REPORT SUMMARY

UPPER TURKEY CREEK BASIN PROJECT
FEASIBILITY REPORT AND INTEGRATED ENVIRONMENTAL ASSESSMENT

Feasibility Scoping Meeting:	26 JAN 2006
Alternative Formulation Briefing:	29 JAN 2013
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STUDY INFORMATION

Study Authority. The Upper Turkey Creek Basin Project, Flood Risk Management Feasibility Study (the Study) for Merriam, Kansas was authorized by Resolution of the Committee on Transportation and Infrastructure, U.S. House of Representatives, Docket 2616, adopted February 16, 2000, which reads as follows:

Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Turkey Creek Basin, Kansas and Missouri, dated June 21, 1999, and other pertinent reports, to determine whether any modifications of the recommendations contained therein are advisable at the present time in the interest of flood damage reduction for areas of Turkey Creek Basin in Johnson and Wyandotte Counties, Kansas, upstream of the project for flood damage reduction authorized in section 101(a)(24) of Public Law 106-53, the Water Resources Development Act of
1999.

Study Sponsor. The City of Merriam, Kansas, designated non-federal Sponsor for ownership, operation and maintenance of the proposed levee system. The City of Merriam represents all entities as the only cost-share sponsor for the Study, although Merriam received significant funding from the Unified Government of Kansas City, Kansas and Wyandotte County, Kansas, and from Johnson County.

Study Purpose and Scope. This is the final report for the authorization above. The purpose of the feasibility study is to identify, evaluate, and recommend to decision makers an appropriate, coordinated, implementable solution to the identified water resources problems and opportunities in the Upper Turkey Creek Basin. Congressional authorization for the Upper Turkey Creek Basin study specifically states the study's primary purpose is flood risk management. The feasibility study

considered ecosystem restoration opportunities in the watershed, and identified some areas potentially in the Federal interest, but there were no sponsors identified to cost share in those measures and they were eliminated from consideration early in the study. The study was conducted using a systems approach including a watershed assessment of the environmental conditions, hydrology and flooding risk. The plan formulation process resulted in identification of three areas of significant flood risk, of which only one, the City of Merriam, Kansas met the criteria for moving forward with detailed plan formulation and a recommended plan.

Project Location / Congressional District. The project is located in Johnson County, Kansas in the City of Merriam. Figure 1 illustrates the project location. The study encompassed the entire political bounds of Merriam to the boundaries of the Turkey Creek watershed. This is within the Kansas Third Congressional District.

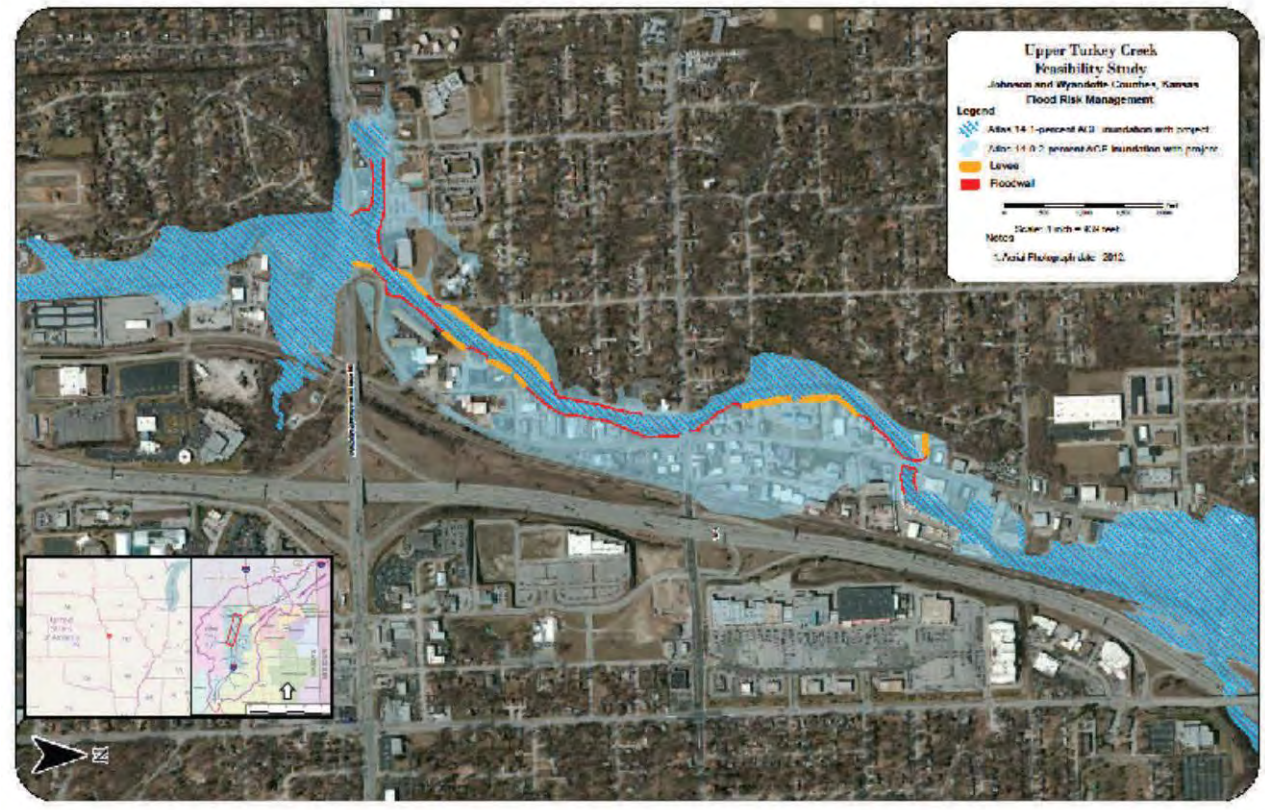


Figure 1: Recommended Plan Map.

Prior Reports and Existing Water Projects. There have been several prior studies and reports of flooding conditions on the Turkey Creek watershed. Those are documented in the feasibility report and are available upon request.

The most notable are the Corps of Engineer's project reports for Turkey Creek, or more specifically, Lower Turkey Creek. A Federal channelization and levee construction project is located on Turkey Creek downstream of the Upper Turkey Creek study area and upstream of the creek's confluence with the Kansas River in Kansas City, Kansas. This project is located between four and six miles downstream.

Flow Frequencies: Following the flood of October 1998, the communities and counties collaborated on stream gages. No USGS gage is present: Only local gages are. None of the periods of record are useful, because they are short periods of time. Therefore, the study is tied to hypothetical rainfall intensities from NOAA National Weather Service (NWS). The 2009 updates to FEMA flood maps are also hypothetical rainfall. The dependency on hypothetical rainfall created a project risk due to any update that might be made: Such an update occurred in NOAA NWS Atlas 14 in 2013. The feasibility study was updated to Atlas 14 rainfall intensities in the without and with project analysis.

Federal Interest. The Federal Interest in flood risk management in Merriam, Kansas, was first established in the reconnaissance study in 2001. This Federal Interest now extends to the current Feasibility Study and the Recommended Plan presented therein. The Recommended Plan provides a reduction in the flood risk, including property damage and potential loss of life. The Recommended Plan minimizes environmental effects, produces a positive benefit to cost ratio, and maximizes the net annual economic benefits of the proposed work.

STUDY OBJECTIVES

Problems and Opportunities. The flash flood hazard, with associated risk to life and damage to property is the main problem addressed with the Recommended Plan.

