMIT NEAR	UPPER XSEC	UPPER LIMIT NEAR
1	4400	EDGEWIID DR,	10775	COUNTY LINE
2	10776	COUNTY LINE	25407	LONGERRIDGE DR.
3	25408	LONGERRIDGE DR.	37897	AT&SF RAILROAD
4	37898	AT&SF RAILROAD	48122	HARKEY RD.
5	48123	HARKEY RD.	57133	CHARLES AVE. – 800 CFS LIMIT

note: Reaches 1-4 are located in Galveston County; Reach 5 lies in Brazoria County

TABLE 5

ECONOMIC REACH DELINEATIONS FOR COWART CREEK

REACH	LOWER XSEC	LOWER LIMIT NEAR	UPPER XSEC	UPPER LIMIT NEAR
1	5560	CASTLEWOOD	9826	SUNSET DR
2	9827	SUNSET DR	16256	COUNTY LINE
3	16257	COUNTY LINE	26581	800 CFS LIMIT

note: Reaches 1 and 2 are located in Galveston County; Reach 3 lies in Brazoria County

TABLE 6

ECONOMIC REACH DELINEATIONS FOR CHIGGER CREEK

REACH	LOWER XSEC	LOWER LIMIT NEAR	UPPER XSEC	UPPER LIMIT NEAR
1	6990	FM 518	12696	GREENBRIAR
2	12697	GREENBRIAR	17901	NARINA
3	17902	NARINA	25090	CONFLUENCE WITH BYPASS—800 CFS LIMIT
4	25091	CONFLUENCE WITH BYPASS	31259	BRAZORIA COUNTY LINE
5	31260	BRAZORIA COUNTY LINE	55600	HEADWATERS OF STREAM

note: Reaches 1-4 are located in Galveston County; Reach 5 lies in Brazoria County

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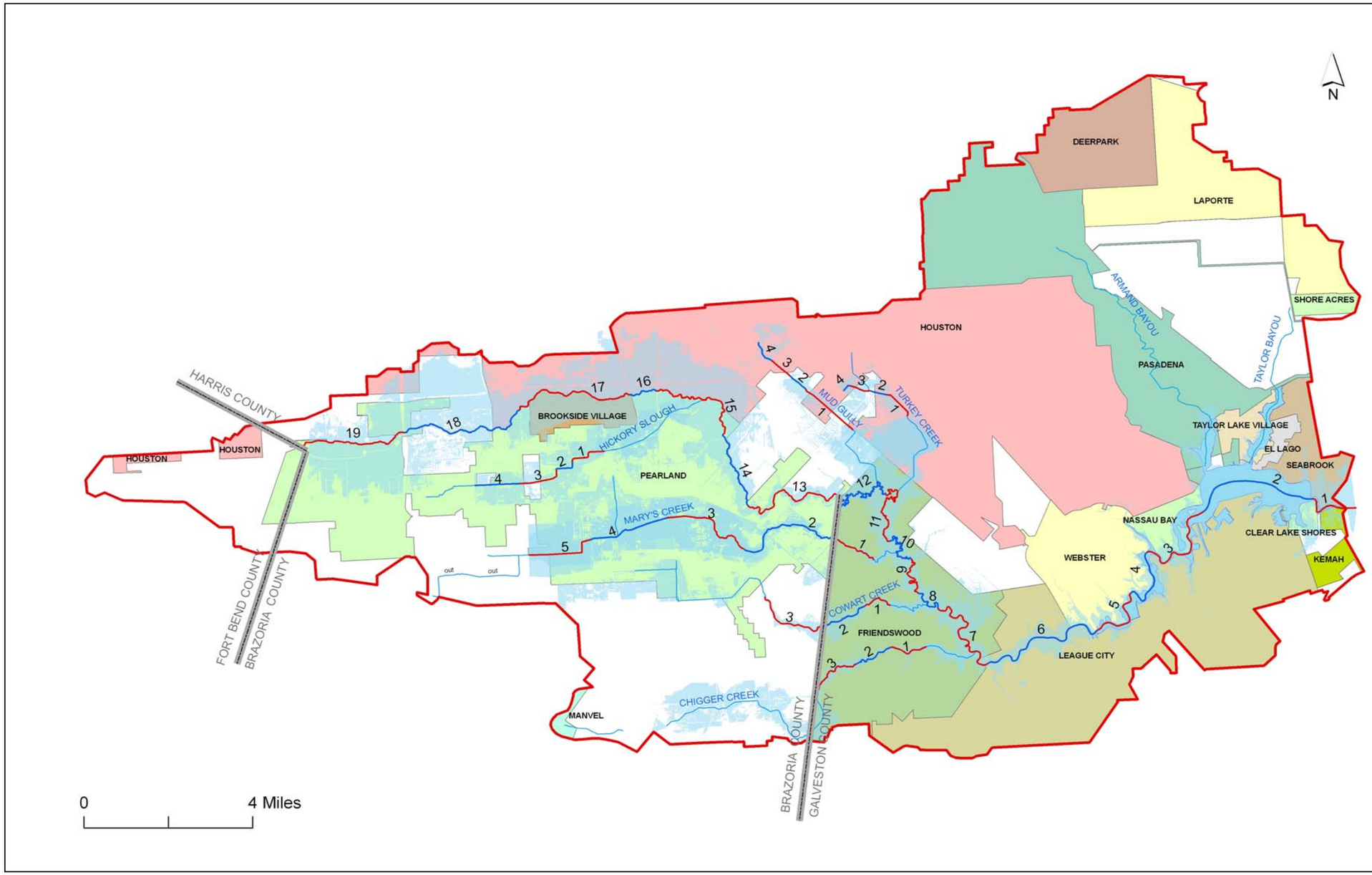
Figure 2. Clear Creek Watershed, 2020 Condition, Economic Reaches and 0.2% Floodplain (light blue)



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DATA COLLECTION AND ANALYSIS PROCEDURES

The methodology detailed below describes the procedures taken to determine project benefits in accordance with the most current guidance, ER 1105-2-100, dated April 22, 2000, and ER 1105-2-101, dated January 3, 2006. Benefit categories investigated for justification of flood risk management measures consist primarily of inundation reduction to structures and contents, inundation reduction to utilities, vehicles, and roads, and reductions in costs sustained by individuals following flood events not identified elsewhere, such as temporary relocation and reoccupation costs. Reduction in administrative costs to the National Flood Insurance Administration (NFIA) is another benefit category applicable to removing structures from the regulatory NFIA floodplain.

Survey of Existing Development. The methodology employed for survey of existing development relied on remote sensing and secondary sources for base information. The inventory of structures within the most likely future median 0.2 percent AEP floodplain was coordinated with the development of the hydrologic baseline information by using shared digital orthophotos flown of the watershed in February, 2000. Horizontal projections were referenced to NAD 83 and the State Plane Coordinate system, South Central Zone. Vertical elevations were referenced to NAVD 88. Photogrammetric digital terrain data were developed within the floodplain with an average spacing of 1 point per 50 feet and an average spacing of 1 point per 100 feet outside the floodplain but within the watershed. A digital terrain model was created using a triangulated irregular network (TIN).

Over 12,000 structures were inventoried on the main stem and an additional 12,000 structures were inventoried along five tributaries using orthophotographs as a base coverage. Points were placed on footprints of structures visually identified on the photographs. Property boundaries, or parcel delineations, were purchased from a vendor who supplied not only the digitized property boundaries but also the attribute tables containing certified year 2001 tax appraisal district records for each parcel. Cross-sections were added as a data layer to associate the hydrology to each structure's point. The ground elevation of the point was assigned from the digital elevation model (TIN) developed from the orthophotographs. Land survey crews surveyed first floor elevations for over 3,300 structures lying closest to the creek. The first floor corrections of the remaining structure inventory were estimated by windshield survey. A data verification team viewed the entire study area to complete the data record—ascertaining the accuracy of the secondary data and making corrections, additions, and deletions as needed from the field. The point file was assigned all the attributes of the various coverages so that a complete data record exists for each structure that contains the tax appraisal district record, the ground elevation, and either the first-floor correction and/or surveyed first-floor elevation, and the nearer cross-section.

After the field verification work was complete, the data record was matched with appropriate depth-damage functions based on structure type and exterior construction. Commercial, public, and industrial structures were also assigned appropriate depth-damage functions for contents based on the current use of the structure coupled with content values taken from the business and personal property tax valuations. Missing structure values for tax-exempt properties were determined by the District's Real Estate Division.

All data developed for the structure inventory is in ESRI ArcGIS format and is archived along with other coverages of the Clear Creek study area.

ANALYTICAL TOOLS AND RISK AND UNCERTAINTY

The Analytical Model. The Hydrologic Engineering Center's Flood Damage Analysis Version 1.2.5 release (HEC-FDA) model is employed in this analysis because its risk-based analysis methods for flood risk management studies meet the requirements of EM 1110-2-1419 and ER 1105-2-101. HEC-FDA Version 1.2.5 is a certified model and appropriate for this application. The analytical method explicitly incorporates descriptions of uncertainty within key parameters and functions into project benefit and performance analyses. Stage frequency data were not adjusted for the dynamic economic model and, therefore, reflect median discharge frequencies, a procedure consistent with current guidance.

Uncertainty in Depth-Damage Functions. ER 1105-2-101, January 3, 2006, explicitly states that uncertainty will be expressed in the following economic variables, as appropriate: depth-damage curves; structure values; content values; structure first-floor elevations; structure types; flood warning times; and flood evacuation effectiveness. Uncertainty in depth-damage relationships is incorporated into the HEC-FDA model with the use of generic depth-damage functions for residential structures without basements as published in Economic Guidance Memorandum 01-03, dated December 4, 2000, and with commercial depth-damage functions prepared by GEC, Inc. under contract with the New Orleans District. The generic depth-damage functions for residential structures negate the need for uncertainty expressions in content values and content-to-structure ratios because the content damage is calculated as a percent of the structure value rather than as a percent of the content value as was once the traditional method. Commercial depth-damage functions pertain to four generalized exterior construction types. ((Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-to-Structure Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies, Final Report, May, 1997)). The depth damage functions produced for the New Orleans District were deemed appropriate to the study area because of similar flooding patterns and construction techniques within Louisiana and Texas Gulf Coasts. The New Orleans

functions were applied to commercial, industrial, and public structures as appropriate. Galveston District commercial, public, and municipal inventory and equipment damage curves were used to estimate content damages to those uses.

Uncertainty in Structure Values. Uncertainty in structure values was determined by expert solicitation of the District's Real Estate Division's appraisal staff. Uncertainty was determined to range within ten percent of the improvement depreciated replacement value and was incorporated into the HEC-FDA model.

Uncertainty in First Floor Elevations. The first floor elevation survey performed for over 3,300 structures closest to Clear Creek was accomplished using GPS Real Time Kinematic-On the Fly (RTK-OTF) for establishing survey control and the Wild TC 1010 Total Station with TDS data collection package for collection and management of the first floor elevation data. The mean precision achieved using Trimble's Real Time Kinematic surveying for determining horizontal positions at control points was ±0.018 feet. Mean vertical precision achieved during the survey was ±0.032 feet (Larry J. Broussard, PLS, John Chance Land Surveys, Inc., letter memorandum, August 21, 2000).

The ground elevations and floor corrections of the remaining structures within the 0.2 percent floodplain of the main stem and for all five tributaries was determined by deriving the ground elevation of the structure footprint from the TIN and by visual estimate of the floor correction. Uncertainty in the first floor elevations of these structures along the main stem and along the five tributaries was determined by comparing a sample of structures within the 1 percent flood plain for which both the land survey and the windshield survey were conducted. The standard error of the estimate associated with the ground elevation error from the digital terrain model coupled with the error associated with the windshield survey method of determining the first floor elevation correction produced a regression coefficient of 1.44 feet.

The standard deviation specific to the survey method used was entered into HEC-FDA for each individual structure (i.e. 0.032 for land-surveyed structures and 1.44 for windshield-surveyed structures).

DAMAGE CATEGORIES

Residential Structures. Residential structure damages include inundation losses for single- and multi-family dwellings including one-, one-and-a-half-, and two-story dwellings, mobile homes, garages, high-raised homes, apartments with living space on one floor, and townhomes/condominiums with living space on multiple floors. Separate depth-percent damage

relationships were applied to the residential inventory based on classification of the structure. No structures within the inventory have basements.

Residential Property Values. Current guidance (ER 1105-2-100) states that if percent damage functions are used in the assessment of stage-damage relationships, replacement cost less depreciation is the correct measure of structure value. In order to comply with this directive, a methodology for assigning depreciated replacement value to inventoried structures has been developed and was applied to the proxy values used to develop the without-project condition. A statistically significant random sample of 50 structures within the 0.2 percent AEP floodplain was drawn for calculation of depreciated replacement values at October, 2005 prices. These values were regressed against their year 2001 assessed values for a factor adjustment of 1.68 at the 85 percent confidence level. These values were again updated to 2008 price levels using Marshall and Swift Estimator software for depreciated replacement value estimation; the results were regressed against their 2001 assessed values for a factor adjustment of 1.73. For the final analysis, Marshall and Swift Estimator again utilized to establish the 2010 price levels (directly updating values from 2001 to 2010). The factor adjustment for the final analysis was 1.68 at the 85 percent confidence level. No property values presented in this report include land values.

It should be noted that the price level indices developed for 2005, 2008 and 2010 are not simply construction cost indices. The percent increase in tax assessor values from the 2001 base takes into account the difference in appraisal methodology, homestead value limitations and price level changes from 2001 to 2010. The development of the indices was necessary to transform the tax assessor values into values required by guidance (depreciated replacement values).

In addition, the 2005 appraisal was conducted by a certified Real Estate appraiser. That appraisal resulted in an index of 1.68 (depreciated replacement cost appraisal), further indicating the reasonableness of the Marshall and Swift-developed indices for 2008 and 2010 of 1.73 and 1.68, respectively.

Commercial and Industrial. Commercial and industrial damages include losses to all properties used in commerce, industry, business trade, servicing, or entertainment. Separate depth-damage relationships were used to assess inundation damage to structures, equipment, and inventories. The total of these assessed damages are presented under the general commercial or industrial category. All commercial and industrial structures in the study area were assigned one of four exterior construction types by visual inspection by the field verification team. Structure and content values were acquired initially from the respective tax appraisal district certified 2001 values for each county within which the structure was located. These values were then adjusted

to reflect depreciated replacement values at current prices using the method described for residential values.

Public. Public damages include damages to public facilities such as public buildings, parks, and other facilities, including equipment and furnishings owned or operated by Federal, State, County or municipal entities. Separate depth damage relationships were used to assess inundation damage to structures, equipment, and inventories. The total of these assessed damages are presented under the general public category. Depreciated replacement values for these structures were as previously described and updated using Marshall and Swift software.

Vehicles. The nature of development within the study area is such that streets are graded lower than the surrounding land in order to function as tertiary drainage conduits from the surrounding urban development. Due to the dual function of roadways for transportation and drainage, vehicles are especially vulnerable to damage from flooding. Flood damage to vehicles includes the labor and parts to dry out and replace materials, as necessary, whenever a vehicle is inundated. The methodology used for this damage category is consistent with EGM 09-04," Generic Depth-Damage Relationships for Vehicles."

GEC, Inc. under contract with the New Orleans District developed generic depth-damage functions for vehicular inundation based on interviews with automobile dealership operators. The New Orleans District (NOD) generic depth-damage functions were utilized due the similar flooding characteristics between study areas. The EGM 09-04 depth-damage curves were deemed inappropriate based upon recent experiences in vehicle flooding in the Houston area (i.e. Tropical Storm Allison, Hurricane Ike). Specifically, the NOD curves have the first significant damages being realized at 2 feet of flooding (above ground level), while the EGM 09-04 depth-damage curves have significant damages occurring with just 1 foot of flooding (above ground level). The EGM curves are inconsistent with flooding circumstances and related vehicle damages in this area. Due to the dual function of the roadways to transport vehicles, water over the roads are extremely common and significant damages are not occurring at the 1 foot level. In addition, the NOD vehicle damage curve has 100 percent damage occurring at the 3 foot level of flooding, while the EGM damage curves only expect approximately 50 percent damage at that level. Again, the NOD curve is more consistent with the damages experienced in the study area, with most vehicles being totaled by the insurance company with just 2 to 3 feet of water. The EGM curves do not have 100 percent damage until the water level is 6 feet – a level vastly different than local experience of totaled vehicles at 2 to 3 feet of water.

The New Orleans survey concentrated on three broad classes of automobiles: compact, mid-size, and full-size (Depth-Damage Relationships for Structures, Contents, and Vehicles and Content-

to-Structure Value Ratios (CSVR) in Support of the Lower Atchafalaya Reevaluation and Morganza to the Gulf, Louisiana Feasibility Studies, Final Report, May, 1997). For this analysis the depth-damage relationship for the mid-size vehicles was used as the mean value for damage estimation relative to the ground elevation while the depth-damage relationship for the compact vehicles established the lower limit of uncertainty and the depth-damage relationship for the full-size vehicles established the upper limit of uncertainty.

The value of vehicles was determined using a triangular distribution for Houston-area used vehicles. The Edmunds.com website was used to ascertain the average depreciated replacement values of 1-year, 5-year and 10-year-old vehicles. The average value was determined to be $13,800, with the low-end value being $6,600 and the high-end value being $25,860.

Stuart Davis established a one-vehicle damaged-to-one-residential-structure-damaged ratio in his unpublished "Houston Residential Flood Survey" (Institute for Water Resources, Fort Belvoir, Va., 1991). In addition, the latest vehicle damage guidance, EGM 09-04, suggests the use of the U.S. Census findings for number of vehicles per household in the study area. In the Clear Creek study area, the census data further supports the use of a one-vehicle-damaged-to-one-residential-structure-damaged ratio. Therefore, the estimate of vehicular damages assumes the same one-to-one ratio based on inundated residential structures. The ground elevation of the structure was used as the proxy for the ground elevation of the associated vehicle.

Utilities. Utility damages include losses to electrical transformers and transmission lines, telephone company lines and switch boxes, and water and gas pipelines. A unit value of $330 per structure damaged was used for the calculation of damages based upon a post flood damage assessment following Tropical Storm Claudette, 1979. The uncertainty estimate for utility damages ranges from a lower limit of zero percent damage to an upper limit of 100 percent damage for a given stage.

Roads. Road damages include repair costs for roads, bridges, street signals, and street lighting. Damage data from Tropical Storm Allison, occurring in June, 2001, were gathered from the Federal Emergency Management Agency (FEMA), the Texas Department of Transportation, Harris County, and the City of Houston. The data showed that over $9,608,000 in damages occurred to roads in the affected area. However, the data did not contain sufficient information regarding the miles of road damaged, and it was impossible to calculate an average cost per mile of damaged road with the information.

Because more recent information could not be utilized for purposes of estimating damages, stage-damage relationships for roads are based on the April 1979 Montgomery County and

Tropical Storm Claudette flood data collected from FEMA by the Galveston District. From the FEMA data, an average repair cost per mile of inundated asphalt, concrete, and dirt road was developed. That unit value applied to road repairs is $13,500 per mile at October, 2009 prices, using the CPI-U as a price adjuster.

Miles of roadway were measured using topographic base maps for each reach within the floodplain of each AEP event in the without-project condition. Depth-damage relationships were derived by applying the event stage at the reach index to the value of repair for the road-miles measured.

Post Disaster Recovery Costs. The Institute for Water Resources' (IWR) 1990 survey of flood victims within the Cypress Creek and Greens Bayou watersheds in Harris County revealed other associated costs of flooding to individuals that lacked prior quantification. These costs include lodging and travel costs, food costs, costs of clean up, costs of moving and storing furniture, vandalism and looting costs, and medical costs all associated directly with the flood experience (Stuart Davis, unpublished "Houston Residential Flood Survey," Institute for Water Resources, Fort Belvoir, Va., 1991). On average, each surveyed household reported costs exceeding $5,700 based on the costs iterated. In the absence of more current data, this value was escalated to current prices and incorporated into the estimate of damages at $8,800 per residential structure damaged. The uncertainty estimate for post-disaster damages ranges from a lower limit of zero percent damage to an upper limit of 100 percent damage for a given stage.

Emergency Response. Many attempts were made to collect data regarding costs of emergency services related to flood events; however, no usable data was available. Due to the unavailability of data, and the relative minor impact of this category on plan formulation, this category was omitted from the analysis.

Recreational Watercraft, Marinas, and Piers. Historically major flood events along Clear Creek and Clear Lake such as Tropical Storm Claudette in 1979 and Hurricane Alicia in 1983 have caused massive damage to watercraft and piers skirting the lake. Following Tropical Storm Allison, which occurred in June, 2001, economists at the Galveston District interviewed marina operators for damages sustained. It was discovered that, even though property along the creek sustained extensive damage, very little damage occurred to lakefront property. The Clear Lake Second Outlet was in place and functioning during the storm in 2001. Not only was the Second Outlet credited with protecting the Clear Lake area, but also advancements in construction for marinas, such as floating piers, and in operational methods, such using tide risers, now allow water levels to rise without damaging watercraft or marinas. No further attempt was made to ascertain benefits for this category.

Savings in National Flood Insurance Administration Costs**.** Benefits can be derived from a reduction in administrative costs to the National Flood Insurance Program (NFIP) if implementation of a proposed plan removes structures from the existing 1 percent AEP floodplain. According to FEMA, the average cost of administering a flood insurance policy was $192 for Fiscal Year 2006 (Economic Guidance Memorandum 06-04 "National Flood Insurance Program Operating Costs, Fiscal Year 2006," April 6, 2006).

Based on hydrologic stages for a median 1 percent AEP flood under 2020 conditions, an estimated 3,800 structures are physically located within the existing floodplain of main stem and tributaries of Clear Creek.

Participation rates in the (NFIP vary by county with an estimated 70 percent participation in Brazoria County, 70 percent in Galveston County (Galveston County Engineer, April, 2006), and 60 percent in Harris County (Harris County Engineer in consultation with NFIP Regional Manager, April 2007). Based on this information, a total of 2,461 structures within the 1 percent AEP floodplain hold NFIP policies in the without-project condition. The total annual cost of administering policies for these structures is estimated to be approximately $472,500.

HYDROLOGIC CONDITIONS IN THE WITHOUT-PROJECT FUTURE

The local sponsors, as well as local municipalities, have adopted watershed management policies and practices for minimizing increases in future development-induced runoff. To evaluate the effect of these policies analytically, a hydrologic model, which estimates the impact on discharges were these local ordinances not in place, was also developed and is referenced as the without-project uncontrolled condition. The without-project condition assumes that these local measures are functioning. The without-project "near term" and "most likely future" conditions applied to this analysis incorporate local sponsors' initiatives for minimizing development-induced runoff. The following comparison of these conditions in Table 7 displays the impact of local initiatives for flood risk management.

Another important aspect of the without-project hydrologic condition integral to this analysis is the assumption that the Clear Lake Second Outlet was not in place for the screening of alternatives. The Second Outlet was added into the final analysis, however. The Second Outlet is a component of the Authorized Federal Project that was actually constructed and operated prior to the project's reevaluation. The existence of the outlet presented an analytical challenge in that it was initially constructed as a mitigation measure to the Authorized Federal Project. But, as it is in place and functional, whereas the Authorized Project is not, the Second Outlet is

TABLE 7
COMPARISON OF RUNOFF SCENARIOS FOR WITHOUT-PROJECT CONDITION
CLEAR CREEK MAIN STEM
(Values in $1,000s, Oct 2009 Price Level)

	Without-Project Condition, Uncontrolled Runoff			Without-Project Condition, Local Sponsor's Initiatives to Control Runoff		
	EXPECTED ANNUAL DAMAGES		EQUIVALENT ANNUAL DAMAGES, 4.125%	EXPECTED ANNUAL DAMAGES		EQUIVALENT ANNUAL DAMAGES, 4.125%
REACH	2020	2070		2020	2070	
1	$117	$244	$159	$105	$138	$116
2	$93	$184	$123	$84	$112	$93
3	$100	$157	$119	$93	$110	$99
4	$128	$175	$144	$127	$132	$129
5	$0	$0	$0	$0	$0	$0
6	$184	$233	$200	$192	$200	$195
7	$820	$1,124	$918	$863	$987	$904
8	$857	$1,247	$983	$914	$1,065	$964
9	$657	$1,025	$777	$703	$859	$755
10	$1,367	$2,265	$1,657	$1,408	$1,774	$1,529
11	$219	$447	$294	$210	$279	$233
12	$98	$185	$127	$88	$131	$102
13	$840	$2,005	$1,219	$682	$1,215	$859
14	$202	$646	$348	$150	$331	$210
15	$5,451	$9,748	$6,842	$4,925	$7,020	$5,621
16	$783	$1,180	$910	$787	$903	$826
17	$2,789	$4,012	$3,182	$2,877	$3,090	$2,948
18	$5,330	$6,768	$5,787	$5,153	$5,360	$5,222
19	$245	$323	$270	$237	$250	$241
Total	$20,281	$31,969	$24,056	$19,598	$23,956	$21,045

Note: Individual numbers may not sum to totals due to rounding.

included in the final planning for the General Reevaluation Study (GRR). The exclusion of the Second Outlet from the earlier screenings does not impact the plan formulation for the GRR.

While the future without-project hydrologic and hydraulic (H&H) condition includes an increase in run-off, the changes in water surface elevations are minimal when compared to the near term. Also, there are no projections associated with the economic-side of the analysis. The inventory as shown in the without-project near-term condition is the same as future without-project inventory. No increase in development is projected. Only existing development (structures and contents) is modeled in the future without-project condition economics.

WITHOUT-PROJECT CONDITION

Description of the Floodplains and Flooding Problems. The Clear Creek watershed is included among the top ten repetitive loss property areas in the Nation, in terms of dollar damages, according to a study by the National Wildlife Federation.

The Clear Creek study area is characterized as relatively flat floodplain with shallow flooding associated with all events. Flooding is based on backwater for the main stem and on normal depth for the tributaries. Velocities do not pose a significant threat to life in any studied reach, with velocities typically ranging from 1 to 5 cubic feet per second (cfs) for all flood events.

Development on the main stem consists of approximately 93 percent residential structures followed by 6 percent commercial structures. Public and industrial occupancy types make up an insignificant portion of the floodplain properties. Of the residential structures identified within the main stem floodplain, 70 percent are one-story single family residential, primarily of slab-on-grade construction. Another 22 percent of the residential structures are two-story single family residential, again constructed slab-on-grade. There are no basements within residential structures in the study area. The average structure value for residential structures surveyed on the main stem is just over $116,000. The average structure value for commercial structures on the main stem is approximately $147,000.

The problem along the Clear Creek main stem is flood damages to residential, commercial and public investment caused by frequent low-level flood events associated with localized rainfall events and larger less frequent events with significant levels of flooding usually associated with tropical events. These frequent events (up to a four percent probability of occurrence) impact over 850 structures on the main stem, with an average depth of flooding of 0.7 feet. The majority of the frequently flooded structures located on the main stem, are located in the upper and middle reaches in the cities of Brookside, Pearland, Friendswood and Houston. The more

infrequent flood events (associated with a 2 percent to 0.2 percent probability of occurrence), impact over 3,100 structures on the main stem, with an average depth of flooding of 1.2 feet.

Development on Marys Creek consists of approximately 82 percent residential structures followed by 15 percent commercial structures. Public and industrial occupancy types make up an insignificant portion of the floodplain properties. Of the residential structures identified in the Marys Creek floodplain, 72 percent are one-story single-family residential, primarily of slab-on-grade construction. Another 19 percent of the residential structures are two-story single family residential, again constructed slab-on-grade. The Marys Creek residential structures also include 7 percent mobile homes. There are no basements within residential structures in the study area. The average structure value for residential structures surveyed on Marys Creek is just over $116,000. The average structure value for commercial structures on Marys Creek is approximately $47,000.

The problem along Marys Creek is again flood damages to residential, commercial and public investment caused by frequent low-level flood events associated with localized rainfall events and larger less frequent events with significant levels of flooding usually associated with tropical events. These frequent events (up to a four percent probability of occurrence) impact approximately 550 structures on Marys Creek, with an average depth of flooding of 0.6 feet. The more infrequent flood events (associated with a 2 percent to 0.2 percent probability of occurrence), impact over 1,900 structures on Marys Creek, with an average depth of flooding of 0.9 feet.

Development on Turkey Creek consists of approximately 99 percent residential structures followed by 1 percent commercial structures. Public and industrial occupancy types make up an insignificant portion of the floodplain properties. Of the residential structures identified in the Turkey Creek floodplain, 83 percent are one-story single-family residential, primarily of slab-on-grade construction. Another 7 percent of the residential structures are two-story single-family residential, again constructed slab-on-grade. The Turkey Creek residential structures also include 11 percent apartments. There are no basements within residential structures in the study area. The average structure value for residential structures surveyed on Turkey Creek is over $91,000. The average structure value for commercial structures on Turkey Creek is approximately $197,000.

The problem along Turkey Creek is again flood damages to residential and commercial investment caused by frequent low-level flood events associated with localized rainfall events and larger less frequent events with significant levels of flooding usually associated with tropical events. These frequent events (up to a four percent probability of occurrence) impact a minimal

number of structures, only 7 structures on Turkey Creek, with an average depth of flooding of 0.2 feet. The more infrequent flood events (associated with a 2 percent to 0.2 percent probability of occurrence), impact over 750 structures on Turkey Creek, with an average depth of flooding of 0.5 feet.

Development on Mud Gully consists of approximately 96 percent residential structures followed by 4 percent commercial structures. Public and industrial occupancy types make up an insignificant portion of the floodplain properties. Of the residential structures identified in the Mud Gully floodplain, 76 percent are one-story single-family residential, primarily of slab-on-grade construction. Another 20 percent of the residential structures are two-story single-family residential, again constructed slab-on-grade. The Mud Gully residential structures also include 4 percent apartments. There are no basements within residential structures in the study area. The average structure value for residential structures surveyed on Mud Gully is almost $102,000. The average structure value for commercial structures on Mud Gully is approximately $130,000.

The problem along Mud Gully is again flood damages to residential and commercial investment caused by frequent low-level flood events associated with localized rainfall events and larger less frequent events with significant levels of flooding usually associated with tropical events. These frequent events (up to a four percent probability of occurrence) impact approximately 90 structures on Mud Gully, with an average depth of flooding of 0.2 feet. The more infrequent flood events (associated with a 2 percent to 0.2 percent probability of occurrence), impact over 1,200 structures on Mud Gully, with an average depth of flooding of 0.8 feet.

Development on Cowart Creek consists of approximately 42 percent residential structures followed by 41 percent commercial structures. Public and industrial occupancy types make up an insignificant portion of the floodplain properties. Of the residential structures identified in the Cowart Creek floodplain, 45 percent are one-story single-family residential, primarily of slab-on-grade construction. Another 40 percent of the residential structures are two-story single-family residential, again constructed slab-on-grade. The Cowart Creek residential structures also include 14 percent mobile homes. There are no basements within residential structures in the study area. The average structure value for residential structures surveyed on Cowart Creek is over $142,000. The average structure value for commercial structures on Cowart Creek is approximately $13,000.

The problem along Cowart Creek is again flood damages to residential and commercial investment caused by frequent low-level flood events associated with localized rainfall events and larger less frequent events with significant levels of flooding usually associated with tropical events. These frequent events (up to a four percent probability of occurrence) impact

approximately 34 structures on Cowart Creek, with an average depth of flooding of 1.4 feet. The more infrequent flood events (associated with a 2 percent to 0.2 percent probability of occurrence) impact approximately 100 structures on Cowart Creek, with an average depth of flooding of 1.5 feet.

Development on Chigger Creek consists of approximately 88 percent residential structures followed by 12 percent commercial structures. Public and industrial occupancy types make up an insignificant portion of the floodplain properties. Of the residential structures identified in the Chigger Creek floodplain, 43 percent are one-story single-family residential, primarily of slab-on-grade construction. Another 43 percent of the residential structures are two-story single-family residential, again constructed slab-on-grade. The Chigger Creek residential structures also include 14 percent mobile homes. There are no basements within residential structures in the study area. The average structure value for residential structures surveyed on Chigger Creek is approximately $231,000. The average structure value for commercial structures on Chigger Creek is approximately $26,000.

The problem along Chigger Creek is again flood damages to residential and commercial investment caused by frequent low-level flood events associated with localized rainfall events and larger less frequent events with significant levels of flooding usually associated with tropical events. These frequent events (up to a four percent probability of occurrence) impact approximately 6 structures on Chigger Creek, with an average depth of flooding of 1.2 feet. The more infrequent flood events (associated with a 2 percent to 0.2 percent probability of occurrence) impact approximately 25 structures on Chigger Creek, with an average depth of flooding of 1.4 feet.

Capital Investment within the Various Floodplains. Table 8 displays a summary of the number of structures and the distribution of capital investment within eight existing median discharge AEP floodplains of the Clear Creek main stem and tributaries based on first floor elevations for the 2020 condition. As can be noted from Table 8, approximately 90 percent of the structures inventoried within the estimated existing median 0.2 percent AEP (500-year) floodplain are residential. In total the 0.2 percent AEP floodplain on the main stem and tributaries contains over 7,200 structures valued at over $806 million dollars, at October 2009 price levels. Of those inventoried, approximately 163 residential structures have been purchased and removed from the floodplain under the FEMA's Hazard Mitigation Program on the main stem of Clear Creek. Under authority of Section 575, Water Resources Development Act (WRDA) 96, as amended, those properties will remain in the structure inventory for Federal project justification. Presentation of the Section 575 analysis will be detailed later in this appendix.

