U.S. Army Corps of Engineers, Kansas City District

Final Feasibility Report

EXHIBITS

Kansas Citys, Missouri and Kansas
Flood Risk Management Project
Final Feasibility Report

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Kansas

Missouri

Fairfax Jersey Creek Unit

North KC Unit

East Bottoms Unit

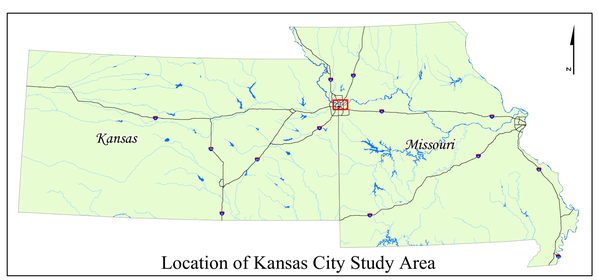
Birmingham Unit

Argentine Unit

Armourdale Unit

CID Unit

NW 68TH ST
NW 56TH ST
NW ENGLEWOOD RD
NE 64TH ST
NE BROOKTREE LN
PLEASANT VALLEY RD
HUGHES RD
NE 48TH ST
NE PARVIN RD
NE 40TH ST
NE BIRMINGHAM RD
STATE HWY 210
CROOKED RD
CNTY HWY FF
NW KLAMM DR
RT A HWY
WAUKOMIS
BROADWAY ST
ANTIOCH RD
CHOTEAU TRFWY
BRIGHTON AVE
RUSH CREEK
MISSOURI RIVER
MILL CREEK
SHOAL CREEK
LINE CREEK
Platte
Clay
Jackson
Wyandotte
BROWN AVE
QUINDARO BLVD
PARALLEL PKWY
WOOD AVE
N 27TH ST
N 5TH ST
FAIRFAX TRFY
ARMOUR RD
BEDFORD AVE
E LEVEE ST
FRONT RD
E FRONT ST
N GARDNER AVE
N CEMENT CITY RD
KENTUCKY RD
DICKINSON RD
MUNCIE
KANSAS
57TH ST
38TH ST
WESTVIEW DR
10TH ST
SPEAKER RD
SWARTZ RD
METROPOLITAN AVE
KANSAS AVE
E 9TH ST
E 12TH ST
E 15TH ST
E 23RD ST
E 31ST ST
E 35TH ST
E 39TH ST
TRUMAN RD
W 23RD ST
CUTOFF
SPRING
BLUE
BLUE RIDGE
S HARDY AVE
S STERLING AVE
S CRYSLER AVE
LEE SUMMIT RD
59TH ST
55TH ST
42ND ST
STEELE RD
SHAWNEE DR
TURKEY CREEK
MISSION RD
SW BLVD
SW TRFY
TROOST AVE
PASEO BLVD
INDIANA AVE



Location of Kansas City Study Area

River Miles
Levees
Highways
Roads
Levee Zones
Counties

0 1 2
Miles

Projection: GCS - Latitude/Longitude
Datum: 1983 North American
Sperhoid: GRS 1980
Semi-major axis: 6378137

Kansas City
Gladstone
North Kansas City
Independence
Riverside
Liberty
Birmingham
Claycomo
Avondale
Parkville
Pleasant Valley
River Bend
Sugar Creek
Randolph

Kansas Citys, Missouri & Kansas Levee Units

Mapped and edited by the
U.S. Army Corps of Engineers,
Kansas City District,
Geospatial Data Systems Team
Date: 09 JAN 2004
File Name: sevenlevees_overview.mxd

EXHIBIT #1

EXHIBIT #2: Photograph of 1951 Kansas River Flood at Kansas City

- **Kansas River flood event**
- **Kansas River Basin lakes not operational**
- **All 3 Kansas River units overtopped in Kansas City**