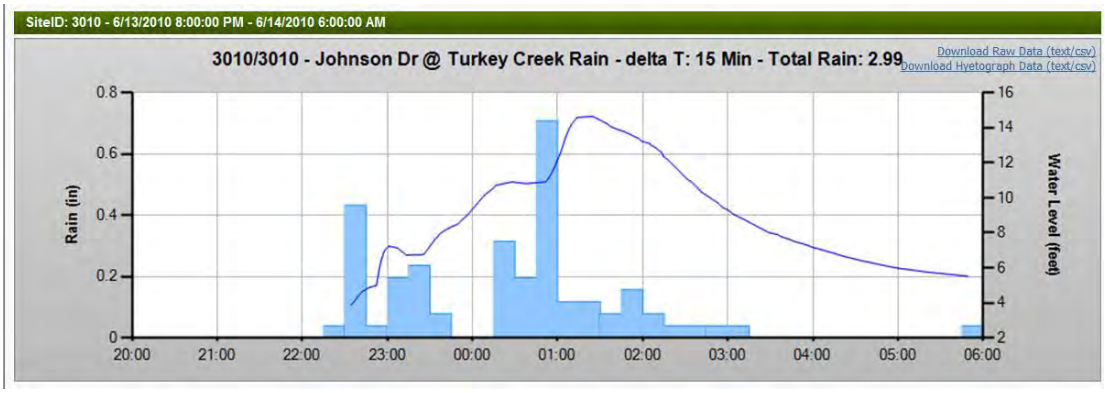
The evaluation of public concerns reflects a range of needs perceived by the public. The principal opportunity is the identification of a plan for significant improvement in flood risk management and reduction of risk to life, property and economic damages.

The existing flood hazard and associated flooding constitute the most serious water resources problem in the Turkey Creek Basin. Flooding within the basin is caused principally by storms of high intensity with resultant flows that concentrate quickly and rise to peak water surface elevations in high risk areas within 2 hours. Intensive development of the area throughout the early 1900's through the 1960's resulted in a heavily urbanized watershed and likely increased storm water runoff. This increased runoff, coupled with inadequate channel capacities and undersized bridge openings, accounts for most of the flooding problems. Flooding causes physical damage to property and loss of commercial, industrial, and public activity, along with the associated loss of business and wages. Rail and vehicular traffic also are adversely affected and cause losses to those who are dependent upon those modes of transportation. The recurring nature of the flooding problem represents a threat to the health and safety of those who live and work in the flood-prone areas.

As recorded on Johnson County's Stormwatch website (City of Overland Park 2012), a

significant part of the flood hazard is flash flooding. Rate of rise, according to a USGS gage at Ward Parkway on the adjacent Brush Creek, documents a rise of seven feet in one hour. The tributary area is similar in size and degree of urbanization as Turkey Creek. Although no USGS gages are on Turkey Creek, the Stormwatch website, which began collecting data following the 1998 flood event, has historical flooding information.

As seen at the Johnson Drive stream gage and depicted in Figure 2, even a small amount of rain can cause sharp rises in water surface elevations. The Johnson Drive gage is in the heart of the area for which alternatives will be developed. Flash flooding, with characteristics shown below, means that little time is available to respond with significant actions. Channel capacity is generally able to conveying flows up to and including the 10 percent annual exceedance probability (AEP) flow at the top of bank, which means any event added to a 1998 base flood would be hazardous in terms of rate of rise, not to mention extent of inundation. Loss of life is such a high risk, and velocities are high enough for the subject creek, that evacuating and avoiding the area is important.



Source: City of Overland Park 2012

Figure 2: Johnson Drive at Turkey Creek Water Surface Elevations

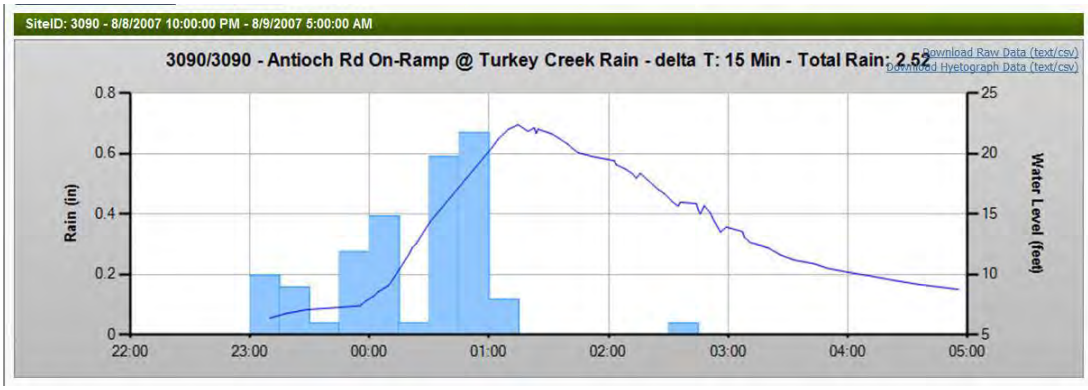
Similar findings are shown just downstream of Johnson Dr at Antioch Rd.

Table 1: Site/Sensor ID 3090/3093
Antioch Road On-Ramp at Turkey Creek Water Level

Stage (ft)	Date
22.40	08/09/2007
18.13	05/06/2007
18.02	06/04/2008
17.72	06/14/2010
17.67	06/24/2009
17.61	06/03/2008
16.58	06/12/2008
15.66	10/13/2007
15.48	05/06/2012
15.19	07/30/2008

Source: City of Overland Park 2012

Maximum Water Level Events (on Record) Sensor was first online on October 6, 2006, at 2:04:31 PM.



Source: City of Overland Park 2012

Figure 3: Antioch Road at Turkey Creek Water Surface Elevations

In the heavily urbanized watershed, flood volumes and flood peaks increase because less water soaks into the ground and more water runoff occurs from the increasing amount of land covered by impervious surfaces, including buildings, roads and parking lots. Increases in impervious land cover have reduced the portion of every rainstorm that historically soaked into the ground and provided recharge water for the shallow groundwater aquifers. Although a majority of the watershed is highly developed, stormwater management ordinances and stormwater management measures implemented in the communities within the Upper Turkey Creek watershed are helping to prevent increases in peak discharges from changes in development that may occur, thereby reducing impacts to flooding on Turkey Creek and its tributaries.

The hydrologic study developed to evaluate flooding on Upper Turkey Creek was analyzed to determine the stage of development in each watershed and to determine whether analysis of future land use was necessary for the hydraulic analysis. This determination was made using Johnson County's Automated Information Mapping System (AIMS) aerial photographs and field observations. Future redevelopment on existing developed areas and in-fill development of small parcels within an otherwise fully developed area was not considered a condition to create a significant change in hydrology.

Within the Upper Turkey Creek watershed, communities must work to preserve routing characteristics so that the USACE flow assumption for runoff (not to increase) remains true. Converting streams to concrete and or straightening their alignments can increase flash flooding to areas downstream. Communities need to be aware of and do coordination as part of expectations of the FEMA National Flood Insurance Program (NFIP) coordination requirements. This means that per the FEMA NFIP, communities (and agencies, such as the state DOT), should already be coordinating any drainage system improvements so as not to induce flood damages on downstream stakeholders.

In addition, communities must address how to coordinate drainage changes in the future, and this needs to be a process that is addressed in the floodplain management plan (FMP). Communities are responsible for preparing the FMP per USACE guidance, Policy Guidance Letter No. 52 and Public Law 104-303 WRDA 1996 amending WRDA 1986).

The majority of the Turkey Creek channel that passes through the City of Merriam can contain up to and including the 20 percent AEP, although two areas flood at the 50 percent AEP. Channel capacities are about 8,095 cubic feet per second (cfs) at river mile 3.165 at the upstream side of Johnson Drive, which is the 20 percent AEP. Most locations have that 20 percent AEP capacity, but in some places it goes as low as the 10 percent AEP or less. Figure 4 shows the existing level of inundation through the City of Merriam. It is estimated that the flow rate at the one percent AEP would have to be reduced by as much as 45 to 50 percent in order to remain within the channel. At 3.165 river mile, that would be a 1,215 cfs reduction in flow. The areas along the main stem of Upper Turkey Creek and its tributaries contain limited open space to provide the potential flood storage required to reduce flooding in Merriam.

Planning Objectives. The principal goal of the feasibility study is to identify a flood risk management alternative that significantly reduces flood risk, in terms of both loss of life and flood damages. A systems approach has been used wherein flood risk management and other opportunities for ecosystem restoration consideration and compatible recreation were considered. Specific ecosystem restoration measures were formulated in the watershed but not carried forward into screening or inclusion in plan formulation because no cost sharing partners were identified.