TABLE 8
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CLEAR CREEK – SUM OF MAINSTEM AND ALL TRIBUTARIES
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-Year)	20% AEP Floodplain (5-Year)"	10% AEP Floodplain or (10-Year)	4% AEP Floodplain (25-Year)	2% AEP Floodplain (50-Year)	1% AEP Floodplain (100-Year)	0.4% AEP Floodplain (250-Year)	0.2% AEP Floodplain (500-Year)
Residential								
Number of Structures	1	133	517	1,274	2,231	3,239	4,886	6,522
Value of Structures	$94	$14,369	$50,106	$121,756	$224,178	$333,766	$523,851	$726,910
Value of Contents	$47	$7,185	$25,053	$60,878	$112,089	$166,883	$261,926	$363,455
Percent of Structures Inundated/Zone	25%	67%	76%	83%	86%	88%	91%	90%
Commercial								
Number of Structures	3	56	133	208	290	346	423	587
Value of Structures	$34	$4,545	$12,542	$15,666	$23,831	$29,195	$39,186	$51,744
Value of Contents	$1	$1,360	$7,041	$9,250	$18,704	$23,085	$32,352	$42,997
Percent of Structures Inundated/Zone	75%	28%	19%	14%	11%	9%	8%	8%
Industrial								
Number of Structures	0	5	18	32	40	42	48	51
Value of Structures	$0	$216	$4,361	$8,324	$9,901	$9,901	$9,941	$10,360
Value of Contents	$0	$1,149	$5,571	$9,425	$14,539	$14,539	$14,582	$14,867
Percent of Structures Inundated/Zone	0%	3%	3%	2%	2%	1%	1%	1%
Public								
Number of Structures	0	6	15	26	33	35	38	58
Value of Structures	$0	$1,283	$2,366	$7,227	$8,437	$8,605	$10,167	$17,410
Value of Contents	$0	$427	$635	$1,645	$2,241	$2,329	$3,004	$5,740
Percent of Structures Inundated/Zone	0%	3%	2%	2%	1%	1%	1%	1%
Total								
Number of Structures	4	200	683	1,540	2,594	3,662	5,395	7,218
Value of Structures	$128	$20,413	$69,375	$152,974	$266,347	$381,466	$583,145	$806,424
Value of Contents	$48	$10,121	$38,300	$81,199	$147,573	$206,836	$311,863	$427,060
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

As previously noted, over 24,000 structures were inventoried on the main stem and tributaries. The 7,200 structures identified in Table 8 represent the structures inundated by the 0.2 percent AEP flood event (or the 500-year event) on the main stem and tributaries in the 2020 without-project condition. In other words, only 7,200 structures (of the original 24,000 study area structures inventoried) are actually within the 500-year floodplain, the rest fall outside the 500-year floodplain.

In development of the structure inventory (of 12,000 structures for the main stem and 12,000 structures for the tributaries), the area was over-inventoried because the flood surface elevations had not yet been established and, given the method used, aerial photography with a Digital Terrain Model (DTM), no major increase in expense was incurred. The survey boundary was set at the FEMA 500-year plus 1,000 feet outward. Every attempt was made to be absolutely inclusive. And, too, there is always an issue of induced damages so that, over-inventorying can capture the effects of a plan that produces stages higher than the without-project condition.

Table 9 displays the structure inventory and distribution of capital investment within the eight existing median discharge AEP floodplains for the main stem and tributaries for the without-project 2070 condition. As with the 2020 condition, the 2070 condition also reveals the majority of structures in the 0.2 percent AEP floodplain to be residential, representing approximately 91 percent. For the 2070 condition, the 0.2 percent AEP floodplain contains over 8,500 structures valued at approximately $958 million dollars. For a break-down of the distribution of capital investment within the individual tributaries and main stem floodplains, see Enclosure 1.

Determination of Flood Damages to Existing Development. Flood damages were estimated for all property within the most likely future median 0.2 percent AEP floodplain of Clear Creek. Damages from inundation are based on data obtained from the survey of existing development. Damage estimates were computed for structures and contents of various types of physical properties classified as residential, commercial, public, or industrial. Damages were also estimated for vehicles, utilities, and roads as well as other costs associated with post disaster recovery. Intangible damages were not evaluated. Benefits not evaluated include erosion, reduced fill, fill, aesthetics, affluence, or intensification.

Single Occurrence Damages. A summary of damages expected to accrue from various flood events along the main stem and tributaries of Clear Creek is displayed in Table 10. These values represent damages expected for individual events under the without-project near-term hydrologic condition and include structure and content damages as well as other benefit categories. Similarly, Table 11 displays the summary of single occurrence damages by event for the tributaries in the future hydrologic condition. The detailed single occurrence damages for the

TABLE 9
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CLEAR CREEK – SUM OF MAIN STEM AND ALL TRIBUTARIES
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-Year)	20% AEP Floodplain (5-Year)"	10% AEP Floodplain or (10-Year)	4% AEP Floodplain (25-Year)	2% AEP Floodplain (50-Year)	1% AEP Floodplain (100-Year)	0.4% AEP Floodplain (250-Year)	0.2% AEP Floodplain (500-Year)
Residential								
Number of Structures	12	297	702	1,737	2,814	4,422	6,235	7,825
Value of Structures	$1,154	$29,746	$68,844	$168,500	$282,568	$486,828	$692,434	$866,914
Value of Contents	$577	$14,873	$34,422	$84,250	$141,284	$243,414	$346,217	$433,457
Percent of Structures Inundated/Zone	50%	76%	79%	85%	88%	89%	90%	91%
Commercial								
Number of Structures	11	77	151	241	318	453	553	631
Value of Structures	$129	$7,120	$13,145	$19,259	$27,196	$33,921	$47,444	$63,260
Value of Contents	$66	$3,689	$7,441	$13,264	$21,465	$28,044	$39,490	$47,133
Percent of Structures Inundated/Zone	46%	20%	17%	12%	10%	9%	8%	7%
Industrial								
Number of Structures	0	8	21	34	41	44	55	61
Value of Structures	$0	$658	$5,145	$8,912	$9,901	$10,301	$10,743	$10,743
Value of Contents	$0	$2,802	$6,011	$9,825	$14,539	$14,812	$15,128	$15,128
Percent of Structures Inundated/Zone	0%	2%	2%	2%	1%	1%	1%	1%
Public								
Number of Structures	1	9	19	29	33	51	53	67
Value of Structures	$16	$1,435	$2,737	$7,384	$8,437	$16,290	$16,295	$17,005
Value of Contents	$6	$525	$821	$1,712	$2,241	$5,311	$5,314	$5,590
Percent of Structures Inundated/Zone	4%	2%	2%	1%	1%	1%	1%	1%
Total								
Number of Structures	24	391	893	2,041	3,206	4,970	6,896	8,584
Value of Structures	$1,299	$38,959	$89,871	$204,055	$328,102	$547,340	$766,916	$957,921
Value of Contents	$648	$21,889	$48,696	$109,051	$179,529	$291,581	$406,149	$501,308
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 10
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
CLEAR CREEK – SUM OF MAINSTEM AND ALL TRIBUTARIES
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$524.5	$10,911.9	$35,884.1	$74,237.9	$114,104.1	$158,780.1	$228,728.9	$313,170.0
Public	$0.1	$1.7	$20.1	$63.8	$97.0	$110.7	$1,744.0	$2,783.3
Commercial	$8.2	$476.9	$1,781.7	$3,617.7	$5,390.6	$6,496.1	$10,094.6	$14,869.5
Industrial	$0.0	$0.9	$585.1	$4,378.9	$6,595.6	$6,634.3	$7,403.6	$13,958.9
Damages to Structures, Contents	$532.8	$11,391.4	$38,271.0	$82,298.3	$126,187.4	$172,021.2	$247,971.0	$344,781.8
Postdisaster Recovery Costs	$412.7	$4,528.4	$11,992.0	$23,061.5	$34,973.3	$47,760.2	$65,555.5	$80,869.8
Utilities	$15.5	$170.4	$451.5	$868.2	$1,316.6	$1,798.0	$2,468.0	$3,044.5
Vehicles	$0.8	$565.4	$1,980.0	$4,904.4	$8,755.3	$13,512.3	$23,093.3	$39,124.5
Roads	$353.2	$889.3	$1,646.5	$2,392.9	$2,974.1	$3,589.6	$4,678.3	$8,277.4
Total Damages by Event	$1,315.1	$17,544.9	$54,340.9	$113,525.3	$174,206.6	$238,681.2	$343,766.0	$476,097.9
Percent Distribution by Event								
Residential	39.9%	62.2%	66.0%	65.4%	65.5%	66.5%	66.5%	65.8%
Public	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.5%	0.6%
Commercial	0.6%	2.7%	3.3%	3.2%	3.1%	2.7%	2.9%	3.1%
Industrial	0.0%	0.0%	1.1%	3.9%	3.8%	2.8%	2.2%	2.9%
Postdisaster Recovery Costs	31.4%	25.8%	22.1%	20.3%	20.1%	20.0%	19.1%	17.0%
Utilities	1.2%	1.0%	0.8%	0.8%	0.8%	0.8%	0.7%	0.6%
Vehicles	0.1%	3.2%	3.6%	4.3%	5.0%	5.7%	6.7%	8.2%
Roads	26.9%	5.1%	3.0%	2.1%	1.7%	1.5%	1.4%	1.7%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 11
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
CLEAR CREEK – SUM OF MAINSTEM AND ALL TRIBUTARIES
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$1,871.7	$20,320.8	$46,170.3	$91,100.8	$134,499.2	$208,425.0	$284,323.4	$349,254.6
Public	$0.4	$9.3	$26.5	$92.3	$107.9	$613.9	$2,425.9	$2,768.7
Commercial	$44.9	$742.0	$2,178.6	$4,061.3	$5,896.8	$8,049.1	$12,681.8	$16,423.1
Industrial	$0.0	$33.5	$940.2	$6,026.0	$6,078.8	$10,652.7	$17,852.2	$23,301.1
Damages to Structures, Contents	$1,917.0	$21,105.6	$49,315.7	$101,280.4	$146,582.8	$227,740.7	$317,283.4	$391,747.4
Postdisaster Recovery Costs	$1,034.9	$7,813.5	$14,930.1	$28,850.4	$42,192.7	$57,776.2	$75,990.5	$90,953.1
Utilities	$38.8	$294.2	$562.1	$1,086.1	$1,588.4	$2,175.1	$2,860.8	$3,424.1
Vehicles	$9.3	$976.2	$2,816.6	$6,396.1	$10,707.6	$21,846.0	$33,851.6	$44,624.8
Roads	$551.2	$1,274.7	$1,919.8	$2,618.2	$3,205.8	$3,805.4	$6,204.2	$8,258.1
Total Damages by Event	$3,551.2	$31,464.2	$69,544.3	$140,231.1	$204,277.4	$313,343.4	$436,190.5	$539,007.5
Percent Distribution by Event								
Residential	52.7%	64.6%	66.4%	65.0%	65.8%	66.5%	65.2%	64.8%
Public	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.6%	0.5%
Commercial	1.3%	2.4%	3.1%	2.9%	2.9%	2.6%	2.9%	3.0%
Industrial	0.0%	0.1%	1.4%	4.3%	3.0%	3.4%	4.1%	4.3%
Postdisaster Recovery Costs	29.1%	24.8%	21.5%	20.6%	20.7%	18.4%	17.4%	16.9%
Utilities	1.1%	0.9%	0.8%	0.8%	0.8%	0.7%	0.7%	0.6%
Vehicles	0.3%	3.1%	4.1%	4.6%	5.2%	7.0%	7.8%	8.3%
Roads	15.5%	4.1%	2.8%	1.9%	1.6%	1.2%	1.4%	1.5%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

main stem and tributaries individually are shown in Enclosure 1 to this appendix. Enclosure 1 details the single occurrence damages in both the near-term and future without-project conditions as well.

In comparing Table 8 and Table 10, the 50 percent AEP flood, or 2-year event, produces an estimated $524,500 in residential damages (Table 10), however, Table 8 shows that only one residential structure is in the 50 percent AEP flood zone. This structure has a total value of structures and contents of $141,000, making the damages seem illogical. The reason for the high level of damages at the 50 percent AEP flood event is that some structure depth-percent damage curves have start-of-damages below the structure's first floor. In fact, some depth-percent damage curves have start-of-damages at -2.0 feet below the first floor (i.e. mobile homes). Structures are assigned to the flood zone coinciding with their finished floor elevation. Single event damages are being incurred with a 50 percent AEP event by structures that actually sit in a higher flood zone. This same effect is carried throughout all the flood zones, but is not as readily apparent in the tables as with the 50 percent AEP event.

HEC-FDA was modified to assure that no damages are being accrued to the 1-year event (100 percent AEP event). This was done by adding a line under the exceedance probability-discharge portion of HEC-FDA corresponding to a 0.999 probability and a corresponding non-damaging cfs. This method is recommended by the Hydrologic Engineering Center as the best method to assure no 1-year damages accrue. This modification was prepared by H&H personnel during input of H&H data into HEC-FDA to ensure correctness.

Additional measures were taken to ensure that damages are not being overstated in the 50 percent AEP event. For structures that are low-lying, the associated depth-damage curve was altered by zeroing-out the percent damage below the first floor. In addition, the ground elevations of all structures located in the frequent events were re-checked and corrected (if necessary) for the final analysis.

In the without-project 2020 condition, a 1 percent AEP event is expected to cause approximately $172 million in structural damages. The value of properties located in the 1 percent AEP floodplain is on the order of $588 million. Damages to structures and contents as a percent of total value of the structures and contents are approximately 29 percent. The average value of the floodplain properties in the 1 percent AEP floodplain is $104 thousand.

In the without-project 2070 condition, a 1 percent AEP event is expected to cause approximately $227 million in structural damages. The value of properties located in the 1 percent AEP floodplain is on the order of $839 million. Damages to structures and contents as a percent of

total value of the structures and contents are approximately 27 percent. The average value of the floodplain properties in the 1 percent AEP floodplain is $110 thousand.

Expected Annual and Average Annual Equivalent (AAE) Damages. Expected annual and AAE damages over the 50-year period of analysis are presented for the without-project or base condition in Table 12 for the main stem and Table 13 for the tributaries inventoried. These damages reflect damages accruing to structures and their contents, utilities, vehicles, roads and costs associated with post-disaster recovery. As can be seen in Table 12 over two-thirds of the damages along the main stem are concentrated within three reaches, numbered 15, 17, and 18.

As shown in Table 13, over 85 percent of the damages along Mud Gully are concentrated in reaches numbered 1 and 2. While damages for Turkey Creek are relatively evenly distributed throughout the tributary's four reaches. As can be seen in Table 13, approximately 46 percent of the damages on Marys Creek are concentrated within Reach 4. Approximately 55 to 60 percent of the damages incurred along Cowart Creek and Chigger Creek are coincidentally centered in Reach 3 of both of the tributaries.

It should be noted, once again, that the increase in damages occurring over the period of analysis is attributed solely to increases in runoff. No projections were made on the economic-side of the analysis (i.e. the floodplain investment remains as it currently stands). Overall, there is an increase in damages of 38 percent from 2020 to 2070. This is equivalent to an average annual growth in damages of approximately 0.65 percent.

As seen from Table 13, Marys Creek has the most significant increase in damages between the 2020 and 2070 condition, with a 63 percent increase in damages. Investigation of the water surface elevations reveals that the average increase in water surface elevation between 2020 and 2070 is less than 0.5 feet for the 1 percent AEP event on Marys Creek. The increase in the number of structures inundated by that slight increase in water surface is almost 900 structures. The increase in damages is simply due to the distribution of structures and the flat nature of the floodplain. With the Clear Creek floodplain, a small increase in flood depth (i.e. less than 0.5 feet) can cause hundreds of additional structures to be inundated.

TABLE 12
EXPECTED ANNUAL AND AVERAGE ANNUAL EQUIVALENT DAMAGES
ALL DAMAGE CATEGORIES
WITHOUT-PROJECT CONDITION
CLEAR CREEK MAIN STEM
(Values in 1000's, Oct 09 Price Levels)

TRIBUTARY & REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EXPECTED ANNUAL DAMAGES		EQUIVALENT ANNUAL DAMAGES, 4.125%	PERCENT DISTRIBUTION
			2020	2070		
MAIN STEM						
1	GALVESTON BAY	ROSEWOOD	$105	$138	$116	0.8%
2	ROSEWOOD	BAL HARBOR	$84	$112	$93	1.3%
3	BAL HARBOR	FM 270	$93	$110	$99	1.1%
4	FM 270	SH 3	$127	$132	$129	0.8%
5	SH 3	IH 45	$0	$0	$0	0.0%
6	IH 45	W BAY AREA BLVD	$192	$200	$195	0.8%
7	W BAY AREA BLVD	FM 528	$863	$987	$904	3.6%
8	FM 528	WHISPERING PINES	$914	$1,065	$964	4.1%
9	WHISPERING PINES	NEAR MARY'S CRK	$703	$859	$755	3.2%
10	NEAR MARY'S CRK	FM 2351	$1,408	$1,774	$1,529	6.5%
11	FM 2351	NEAR TURKEY CRK	$210	$279	$233	1.0%
12	NEAR TURKEY CRK	DIXIE FARM RD	$88	$131	$102	0.4%
13	DIXIE FARM RD	COUNTRY CLUB DR	$682	$1,215	$859	3.4%
14	COUNTRY CLUB DR	BENNIE KATE	$150	$331	$210	0.7%
15	BENNIE KATE	SH 35	$4,925	$7,020	$5,621	24.9%
16	SH 35	MYKAWA	$787	$903	$826	4.3%
17	MYKAWA	STONE RD	$2,877	$3,090	$2,948	13.6%
18	STONE RD	SH 288	$5,153	$5,360	$5,222	28.5%
19	SH 288	ALMEDA SCHOOL RD	$237	$250	$241	1.1%
		SUBTOTAL - Mainstem	$19,598	$23,956	$21,045	100.0%

Note: Includes damages to structures, contents, vehicles, utilities, roads and post disaster recovery costs. Does not include NFIP benefits.
Individual numbers may not sum to totals due to rounding.

TABLE 13
EXPECTED ANNUAL AND AVERAGE ANNUAL EQUIVALENT DAMAGES
ALL DAMAGE CATEGORIES
WITHOUT-PROJECT CONDITION
CLEAR CREEK TRIBUTARIES
(Values in 1000's, Oct 09 Price Levels)

TRIBUTARY & REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EXPECTED ANNUAL DAMAGES		EQUIVALENT ANNUAL DAMAGES, 4.125%	PERCENT DISTRIBUTION
			2020	2070		
MUD GULLY						
1	90 DEGREE TURN SW	HALL RD	$2,195	$2,721	$2,369	52.3%
2	HALL RD	BELTWAY 8	$1,382	$1,704	$1,489	32.9%
3	BELTWAY 8	KINGSPOINT	$135	$176	$149	3.3%
4	KINGSPOINT	UPPER LIMIT	$460	$641	$520	11.5%
		SUBTOTAL - Mud Gully	$4,172	$5,241	$4,527	100%
TURKEY CREEK						
1	START	NYACK	$776	$948	$833	30.9%
2	NYACK	SCARSDALE	$445	$576	$489	18.1%
3	SCARSDALE	BELTWAY 8	$389	$491	$423	15.7%
4	BELTWAY 8	SAGEDOWNE	$882	$1,087	$950	35.3%
		SUBTOTAL - Turkey Creek	$2,492	$3,102	$2,695	100.0%
MARY'S CREEK						
1	EDDEWOOD DR.	COUNTY LINE	$77	$97	$84	0.7%
2	COUNTY LINE	LONGHERRIDGE DR	$1,274	$2,230	$1,592	13.3%
3	LONGHERRIDGE DR.	AT&SF RR	$2,426	$4,113	$2,986	25.0%
4	AT&SF RR	HARKEY RD	$4,502	$7,461	$5,485	45.9%
5	HARKEY RD	CHARLES AVE	$1,600	$2,190	$1,796	15.0%
		SUBTOTAL - Mary's Creek	$9,879	$16,091	$11,942	100.0%

Note: Includes damages to structures, contents, vehicles, utilities, roads and post disaster recovery costs. Does not include NFIP benefits. .
Individual numbers may not sum to totals due to rounding.

TABLE 13 (continued)
EXPECTED ANNUAL AND AVERAGE ANNUAL EQUIVALENT DAMAGES
ALL DAMAGE CATEGORIES
WITHOUT-PROJECT CONDITION
CLEAR CREEK TRIBUTARIES
(Values in 1000's, Oct 09 Price Levels)

TRIBUTARY & REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EXPECTED ANNUAL DAMAGES		EQUIVALENT ANNUAL DAMAGES, 4.125%	PERCENT DISTRIBUTION
			2020	2070		
COWART CREEK						
1	CASTLEWOOD	SUNSET DR	$27	$31	$29	9.6%
2	SUNSET DR	COUNTY LINE	$99	$109	$102	34.5%
3	COUNTY LINE	800 CFS LIMIT	$162	$314	$166	55.9%
		SUBTOTAL - Cowart Creek	$289	$455	$297	100.0%
CHIGGER CREEK						
1	FM 518	GREENBRIAR	$81	$101	$87	28.9%
2	GREENBRIAR	NARINA	$34	$40	$36	12.0%
3	NARINA	CONFLUENCE W/ BYPASS (800 CFS LIMIT)	$175	$185	$178	59.0%
4	CONFLUENCE WITH BYPASS	BRAZORIA COUNTY LINE	$0	$0	$0	0.0%
5	BRAZORIA COUNTY LINE	HEADWATERS OF STREAM	$0	$0	$0	0.0%
		SUBTOTAL - Chigger Creek	$290	$326	$302	100.0%
TOTAL - MAIN STEM AND ALL TRIBUTARIES			**$36,720**	**$49,172**	**$40,808**	

Note: Includes damages to structures, contents, vehicles, utilities, roads and post disaster recovery costs. Does not include NFIP benefits.
Individual numbers may not sum to totals due to rounding.

WITH-PROJECT CONDITION

Various structural and nonstructural solutions to flooding were considered to mitigate flood damages in the study area. These include construction of detention basins, channel modifications, watershed management, bridge replacements, floodplain buyout, raising-in-place, etc., and several combinations of the aforementioned.

Each alternative project condition was analyzed with risk and uncertainty using the HEC-FDA program in the same manner as the without-project condition. Economic benefits from each alternative were computed and compared with the without-project condition. The aim of the economic analysis was to select a plan that maximized net benefits. A detailed discussion of the analytical process followed throughout the study is provided in Enclosure 2 to the Economic Appendix.

Structural Analysis. The analysis of structural measures took place in phases over the study period. Each measure was optimized and incrementally justified. In this way, poor performing and less-beneficial measures were eliminated from further consideration. The resultant optimized structural alternative was carried forward to the final array.

In addition, analysis of two legacy plans took place, namely, the Sponsor Proposed Alternative (SPA) and of the Authorized Federal Plan (AFP). The AFP includes conveyance improvement from Mykawa Road to Clear Lake plus the Second Outlet Channel and Gate Structure. The Second Outlet and Gate Structure were developed as part of the AFP to mitigate flows into Clear Lake from the enlarged channel upstream. As previously mentioned, the Second Outlet and Gate Structure have been constructed and are considered sunk costs with no benefits being claimed in this analysis. The Second Outlet and Gate Structure were not initially included in the analysis, but were added at the end of the study to better reflect existing conditions. The effect of the outlet is negligible and does not impact plan formulation.

The SPA was developed in 1997 as an alternative to the AFP. This alternative reduced the size of the proposed federal alternative channel and included a bypass channel near the Friendswood area.

Nonstructural Analysis. Nonstructural measures were investigated early in the first-added measures phase of the study, but with the many changes and updates made over time, in-depth analysis, including the tributaries, was deemed necessary. In addition, nonstructural measures were analyzed in addition to structural measures. The detailed nonstructural analysis results are

shown in Enclosure 4 of the economic appendix.

COMPARISON OF ALTERNATIVES

Based upon the results of the first-added and second-added measures analysis (detailed in Enclosure 2) the optimized plan unfolded as the analysis took place. Several combinations of measures meet the objective of positive net benefits. However, with each step of the analysis a combination of measures producing greater net benefits than the previous was revealed until the General Reevaluation Plan (hereafter referred to as the GRP) was identified. In addition, two other plans were carried forward from previous studies, including the AFP and the SPA plan. Incremental analysis was conducted throughout the analysis, resulting in the final array of alternatives being considered.

No Action Alternative

The No Action Alternative would retain the existing Clear Creek and tributaries at their present configurations. Many of the municipalities in the area have incorporated no impact policies in addressing new development. These are generally established to protect the flow at a 1 percent AEP level of protection. However, these requirements are not in place for the entire watershed. Development upstream of Clear Lake will continue to increase flows into Clear Creek and its tributaries. These increased flows will continue to cause increases in water elevation sufficient to cause flooding in many areas. For the Clear Creek GRR study, the No Action Alternative and the without-project condition are the same.

Authorized Federal Project Alternative

The Authorized Federal Project (AFP) Alternative is detailed in a Preconstruction Authorization Planning Report dated May 1982. The plan includes conveyance improvement from Mykawa Road to Clear Lake plus the Second Outlet Channel and Gate Structure. The newly designed channel project was sized to contain a 10-percent annual exceedance flood for future watershed development conditions. The design included a trapezoidal earthen channel (1v:3h side slopes). Bottom widths varied from 70 feet to 130 feet. The Second Outlet Channel and Gate Structure were developed as part of the AFP to mitigate increased flows into Clear Lake from the enlarged channel upstream. The Clear Lake community was concerned that the channel modifications upstream would increase their likelihood of being impacted by increased flows into the lake. The Second Outlet was designed to ensure that flows would be allowed to continue into Galveston Bay with no impact to houses around the lake. The channel was gated to ensure that Clear Lake did not experience an increase in salinities due to water flowing from the bay in high

tide circumstances. A formal agreement was signed in 1986 by the local sponsors (Harris County Flood Control District and Galveston County) and the US Army Corps of Engineers to construct the 14-mile reach of the project downstream of Dixie Farm Road. Only the Second Outlet Channel and Gate Structure were ever constructed.

Sponsor Proposed Alternative

This plan was developed in 1997 as an alternative to the AFP. Concerns about the impacts associated with the AFP caused the non-Federal sponsors to request that construction halt so that they could develop a potential plan with reduced impact. A detailed description of the SPA plan is provided in the December 1997 report titled "Clear Creek, Federal Flood Control Project Review." The main features of the plan were "reduced channel rectification" and a bypass channel. The channel rectification was reduced in size (smaller bottom widths) from the AFP. The reach of the natural Clear Creek channel near the Friendswood area would be avoided by providing the needed flood capacity with a bypass channel. The design included a trapezoidal channel that follows the alignment of the existing AFP except for the bypass channel near the Friendswood area. Bottom widths for the plan vary from 30 feet to 80 feet.

General Reevaluation Plan (GRP)

This alternative consists of channelization on Clear Creek including 200-foot bench cut from SH 288 to 4,000 feet downstream of Bennie Kate, and 90-foot bench cut from 4,000 feet downstream of Bennie Kate to Dixie Farm Road. This channel improvement is 15.1 miles in length.

In addition, the GRP consists of channel improvement on Mud Gully (45-foot concrete-lined trapezoid section) from downstream of Sagedowne to downstream of Astoria. The alternative also includes channel improvement on Turkey Creek 2.4 miles in length with a 20 to 25 –foot trapezoid section, from Dixie Farm Road to the mouth. Also included is channelization on Marys Creek at varying widths (from 15-feet to 35-feet) from Harkey Road to SH 35. The channel improvement on Marys Creek is 2.1 miles in length.

The GRP includes linear detention on the main stem. The inline detention has a capacity of 485 acre-feet from Cullen to downstream of SH-35.

Table 14 shows the damages reduced by each of the alternatives above, under 2020 conditions. Damage reductions for the plans are between -$2.0 million and $17.7 million. Net economic

benefits are between -$21.7 million and $8.2 million. The plan that reasonably maximizes net benefits is the GRP, which is, therefore, carried forward as the National Economic Development (NED) plan.

REFINEMENT OF THE NED PLAN

Capital Investment within the Various Floodplains for the NED Plan. Table 15 displays a summary of the number of structures and the distribution of capital investment within eight median discharge AEP floodplains of the main stem and tributaries of Clear Creek based on first floor elevations with the NED plan in place in the 2020 condition. As can be noted from Table 15, approximately 90 percent of the structures inventoried within the estimated existing median 0.2 percent AEP (500-year) floodplain are residential. In total the 0.2 percent AEP floodplain on the main stem and tributaries contains over 4,200 structures valued at over $471 million dollars, at October 2009 price levels. For a break-down of the distribution of capital investment within the individual tributaries and main stem floodplains, see Enclosure 4.

As shown in Table 15, the 1 percent AEP (100-year) floodplain with the NED plan in place on the contains 1,569 structures, a reduction of almost 2,100 structures when compared to the without-project condition. The NED plan effectively removes over 3,000 structures from the 0.2 percent AEP (500-year) floodplain of the entire study area, a reduction of over 40 percent of the structures inundated by the 500-year event in the near-term condition.

Similar to Table 15, Table 16 displays the structure inventory and distribution of capital investment within the eight existing median discharge AEP floodplains for the main stem and tributaries for the future without-project 2070 condition. As with the 2020 condition, the 2070 condition also reveals the majority of structures in the 0.2 percent AEP floodplain to be residential, representing 90 percent. For the 2070 condition, the 0.2 percent AEP floodplain contains over 4,800 structures valued at over $550 million dollars.

TABLE 14
COMPARISON OF ALTERNATIVES
AVERAGE ANNUAL DAMAGES, 2020 CONDITION
(Values in 1000's, Oct 09 Price Levels, 4.125%)

Alternative	Average Annual Damages 2020	Average Annual Damage Reduction	Average Annual Cost	Net Excess Benefits	Benefit-to-Cost Ratio
Without Project	$36,720.0				
Authorized Federal Plan	$28,233.5	$8,486.5	$18,356.5	-$9,870.0	0.46
Sponsor Preferred Alternative	$38,639.2	-$1,919.2	$19,784.1	-$21,703.3	-0.10
GRP Alternative	$18,984.5	$17,735.5	$9,544.0	$8,191.5	1.86

* Note - Average annual damages (2020 condition) are shown rather than average annual equivalent values. Future condition H&H runs were not provided for the AFP and SPA Alternatives due to lack of feasibility of the alternatives.