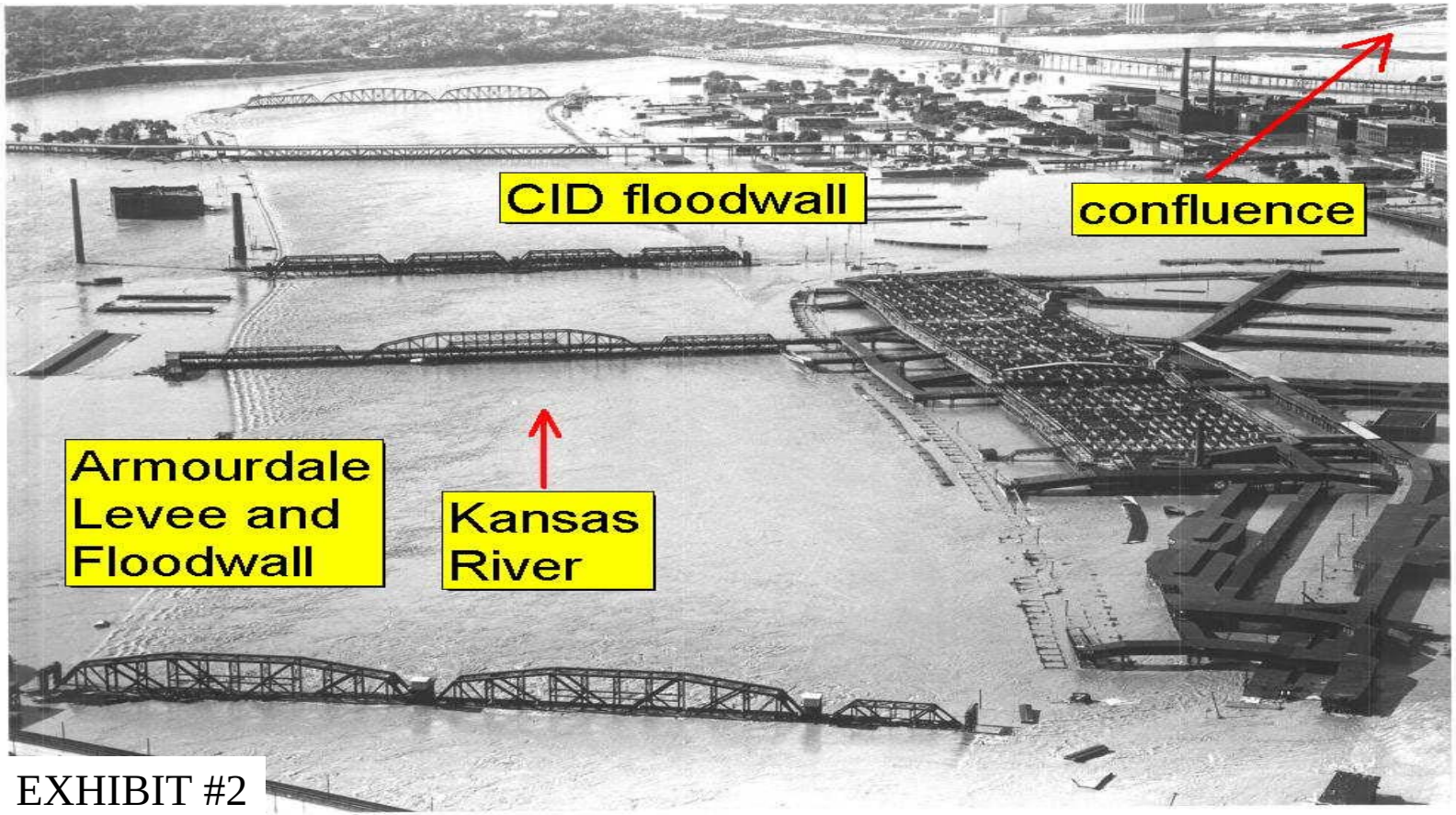


EXHIBIT #2

EXHIBIT #3: 1993 Flood Event Hydrograph
Kansas City Gage – Missouri River

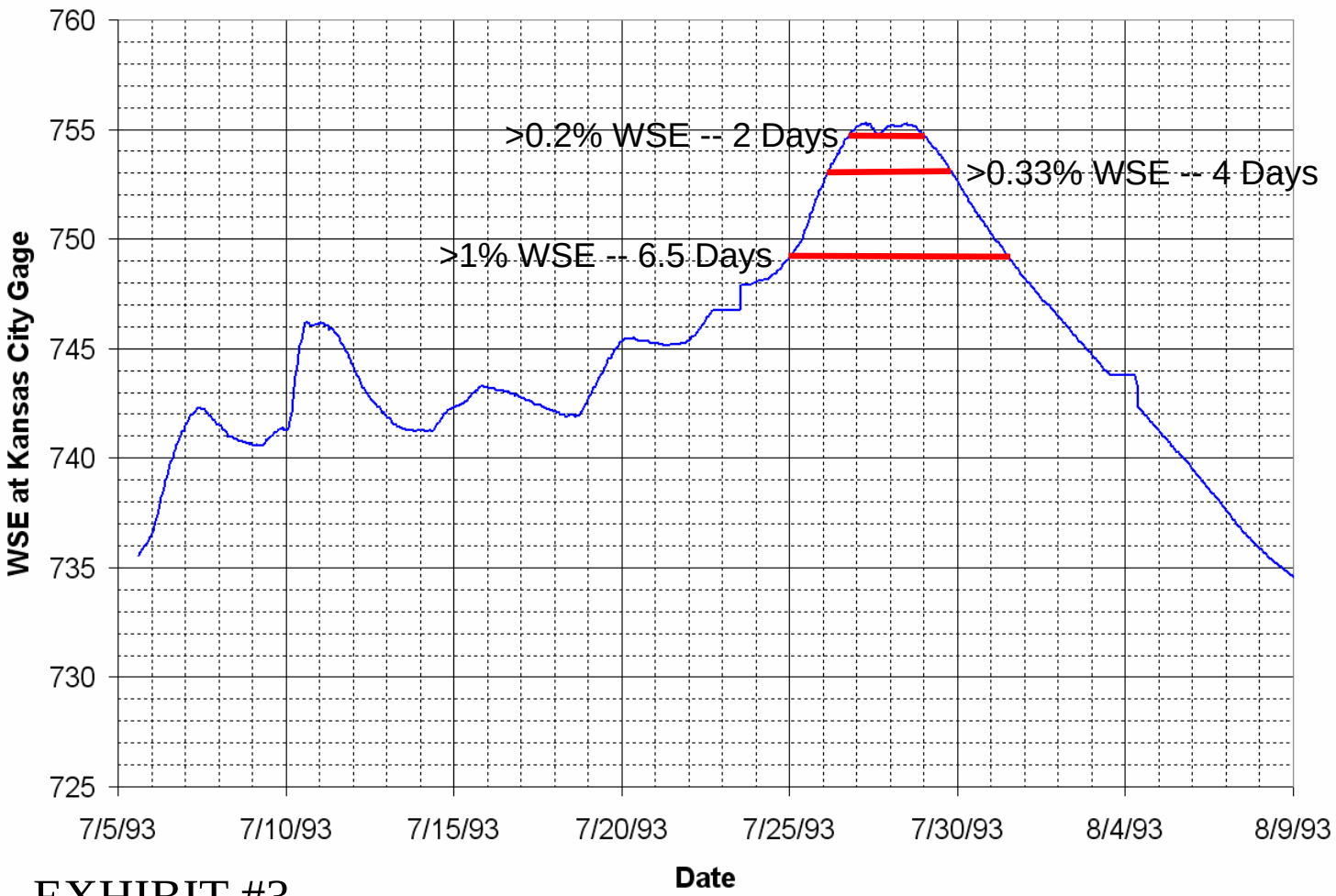


EXHIBIT #3

EXHIBIT # 4: ADDITIONAL DESIGN AND CONSTRUCTION CONSIDERATIONS

Additional descriptions of site-specific design and construction requirements for implementation of the Recommended Plan are listed below.

Levee Raise Design and Construction Considerations

In general, the following two factors will affect design and construction along several areas of the levee raise.

- Several areas along the Armourdale levee were identified as Hazardous, Toxic, or Radiological Waste (HTRW) sites. A section within the main feasibility report describes HTRW considerations of the Recommended Plan. Design and construction procedures need to recognize these sites and adapt accordingly. Construction cannot normally occur on top of contaminated soil.

- The Recommended Plan for the Armourdale and CID raises involves no permanent impact to existing railroad tracks, but the design and construction in for all areas with adjacent railroad tracks does require coordination with the railroads. Trains may need to be temporarily re-scheduled so as to allow movement of construction equipment into and out of the construction area.

Armourdale T-wall on Levee Construction. The pre-construction coordination should include careful planning sessions where the T-wall procedures are sequenced and scheduled to avoid undue delays with an open levee crown. During T-wall construction, the levee crown is removed along with any rip rap cover. The T-wall installation proceeds and then the levee crown is rebuilt as soon as practical.

Utility Crossings. Utilities crossing the Units were studied to estimate the costs for relocation or removal of (functioning or abandoned) utilities, and for the real estate implications related to preliminary compensability determinations. As a general rule, pressure pipelines passing through or under the levee are generally relocated over the raised levee. An additional amount of earth cover tops off the utility lines and the resulting “mound” is sloped on each side to allow vehicular transverse. Normally these utility lines are hot-tapped thus maintaining service to customers during construction.

Bridges and Roadways. The Recommended Plan does not require any bridge superstructure modifications, nor does the Recommended Plan require any road realignments. Transportation of levee raise materials may at times increase traffic along nearby roadways but this area is industrial and truck traffic is common.

The final grade and slope on the raised top-of-levee access road needs close coordination with the sponsor. The raised top-of-levee road incorporates up-and-over utility crossings under the Recommended Plan. The design for these crossings points and the amount of roadway cover should allow vehicular traffic (such as passenger cars and trucks) to traverse the crossings with relative ease. The design of the top-of-levee road may need some realignment to maintain required minimum clearance under the I-635 bridge structure.

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EXHIBIT #5
PERSPECTIVES and DISCUSSION ON
KANSAS CITYS LEVEES PERFORMANCE ANALYSIS

Principles of Flood Risk Management Planning and Associated Analysis
The Corps of Engineers functions and operates in accordance with laws established by Congress. The Corps develops policy and guidance for implementation of the laws under which it operates. The laws, and Corps policy and guidance, provide for the use of prescribed methodologies and nationwide uniformity in the Corps planning process. Corps planning products are reviewed locally, independently, and by three levels of Washington review, i.e., Corps Headquarters, Assistant Secretary of the Army for Civil Works, and Office of Management and Budget. Reviews not only ensure consistency and accuracy in the application of the prescribed methodologies, but determine and confirm that the work was completed with adherence to guidance, policy and the law.