The planning objectives are

1. Significantly reduce flood risk and damages for events with an ACE in the range of 1 percent in the highly urbanized Upper Turkey Creek watershed caused by recurring and severe flash flooding.

Figure 4: Merriam Existing Inundation in the Highly Developed Watershed.

2. In partnership with other floodplain management agencies, provide the sponsor and stakeholders in the study area with a clear understanding of flood and residual flood risk. This will be accomplished through public meetings, inclusion of risk information in the report, public presentation and implementation of the Floodplain Management Plan, and ongoing assistance to the sponsor in flood preparedness via the O&M Manual, PL 84-99 Program, and other programs as funding provides. This objective will be accomplished throughout the project life including during design, construction and post-construction project support.

The planning objectives are focused on the Merriam reach, which is one of three. All considered the potential for loss of life.

Planning Constraints. Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. Further, plan formulation must provide safe conditions in the interest of public safety and be socially acceptable to the community. The planning constraints identified in this study area are in compliance with local land use plans and the resolution from the Committee on Transportation and Infrastructure, U.S. House of Representatives, Docket 2616, adopted February 16, 2000.

The Upper Turkey Creek Basin of Johnson and Wyandotte Counties, Kansas, is heavily urbanized, comprising residential, commercial, and industrial land uses. The Turkey Creek channel and floodplain have become a common location for public infrastructure including utilities, transportation, drainage diversions, homes, businesses, and public areas. For most of its length in Johnson and Wyandotte Counties, Turkey Creek is constrained between I-35 on one side and naturally high, non-floodplain banks on the opposite side. What may have been a 1,000-foot-wide floodplain a hundred years ago, is from 50 to 400 feet wide today. Further development along the higher bank areas has caused the floodplain, channel banks, and, in some areas, the waterways to be filled in or relocated for development, leaving limited space for conveyance of floodwaters. Therefore, one planning constraint is a lack of space in which to formulate alternatives along the creek.

Another constraint is that deepening a channel is not cost effective due to the geology along the main channel. Geotechnical borings in the area document this constraint (Appendix B). The channel bottom of the creek and tributaries is primarily limestone underlain by black/gray shale. Based on the differences in channel bottom elevations compared to older stormwater and utilities and the development of several waterfalls, it appears the channel bottom in many areas has been lowered or is incising, such as the tributaries. Long stretches of Turkey Creek through the City of Merriam have been lined with limestone blocks to stabilize the stream banks, and many of the tributaries have sections that have been channelized. There have been no natural, undisturbed stretches of Turkey Creek identified to date.

Despite ongoing efforts to reduce flooding the increasing development has resulted in increased flood frequency, peak flood flows, flood flow volumes, and channel velocities. Additionally, these modifications have shortened the lag time from peak precipitation to peak flow.

A systems approach is mindful of potential impacts to the USACE flood risk management project being constructed downstream. Any develop built in Merriam should not adversely affect reaches in Lower Turkey Creek by changes to flow or timing. Already implemented improvements are those to the very large bypass tunnel and the new, widened channel adjacent to the cooperative work with KDOT for I-35. Construction of the levee, railroad bridge improvements, and walled channel is currently happening adjacent to the channel.

In addition to the planning constraints discussed above the following were also considered:

- **Hazardous, Toxic, and Radioactive Waste**—Alternatives cannot cause disturbance of hazardous, toxic, and radioactive waste (HTRW) to minimize and prevent Federal

liability under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

- **Flood Heights**—Alternatives cannot negatively impact the 100-year flood profile (within the floodway, per NFIP).
- **Environmental and Cultural Resources**—Alternatives should be designed to minimize adverse impacts to environmental and cultural resources.
- **FEMA Voluntary Acquisition Program**—Alternatives will not be developed that interfere with restrictive use guidelines established for properties purchased with Hazard Mitigation Grant Program funding.
- **Avoidance of Induced Flooding**—Inducing adverse flood impacts associated with the implementation of any flood risk management project should be avoided.

Part of the Turkey Creek channel in the study area is operated and maintained by the MDD under a state charter that provides the MDD authorities independent of the City of Merriam or Johnson County. The MDD has institutional responsibilities and real estate holdings in and near the Turkey Creek channel; therefore, the future of the MDD is a key element in assessing of any plan for Turkey Creek.

ALTERNATIVES CONSIDERED

Plan Formulation Rationale. The results of the existing conditions analysis, observations and effects from historic and recent flood events were used to formulate potential solutions targeted at lowering the risk of flooding using a watershed perspective. Three primary sites of flood vulnerability were identified during the reconnaissance phase of the study: City of Merriam, Johnson County, Kansas; Roe Lane Industrial Area in Wyandotte County, Kansas; and the low-lying areas of I-35 in Johnson and Wyandotte Counties. These areas were the subject of subsequent flood risk management plan formulation and screening.

Management Measures and Alternative Plans. Flood risk management measures are either structural or nonstructural. Structural alternatives modify the flood and "take floods away from people" by features such as channels, levees, and dams. Nonstructural alternatives basically "take people away from floods," leaving the flood to pass unmodified. Nonstructural measures include both features and activities. Example non-structural activities include land use regulations, redevelopment and relocation policies, disaster preparedness, flood warning and forecasting systems, flood plain information, flood plain acquisition and easements. Nonstructural measures also include features such as flood proofing, and onsite detention of flood waters by protection of natural storage areas or in human-made areas. Documenting the full menu of measures will contribute to better flood risk management in the watershed, and this information will be carried forward in the FMP.

Importantly, the public must be educated about flood risk management risks and actions

that can be taken to reduce these risks. Because of this complex arrangement of responsibilities, only a life-cycle, comprehensive and collaborative watershed perspective enables communities to sustain an effective reduction of risks from flooding.

The methods used to evaluate the formulated alternatives include those for the primary authorized mission, flood risk management. The methods used for characterizing water surface elevations included standard hydraulic modeling program, HEC-RAS, and the standard hydrologic program, HEC-1. The HEC-Hydrologic Modeling System (HMS) was required for portions of the work. Because of the high degree of urbanization and the number of enclosed conveyance systems, standard practices (i.e., formulae for time of concentration adjustments) were used in the modeling and the characterization of hydrology patterns. The hydraulic and hydrologic modeling also used the hydrologic and hydraulic analysis prepared by Johnson County to develop the revised Flood Insurance Study.

Preliminary Alternatives. Based on the identified problems and opportunities, project goals, objectives, and conditions in this study area, measures with the greatest potential for meeting planning objectives were formulated into alternative plans. The planning steps of formulating, evaluating, and comparing alternative plans were accomplished iteratively as information about the alternatives developed. The product of this process was to establish the alternatives for the evaluation step in the P&G six step planning process.

Based upon judgment and existing conditions analyses, the structural flood risk management measures retained were used to develop basic series of alternative concepts or "themes" that would be necessary for the alternatives to address the planning objectives.

- Alternative 1 Concepts: Channel Widening
- Alternative 2 Concepts: Levees / Floodwalls
- Alternative 3 Concepts: Combination of Channel Widening and Levees / Floodwalls

The Federal government has endeavored to support nonstructural approaches (such as flood warning systems, flood-proofing of structures, floodplain management, and property buyout). Nonstructural approaches have merit when the site characteristics and the flooding threat are compatible with the nonstructural capabilities and found acceptable to stakeholders. Additionally, it may be possible to combine nonstructural and structural measures to improve the overall level of flood risk management. The ability for this to be feasible depends on the specific conditions of the area being considered.

Based upon judgment and existing conditions analyses, the nonstructural flood risk management measures retained were used to develop a nonstructural alternative concept or "theme" that would be necessary for the alternatives to address the planning objectives.

- Alternative 4 Concept: Buyout

The planning team conducted a real estate cost analysis for the inundation area of the one percent AEP, or the NFIP base flood extents. No hybrid of nonstructural and structural combination was

evaluated. This floodplain buyout alternative used the following assumptions.