TABLE 15
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
SUMMARY OF MAIN STEM AND ALL TRIBUTARIES
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-Year)	20% AEP Floodplain (5-Year)"	10% AEP Floodplain or (10-Year)	4% AEP Floodplain (25-Year)	2% AEP Floodplain (50-Year)	1% AEP Floodplain (100-Year)	0.4% AEP Floodplain (250-Year)	0.2% AEP Floodplain (500-Year)
Residential								
Number of Structures	1	39	188	421	891	1,310	2,488	3,765
Value of Structures	$94	$4,959	$21,285	$43,629	$95,977	$140,920	$276,665	$423,266
Value of Contents	$47	$2,480	$10,642	$21,815	$47,988	$70,460	$138,332	$211,633
Percent of Structures Inundated/Zone	25%	50%	74%	77%	81%	83%	87%	89%
Commercial								
Number of Structures	3	34	53	106	173	208	297	363
Value of Structures	$34	$464	$2,174	$8,391	$15,347	$18,184	$25,382	$29,457
Value of Contents	$1	$266	$833	$4,249	$8,701	$10,293	$16,335	$22,495
Percent of Structures Inundated/Zone	75%	44%	21%	19%	16%	13%	10%	9%
Industrial								
Number of Structures	0	4	7	12	19	28	42	51
Value of Structures	$0	$0	$92	$1,931	$4,559	$6,319	$7,610	$9,733
Value of Contents	$0	$0	$63	$3,668	$5,705	$8,062	$10,978	$14,425
Percent of Structures Inundated/Zone	0%	5%	3%	2%	2%	2%	1%	1%
Public								
Number of Structures	0	1	5	10	19	23	31	35
Value of Structures	$0	$16	$1,150	$5,730	$6,358	$7,167	$8,658	$8,897
Value of Contents	$0	$6	$375	$820	$1,161	$1,640	$2,428	$2,525
Percent of Structures Inundated/Zone	0%	1%	2%	2%	2%	1%	1%	1%
Total								
Number of Structures	4	78	253	549	1,102	1,569	2,858	4,214
Value of Structures	$128	$5,439	$24,701	$59,682	$122,240	$172,592	$318,314	$471,352
Value of Contents	$48	$2,752	$11,914	$30,552	$63,556	$90,456	$168,074	$251,079
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 16
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
SUMMARY OF MAIN STEM AND ALL TRIBUTARIES
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-Year)	20% AEP Floodplain (5-Year)"	10% AEP Floodplain or (10-Year)	4% AEP Floodplain (25-Year)	2% AEP Floodplain (50-Year)	1% AEP Floodplain (100-Year)	0.4% AEP Floodplain (250-Year)	0.2% AEP Floodplain (500-Year)
Residential								
Number of Structures	4	54	239	606	1,082	1,548	3,181	4,329
Value of Structures	$271	$7,194	$25,777	$64,675	$116,241	$169,005	$351,786	$488,276
Value of Contents	$136	$3,597	$12,889	$32,338	$58,120	$84,503	$175,893	$244,138
Percent of Structures Inundated/Zone	40%	57%	73%	78%	82%	84%	88%	90%
Commercial								
Number of Structures	6	35	76	133	195	238	341	406
Value of Structures	$57	$465	$2,764	$10,240	$17,586	$21,530	$28,384	$42,229
Value of Contents	$17	$267	$1,200	$5,263	$9,778	$11,705	$19,589	$28,622
Percent of Structures Inundated/Zone	60%	37%	23%	17%	15%	13%	9%	8%
Industrial								
Number of Structures	0	5	7	18	22	29	46	56
Value of Structures	$0	$92	$188	$4,522	$5,835	$6,987	$9,281	$10,302
Value of Contents	$0	$63	$128	$5,430	$6,573	$8,516	$12,115	$14,812
Percent of Structures Inundated/Zone	0%	5%	2%	2%	2%	2%	1%	1%
Public								
Number of Structures	0	1	6	16	20	28	34	41
Value of Structures	$0	$16	$1,166	$5,988	$6,465	$8,218	$9,306	$9,468
Value of Contents	$0	$6	$381	$976	$1,201	$1,975	$2,525	$2,585
Percent of Structures Inundated/Zone	0%	1%	2%	2%	2%	2%	1%	1%
Total								
Number of Structures	10	95	328	773	1,319	1,843	3,602	4,832
Value of Structures	$328	$7,767	$29,896	$85,426	$146,127	$205,740	$398,757	$550,275
Value of Contents	$152	$3,933	$14,598	$44,007	$75,672	$106,699	$210,122	$290,158
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

Single Occurrence Damages for the NED Plan. Damages expected to accrue from various flood events along the main stem and tributaries of Clear Creek for the NED Plan are displayed in Table 17. These values represent damages expected for individual events under the with-project near-term hydrologic condition and include structure and content damages as well as other benefit categories. Similarly, Table 18 displays the summary of single occurrence damages by event for the main stem and tributaries in the future hydrologic condition. The detailed single occurrence damages for the main stem and tributaries individually are shown in Enclosure 4 to this appendix. Enclosure 4 details the single occurrence damages in both the near-term and future without-project conditions as well.

In the with-project 2020 condition, a 1 percent AEP event is expected to cause approximately $85 million in damages to structures and contents, representing over 50 percent reduction in damages when compared to the without-project condition 1 percent AEP event. The value of properties located in the 1 percent AEP floodplain is on the order of $173 million. Damages to structures and contents as a percent of total value of the structures and contents are approximately 32 percent. The average value of the residual floodplain properties in the 1 percent AEP floodplain is $110 thousand.

In the with-project 2070 condition, a 1 percent AEP event is expected to cause approximately $101 million in damages to structures and contents. The value of properties located in the 1 percent AEP floodplain is on the order of $206 million. Damages to structures and contents as a percent of total value of the structures and contents are approximately 32 percent. The average value of the residual floodplain properties in the 1 percent AEP floodplain is $111 thousand.

TABLE 17
SINGLE OCCURRENCE DAMAGES BY EVENT
NED PLAN, 2020 CONDITION
SUMMARY OF CLEAR CREEK MAINSTEM AND ALL TRIBUTARIES
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$298.5	$4,389.7	$13,726.6	$29,797.7	$55,747.6	$79,824.8	$134,457.0	$192,519.1
Public	$0.1	$1.5	$2.2	$5.7	$18.5	$31.3	$1,437.3	$1,741.0
Commercial	$1.9	$58.2	$279.3	$875.2	$2,089.1	$3,246.7	$5,374.3	$7,347.6
Industrial	$0.0	$0.9	$12.4	$90.5	$852.1	$1,418.6	$3,349.8	$5,429.9
Damages to Structures, Contents	$300.5	$4,450.3	$14,020.6	$30,769.1	$58,707.4	$84,521.4	$144,618.5	$207,037.6
Postdisaster Recovery Costs	$260.1	$1,924.2	$5,140.7	$9,508.4	$15,968.0	$21,887.9	$37,558.0	$53,042.7
Utilities	$9.8	$72.3	$193.5	$358.0	$601.1	$824.0	$1,413.9	$1,996.9
Vehicles	$0.7	$105.0	$689.9	$1,648.2	$3,173.3	$5,590.8	$10,942.0	$17,994.1
Roads	$330.4	$615.4	$1,008.2	$1,632.6	$2,179.1	$2,661.1	$3,450.4	$4,994.5
Total Damages by Event	$901.6	$7,167.2	$21,052.9	$43,916.3	$80,628.9	$115,485.2	$197,983.0	$285,065.8
Percent Distribution by Event								
Residential	33.1%	61.2%	65.2%	67.9%	69.1%	69.1%	67.9%	67.5%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	0.6%
Commercial	0.2%	0.8%	1.3%	2.0%	2.6%	2.8%	2.7%	2.6%
Industrial	0.0%	0.0%	0.1%	0.2%	1.1%	1.2%	1.7%	1.9%
Postdisaster Recovery Costs	28.9%	26.8%	24.4%	21.7%	19.8%	19.0%	19.0%	18.6%
Utilities	1.1%	1.0%	0.9%	0.8%	0.7%	0.7%	0.7%	0.7%
Vehicles	0.1%	1.5%	3.3%	3.8%	3.9%	4.8%	5.5%	6.3%
Roads	36.7%	8.6%	4.8%	3.7%	2.7%	2.3%	1.7%	1.8%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 18
SINGLE OCCURRENCE DAMAGES BY EVENT
NED PLAN, 2070 CONDITION
SUMMARY OF CLEAR CREEK MAINSTEM AND ALL TRIBUTARIES
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$524.5	$5,773.4	$17,755.3	$42,602.5	$66,738.9	$93,788.5	$160,180.6	$216,553.0
Public	$0.2	$20.2	$111.5	$330.7	$696.4	$1,049.2	$1,498.4	$1,795.8
Commercial	$3.1	$71.3	$368.4	$1,415.5	$2,550.6	$3,786.8	$6,330.9	$8,707.5
Industrial	$0.0	$1.5	$47.6	$1,065.4	$1,716.3	$2,649.5	$5,295.1	$7,206.9
Damages to Structures, Contents	$527.8	$5,866.3	$18,282.9	$45,414.1	$71,702.3	$101,274.1	$173,304.9	$234,263.2
Postdisaster Recovery Costs	$421.6	$2,461.4	$6,407.2	$12,695.4	$18,651.4	$26,019.6	$46,033.5	$59,296.3
Utilities	$15.8	$92.6	$241.2	$477.9	$702.2	$979.6	$1,733.0	$2,232.3
Vehicles	$3.5	$188.5	$877.0	$2,156.0	$3,935.8	$6,500.0	$13,541.0	$21,198.0
Roads	$370.2	$680.3	$1,265.8	$1,902.2	$2,377.7	$2,877.6	$3,898.2	$5,254.4
Total Damages by Event	$1,338.9	$9,289.1	$27,074.1	$62,645.6	$97,369.4	$137,650.9	$238,510.6	$322,244.2
Percent Distribution by Event								
Residential	39.2%	62.2%	65.6%	68.0%	68.5%	68.1%	67.2%	67.2%
Public	0.0%	0.2%	0.4%	0.5%	0.7%	0.8%	0.6%	0.6%
Commercial	0.2%	0.8%	1.4%	2.3%	2.6%	2.8%	2.7%	2.7%
Industrial	0.0%	0.0%	0.2%	1.7%	1.8%	1.9%	2.2%	2.2%
Postdisaster Recovery Costs	31.5%	26.5%	23.7%	20.3%	19.2%	18.9%	19.3%	18.4%
Utilities	1.2%	1.0%	0.9%	0.8%	0.7%	0.7%	0.7%	0.7%
Vehicles	0.3%	2.0%	3.2%	3.4%	4.0%	4.7%	5.7%	6.6%
Roads	27.6%	7.3%	4.7%	3.0%	2.4%	2.1%	1.6%	1.6%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

Average Annual Equivalent Damages for the NED Plan. Tables 19 through 24 show the AAE damages reduced for the NED Plan for the main stem and tributaries inventoried. Also shown are the probabilities that annual damages exceed indicated values for the 0.75, 0.50, and 0.25 probabilities. To illustrate, for Reach 8 on the main stem, equivalent annual damages reduced are $622,000 with the NED plan in place. For the same reach, there is a 75 percent probability that the damages reduced (or benefits) exceed $268,000, a 50 percent probability that the benefits exceed $469,000, and a 25 percent probability that the benefits exceed $813,000.

For the main stem, the greatest reductions in damages are realized in Reaches 8 through 11 (with reductions ranging from 65 to 78 percent). Additional significant reductions in damages on the main stem are realized in Reaches 15 through 18, with reductions ranging from 40 to 65 percent.

On Mud Gully, the NED Plan reduces damages significantly in the first three reaches, with reductions ranging from over 34 percent to 45 percent from the without-project condition. For Turkey Creek, damages are reduced significantly in all reaches, with percent reduction ranging from 78 percent to 94 percent. On Marys Creek, the greatest reduction in damages with the NED Plan in place occurs in Reaches 3 and 4, ranging from 48 to 81 percent.

The overall change in hydrology and hydraulics due to implementation of the NED Plan is expected to result in residual AAE damages of $20.5 million. When compared with the without-project condition, this is a $20.3 million reduction in AAE damages.

Figures 3 through 6 graphically illustrate the reduction in AAE damages for each the Main Stem (Figure 3), Mud Gully (Figure 4), Turkey Creek (Figure 5), and Marys Creek (Figure 6). Cowart and Chigger Creeks are not shown graphically since there is no damage reduction expected to these two tributaries with the NED plan in place.

TABLE 19
EQUIVALENT ANNUAL DAMAGES REDUCED AND DISTRIBUTED FOR THE NED PLAN
CLEAR CREEK MAIN STEM
Dollar Values in 1,000s, Oct 2009 Price levels, Discount Rate of 4.125%, 50-Year Period of Analysis

REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EQUIVALENT ANNUAL DAMAGE			Percent Reduction	PROBABILITY DAMAGE REDUCED EXCEEDS INDICATED VALUES		
			Total Without Project	Total With Project	Damage Reduced		0.75	0.50	0.25
1	GALVESTON BAY	ROSEWOOD	$116	$115	$0	0.3%	$0	$1	$2
2	ROSEWOOD	BAL HARBOR	$93	$92	$1	0.7%	$0	$1	$1
3	BAL HARBOR	FM 270	$99	$94	$5	4.9%	$2	$2	$6
4	FM 270	SH 3	$129	$120	$9	6.7%	$3	$5	$11
5	SH 3	IH 45	$0	$0	$0	7.4%	$0	$0	$0
6	IH 45	W BAY AREA BLVD	$195	$180	$15	7.7%	$8	$13	$19
7	W BAY AREA BLVD	FM 528	$904	$609	$295	32.6%	$188	$271	$373
8	FM 528	WHISPERING PINES	$964	$343	$622	64.5%	$268	$469	$813
9	WHISPERING PINES	NEAR MARY'S CRK	$755	$219	$535	70.9%	$232	$432	$730
10	NEAR MARY'S CRK	FM 2351	$1,529	$351	$1,179	77.1%	$659	$1,040	$1,545
11	FM 2351	NEAR TURKEY CRK	$233	$52	$181	77.6%	$68	$130	$236
12	NEAR TURKEY CRK	DIXIE FARM RD	$102	$112	-$10	-9.6%	-$14	-$8	-$4
13	DIXIE FARM RD	COUNTRY CLUB DR	$859	$785	$74	8.6%	$49	$71	$100
14	COUNTRY CLUB DR	BENNIE KATE	$210	$163	$47	22.2%	$14	$35	$62
15	BENNIE KATE	SH 35	$5,621	$3,486	$2,135	38.0%	$1,298	$1,944	$2,794
16	SH 35	MYKAWA	$826	$293	$532	64.5%	$248	$440	$726
17	MYKAWA	STONE RD	$2,948	$1,086	$1,862	63.2%	$970	$1,598	$2,482
18	STONE RD	SH 288	$5,222	$3,136	$2,086	39.9%	$1,059	$1,664	$2,656
19	SH 288	ALMEDA SCHOOL RD	$241	$239	$2	0.7%	$1	$2	$3
TOTAL			$21,045	$11,476	$9,569	45.5%	$5,052	$8,110	$12,555

Note: Individual numbers may not sum to totals due to rounding.

TABLE 20
EQUIVALENT ANNUAL DAMAGES REDUCED AND DISTRIBUTED FOR THE
NED PLAN
MUD GULLY
Dollar Values in 1,000s, Oct 2009 Price levels, Discount Rate of 4.125%, 50-Year Period of Analysis

REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EQUIVALENT ANNUAL DAMAGE			Percent Reduction	PROBABILITY DAMAGE REDUCED EXCEEDS INDICATED VALUES		
			Total Without Project	Total With Project	Damage Reduced		0.75	0.50	0.25
1	90 DEGREE TURN SW	HALL RD	$2,369	$1,315	$1,054	44.5%	$523	$899	$1,425
2	HALL RD	BELTWAY 8	$1,489	$866	$623	41.8%	$355	$538	$806
3	BELTWAY 8	KINGSPOINT	$149	$98	$51	34.1%	$22	$40	$66
4	KINGSPOINT	UPPER LIMIT	$520	$505	$15	2.8%	$7	$11	$20
TOTAL			$4,527	$2,784	$1,743	38.5%	$907	$1,488	$2,317

Note: Individual numbers may not sum to totals due to rounding.

TABLE 21
EQUIVALENT ANNUAL DAMAGES REDUCED AND DISTRIBUTED FOR THE
NED PLAN
TURKEY CREEK
Dollar Values in 1,000s, Oct 2009 Price levels, Discount Rate of 4.125%, 50-Year Period of Analysis

REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EQUIVALENT ANNUAL DAMAGE			Percent Reduction	PROBABILITY DAMAGE REDUCED EXCEEDS INDICATED VALUES		
			Total Without Project	Total With Project	Damage Reduced		0.75	0.50	0.25
1	START	NYACK	$833	$51	$782	93.9%	$288	$581	$1,045
2	NYACK	SCARSDALE	$489	$61	$428	87.6%	$156	$313	$570
3	SCARSDALE	BELTWAY 8	$423	$72	$351	83.0%	$153	$277	$471
4	BELTWAY 8	SAGEDOWNE	$950	$206	$744	78.3%	$352	$608	$990
TOTAL			$2,695	$390	$2,305	85.5%	$950	$1,779	$3,076

Note: Individual numbers may not sum to totals due to rounding.

TABLE 22
EQUIVALENT ANNUAL DAMAGES REDUCED AND DISTRIBUTED FOR THE
NED PLAN
MARYS CREEK
Dollar Values in 1,000s, Oct 2009 Price levels, Discount Rate of 4.125%, 50-Year Period of Analysis

REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EQUIVALENT ANNUAL DAMAGE			Percent Reduction	PROBABILITY DAMAGE REDUCED EXCEEDS INDICATED VALUES		
			Total Without Project	Total With Project	Damage Reduced		0.75	0.50	0.25
1	EDGEWOOD DR.	COUNTY LINE	$84	$81	$3	3.3%	$3	$4	$5
2	COUNTY LINE	LONGHERRIDGE DR	$1,592	$1,078	$513	32.3%	$124	$150	$797
3	LONGHERRIDGE DR.	AT&SF RR	$2,986	$1,560	$1,426	47.8%	$216	$790	$2,182
4	AT&SF RR	HARKEY RD	$5,485	$1,023	$4,462	81.4%	$2,019	$3,622	$6,108
5	HARKEY RD	CHARLES AVE	$1,796	$1,468	$328	18.2%	$107	$221	$437
TOTAL			$11,942	$5,210	$6,732	56.4%	$2,469	$4,788	$9,528

Note: Individual numbers may not sum to totals due to rounding.

TABLE 23
EQUIVALENT ANNUAL DAMAGES REDUCED AND DISTRIBUTED FOR THE
NED PLAN
COWART CREEK
Dollar Values in 1,000s, Oct 2009 Price levels, Discount Rate of 4.125%, 50-Year Period of Analysis

REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EQUIVALENT ANNUAL DAMAGE			Percent Reduction	PROBABILITY DAMAGE REDUCED EXCEEDS INDICATED VALUES		
			Total Without Project	Total With Project	Damage Reduced		0.75	0.50	0.25
1	CASTLEWOOD	SUNSET DR	$29	$29	$0	0.0%	$0	$0	$0
2	SUNSET DR	COUNTY LINE	$102	$102	$0	0.0%	$0	$0	$0
3	COUNTY LINE	800 CFS LIMIT	$166	$166	$0	0.0%	$0	$0	$0
TOTAL			$297	$297	$0	0.0%	$0	$0	$0

Note: Individual numbers may not sum to totals due to rounding.

TABLE 24
EQUIVALENT ANNUAL DAMAGES REDUCED AND DISTRIBUTED FOR THE
NED PLAN
CHIGGER CREEK
Dollar Values in 1,000s, Oct 2009 Price levels, Discount Rate of 4.125%, 50-Year Period of Analysis

REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	EQUIVALENT ANNUAL DAMAGE			Percent Reduction	PROBABILITY DAMAGE REDUCED EXCEEDS INDICATED VALUES		
			Total Without Project	Total With Project	Damage Reduced		0.75	0.50	0.25
1	FM 518	GREENBRIAR	$87	$87	$0	0.0%	$0	$0	$0
2	GREENBRIAR	NARINA	$36	$36	$0	0.0%	$0	$0	$0
3	NARINA	CONFLUENCE W/ BYPASS (800 CFS LIMIT)	$178	$178	$0	0.0%	$0	$0	$0
4	CONFLUENCE WITH BYPASS	BRAZORIA COUNTY LINE	$0	$0	$0	0.0%	$0	$0	$0
5	BRAZORIA COUNTY LINE	HEADWATERS OF STREAM	$0	$0	$0	0.0%	$0	$0	$0
TOTAL			$302	$302	$0	0.0%	$0	$0	$0

Note: Individual numbers may not sum to totals due to rounding.

Figure 3
Clear Creek Main Stem
Equivalent Annual Damages by Reach
(000's of dollars)

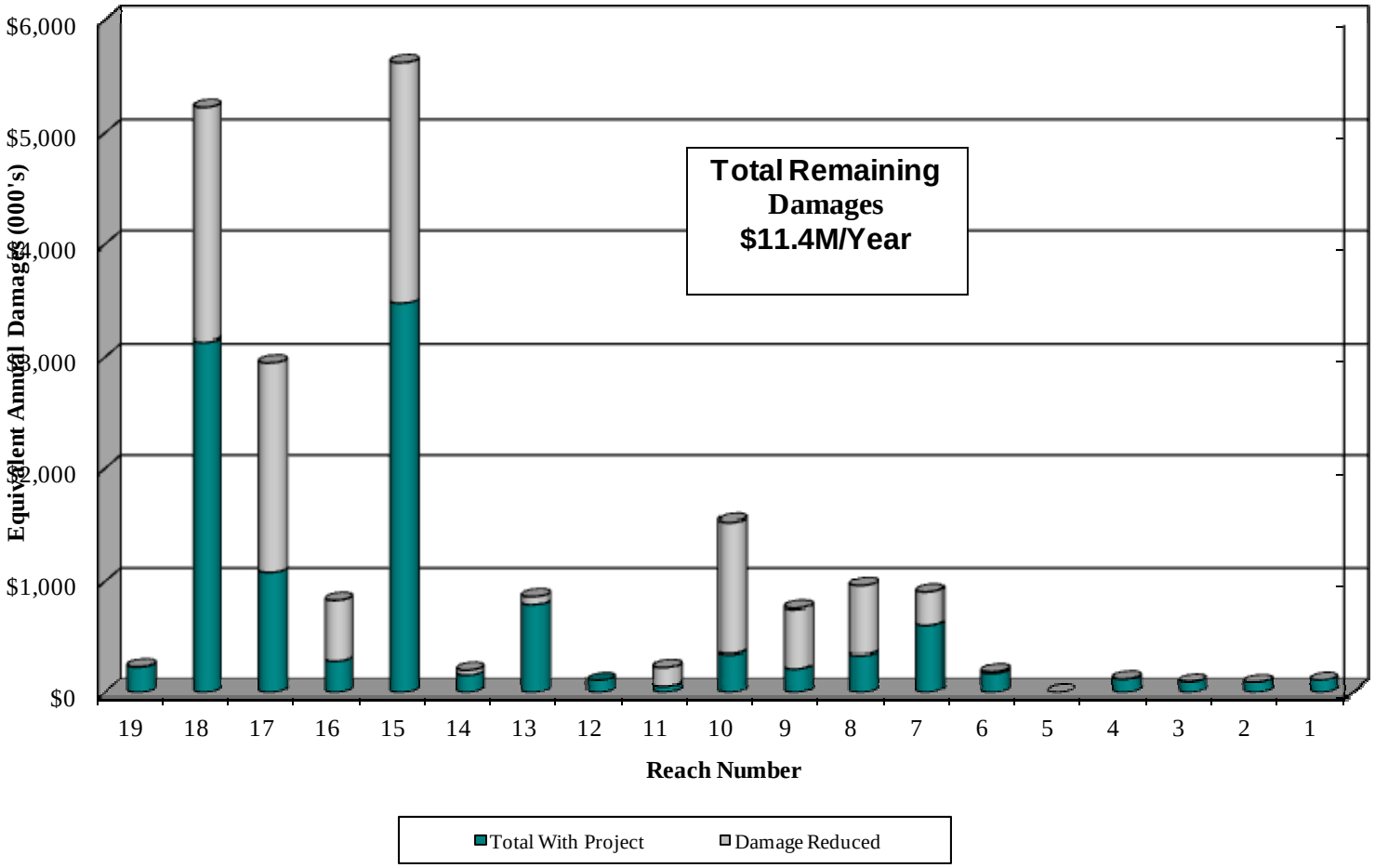


Figure 4
Mud Gully
Equivalent Annual Damages by Reach
(000's of dollars)

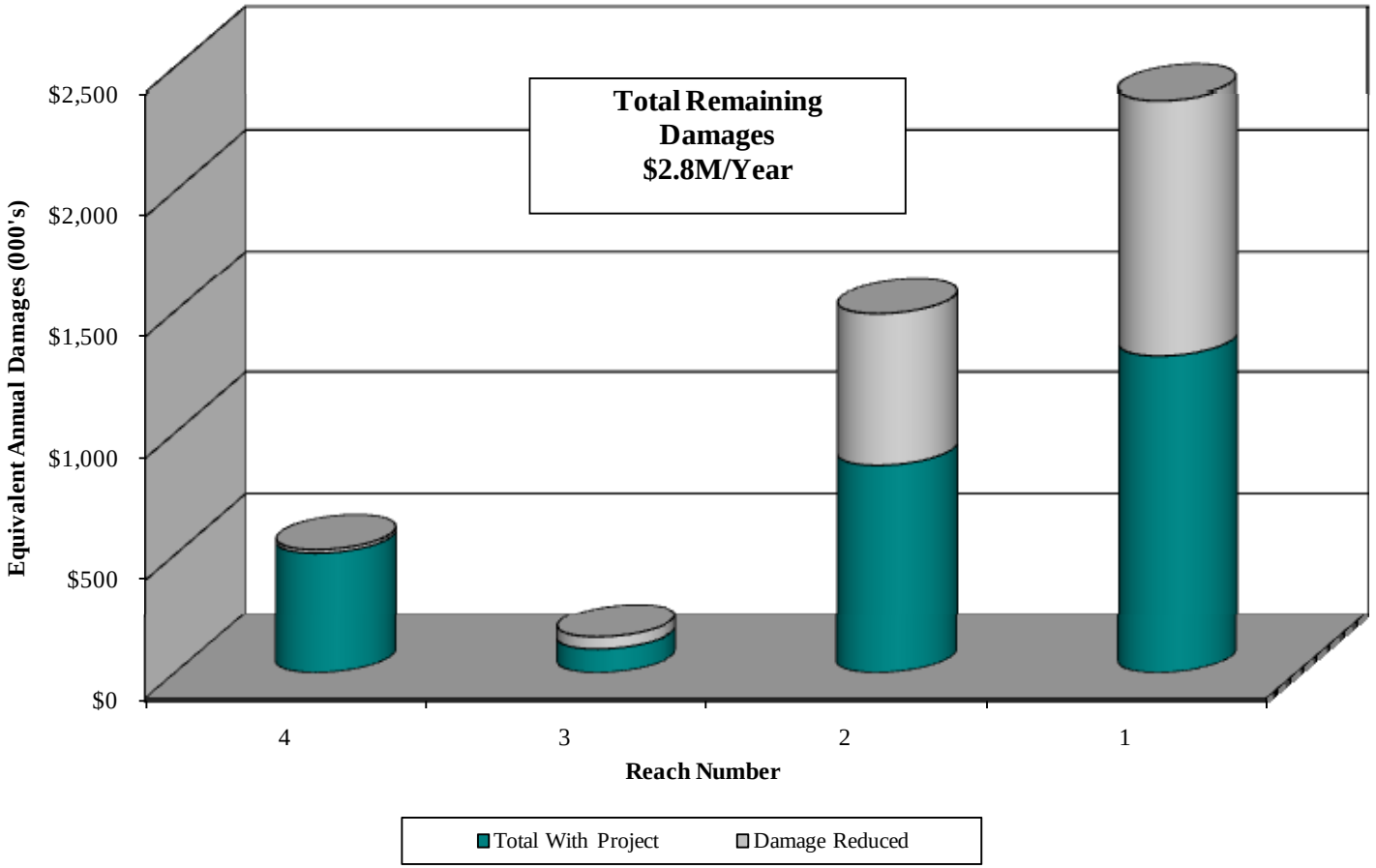


Figure 5
Turkey Creek
Equivalent Annual Damages by Reach
(000's of dollars)

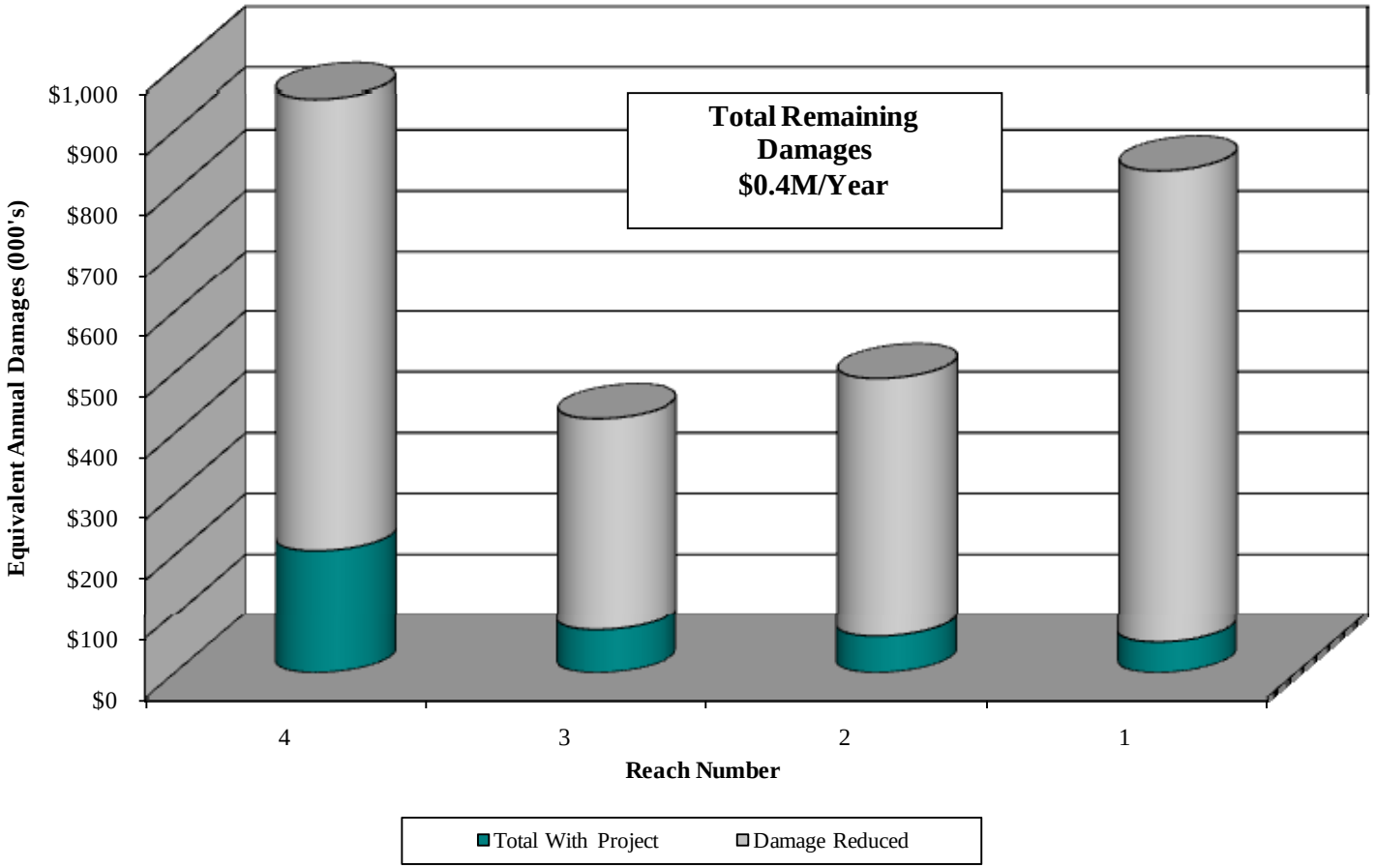
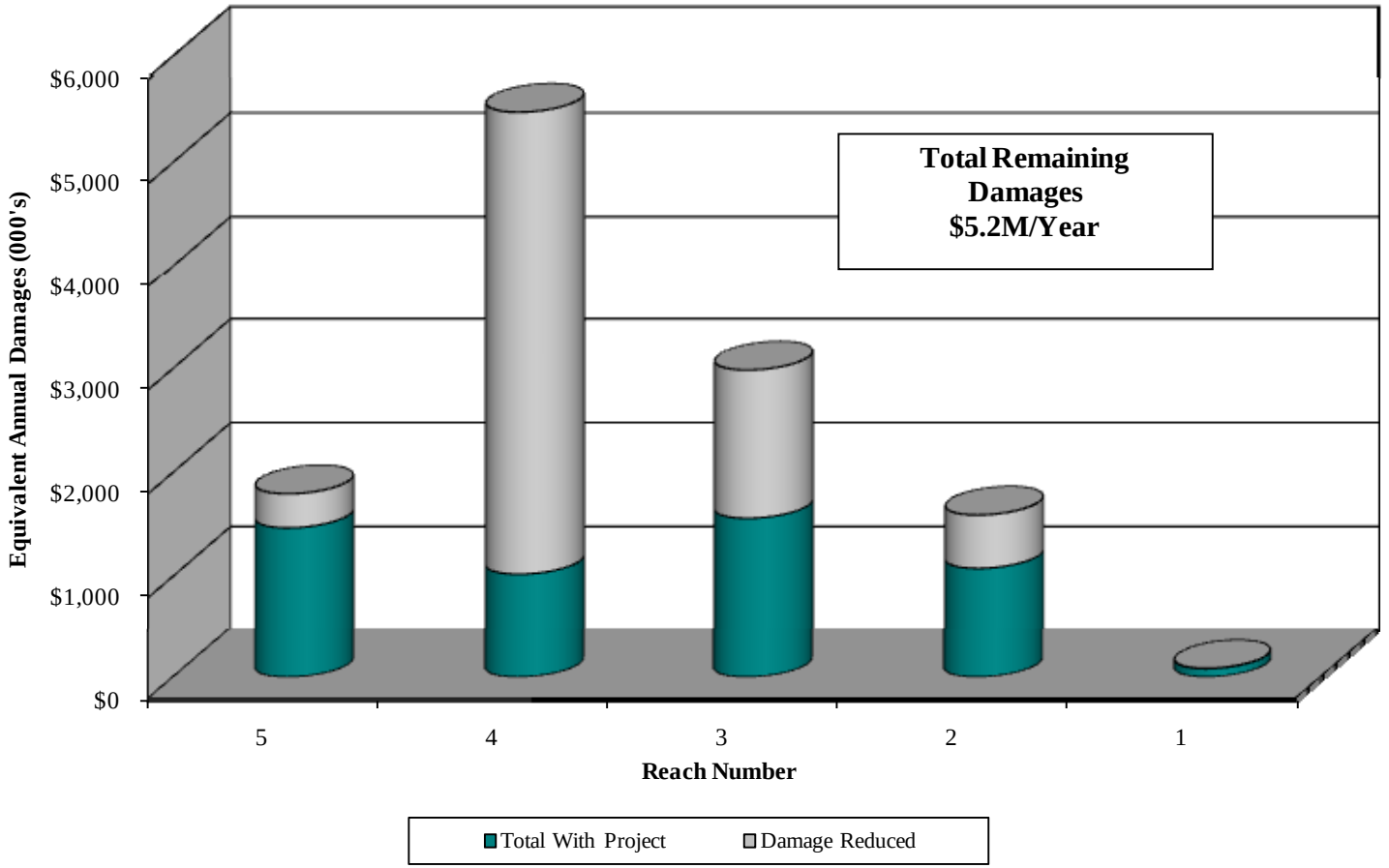


Figure 6
Mary's Creek
Equivalent Annual Damages by Reach
(000's of dollars)



Consideration of Induced Flooding Effects**.** Conveyance measures work to reduce flooding by increasing flow capacity and reducing storage. This generally results in higher flood flows (i.e. induced flooding) in the adjacent, downstream reach. The resulting increase in damage can offset economic benefits to the upstream reach. Even when the downstream reach is undeveloped, there is still an impact since property values are affected. Harris County and some other entities generally prohibit projects that cause induced flooding.