The structured and uniform planning process implemented and followed by the Corps of Engineers is documented in Engineering Regulation 1105-2-100, Planning Guidance Notebook. This regulation is grounded in the laws which apply to the Civil Works Program and to the Corps of Engineers missions, and is particularly based on the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (March 10, 1983). The P&G were established pursuant to Section 103 of the Water Resources Planning Act (Public Law 89-80) and Executive Order 11747.

Corps policy and guidance provide for proper and consistent planning in the formulation of reasonable plans responsive to National, State, and local concerns. The resulting plans recommended for implementation are economically and environmentally sound and in general reasonably maximize net national economic development benefits, consistent with protecting the Nation's environment (NED plan). Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, and are the direct net benefits that accrue in the planning area and in the rest of the nation as a result of project implementation.

The Corps uniform planning process includes certain fundamental principles in the analysis of flood risk management alternatives. These principles include, among others:

- With and Without-Project Analysis. The without-project condition is the most likely condition expected to exist in the future in the absence of a proposed water resources project. The future without project condition constitutes the benchmark against which plans are evaluated.

- Benefit-Cost Analysis and Cost Effectiveness Analysis. This is a framework used in evaluating government investments. All pertinent costs and effects of a proposed project are systematically identified and tallied. The stream of monetized benefits that occur through time with project implementation are accumulated and are discounted to a base year in order to express a single total benefit figure. Similarly on the cost side the same accumulating and discounting process is conducted so the costs are also expressed as a single value in the base year. This process allows direct comparison of benefits and costs on a common basis. If the benefits exceed the costs the project is considered economically justified. Allowable benefits categories and required cost categories to be

used in analysis of Corps water resource projects are standardized across the nation. Cost effectiveness analysis seeks to answer the question: given an adequately described objective, what is the least-costly way of attaining that objective.

- Net Benefits, Optimization Analysis. Benefits can be monetary or non-monetary. The scale of flood risk managment alternative that reasonably maximizes expected net benefits (returns the greatest excess of benefits over costs) is the National Economic Development (NED) Plan.

- Risk and Uncertainty. Risk-based analysis is defined as an approach to evaluation and decision making that explicitly, and to the extent practical, analytically, incorporates considerations of risk and uncertainty in a flood risk management study. In water resources planning, risk-based analysis is used to compare plans in terms of the likelihood and variability of their physical performance, economic success, and residual risks. It captures and quantifies the extent of risk and uncertainty in the various planning and design components of an investment project.

Risk Based Analysis of Flood Risk Management Alternatives

Flood risk management projects can significantly reduce risk of flooding, but 100% absolute protection from flooding is not an achievable goal. A zero residual risk does not exist because no project can completely eliminate natural hazards. Flooding may occur less frequently but there is always some residual risk of flooding after implementation of any flood risk management project.

Historically, many flood control projects were planned, designed, and constructed on the Standard Project Flood (SPF). The SPF was generated using modeling techniques to determine a single target design discharge. In later years, the SPF may have been associated with a return interval to describe an expected level of protection for a given flood control project. In the context of risk analysis guidance, the SPF is no longer used for a “target design”. Instead, a range of floods, including those that exceed the SPF, are to be used in formulation and evaluation of alternatives. The historic SPF method relied on safety factors and freeboard, estimates of worst case scenarios, and other indirect methods to compensate for uncertainty. These indirect methods were necessitated due to the mathematical complexities involved in computing the interaction of uncertainties in hydrologic, hydraulic, and economic functions. However, with computational advances it is now possible to describe these uncertainties explicitly and calculate that interaction.

For risk and uncertainty analysis, the Corps of Engineers uses risk-based analysis procedures for formulating and evaluating flood risk management measures according to guidance in Engineering Manual 1110-2-1619, Engineering and Design Risk Based Analysis for Flood Damage Reduction Studies; and in Engineering Regulation 1105-2-101, Planning Risk Analysis for Flood Damage Reduction Studies. Risk and uncertainty arise from measurement errors and from the underlying variability of complex natural, social, and economic situations. Flooding is random in nature and flood problems are multi-dimensional making it difficult to fully understand, document, and model the physical nature of flooding, its magnitude, its probability of occurrence, and its consequences. Risk is defined as the probability an area will be flooded, resulting in undesirable consequences. Uncertainty is a measure of imprecision of knowledge of parameters and functions used to describe the hydraulic, hydrologic, geotechnical, structural, and economic aspects of a project plan.

In water resource planning for flood risk management, uncertainties in the hydrologic and hydraulic data about discharges and flood stages, uncertainties in economic data about investment values, beginning damage elevations, and damages with various flood depths, and uncertainties about the potential for geotechnical or structural failure of features in an existing flood control project can have significant impact on the residual damages, benefits, costs, planning, design, and reliabilities of a proposed flood control project.

To develop a risk based analysis as required by regulation, the Corps uses the HEC (Hydrologic Engineering Center) Flood Damage Analysis (HECFDA) model. The HECFDA model combines the engineering and economic study data to determine economic performance (flood damages) and engineering performance (probability of design exceedance) with and without a flood control project. The HECFDA model uses the Monte Carlo simulation process which incorporates the risk and uncertainties associated with the required HECFDA input values.

Planners cannot know with full certainty the exact value of a variable that may ultimately be important to the selection and implementation of a plan. The analysis instead considers a best estimate of the value, and recognizes the uncertainty inherent in that value by also using other possible values (often in terms of input curve). The range of outcomes in some areas of risk and uncertainty can be reasonably described or characterized by a probability distribution. Certain future demographic, economic, hydrologic, and meteorological events are essentially unpredictable because they are subject to random influences; however the randomness can sometimes be described by a probability distribution based on historical data. If there is no historical database, the probability distribution of random future events can be described subjectively, based on insight and judgment.

Key variables explicitly incorporated into the risk based analyses used in the Kansas Citys feasibility study included the following:

- Hydraulic uncertainty. A stage-exceedance probability function was developed from the water surface profiles and a normal probability distribution was selected. Conveyance roughness and cross-section geometry were evaluated to determine a standard deviation of 1.5 feet in the base year and 1.8 feet in future years for uncertainty in river elevation, given a certain discharge.

- Hydrologic uncertainty. A graphical discharge-frequency exceedance probability function was developed in the HEC-FDA model for each reach based on a 70 year period of record. The distribution of errors is assumed to be a non-central t-distribution about the specified function.

- Investment value uncertainty. Interview data about most likely structure and content values, and the minimum and maximum range of values for each were obtained from business owners and representatives and entered into HEC-FDA. For structures that did not have specific data obtained by surveys and interviews, expected values for structures and contents were estimated using Marshall & Swift professional valuation software or from locally obtained study area data for similar businesses. The uncertainty was defined using a normal or triangular probability distribution, depending on the type of structure and category of damage, and any other specific data available.