Final Array of Alternatives. The study team performed preliminary technical analysis of proposed measures and evaluated these using the screening criteria to focus on the most implementable alternatives. Those measures that appeared to be most viable with respect to planning criteria were refined and further developed. Using the information developed, the study team compared the alternatives to each other to screen out inferior plans and identify the most feasible and beneficial plans. Initial screening results were presented to the non-federal sponsor in November 2009. This discussion was used to narrow the alternatives further.

Three basic series or concepts of structural alternatives were developed: Channel Widening Alternatives, Levees and Floodwalls Alternatives, and Combination Channel Widening and Levees/Floodwalls Alternatives and one nonstructural alternative was developed, Buyout.

Alternative 1: Channel Widening—Channel widening was considered as a flood abatement measure in areas where overbank expansion was available. Because the majority of the channel currently has a hard slate bottom, channel bottom deepening was minimized. The proposed channel bottom width was kept constant, wherever possible, with a maximum side slope in most areas of 2H:1V (or horizontal:vertical), which allows the channels to be lined with either biostabilization, rip rap or concrete block measures.

Alternative 2: Levees and Floodwalls—A levee is a compacted and engineered earthen embankment. For this study, practical levee dimensions ranged from heights of 2 to 6.5 feet high and practical proportional footprints ranging from 2 to 3H to 1V. Floodwalls were used when overbank area or proximity to structures precluded a levee footprint. The proposed floodwalls would consist of a reinforced concrete retaining wall generally with a minimum thickness of two feet. Bridge modifications were not considered a part of this alternative.

Alternative 3: Combination of Channel Widening and Levees/Floodwalls—The combination alternative minimizes the required channel width by introducing either a levee or a floodwall where needed. A combination of channel widening and levee walls was considered and could be more cost effective than levees or floodwalls alone, while providing better flood protection than channel widening alone. The channel widening component of the combination alternative included rip rap slope stabilization, biostabilization slope protection, and necessary bridge modifications.

Alternative 4: Non-structural: Buyout—Once structures in the floodplain are removed, they are no longer subject to flood damages. There are many considerations associated with a property buyout including demolition, relocation, and other costs. The floodplain can be considered for restoration after a property buyout would be implemented.

Comparison of Alternatives. From the array of final alternatives, the planning team chose the alternative from each concept (Alternative 1, Channel Widening; Alternative 2, Levees and Floodwalls; Alternative 3, Combination of Channel Widening and Levees/ Floodwalls) with the highest net annual benefits for further consideration. The alternatives range from downstream of the Merriam Drive Bridge over Turkey Creek to the upstream face of the Shawnee Mission

Parkway culvert. The neighborhoods protected in all alternatives included in the final array are proceeding north to south; Merriam downtown or Farmers' Market area, Industrial and Railway Drive, and the Parkway vicinity.

Planners conducted an economic analysis, which is an iterative process that reveals the alternative with the highest net annual benefits with corresponding higher orders of magnitude of protection. The levee height for the NED plan revealed the alternative with the maximum net annual benefits, Table 2 outlines the costs and economic performance of each alternative.

Table 2: Total Project Costs and Economic Performance for Final Array of Alternatives

Alternative	**1d**	**2d**	**3d**	**4 Property Buy-Outs**
Construction (including S&A)	$10,984,200	$12,232,100	$14,173,000	$ -
PE&D	$1,021,800	$1,137,900	$1,318,400	$ -
LERRD	$5,652,200	$3,963,500	$4,872,800	$58,232,500
Environmental mitigation	$29,300	$24,000	$29,300	$ -
Total First Cost	$17,687,500	$17,357,500	$20,393,500	$58,232,500
Interest during construction	$1,135,100	$1,040,100	$1,232,100	$ -
Total investment cost	$18,822,600	$18,397,600	$21,625,600	$58,232,500
Annual economic cost	$876,200	$856,400	$1,006,700	$2,710,700
OMRR&R	$152,500	$212,100	$252,200	$ -
Residual damages with project	$1,425,400	$655,600	$661,700	$59,700
Average annual costs	$1,028,700	$1,068,500	$1,258,900	$2,710,700
Average annual benefits	$2,031,300	$2,812,100	$2,795,000	$3,397,000
Net annual benefits	$1,002,600	$1,743,600	$1,536,100	$686,300
B/C ratio	2.0	2.6	2.2	1.3

The following alternatives from each plan formulation concept with the highest net annual benefits from the final array of alternatives were carried forward and were evaluated under plan formulation and under NEPA as shown in the table.

- No Action
- Alternative 1d: Channel Widening
- Alternative 2d: Levees/Floodwalls

- Alternative 3d: Combination/Channel Widening and Levees/Floodwalls
- Alternative 4: Property Buy-Outs

Alternative Array 2 is the array clearly showing the maximum net annual benefits, and Plan 2d is the plan that reasonably maximizes net annual benefits, meets the planning objectives, and satisfies the requirements of technical feasibility, environmental and local acceptability, and completeness.

No Action Alternative

The District has considered the No Action Alternative throughout the analysis in order to comply with the requirements of the NEPA. Under the No Action Alternative, it is assumed that no project would be implemented by the District to achieve the planning objectives. The No Action Alternative forms the basis against which all other alternatives are measured.

Atlas 14 Update

In late 2013 the study's Independent External Peer Review (IEPR) brought to light that the National Oceanographic and Atmospheric Administration (NOAA) had recently published updated rainfall frequency information in the document titled "*Hydrometeorological Design Studies Center Frequency Data Server Atlas 14* (NOAA 2013)", replacing the TP-40 document, which would change the probability of flooding in the Upper Turkey Creek study area. USACE guidance requires that the most updated NOAA rainfall information is to be utilized for hydrology in the formulation and design of flood risk management plans. Given the potential change in discharge accounted for in this new rainfall data, the USACE vertical team determined that the opportunity to evaluate the plans under Atlas 14 should be taken during the feasibility phase of the project. The Atlas 14 rainfall estimates were formally adopted at this point in the study. An updated HEC-RAS model was developed incorporating Atlas 14 in the hydrology with a resultant revised hydraulic model. The Atlas 14-based model showed flood probabilities that were generally higher than previous estimates. This meant that any with-project alternative would have both greater benefits and greater residual damages than previously estimated. The alternatives were reevaluated under the Atlas 14 conditions using the federal criteria for completeness, efficiency, effectiveness, and acceptability. It was reaffirmed that levees and floodwalls (Alternative 2 array) better meets the criteria than channelization either singly or in combination with levees and floodwalls, the sensitivity analysis focused on whether or not a levee and floodwall project was still justified and what the recommended levee/floodwall height should be.

Table 3 shows a comparison of flows under previous hydrology, and under the new Atlas 14 hydrology for selected locations in the Merriam project reach. More detailed information regarding hydraulic analyses is contained in the report Engineering Appendix B.

During the Atlas 14 update it is critical to note that all plan analysis was conducted with hydrology and hydraulics utilizing Atlas 14 rainfall intensities.