The GRR NED formulation was predicated on economic optimization without the constraint that induced flooding must be mitigated. Components were selected and sized to optimize net benefits. Investigation of the water surface elevations reveals that there is a maximum of 0.15 feet (less than 2 inches) of induced flooding in the Clear Creek watershed with the NED plan in place. This is well within one standard deviation of uncertainty in water surface elevations (one standard deviation is generally on the order of 0.75 feet) and, therefore, the induced damages for the NED plan are considered statistically insignificant. Since induced damages are statistically insignificant (meaning there is no statistical basis indicating that induced damages actually exist), a real estate analysis was not undertaken.

Savings in National Flood Insurance Administration Costs**.** Benefits can be derived from a reduction in administrative costs to the NFIP if implementation of a plan removes structures from the existing 1 percent AEP (100-year) floodplain. According to FEMA, the average cost of administering a flood insurance policy was $192 for Fiscal Year 2006 (Economic Guidance Memorandum 06-04 "National Flood Insurance Program Operating Costs, Fiscal Year 2006," April 6, 2006). This is the latest estimate available for NFIP operating costs.

Based on hydrologic stages for a median 1 percent AEP flood under the NED plan, an estimated 1,569 structures are physically located within the improved floodplain of main stem and tributaries of Clear Creek under the 2020 condition.

As previously stated, participation rates in the NFIP vary by county with an estimated 70 percent participation in Brazoria County, 70 percent in Galveston County (Galveston County Engineer, April, 2006), and 60 percent in Harris County (Harris County Engineer in consultation with NFIP Regional Manager, April 2007). Based on this information, a total of 1,050 structures within the 1 percent chance flood plain hold NFIP policies with the NED Plan in place. The total estimated cost of administering policies for the 1 percent AEP floodplain with the NED Plan in place is $201,500. The total annual cost of administering policies for the structures under the without-project condition was estimated to be approximately $472,500. The difference, or reduction in NFIP costs, represents a project benefit and is estimated at $271,000.

LOCALLY PREFERRED PLAN

Economic evaluation of plans during the analytical process resulted in selection the GRP as the NED Plan. This alternative has no adverse economic impacts downstream and meets the local sponsor's criteria of no increase in water surface elevations. In addition, the plan was formulated to alleviate the environmental issues the sponsors had with the AFP. As a result, no additional locally preferred plans were investigated or recommended.

TENTATIVELY RECOMMENDED PLAN

The tentatively recommended plan for Clear Creek, Texas is the NED Plan. Table 25 presents the summary of the benefits and costs of the NED Plan at the current discount rate of 4.125 percent and the rate of 7.0 percent. The rate of 7.0 percent is presented for annual budget presentation purposes and in accordance with Executive Order 12893. Detailed calculations for interest during construction and operations and maintenance costs are shown in Enclosure 5. The tentatively recommended plan has a benefit-to-cost ratio (BCR) of 2.1 at 4.125 percent and a BCR of 1.7 at 7.0 percent.

Enclosure 6 to this appendix details the results of several sensitivity analyses conducted. These sensitivities were conducted based upon a variety of review comments and concerns raised regarding the results of this analysis. The sensitivity analyses further support the selection of the tentatively recommended plan.

SECTION 575 ANALYSIS

Section 575 of WRDA 1996 provides that "during an evaluation of economic benefits and costs for projects set forth in subsection (b) that occurs after the date of the enactment of this Act, the Secretary shall not consider flood control works constructed by non-Federal interests within the drainage area of such projects prior to the date of such evaluation in the determination of conditions existing prior to construction of the project." Section 354 of WRDA 99 amended Section 575 to include Clear Creek. The WRDA 96, Section 575 (b) provides that:

> (b) SPECIFIC PROJECTS. –The projects to which subsection (a) apply are—
> (1) the project for flood control, Buffalo Bayou Basin, Texas, authorized by Section 203 of the Flood Control Act of 1954 (68 Stat. 1258);
> (2) the project for flood control, Buffalo Bayou and tributaries, Texas, authorized by section 101(a) of the Water Resources Development Act of 1990 (104 Stat. 4610); and
> (3) the project for flood control, Cypress Creek, Texas authorized by section 3(a)(13) of

TABLE 25
SUMMARY OF THE TENTATIVELY RECOMMENDED/NED PLAN
AVERAGE ANNUAL EQUIVALENT VALUES
(50-year Period of Analysis, dollar values in thousands, October 2011 Price Levels)

	Discount Rate	
NED Average Annual Impacts	**4.125%**	**7.000%**
Without-Project Conditions:		
Flood Damages	$40,808.0	$40,827.7
NFIP Costs	$472.5	$472.5
Subtotal Without-Project	$41,280.5	$41,300.2
NED Plan Conditions:		
Flood Damages	$20,460.0	$17,059.7
NFIP Costs	$201.5	$201.5
Subtotal Without-Project	$20,661.5	$17,261.2
Total Annual Benefits	$20,619.0	$24,039.0
Project First Costs:	$180,929.0	$180,929.0
Annual Costs:		
Interest and Amortization	$8,603.4	$13,110.1
Interest During Construction	$287.0	$755.0
OMRR&R	$902.7	$654.2
Total Annual Project Costs	$9,793.0	$14,519.3
Benefit/Cost Ratio	2.1	1.7

Note: Discount Rate of 7% is shown for annual budget comparison purposes and in accordance with Executive Order 12893.

Individual numbers may not sum to totals due to rounding.

the Water Resources Development Act of 1988 (102 Stat. 401Buffalo Bayou and tributaries, Texas, authorized by section 101(a) of the Water Resources Development Act of 1990 (104 Stat. 4610); and

(3) the project for flood control, Cypress Creek, Texas authorized by section 3(a)(13) of the Water Resources Development Act of 1988 (102 Stat. 4014).

The WRDA 99, Section 354 states:

Section 575 of the Water Resources Development Act of 1996 (110 Stat. 3789) is amended –

(1) In subsection (a)-

(A) By inserting "or nonstructural actions" after "flood control works constructed"; and

(B) By inserting "or nonstructural actions" after "construction of the project"; and

(2) In subsection (b)-

(A) In paragraph (2), by striking "and" at the end;

(B) In paragraph (3), by striking the period at the end and inserting "; and"; and

(C) By adding at the end the following:

"(4) the project for flood control, Clear Creek, Texas, authorized by section 203 of the Floor Control Act of 1968 (82 Stat. 742).".

To meet the intent of the legislation, the without-project condition for Clear Creek (main stem and tributaries) was formulated without consideration of ongoing construction and property relocations within the study area. Only after the Federal NED plan was developed and fully evaluated was additional analysis performed, testing the effect of activities by non-Federal interests. Two activities had the potential for altering either the hydrologic or economic profile of the study area—the construction of detention basins on Marys Creek and the purchase and demolition of 163 properties along the main stem of Clear Creek following Tropical Storm Allison, which occurred June 2001. FEMA's Hazard Mitigation Grant Program (HMGP) and the Harris County Flood Control District funded the buyouts.

Section 575 Implementation Guidance states that the following steps should be applied in the order presented to any current and future analyses:

1. Exclude non-Federal flood control works completed prior to the evaluation of benefits

and costs from the existing and future "without-project" condition descriptions.

2. Exclude the same completed non-Federal flood control works from the "with-project" conditions for each alternative considered.

3. Combine the completed non-Federal flood control works with the recommended Federal project to form a total project. Identify the total project output.

4. Reexamine and possibly modify the design and operation of the recommended Federal project to more efficiently achieve the total project output.

Since there are two separate water bodies on Clear Creek affected by Section 575, it is necessary to analyze them in two parts.

Main Stem Section 575 Analysis. Of the structures inventoried, 163 residential structures have been purchased and removed from the floodplain under the FEMA's Hazard Mitigation Program on the main stem of Clear Creek. Under authority of Section 575, WRDA 96, as amended, those properties remain in the structure inventory for Federal project justification. The Section 575 analysis for the FEMA buyouts is shown in Table 26.

The removal of 163 damageable properties from the 0.2 percent AEP floodplain of the main stem of Clear Creek reduced residual damages in the with-project condition by $948,000 on an AAE basis and decreased the benefits attributable to the tentatively recommended plan by 8 percent. By reducing the benefits attributable to the tentatively recommended plan, the BCR of the main stem portion of the NED plan with the non-Federal project is 1.3, compared to the BCR of the main stem portion of the NED plan without the non-Federal project in place ratio of 1.4.

TABLE 26
SECTION 575 ANALYSIS
AVERAGE ANNUAL EQUIVALENT DAMAGES 4.125%, 50 years
CLEAR CREEK MAIN STEM
VALUES IN THOUSANDS, OCT 2009 PRICES

			Step 1: Exclude non-Fed from benefits and costs for Existing and FWOPC	Step 2: Exclude the same complete non-Fed project from the with-project condition		Step 3: Combine the completed non-Fed project with the recommended Fed project			Step 4: Reexamine and possibly modify the design and operation of the recommended Fed project to more efficiently achieve total project output	
REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	Without Project	NED Plan	Damage Reduced	Without Project (w/ non-Fed project)	NED plan (w/ non-Fed project)	Damage Reduced	Change in Benefits with non-Fed project	Percent Change in Residual Damages w/ and w/o non-Fed project
1	GALVESTON BAY	ROSEWOOD	$116	$115	$0	$116	$115	$0	$0	0%
2	ROSEWOOD	BAL HARBOR	$93	$92	$1	$93	$92	$1	$0	0%
3	BAL HARBOR	FM 270	$99	$94	$5	$99	$94	$5	$0	0%
4	FM 270	SH 3	$129	$120	$9	$129	$120	$9	$0	0%
5	SH 3	IH 45	$0	$0	$0	$0	$0	$0	$0	0%
6	IH 45	W BAY AREA BLVD	$195	$180	$15	$169	$156	$13	-$2	-14%
7	W BAY AREA BLVD	FM 528	$904	$609	$295	$862	$585	$277	-$18	-4%
8	FM 528	WHISPERING PINES	$964	$343	$622	$769	$224	$546	-$76	-35%
9	WHISPERING PINES	NEAR MARY'S CRK	$755	$219	$535	$572	$160	$412	-$123	-27%
10	NEAR MARY'S CRK	FM 2351	$1,529	$351	$1,179	$645	$101	$545	-$634	-71%
11	FM 2351	NEAR TURKEY CRK	$233	$52	$181	$201	$42	$158	-$23	-19%
12	NEAR TURKEY CRK	DIXIE FARM RD	$102	$112	-$10	$90	$99	-$9	$1	-12%
13	DIXIE FARM RD	COUNTRY CLUB DR	$859	$785	$74	$615	$557	$59	-$15	-29%
14	COUNTRY CLUB DR	BENNIE KATE	$210	$163	$47	$210	$163	$47	$0	0%
15	BENNIE KATE	SH 35	$5,621	$3,486	$2,135	$5,407	$3,330	$2,077	-$58	-4%
16	SH 35	MYKAWA	$826	$293	$532	$826	$293	$532	$0	0%
17	MYKAWA	STONE RD	$2,948	$1,086	$1,862	$2,948	$1,086	$1,862	$0	0%
18	STONE RD	SH 288	$5,222	$3,136	$2,086	$5,222	$3,136	$2,086	$0	0%
19	SH 288	ALMEDA SCHOOL RD	$241	$239	$2	$241	$239	$2	$0	0%
TOTAL			$21,045	$11,476	$9,569	$19,213	$10,592	$8,621	-$948	-8%

First Costs of Construction (Main Stem Only)	$123,680	$123,680
AAEV Cost at 4.125%, 50-yrs (includes IDC & O&M)	$6,862	$6,862
Net Benefits	$2,707	$1,759
B/C Ratio (Main Stem Only)	1.4	1.3

Note: Individual numbers may not sum to totals due to rounding.

Marys Creek Section 575 Analysis. During the study of this project, offline detentions on Marys Creek were constructed by the local sponsor. These detentions, named SWEC and West Marys Detentions, were initially analyzed for inclusion in the Federal plan, so the detention sizes were optimized (see Enclosure 2 of this appendix). The detentions were eventually dropped from analysis and analyzed as Section 575 projects. Analysis of the effect of the construction of these detentions on the Federal plan is show in Table 27. As can be seen from the table, the Marys Creek detentions further reduces residual damages along Marys Creek on an AAE basis of $1.1 million and increased benefits attributable to the tentatively recommended plan by 16 percent.

By increasing the benefits attributable to the tentatively recommended plan, the BCR of the Marys Creek portion of NED plan with the non-Federal project is 6.9, compared to the BCR of the NED plan without the non-Federal project in place ratio of 8.2. The non-Federal project (detentions) impacts the tentatively recommended plan by simultaneously reducing residual damages and decreasing benefits.

Since the recommended plan (with the detention on Marys Creek) has a very robust BCR, additional modification to the design and operation of the recommended Federal plan is not required.

ABILITY TO PAY ANALYSIS

In accordance with ER 1165-2-121, an ability to pay analysis was conducted for the Clear Creek GRR flood damage mitigation project. The ability to pay test determines the eligibility of the study sponsors to qualify for a reduction in the amount they are required to cost share. To qualify for a reduction the results of both the benefit and income portions of the two-fold ability to pay test must fall within the specified guidelines.

The benefits' test determines the maximum reduction, called the "benefits based floor" (or BBF), in the level of non-Federal cost sharing for any project. The factor is determined by dividing the BCR 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 standard level cost share for a flood control project is 25 percent. The NED Plan's BCR of 2.1 was divided by four to yield a BBF of 52.5 percent.

TABLE 27
SECTION 575 ANALYSIS
AVERAGE ANNUAL EQUIVALENT DAMAGES 4.125%, 50 years
MARYS CREEK
VALUES IN THOUSANDS, OCT 2009 PRICES

			Step 1: Exclude non-Fed from benefits and costs for Existing and FWOPC	Step 2: Exclude the same complete non-Fed project from the with-project condition		Step 3: Combine the completed non-Fed project with the recommended Fed project			Step 4: Reexamine and possibly modify the design and operation of the recommended Fed project to more efficiently achieve total project output	
REACH	LOWER LIMIT NEAR	UPPER LIMIT NEAR	Without Project	NED Plan	Damage Reduced	Without Project (w/ non-Fed project)	NED plan (w/ non-Fed project)	Damage Reduced	Change in Benefits with non-Fed project	Percent Change in Residual Damages w/ and w/o non-Fed project
1	EDGEWOOD DR.	COUNTY LINE	$84	$81	$3	$114	$72	$41	$39	-11%
2	COUNTY LINE	LONGHERRIDGE DR	$1,592	$1,078	$513	$1,986	$1,007	$979	$466	-7%
3	LONGHERRIDGE DR.	AT&SF RR	$2,986	$1,560	$1,426	$2,094	$1,197	$897	-$529	-23%
4	AT&SF RR	HARKEY RD	$5,485	$1,023	$4,462	$4,316	$722	$3,594	-$868	-29%
5	HARKEY RD	CHARLES AVE	$1,796	$1,468	$328	$1,500	$1,361	$139	-$188	-7%
TOTAL			$11,942	$5,210	$6,732	$10,010	$4,359	$5,651	-$1,081	-16%

First Costs of Construction (Mary's Creek Only)	$16,455	$16,455
AAEV Cost at 4.125%, 50-yrs (includes IDC & O&M)	$817	$817
Net Benefits	$5,915	$4,834
B/C Ratio (Mary's Creek Only)	8.2	6.9

Note: Individual numbers may not sum to totals due to rounding.

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

In accordance with the factors released in Economic Guidance Memorandum 08-05, the income index factor for the State of Texas is 93.38 and for the counties of Galveston, Harris and Brazoria, the index factors are 96.69, 118.36, and 87.13, respectively. The Eligibility Factor (EF) for a flood damage mitigation project is calculated according to the following formula:

$$EF = a - b_1*(\text{State Factor}) - b_2*(\text{Area Factor})$$

Where: $a = 18.12$
$b_1 = .078$
$b_2 = .156$

When a project area, as determined by the location of the project's beneficiaries, includes more than one county, calculation of a composite project area index is necessary by taking a weighted average of the county index numbers, the weights being equal to the relative levels of benefits received in each county. The composite area index for the Clear Creek study area is 102.14.

Utilizing the above formula and the composite area index, an EF of or the Clear Creek NED project is -5.10. An EF less than zero indicates ineligibility for a reduction in construction cost sharing.

As stated previously, a BBF factor for the NED plan was calculated at 52.5 percent. To qualify for a reduction, the BBF factor must be less than the standard level of cost sharing. According to ER-1165-2-121 paragraph 5a(2), the project and sponsors do not meet the criteria for a reduction in cost sharing. This project does not meet either of the tests; therefore, the sponsors must pay the standard percentage of the total project cost.

ECONOMIC BENEFIT UPDATE PLAN

In accordance with ER 1105-2-100, a plan is included to update the economic benefits of the project every three years after project approval. Only the important economic variables are considered for update.

As part of this economic update, changes to floodplain development will not be considered due to the fact that the study area participates in floodplain development restrictions, thus inhibiting any development from occurring below the FEMA 100-year floodplain. Structure values for residential, commercial, industrial and public categories will be updated by creating a random sample of inventoried structures and valuing these structures using off-the-shelf valuation software. The resultant index will be used to update all structure values. Automobile values will be updated using the latest published values (for average mid-sized sedans). The NFIP benefit category will be updated using the latest available Economic Guidance Memorandum. Finally, utilities, roads and post disaster recovery benefit categories will be updated using the most appropriate CPI index.

Enclosure 1
Detailed Tables for Main Stem and Tributaries Without-Project 2020 and 2070 Conditions

Details of Distribution of Capital Investment within the Without-Project Floodplain. Tables 1-1 through 1-6 of this enclosure show the detailed distribution of structures by type by flood event for the 2020 without-project condition. For example, Table 1-3 shows the distribution of capital investment on Turkey Creek in the 2020 without-project condition. Tables 1-7 through 1-12 likewise display the distribution of structures by type by flood event; however, the condition is for the 2070 future without-project condition.

TABLE 1-1
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CLEAR CREEK MAIN STEM
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	105	358	758	1,184	1,636	2,443	2,949
Value of Structures	$0	$10,805	$37,941	$75,552	$124,245	$179,783	$279,938	$342,609
Value of Contents	$0	$5,402	$18,970	$37,776	$62,122	$89,891	$139,969	$171,304
Percent of Structures Inundated/Zone	0%	78%	83%	89%	90%	91%	92%	93%
Commercial								
Number of Structures	$1	23	57	74	98	127	170	202
Value of Structures	$33	$4,113	$10,717	$12,043	$15,022	$17,572	$25,776	$29,660
Value of Contents	$0	$1,094	$5,855	$6,592	$9,903	$11,096	$18,935	$21,751
Percent of Structures Inundated/Zone	100%	17%	13%	9%	7%	7%	6%	6%
Industrial								
Number of Structures	$0	1	4	7	14	14	14	14
Value of Structures	$0	$216	$688	$1,172	$2,160	$2,160	$2,200	$2,200
Value of Contents	$0	$1,149	$3,073	$4,562	$9,276	$9,276	$9,319	$9,319
Percent of Structures Inundated/Zone	0%	1%	1%	1%	1%	1%	1%	0%
Public								
Number of Structures	$0	5	10	16	19	19	19	23
Value of Structures	$0	$1,268	$2,092	$6,844	$7,694	$7,694	$7,694	$7,794
Value of Contents	$0	$422	$492	$1,435	$1,888	$1,888	$1,888	$1,939
Percent of Structures Inundated/Zone	0%	4%	2%	2%	1%	1%	1%	1%
Total								
Number of Structures	1	134	429	855	1,315	1,796	2,646	3,188
Value of Structures	$33	$16,402	$51,437	$95,611	$149,120	$207,209	$315,609	$382,263
Value of Contents	$0	$8,067	$28,391	$50,364	$83,189	$112,152	$170,111	$204,313
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-2
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MUD GULLY
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	1	87	377	625	952	1,189
Value of Structures	$0	$0	$117	$9,915	$38,136	$64,909	$97,381	$121,212
Value of Contents	$0	$0	$58	$4,957	$19,068	$32,455	$48,690	$60,606
Percent of Structures Inundated/Zone				98%	93%	94%	96%	96%
Commercial								
Number of Structures	0	0	0	2	26	38	42	48
Value of Structures	$0	$0	$0	$87	$2,818	$4,551	$5,121	$6,222
Value of Contents	$0	$0	$0	$79	$4,068	$5,942	$6,207	$7,114
Percent of Structures Inundated/Zone				2%	6%	6%	4%	4%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	2	2	2	2
Value of Structures	$0	$0	$0	$0	$204	$204	$204	$204
Value of Contents	$0	$0	$0	$0	$75	$75	$75	$75
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	1	89	405	665	996	1,239
Value of Structures	$0	$0	$117	$10,001	$41,157	$69,663	$102,706	$127,637
Value of Contents	$0	$0	$58	$5,036	$23,211	$38,472	$54,972	$67,795
Percent of Structures Inundated/Zone	n/a	n/a	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-3
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
TURKEY CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	0	6	55	313	697	744
Value of Structures	$0	$0	$0	$728	$4,922	$24,841	$62,901	$68,246
Value of Contents	$0	$0	$0	$364	$2,461	$12,420	$31,450	$34,123
Percent of Structures Inundated/Zone				86%	96%	98%	99%	99%
Commercial								
Number of Structures	0	0	0	1	2	5	9	9
Value of Structures	$0	$0	$0	$192	$459	$1,287	$1,770	$1,770
Value of Contents	$0	$0	$0	$175	$418	$1,565	$2,164	$2,164
Percent of Structures Inundated/Zone				14%	4%	2%	1%	1%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	0	7	57	318	706	753
Value of Structures	$0	$0	$0	$921	$5,381	$26,128	$64,671	$70,016
Value of Contents	$0	$0	$0	$539	$2,879	$13,985	$33,614	$36,287
Percent of Structures Inundated/Zone	n/a	n/a	n/a	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-4
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MARYS CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	1	24	151	409	597	640	743	1,576
Value of Structures	$94	$3,247	$11,162	$34,169	$54,619	$61,167	$74,605	$183,794
Value of Contents	$47	$1,623	$5,581	$17,085	$27,310	$30,583	$37,302	$91,897
Percent of Structures Inundated/Zone	33%	52%	67%	74%	78%	79%	79%	82%
Commercial								
Number of Structures	2	21	61	113	139	142	159	284
Value of Structures	$1	$141	$1,524	$3,038	$5,132	$5,279	$5,909	$13,466
Value of Contents	$1	$96	$1,008	$2,224	$4,128	$4,240	$4,745	$11,656
Percent of Structures Inundated/Zone	67%	46%	27%	21%	18%	17%	17%	15%
Industrial								
Number of Structures	0	0	8	17	18	18	18	20
Value of Structures	$0	$0	$3,581	$6,965	$7,553	$7,553	$7,553	$7,953
Value of Contents	$0	$0	$2,435	$4,736	$5,136	$5,136	$5,136	$5,408
Percent of Structures Inundated/Zone	0%	0%	4%	3%	2%	2%	2%	1%
Public								
Number of Structures	0	1	5	10	12	14	17	33
Value of Structures	$0	$16	$274	$382	$539	$707	$2,269	$9,412
Value of Contents	$0	$6	$143	$210	$277	$365	$1,040	$3,726
Percent of Structures Inundated/Zone	0%	2%	2%	2%	2%	2%	2%	2%
Total								
Number of Structures	3	46	225	549	766	814	937	1,913
Value of Structures	$95	$3,404	$16,541	$44,555	$67,843	$74,705	$90,336	$214,625
Value of Contents	$48	$1,725	$9,167	$24,255	$36,850	$40,325	$48,223	$112,687
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-5
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
COWART CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	3	5	9	13	17	32	42
Value of Structures	$0	$66	$138	$317	$1,182	$1,544	$4,303	$5,971
Value of Contents	$0	$33	$69	$159	$591	$772	$2,151	$2,985
Percent of Structures Inundated/Zone		17%	20%	26%	29%	29%	36%	42%
Commercial								
Number of Structures	0	11	14	17	24	32	40	41
Value of Structures	$0	$255	$267	$271	$365	$444	$532	$549
Value of Contents	$0	$170	$178	$181	$187	$241	$301	$312
Percent of Structures Inundated/Zone		61%	56%	50%	53%	54%	45%	41%
Industrial								
Number of Structures	0	4	6	8	8	10	16	17
Value of Structures	$0	$0	$92	$188	$188	$188	$188	$206
Value of Contents	$0	$0	$63	$128	$128	$128	$128	$140
Percent of Structures Inundated/Zone		22%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	18	25	34	45	59	88	100
Value of Structures	$0	$321	$497	$776	$1,734	$2,175	$5,022	$6,726
Value of Contents	$0	$203	$310	$467	$906	$1,141	$2,580	$3,438
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-6
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CHIGGER CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	1	2	5	5	8	19	22
Value of Structures	$0	$252	$749	$1,075	$1,075	$1,523	$4,724	$5,079
Value of Contents	$0	$126	$374	$538	$538	$762	$2,362	$2,540
Percent of Structures Inundated/Zone		50%	67%	83%	83%	80%	86%	88%
Commercial								
Number of Structures	0	1	1	1	1	2	3	3
Value of Structures	$0	$35	$35	$35	$35	$62	$77	$77
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		50%	33%	17%	17%	20%	14%	12%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	2	3	6	6	10	22	25
Value of Structures	$0	$287	$784	$1,110	$1,110	$1,585	$4,801	$5,156
Value of Contents	$0	$126	$374	$538	$538	$762	$2,362	$2,540
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-7
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CLEAR CREEK MAIN STEM
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	2	197	506	899	1,375	1,795	2,631	3,180
Value of Structures	$137	$21,526	$53,710	$92,218	$148,058	$205,413	$306,767	$371,646
Value of Contents	$68	$10,763	$26,855	$46,109	$74,029	$102,707	$153,384	$185,823
Percent of Structures Inundated/Zone	67%	84%	86%	90%	90%	91%	92%	93%
Commercial								
Number of Structures	1	30	63	78	115	134	181	212
Value of Structures	$33	$6,394	$10,995	$12,120	$16,799	$17,822	$26,550	$37,189
Value of Contents	$0	$3,181	$6,018	$6,687	$10,602	$11,117	$19,321	$22,415
Percent of Structures Inundated/Zone	33%	13%	11%	8%	8%	7%	6%	6%
Industrial								
Number of Structures	0	3	5	8	14	14	17	17
Value of Structures	$0	$565	$833	$1,172	$2,160	$2,160	$2,200	$2,200
Value of Contents	$0	$2,739	$3,080	$4,562	$9,276	$9,276	$9,319	$9,319
Percent of Structures Inundated/Zone	0%	1%	1%	1%	1%	1%	1%	0%
Public								
Number of Structures	0	5	13	17	19	19	20	27
Value of Structures	$0	$1,268	$2,462	$6,844	$7,694	$7,694	$7,694	$8,063
Value of Contents	$0	$422	$677	$1,435	$1,888	$1,888	$1,888	$2,006
Percent of Structures Inundated/Zone	0%	2%	2%	2%	1%	1%	1%	1%
Total								
Number of Structures	3	235	587	1,002	1,523	1,962	2,849	3,436
Value of Structures	$169	$29,754	$68,000	$112,355	$174,711	$233,090	$343,212	$419,099
Value of Contents	$68	$17,106	$36,629	$58,792	$95,795	$124,988	$183,912	$219,563
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-8
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MUD GULLY
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	6	202	471	733	1,069	1,366
Value of Structures	$0	$0	$671	$19,551	$48,449	$75,534	$106,806	$140,464
Value of Contents	$0	$0	$335	$9,776	$24,225	$37,767	$53,403	$70,232
Percent of Structures Inundated/Zone			100%	97%	94%	95%	96%	96%
Commercial								
Number of Structures	0	0	0	7	30	38	44	59
Value of Structures	$0	$0	$0	$1,305	$3,432	$4,551	$5,587	$7,546
Value of Contents	$0	$0	$0	$2,077	$5,019	$5,942	$6,810	$8,383
Percent of Structures Inundated/Zone			0%	3%	6%	5%	4%	4%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone			0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	2	2	2	5
Value of Structures	$0	$0	$0	$0	$204	$204	$204	$402
Value of Contents	$0	$0	$0	$0	$75	$75	$75	$181
Percent of Structures Inundated/Zone			0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	6	209	503	773	1,115	1,430
Value of Structures	$0	$0	$671	$20,856	$52,085	$80,289	$112,596	$148,411
Value of Contents	$0	$0	$335	$11,852	$29,319	$43,785	$60,288	$78,796
Percent of Structures Inundated/Zone	n/a	n/a	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-9
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
TURKEY CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	2	62	334	449	881	1,377
Value of Structures	$0	$0	$247	$5,431	$25,527	$36,031	$79,738	$120,595
Value of Contents	$0	$0	$123	$2,716	$12,763	$18,016	$39,869	$60,298
Percent of Structures Inundated/Zone			100%	97%	99%	99%	99%	99%
Commercial								
Number of Structures	0	0	0	2	5	6	9	20
Value of Structures	$0	$0	$0	$459	$1,287	$1,554	$1,770	$4,264
Value of Contents	$0	$0	$0	$418	$1,565	$2,021	$2,164	$4,520
Percent of Structures Inundated/Zone				3%	1%	1%	1%	1%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	2	64	339	455	890	1,397
Value of Structures	$0	$0	$247	$5,891	$26,814	$37,585	$81,508	$124,859
Value of Contents	$0	$0	$123	$3,134	$14,328	$20,037	$42,033	$64,818
Percent of Structures Inundated/Zone	n/a	n/a	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-10
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MARYS CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	10	96	180	560	614	1,416	1,600	1,829
Value of Structures	$1,017	$7,903	$13,325	$49,906	$58,015	$165,945	$189,720	$221,115
Value of Contents	$508	$3,951	$6,663	$24,953	$29,007	$82,972	$94,860	$110,558
Percent of Structures Inundated/Zone	48%	71%	67%	77%	78%	83%	83%	84%
Commercial								
Number of Structures	10	35	73	135	141	241	276	289
Value of Structures	$97	$436	$1,848	$4,983	$5,255	$9,488	$12,928	$13,565
Value of Contents	$66	$337	$1,245	$3,901	$4,075	$8,722	$10,894	$11,454
Percent of Structures Inundated/Zone	48%	26%	27%	19%	18%	14%	14%	13%
Industrial								
Number of Structures	0	0	9	18	18	20	22	22
Value of Structures	$0	$0	$4,124	$7,553	$7,553	$7,953	$8,355	$8,355
Value of Contents	$0	$0	$2,804	$5,136	$5,136	$5,408	$5,681	$5,681
Percent of Structures Inundated/Zone	0%	0%	3%	2%	2%	1%	1%	1%
Public								
Number of Structures	1	4	6	12	12	30	31	35
Value of Structures	$16	$167	$275	$539	$539	$8,392	$8,397	$8,540
Value of Contents	$6	$104	$144	$277	$277	$3,347	$3,351	$3,404
Percent of Structures Inundated/Zone	5%	3%	2%	2%	2%	2%	2%	2%
Total								
Number of Structures	21	135	268	725	785	1,707	1,929	2,175
Value of Structures	$1,129	$8,505	$19,572	$62,982	$71,361	$191,778	$219,400	$251,575
Value of Contents	$580	$4,392	$10,856	$34,267	$38,495	$100,450	$114,786	$131,096
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-11
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
COWART CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	3	6	9	14	19	34	49
Value of Structures	$0	$66	$143	$317	$1,188	$1,806	$4,661	$7,515
Value of Contents	$0	$33	$71	$159	$594	$903	$2,330	$3,758
Percent of Structures Inundated/Zone		16%	22%	26%	29%	31%	38%	41%
Commercial								
Number of Structures	0	11	14	18	26	32	40	48
Value of Structures	$0	$255	$267	$356	$389	$444	$532	$619
Value of Contents	$0	$170	$178	$181	$204	$241	$301	$360
Percent of Structures Inundated/Zone		58%	52%	51%	53%	52%	44%	40%
Industrial								
Number of Structures	0	5	7	8	9	10	16	22
Value of Structures	$0	$92	$188	$188	$188	$188	$188	$188
Value of Contents	$0	$63	$128	$128	$128	$128	$128	$128
Percent of Structures Inundated/Zone		26%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	19	27	35	49	61	90	119
Value of Structures	$0	$413	$597	$861	$1,765	$2,438	$5,380	$8,322
Value of Contents	$0	$266	$377	$468	$925	$1,272	$2,759	$4,245
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-12
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CHIGGER CREEK
Cumulative Totals Based on First-Floor Elevations and Without-Project 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	1	2	5	6	10	20	24
Value of Structures	$0	$252	$749	$1,075	$1,331	$2,098	$4,742	$5,579
Value of Contents	$0	$126	$374	$538	$666	$1,049	$2,371	$2,789
Percent of Structures Inundated/Zone		50%	67%	83%	86%	83%	87%	89%
Commercial								
Number of Structures	0	1	1	1	1	2	3	3
Value of Structures	$0	$35	$35	$35	$35	$62	$77	$77
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		50%	33%	17%	14%	17%	13%	11%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	2	3	6	7	12	23	27
Value of Structures	$0	$287	$784	$1,110	$1,366	$2,160	$4,819	$5,656
Value of Contents	$0	$126	$374	$538	$666	$1,049	$2,371	$2,789
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

Details of Single Occurrence Damages in the Without-Project Condition. Tables 1-13 through 1-18 of this enclosure show the damages expected to accrue from various flood events along the individual streams on Clear Creek under the 2020 condition. These values represent damages expected for individual events under the without-project near-term hydrologic condition and include structure and content damages as well as other benefit categories. Similarly, Tables 1-19 through 1-24 display the summary of single occurrence damages by event for the tributaries in the future hydrologic condition.