- Structure and beginning damage elevation uncertainty. Uncertainties about ground and first floor elevations (beginning damage elevations) were determined based on two and four foot contours on study area mapping. Uncertainties were determined per guidance in Engineering Manual 1110-2-1619, Risk Based Analysis for Flood Damage Reduction Studies.

- Depth-damage relationship uncertainty. Structure occupancy types were defined for each type of structure and category of damage. The structure occupancy code defines the depth-percent damage function and its uncertainties. Normal and triangular probability distributions were used based on the category of damage, type of structure, and type of use.

- Uncertainty about geotechnical or structural failure. Probabilities of geotechnical and structural failure in each unit were developed using engineering analysis. Geotechnical and structural engineers determined the most likely expected modes and sites of failure prior to overtopping in each unit. A range of conditional probabilities of failure versus river stage elevation encompassing the probable failure point and non failure point were determined for each site/mode of failure. The river elevation versus probability of failure relationship developed by the geotechnical and structural engineers for each potential failure site/mode was then translated to the index point of the reach (levee unit) and each individual potential failure site/mode was determined to be independent. The probabilities of failure for each site/mode were then combined using a formula contained in ETL 1110-2-556 to derive a single combined probability of failure versus river stage curve that accounted for all the sites or modes of potential failure. The resulting combined probability of failure curve was then entered into the HECFDA study file.

Future With-and Without-Project Condition Economic Performance

Economic Performance of Overall Plan. Implementation of the recommended plan (NED plan) in each of the units addressed in the final feasibility report will provide significant reduction in physical flood damages and other costs that result from flooding. The damages reduced represent the benefits provided by the recommended plan and are typically characterized in terms of annualized equivalent values as computed in the HECFDA program.

The table on the following page summarizes the equivalent annual damages that would be expected to occur with and without the recommended plan. The uncertainties in evaluation of project benefits are characterized in the far right three columns of the table.

Equivalent Annual Damages and Damages Reduced (Oct 2012 Prices, 5.125% Inter Rate, 50 Yr Period of Anal, $000

Plan	Top of Levee/ Floodwall Elev (ft)	Expected Value and Probabilistic Values of EAD and EAD Reduced					
		Equivalent Annual Damage			Probability EAD Reduced Exceeds Indicated Amount		
		Without Plan	With Plan	Damage Reduced	.75	.50	.25
ARMOURDALE UNIT							
Future **WITHOUT** Project							
Future **WITH** Project:							
CENTRAL INDUSTRIAL DISTRICT							
Future **WITHOUT** Project							
Future **WITH** Project:							

Future With- and Without-Project Condition Engineering Performance

Conditional Probability of Design Non-Exceedance. One of the many metrics that can be used to characterize the performance of a flood risk management project is overall project reliability against the 1% event. Project reliability is characterized in the HECFDA model by the probability of the project design containing a specified event or the probability of design non-exceedance. Overall reliability against the 1% event and other engineering performance data include consideration of both the probability of overtopping and also the probability of geotechnical and structural failure.

The table below displays for each unit addressed in the Final Feasibility Report the with- and without- project condition overall project reliability against the 1% probability event, and shows the top of levee margins above the 1% and 0.2% event water surface profile.

FUTURE CONDITION OVERTOPPING MARGINS AND OVERALL RELIABILITY AGAINST THE 1% CHANCE EVENT WITH AND WITHOUT PROJECT				
	Top of Levee/ Floodwall Elev. at Index Point (ft, msl)	**Overtopping Margin (ft) Above 1.0% Chance Event Profile**	**Overtopping Margin (ft) Above the 0.2% Chance Event Profile**	**Overall Reliability Against the 1% Chance Event (includes geotechnical and structural risk considerations)**
ARMOURDALE UNIT				
Future **WITHOUT** Project				
Future **WITH** Project				
Net Change in Margins and Overall Reliability				
CENTRAL INDUSTRIAL DISTRICT UNIT				
Future **WITHOUT** Project				
Future **WITH** Project				
Net Change in Margins and Overall Reliability				

**Any discrepancies due to rounding

Levee Performance in Any Given Year and Equivalent Long-term Risk. Long-term risk indicates how successfully a flood control project would protect against floods given the uncertainties and over a long period of time. Annual Exceedance Probability is the probability that flooding will occur in any given year considering the full range of possible annual floods. (*Note:* The terms "exceeded" or "exceedance" when used herein with regard to engineering performance data include consideration of both geotechnical and structural failure potential and consideration of the potential for levee overtopping.)

For each of the units addressed by the Final Feasibility Report, the table below shows the long-term risk or probability of the project being exceeded in a 10-, 25-, and 50-year period, with and without the recommended plan for each unit. The table below also shows the expected probability of the levee design being exceeded (occurrence of flooding) in any given year.

ENGINEERING PERFORMANCE IN ANY GIVEN YEAR AND EQUIVALENT LONG-TERM RISK WITHOUT- PROJECT AND WITH-PROJECT RECOMMENDED PLAN					
	Top of Levee/ Floodwall Elevation (ft msl) at Index Pt.	**Annual Exceedance Probability (Expected Probability that Flooding Will Occur in any Given Year)**	**Equivalent Long-Term Risk (Probability of Exceedance Over the Indicated Time Period) (includes geotechnical and structural risk considerations)**		
			10 Years	25 Years	50 Years
ARMOURDALE UNIT					
Future **WITHOUT** Project					
Future **WITH** Project					
Net Change in Probability of Exceedance (Flooding)					
CENTRAL INDUSTRIAL DISTRICT UNIT					
Future **WITHOUT** Project					
Future **WITH** Project					
Net Change in Probability of Exceedance (Flooding)					

Note: Any discrepancies due to rounding

As shown in the table on the following page, long term risk can be alternatively described in terms of chance of flooding in any one year or in a specified time period.

ALTERNATIVE DISPLAY OF ENGINEERING PERFORMANCE IN ANY GIVEN YEAR AND EQUIVALENT LONG TERM RISK WITHOUT PROJECT AND WITH-PROJECT RECOMMENDED PLAN					
	Top of Levee/ Floodwall Elevation at Index Point (ft msl)	**Chance of Exceedance (Flooding) in any Given Year**	**Equivalent Long-Term Risk (Chance of Exceedance Over the Indicated Time Period) (includes geotechnical and structural risk considerations)**		
			10 Years	25 Years	50 Years
ARMOURDALE UNIT					
Future **WITHOUT** Project					
Future **WITH** Project					
CENTRAL INDUSTRIAL DISTRICT UNIT					
Future **WITHOUT** Project					
Future **WITH** Project					

Note: Any discrepancies due to rounding

Residual Risk.

In an environment where competition for public funds is keen, most communities cannot be made 100% safe from the threat of flooding. It is important that floodplain occupants are aware of the nature of the flood threats and are able to make informed decisions about acceptable levels of risk. Often, however, the concepts of risk and probabilistic characterizations are difficult to understand.