Table 3: Comparison of Flows from Original to Atlas 14 Based Hydrology

Channel Location	Original 1-Percent ACE Discharge cfs	Atlas 14 1-Percent ACE Discharge cfs	Original 0.2-Percent ACE Discharge cfs	Atlas 14 0.2-Percent ACE Discharge cfs
Shawnee Mission Parkway Bridge	9,210	10,380	11,250	13,360
Johnson Drive Bridge	15,670	17,691	19,100	22,290

The following is a comparison of flow depths and velocities for the one percent AEP event under original and Atlas 14 based flows at selected locations in Merriam, without project condition:

Shawnee Mission Parkway Bridge: **Original**- 0.22 ft at 6.3 fps; **Atlas 14 -** 1.32 ft at 5.3 fps

Merriam Marketplace: O**riginal-** 3.67 ft at 8.1 fps; **Atlas 14-** 4.67 ft at 7.8 fps

West 61st Street: **Original** 3.0 ft at 11.8 fps; **Atlas 14-** 3.0 ft at 12.3 fps

Merriam Drive Bridge: O**riginal-** 1.73 ft at 9.1 fps; **Atlas 14-** 2.9 ft at 8.3 fps

Based upon these findings, a new plan - "Plan 2f" - was formulated to accomplish a sensitivity analysis. Plan 2f was intended to achieve a relative level of reliability equivalent to what had been previously estimated for the NED Plan. The NED Plan 2d happens to have been a plan with greater than 95 percent reliability against the one percent AEP discharge under the previous TP-40 based hydrology. Thus Plan 2f was developed such that it would have 95 percent or greater reliability of passing the one percent chance AEP Atlas 14 discharge (on average 13 to 15 percent greater than the one percent AEP discharge under TP-40 based hydrology). The updated benefits and costs of the NED Plan (with top-of-levee elevation of 920.98 at the index point) were compared against Plan 4f (with top-of-levee elevation of 922.69 at the index point), and both plans were compared against the future without-project condition, using the updated Atlas 14 based discharge-frequency data.

Plan 2f was developed with costs estimated at the same level of detail as the NED Plan 2d. Plan 2f was designed utilizing the parameters agreed upon the Corps of Engineers vertical team, a plan that would have levee and floodwall heights to allow for 95 percent or greater reliability against the one percent AEP Atlas 14 discharge. The required height of levees and floodwalls for Plan 2f was on average 2-3 feet higher throughout the project area than for Plan 2d. The increase in the 1-percent discharge caused a significant hydraulic challenge at the Merriam Drive Bridge at the downstream end of the project. It was determined in analysis that in addition to raising the parapet walls at that bridge from 4 feet to 8 feet high, a triple box 5x5 RCB hydraulic diversion structure 320 feet long

would be required to successfully pass the design discharge. This configuration was determined to be optimal in performance versus cost after several alternative box and culvert combinations were modeled. The replacement of the Merriam Drive Bridge would be more costly than any of the bypass alternatives evaluated, and would still not address significant hydraulic inefficiency at that location. At the Johnson Drive Bridge, where no modifications to the bridge were deemed necessary with Plan 2d, the hydraulic analysis showed that under the Atlas 14 one percent discharge, parapet walls 7 feet high would be required. The length of floodwall and levee for Plan 2f was less in comparison to the NED Plan. This is because in Reach 3 in order to achieve successful hydraulic tie-in to high ground under the Atlas 14 design flow, the tie-in point would have to be well downstream of the Shawnee Mission Parkway Bridge, just downstream of the pedestrian bridge.

Revised Screening to Verify NED Plan. In order to sufficiently verify the plan having the highest net annual economic benefits under Atlas 14 flow conditions, it was determined that there was a need to reevaluate certain screening level plans in comparison to Plans 2d and 2f. In reviewing the results of the screening and Atlas 14 sensitivity analyses, it was determined that the narrow difference in net benefits between alternatives 2b, 2c and 2d necessitated an additional step to confirm the plan with highest net benefits in the Atlas 14 flow regime. The comparison was limited to these three alternatives from the original screening array because alternative 2d appeared to represent a peak in net benefits – i.e., net benefits for the next largest alternative, 2e, dropped slightly. The comparison of 2b and 2c with the NED Plan 2d required that 2b and 2c be updated in a manner reasonably consistent with the updating of alternative 2d and the Atlas 14 Plan. Therefore, in addition to refinement of features and costs for 2d and development of features and costs for Plan 2f, alternatives 2b and 2c were also updated to reflect current estimates of features and costs and were also analyzed under the Atlas 14 flow regime for comparison to Plan 2d and Plan 2f. The floodwall and levee profiles for Plans 2b and 2c were determined in the refined analysis on average only 1 foot and 0.5 feet lower than Plan 2d. The engineering features required for Plans 2b and 2c were virtually the same and in the same lengths as those required in Plan 2d except the heights of protection were lower that 2d as stated. As such, the features for those plans as estimated were virtually identical to Plan 2d, only lower in overall average height.

Engineering and Cost Updates. As is often encountered during refinement of alternative plan details, certain engineering refinements were deemed necessary in updating the array of plans compared at this phase of study. During the engineering analysis for the Atlas 14 Update, it was determined that the existing stacked rock wall lining the channel in most locations was not adequately reliable to support a cantilever T-type reinforced concrete floodwall without a foundation ground modification. This is because of the relatively close proximity of the floodwall foundation to the existing channel walls. The geotechnical engineers decided to design an array of auger cast grout piles for a suitable ground modification to ensure floodwall foundation stability. This was necessary for the final engineering refinement to the Plans 2b, 2c and 2d and 2f. This required that there be over 4,500 grout piles placed in Reach 1, over 3,800 piles in Reach 2, and over 4,000 piles in Reach 3 for Plan 2d (over 12,300 total), a similar number of piles for Plans 2b and 2c, and a greater number was required for Plan 2f. Additionally, the team determined that due

to the number of storm drainage pipes and utilities, that there would be more relocations required than originally estimated. The engineers also re-routed and consolidated the larger storm sewers into junction boxes with flap gates. All of these improvements were necessary engineering changes that affected the most cost effective plans and Plan 2f in a similar manner. The team also determined that for Plan 2d the maximum height from ground in one location was actually 6.5 instead of 6 feet. In the refined analysis and in applying consideration of actual site conditions and features, experience from other similar projects, the OMRR&R and mitigation costs were estimated to be lower than in previous screening analysis and essentially the same for all plans considered in this comparison. The additional box culverts in the Atlas 14 Plan could result in somewhat higher annual OMRR&R costs for that plan, but those were not included for the purposes of this comparison. After revised cost estimates were developed and the new array of plans was evaluated in HEC-FDA economic analysis, the team's economist verified that Plan 2d is the plan with the highest net annual economic benefits.

Table 4: Comparison of Features - Plans 2d and 2f

Alternative	**Alternative Plan 2d**	**Alternative Plan 2f**
Primary Features Comparison	- 6,822 ft floodwall 3-6.5 ft high - 3,383 ft levee 3-6 ft high - 4 ft high parapet wall on upstream and downstream sides of Merriam Drive Bridge - Soil mixing floodwall foundation on an array of auger grout piles - 2.1 acre interior detention pond - stormwater, sanitary, and water utility relocations	- 5,565 ft floodwall 6-8' high - 2,300 ft levee 7-8 ft high - 320 ft. long triple 5x5 box culvert hydraulic diversion at downstream of project under Merriam Drive Bridge - 8 ft high parapet wall on upstream and downstream sides of Merriam Drive Bridge - 7 ft high parapet wall on upstream and downstream sides of Johnson Drive Bridge - Soil mixing floodwall foundation on an array of auger grout piles - 2.1 acre interior detention pond - stormwater, sanitary, and water utility relocations

Table 5: Screening Summary With-Project Annual Benefits, Costs, and Net Benefits

(October 2014 Prices, 3.375% Interest Rate, 50-Year Period of Analysis, $1,000s)

Reach Alternative	tal Annual Costs of Project[a]	Annual Benefits	Residual Damages	B/C Ratio	Net Benefits
Future Without Project	NA	NA	$ 4,749.6	NA	NA
Alternative 2b	$ 1,694.5	$ 3,160.6	$ 1,589.0	1.9	$ 1,466.1
Alternative 2c	$ 1,712.9	$ 3,312.1	$ 1,437.5	1.9	$ 1,599.2
Alternative 2d (NED Plan)	$ 1,732.2	$ 3,444.7	$ 1,304.9	2.0	$ 1,712.5
Alternative 2f	$ 2,001.6	$ 3,702.9	$ 1,046.7	1.8	$ 1,701.3

Recommended Plan. The USACE Planning Guidance Notebook, ER 1105-2-100, states, "A plan that reasonably maximizes net national economic development benefits, consistent with the federal objective, is to be formulated. This plan is to be identified as the National Economic Development (NED) plan." The Environmental Assessment for this study has been integrated into the following Feasibility Report in accordance with ER 1105-2-100.