It should be noted, once again, that the increase in damages occurring over the period of analysis is attributed solely to increases in runoff. No projections were made on the economic-side of the analysis (i.e. the floodplain investment remains as it currently stands). Overall, there is an increase in damages of 10 percent from 2020 to 2070. This is equivalent to an average annual growth in damages of approximately 0.1 percent over the period of analysis.

TABLE 1-13
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
CLEAR CREEK MAIN STEM
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$283.4	$9,047.6	$23,044.0	$39,949.6	$59,797.8	$85,051.9	$127,237.0	$156,516.0
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1,594.3	$1,805.1
Commercial	$7.1	$447.2	$1,437.2	$2,516.4	$3,829.3	$4,514.5	$7,476.6	$9,619.7
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$718.0	$754.7
Damages to Structures, Contents	$290.6	$9,494.7	$24,481.1	$42,466.0	$63,627.1	$89,566.4	$137,025.9	$168,695.4
Postdisaster Recovery Costs	$216.4	$3,562.8	$7,745.1	$12,682.9	$18,133.5	$23,597.2	$32,795.6	$38,593.5
Utilities	$8.1	$134.1	$291.6	$477.5	$682.7	$888.4	$1,234.7	$1,452.9
Vehicles	$0.0	$511.7	$1,717.3	$3,909.8	$6,794.6	$10,301.7	$17,041.6	$21,199.8
Roads	$337.3	$736.9	$1,073.4	$1,443.0	$1,777.9	$2,127.0	$2,868.2	$6,204.8
Total Damages by Event	$852.5	$14,440.3	$35,308.6	$60,979.1	$91,015.7	$126,480.7	$190,966.0	$236,146.5
Percent Distribution by Event								
Residential	33.2%	62.7%	65.3%	65.5%	65.7%	67.2%	66.6%	66.3%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.8%
Commercial	0.8%	3.1%	4.1%	4.1%	4.2%	3.6%	3.9%	4.1%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.3%
Postdisaster Recovery Costs	25.4%	24.7%	21.9%	20.8%	19.9%	18.7%	17.2%	16.3%
Utilities	1.0%	0.9%	0.8%	0.8%	0.8%	0.7%	0.6%	0.6%
Vehicles	0.0%	3.5%	4.9%	6.4%	7.5%	8.1%	8.9%	9.0%
Roads	39.6%	5.1%	3.0%	2.4%	2.0%	1.7%	1.5%	2.6%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-14
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
MUD GULLY
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$203.8	$2,500.3	$9,291.0	$19,556.4	$29,086.8	$42,560.1	$50,979.5
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.0	$1.6	$33.2	$194.6	$480.7	$895.3	$1,139.0
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$0.0	$203.9	$2,501.9	$9,324.2	$19,751.1	$29,567.4	$43,455.3	$52,118.6
Postdisaster Recovery Costs	$0.0	$0.0	$8.8	$779.2	$3,502.0	$5,822.1	$8,720.0	$10,812.4
Utilities	$0.0	$0.0	$0.3	$29.3	$131.8	$219.2	$328.3	$407.1
Vehicles	$0.0	$0.0	$0.5	$42.5	$320.8	$1,041.8	$2,656.1	$4,092.1
Roads	$0.0	$2.6	$30.8	$124.6	$290.5	$449.7	$676.5	$828.5
Total Damages by Event	$0.0	$206.5	$2,542.2	$10,299.8	$23,996.3	$37,100.3	$55,836.2	$68,258.6
Percent Distribution by Event								
Residential	0.0%	98.7%	98.3%	90.2%	81.5%	78.4%	76.2%	74.7%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.1%	0.3%	0.8%	1.3%	1.6%	1.7%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	0.0%	0.3%	7.6%	14.6%	15.7%	15.6%	15.8%
Utilities	0.0%	0.0%	0.0%	0.3%	0.5%	0.6%	0.6%	0.6%
Vehicles	0.0%	0.0%	0.0%	0.4%	1.3%	2.8%	4.8%	6.0%
Roads	0.0%	1.3%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-15
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
TURKEY CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$40.0	$287.9	$2,099.8	$4,112.9	$10,399.6	$17,901.3	$18,710.9
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.0	$0.7	$6.8	$16.7	$65.5	$154.3	$157.7
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.2	$0.2
Damages to Structures, Contents	$0.0	$40.0	$288.6	$2,106.6	$4,129.6	$10,465.2	$18,055.8	$18,868.8
Postdisaster Recovery Costs	$0.0	$4.8	$38.8	$873.7	$2,122.8	$6,225.1	$10,351.5	$10,686.8
Utilities	$0.0	$0.2	$1.5	$32.9	$79.9	$234.4	$389.7	$402.3
Vehicles	$0.0	$0.0	$0.0	$8.6	$42.9	$335.4	$1,087.5	$1,235.6
Roads	$0.8	$20.9	$67.7	$140.1	$164.1	$215.1	$239.6	$241.2
Total Damages by Event	$0.8	$65.9	$396.5	$3,161.9	$6,539.4	$17,475.0	$30,124.2	$31,434.8
Percent Distribution by Event								
Residential	0.0%	60.7%	72.6%	66.4%	62.9%	59.5%	59.4%	59.5%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.2%	0.2%	0.3%	0.4%	0.5%	0.5%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	7.2%	9.8%	27.6%	32.5%	35.6%	34.4%	34.0%
Utilities	0.0%	0.3%	0.4%	1.0%	1.2%	1.3%	1.3%	1.3%
Vehicles	0.0%	0.0%	0.0%	0.3%	0.7%	1.9%	3.6%	3.9%
Roads	100.0%	31.8%	17.1%	4.4%	2.5%	1.2%	0.8%	0.8%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-16
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
MARYS CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$239.5	$1,440.5	$9,679.1	$22,216.8	$29,529.8	$32,414.3	$37,613.8	$82,055.9
Public	$0.1	$1.7	$20.1	$63.8	$97.0	$110.7	$149.7	$978.2
Commercial	$1.0	$17.9	$303.5	$1,012.7	$1,294.0	$1,370.7	$1,487.7	$3,860.6
Industrial	$0.0	$0.0	$573.3	$4,356.5	$6,566.2	$6,598.8	$6,643.2	$13,157.5
Damages to Structures, Contents	$240.6	$1,460.1	$10,576.0	$27,649.9	$37,487.1	$40,494.6	$45,894.5	$100,052.3
Postdisaster Recovery Costs	$163.5	$704.2	$3,766.4	$8,128.8	$10,445.0	$11,133.8	$12,395.4	$19,239.1
Utilities	$6.2	$26.4	$141.8	$306.0	$393.2	$419.2	$466.7	$724.3
Vehicles	$0.8	$49.3	$233.1	$876.7	$1,497.0	$1,680.8	$2,045.1	$12,210.1
Roads	$14.2	$121.8	$460.0	$660.2	$702.4	$734.6	$779.3	$839.5
Total Damages by Event	$425.3	$2,361.8	$15,177.4	$37,621.6	$50,524.7	$54,462.9	$61,580.9	$133,065.3
Percent Distribution by Event								
Residential	56.3%	61.0%	63.8%	59.1%	58.4%	59.5%	61.1%	61.7%
Public	0.0%	0.1%	0.1%	0.2%	0.2%	0.2%	0.2%	0.7%
Commercial	0.2%	0.8%	2.0%	2.7%	2.6%	2.5%	2.4%	2.9%
Industrial	0.0%	0.0%	3.8%	11.6%	13.0%	12.1%	10.8%	9.9%
Postdisaster Recovery Costs	38.4%	29.8%	24.8%	21.6%	20.7%	20.4%	20.1%	14.5%
Utilities	1.4%	1.1%	0.9%	0.8%	0.8%	0.8%	0.8%	0.5%
Vehicles	0.2%	2.1%	1.5%	2.3%	3.0%	3.1%	3.3%	9.2%
Roads	3.3%	5.2%	3.0%	1.8%	1.4%	1.3%	1.3%	0.6%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-17
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
COWART CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$40.1	$114.8	$262.7	$487.0	$846.6	$1,717.5	$2,481.7
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$10.6	$34.6	$43.1	$49.5	$56.7	$68.8	$78.6
Industrial	$0.0	$0.9	$11.8	$22.4	$29.4	$35.4	$42.1	$46.5
Damages to Structures, Contents	$0.0	$51.6	$161.2	$328.1	$565.9	$938.8	$1,828.4	$2,606.8
Postdisaster Recovery Costs	$32.5	$222.9	$374.1	$524.3	$665.4	$812.4	$1,023.4	$1,171.0
Utilities	$1.2	$8.4	$14.1	$19.7	$25.0	$30.6	$38.5	$44.1
Vehicles	$0.0	$3.7	$23.5	$48.0	$74.2	$114.7	$197.3	$278.3
Roads	$0.4	$1.5	$4.8	$9.7	$16.7	$27.7	$54.0	$77.0
Total Damages by Event	$34.1	$288.1	$577.6	$929.9	$1,347.2	$1,924.2	$3,141.6	$4,177.1
Percent Distribution by Event								
Residential	0.0%	13.9%	19.9%	28.2%	36.1%	44.0%	54.7%	59.4%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	3.7%	6.0%	4.6%	3.7%	2.9%	2.2%	1.9%
Industrial	0.0%	0.3%	2.0%	2.4%	2.2%	1.8%	1.3%	1.1%
Postdisaster Recovery Costs	95.2%	77.4%	64.8%	56.4%	49.4%	42.2%	32.6%	28.0%
Utilities	3.6%	2.9%	2.4%	2.1%	1.9%	1.6%	1.2%	1.1%
Vehicles	0.0%	1.3%	4.1%	5.2%	5.5%	6.0%	6.3%	6.7%
Roads	1.2%	0.5%	0.8%	1.0%	1.2%	1.4%	1.7%	1.8%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-18
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2020 CONDITION
CHIGGER CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$1.6	$139.9	$258.1	$418.1	$620.1	$980.8	$1,699.2	$2,426.1
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$1.2	$4.2	$5.5	$6.5	$8.0	$11.9	$13.9
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$1.6	$141.1	$262.3	$423.6	$626.6	$988.8	$1,711.1	$2,440.0
Postdisaster Recovery Costs	$0.3	$33.7	$58.7	$72.6	$104.6	$169.6	$269.6	$366.9
Utilities	$0.0	$1.3	$2.2	$2.7	$3.9	$6.4	$10.1	$13.8
Vehicles	$0.0	$0.7	$5.6	$18.8	$25.7	$37.9	$65.7	$108.6
Roads	$0.5	$5.5	$9.7	$15.3	$22.4	$35.4	$60.6	$86.3
Total Damages by Event	$2.4	$182.3	$338.6	$533.0	$783.3	$1,238.1	$2,117.1	$3,015.6
Percent Distribution by Event								
Residential	68.6%	76.8%	76.2%	78.5%	79.2%	79.2%	80.3%	80.4%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.7%	1.2%	1.0%	0.8%	0.6%	0.6%	0.5%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	11.1%	18.5%	17.4%	13.6%	13.4%	13.7%	12.7%	12.2%
Utilities	0.4%	0.7%	0.7%	0.5%	0.5%	0.5%	0.5%	0.5%
Vehicles	0.0%	0.4%	1.7%	3.5%	3.3%	3.1%	3.1%	3.6%
Roads	19.9%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-19
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
CLEAR CREEK MAIN STEM
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$1,203.7	$14,218.6	$29,605.4	$47,712.2	$71,948.8	$96,476.5	$139,405.9	$172,331.0
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1,634.1	$1,858.0
Commercial	$40.6	$642.8	$1,691.2	$2,697.2	$4,242.8	$4,792.1	$8,058.3	$10,455.8
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$746.4	$756.1
Damages to Structures, Contents	$1,244.3	$14,861.3	$31,296.6	$50,409.4	$76,191.7	$101,268.6	$149,844.7	$185,400.9
Postdisaster Recovery Costs	$546.2	$5,129.3	$9,466.1	$14,470.2	$20,765.9	$25,581.7	$34,937.0	$41,194.1
Utilities	$20.6	$193.1	$356.4	$544.8	$781.8	$963.1	$1,315.3	$1,550.8
Vehicles	$3.2	$838.5	$2,433.8	$4,835.5	$8,414.9	$11,618.4	$18,743.1	$23,165.9
Roads	$476.3	$897.6	$1,247.1	$1,610.2	$1,960.1	$2,286.0	$4,320.6	$6,186.9
Total Damages by Event	$2,290.6	$21,919.8	$44,800.1	$71,870.0	$108,114.3	$141,717.8	$209,160.7	$257,498.6
Percent Distribution by Event								
Residential	52.5%	64.9%	66.1%	66.4%	66.5%	68.1%	66.7%	66.9%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.7%
Commercial	1.8%	2.9%	3.8%	3.8%	3.9%	3.4%	3.9%	4.1%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.3%
Postdisaster Recovery Costs	23.8%	23.4%	21.1%	20.1%	19.2%	18.1%	16.7%	16.0%
Utilities	0.9%	0.9%	0.8%	0.8%	0.7%	0.7%	0.6%	0.6%
Vehicles	0.1%	3.8%	5.4%	6.7%	7.8%	8.2%	9.0%	9.0%
Roads	20.8%	4.1%	2.8%	2.2%	1.8%	1.6%	2.1%	2.4%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-20
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
MUD GULLY
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$2.5	$214.0	$2,737.4	$9,961.3	$19,240.5	$28,238.2	$41,112.6	$50,572.3
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.1	$1.6	$35.3	$179.4	$436.0	$845.2	$1,123.4
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$2.5	$214.1	$2,739.0	$9,996.6	$19,419.9	$28,674.2	$41,957.7	$51,695.8
Postdisaster Recovery Costs	$0.0	$0.0	$8.8	$1,208.2	$3,423.2	$5,603.2	$8,509.9	$10,786.2
Utilities	$0.0	$0.0	$0.3	$45.5	$128.9	$210.9	$320.4	$406.1
Vehicles	$0.0	$0.0	$0.6	$49.1	$296.4	$942.1	$2,427.9	$4,019.8
Roads	$0.2	$4.1	$40.1	$146.1	$298.3	$459.7	$686.8	$821.6
Total Damages by Event	$2.7	$218.2	$2,788.8	$11,445.5	$23,566.7	$35,890.2	$53,902.7	$67,729.4
Percent Distribution by Event								
Residential	93.5%	98.1%	98.2%	87.0%	81.6%	78.7%	76.3%	74.7%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.1%	0.3%	0.8%	1.2%	1.6%	1.7%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	0.0%	0.3%	10.6%	14.5%	15.6%	15.8%	15.9%
Utilities	0.0%	0.0%	0.0%	0.4%	0.5%	0.6%	0.6%	0.6%
Vehicles	0.0%	0.0%	0.0%	0.4%	1.3%	2.6%	4.5%	5.9%
Roads	6.5%	1.9%	1.4%	1.3%	1.3%	1.3%	1.3%	1.2%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-21
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
TURKEY CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$162.9	$1,554.3	$4,701.0	$10,561.3	$13,121.2	$20,746.0	$29,376.8
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.2	$0.6
Commercial	$0.0	$0.0	$5.9	$22.9	$82.4	$117.5	$183.9	$296.2
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.3	$0.8
Damages to Structures, Contents	$0.0	$162.9	$1,560.2	$4,723.9	$10,643.7	$13,238.8	$20,930.4	$29,674.5
Postdisaster Recovery Costs	$0.0	$17.9	$552.0	$2,531.0	$6,340.0	$7,983.7	$11,766.2	$15,521.6
Utilities	$0.0	$0.7	$20.8	$95.3	$238.7	$300.6	$443.0	$584.3
Vehicles	$0.0	$0.0	$2.7	$50.2	$295.2	$463.6	$1,613.6	$3,951.7
Roads	$3.3	$32.8	$108.7	$149.8	$186.4	$194.0	$225.5	$231.0
Total Damages by Event	$3.3	$214.4	$2,244.4	$7,550.1	$17,704.0	$22,180.6	$34,978.7	$49,963.1
Percent Distribution by Event								
Residential	0.0%	76.0%	69.3%	62.3%	59.7%	59.2%	59.3%	58.8%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.3%	0.3%	0.5%	0.5%	0.5%	0.6%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	8.4%	24.6%	33.5%	35.8%	36.0%	33.6%	31.1%
Utilities	0.0%	0.3%	0.9%	1.3%	1.3%	1.4%	1.3%	1.2%
Vehicles	0.0%	0.0%	0.1%	0.7%	1.7%	2.1%	4.6%	7.9%
Roads	100.0%	15.3%	4.8%	2.0%	1.1%	0.9%	0.6%	0.5%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-22
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
MARYS CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$659.5	$5,515.1	$11,863.1	$27,982.8	$31,484.6	$68,483.3	$79,265.2	$91,583.4
Public	$0.4	$9.3	$26.5	$92.3	$107.9	$613.9	$791.7	$910.1
Commercial	$4.2	$84.0	$440.1	$1,256.6	$1,335.0	$2,636.4	$3,512.0	$4,453.6
Industrial	$0.0	$32.0	$927.8	$6,003.0	$6,048.7	$10,616.5	$17,062.8	$22,497.2
Damages to Structures, Contents	$664.2	$5,640.5	$13,257.6	$35,334.7	$38,976.2	$82,350.1	$100,631.7	$119,444.2
Postdisaster Recovery Costs	$437.8	$2,390.9	$4,456.5	$10,026.8	$10,855.8	$17,569.1	$19,431.4	$21,823.4
Utilities	$16.3	$90.0	$167.8	$377.5	$408.7	$661.4	$731.5	$821.6
Vehicles	$6.1	$131.7	$345.8	$1,390.8	$1,594.6	$8,657.8	$10,782.9	$13,067.8
Roads	$69.9	$331.7	$507.7	$684.1	$715.3	$791.6	$841.8	$848.4
Total Damages by Event	$1,194.2	$8,584.7	$18,735.3	$47,813.9	$52,550.5	$110,030.0	$132,419.4	$156,005.4
Percent Distribution by Event								
Residential	55.2%	64.2%	63.3%	58.5%	59.9%	62.2%	59.9%	58.7%
Public	0.0%	0.1%	0.1%	0.2%	0.2%	0.6%	0.6%	0.6%
Commercial	0.4%	1.0%	2.3%	2.6%	2.5%	2.4%	2.7%	2.9%
Industrial	0.0%	0.4%	5.0%	12.6%	11.5%	9.6%	12.9%	14.4%
Postdisaster Recovery Costs	36.7%	27.9%	23.8%	21.0%	20.7%	16.0%	14.7%	14.0%
Utilities	1.4%	1.0%	0.9%	0.8%	0.8%	0.6%	0.6%	0.5%
Vehicles	0.5%	1.5%	1.8%	2.9%	3.0%	7.9%	8.1%	8.4%
Roads	5.9%	3.9%	2.7%	1.4%	1.4%	0.7%	0.6%	0.5%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-23
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
COWART CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$47.5	$126.1	$281.0	$539.5	$945.3	$1,828.1	$2,596.5
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$13.6	$35.4	$43.6	$50.2	$57.9	$69.8	$79.5
Industrial	$0.0	$1.5	$12.4	$23.0	$30.2	$36.2	$42.6	$47.0
Damages to Structures, Contents	$0.0	$62.6	$173.9	$347.6	$619.9	$1,039.4	$1,940.5	$2,723.0
Postdisaster Recovery Costs	$49.9	$236.6	$386.2	$535.6	$685.4	$839.2	$1,043.2	$1,191.3
Utilities	$1.9	$8.9	$14.5	$20.2	$25.8	$31.6	$39.3	$44.8
Vehicles	$0.0	$5.2	$25.6	$49.8	$78.6	$122.2	$208.2	$290.5
Roads	$0.5	$1.9	$5.4	$10.6	$18.7	$31.2	$57.9	$80.5
Total Damages by Event	$52.3	$315.2	$605.6	$963.8	$1,428.5	$2,063.6	$3,289.0	$4,330.1
Percent Distribution by Event								
Residential	0.0%	15.1%	20.8%	29.2%	37.8%	45.8%	55.6%	60.0%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	4.3%	5.9%	4.5%	3.5%	2.8%	2.1%	1.8%
Industrial	0.0%	0.5%	2.0%	2.4%	2.1%	1.8%	1.3%	1.1%
Postdisaster Recovery Costs	95.4%	75.0%	63.8%	55.6%	48.0%	40.7%	31.7%	27.5%
Utilities	3.6%	2.8%	2.4%	2.1%	1.8%	1.5%	1.2%	1.0%
Vehicles	0.0%	1.6%	4.2%	5.2%	5.5%	5.9%	6.3%	6.7%
Roads	1.0%	0.6%	0.9%	1.1%	1.3%	1.5%	1.8%	1.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 1-24
SINGLE OCCURRENCE DAMAGES BY EVENT
WITHOUT-PROJECT 2070 CONDITION
CHIGGER CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$6.0	$162.7	$284.0	$462.6	$724.4	$1,160.5	$1,965.7	$2,794.5
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$1.5	$4.4	$5.7	$6.9	$9.2	$12.7	$14.6
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$6.0	$164.2	$288.4	$468.2	$731.3	$1,169.7	$1,978.3	$2,809.1
Postdisaster Recovery Costs	$1.0	$38.8	$60.6	$78.5	$122.5	$199.3	$302.9	$436.5
Utilities	$0.0	$1.5	$2.3	$3.0	$4.6	$7.5	$11.4	$16.4
Vehicles	$0.0	$0.9	$8.1	$20.6	$27.9	$41.9	$75.9	$129.1
Roads	$1.0	$6.6	$10.8	$17.4	$27.0	$42.8	$71.5	$89.8
Total Damages by Event	$8.0	$211.9	$370.1	$587.7	$913.3	$1,461.2	$2,440.1	$3,481.0
Percent Distribution by Event								
Residential	74.4%	76.8%	76.7%	78.7%	79.3%	79.4%	80.6%	80.3%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.7%	1.2%	1.0%	0.8%	0.6%	0.5%	0.4%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	12.0%	18.3%	16.4%	13.4%	13.4%	13.6%	12.4%	12.5%
Utilities	0.5%	0.7%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%
Vehicles	0.0%	0.4%	2.2%	3.5%	3.1%	2.9%	3.1%	3.7%
Roads	13.1%	3.1%	2.9%	3.0%	3.0%	2.9%	2.9%	2.6%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

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Enclosure 2
First and Second-Added Analysis Process

First-Added Measures Analysis – Initial Screening of Stand-Alone Features. The first-added measures phase of the formulation process is described in the report entitled *Clear Creek General Reevaluation Report, Flood Damage Reduction, 1st Added Measures Results,* dated July 2004, (see enclosure to the main report). The 1st Added Measures report documents the identification and ranking of individual flood risk mitigation measures analyzed for the Clear Creek GRR study. A total of twenty-four different structural and nonstructural measures were analyzed on a stand-alone basis to determine their costs and benefits. The measures can be grouped into the following broad categories:

Nonstructural measures:

Buyout – Buyout of structures at various frequencies along the main stem of Clear Creek.

Structural measures:

Conveyance measures – Ten measures in three sizes each including channel rectification, clearing and snagging, cutoffs and bypasses, bridge modifications, removal of side-cast dredge material mounds, and increasing the outlet capacity from Clear Lake.

Detention measures – Twelve measures in three sizes each including offline detention and linear detention at sites along the main stem and major tributaries.

Watershed management – Creation of 100 percent effective, basin-wide detention policy for new development.

For the first-added measures analysis, each measure was analyzed without risk and uncertainty using the HEC-FDA program, at 2001 price levels. Early in the screening of measures the decision was made to screen alternatives in the base condition only; the reason being that any measures should be justified in the base condition before moving on to the next step. The analytical results of the first-added measures are shown in the First-Added Measures report, Table 1 – Summary Table.

The results of the first-added measures analysis helped provide insight into the relative effectiveness of the proposed measures. This helped the team plan a strategy for formulating the NED plan, the plan that maximizes net benefits. With the knowledge gained from the first-added process, it was determined that the process for combining and testing measures should begin in the upstream reach of Clear Creek.

Second-Added Measures Analysis - Building a System for Flood Risk Management. The second-added measures phase of the formulation process involved combining measures to arrive at a complete NED plan. The second-added measures process can be separated into four phases for economic purposes. The first phase was conducted at 2001 prices levels and discount rate appropriate at the time, with uncertainty. Not all uncertainty parameters or benefit categories were defined at the time of the first phase, as the analysis and data were continuing to evolve. The second phase was conducted at 2005 price levels and discount rate appropriate at the time. Additional damage categories were added during the second phase of the analysis, as well as additional uncertainty parameters applied, however, the data and analysis was continuing to evolve, with minor damage categories to be added later. The third phase of the second-added analysis was conducted at October 2007 price levels and 4.875 percent discount rate. The fourth phase was initiated in 2008 price levels and discount rate, but was completed in 2010 price levels and at the rate of 4.375 percent. The sequence of competing and aggregating second-added measures is described in detail below.

The second-added measures analysis included optimization and incremental justification of every measure investigated. In this way, poor performing and less-optimal measures were eliminated from further consideration. This phase began with optimization of an upstream anchor component. Additional measures were added sequentially in a downstream direction. The individual measures were tested in three or more sizes. If a measure was optimized and incrementally justified, it was carried through with any previously selected measures to the next step. This systematic approach ensured that the resultant combination of measures improved, economically speaking, with each step, or measure, added.

Measures analyzed in the second-added measures phase of the analysis included:

Nonstructural measures:

Buyout – Buyout of structures at various frequencies along the main stem and tributaries of Clear Creek.

Structural measures:

Conveyance measures – Fourteen conveyance measures on the upstream of the main stem in order to establish the anchor. Three conveyance measures were investigated on Mud Gully. Conveyance improvement investigated on Turkey Creek in five sizes, as well as conveyance improvement on Marys Creek in fourteen sizes. Upper

reach main stem conveyance measures were investigated in five sizes. Mid-reach conveyance measures on the main stem in nine sizes, and lower reach measures on the main stem in eight sizes.

Detention measures – At least seven measures in twenty-five sizes each including offline detention and linear detention at sites along the main stem and major tributaries.

Phase 1 – Second-Added Measures Analysis: This phase began with testing and optimization of an upstream anchor component. Additional measures were added sequentially in a downstream direction. The individual measures were tested in three or more sizes. If a measure was optimized and incrementally justified, it was carried through with any previously selected measures to the next step. This systematic approach ensured that the resultant alternative improved with each step, or measure, added. The specific measures tested are described below and in the Second-Added Measures Notebook (Exhibit 2-4 to the H&H portion of the Engineering Appendix). Table 2-1 illustrates the optimization and incremental analysis of the first phase of the second-added analysis for the main stem and tributaries. Tables 2-2, 2-3 and 2-4 detail the first phase of the second-added measures optimization and incremental analysis for the individual tributaries (Mud, Turkey and Marys, respectively).

Phase 1 of the second-added measures process resulted in optimization of upstream anchor channel improvement on the main stem, additional upstream channelization on the main stem, mid-reach channelization on the main stem, channelization on Mud Gully, channelization on Turkey Creek, and channelization on Marys Creek.

Details of Phase 1 – Second-Added Measures Process:

Step 1: Selection and optimization of Upstream Anchor

- Conveyance improvement on the main stem (SH 288 to Bennie Kate Rd.) (SuperC)
- System testing of conveyance measure combined with detention near Bennie Kate (Super Ca with Detention)
- Shortened bench-cut conveyance measure on Clear Creek (SH288 to BNSF RR) (SuperC Shortened)
- System testing of conveyance measure combined with offline detention near Mykawa (SuperCa with Detention)

Measure Justified/Optimized? Yes, Conveyance improvements on main stem (SuperCd)

Step 2: Test for Clear Creek upper-reach measures

- Linear Detention on Clear Creek from Bennie Kate to Dixie Farm Road (LD4)
- Bench-cut conveyance on Clear Creek from Bennie Kate to Dixie Farm Road (C5)

Measure Justified/Optimized? No

Step 3: Test for measures on Mud Gully

- Conveyance improvement from Sagedowne to Astoria (MUC1)

Measure Justified/Optimized? Yes, Mud conveyance from Sagedowne to Astoria (MUC1b) – for detailed incremental analysis on Mud Gully, Table 2-2.

Step 4: Test for measures on Turkey Creek

- Conveyance improvement from Dixie Farm Road to Mouth (TKC1)

Measure Justified/Optimized? Yes, Turkey conveyance from Dixie Farm Road to Mouth (TKC1d) - for detailed incremental analysis on Turkey, see Table 2-3.

Step 5: Test for measures on Marys Creek

- Conveyance from BN&SF RR to SH 35 (MAC1)
- Conveyance from Harkey Road to SH35 (MAC2)
- Conveyance on Marys Creek By-Pass Channel (MAC3)
- Offline detention at existing West Marys and SWEC Facilities (MAD1)
- System testing of detention measure (MAD1b) combined with 3 sizes of conveyance (MAC2)

Measure Justified/Optimized? Yes, Marys conveyance from Harkey Road to SH35 (MAC2a) - for detailed incremental analysis on Marys Creek, see Table 2-4.