The tables presented in this paper show that the recommended plan for the units addressed by this final feasibility report provides a significant increase in reliability against flooding. Flooding will be less frequent; however, the analyses show there is still residual risk of flooding. For the Corps, determining an acceptable level of risk is in most cases a function of the NED process. The goal is to manage the risk of flooding within limited budget and funding constraints, and yet implement a cost effective and efficient flood risk management plan that reasonably maximizes net economic benefits (flood risk management benefits) consistent with protecting the Nation's environment (NED plan).

From the Federal perspective, selection of the NED plan as the recommended alternative is a determination of an acceptable level of residual risk based on trade-offs between potential benefits and the associated level of residual risk versus the cost of a larger and more risk-adverse flood risk management project. Increases in project reliability above what is provided by the NED plan can sometimes be achieved with much larger projects. However, in most instances, costs for larger projects increase dramatically faster than project benefits. The NED plan maximizes net benefits as measured by the difference between annual benefits and annual costs.

From the local perspective, a community or sponsor may desire less residual risk of flooding than that provided by the NED plan. Many persons in a community might express the desire for zero residual risk and no chance of damage from a recurrence of flooding, even though this is an economically unattainable goal. The level of risk a community (or sponsor) is willing to bear can be indicated by their willingness to pay for each additional increment of flood risk reduction. In accordance with Federal law, if a larger (more costly) "Locally Preferred Plan" than the NED plan is selected (a plan that may have higher benefits, higher costs and fewer net benefits than the NED plan), the project sponsor is required to "buy-up" or pay the difference in cost between the NED plan and the Locally Preferred Plan.

Other Considerations Related to Risk and Reliability

It is important to bear in mind the variability and uncertainty associated with the inputs to a risk and uncertainty analysis.

- Care must be taken to consider the entire output of the analysis rather than placing undue reliance on any one statistic.
- Such simulations are sensitive to assumptions about correlations between parameters, the likelihood that a particular specification is correct, any omitted factors, and assumptions about the appropriate distribution for parameters, etc.
- Generally, the quality of the overall analysis is reflective of the quality (or accuracy) of its input components.

This final feasibility study is, in many respects, a groundbreaking effort with regard to the scale and scope of effort. In the past, many Corps studies have been performed using risk and uncertainty principles for planning smaller levee systems limited to flood events at or about the 1% event. The target conveyance in the original authorizations places this system in the upper echelon of U.S. levee systems. This makes it difficult for direct comparisons to other levee systems of the results and reliabilities produced by this analysis. The possibility for better characterization and comparison for residual risk is expected as the number of larger levee systems analyzed using risk and uncertainty principles increases over time.

In general, water resource development and planning continues to be a field where judgment and context plays a vital role. There can never be one exact solution to all conceivable issues. The feasibility process undertaken in this study allows for a reasoned and systematic approach to formulating plans. However, natural environments and especially the dynamic characteristics inherent in river systems, remain subject to re-interpretation and refinements as the knowledge base and experience with those systems grow over time.

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Kansas City Levees
Armourdale Unit

Levee/Floodwall Configuration
Current and Proposed N500+3

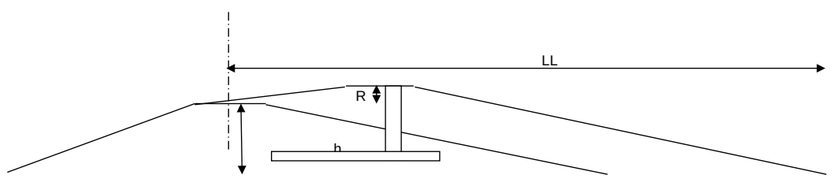
DRAFT - WORKING COPY
Date: Jan 31, 2013

Unit Descriptions				Existing			Proposed				HTRW	Real Est. (RE)	
Map Sheet #	Station Beginning	Station Ending	Length of Unit FT	Description	Relief Well Systems, Pump Plants, and Stability Features	Primary Levee Height (h) FT	Description	Stability Control Needed	Under-seepage Control	Proposed Primary Levee Raise R=N500+3 FT	HTRW	Real Estate Notes	Notes
A1	00+05UE	3+25UE	320	Stop log Gap		13	New SLG			3.8		RR lost time issues if traffic stopped	Busy RR crossing will make replacement a challenge. Existing SLG is integral with forcemain valve.
	3+25UE	10+00UE	675	Levee		9	Riverside Levee Raise	L Berm		3.8		No RE Issues at this time	H&H input needed for this riverside Levee Raise.
	10+00UE	16+48UE	648	Levee	13+50 to 14+50: Riverside Slope Stability Berm	9.5	Modify F-AC					No RE Issues at this time. Coordination for removal of abandon RR tract required.	RR tracks are landside. Two out fall structures (Mattoon Creek is one) are riverside. Floodwall will reduce RR and outfall issues.
	16+48UE	20+08.89UE	360.89	Levee		9.5	Levee Raise			3.9		No RE Issues at this time	High Ground landside above top of existing levee.
	Station Equation: 20+08.89UE BK = 9+71.16AH.												
	9+71.16	15+00	528.84	Levee		9.5	Levee Raise			3.9		No RE Issues at this time	High Ground landside above top of existing levee.
	15+00	35+00	2000	Levee		4 to 6	Levee Raise	Flattened Slope		4.1		May go beyond current right-of-way when the estimated 15 feet of permanent and 15 feet of temporary right-of-way is added. May get into abandoned rails. Looking at UP ownership.	
	35+00	42+50	750	Levee		13.5	Levee Raise	Flattened Slope w/ Berm		4.1		Will go beyond current right-of-way. Estimate up to 15 feet of permanent and 15 feet of temporary right-of-way will be needed. Will get into abandoned rails. Looking at UP ownership.	Need to confirm we can take abandoned RR - 1 set exists
A2	42+50	58+00	1550	Levee		11.5 to 13.5	T-wall on exist Levee	Flattened Slope w/ Berm		4.3	HTRW A	Potential P&G interference. RR @ toe of levee. Not in use. Need to identify the track owner. Loss of operation area and fence replacement. Fencing will have to be replaced.	1 set Rails visible but unused
	58+00	60+40	240	Levee		11.5 to 13.5	Modify F-AC				HTRW A	Area for temporary right-of-way will be limited	Floodwall to avoid Procter & Gamble
	60+40	77+80	1740	Floodwall	Osage PP Sta 76+83	11 to 15	Replace F w/ F-AC		COW starts at 62+00	4.3	HTRW A	No RE Issues at this time	Positive cut off wall to bedrock with be used for underseepage 62+00 to 82+00. Riverside earthen levee raise was considered but deemed too costly compared to floodwall. Environmental impacts are minimized with floodwall.
	77+80	81+00	320	Levee	Osage PP Sta 76+83	13	Replace L with F-AC		COW	4.6	HTRW A	Determine compensability of KAW Valley Power utilities.	Positive cut off wall to bedrock with be used for underseepage 62+00 to 82+00. KAW PP utilities will be cut off due to slurry wall. This includes all intake lines, discharge lines and associated utilities. Intake access bridge will be removed. Intake bridge is owned by KAW PP . Osage Pump Plant and Piping to remain. KAW PP Seiling weir drainage structures' and pipes exist and must be cut for installation of cutoff wall. With T-wall or levee at 77+78 would possibly interfere with operational RR tracks.
A3	81+00	96+00	1500	Levee		11 to 12	Levee Raise	Flattened Slope	COW End Sta. 82+00	4.8		No RE Issues at this time	Trash may have been dumped near area proposed for levee expansion.
	96+00	105+00	900	Levee		11	T-Wall on Levee	Flattened Slope w/ Berm		5.2		Storage Silo, Maint Bldg and Access Road possibly affected. Relocation needs to be determined. The need for estimated permanent and temporary easement will affect building, access road, and maneuver area. Land survey required to verify current easement line.	Twall to avoid KC Hardwood property. 58' to building but access to bldg is needed between levee and bldg. T-wall on bridge will jog around bridge piers. Need to route levee road to the land side to avoid 18th St. Bridge pier.
	105+00	129+00	2400	Levee		8.5 to 14	Levee Raise	Flattened Slope (w/ Berm 115 to 129)		5	HTRW B	Land survey essential to determine correct right-of-way. Both salvage yards and KC Railway will be affected by perm easement. Work area easement on KC Railyard also of concern.	
A4			12th Street Bridge Crossing				New SBG						
	129+00	157+00	2800	Levee	12th Street PP Sta 129+00; Mill St PP Sta 156+75	5.5	T-Wall on Levee	Flattened Slope		4.8	HTRW C	May go beyond current right-of-way. Estimate that will need 30 additional feet. Ditch at Station 155+00, between Trimodal and adjacent landowner to east, will need to be maintained with fill for integrity of project (this will require a permanent easement). Land survey required to verify existing easement line, encroachments and determine additional ROW required	T-wall extended upstream to reduce impacts that a levee raise would have on the 12th Street Pump Station. T-wall extended downstream to reduce impacts that a levee raise or T-wall would have on the Mill Street Pump Station. Access onto Trimodal Container Recycling has been discussed with Corps attorney and preliminary review indicates we will be able to allow contractor to drive on top of the area. This is pending a review by a Real Estate Attorney who would look into the Construction Easement issues.
A5	157+00	172+50	1550	Levee		4.5	Levee Raise	Flattened Slope	Fill ditch behind Mill St. PP	4.6	HTRW C	No RE issues at this time	
	172+50	185+00	1250	Levee		4.3	T-Wall on Levee	Flattened Slope		4.5		Appears to be within existing right-of-way except for approximately 30 feet of permanent and temporary easement requirements. Additional 30 feet will interfere with access roads, loading dock, parking, storage areas, power lines and fire hydrant.	
	185+00	197+00	1200	Levee	5th St PP Sta 185+70, W-I; Midwest Cold PP Sta 194+60	14 to 15.5	Modify F-AC		RW	4.3		No RE Issues at this time but limited RE available for work area.	Floodwall extended upstream to reduce impacts on 5th Street P.S. with a levee raise or T-wall and berm. Midwest Cold Storage building may need to be evaluated due to its old age and closeness to the levee
	197+00	206+12	912.43	Levee	W-I	10.5 to 13	Levee Raise	Flattened Slope	RW	4.3		Acq of approximately 20 ft of parking areas, storage area, and note diesel tanks at station 204+05 (this may require relocation). Land survey required to verify existing easement line, have attorney review the survey to determine any adverse possession rights entitled to landowner.	Raise Well Manholes w/ Levee Raise. Relief well collection system W-I is deep. Addition to or replacement of will be difficult.
	Station Equation 206+12.43 BK = 212+00 AH												
	212+00	227+85	1585	Levee	W-I	15	Modify F-AC		RW	4		No RE Issues at this time	Floodwall reduces impacts on adjoining businesses.