The feasibility study's project delivery team identified Alternative 2d as the NED Plan and selected Alternative 2d as the Recommended Plan. Alternative 2d is the plan that reasonably maximizes the net NED benefits (as shown in the initial screening of alternatives in Section 5.3 and post-Atlas-14 sensitivity-analysis described in Section 5.4), while also being environmentally acceptable (as shown in Chapter 6). Alternative 2d would pass the one percent AEP through downtown Merriam with an estimated assurance f 82.9-percent, provide greater net annual benefits in reduction of flood damages than the other alternatives, and meet the needs of the local community.

The primary plan features are 3,383 feet of levee up to approximately six feet in height and 6,822 feet of floodwall up to approximately 6.5 feet in height. The floodwall system includes ground modification in the form of an array of auger grout piles supporting foundation. Bridge modification includes headwalls for the purpose of tying in proposed levees and floodwalls at the Merriam Drive Bridge. A 2.1 acre-foot gravity drained stormwater detention pond is included for interior drainage adjacent to the Merriam Marketplace. The project also includes stormwater, water and sanitary utility relocations, and environmental compensatory mitigation of 7 acres of mast producing trees.

The cost of the NED Plan Alternative 2d increased significantly during development of the detailed plan analysis. This is not uncommon when considering the proposed selected/NED Plan in more detail that the costs will increase as more engineering and cost estimating effort is applied. The sensitivity analysis completed in Section 5.4 utilizing updated features and costs for the most economically effective plans 2c, 2b and 2f confirmed Plan 2d as the plan with the highest net annual benefits.

A Cost and Schedule Risk Analysis (CSRA) was performed on the Recommended Plan (Alternative 2d). The project cost including the contingency estimate that resulted from the CSRA for Alternative 2d is $37,579,000 (price level date 1 Oct 2014). There is also an additional economic cost of interest during construction (IDC) of $3,003,900, for a total investment cost of $40,582,900. Total annual NED cost is $1,732,200. Total annual benefits are $3,444,700. The benefit-cost ratio is 2.0 to 1, with net benefits of $1,712,500.

Plan Accomplishments

The Recommended Plan meets the objectives identified in Chapter 2, Section 2.4 The P&G defines effectiveness as a measure of the extent to which a plan achieves its objectives. The Recommended Plan meets the criteria of effectiveness, because it reduces risk to the City business district and public facilities, and allows these facilities to remain functional during all but the largest flood events. Additionally, through the systems approach used by the USACE throughout the study numerous collaborative planning achievements were met. These include working jointly with the cities and counties on watershed based tools to reduce flood hazards, developing environmental restoration strategies, integrating recreational trails, and working with numerous stakeholder groups within the watershed.

Given the cost, the Recommended Plan is estimated to provide the greatest level of damage reduction of approximately 73-percent of total equivalent annual damages within the Upper Turkey Creek watershed to the City of Merriam with residual damages of 27-percent of the future without-project damages.

Because of the area of the City that is susceptible to flooding and the velocity of the flood waters, there is a risk for loss of life during flood fighting and other emergency measures. The flood of July 1993 caused one fatality and resulted in damages estimated at $3.4 million in Merriam, and $20 million in the lower basin areas. The flood of October 1998 caused an estimated $12 million of damages in Merriam, and damages in the lower basin equivalent to those of 1993. The flood peak occurred in the late evening, and if the peak had occurred during rush hour, loss of life would have been very likely for travelers on I-35, which was overtopped by flood waters at multiple locations. The Recommended Plan would substantially reduce flood risk in the City of Merriam to 69 commercial/industrial structures and nine residential structures and would also likely reduce the risk of loss of life from flooding, due to the decreased probability of a flood event inundating the floodplain with short warning time. The planners and hydraulic engineers developed inundation maps for the without and with project conditions to depict estimates of flooding and the effects of the Recommended Plan. Those are located in plates at the beginning of Section 7.2.

Table 6: Recommended Plan Construction Features

Construction Features*	
Levees/Floodwalls: Left Bank	Reach 3b-1 - Merriam Downtown : • 160 feet floodwall downstream of Merriam • 75 feet of floodwall upstream of Merriam Drive • 168 feet of levee upstream of Merriam Drive Reach 3b-2 - Industrial and Railway Drive (West 61st Street): • 840 feet of floodwall begins at 300 feet upstream of Johnson Drive to 500 feet upstream of West 60th Street • 290 feet of levee from 500 feet upstream of West 60th Street to West 61st Street Reach 3b-3 - Parkway Vicinity: • 744 feet of levee from West 61st Street to 70 feet downstream of West 62nd Street • 200 feet of floodwall from 70 feet downstream of West 60th Street to 20 feet upstream of West 62nd Street • 320 feet of levee from 20 feet upstream of West 62nd Street to 60 feet upstream of pedestrian bridge (North side of Skate World Parking Lot) • 1,070 feet of floodwall from 60 feet upstream of pedestrian bridge , to south side of Skateland Parking lot, then along west 62nd Terrace
Levees/Floodwalls: Right Bank	Reach 3b-1 - Merriam Downtown: • 220 feet of floodwall downstream of Merriam Drive to Merriam Drive Parapet wall • 532 feet of floodwall from Merriam Drive Parapet wall to West 57th Street • 1051 feet of levee from West 57th Street to 180 feet South of Farmers Market Parking Lot • 595 feet of floodwall downstream of Johnson Drive Reach 3b-2 - Industrial and Railway Drive (West 61st Street): • 1,390 feet of floodwall south of Johnson Drive to 70 feet north of West 61st Street • 150 feet of levee to West 61st Street Reach 3b-3 - Parkway Vicinity: • 240 feet of levee from W 61st Street to190 feet north of W 62nd Street • 290 feet of floodwall from 190 feet north of W 62nd Street to W 62nd Street • 240 feet of levee from 62nd Street to 240 feet south of W 62nd Street • 890 feet of floodwall from 240 feet south of W 62nd Street to 130 feet north of Shawnee Mission Parkway • 180 feet of levee to Shawnee Mission Parkway • 560 feet of floodwall on W Side of Turkey Creek extending to North of Shawnee Mission Parkway and running along South side of drainage ditch the runs parallel to W. 62nd Terrace
Bridge Modifications/ Headwalls	Reach 3b-1 - Merriam Downtown: • Merriam Drive Bridge – approximately 4.5 to 6 foot high headwall (upstream/downstream) Reach 3b-3 - Parkway Vicinity: • Pedestrian Bridge located at River Mile/Station 3.568 - modification to span 175 feet across the new levee walls

Storm Sewer Modifications	Reach 3b-1 - Merriam Downtown: • 7 Outfalls modified with flap gates. • 4 Outfalls abandoned and combined with outfalls modified • Detention Basin, including 2.14 acre-foot (80 feet wide by 250 feet long) grass detention basin and 60 in RCP outfall with flap gate, located in property north of the outdoor farmers' market. • 3 Outfalls abandoned and combined with Detention Basin. Reach 3b-2 - Industrial and Railway Drive: • 6 Outfalls modified with flap gates • 2 Outfalls combined with outfalls modified • 2 Headwall modifications with flap gates Reach 3b-3 - Parkway Vicinity: • 7 Outfalls modified with flap gates • 3 Outfalls combined with outfalls modified
Utility Impacts/ Relocations	Reach 3b-1 - Merriam Downtown: • 2 Domestic Water reconstructions • 1 Natural Gas reconstruction • 3 Sanitary Sewer reconstructions Reach 3b-2 - Industrial and Railway Drive: • 1 Domestic Water reconstruction • 2 Natural Gas reconstructions • 1 Sanitary Sewer reconstructions • 1 Overhead electric reconstruction Reach 3b-3 - Parkway Vicinity: • 1 Domestic Water reconstruction • 3 Sanitary Sewer reconstructions • 1 Domestic Water reconstruction
Notes: Merriam Downtown (includes farmers' market called Merriam Market Place) = Merriam Drive to Johnson Drive, RM/RS 2.623 to 3.05, *Reach 3b-1; Industrial and Railway Drive = Johnson Drive to West 61st Street, RM/RS 3.05 to 3.345, *Reach 3b-2; Parkway Vicinity = West 61st Street to Shawnee Mission Parkway, RM/RS 3.345 to 3.726 with the exception of Alternative 1 which extends from RM/RS 3.345 to RM/RS 3.855, *Reach 3b-3	

Systems / Watershed Context. The use of a systems approach was referenced in both of the previous goals. By using a systems approach, community planners find better solutions that:

- Consider the long-term
- Are more sustainable for the community
- Are the most effective way to spend money

We conducted the study in a watershed context which included evaluating the environment

of the watershed, the hydrology and hydraulics of the watershed, and identifying the significant floodrisk areas in the watershed. The project spent significant effort in looking at possible environmental enhancements as part of the study, and this is documented in Appendix J.