Step 6: Re-test Best Performing Upper Reach Main Stem Measure

- Bench-cut conveyance on Clear from Bennie Kate to Dixie Farm Road (C5d)

  Measure Justified/Optimized? Yes, system effect with other measures in place improved performance of C5d

Step 7: Test for Clear Creek mid-reach measures

- Enlarge existing high-flow bypasses on main stem (EHFB)
- Conveyance improvement on Clear Creek from FM2351 to FM528 (C4)
- Conveyance improvement on Clear Creek (clearing and snagging) from FM2351 to D/S of Chigger Confluence (CS)

  Measure Justified/Optimized? Yes, Conveyance Improvement (clearing and snagging) from FM 2351 to D/S of Chigger confluence (CSb)

Step 8: Test for Clear Creek lower-reach measures

- Conveyance improvement on main stem (enlarge/add to I-45 bridge opening) (I-45)
- Conveyance improvement on main stem (additional Clear Lake outlet capacity) (ACLO)

  Measure Justified/Optimized: No

Table 2-1
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$12,900.0**						
Step 1 - Selection and Optimization of Upstream Anchor Component	SuperCa	$10,034.4	$2,865.5	$44,389.7	$32,152.8	$12,236.9	$789.9	1.38
	SuperCb	$9,879.7	$3,020.3	$46,787.4	$41,689.6	$5,097.8	$329.1	1.12
	SuperCc	$9,845.9	$3,054.1	$47,310.9	$51,281.4	-$3,970.5	-$256.3	0.92
	SuperCd	**$10,533.6**	**$2,366.4**	**$36,658.0**	**$20,724.1**	**$15,933.9**	**$1,028.6**	**1.77**
	SuperCe	$11,814.4	$1,085.6	$16,816.6	$6,861.7	$9,954.9	$642.6	2.45
	SuperCa w/Detention a	$9,333.4	$3,566.6	$55,249.3	$84,192.7	-$28,943.4	-$1,868.4	0.66
	SuperCa w/Detention b	$9,002.1	$3,897.9	$60,381.2	$120,265.8	-$59,884.6	-$3,865.8	0.50
	SuperCa w/Detention c	$8,996.9	$3,903.1	$60,462.6	$156,469.9	-$96,007.3	-$6,197.7	0.39
	SuperC Shortened a	$12,814.6	$85.4	$1,322.3	$2,649.7	-$1,327.4	-$85.7	0.50
	SuperC Shortened b	$12,794.3	$105.6	$1,636.3	$5,180.7	-$3,544.4	-$228.8	0.32
	SuperC Shortened c	$12,698.0	$201.9	$3,128.1	$7,509.4	-$4,381.3	-$282.8	0.42
	Super Ca	$10,034.4	$2,865.5	$44,389.7	$32,152.8	$12,236.9	$789.9	1.38
	with increment detention a	$12,198.9	$701.0	$10,859.6	$52,039.9	-$41,180.3	-$2,658.4	0.21
	with increment detention b	$11,867.7	$1,032.3	$15,991.6	$88,113.0	-$72,121.4	-$4,655.7	0.18
	with increment detention c	$11,862.4	$1,037.6	$16,072.9	$124,317.1	-$108,244.2	-$6,987.6	0.13

Notes: [^1] C5e costs subtracted from all previous C5 sizes to estimate FDR costs only (C5e provided ecosystem restoration only).
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-1 - continued
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$12,900.0**						
Step 2 - Test for Upper Reach Measures	Super Cd + LD4a	$10,337.2	$2,562.8	$39,700.4	$32,274.1	$7,426.3	$479.4	1.23
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment LD4a		$196.4	$3,042.4	$11,550.0	-$8,507.6	-$549.2	0.26
	Super Cd + LD4b	$9,988.8	$2,911.2	$45,097.1	$39,387.6	$5,709.5	$368.6	1.14
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment LD4b		$544.8	$8,439.1	$18,663.5	-$10,224.4	-$660.0	0.45
	Super Cd + LD4c	$9,793.4	$3,106.5	$48,123.0	$48,070.1	$52.8	$3.4	1.00
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment LD4c		$740.1	$11,465.0	$27,346.0	-$15,881.0	-$1,025.2	0.42
	SuperCd + C5a^[1]	$10,187.4	$2,712.5	$42,019.6	$32,119.9	$9,899.7	$639.1	1.31
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment C5a^[1]		$346.1	$5,361.6	$11,395.8	-$6,034.2	-$389.5	0.47
	SuperCd + C5b^[1]	$10,023.4	$2,876.5	$44,560.2	$36,836.6	$7,723.6	$498.6	1.21
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment C5b^[1]		$510.1	$7,902.2	$16,112.5	-$8,210.2	-$530.0	0.49
	SuperCd + C5c^[1]	$9,877.7	$3,022.3	$46,817.7	$41,876.2	$4,941.5	$319.0	1.12
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment C5c^[1]		$655.8	$10,159.7	$21,152.1	-$10,992.4	-$709.6	0.48
	SuperCd + C5d ^[1]	$10,472.8	$2,427.1	$37,598.5	$23,361.9	$14,236.5	$919.0	1.61
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment C5d^[1]		$60.7	$940.5	$2,637.8	-$1,697.4	-$109.6	0.36
	SuperCd + C5e	$11,305.0	$1,594.9	$24,707.1	$20,724.1	$3,982.9	$257.1	1.19
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment C5e (eco_restoration only, no FDR)		-$771.5	-$11,950.9	$0.0	-$11,950.9	-$771.5	

Notes: ^[1] C5e costs subtracted from all previous C5 sizes to estimate FDR costs only (C5e provided ecosystem restoration only).
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-1 – continued
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$12,900.0**						
Steps 3 & 4 - Mud & Turkey (see trib analysis tables)	SuperCd+MUC1b+TKC1d	$9,519.0	$3,381.0	$52,374.3	$34,712.0	$17,662.3	$1,140.2	1.51
	with increment SuperCd	$10,533.6	$2,366.4	$36,658.0	$20,724.1	$15,933.9	$1,028.6	1.77
	with increment MUC1b+TKC1d		**$1,014.6**	**$15,716.3**	**$13,987.9**	**$1,728.4**	**$111.6**	**1.12**
Step 5 - Mary's Creek (see trib analysis table)	SuperCd +MUC1b+TKC1d+MAC2a	$8,054.7	$4,845.3	$75,057.3	$42,055.0	$33,002.3	$2,130.4	1.78
	with increment 2nd Added-SuperCd+MUC1b+TKC1d	$9,519.0	$3,381.0	$52,374.3	$34,712.0	$17,662.3	$1,140.2	1.51
	with increment MAC2a		**$1,464.3**	**$22,683.0**	**$7,343.0**	**$15,340.0**	**$990.3**	**3.09**
Step 6 - Re-Test Best Perform-ing Upper Reach Measure	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment 2nd Added-SuperCd +MUC1b+TKC1d+MAC2a	$8,054.7	$4,845.3	$75,057.3	$42,055.0	$33,002.3	$2,130.4	1.78
	with increment C5d		**$196.5**	**$3,044.6**	**$2,637.8**	**$406.8**	**$26.3**	**1.15**

Notes: ^[1] C5e costs subtracted from all previous C5 sizes to estimate FDR costs only (C5e provided ecosystem restoration only).
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-1 – continued
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$12,900.0**						
Step 7 - Test for Mid-Reach Measures	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a+EHFBa	$7,804.1	$5,095.9	$78,939.7	$45,636.9	$33,302.8	$2,149.8	1.73
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment EHFBa		$54.1	$837.7	$944.1	-$106.3	-$6.9	0.89
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a+EHFBb	$7,789.3	$5,110.7	$79,168.8	$45,908.6	$33,260.2	$2,147.1	1.72
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment EHFBb		$68.9	$1,066.9	$1,215.8	-$148.9	-$9.6	0.88
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a+EHFBc	$7,774.0	$5,126.0	$79,406.6	$46,388.0	$33,018.5	$2,131.5	1.71
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment EHFBc		$84.2	$1,304.6	$1,695.2	-$390.6	-$25.2	0.77
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a + CSa	$7,734.6	$5,165.4	$80,016.6	$45,005.6	$35,011.0	$2,260.1	1.78
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment CSa		$123.6	$1,914.7	$312.8	$1,601.9	$103.4	6.12
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a + CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment CSb		**$706.1**	**$10,937.4**	**$3,682.4**	**$7,255.0**	**$468.3**	**2.97**
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a + CSc	$7,105.4	$5,794.6	$89,763.9	$53,334.3	$36,429.7	$2,351.7	1.68
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment CSc		$752.8	$11,662.0	$8,641.5	$3,020.6	$195.0	1.35
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a + C4a	$6,697.4	$6,202.6	$96,083.3	$58,023.8	$38,059.5	$2,456.9	1.66
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment C4a		$1,160.8	$17,981.4	$13,331.0	$4,650.4	$300.2	1.35
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a + C4b	$6,601.7	$6,298.3	$97,565.9	$61,853.8	$35,712.1	$2,305.4	1.58
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment C4b		$1,256.5	$19,464.0	$17,161.0	$2,303.0	$148.7	1.13
	SuperCd+C5d^[1]+MUC1b+TKC1d+MAC2a + C4c	$6,577.6	$6,322.4	$97,939.6	$65,747.8	$32,191.7	$2,078.1	1.49
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$7,858.2	$5,041.8	$78,101.9	$44,692.8	$33,409.1	$2,156.7	1.75
	with increment C4c		$1,280.6	$19,837.7	$21,055.0	-$1,217.3	-$78.6	0.94

Notes: ^[1] C5e costs subtracted from all previous C5 sizes to estimate FDR costs only (C5e provided ecosystem restoration only).
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-1 – continued
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$12,900.0**						
Step 8 - Test for Lower Reach Measures	SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb+I-45a	$7,148.1	$5,751.9	$89,101.4	$50,138.9	$38,962.5	$2,515.2	1.78
	with increment SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment I-45a		$4.0	$62.1	$1,763.7	-$1,701.6	-$109.8	0.04
	SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb+I-45b	$7,146.2	$5,753.7	$89,130.7	$51,388.0	$37,742.6	$2,436.4	1.73
	with increment SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment I-45b		$5.9	$91.4	$3,012.8	-$2,921.4	-$188.6	0.03
	SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb+I-45c	$7,140.9	$5,759.1	$89,213.5	$52,379.3	$36,834.3	$2,377.8	1.70
	with increment SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment I-45c		$11.3	$174.3	$4,004.1	-$3,829.8	-$247.2	0.04
	SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb+I-45d	$7,150.9	$5,749.1	$89,058.3	$48,666.7	$40,391.7	$2,607.4	1.83
	with increment SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment I-45d		$1.2	$19.1	$291.5	-$272.4	-$17.6	0.07
	SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb+I-45e	$7,133.1	$5,766.8	$89,333.6	$49,742.6	$39,591.0	$2,555.8	1.80
	with increment SuperCd+C5d$^{\wedge 1}$+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment I-45e		$19.0	$294.3	$1,367.4	-$1,073.0	-$69.3	0.22
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb+ACLOa	$6,964.5	$5,935.5	$91,946.0	$59,913.3	$32,032.7	$2,067.8	1.53
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment ACLOa		$187.6	$2,906.7	$11,538.1	-$8,631.4	-$557.2	0.25
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb+ACLOb	$6,936.7	$5,963.3	$92,376.2	$65,682.4	$26,693.8	$1,723.2	1.41
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment ACLOb		$215.4	$3,336.9	$17,307.2	-$13,970.3	-$901.8	0.19
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb+ACLOc	$6,914.8	$5,985.2	$92,715.9	$71,451.4	$21,264.4	$1,372.7	1.30
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb	$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84
	with increment ACLOc		$237.3	$3,676.6	$23,076.2	-$19,399.6	-$1,252.3	0.16
Measures carried forward to Phase 2: SuperCd + C5d$^{\wedge 1}$ + MUC1b + TKC1d + MAC2a + CSb		$7,152.1	$5,747.8	$89,039.3	$48,375.2	$40,664.1	$2,625.0	1.84

Notes: $^{\wedge 1}$ C5e costs subtracted from all previous C5 sizes to estimate FDR costs only (C5e provided ecosystem restoration only).
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-2
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Mud Gully
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, Mud Gully	$1,180.7						
Step 3 - Test for Measures on Mud Gully	MUC1a	$705.3	$475.4	$7,363.6	$5,406.5	$1,957.1	$126.3	1.36
	MUC1b	**$594.8**	**$585.9**	**$9,075.5**	**$6,467.8**	**$2,607.7**	**$168.3**	**1.40**
	MUC1c	$551.1	$629.6	$9,753.1	$7,527.4	$2,225.7	$143.7	1.30

Notes: * Includes main stem effect (downstream of Reach 13)
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-3
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Turkey Creek
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, Turkey Creek	$656.0						
Step 4 - Test for Measures on Turkey Creek	TKC1a	$86.6	$569.4	$8,820.1	$7,357.4	$1,462.7	$94.4	1.20
	TKC1b	$42.6	$613.4	$9,502.1	$10,519.7	-$1,017.5	-$65.7	0.90
	TKC1c	$19.1	$636.9	$9,865.7	$13,717.4	-$3,851.7	-$248.6	0.72
	TKC1d (smaller than a)	**$108.4**	**$547.6**	**$8,482.4**	**$6,152.9**	**$2,329.5**	**$150.4**	**1.38**
	TKC1e (smaller than d)	$149.7	$506.3	$7,843.0	$5,645.0	$2,198.1	$141.9	1.39

Notes: * Includes main stem effect (downstream of Reach 12)
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

Table 2-4
Phase 1 – Optimization and Incremental Justification of Second-Added Measures
Marys Creek
Oct 2001 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 6.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 6.125%	BCR a/b
	Without project condition, Mary's Creek	**$2,944.1**						
Step 5 - Test for Measures on Mary's Creek	MAC1a	$2,237.0	$707.1	$10,953.5	$2,277.6	$8,675.8	$560.1	4.81
	MAC1b	$2,214.4	$729.7	$11,303.6	$4,089.2	$7,214.4	$465.7	2.76
	MAC1c	$2,163.0	$781.0	$12,098.6	$5,899.4	$6,199.1	$400.2	2.05
	MAC2a	**$1,489.6**	**$1,454.4**	**$22,530.4**	**$7,343.0**	**$15,187.4**	**$980.4**	**3.07**
	MAC2b	$1,359.5	$1,584.6	$24,546.9	$12,676.0	$11,870.9	$766.3	1.94
	MAC2c	$1,259.9	$1,684.1	$26,088.9	$18,032.0	$8,056.9	$520.1	1.45
	MAC2d	$1,129.1	$1,815.0	$28,115.7	$21,323.0	$6,792.7	$438.5	1.32
	MAC2e	$1,574.8	$1,369.3	$21,211.5	$8,312.4	$12,899.1	$832.7	2.55
	MAC3a	$2,937.1	$7.0	$108.3	$668.6	-$560.3	-$36.2	0.16
	MAC3b	$2,548.5	$395.5	$6,127.3	$1,112.7	$5,014.5	$323.7	5.51
	MAC3c	$2,426.4	$517.7	$8,019.3	$1,577.1	$6,442.2	$415.9	5.08
	MAD1a	$2,275.4	$668.6	$10,357.5	$7,189.5	$3,168.1	$204.5	1.44
	MAD1b	$1,831.3	$1,112.7	$17,237.2	$12,295.5	$4,941.7	$319.0	1.40
	MAD1c	$1,366.9	$1,577.1	$24,431.0	$22,460.7	$1,970.3	$127.2	1.09

Notes: * Includes main stem effect (downstream of Reach 11)
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (6.125%, 50-yr)
AAEV = Average Annual Equivalent Value (6.125%, 50-yr)
Not all damage categories included, not all uncertainty parameters defined at this early stage of analysis.
Screening level cost estimates provided by Cost Engineering.

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Phase 2 – Second-Added Measures Analysis: Phase 2 of the second-added measures analysis was simply a continuation of the phase 1, however, price levels and discount rates were updated to 2005 levels. All risk parameters were applied during this phase and all but the minor category of damages to roads were included. The phase 1 analysis resulted in a complete channelization project, so phase 2 would focus on feasibility of the addition of detention measures.

This phase began with re-evaluation of the mid-reach measure, Clearing and Snagging (CSb). An in-depth environmental analysis was conducted by the Inter-Agency Coordination Team (ICT) on this particular measure due to the environmentally pristine nature of the area. The environmental analysis revealed that the mitigation costs would be significantly higher than the preliminary estimate, resulting in failure of the measure to be incrementally justified. Therefore, Clearing and Snagging (CSb) was dropped from further consideration. Of note is the fact that the measure C4 from the phase 1 analysis was also dropped from further consideration because the measure has the same footprint in the same reach.

The specific measures tested in phase 2 are described below. Table 2-5 illustrates the optimization and incremental analysis of the second phase of the second-added analysis. Tables 2-6, 2-7 and 2-8 detail the second phase of the second-added measures optimization and incremental analysis for the tributaries (Mud, Chigger and Marys, respectively).

Phase 2 of the second-added measures process resulted in removal of one of the previously selected measures, clearing and snagging, from the mid-reach of the main stem, addition of detention on Mud Gully, addition of inline and offline detention on the main stem, as well as detention on Marys Creek.

Details of Phase 2 – Second-Added Measures Process:

Step 1: Re-evaluation of selected Clear Creek mid-reach measures due to detailed environmental analysis

- Conveyance improvement on Clear Creek (clearing and snagging) from FM 2351 to D/S of Chigger Confluence (CS) – size CSb optimized in Phase 1. Re-evaluated sizes CSa & CSb with revised environmental mitigation estimates.

  Measure Justified/Optimized? No, resulting in CSb removed from further consideration

Step 2: Test for additional measures on Mud Gully

- Offline detention on Mud Gully (Mud Det) (for detailed incremental analysis on Mud Creek see Table 2-6)

  Measure Justified/Optimized? Yes, 1,515 acre-foot detention, representing largest size detention size analyzed; size is limited by the maximum available capacity at the site (Mud Det C).

Step 3: Test for measures on Chigger Creek

- Inline detention on Chigger Creek (Chig Det) (for detailed incremental analysis on Chigger Creek, see Table 2-7)

  Measure Justified/Optimized? No

Step 4: Test for additional measures on Clear Creek

- Inline and offline detention on Clear Creek (tested as one measure in three sizes (a, b & c) and three roughness coefficients (rough, average, & smooth), for a total of 9 combinations). The naming convention for the measure is as follows: ClrCrk Det rough-a (rough, size a), ClrCrk Det average-b (average roughness, size b), etc.

  Measure Justified/Optimized? Yes, ClrCrk Det smooth-b (smooth, size b)

Step 5: Test for additional measures on Marys Creek

- Offline detention on Marys Creek (incorporation of percentage of existing detention sites, SWEC and West Marys) (MAD1) (for detailed incremental analysis on Marys Creek, see Table A-8)

  Measure Justified/Optimized? Yes, 857 acre-feet detention (representing 75 percent of existing SWEC and West Marys sites) (Size MAD1b1/2)

Table 2-5

Phase 2 – Optimization and Incremental Justification of Second-Added Measures

Clear Creek – Main Stem and Tributaries

Oct 2005 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 5.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 5.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$37,157.0**						
	End of Phase 1: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb (with revised environmental analysis)	**$21,074.5**	**$16,082.6**	**$288,021.6**	**$120,402.7**	**$167,618.9**	**$9,359.5**	**2.39**
Step 1 - Re-evaluation of mid-reach measures using detailed environmental analysis	End of Phase 1: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSb (with revised environmental analysis)	$21,074.5	$16,082.6	$288,021.6	$120,402.7	$167,618.9	$9,359.5	2.35
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	**$22,710.3**	**$14,446.7**	**$258,725.3**	**$64,448.4**	**$194,276.9**	**$10,848.0**	**4.01**
	with increment CSb (with revised environmental analysis)		$1,635.9	$29,296.3	$55,954.3	-$26,658.0	-$1,488.5	0.52
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+CSa (with revised environmental analysis)	$22,426.4	$14,730.6	$263,809.1	$92,452.9	$171,356.2	$9,568.2	2.85
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$22,710.3	$14,446.7	$258,725.3	$64,448.4	$194,276.9	$10,848.0	4.01
	with increment CSa		$283.9	$5,083.8	$28,004.5	-$22,920.7	-$1,279.8	0.18
Step 2 - Test add'l measures on Mud (see trib analysis table)	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$22,710.3	$14,446.7	$258,725.3	$64,448.4	$194,276.9	$10,848.0	4.01
	with increment Mud Det C (largest capacity available at site)		**$1,557.2**	**$27,887.4**	**$25,790.1**	**$2,097.3**	**$117.1**	**1.08**
Step 3 - Test measures on Chigger Creek (see trib analysis table)	No measures justified - see Phase 2 table for Chigger Creek for details							

Notes: Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (5.125%, 50-yr)
AAEV = Average Annual Equivalent Value (5.125%, 50-yr)
All damage categories included, except roads.
Calculated with risk & uncertainty.
Screening level cost estimates provided by Cost Engineering.

Table 2-5 - continued
Phase 2 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2005 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 5.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 5.125%	BCR a/b
	Without project condition, mainstem and tributaries	**$37,157.0**						
Step 4 - Test for additional measures on Clear Creek	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det average-a	$19,190.4	$17,966.6	$321,762.2	$124,337.6	$197,424.6	$11,023.8	2.59
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det average-a		$1,962.7	$35,149.5	$34,099.1	$1,050.4	$58.7	1.03
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det average-b	$17,649.6	$19,507.5	$349,357.5	$146,102.5	$203,255.0	$11,349.4	2.39
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det average-b		$3,503.6	$62,744.8	$55,864.0	$6,880.8	$384.2	1.12
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det average-c	$16,741.7	$20,415.3	$365,615.8	$195,803.5	$169,812.2	$9,482.0	1.87
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det average-c		$4,411.4	$79,003.1	$105,565.0	-$26,561.9	-$1,483.2	0.75
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det rough-a	$19,951.9	$17,205.1	$308,124.9	$125,235.5	$182,889.5	$10,212.2	2.46
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det rough-a		$1,201.2	$21,512.2	$34,996.9	-$13,484.7	-$753.0	0.61
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det rough-b	$18,435.1	$18,721.9	$335,289.4	$147,000.4	$188,289.0	$10,513.7	2.28
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det rough-b		$2,718.0	$48,676.6	$56,761.9	-$8,085.2	-$451.5	0.86
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det rough-c	$17,423.0	$19,734.0	$353,415.2	$196,701.4	$156,713.7	$8,750.6	1.80
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det rough-c		$3,730.1	$66,802.5	$106,462.9	-$39,660.4	-$2,214.6	0.63
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-a	$18,635.6	$18,521.4	$331,698.3	$123,482.8	$208,215.4	$11,626.3	2.69
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det smooth-a		$2,517.5	$45,085.5	$33,244.3	$11,841.2	$661.2	1.36
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b	$17,157.2	$19,999.9	$358,175.9	$145,247.8	$212,928.1	$11,889.5	2.47
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det smooth-b		**$3,996.0**	**$71,563.2**	**$55,009.2**	**$16,553.9**	**$924.3**	**1.30**
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-c	$16,624.2	$20,532.9	$367,721.7	$194,948.8	$172,772.9	$9,647.3	1.89
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C	$21,153.1	$16,003.9	$286,612.7	$90,238.5	$196,374.2	$10,965.2	3.18
	with increment ClrCrk Det smooth-c		$4,529.0	$81,109.0	$104,710.3	-$23,601.3	-$1,317.8	0.77
Step 5 - Test additional measures on Mary's (see trib analysis table)	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,035.7	$22,121.4	$396,170.0	$165,434.8	$230,735.2	$12,883.8	2.39
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b	$17,157.2	$19,999.9	$358,175.9	$145,247.8	$212,928.1	$11,889.5	2.47
	with increment MAD1B1/2		**$2,121.5**	**$37,994.2**	**$20,187.1**	**$17,807.1**	**$994.3**	**1.88**

Notes: Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (5.125%, 50-yr)
AAEV = Average Annual Equivalent Value (5.125%, 50-yr)
All damage categories included, except roads.
Calculated with risk & uncertainty.
Screening level cost estimates provided by Cost Engineering.

Table 2-6
Phase 2 – Optimization and Incremental Justification of Second-Added Measures
Mud Gully
Oct 2005 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 5.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 5.125%	BCR a/b
	Without project condition, Mud Gully	$3,248.1						
Phase 1	**MUC1b**	**$1,831.5**	**$1,416.6**	**$25,369.8**	**$7,835.0**	**$17,534.8**	**$979.1**	**3.24**
Step 2 - Test additional measures on Mud Gully	MUC1b+Mud Det A	$1,407.8	$1,840.3	$32,957.8	$16,509.5	$16,448.3	$918.4	2.00
	with increment MUC1b	$1,831.5	$1,416.6	$25,369.8	$7,835.0	$17,534.8	$979.1	3.24
	with increment Mud Det A		$423.7	$7,588.0	$8,674.4	-$1,086.4	-$60.7	0.87
	MUC1b+Mud Det B	$938.9	$2,309.3	$41,356.2	$25,037.2	$16,319.0	$911.2	1.65
	with increment MUC1b	$1,831.5	$1,416.6	$25,369.8	$7,835.0	$17,534.8	$979.1	3.24
	with increment Mud Det B		$892.7	$15,986.4	$17,202.2	-$1,215.7	-$67.9	0.93
	MUC1b+Mud Det C	$121.3	$3,126.8	$55,997.6	$33,625.1	$22,372.5	$1,249.2	1.67
	with increment MUC1b	$1,831.5	$1,416.6	$25,369.8	$7,835.0	$17,534.8	$979.1	3.24
	with increment Mud Det C (largest capacity available at site)		**$1,710.2**	**$30,627.8**	**$25,790.1**	**$4,837.7**	**$270.1**	**1.19**

Notes: Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (5.125%, 50-yr)
AAEV = Average Annual Equivalent Value (5.125%, 50-yr)
All damage categories included, except roads.
Calculated with risk & uncertainty.
Screening level cost estimates provided by Cost Engineering.

Table 2-7
Phase 2 – Optimization and Incremental Justification of Second-Added Measures
Chigger Creek
Oct 2005 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 5.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 5.125%	BCR a/b
	Without project condition	**$3,759.7**						
Step 3 - Test measures on Chigger	Chig Det A	$3,571.5	$188.1	$3,369.4	$4,826.4	-$1,457.0	-$81.4	0.70
	Chig Det B	$3,550.8	$208.9	$3,740.6	$9,593.2	-$5,852.5	-$326.8	0.39
	Chig Det C	$3,532.4	$227.3	$4,069.8	$14,411.9	-$10,342.1	-$577.5	0.28

Notes: Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (5.125%, 50-yr)
AAEV = Average Annual Equivalent Value (5.125%, 50-yr)
All damage categories included, except roads.
Calculated with risk & uncertainty.
Screening level cost estimates provided by Cost Engineering.

Table 2-8
Phase 2 – Optimization and Incremental Justification of Second-Added Measures
Marys Creek
Oct 2005 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands 5.125% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 5.125%	BCR a/b
	Without project condition	**$8,674.3**						
Phase 1	**MAC2a**	**$4,558.9**	**$4,115.3**	**$73,701.2**	**$8,537.7**	**$65,163.5**	**$3,638.6**	**8.63**
Step 4 -Test additional measures on Mary's Creek	MAC2a + MAD1a (25%)*	$3,709.6	$4,964.6	$88,910.8	$16,695.9	$72,214.9	$4,032.3	5.33
	with increment MAC2a	$4,558.9	$4,115.3	$73,701.2	$8,537.7	$65,163.5	$3,638.6	8.63
	with increment MAD1a (25%)*		$849.3	$15,209.7	$8,158.2	$7,051.5	$393.7	1.86
	MAC2a + MAD1b (50%)*	$3,019.3	$5,654.9	$101,273.9	$23,155.8	$78,118.1	$4,362.0	4.37
	with increment MAC2a	$4,558.9	$4,115.3	$73,701.2	$8,537.7	$65,163.5	$3,638.6	8.63
	with increment MAD1b (50%)*		$1,539.6	$27,572.8	$14,618.1	$12,954.7	$723.4	1.89
	MAC2a + MAD1b1/2 (75%)*	$2,530.1	$6,144.1	$110,035.0	$28,725.5	$81,309.4	$4,540.2	3.83
	with increment MAC2a	$4,558.9	$4,115.3	$73,701.2	$8,537.7	$65,163.5	$3,638.6	8.63
	with increment MADb1/2 (75%)*		**$2,028.8**	**$36,333.8**	**$20,187.8**	**$16,146.0**	**$901.6**	**1.80**
	MAC2a + MAD1d (12.5%)*	$4,315.9	$4,358.3	$78,052.7	$12,358.9	$65,693.8	$3,668.2	6.32
	with increment MAC2a	$4,558.9	$4,115.3	$73,701.2	$8,537.7	$65,163.5	$3,638.6	8.63
	with increment MAD1d (12.5%)*		$243.0	$4,351.5	$3,821.2	$530.4	$29.6	1.14
	MAC2a + MAD1e (5%)*	$4,506.5	$4,167.8	$74,639.9	$10,274.2	$64,365.7	$3,594.1	7.26
	with increment MAC2a	$4,558.9	$4,115.3	$73,701.2	$8,537.7	$65,163.5	$3,638.6	8.63
	with increment MAD1e (5%)*		$52.4	$938.8	$1,736.5	-$797.8	-$44.5	0.54
	MAC2a + MAD Large Det (200%)*	$2,420.8	$6,253.5	$111,993.1	$68,579.4	$43,413.7	$2,424.1	1.63
	with increment MAC2a	$4,558.9	$4,115.3	$73,701.2	$8,537.7	$65,163.5	$3,638.6	8.63
	with increment MAD Large Det (200%)*		$2,138.2	$38,292.0	$60,041.7	-$21,749.7	-$1,214.5	0.64

Notes: *Percent of SWEC and West Marys existing detentions
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (5.125%, 50-yr)
AAEV = Average Annual Equivalent Value (5.125%, 50-yr)
All damage categories included, except roads.
Calculated with risk & uncertainty.
Screening level cost estimates provided by Cost Engineering

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Phase 3 – Second-Added Measures Analysis: The third phase of the second-added measures process began with Mii cost estimate of the phase 2 optimized structural plan to-date. The Mii estimate is over two times higher than the planning level estimate, however, the overall project remained justified. In addition, the right-of-way buyouts necessary for implementation of the optimized structural plan were isolated and captured as a project benefit, however minimal. Phase 3 was conducted at Oct 2007 price levels and at the current 4.875% discount rate. All risk parameters were applied during this phase and the damage category of roads was added.

Phase 3 continued with re-evaluation of nonstructural buyouts as a first-added measure. Nonstructural measures were investigated early in the study, but many changes and updates were made over time, therefore re-analysis was deemed necessary. Nonstructural measures generally work best in frequent, deep flooding events. The flooding that occurs in the Clear Creek watershed is frequent but shallow due to the nature of the floodplain. Detailed discussion and analysis of nonstructural measures can be found in Enclosure 3.

Buyouts were considered both as stand-alone alternatives and with the optimized structural plan in place (i.e. the phase 2 optimized plan plus residual flood plain buyout). Buyouts were formulated by flood zone, specifically 0-2-year, 0-5-year and 0-10-year buyouts. Buyout of the 0-25-year flood zone was not analyzed as experience has proven that buyout to be unjustifiable.

The buyout analysis was further broken down by analyzing the plans by varying levels of participation. For example, buyout as a stand-alone measure is more likely to be a "mandated" buyout, while buyout in addition to a structural plan would be much less likely to be "mandated." It is highly unlikely that there would be 100 percent participation in any case; therefore, the highest level of participation for the high-most likely-low ranges is 95 percent, in the case of a without-project buyout of flood plain structures. All ranges of participation and results are detailed in Table 2-9 below.

The specific measures tested in phase 3 are described below. Table 2-9 illustrates the optimization and incremental analysis of the third phase of the second-added analysis.

Details of Phase 3 – Second-Added Measures Process:

Step 1: Update of Optimized Structural Plan Costs with Mii Cost Estimate

- Mii estimate prepared for optimized structural measures – Upstream Anchor Main Stem Conveyance (SuperCd), Upstream Main Stem Conveyance (C5d) , Marys

Conveyance (MAC2a), Turkey Conveyance (TKC1d), Mud Conveyance, (MUC1b), Main Stem Inline and Offline Detention (Clr Crk Det smooth-b), Mud Detention (Mud Det C), Marys Detention (MAD1b1/2)

Measure Justified? Yes

Step 2: Nonstructural Analysis (stand-alone buyout)

- Buyout of the 2-, 5- and 10-year flood zones as first-added measures (i.e. without-project in place) (Tested at various levels of participation)

  Measure Justified/Optimized? No

Step 3: Nonstructural Analysis (with GRR Plan in Place)

- Buyout of the residual 2-, 5- and 10-year flood plain (i.e. with the optimized structural plan in place) (Tested at various levels of participation)

  Measure Justified/Optimized? No

Table 2-9
Phase 3 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2007 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 4.875% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 4.875%	BCR a/b
	Without project condition, mainstem and tributaries	**$39,187.7**						
Step 1 - Mii Estimate	Phase 2 Optimized Structural Plan w/Mii Cost Estimate: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
Step 2 - Nonstructural Analysis - Test of buyout by zone as Stand-Alone Project at various levels of participation	100% Participation Buyout - 0-2 yr (w/o project) 5 structures	$39,058.8	$128.9	$2,398.8	$15,560.4	($13,161.6)	($707.1)	0.15
	100% Participation Buyout - 0-5 yr (w/o project) - 176 structures	$36,466.0	$2,721.7	$50,662.4	$80,944.0	($30,281.6)	($1,626.8)	0.63
	100% Participation Buyout - 0-10 yr (w/o project) - 549 structures	$32,456.1	$6,731.6	$125,302.8	$235,043.4	($109,740.7)	($5,895.5)	0.53
	High Participation 95% Buyout - 0-2 yr (w/o project)	$39,065.2	$122.4	$2,278.9	$15,407.9	($13,129.0)	($705.3)	0.15
	High Participation 95 % Buyout - 0-5 yr (w/o project)	$36,602.0	$2,585.6	$48,129.3	$77,941.5	($29,812.2)	($1,601.6)	0.62
	High Participation 95% Buyout - 0-10 yr (w/o project)	$32,792.7	$6,395.0	$119,037.6	$225,913.3	($106,875.7)	($5,741.6)	0.53
	Most Likely Participation 85% Buyout - 0-2 yr (w/o project)	$39,078.1	$109.5	$2,039.0	$15,102.9	($13,063.9)	($701.8)	0.14
	Most Likely Participation 85% Buyout - 0-5 yr (w/o project)	$36,874.2	$2,313.4	$43,063.0	$71,936.6	($28,873.5)	($1,551.2)	0.60
	Most Likely Participation 85% Buyout - 0-10 yr (w/o project)	$33,465.8	$5,721.8	$106,507.3	$207,653.2	($101,145.8)	($5,433.8)	0.51
	Low Participation 75% Buyout - 0-2 yr (w/o project)	$39,091.0	$96.7	$1,799.1	$14,798.0	($12,998.8)	($698.3)	0.12
	Low Participation 75% Buyout - 0-5 yr (w/o project)	$37,146.4	$2,041.3	$37,996.8	$65,931.7	($27,934.9)	($1,500.7)	0.58
	Low Participation 75% Buyout - 0-10 yr (w/o project)	$34,139.0	$5,048.7	$93,977.1	$189,393.0	($95,416.0)	($5,126.0)	0.50

Notes: Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (4.875%, 50-yr)
AAEV = Average Annual Equivalent Value (4.875%, 50-yr)
All damage categories included.
Calculated with risk & uncertainty.
Mii for optimized structural plan by Cost Engineering.