Unit Descriptions				Existing			Proposed				HTRW	Real Est. (RE)	
Map Sheet #	Station Beginning	Station Ending	Length of Unit FT	Description	Relief Well Systems, Pump Plants, and Stability Features	Primary Levee Height (h) FT	Description	Stability Control Needed	Under-seepage Control	Proposed Primary Levee Raise R=N500+3 FT	HTRW	Real Estate Notes	Notes
A6	226+75			SLG			New SLG : KCT Bridge					RR lost time issues if traffic stopped	
	227+85	24000	1215	Levee	Shawnee Ave Sta 230+78; W-I	15 to 17	T-Wall on Levee	Flattened Slope w/ Berm	RW	4		Abandon RR visible. Building concerns at Sambol, SELCO and Pensky. Significant loss of parking and maneuver areas.	
	240+00	257+66.26	1766.26	Floodwall/Levee	W-I	13 to 16.5	Modify F-AC		RW	3.8		RR lost time issues if traffic stopped	CRI&P stop log gap at 249+54 has been filled in with concrete. Floodwall extended to reduce impacts on adjoining businesses having parking area and substantial loading docks. Reach includes approx. 367 lf of existing floodwall.
A7	Station Equation 257+66.26 BK = 257+64.97 AH												
	257+64.97	261+50	385.03	Floodwall	W-II	13	Modify F - New Row of Piles		Fill Slot ARW	3.5		Possible temporary lost parking due to work area easement	
	261+50	274+36	1286	Floodwall	W-II		Modify F - No New Piles		Fill Slot ARW	3.5		Possible temporary lost parking due to work area easement	
	274+36	277+21	285	SBG x 2	W-II		SLG x 2		Fill Slot ARW	3.5	HTRW D	RR lost time issues if traffic stopped	UP and MO Pac RR Bridge Closure Structure. Major coordination with RR will be needed during detailed design.
	277+21	283+50	629	Floodwall	W-II		Modify F - No New Piles		Fill Slot ARW	3			
	283+50	295+50	1200	Floodwall	W-II; KCS RR PP Sta 276+79; PBI Gordan PP Sta 286+59	12.5	Modify F - New Row of Piles		Fill Slot ARW	3	HTRW D	RR visible but not in use under bridges (slot area). Need to ID RR ownership and verify activity. Possible temporary lost of parking due to work area easement.	PBI Gordan currently expanding upstream toward the RR crossing. KVDD should watch construction activity to make sure no spoiling or disposal done in KVDD ROW. Floodwall proximity to KCS Pump Station may prove very challenging during construction.
A8			Cetnral Avenue Bridge Crossing				New SBG						
	295+50	302+58	708	Floodwall	W-III; National Beef PP Sta 295+52; Central Ave PP Sta. 299+20	17.5 to low ground	Modify F - New Row of Piles		RW	1.8		Need to ID RR ownership and verify activity. Ponding area will require a flowage easement, Two pump stations will be removed and not replaced.	A levee requires removal of pump station and well system W-III. Levee requires replacement and realignment of Cent. Ave. Off ramp. Central Ave. off ramp is in poor condition. Removal of pump stations will create a ponding area near the APAC property.
	302+58	315+00	1242	Levee		12 to 17.5	Levee Raise	Flattened Slope	RW	1.3		Temp work area may be within UP ROW	
A9	315+00	322+85.41	785.41	Levee		4 to 9	Levee Raise	Flattened Slope		1.2		Temp work area may be within UP ROW	
	Station Equation 322+85.41 BK = 39+71.83 L.E. AH												
	39+71.83LE	42+50LE	278.17	Levee		4 to 9	L	Flattened Slope		1.2		Temp work area may be within UP ROW	
	42+50LE						New SBG					RR lost time issues if traffic stopped	Since end of unit is currently high ground, the raise will end near 42+50 with a sandbag closure across the railroad.
	42+50LE	61+00LE	1850	Levee			No Raise						End authorized levee unit ~2000 feet sooner with closure structure