Environmental Operating Principles. For the USACE flood risk management, watershed planning, and the ecosystem restoration missions, the planners did the EOPs a credit. Throughout the project, they looked at green as opposed to grey solutions (such as concrete). Appendix J is evidence of the effort. The study did not have a watershed authorization, but to the extent practicable, the watershed perspective was applied to the study. In addition, green solutions were examined, not only in the channel, but in the upland areas as well. No sponsor could be found to move forward with any of the ecosystem restoration concepts, even though many were well developed and are available for future implementation. The flood risk management authorization was the main driver for the context of the report, however, the EOPs were strongly considered during the planning work. In design phase in line with EOP we will continue to evaluate features that can be implemented in an environmentally sensitive manner.

Peer Review. Independent External Peer Review (IEPR) was completed October of 2013. The most significant comment was a need to explain if the late rollout of the NOAA National Weather Service precipitation atlas in March 2013, which came after the AFB and development of the Recommended Plan, would in some way help the project analysis. As a result of the comment and in consultation with Division and Headquarters, the study hydrology and hydraulics was fully updated to Atlas 14 rainfall intensities for the without and with project conditions. The effect was to increase with project damages, with project benefits and with project residual damages. The sensitivity analysis done after updating to Atlas 14 demonstrated that the Recommended Plan 2d still reasonably maximized net annual benefits.

Project Costs. The detailed construction cost estimate has been developed based on conceptual design of the Recommended Plan using the USACE Micro-Computer Aided Cost Estimating System MII (MCACES 2nd Generation) in accordance with guidance contained in ER 1110-2-1302, Civil Works Cost Engineering.

Table 7: Cost Estimate Summary

(October 2014 Price Levels)

Cost Account	Estimated Cost
Lands and Damages	$4,854,000
Relocations	$5,268,000
Fish & Wildlife Facilities (Mitigation Costs)	$15,000
Levee & Floodwalls (excluding EDC)	$22,565,000
Planning, Engineering, and Design (including EDC)	$3,066,000
Construction Management	$1,811,000
Project Cost Totals	**$37,579,000**

Table 8: Annual Cost Calculation

Cost Account	Estimated Cost
Project Implementation Cost	$37,579,000
Interest During Construction	$3,003,900
Total Investment	$40,582,900
Annual Economic Cost	$1,691,400
Annual OMRR&R	$40,800
Total Average Annual Cost	**$1,732,200**

Expected Project Performance Total annual NED cost is $1,732,200. Total annual benefits are $3,444,700. The benefit-cost ratio is 2.0 to 1, with net benefits of $1,712,500. The engineering performance characteristics are displayed in Table 9 below.

Table 9: With-Project Engineering Performance

	Without	With
Annual Exceedance Probability	28.3%	0.5%
Assurance of Containing flows over time		
10 years period	3.6%	94.9%
30 years period	0.02%	87.8%
50 years period	0.0%	77.1%
Assurance of Containing Flows		
10% AEP	9.0%	99.98%
4% AEP	0.9%	99.2%
2% AEP	0.3%	94.3%
1% AEP	0.1%	82.9%
0.40% AEP	0.03%	65.3%
0.20% AEP	0.02%	53.0%

Cost Sharing. The non-federal sponsor will be required to sign a design agreement and PPA for implementation of the project. Pursuant to that, the sponsors shall provide 35 percent of the implementation cost of the project, which includes design, construction, project/construction management, and acquisition of all LERRDs, as required for implementation of the project. This will be a combination of cash and LERRD acquisition, with the sponsor required to provide a minimum of 5 percent of the 35-percent cost share in cash. The sponsor is directly responsible for all LERRD acquisition costs. The local sponsor shall be required to operate and maintain the project to provide the authorized performance for the life of the project.

The USACE will provide for 65 percent of the implementation costs of the project and will generally solicit, award, and manage design and construction contracts for implementation. Upon notice by the District Commander to the sponsor of completion of construction of the project, the sponsor will assume its obligation to operate, maintain, repair, replace, and rehabilitate the project.

Project costs are allocated to the Flood Risk Management purpose. Based on the October 2014 price levels, the estimated first cost to the plan is $37,579,000. In accordance with the cost sharing provisions of Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended by Section 202 of WRDA 1996, the federal share of the total project cost would be $24,426,000 (65 percent). The non-federal sponsor is responsible for the costs of the LERRDs, not to exceed 50 percent of the total project cost, and for a minimum cash contribution of 5 percent. The LERRDs for the Recommended Plan are anticipated to cost $9,652,000, less than the project minimum 35-percent contribution that is required. The remaining non-federal share will be a cash contribution of

$3,501,000; this exceeds the minimum cash contribution meaning no additional cash is needed.

Table 10: Cost Sharing

Cost Apportionment	OCT 2014	Fully Funded
Construction, PED, construction management, mitigation (compensatory restoration)	$27,927,000	$32,763,000
LERRD	$ 9,652,000	$10,934,000
NED Plan Total Project Cost	$37,579,000	$43,697,000
Federal Share	$24,426,000	$28,403,000
Non-federal Cash	$ 3,501,000	$ 4,360,000

Project Implementation. The non-federal sponsor for project implementation is the City of Merriam, Kansas. The city has established funding through its capital improvement program. The city also is counting on support from the Public Works Department at Johnson County, Kansas through their Stormwater Management Program. In addition, the city has a well developed understanding with the Merriam Drainage District (MDD) and how that legal state entity may also provide support in the design and in implementation phases at least, especially considering the MDD's already established mill levy. The details on this financial, and also for regulatory compliance with the FEMA NFIP, will be clarified in the floodplain management plan in 2014. The Kansas City District lead planner, project manager, and the lead Silver Jackets Coordinator for the state hazard mitigation team, are preparing the FMP for Merriam per the sponsors request and per specific arrangements in the feasibility cost sharing agreement. The FMP will help clarify floodplain management roles and responsibilities for the state as well as federal agencies, and the city will maintain the FMP with annual revisions to get credit under the FEMA Community Rating System. This tool allows more than adequate satisfaction of adaptive management. The city will maintain the project features and the resource monitoring (for compensatory mitigation) per the Operation and Maintenance plan. The city will need to clarify how MDD may be assisting in any management for constructed features, so that MDD does not inadvertently jeopardize these features by MDD's channel maintenance work, which it is so accustomed to doing.

Table 11. Project Implementation Schedule

Milestone	Start Date	Finish Date
PED	October 2016	September 2018
Initial Real Estate Acquisition	October 2018	September 2019
Project Construction		
Contract 1	October 2019	April 2021
Contract 2	May 2021	October 2022
Contract 3	November 2022	April 2024

Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R). For the annual O&M cost, unit costs and quantities for each alternative were estimated based on past project experience, and assumptions were made for quantities of line items for channel clearing and loading, hauling, and debris disposal. The unit costs for the drainage system maintenance were based on 10 percent of the particular drainage system costs for that level of intensity. Additionally, repairs, rehabilitation, and replacement unit costs were examined for each alternative. It was assumed that these percentages of the Recommended Plan would be repaired every 10 years, rehabilitated every 25 years, and replaced every 50 years. A specific percentage for each line item of each alternative is given in Appendix B, Chapter 4, paragraph 8. A summary of these costs and how frequently they occur can be found in Table 12 below. The present value and the average annual cost of each repair, rehabilitation and replacement (RR&R) cost that would occur over the 50-year period of analysis was calculated using the FY2013 discount rate of 3.75 percent, and that value was added to the annual O&M cost ($153,800) to arrive at the average annual OMRR&R cost ($215,600) for the Recommended Plan.