Table 2-9 - continued
Phase 3 – Optimization and Incremental Justification of Second-Added Measures
Clear Creek – Main Stem and Tributaries
Oct 2007 price levels

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced* in thousands	PWE Damages Reduced in thousands 4.875% a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits 4.875%	BCR a/b
	Without project condition, mainstem and tributaries	**$39,187.7**						
Step 3 - Nonstructural Analysis - Test of buyout by zone in Addition to Optimized Structural Plan at various levels of participation	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + 100% 0-5-yr Buyout (27 structures)	$15,545.7	$23,642.0	$440,077.7	$385,025.2	$55,052.5	$2,957.5	1.14
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment 100% 0-5-yr Buyout (27 structures)		$430.8	$8,019.2	$9,441.2	($1,422.0)	($76.4)	0.85
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + 100% 0-10-yr Buyout (136 structures)	$14,457.4	$24,730.3	$460,335.1	$419,959.0	$40,376.1	$2,169.1	1.10
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment 100% 0-10-yr Buyout (136 structures)		$1,519.1	$28,276.5	$44,374.9	($16,098.4)	($864.8)	0.64
				$0.0				
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + High Participation 75% 0-5-yr Buyout	$15,653.4	$23,534.3	$438,072.9	$382,748.0	$55,324.9	$2,972.2	1.14
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment High Participation 75% 0-5-yr Buyout		$323.1	$6,014.4	$7,164.0	($1,149.6)	($61.8)	0.84
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + High Participation 75% 0-10-yr Buyout	$14,837.2	$24,350.5	$453,265.9	$410,088.9	$43,177.0	$2,319.6	1.11
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment High Participation 75% 0-10-yr Buyout		$1,139.3	$21,207.4	$34,504.8	($13,297.4)	($714.4)	0.61
				$0.0				
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + Most Likely Participation 50% 0-5-yr Buyout	$15,761.1	$23,426.6	$436,068.1	$380,470.8	$55,597.3	$2,986.8	1.15
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Most Likely Participation 50% 0-5-yr Buyout		$215.4	$4,009.6	$4,886.8	($877.2)	($47.1)	0.82
				$0.0				
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + Most Likely Participation 50% 0-10-yr Buyout	$15,217.0	$23,970.7	$446,196.8	$400,218.8	$45,978.0	$2,470.0	1.11
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Most Likely Participation 50% 0-10-yr Buyout		$759.5	$14,138.3	$24,634.8	($10,496.5)	($563.9)	0.57
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + Low Participation 25% 0-5-yr Buyout	$15,868.8	$23,318.9	$434,063.3	$378,193.6	$55,869.7	$3,001.4	1.15
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Low Participation 25% 0-5-yr Buyout		$107.7	$2,004.8	$2,609.6	($604.8)	($32.5)	0.77
	SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 + Low Participation 25% 0-10-yr Buyout	$15,596.7	$23,590.9	$439,127.7	$390,348.8	$48,778.9	$2,620.5	1.12
	with increment SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Low Participation 25% 0-10-yr Buyout		$379.8	$7,069.1	$14,764.7	($7,695.6)	($413.4)	0.48

Notes: Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (4.875%, 50-yr)
AAEV = Average Annual Equivalent Value (4.875%, 50-yr)
All damage categories included.
Calculated with risk & uncertainty.
Mii for optimized structural plan by Cost Engineering.

Phase 4 – Second-Added Measures Analysis: Phase 4 of the second-added measures process began with reevaluation of individual detention components. As mentioned, the Mii cost estimates significantly increased from the screening level cost estimates for the detentions. As such, it was necessary to reconfirm the individual viability of the detention elements. Further analysis revealed that the offline detention elements on Mud Gully and the main stem were no longer incrementally justified while all other components remain viable. Reevaluation of the detentions was conducted at Oct 2007 price levels and at 4.875 percent discount rate.

Phase 4 continued with update of price levels to October 2009 and the current discount rate of 4.375 percent, as well as removal of Marys detentions as a component of the Federal project. Guidance was provided through the review process, which required existing Marys Detentions to be analyzed under Section 575. In addition, further guidance required the inclusion of the Clear Lake Second Outlet in both the without and with-project condition. The exclusion of the Second Outlet did not affect plan formulation.

The results of additional analysis in phase 4 are described below. Table 2-10 illustrates the optimization and incremental analysis of the fourth phase of the second-added analysis.

Details of Phase 4 – Second-added Measures Process:

Step 1: Reevaluation of Detention Components with Mii Cost Estimate

- Incremental analysis of detention components due to significant increase in Mii estimates – Main Stem Offline Detention (Clr Crk Det smooth-b), Mud Detention (Mud Det C)

  Measures Justified? No

Step 2: Update Price Levels, Discount Rate and remove Existing Marys Detentions (analyzed under Section 575), include Second Outlet and Gate Structure in both the without- and with-project conditions.

- Arrive at Tentatively Recommended Plan – comprised of Upstream Anchor Main Stem Conveyance (SuperCd), Upstream Main Stem Conveyance (C5d) , Marys Conveyance (MAC2a), Turkey Conveyance (TKC1d), Mud Conveyance, (MUC1b), Main Stem Inline Detention

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Table 2-10

Phase 4 – Optimization and Incremental Justification of Second-Added Measures

Clear Creek – Main Stem and Tributaries

Oct 2007 and Oct 2009 price levels and Discount Rates

Formulation Sequence	Plan Description/Measure Added	2020 Expected Annual Damages in thousands	Net Expected Annual Damages Reduced in thousands	PWE Damages Reduced in thousands a	Total Project Cost in thousands b	net excess benefits a-b	AAEV net excess benefits	BCR a/b
	Without project condition, mainstem and tributaries (FY08 Price Levels)	**$39,187.7**						
Optimized Plan (thru Phase 3)	Phase 2 Optimized Structural Plan w/Mii Cost Estimate: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 (FY08 Price levels and 4.875%)	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
Step 1 - Remove Detentions based upon Revised Cost Estimates	Phase 2 Optimized Structural Plan w/Mii Cost Estimate: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 (FY08 Price levels and 4.875%)	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Optimized Stuctural Plan minus Mud Detention (Mud Det C) (FY08 Price Levels and 4.875%)	$17,222.5	$21,965.2	$408,864.8	$339,428.1	$69,436.7	$3,730.3	1.20
	with increment Mud Detention (Mud Det C) (FY08 Price Levels and 4.875%)		$1,246.0	$23,193.7	$36,156.0	-$12,962.2	-$696.4	0.64
	Phase 2 Optimized Structural Plan w/Mii Cost Estimate: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 (FY08 Price levels and 4.875%)	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Optimized Structural Plan minus Mainstem Offline Detention (ClrCrk Det smooth-b) (FY08 Price levels and 4.875%)	$18,195.5	$20,992.2	$390,753.1	$323,270.7	$67,482.4	$3,625.3	1.21
	with increment Mainstem Offline Detention (ClrCrk Det smooth-b) (FY08 Price Levels and 4.875%)		$2,219.0	$41,305.4	$52,313.3	-$11,007.9	-$591.4	0.79
	Phase 2 Optimized Structural Plan w/Mii Cost Estimate: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a+Mud Det C+ClrCrk Det smooth-b+MAD1b1/2 (FY08 Price levels and 4.875%)	$15,976.5	$23,211.2	$432,058.5	$375,584.1	$56,474.5	$3,033.9	1.15
	with increment Optimized Structural Plan minus Mud Detention (Mud Det C) and Mainstem Offline Detention (ClrCrk Det smooth-b) (FY08 Price levels and 4.875%)	**$19,110.8**	**$20,076.9**	**$373,715.5**	**$210,929.2**	**$162,786.4**	**$8,745.3**	**1.77**
	with increment Mud Detention (Mud Det C) and Mainstem Offline Detention (ClrCrk Det smooth-b) (FY08 Price Levels and 4.875%)		$3,134.3	$58,343.0	$164,654.9	-$106,311.9	-$5,711.3	0.35

Formulation Sequence	Plan Description/Measure Added	Average Annual Equivalent Damages in thousands Oct 09 prices @ 4.375%	Average Annual Equivalent Damages Reduced in thousands	PWE Damages Reduced @ 4.375% in thousands a	Total_Project_Cost in thousands (including IDC & O&M) b	net excess benefits a-b	AAEV net excess benefits	BCR a/b
	Without project conditions, mainstem and tributaries (updated to FY10 Price Levels and 4.375%)	**$42,031.0**						
Step 2- Update of Tentatively Recommended Plan	NED Plan: SuperCd+C5d^1+MUC1b+TKC1d+MAC2a	$22,057.0	$19,974.0	$402,887.1	$215,174.5	$187,712.6	$9,306.3	1.87

Notes: Does not include NFIP costs/benefits.
Only FDR features modeled for NED benefit analysis.
PWE = Present worth equivalent (4.875%, 50-yr)
AAEV = Average Annual Equivalent Value (4.875%, 50-yr)
All damage categories included.
Calculated with risk & uncertainty.
Mii for optimized structural plan by Cost Engineering.

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Enclosure 3
Details of Nonstructural Analysis

Nonstructural Analysis. As previously mentioned, nonstructural measures were investigated early in the first-added measures phase of the study, but with the many changes and updates made over time, in-depth analysis, including the tributaries, was deemed necessary. In addition, nonstructural measures were analyzed as an addition to the optimized structural measures. Nonstructural measures generally work best in frequent, deep flooding events. The flooding that occurs in the Clear Creek watershed is frequent but shallow due to the nature of the floodplain. The final nonstructural analysis was conducted at 2007 price levels and a discount rate of 4.875 percent.

Raising-in-place and relocation were considered initially, however, most of the structures within the floodplain are residential and slab-on-grade foundation. While not impossible to raise slab-on-grade structures, experience has shown the costs to be prohibitive. Costs obtained from the National Flood Proofing Committee show estimates in excess of $100 thousand per structure, just for the physical raising. Raising-in-place is also less desirable as it does not eliminate residual damages to the structures, leaving homes vulnerable to infrequent, but damaging events (i.e. 100-year event would still cause damage). In the event of frequent events, the homeowners may become stranded when their home is surrounded by water.

Wet flood proofing is not appropriate for residential structures but can be used in the case of out-buildings, storage, garages, agricultural-related structures, and structures whose functions are tied to the water. Dry flood proofing may be appropriate for residential structures; however, the property must have adequate space to accommodate a floodwall or berm. Finally, dry flood proofing requires active participation of the homeowner and may actually put them at greater risk. The homeowner may choose to stay behind in order to activate the flood proofing closures and because of the sense that their home is “safe” from the on-coming flood waters because they have flood proofing. Residual risks also remain with flood proofing as the structure and contents still remain in the floodplain. For these reasons, flood proofing was not considered the optimal nonstructural choice for residential properties.

Section 73 of the WRDA of 1974 requires consideration of nonstructural alternatives in flood damage reduction studies. Section 219 of the WRDA of 1999 directs the USACE to calculate benefits for nonstructural flood damage mitigation projects using methods similar to those used in calculating the benefits for structural projects, including similar treatment in calculating the benefits from losses avoided. It further states that in carrying out this directive, the USACE should avoid double counting of benefits.

Previous USACE guidance directed the use of only the externalized portion of flood damages

prevented in calculating benefits for evacuation projects. The guidance was based on the fact that the internalized portion of flood damages is reflected in the reduced market value of the properties used in the calculation of evacuation costs, the cost of buyout of the floodplain. The internalized portion of flood damages includes uninsured losses, flood insurance premiums and deductible as well as agent's fees. Typically, externalized flood damages were estimated by calculating total flood damages using standard depreciated replacement cost techniques as in structural flood control projects and then subtracting the internalized portion of flood damages. The subtraction of the internalized portion of flood damages was intended to remove potential double counting from the benefit-cost calculation. The following new implementation procedures, which avoid double counting internalized costs, were used in development of the costs and benefits for buyout alternatives on Clear Creek.

Per the implementing guidance associated with Section 219 (a) of WRDA of 1999, flood damage mitigation benefits for evacuation projects were calculated as the total flood damages reduced. No correction was made to remove the internalized portion of flood damages in the benefit calculation.

In accordance with Section 219, the economic analysis for evacuation alternatives utilized comparable flood-free land costs in the valuation of floodplain land. Flood-free land cost is the cost of comparable land without the flood-risk (defined as outside the Federal Insurance Administration (FIA)-designated 100-year floodplain). Additionally, for residential properties under Public Law 91-646, the amount by which the market value of a replacement dwelling (non-floodplain property) exceeds the market value of the displacement dwelling (floodplain property) also is determined. This cost (the market value of the floodplain property, land and structures, plus any additional amount to equal the market value of a comparable replacement dwelling outside the floodplain) is the flood-free property cost. Additional costs were added for demolition and removal of structures and administrative costs.

Buyout alternatives were considered both as stand-alone alternatives and with the optimized structural plan in place (i.e., buyout of the residual floodplain). Buyouts were formulated by flood zone, specifically 50 percent AEP (2-year), 20 percent AEP (5-year) and 10 percent AEP (10-year) floodplain buyouts. Buyout of the 4 percent AEP (25-year) floodplain was not analyzed as experience has proven it to be unjustifiable.

The buyout analysis was further broken down by assuming various levels of participation. Assumptions were made based upon knowledge of the study area and history of participation in previous nonstructural plans in the area. For example, it is reasonable to assume that buyout as a

stand-alone measure is more likely to be an "agency-mandated" buyout (since benefits realized from the buyout are required justify the project). Buyout as an addition to a structural plan would be much less likely to be "agency-mandated" (since benefits simply augment the plan and are not required to justify the project.) There are many other variables to take into consideration when determining levels of participation, such as personal preference (i.e. risk aversion of the property owner), time elapsed since the last flood event, and whether the particular owner has suffered losses (new residents may not believe the risk is high, since they have not suffered damages). All of these variables were taken into account when determining the levels of participation.

Nonstructural Buyout as Stand-Alone Project. For the without-project, or stand-alone buyout the levels of participation are assumed to be 75 percent , 85 percent and 95 percent, for the low, most likely and high levels of participation, respectively. The levels of participation for the buyouts with-structural plan in place are assumed to be 25 percent, 50 percent and 75 percent, for the low, most likely and high levels of participation, respectively. Benefits and costs for each level of participation were apportioned accordingly, using the appropriate rate for low-medium-high participation, as there is no way to identify individual structures likely or unlikely to participate.

The buyout analyses were conducted by first removing ancillary structures from consideration. These include barns, sheds and other similar, minimally valued structures. The results of the stand-alone buyout analysis are shown in Table 3-1 for the various levels of participation and flood zones considered. As shown, buyouts of floodplain properties as stand-alone alternatives are proven to be unjustified under all participation rate scenarios and for all flood zones.

TABLE 3-1
ECONOMIC ANALYSIS OF NONSTRUCTURAL (BUYOUT) OPTION AS A STAND-ALONE ALTERNATIVE
(WITHOUT-PROJECT BUYOUT, 2020 CONDITION)
AT VARIOUS LEVELS OF PARTICIPATION AND FLOOD ZONES
Dollar Values in 1,000s, Oct 2007 Price levels, Discount Rate of 4.875%

Plan	50% AEP Floodplain (2-Year) Buyout			20% AEP Floodplain (5-Year) Buyout			10% AEP Floodplain (10-Year) Buyout		
	Level of Participation			Level of Participation			Level of Participation		
Stand-Alone Buyout	Low (75%)	Most Likely (85%)	High (95%)	Low (75%)	Most Likely (85%)	High (95%)	Low (75%)	Most Likely (85%)	High (95%)
Total Annual Benefits	$97	$110	$122	$2,041	$2,313	$2,586	$5,049	$5,722	$6,395
Total Annual Costs	$795	$811	$828	$3,542	$3,865	$4,187	$10,175	$11,156	$12,137
Net Benefits	-$698	-$702	-$705	-$1,501	-$1,551	-$1,602	-$5,126	-$5,434	-$5,742
B/C Ratio	0.12	0.14	0.15	0.58	0.60	0.62	0.50	0.51	0.53
Number of Structures	approx. 4	approx. 5	approx. 5	approx. 132	approx. 150	approx.168	approx. 412	approx. 467	approx. 522

Notes: Includes damages to structures, contents, vehicles, utilities, roads and post disaster recovery costs. Does not include NFIP benefits.

100% participation rate for Stand-Alone Buyouts:

0-2 year = 5 structures

0-5 year = 176 structures

0-10 year = 549 structures

Totals do not match numbers found in Table 14 because certain ancillary/support structures were removed from consideration for removal.

Buyout of Residual Floodplain. This alternative consists of all the measures described under the NED Plan plus two separate residual floodplain buyout alternatives (namely, 20 percent AEP (5-year) floodplain buyout, and the 10 percent AEP (10-year) floodplain buyout. There were no structures in the residual 50 percent AEP (2-year) floodplain to consider for buyout. The assumption was made that the "most-likely" level of participation would take place, that being 50 percent. As shown, buyouts of the residual floodplain properties are proven to be unjustified under all participation rate scenarios and for all flood zones.

TABLE 3-2
ECONOMIC ANALYSIS OF RESIDUAL FLOODPLAIN BUYOUT
(WITH NED PLAN IN PLACE, 2020 CONDITION)
AT VARIOUS LEVELS OF PARTICIPATION AND FLOOD ZONES
Dollar Values in 1,000s, Oct 2007 Price levels, Discount Rate of 4.875%

Plan	50% AEP Floodplain (2-Year) Buyout			20% AEP Floodplain (5-Year) Buyout			10% AEP Floodplain (10-Year) Buyout		
	Level of Participation			Level of Participation			Level of Participation		
Buyout of Residual Floodplain (i.e. with GRR Plan in place)	**Low (25%)**	**Most Likely (50%)**	**High (75%)**	**Low (25%)**	**Most Likely (50%)**	**High (75%)**	**Low (25%)**	**Most Likely (50%)**	**High (75%)**
Total Annual Benefits				$108	$215	$323	$380	$760	$1,139
Total Annual Costs				$140	$263	$385	$793	$1,323	$1,854
Net Benefits				-$32	-$47	-$62	-$413	-$564	-$714
B/C Ratio				0.77	0.82	0.84	0.48	0.57	0.61
Number of Structures	0	0	0	approx. 7	approx. 14	approx. 21	approx. 34	approx. 68	approx. 102

100% Participation Rate for Buyout of Residual Floodplain:
2-Year = 0 structures
5-Year = 27 structures
10-Year = 136 structures

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Enclosure 4
Detailed Tables for Main Stem and Tributaries
For the With-Project 2020 and 2070 Conditions

Details of Distribution of Capital Investment within the With-project Floodplains. Tables 4-1 through 4-6 of this enclosure show the detailed distribution of structures by type by flood event for the 2020 with-project condition. For example, Table 4-3 shows the distribution of capital investment on Turkey Creek in the 2020 with-project condition. Tables 4-7 through 4-12 likewise display the distribution of structures by type by flood event; however, the condition is for the 2070 future with-project condition.

TABLE 4-1
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CLEAR CREEK MAIN STEM
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	16	142	323	559	811	1,382	1,894
Value of Structures	$0	$2,470	$15,730	$33,857	$62,466	$89,077	$155,589	$218,541
Value of Contents	$0	$1,235	$7,865	$16,929	$31,233	$44,538	$77,794	$109,271
Percent of Structures Inundated/Zone	0%			88%	86%	88%	90%	91%
Commercial								
Number of Structures	1	1	8	34	71	85	123	149
Value of Structures	$33	$33	$1,547	$7,061	$11,741	$13,561	$17,145	$18,267
Value of Contents	$0	$0	$393	$3,355	$6,369	$6,991	$8,889	$11,690
Percent of Structures Inundated/Zone	100%	6%	6%	9%	11%	9%	8%	7%
Industrial								
Number of Structures	0	0	1	3	4	8	12	15
Value of Structures	$0	0	0	565	688	1,172	1,727	2,160
Value of Contents	$0	0	0	2,739	3,073	4,562	6,978	9,276
Percent of Structures Inundated/Zone	0%	0%	1%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	4	8	14	17	20	20
Value of Structures	$0	$0	$1,134	$5,698	$6,119	$6,844	$7,694	$7,694
Value of Contents	$0	$0	$370	$808	$1,013	$1,435	$1,888	$1,888
Percent of Structures Inundated/Zone	0%	0%	3%	0%	0%	0%	0%	0%
Total								
Number of Structures	1	17	155	368	648	921	1,537	2,078
Value of Structures	$33	$2,502	$18,411	$47,181	$81,014	$110,654	$182,155	$246,663
Value of Contents	$0	$1,235	$8,628	$23,832	$41,688	$57,526	$95,550	$132,125
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-2
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MUD GULLY
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	0	2	64	242	518	856
Value of Structures	$0	$0	$0	$191	$7,116	$22,482	$53,857	$91,043
Value of Contents	$0	$0	$0	$96	$3,558	$11,241	$26,928	$45,521
Percent of Structures Inundated/Zone				100%	97%	97%	96%	95%
Commercial								
Number of Structures	0	0	0	0	2	8	23	39
Value of Structures	$0	$0	$0	$0	$87	$625	$3,011	$4,816
Value of Contents	$0	$0	$0	$0	$79	$752	$3,902	$6,184
Percent of Structures Inundated/Zone				0%	3%	3%	4%	4%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	2
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$204
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$75
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	0	2	66	250	541	897
Value of Structures	$0	$0	$0	$191	$7,203	$23,107	$56,868	$96,063
Value of Contents	$0	$0	$0	$96	$3,637	$11,993	$30,830	$51,781
Percent of Structures Inundated/Zone	n/a	n/a	n/a	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-3
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
TURKEY CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	0	0	0	2	97	358
Value of Structures	$0	$0	$0	$0	$0	$247	$9,778	$36,831
Value of Contents	$0	$0	$0	$0	$0	$123	$4,889	$18,416
Percent of Structures Inundated/Zone						100%	99%	99%
Commercial								
Number of Structures	0	0	0	0	0	0	1	5
Value of Structures	$0	$0	$0	$0	$0	$0	$192	$354
Value of Contents	$0	$0	$0	$0	$0	$0	$175	$268
Percent of Structures Inundated/Zone						0%	1%	1%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone						0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone						0%	0%	0%
Total								
Number of Structures	0	0	0	0	0	2	98	363
Value of Structures	$0	$0	$0	$0	$0	$247	$9,971	$37,185
Value of Contents	$0	$0	$0	$0	$0	$123	$5,064	$18,684
Percent of Structures Inundated/Zone	n/a	n/a	n/a	n/a	n/a	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-4
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MARYS CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	1	19	39	82	182	281	424	597
Value of Structures	$94	$2,172	$4,668	$8,188	$19,603	$30,711	$46,476	$65,851
Value of Contents	$47	$1,086	$2,334	$4,094	$9,802	$15,356	$23,238	$32,926
Percent of Structures Inundated/Zone	33%	46%	56%	59%	68%	74%	76%	79%
Commercial								
Number of Structures	2	21	30	54	75	82	106	126
Value of Structures	$1	$141	$325	$1,025	$3,119	$3,543	$4,297	$5,393
Value of Contents	$1	$96	$262	$713	$2,066	$2,355	$2,887	$4,040
Percent of Structures Inundated/Zone	67%	51%	43%	39%	28%	22%	19%	17%
Industrial								
Number of Structures	0	0	0	1	7	10	14	19
Value of Structures	$0	$0	$0	$1,178	$3,683	$4,960	$5,694	$7,366
Value of Contents	$0	$0	$0	$801	$2,505	$3,373	$3,872	$5,009
Percent of Structures Inundated/Zone	0%	0%	0%	1%	3%	3%	3%	3%
Public								
Number of Structures	0	1	1	2	5	6	11	13
Value of Structures	$0	$16	$16	$32	$239	$323	$964	$999
Value of Contents	$0	$6	$6	$12	$148	$205	$540	$562
Percent of Structures Inundated/Zone	0%	2%	1%	1%	2%	2%	2%	2%
Total								
Number of Structures	3	41	70	139	269	379	555	755
Value of Structures	$95	$2,329	$5,009	$10,423	$26,645	$39,537	$57,432	$79,609
Value of Contents	$48	$1,188	$2,602	$5,620	$14,521	$21,288	$30,538	$42,536
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-5
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
COWART CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	3	5	9	13	17	32	42
Value of Structures	$0	$66	$138	$317	$1,182	$1,544	$4,303	$5,971
Value of Contents	$0	$33	$69	$159	$591	$772	$2,151	$2,985
Percent of Structures Inundated/Zone		17%	20%	26%	29%	29%	36%	42%
Commercial								
Number of Structures	0	11	14	17	24	32	40	41
Value of Structures	$0	$255	$267	$271	$365	$444	$532	$549
Value of Contents	$0	$170	$178	$181	$187	$241	$301	$312
Percent of Structures Inundated/Zone		61%	56%	50%	53%	54%	45%	41%
Industrial								
Number of Structures	0	4	6	8	8	10	16	17
Value of Structures	$0	$0	$92	$188	$188	$188	$188	$206
Value of Contents	$0	$0	$63	$128	$128	$128	$128	$140
Percent of Structures Inundated/Zone		22%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	18	25	34	45	59	88	100
Value of Structures	$0	$321	$497	$776	$1,734	$2,175	$5,022	$6,726
Value of Contents	$0	$203	$310	$467	$906	$1,141	$2,580	$3,438
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-6
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CHIGGER CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2020 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	1	2	5	5	8	19	22
Value of Structures	$0	$252	$749	$1,075	$1,075	$1,523	$4,724	$5,079
Value of Contents	$0	$126	$374	$538	$538	$762	$2,362	$2,540
Percent of Structures Inundated/Zone		50%	67%	83%	83%	80%	86%	88%
Commercial								
Number of Structures	0	1	1	1	1	2	3	3
Value of Structures	$0	$35	$35	$35	$35	$62	$77	$77
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		50%	33%	17%	17%	20%	14%	12%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	2	3	6	6	10	22	25
Value of Structures	$0	$287	$784	$1,110	$1,110	$1,585	$4,801	$5,156
Value of Contents	$0	$126	$374	$538	$538	$762	$2,362	$2,540
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-7
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CLEAR CREEK MAIN STEM
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	18	167	368	626	885	1,474	2,013
Value of Structures	$0	$2,706	$18,440	$39,269	$70,061	$99,177	$168,259	$236,127
Value of Contents	$0	$1,353	$9,220	$19,635	$35,030	$49,588	$84,130	$118,064
Percent of Structures Inundated/Zone	0%			88%	87%	89%	90%	91%
Commercial								
Number of Structures	1	1	17	38	79	91	131	159
Value of Structures	$33	$33	$1,869	$7,342	$13,126	$15,493	$17,642	$29,605
Value of Contents	$0	$0	$582	$3,449	$6,769	$7,442	$9,272	$16,344
Percent of Structures Inundated/Zone	100%	6%	10%	9%	11%	9%	8%	7%
Industrial								
Number of Structures	0	0	0	2	3	7	11	14
Value of Structures	$0	0	0	565	688	1,172	1,727	2,160
Value of Contents	$0	0	0	2,739	3,073	4,562	6,978	9,276
Percent of Structures Inundated/Zone	0%	0%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	4	11	14	17	19	20
Value of Structures	$0	$0	$1,134	$5,749	$6,119	$7,253	$8,103	$8,103
Value of Contents	$0	$0	$370	$828	$1,013	$1,435	$1,888	$1,888
Percent of Structures Inundated/Zone	0%	0%	2%	0%	0%	0%	0%	0%
Total								
Number of Structures	1	19	188	419	722	1,000	1,635	2,206
Value of Structures	$33	$2,739	$21,443	$52,926	$89,994	$123,095	$195,732	$275,995
Value of Contents	$0	$1,353	$10,172	$26,651	$45,885	$63,027	$102,268	$145,571
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-8
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MUD GULLY
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	0	13	133	253	749	940
Value of Structures	$0	$0	$0	$1,245	$11,913	$24,600	$79,207	$98,763
Value of Contents	$0	$0	$0	$623	$5,957	$12,300	$39,603	$49,382
Percent of Structures Inundated/Zone				100%	99%	96%	95%	96%
Commercial								
Number of Structures	0	0	0	0	2	11	37	40
Value of Structures	$0	$0	$0	$0	$87	$1,204	$4,386	$4,841
Value of Contents	$0	$0	$0	$0	$79	$1,061	$5,708	$6,207
Percent of Structures Inundated/Zone				0%	1%	4%	5%	4%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	2	2
Value of Structures	$0	$0	$0	$0	$0	$0	$204	$204
Value of Contents	$0	$0	$0	$0	$0	$0	$75	$75
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	0	13	135	264	788	982
Value of Structures	$0	$0	$0	$1,245	$12,000	$25,804	$83,796	$103,808
Value of Contents	$0	$0	$0	$623	$6,036	$13,361	$45,387	$55,664
Percent of Structures Inundated/Zone	n/a	n/a	n/a	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-9
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
TURKEY CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	0	0	0	1	13	338	474
Value of Structures	$0	$0	$0	$0	$128	$1,495	$32,143	$44,593
Value of Contents	$0	$0	$0	$0	$64	$747	$16,072	$22,297
Percent of Structures Inundated/Zone					100%	93%	99%	99%
Commercial								
Number of Structures	0	0	0	0	0	1	4	6
Value of Structures	$0	$0	$0	$0	$0	$192	$354	$621
Value of Contents	$0	$0	$0	$0	$0	$175	$268	$511
Percent of Structures Inundated/Zone					0%	7%	1%	1%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone				0%	0%	0%	0%	0%
Total								
Number of Structures	0	0	0	0	1	14	342	480
Value of Structures	$0	$0	$0	$0	$128	$1,687	$32,497	$45,214
Value of Contents	$0	$0	$0	$0	$64	$922	$16,340	$22,808
Percent of Structures Inundated/Zone	n/a	n/a	n/a	n/a	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-10
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
MARYS CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	4	32	64	209	272	378	571	846
Value of Structures	$271	$4,171	$6,445	$22,567	$28,751	$40,701	$63,132	$97,497
Value of Contents	$136	$2,085	$3,223	$11,283	$14,376	$20,351	$31,566	$48,749
Percent of Structures Inundated/Zone	44%	58%	58%	70%	73%	75%	78%	82%
Commercial								
Number of Structures	5	22	44	76	85	101	126	150
Value of Structures	$24	$143	$594	$2,507	$3,813	$4,134	$5,393	$6,465
Value of Contents	$17	$97	$440	$1,633	$2,538	$2,786	$4,040	$5,201
Percent of Structures Inundated/Zone	56%	40%	40%	26%	23%	20%	17%	14%
Industrial								
Number of Structures	0	0	0	8	10	12	19	20
Value of Structures	$0	$0	$0	$3,769	$4,960	$5,628	$7,366	$7,954
Value of Contents	$0	$0	$0	$2,563	$3,373	$3,827	$5,009	$5,409
Percent of Structures Inundated/Zone	0%	0%	0%	3%	3%	2%	3%	2%
Public								
Number of Structures	0	1	2	5	6	11	13	19
Value of Structures	$0	$16	$32	$239	$346	$964	$999	$1,162
Value of Contents	$0	$6	$12	$148	$188	$540	$562	$622
Percent of Structures Inundated/Zone	0%	2%	2%	2%	2%	2%	2%	2%
Total								
Number of Structures	9	55	110	298	373	502	729	1,035
Value of Structures	$296	$4,329	$7,071	$29,082	$37,870	$51,428	$76,890	$113,078
Value of Contents	$152	$2,188	$3,674	$15,628	$20,474	$27,503	$41,177	$59,980
Percent of Structures Inundated/Zone	100%	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-11
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
COWART CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	3	6	9	14	19	34	49
Value of Structures	$0	$66	$143	$317	$1,188	$1,806	$4,661	$7,515
Value of Contents	$0	$33	$71	$159	$594	$903	$2,330	$3,758
Percent of Structures Inundated/Zone		16%	22%	26%	29%	31%	38%	41%
Commercial								
Number of Structures	0	11	14	18	26	32	40	48
Value of Structures	$0	$255	$267	$356	$389	$444	$532	$619
Value of Contents	$0	$170	$178	$181	$204	$241	$301	$360
Percent of Structures Inundated/Zone		58%	52%	51%	53%	52%	44%	40%
Industrial								
Number of Structures	0	5	7	8	9	10	16	22
Value of Structures	$0	$92	$188	$188	$188	$188	$188	$188
Value of Contents	$0	$63	$128	$128	$128	$128	$128	$128
Percent of Structures Inundated/Zone		26%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	19	27	35	49	61	90	119
Value of Structures	$0	$413	$597	$861	$1,765	$2,438	$5,380	$8,322
Value of Contents	$0	$266	$377	$468	$925	$1,272	$2,759	$4,245
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-12
CUMULATIVE DISTRIBUTION OF STRUCTURES BY TYPE BY FLOOD EVENT
CHIGGER CREEK
Cumulative Totals Based on First-Floor Elevations and NED Plan 2070 Condition
(Dollar Values in $1,000s, Oct 2009 Price Levels)

Structure Type/Flood Event	50% AEP Floodplain (2-year)	20% AEP Floodplain (5-year)	10% AEP Floodplain (10-year)	4% AEP Floodplain (25-year)	2% AEP Floodplain (50-year)	1% AEP Floodplain (100-year)	0.4% AEP Floodplain (250-year)	0.2% AEP Floodplain (500-year)
Residential								
Number of Structures	0	1	2	5	6	10	20	24
Value of Structures	$0	$252	$749	$1,075	$1,331	$2,098	$4,742	$5,579
Value of Contents	$0	$126	$374	$538	$666	$1,049	$2,371	$2,789
Percent of Structures Inundated/Zone		50%	67%	83%	86%	83%	87%	89%
Commercial								
Number of Structures	0	1	1	1	1	2	3	3
Value of Structures	$0	$35	$35	$35	$35	$62	$77	$77
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		50%	33%	17%	14%	17%	13%	11%
Industrial								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Public								
Number of Structures	0	0	0	0	0	0	0	0
Value of Structures	$0	$0	$0	$0	$0	$0	$0	$0
Value of Contents	$0	$0	$0	$0	$0	$0	$0	$0
Percent of Structures Inundated/Zone		0%	0%	0%	0%	0%	0%	0%
Total								
Number of Structures	0	2	3	6	7	12	23	27
Value of Structures	$0	$287	$784	$1,110	$1,366	$2,160	$4,819	$5,656
Value of Contents	$0	$126	$374	$538	$666	$1,049	$2,371	$2,789
Percent of Structures Inundated/Zone	n/a	100%	100%	100%	100%	100%	100%	100%

Note: Individual numbers may not sum to totals due to rounding.