Legend and Notes

**	Dimension is for entire levee footprint including stability controls on landside and riverside of levee
***	Dimension from centerline of existing levee to proposed toe includes any stability berms recommended.
L	Levee
COW	Cut off Wall for underseepage
F-AC	Floodwall with auger cast piles
ROW	Right of Way
SLG	Stop Log Gap (not all are shown)
SBG	Sand Bag Gap (not all are shown)
RW	Relief Well
W-I	Relief Well System I (Station 190+75 to 246+35) - Pumped by Shawnee Ave Pump Plant
W-II	Relief Well System II (Station 268+11 or 268+59 to 282+29) - Pumped by KCS Railroad Pump Plant
W-III	Relief Well System III (Station 296+23 to 302+40) - Pumped by Central Ave. Pump Plant
Osage	Osage Pump Station Area
RW	Relief Well
ARW	Abandon Relief Well
R	Height of Levee Raise
h	Existing Levee Height
LL	Landside Levee Width (measured from centerline of existing levee or floodwall)
HTRW A	Station 45+00 to 75+00 - Proctor and Gamble has evidence of VOCs in GW 11 & 12. Relief wells in this area may impact the contamination in the groundwater. Sta 45 to 60 - Proctor & Gamble: HTRW testing is recommended if plans call for the disturbance of soil in the fire training area.
HTRW B	Sta. 110 to 130: HTRW Testing recommended during design if plans require disturbing soil within the auto salvage yards.
HTRW C	Sta. 135 to 157: Superfund landfill and cover system adjacent to the property line. Excavation or relief wells in this area will impact the Superfund site which is not desired. Coordination with EPA is recommended for any work on site.
HTRW D	Sta. 277 to 295 - PBI Gordon: Pesticides have been found in this area. Additional investigation of the soil and groundwater is recommended prior to expansion of existing ROW limits or any relief well system.



h	existing levee height (ft)
R	proposed levee raise (ft)
LL	proposed dimension from centerline of existing levee to proposed toe (including any stability berms)