Table 12. OMRR&R Cost Summary

Items	Cost	Frequency
Operations and Maintenance	$28,000	Every year
Repairs	$49,000	Every 10
Rehabilitations	$104,000	Every 25
Replacements	$748,000	Every 50

Key Social and Environmental Factors. Generally, the proposed levee and floodwall impacts the overbanks, where minimal disturbance to the channel. During constructions, minor disturbances will occur to some businesses and to some traffic. Impacts to the overbanks is the main environmental factor and is a noticeably small impact, relative the larger cost components of the project and considering this is an urban area with minor environmental resources. Compensatory mitigation is proposed for all impacts. Temporary impacts to wildlife will result from noise and traffic associated with the construction efforts.

A detailed ecosystem mitigation plan is described in the Environmental Assessment. This plan has been coordinated with local and federal agencies including the U.S. Fish & Wildlife Service and the Kansas Department of Wildlife and Parks.

Stakeholder Perspectives. Since the sponsor began participating in the feasibility study in October 22, 2001, significant public participation has occurred. A series of meetings were held within the project area. The meetings allowed the PDT to present the existing flood risks and associated flood damages and to show the public flood risk management study alternatives and gather input on any issues that needed to be addressed prior to study initiation and throughout the study process.

- July 25, 2001 – a public workshop was held at Merriam City Hall in the City of Merriam to inform the public of the scope of the reconnaissance study. The workshop included a presentation of the existing flood risk, purpose of the analysis, potential benefits, and possible environmental impacts.
- July 17, 2003 –the Turkey Creek Awareness Workshop was held at the Antioch Public Library in Shawnee Mission, Kansas to inform the public of ongoing activities of the City, State, Federal, and other types of organizations to gather information for the future management of Turkey Creek.
- September 16, 2004 –the Upper Turkey Creek Concepts Workshop was held at the Community Center in the City of Merriam. The District presented the concepts developed at that time as opportunities for flood risk management for public consideration. The workshop was an opportunity for the public to ask questions and provide suggestions for improvement.
- October 19, 2011 – a public meeting was held at the Community Center in the City of Merriam to inform and receive input from the public about the suite of measures that could be used in alternatives.
- August 14, 2013 – a public meeting was held at the Merriam City Hall during the public review period of the Study to inform and receive input from the public about the Recommended Plan. This meeting explained the District's Recommended Plan for FRM. Comments were received on the draft report and are included in Appendix H.
- October 14, 2014 – The city held a meeting on the preliminary design. The USACE showed the levee/floodwall designed and explained how higher rainfall intensities called

for a more robust approach over the last year. This was tied to an update from NOAA, National Weather Service, in their precipitation atlas called Atlas 14. This new flood risk was known in April 2013. The USACE decided to address this in the design in November 2013. The meeting described the performance ability of the proposed low, 6-foot high levees and floodwall. Approximately ten people attended and offered good comments.

Upon the release of the Draft Feasibility Study with Integrated Environmental Assessment, a Public Notice was be issued, the Study was be made available for public review and another public meeting scheduled to obtain input on the recommended alternative.

The Draft Feasibility Report with Integrated Environmental Assessment was available by Public Notice for a 30 day public review period on June 27, 2013. The review period closed on August 21, 2013 after being extended by 26 days. The review period generated questions and comments on the Draft Feasibility Report with Integrated Environmental Assessment that covered a range of topics. These comments are provided in Appendix H, Comments and Correspondence.

The public was more attuned to preserving recreational aspects of the creek. The existing hike and bike trail was a focus. This has been preserved and integrated into the Recommend Plan.

Extensive coordination with several State and Federal agencies took place during development and evaluation of the Recommended Plan and the Environmental Assessment. The following agencies were coordinated with and in some cases have provided comments or participated in the review of this project:

- Federal Emergency Management Agency (FEMA)
- U.S. Environmental Protection Agency (EPA)
- U.S. Fish and Wildlife Service
- Natural Resources Conservation Service
- Kansas Department of Agriculture, Division of Water Resources
- Kansas Department of Wildlife & Parks
- Kansas Department of Health and Environment
- Kansas State Historic Preservation Office

The planners collaborated significantly with EPA Region 7 on environmental concerns. The study team took collaborative planning and watershed perspective work to the most extreme level of effort possible under those USACE guidance principles within the funding provided. The sponsors, several cities, and stakeholders have expressed satisfaction with that work, although the key concern is the flash flood hazard. Considering the amount of time evaluating district Regulatory and community interest or capacity building for an EPA Special Area Management Plan, extensive stream assessments, and the well developed plan formulation of some green solutions (see Appendix I), the study more than satisfies the planning needs that

USACE can provide given the limits of the authority, considering the district did and does not have a watershed planning authority.

Environmental Compliance. The feasibility report consists of a main report, with an integrated environmental assessment (EA), and appropriate appendices. There are no anticipated significant environmental, cultural or social impacts from construction of the Selected (NED) Plan. The project has responded to all resource agency and interested party comments, and compensatory mitigation for environmental losses are included in the plan. The mitigation plan has undergone an appropriate incremental analysis commensurate with the small impacted area. The report has justified compensation. The Recommended Plan would result in the removal of trees that provide approximately 4.2 acres of canopy cover. Most of the canopy cover is overstory, with limited woody understory vegetation. Approximately 238 hard mast producing trees, such as oaks and walnut, would be planted over a 9 acre area to compensate for the loss of trees. Temporary impacts due to construction and hauling of waste materials have been satisfactorily addressed in the plan. The plan has received Section 106 Clearance from the Kansas State Historic Preservation Office (SHPO) on May 15, 2013 with a preliminary review, which was finalized July 1, 2013 in a second letter. The final U.S. Fish & Wildlife Service Coordination Act Report was received on August 21, 2013, and the Selected Plan will result in no significant impacts on endangered species.

The Recommended Plan, would have minor, short-term construction related impacts to water quality due to activities occurring within the creek channel and on the creek banks in order to construct the levees and floodwalls. Additionally, two sewer lines and two waterlines that currently cross under Turkey Creek would be replaced. During construction, downstream waters would experience an increase in turbidity. However, it is expected that these short-term increases in turbidity would be less than would occur under either Alternative 1 or Alternative 3 because the amount of construction activity occurring in the creek channel would be less. The detention basin may result in minor, long-term beneficial impacts to water quality by removing some suspended sediment from stormwater runoff before it would enter Turkey Creek. A CWA Section 401 State Water Quality Certification would be required prior to beginning any construction. Additionally, the construction contractor would be required to obtain a Section 402 NPDES stormwater permit from KDHE prior to beginning any construction activities.

Certification of Agency Technical Review, Cost Center, Independent External Peer Review and Legal Review.

All review elements have been completed per the projects review plan, including an update for the new rainfall intensities per NOAA NWS Atlas 14. Independent External Peer Review was completed with all comments satisfactorily closed in October 2013. Final Agency Technical Review (ATR) was certified on March 11, 2015, with all review comments being satisfactorily addressed. Final Legal Certification was completed on March 9, 2015, by Kansas City District Council with the Feasibility Report and EA considered legally sufficient. The Cost Center review

was completed by the Walla Walla District and certified on February 11, 2015. The Walla Walla review comments resulted in improvement in some of the computations, characterizations, descriptive elements and format of the total project cost estimate.

Policy Compliance Review. The Policy Compliance Review conducted to date is documented in the Policy Guidance Memorandum dated June 25, 2013, and updated April 30th, 2015, which contains District responses to all comments. All responses have been incorporated into the final report, EA, and appendices as appropriate. The final policy review findings will be documented herein when completed by HQUSACE.