Details of Single Occurrence Damages in the With-project Condition. Tables 4-13 through 4-18 of this enclosure show the damages expected to accrue from various flood events along the individual streams on Clear Creek. These values represent damages expected for individual events under the with-project near-term hydrologic condition and include structure and content damages as well as other benefit categories. Similarly, Tables 4-19 through 4-24 display the single occurrence damages by event for the main stem and tributaries in the future hydrologic condition.

TABLE 4-13
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2020 CONDITION
CLEAR CREEK MAIN STEM
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$75.1	$3,097.6	$10,747.6	$19,930.5	$31,351.9	$45,620.7	$74,166.2	$103,655.9
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1,375.1	$1,646.6
Commercial	$1.0	$30.0	$205.3	$679.4	$1,515.9	$2,404.3	$3,907.1	$5,021.3
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$449.4	$537.7
Damages to Structures, Contents	$76.0	$3,127.6	$10,952.9	$20,609.9	$32,867.9	$48,024.9	$79,897.8	$110,861.5
Postdisaster Recovery Costs	$77.2	$1,117.3	$3,846.7	$6,649.5	$9,839.2	$13,546.7	$20,699.9	$27,091.9
Utilities	$2.9	$42.1	$144.8	$250.3	$370.4	$510.0	$779.3	$1,019.9
Vehicles	$0.1	$57.5	$526.4	$1,284.2	$2,522.7	$4,594.4	$8,745.0	$13,069.8
Roads	$328.8	$576.5	$852.7	$1,158.9	$1,440.4	$1,741.1	$2,187.3	$3,444.5
Total Damages by Event	$485.1	$4,920.9	$16,323.5	$29,952.8	$47,040.6	$68,417.1	$112,309.3	$155,487.7
Percent Distribution by Event								
Residential	15.5%	62.9%	65.8%	66.5%	66.6%	66.7%	66.0%	66.7%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.2%	1.1%
Commercial	0.2%	0.6%	1.3%	2.3%	3.2%	3.5%	3.5%	3.2%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.3%
Postdisaster Recovery Costs	15.9%	22.7%	23.6%	22.2%	20.9%	19.8%	18.4%	17.4%
Utilities	0.6%	0.9%	0.9%	0.8%	0.8%	0.7%	0.7%	0.7%
Vehicles	0.0%	1.2%	3.2%	4.3%	5.4%	6.7%	7.8%	8.4%
Roads	67.8%	11.7%	5.2%	3.9%	3.1%	2.5%	1.9%	2.2%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-14
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2020 CONDITION
MUD GULLY
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$83.6	$570.2	$3,004.3	$9,912.3	$15,816.0	$25,455.9	$39,000.6
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.0	$0.3	$1.7	$27.7	$77.2	$271.4	$763.5
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$0.0	$83.6	$570.5	$3,006.0	$9,940.1	$15,893.1	$25,727.3	$39,764.1
Postdisaster Recovery Costs	$0.0	$0.0	$0.0	$17.5	$577.8	$2,188.8	$4,675.2	$7,792.0
Utilities	$0.0	$0.0	$0.0	$0.7	$21.8	$82.4	$176.0	$293.3
Vehicles	$0.0	$0.0	$0.0	$1.2	$41.5	$116.9	$534.6	$1,939.9
Roads	$0.0	$2.1	$20.7	$79.6	$195.6	$309.9	$497.5	$681.6
Total Damages by Event	$0.0	$85.6	$591.2	$3,105.0	$10,776.7	$18,591.1	$31,610.6	$50,471.0
Percent Distribution by Event								
Residential	0.0%	97.6%	96.5%	96.8%	92.0%	85.1%	80.5%	77.3%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.9%	1.5%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	0.0%	0.0%	0.6%	5.4%	11.8%	14.8%	15.4%
Utilities	0.0%	0.0%	0.0%	0.0%	0.2%	0.4%	0.6%	0.6%
Vehicles	0.0%	0.0%	0.0%	0.0%	0.4%	0.6%	1.7%	3.8%
Roads	0.0%	2.4%	3.5%	2.6%	1.8%	1.7%	1.6%	1.4%
	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-15
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2020 CONDITION
TURKEY CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$0.0	$0.0	$23.2	$141.5	$538.0	$5,289.9	$10,960.6
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.7	$12.5	$31.4
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$0.0	$0.0	$0.0	$23.2	$141.5	$538.8	$5,302.4	$10,992.0
Postdisaster Recovery Costs	$0.0	$0.0	$0.0	$2.2	$17.1	$75.0	$2,744.3	$6,333.2
Utilities	$0.0	$0.0	$0.0	$0.1	$0.6	$2.8	$103.3	$238.4
Vehicles	$0.0	$0.0	$0.0	$0.0	$0.0	$0.4	$104.4	$625.0
Roads	$0.0	$0.0	$3.0	$14.2	$28.3	$58.9	$124.9	$177.0
Total Damages by Event	$0.0	$0.0	$3.0	$39.7	$187.5	$675.8	$8,379.3	$18,365.7
Percent Distribution by Event								
Residential	0.0%	0.0%	0.0%	58.4%	75.5%	79.6%	63.1%	59.7%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	0.0%	0.0%	5.6%	9.1%	11.1%	32.8%	34.5%
Utilities	0.0%	0.0%	0.0%	0.2%	0.3%	0.4%	1.2%	1.3%
Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.2%	3.4%
Roads	0.0%	0.0%	100.0%	35.8%	15.1%	8.7%	1.5%	1.0%
	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-16
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2020 CONDITION
MARYS CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$221.8	$1,025.9	$2,037.2	$6,165.1	$12,097.1	$17,230.3	$26,063.3	$34,154.5
Public	$0.1	$1.5	$2.2	$5.7	$18.5	$31.3	$62.2	$94.5
Commercial	$0.9	$16.4	$34.9	$145.5	$485.9	$721.6	$1,100.6	$1,437.8
Industrial	$0.0	$0.0	$0.6	$68.2	$822.8	$1,383.1	$2,858.3	$4,845.7
Damages to Structures, Contents	$222.8	$1,043.7	$2,075.0	$6,384.5	$13,424.3	$19,366.3	$30,084.4	$40,532.5
Postdisaster Recovery Costs	$150.1	$550.3	$861.1	$2,242.3	$4,168.5	$5,577.1	$8,014.3	$10,261.5
Utilities	$5.7	$20.6	$32.4	$84.4	$156.9	$210.0	$301.7	$386.3
Vehicles	$0.7	$43.2	$134.4	$296.0	$493.9	$748.6	$1,287.0	$1,947.8
Roads	$0.7	$30.4	$124.5	$383.2	$538.9	$600.9	$680.1	$722.3
Total Damages by Event	$380.0	$1,688.2	$3,227.4	$9,390.6	$18,782.6	$26,503.0	$40,367.5	$53,850.3
Percent Distribution by Event								
Residential	58.4%	60.8%	63.1%	65.7%	64.4%	65.0%	64.6%	63.4%
Public	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
Commercial	0.2%	1.0%	1.1%	1.5%	2.6%	2.7%	2.7%	2.7%
Industrial	0.0%	0.0%	0.0%	0.7%	4.4%	5.2%	7.1%	9.0%
Postdisaster Recovery Costs	39.5%	32.6%	26.7%	23.9%	22.2%	21.0%	19.9%	19.1%
Utilities	1.5%	1.2%	1.0%	0.9%	0.8%	0.8%	0.7%	0.7%
Vehicles	0.2%	2.6%	4.2%	3.2%	2.6%	2.8%	3.2%	3.6%
Roads	0.2%	1.8%	3.9%	4.1%	2.9%	2.3%	1.7%	1.3%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-17
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2020 CONDITION
COWART CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$40.1	$114.8	$262.7	$487.0	$846.6	$1,717.5	$2,481.7
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$10.6	$34.6	$43.1	$49.5	$56.7	$68.8	$78.6
Industrial	$0.0	$0.9	$11.8	$22.4	$29.4	$35.4	$42.1	$46.5
Damages to Structures, Contents	$0.0	$51.6	$161.2	$328.1	$565.9	$938.8	$1,828.4	$2,606.8
Postdisaster Recovery Costs	$32.5	$222.9	$374.1	$524.3	$665.4	$812.4	$1,023.4	$1,171.0
Utilities	$1.2	$8.4	$14.1	$19.7	$25.0	$30.6	$38.5	$44.1
Vehicles	$0.0	$3.7	$23.5	$48.0	$74.2	$114.7	$197.3	$278.3
Roads	$0.4	$1.5	$4.8	$9.7	$16.7	$27.7	$54.0	$77.0
Total Damages by Event	$34.1	$288.1	$577.6	$929.9	$1,347.2	$1,924.2	$3,141.6	$4,177.1
Percent Distribution by Event								
Residential	0.0%	13.9%	19.9%	28.2%	36.1%	44.0%	54.7%	59.4%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	3.7%	6.0%	4.6%	3.7%	2.9%	2.2%	1.9%
Industrial	0.0%	0.3%	2.0%	2.4%	2.2%	1.8%	1.3%	1.1%
Postdisaster Recovery Costs	95.2%	77.4%	64.8%	56.4%	49.4%	42.2%	32.6%	28.0%
Utilities	3.6%	2.9%	2.4%	2.1%	1.9%	1.6%	1.2%	1.1%
Vehicles	0.0%	1.3%	4.1%	5.2%	5.5%	6.0%	6.3%	6.7%
Roads	1.2%	0.5%	0.8%	1.0%	1.2%	1.4%	1.7%	1.8%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-18
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2020 CONDITION
CHIGGER CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$1.6	$139.9	$258.1	$418.1	$620.1	$980.8	$1,699.2	$2,426.1
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$1.2	$4.2	$5.5	$6.5	$8.0	$11.9	$13.9
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$1.6	$141.1	$262.3	$423.6	$626.6	$988.8	$1,711.1	$2,440.0
Postdisaster Recovery Costs	$0.3	$33.7	$58.7	$72.6	$104.6	$169.6	$269.6	$366.9
Utilities	$0.0	$1.3	$2.2	$2.7	$3.9	$6.4	$10.1	$13.8
Vehicles	$0.0	$0.7	$5.6	$18.8	$25.7	$37.9	$65.7	$108.6
Roads	$0.5	$5.5	$9.7	$15.3	$22.4	$35.4	$60.6	$86.3
Total Damages by Event	$2.4	$182.3	$338.6	$533.0	$783.3	$1,238.1	$2,117.1	$3,015.6
Percent Distribution by Event								
Residential	68.6%	76.8%	76.2%	78.5%	79.2%	79.2%	80.3%	80.4%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.7%	1.2%	1.0%	0.8%	0.6%	0.6%	0.5%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	11.1%	18.5%	17.4%	13.6%	13.4%	13.7%	12.7%	12.2%
Utilities	0.4%	0.7%	0.7%	0.5%	0.5%	0.5%	0.5%	0.5%
Vehicles	0.0%	0.4%	1.7%	3.5%	3.3%	3.1%	3.1%	3.6%
Roads	19.9%	3.0%	2.9%	2.9%	2.9%	2.9%	2.9%	2.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-19
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2070 CONDITION
CLEAR CREEK MAIN STEM
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$128.4	$3,990.1	$11,939.3	$22,346.5	$34,968.1	$49,548.3	$79,885.0	$110,898.9
Public	$0.0	$18.3	$107.5	$307.9	$664.5	$1,000.3	$1,409.8	$1,667.0
Commercial	$0.9	$34.4	$214.7	$814.6	$1,699.7	$2,621.5	$4,211.8	$5,988.9
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$463.3	$552.9
Damages to Structures, Contents	$129.3	$4,042.8	$12,261.5	$23,468.9	$37,332.2	$53,170.1	$85,970.0	$119,107.6
Postdisaster Recovery Costs	$96.1	$1,533.6	$4,187.3	$7,339.7	$10,693.7	$14,434.8	$21,849.4	$28,623.9
Utilities	$3.6	$57.7	$157.6	$276.3	$402.6	$543.4	$822.6	$1,077.6
Vehicles	$0.2	$103.5	$630.3	$1,544.4	$3,048.3	$5,143.6	$9,633.7	$14,318.2
Roads	$366.4	$621.3	$898.8	$1,224.0	$1,516.7	$1,804.7	$2,454.2	$3,601.6
Total Damages by Event	$595.7	$6,358.8	$18,135.5	$33,853.3	$52,993.5	$75,096.6	$120,729.8	$166,729.0
Percent Distribution by Event								
Residential	21.6%	62.7%	65.8%	66.0%	66.0%	66.0%	66.2%	66.5%
Public	0.0%	0.3%	0.6%	0.9%	1.3%	1.3%	1.2%	1.0%
Commercial	0.2%	0.5%	1.2%	2.4%	3.2%	3.5%	3.5%	3.6%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.3%
Postdisaster Recovery Costs	16.1%	24.1%	23.1%	21.7%	20.2%	19.2%	18.1%	17.2%
Utilities	0.6%	0.9%	0.9%	0.8%	0.8%	0.7%	0.7%	0.6%
Vehicles	0.0%	1.6%	3.5%	4.6%	5.8%	6.8%	8.0%	8.6%
Roads	61.5%	9.8%	5.0%	3.6%	2.9%	2.4%	2.0%	2.2%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-20
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2070 CONDITION
MUD GULLY
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$164.0	$1,023.2	$5,724.7	$12,102.0	$16,951.7	$33,937.2	$42,287.7
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.0	$0.4	$5.1	$36.6	$97.0	$594.1	$870.2
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$0.0	$164.0	$1,023.6	$5,729.9	$12,138.5	$17,048.7	$34,531.3	$43,157.9
Postdisaster Recovery Costs	$0.0	$0.0	$0.0	$113.8	$1,181.9	$2,311.3	$6,898.9	$8,571.1
Utilities	$0.0	$0.0	$0.0	$4.3	$44.5	$87.0	$259.7	$322.7
Vehicles	$0.0	$0.0	$0.3	$5.7	$60.6	$152.8	$1,320.3	$2,403.8
Roads	$0.1	$5.6	$38.9	$130.7	$263.2	$384.1	$615.2	$717.6
Total Damages by Event	$0.1	$169.6	$1,062.9	$5,984.4	$13,688.7	$19,984.0	$43,625.5	$55,173.1
Percent Distribution by Event								
Residential	0.0%	96.7%	96.3%	95.7%	88.4%	84.8%	77.8%	76.6%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	1.4%	1.6%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	0.0%	0.0%	1.9%	8.6%	11.6%	15.8%	15.5%
Utilities	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.6%	0.6%
Vehicles	0.0%	0.0%	0.0%	0.1%	0.4%	0.8%	3.0%	4.4%
Roads	100.0%	3.3%	3.7%	2.2%	1.9%	1.9%	1.4%	1.3%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-21
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2070 CONDITION
TURKEY CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$0.0	$2.6	$140.8	$260.9	$2,617.2	$10,250.4	$12,643.8
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$0.0	$0.0	$0.0	$0.2	$5.0	$28.0	$44.6
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$0.0	$0.0	$2.6	$140.8	$261.1	$2,622.2	$10,278.4	$12,688.4
Postdisaster Recovery Costs	$0.0	$0.0	$0.0	$17.6	$30.7	$1,009.5	$6,007.5	$7,210.0
Utilities	$0.0	$0.0	$0.0	$0.7	$1.2	$38.0	$226.2	$271.4
Vehicles	$0.0	$0.0	$0.0	$0.0	$0.0	$24.4	$525.5	$816.8
Roads	$0.0	$0.0	$8.5	$24.5	$50.4	$98.9	$177.4	$208.0
Total Damages by Event	$0.0	$0.0	$11.1	$183.6	$343.4	$3,793.0	$17,215.0	$21,194.6
Percent Distribution by Event								
Residential	0.0%	0.0%	23.5%	76.7%	76.0%	69.0%	59.5%	59.7%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	0.0%	0.0%	0.0%	9.6%	8.9%	26.6%	34.9%	34.0%
Utilities	0.0%	0.0%	0.0%	0.4%	0.3%	1.0%	1.3%	1.3%
Vehicles	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%	3.1%	3.9%
Roads	0.0%	0.0%	76.5%	13.4%	14.7%	2.6%	1.0%	1.0%
	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-22
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2070 CONDITION
MARYS CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$390.2	$1,404.1	$4,374.7	$13,500.8	$17,233.3	$23,026.8	$32,379.6	$45,569.2
Public	$0.2	$1.9	$4.1	$22.8	$32.0	$48.9	$88.6	$128.9
Commercial	$2.2	$21.8	$113.5	$546.4	$750.8	$1,001.6	$1,413.7	$1,713.8
Industrial	$0.0	$0.0	$35.2	$1,042.4	$1,686.1	$2,613.3	$4,789.1	$6,607.0
Damages to Structures, Contents	$392.6	$1,427.7	$4,527.5	$15,112.4	$19,702.2	$26,690.6	$38,671.0	$54,018.9
Postdisaster Recovery Costs	$274.6	$652.4	$1,773.1	$4,592.6	$5,657.1	$7,313.1	$9,975.4	$13,394.7
Utilities	$10.3	$24.5	$66.8	$172.9	$213.0	$275.3	$375.5	$504.3
Vehicles	$3.3	$79.0	$212.7	$535.1	$707.5	$1,025.2	$1,759.6	$3,217.6
Roads	$2.2	$48.8	$323.6	$549.5	$598.6	$658.9	$716.6	$753.1
Total Damages by Event	$683.0	$2,232.5	$6,903.6	$20,962.5	$26,878.3	$35,963.1	$51,498.0	$71,888.5
Percent Distribution by Event								
Residential	57.1%	62.9%	63.4%	64.4%	64.1%	64.0%	62.9%	63.4%
Public	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.2%	0.2%
Commercial	0.3%	1.0%	1.6%	2.6%	2.8%	2.8%	2.7%	2.4%
Industrial	0.0%	0.0%	0.5%	5.0%	6.3%	7.3%	9.3%	9.2%
Postdisaster Recovery Costs	40.2%	29.2%	25.7%	21.9%	21.0%	20.3%	19.4%	18.6%
Utilities	1.5%	1.1%	1.0%	0.8%	0.8%	0.8%	0.7%	0.7%
Vehicles	0.5%	3.5%	3.1%	2.6%	2.6%	2.9%	3.4%	4.5%
Roads	0.3%	2.2%	4.7%	2.6%	2.2%	1.8%	1.4%	1.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-23
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2070 CONDITION
COWART CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$0.0	$47.5	$126.1	$281.0	$539.5	$945.3	$1,828.1	$2,596.5
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$13.6	$35.4	$43.6	$50.2	$57.9	$69.8	$79.5
Industrial	$0.0	$1.5	$12.4	$23.0	$30.2	$36.2	$42.6	$47.0
Damages to Structures, Contents	$0.0	$62.6	$173.9	$347.6	$619.9	$1,039.4	$1,940.5	$2,723.0
Postdisaster Recovery Costs	$49.9	$236.6	$386.2	$535.6	$685.4	$839.2	$1,043.2	$1,191.3
Utilities	$1.9	$8.9	$14.5	$20.2	$25.8	$31.6	$39.3	$44.8
Vehicles	$0.0	$5.2	$25.6	$49.8	$78.6	$122.2	$208.2	$290.5
Roads	$0.5	$1.9	$5.4	$10.6	$18.7	$31.2	$57.9	$80.5
Total Damages by Event	$52.3	$315.2	$605.6	$963.8	$1,428.5	$2,063.6	$3,289.0	$4,330.1
Percent Distribution by Event								
Residential	0.0%	15.1%	20.8%	29.2%	37.8%	45.8%	55.6%	60.0%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	4.3%	5.9%	4.5%	3.5%	2.8%	2.1%	1.8%
Industrial	0.0%	0.5%	2.0%	2.4%	2.1%	1.8%	1.3%	1.1%
Postdisaster Recovery Costs	95.4%	75.0%	63.8%	55.6%	48.0%	40.7%	31.7%	27.5%
Utilities	3.6%	2.8%	2.4%	2.1%	1.8%	1.5%	1.2%	1.0%
Vehicles	0.0%	1.6%	4.2%	5.2%	5.5%	5.9%	6.3%	6.7%
Roads	1.0%	0.6%	0.9%	1.1%	1.3%	1.5%	1.8%	1.9%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

TABLE 4-24
SINGLE OCCURRENCE DAMAGES BY EVENT
WITH-PROJECT 2070 CONDITION
CHIGGER CREEK
(Dollar Values in $1,000s, Oct 2009 Price Level)

	Annual Exceedance Probability Events							
Damage Category	50% or "2-Year"	20% or "5-Year"	10% or "10-Year"	4% or "25-Year"	2% or "50-Year"	1% or "100-Year"	0.4% or "250-Year"	0.2% or "500-Year"
Residential	$6.0	$162.7	$284.0	$462.6	$724.4	$1,160.5	$1,965.7	$2,794.5
Public	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Commercial	$0.0	$1.5	$4.4	$5.7	$6.9	$9.2	$12.7	$14.6
Industrial	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Damages to Structures, Contents	$6.0	$164.2	$288.4	$468.2	$731.3	$1,169.7	$1,978.3	$2,809.1
Postdisaster Recovery Costs	$1.0	$38.8	$60.6	$78.5	$122.5	$199.3	$302.9	$436.5
Utilities	$0.0	$1.5	$2.3	$3.0	$4.6	$7.5	$11.4	$16.4
Vehicles	$0.0	$0.9	$8.1	$20.6	$27.9	$41.9	$75.9	$129.1
Roads	$1.0	$6.6	$10.8	$17.4	$27.0	$42.8	$71.5	$89.8
Total Damages by Event	$8.0	$211.9	$370.1	$587.7	$913.3	$1,461.2	$2,440.1	$3,481.0
Percent Distribution by Event								
Residential	74.4%	76.8%	76.7%	78.7%	79.3%	79.4%	80.6%	80.3%
Public	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Commercial	0.0%	0.7%	1.2%	1.0%	0.8%	0.6%	0.5%	0.4%
Industrial	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Postdisaster Recovery Costs	12.0%	18.3%	16.4%	13.4%	13.4%	13.6%	12.4%	12.5%
Utilities	0.5%	0.7%	0.6%	0.5%	0.5%	0.5%	0.5%	0.5%
Vehicles	0.0%	0.4%	2.2%	3.5%	3.1%	2.9%	3.1%	3.7%
Roads	13.1%	3.1%	2.9%	3.0%	3.0%	2.9%	2.9%	2.6%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Individual numbers may not sum to totals due to rounding.

Enclosure 5
Details of Cost Calculations

Details of Cost Calculations. Table 5-1 shows the detailed cost schedule for operations and maintenance (O&M) of the NED plan. Total average annual O&M is $903,000. Table 5-2 details the construction costs, annualized costs and interest during construction (IDC) for the NED plan at the current discount rate and for the 50-year period of analysis. Total project first cost is $180,929,000, which on an annual basis equates to $8,603,400, at a discount rate of 4.125 percent and 50-year period of analysis. The total annual IDC is $287,000. The total annual cost of the project including IDC and O&M is $9,793,000.

TABLE 5-1
DETAILED COST SCHEDULE FOR OPERATIONS & MAINTENANCE
FOR THE NED PLAN
(4.125%, 50-year Period of Analysis)

Project Year	Contract 1 - Mud Conveyance	Contract 2 - Turkey Conveyance	Contract 3 - Mary's Conveyance	Contract 4 - Lower Main Stem Conveyance	Contract 5 - RR Bridge	Contract 6 - Mid-Main Stem Conveyance	Contract 7 Upper Main Stem Conveyance
1	$2,000	$16,900	$12,200	$244,000	$0	$825,760	$80,200
2	$2,000	$16,900	$12,200	$244,000	$0	$825,760	$80,200
3	$4,400	$29,000	$24,300	$280,300	$4,800	$862,060	$116,500
4	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
5	$2,000	$16,900	$12,200	$244,000	$0	$1,199,630	$75,200
6	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
7	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
8	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
9	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
10	$23,300	$52,800	$48,200	$316,500	$0	$2,022,530	$183,400
11	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
12	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
13	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
14	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
15	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$111,500
16	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
17	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
18	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
19	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
20	$23,300	$52,800	$48,200	$316,500	$2,400	$431,300	$183,400
21	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
22	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
23	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
24	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
25	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$75,200
26	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
27	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
28	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
29	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
30	$25,700	$64,900	$60,300	$352,800	$4,800	$467,600	$219,700
31	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
32	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
33	$4,400	$29,000	$24,300	$280,300	$4,800	$467,600	$83,900
34	$2,000	$16,900	$12,200	$244,000	$0	$431,300	$47,600
35	$2,000	$16,900	$12,200	$244,000	$0	$447,030	$75,200
36	$4,400	$29,000	$24,300	$65,800	$4,800	$67,200	$83,900
37	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
38	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
39	$4,400	$29,000	$24,300	$65,800	$4,800	$67,200	$83,900
40	$23,300	$52,800	$48,200	$102,000	$2,400	$30,900	$183,400
41	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
42	$4,400	$29,000	$24,300	$65,800	$4,800	$67,200	$83,900
43	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
44	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
45	$4,400	$29,000	$24,300	$65,800	$4,800	$67,200	$111,500
46	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
47	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
48	$4,400	$29,000	$24,300	$65,800	$4,800	$67,200	$83,900
49	$2,000	$16,900	$12,200	$29,500	$0	$30,900	$47,600
50	$23,300	$52,800	$48,200	$102,000	$0	$30,900	$183,400
Sum	$244,900	$1,218,100	$983,600	$9,925,800	$81,600	$19,698,470	$3,875,600
Average Annual O&M	$4,614	$24,178	$19,391	$238,933	$1,622	$534,944	$78,980
Total Average Annual O&M							$902,663

TABLE 5-2
DETAILED CALCULATIONS OF INTEREST DURING CONSTRUCTION
FOR THE NED PLAN
(4.125%, 50-year Period of Analysis)

Contract No.	Measure/Contract Description	First Cost of Construction (FY10)	Construction Duration (months)	Monthly Cost = (a)/(b)	1+ (i/12 months) where i = 4.125%	$(1 + (i/12)^{(months)} - 1 = (d)^{(b)} - 1$	total investment cost for applicable period = (e)/i	construction period = (f) * 12	Total with IDC = (c) * (g)	IDC = (h) - (a)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
Contract 1	Mud Gully Conveyance	$9,529,000	9	$1,058,778	1.003	0.03137	0.7604	9.1	$9,661,080	$132,080
Contract 2	Turkey Creek Conveyance	$27,230,000	8	$3,403,750	1.003	0.02783	0.6747	8.1	$27,559,873	$329,873
Contract 3	Mary's Creek Conveyance	$16,930,000	11	$1,539,091	1.003	0.03847	0.9326	11.2	$17,224,006	$294,006
Contract 4	Lower Clear Creek Conveyance	$30,745,000	19	$1,618,158	1.003	0.06737	1.6333	19.6	$31,714,959	$969,959
Contract 5	BN&SF RR Bridge	$2,210,000	12	$184,167	1.003	0.04204	1.0191	12.2	$2,252,265	$42,265
Contract 6	Mid-Clear Creek Conveyance (Mykawa to Bennie Kate)	$56,431,000	27	$2,090,037	1.003	0.09708	2.3535	28.2	$59,026,512	$2,595,512
Contract 7	Upper Clear Creek Conveyance (Hwy 288 to Mykawa)	$37,854,000	26	$1,455,923	1.003	0.09332	2.2624	27.1	$39,526,167	$1,672,167
	Totals	$180,929,000							$186,964,862	$6,035,862
	* Amortizaton Factor (4.125%, 50-years)	0.047551							0.047551	0.047551
	= Annualized Costs	$8,603,353							$8,890,364	$287,011

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Enclosure 6
Sensitivity Analyses

Sensitivity Analyses. As a result of in-depth review of the HEC-FDA model results conducted by the Hydrologic Engineering Center (HEC), further analyses were done to investigate the effect of varying uncertainty parameters as follows:

1. Stage-Discharge Rating Curves
2. Residential First-Floor Stage
3. Risk vs. No Risk

1. Stage-discharge rating curve: Further analysis was done to investigate the effect of various levels of uncertainty in stage-discharge on the recommended plan's BCR. Three levels of uncertainty were investigated – low, most-likely and high. The analysis reveals that reducing the stage-discharge uncertainty to a minimum value of 0.3 to 0.5 results in a BCR of 1.9. The "most-likely" value (as presented in the main economic appendix) results in a BCR of 2.1, while the highest stage-discharge uncertainty value results in a BCR of 2.7. As shown in Table 6-1 below, these changes to the stage-discharge uncertainty values do not significantly alter the final results and indicate that a significant change in stage-discharge uncertainty would not jeopardize project feasibility.

Table 6-1
SENSITIVITY IN STAGE-DISCHARGE RATING CURVES
(4.125%, 50-year Period of Analysis, FY09 Price Levels,)
(Thousands of Dollars)

Uncertainty in Stage-Discharge Rating Curve			
NED Average Annual Impacts	**Low (0.3-0.5 ft)**	**Best**	**High (1.5 ft)**
Total Annual Benefits	$17,693.5	$20,307.0	$25,670.2
Total Annual Project Costs	$9,544.2	$9,544.2	$9,544.2
Benefit/Cost Ratio	1.9	2.1	2.7

2. Residential First-Floor Stage: Further analysis was done to investigate the effect of various levels of uncertainty in the residential first floor stage on the recommended plan's BCR. Three levels of uncertainty were investigated – low, most-likely and high. The analysis reveals that reducing the first-floor uncertainty to a minimum of 0.5 feet results in a BCR of 1.8. The "most-likely" value (as presented in the main economic appendix) results in a BCR of 2.1, while the highest level of uncertainty in first floor elevation results in a BCR of 2.5. As shown in Table 6-2 below, these changes to the residential first-floor uncertainty values do not significantly alter the final results and indicate that a significant change in first floor stage would not jeopardize project feasibility.

Table 6-2
SENSITIVITY IN FINISHED FLOOR ELEVATIONS
(4.125%, 50-year Period of Analysis, FY09 Price Levels,)
(Thousands of Dollars)

Uncertainty in Finished Floor Elevations			
NED Average Annual Impacts	**Low (0.5 ft)**	**Best (1.44 ft)**	**High (1.5 ft)**
Total Annual Benefits	$17,600.5	$20,307.0	$24,235.9
Total Annual Project Costs	$9,544.2	$9,544.2	$9,544.2
Benefit/Cost Ratio	1.8	2.1	2.5

3. Risk vs. No Risk: Further analysis was done to investigate the effect of risk vs. no risk on the recommended plan's BCR. This analysis is only reasonable in establishing the relative importance of uncertainty in the study results. This sensitivity simply removes uncertainty from the analytical results, but does not remove the real uncertainties inherent in the data. This is the most dramatic and conservative of all the sensitivity analyses.

   The results of the risk vs. no risk sensitivity are shown in Table 6-3 below. By ignoring uncertainties inherent in the data, the recommended plan remains viable.

Table 6-3

SENSITIVITY ANALYSIS - RISK VS. NO RISK

(4.125%, 50-year Period of Analysis, FY09 Price Levels,)

(Thousands of Dollars)

With & Without Uncertainty		
NED Average Annual Impacts	**w/ Uncertainty (Best)**	**w/o Uncertainty**
Total Annual Benefits	$20,307.0	$12,614.8
Total Annual Project Costs	$9,544.2	$9,544.2
Benefit/Cost Ratio	2.1	1.3