Kansas Citys Levees
Central Industrial District Unit - Kansas

Levee/Floodwall Configuration
Current and Proposed N500+3

DRAFT - WORKING COPY
Date: Jan 31, 2013

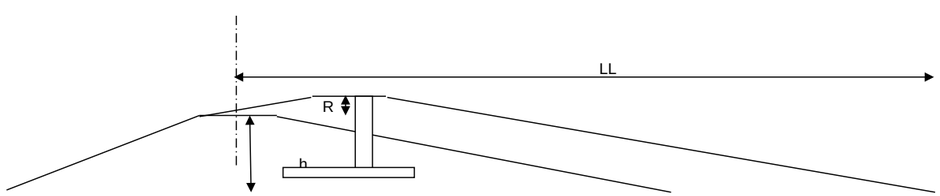
Unit Descriptions				Existing			Proposed					HTRW	Real Est. (RE)	
Map Sheet #	Station Beginning	Station Ending	Length of Unit FT	Description	Relief Well Systems, Pump Plants, and Stability Features	Primary Levee Height (h) FT	Description	Stability Control Needed	Under-seepage Control	Existing Centerline to Proposed Toe Dimension (LL), FT ***	Proposed Primary Levee Raise R=N500+3 FT	HTRW	Real Estate Notes	Notes
A1	83+01.29	85+00	198.71	Levee	Ohio Ave Pump Plant Sta 83+52	7.90	No Raise	na		NA	0.00		See Note A - Sheet M2	
	85+00	89+37.34	437.34	Levee		7.90	No Raise	na		NA	0.00		See Note A - Sheet M2	
	Station Equation STA 89+37.34 BK = STA 0+00 AH													
	0+00	5+00	500	Levee		0.00	No Raise	na		NA	0.00		See Note A - Sheet M2	
	5+00	10+00	500	Levee		0.00	No Raise	na		NA	0.00		See Note A - Sheet M2	
	10+00	15+00	500	Levee		0.00	No Raise	na		NA	0.00		See Note A - Sheet M2	
	15+00	18+15	315	Levee		0.00	No Raise	na		NA	0.00		See Note A - Sheet M2	
	18+15	19+73	158		Railroad Bridge								See Note A - Sheet M2	
	19+73	20+00	27	Levee		3.90	Levee Raise	na		25	0.20		See Note B - Sheet M2	Start of levee raise at station 19+73
	20+00	25+00	500	Levee		3.90	Levee Raise	na		25	0.70		See Note B - Sheet M2	
	25+00	25+90	90	Levee		3.90	Levee Raise	na		25	0.80		See Note B - Sheet M2	
	25+90	26+72.66	82.66		James Street Bridge Crossing					3.25	1		See Note A - Sheet M2	
	26+72.66	30+00	327.34	Floodwall	Cut off Wall at Sta 26+72.66	11.5	Modify Floodwall			3.25	1.1		See Note C - Sheet M2	
	30+00	32+50	250	Floodwall		11.5	Modify Floodwall			3.25	1.2		See Note C - Sheet M2	
	32+50	38+00	550	Floodwall	Mistletoe Pump Plant Sta 37+07	11.5	Modify Floodwall		Area Fill	3.25	1.3		See Note D - Sheet M2	Area Fill from Sta 32+50 to Sta 38+00, to a minimum elevation of 748, with storm drain modification.
A2	38+00	40+31.25	231.25	Floodwall		11.5	Modify Floodwall			3.25	1.4		See Note C - Sheet M2	
	40+31.25	40+61.66	30.41	Levee		10.10	Levee Raise	na		50	0.40		See Note E - Sheet M2	
	Station Equation STA 40+61.66 BK = STA 40+91.60 AH											Advantage Metals Recycling - HTRW Concern Sta 40+31.25 to Sta 51+00		The landside slope will be steepened to avoid HTRW area.
	40+91.60	45+00	408.40	Levee		10.10	Levee Raise	na		50	0.40		See Note E - Sheet M2	
	45+00	50+00	500	Levee		10.10	Levee Raise	na		50	0.90		See Note E - Sheet M2	
	50+00	55+00	500	Levee		10.10	Levee Raise	na		60	1.30		See Note E - Sheet M2	
	55+00	57+07	207	Levee		10.10	Levee Raise	na		60	1.50		See Note E - Sheet M2	
	57+07	57+49	42		Central Avenue Double Deck Bridge		New SBG						See Note F - Sheet M2	New Sandbag Gap to be constructed. Construction to be coordinated with Armourdale Central Avenue Closure Structure so that Central Avenue only has to be closed once.
	57+49	60+00	251	Levee	Well Numbers 1, 2, 3, and 4 (All Plugged), KCK Flood Station #16 sta 58+35, Stock Yards #3 Pump Plant 74+21	12.10	Levee Raise	na		70	1.80		See Note G - Sheet M2	
	60+00	63+00	300	Levee		12.10	Levee Raise	na		70	2.10		See Note G - Sheet M2	
	63+00	65+00	200	Levee		11.10	Levee Raise	na		70	2.30	Concrete Rubble Mixed with Municipal Solid Waste	See Note H - Sheet M2	Area Fill from Sta 63+00 to Sta 74+75, to a minimum elevation of 751 at levee toe. Approx slope of fill from levee to ground is 1%
	65+00	70+00	500	Levee		11.20	Levee Raise	na	Area Fill	70	2.70		See Note H - Sheet M2	
A3	70+00	74+35.94	435.94	Levee		11.50	Levee Raise	na		70	2.80		See Note H - Sheet M2	
	74+35.94	75+25	89.06	Floodwall	Well Number 5 (Plugged)	12.8	Modify Floodwall			8	2.8		See Note I - Sheet M2	
	75+25	75+76	51		Missouri Pacific Railroad Bridge		New SBG							
				floodwall	Well Number 6 (Plugged)	12.8	Modify Floodwall			8	2.9			
				Sandbag Gap	Union Pacific Railroad Bridge		New SLG						See Note I - Sheet M2	
	75+76	77+27.75	151.75	Floodwall		12.8	Replace FW w/ New FW			30	3		See Note C - Sheet M2	
	77+27.75	80+00	272.25	Levee	Well Numbers 7 thru 17 (Number 7 is plugged), Gateway Pump Plant 80+90, South Stockyards 84+90, 88+19, and 94+32, Stockyards #1 98+05	13.50	Levee Raise	Replace landward retaining wall with berms	Area Fill	120	3.30		See Note H - Sheet M2	Area Fill from Sta 77+27 to Sta 94+50, to a minimum elevation of 749, with Gateway 2000 Inlet Modification. Approx slope of Area fill from levee to ground is 1%
	80+00	85+00	500	Levee		13.50	Levee Raise		Area Fill	120	3.60		See Note H - Sheet M2	
	85+00	90+00	500	Levee		13.80	Levee Raise		Area Fill	120	3.70		See Note H - Sheet M2	
	90+00	95+00	500	Levee		14.50	Levee Raise		Area Fill	120	3.40		See Note H - Sheet M2	
	95+00	100+00	500	Levee		14.10	Levee Raise			120	3.20		See Note H - Sheet M2	
A4	100+00	102+73.39	273.39	Levee		4.55	Levee Raise			120	2.90		See Note H - Sheet M2	
	102+73.38	106+00	326.62	Floodwall	Abandoned CRI&P RR Bridge Sta 104+51.5	13.3	New Floodwall at RR Bridge			11.75	2.8		See Note C - Sheet M2	The Abandoned CRIP RR Bridge had a SLG that was filled in. Replace gap with new raised floodwall.
	106+00	110+00	400	Floodwall	Kemper Arena Pump Plant 106+49	13.3			Wells	11.75	2.9		See Note J - Sheet M2	27 new relief wells, surface discharging at total of 18 cfs.
	110+00	115+00	500	Floodwall		13.4	Modify Floodwall		Wells	11.75	3		See Note J - Sheet M2	
	115+00	116+70	170	Floodwall		13.5	Modify Floodwall		Wells	11.75	3.1		See Note J - Sheet M2	
	116+70	120+00	330	Floodwall		13.6	Modify Floodwall			11.75	3.2		See Note C - Sheet M2	
	120+00	125+00	500	Floodwall		13.6	Modify Floodwall			11.75	3.3		See Note C - Sheet M2	
	125+00	130+00	500	Floodwall		13.6	Modify Floodwall			11.75	3.6		See Note C - Sheet M2	
A5	132+20			SLG	KC Terminal Double Deck Hydraulic RR Bridge		Replace SLG						See Note K - Sheet M2	
	130+00	137+50	750	Floodwall		13.6	Modify Floodwall		Wells	11.75	3.8		See Note J - Sheet M2	Construct approximately 600 feet of new concrete floodwall tieback from existing wall at Station 137+50 southeasterly to the existing bluff. Install 30 new relief wells surface discharging a total of 45 cfs. Install two new stop log gaps at railroad crossings.
	137+50	BLUFF	600	Floodwall		13.7	New Floodwall		Wells	11.75			See Note G - Sheet M2	
	137+50	145+00	750	Floodwall		13.9	No Raise	na		NA	0.00			
	145+00	150+00	500	Floodwall		13.9	No Raise	na		NA	0.00			
	150+00	155+00	500	Floodwall		14.1	No Raise	na		NA	0.00			
	155+00	160+00	500	Floodwall		14.2	No Raise	na		NA	0.00			
	160+00	165+00	500	Floodwall		14.4	No Raise	na		NA	0.00			
	165+00	166+25	125	Floodwall		14.5	No Raise	na		NA	0.00			
	166+25	168+16	191	Stop log Gap	Railroad Corridor			na		NA	0.00			
	168+16	168+36	20	Levee		8.80	No Raise	na		NA	0.00			

LEGEND AND NOTES

Abbreviation	Description
**	Dimension is for entire levee footprint including stability controls on landside and riverside of levee
***	Dimension from centerline of existing levee to proposed toe includes any stability berms recommended.
L	Levee
FW	Floodwall
NR-FW	New Raised Floodwall
COW	Cut off Wall for underseepage
F-AC	Floodwall with auger cast piles
RAP	Railroad or Roadway above Protection
ROW	Right of Way
SLG	Stop Log Gap (not all are shown)
SBG	Sand Bag Gap (not all are shown)
RW	Relief Well
W-I	Relief Well System I (Station 190+75 to 246+35) - Pumped by Shawnee Ave Pump Plant
W-II	Relief Well System II (Station 268+11 or 268+59 to 282+29) - Pumped by KCS Railroad Pump Plant
W-III	Relief Well System III (Station 296+23 to 302+40) - Pumped by Central Ave. Pump Plant
Osage	Osage Pump Station Area
RW	Relief Well
ARW	Abandon Relief Well
R	Height of Levee Raise
h	Existing Levee Height
LL	Landside Levee Width (measured from centerline of existing levee or floodwall)
HTRW	

Station Equations
Station Equation STA 89+37.34 BK = STA 0+00 AH
Station Equation 40+61.66 BK = 40+91.60 AH

Real Estate Notes	
A	No Real Estate Concerns at this time
B	Some additional permanent ROW and 15' of temporary ROW will be required.
C	Some temporary ROW may be needed.
D	Some temporary ROW may be needed. Will need temporary construction ROW for the area fill.
E	Will need 15' additional permanent ROW and 15' temporary ROW.
F	Need to determine how much additional permanent and temporary ROW will be required.
G	Will need additional permanent ROW and 15' temporary ROW.
H	Will need additional permanent ROW and 15' temporary ROW. Will need temporary construction ROW for the area fill.
I	Need to determine if additional permanent ROW is needed and how much temporary ROW will be required.
J	Some temporary ROW may be needed. Need to determine if additional permanent ROW will be needed for the relief wells.
K	Need to determine if additional permanent ROW is required and how much temporary ROW is required.



h	existing levee height (ft)
R	proposed levee raise (ft)
LL	proposed dimension from centerline of existing levee to proposed toe (including any stability berms)