DRAFT

University City Branch, River Des Peres, Missouri
General Reevaluation Report (GRR)
with Integrated Environmental Assessment (EA)

A Flood Risk Management Study

Photo: University City

U.S. Army Corps of Engineers
Mississippi Valley Division (MVD)
St. Louis District (MVS)

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* Environmental Assessment sections

EXECUTIVE SUMMARY

This Draft Report of the integrated General Reevaluation Report (GRR) and Environmental Assessment (EA) presents the results of a U.S. Army Corps of Engineers, St. Louis District (USACE) study undertaken to identify and evaluate flood risk management (FRM) problems and opportunities for the River Des Peres in University City, Missouri. The GRR will constitute a reevaluation of the University City portion of the authorized project proceeding from the 1989 Chief's Report approving the recommended plan from the 1988 River Des Peres, Missouri Feasibility Report, EA, and Finding of No Significant Impact (FONSI). The 1988 study and this reevaluation are authorized by Section 101(a) (17) of the Water Resources Development Act of 1990.

The non-Federal sponsor for the study is the city of University City, Missouri. This report provides documentation of the plan formulation process to select a Tentatively Selected Plan (TSP), which will allow additional design and analysis to proceed towards identifying the final recommended plan.

The study area encompasses the upper River Des Peres headwaters which flow west to east through the municipalities of Olivette and Overland before entering University City east of I-170. The downstream extent of the study area is the point where the river goes underground into a large underground sewer system network known as "the Tubes". Flooding in the study area has caused problems including direct life loss and life safety risk, flooding of critical infrastructure, and flood damage to structures and associated economic loss.

The plan formulation process identified several structural and non-structural measures to address flood risk in the study area. An initial array of alternatives underwent early rounds of qualitative screening. Additional evaluation, comparison, and optimization of alternatives assisted the study team in identifying and evaluating the final array of six alternatives, along with the addition of two alternatives (7 and 8).

The National Economic Development (NED) Plan is the flood risk management alternative that reasonably maximizes net benefits while remaining consistent with the Federal objective of protecting the environment. The alternative with the highest net benefits is the nonstructural alternative, Alternative 6 – Floodproofing and Elevation. This alternative is the TSP (Figure 28). It includes floodproofing of approximately 500 structures and elevation of approximately seven structures in the area of 4% Annual Exceedance Probability (AEP) (25-year floodplain). It maximizes benefits in the NED benefit category, and scores well in the other three benefit categories: Regional Economic Development, Environmental Quality, and Other Social Effects. At the fiscal year (FY) 2021 discount rate, the total project first cost of the TSP is approximately $69 million, The benefit-cost ratio for the TSP and NED Plan is 1.67, and the annual net benefits of the plan are estimated at $1,675,000, as evaluated using a 50-year period of analysis starting in 2025.

The public will have the opportunity to review and comment on this draft report during the 30-day public review period which will begin in July 2021. A public meeting is planned for July 2021 to present the TSP and allow the public to respond and ask questions. The final report is scheduled to be complete in 2023.

1 INTRODUCTION*

1.1. STUDY AUTHORITY

The 1988 River Des Peres, Missouri Feasibility Study was authorized by the United States Congress as part of the St. Louis Metropolitan Area, Missouri and Illinois Summary Report and Background Information Report published in September 1977. Study authorities cited in the Feasibility Study that apply to River des Peres include United States Senate Public Works Committee Resolutions dated October 4, 1966, July 15, 1970, and October 2, 1972, and United States House of Representatives Public Works Committee Resolutions dated July 29, 1971 and October 12, 1972. Copies of these resolutions are reproduced in Appendix A of the Feasibility Study (U.S. Army Corps of Engineers, 1988). The Feasibility Study reviewed and included recommendations for four areas: the University City Branch of the River Des Peres, Deer Creek, Black Creek, and the Kirkwood Branch of Gravois Creek. A timeline of study authority events is shown in Figure 1.

Construction of the recommended plan from the River Des Peres, Missouri Feasibility Study was authorized by Section 101(a) (17) of the Water Resources Development Act (WRDA) of 1990. The authorized costs are at October 1987 price levels. The language in the Act is as follows:

> *River Des Peres, Missouri. The project for flood control, River Des Peres, Missouri: Report of the Chief of Engineers, dated May 23, 1989, at a total cost of $21,318,000, with an estimated first Federal cost of $15,846,000 and an estimated first non-Federal cost of $5,472,000.*[1]

Of the original $21M project cost, $5,999,000 was the estimated first cost associated with the channel modifications recommended in the upper River Des Peres (measure U-12). This cost does not include the flood forecasting system that was recommended to cover the entire study area, of which University City was a part.

The Energy and Water Development Appropriations Act for Fiscal Year 2004, Public Law 108-137, included funds for the Government to initiate detailed design of the University City Branch of the River Des Peres at University City, Missouri project. When pre-construction, engineering, and design revealed that the recommended plan would create flood impacts downstream of the University City Branch of the River Des Peres project area, that part of the recommended plan was not implemented.

1966	1977	1988	1989	1990	2020
Feasibility Study authorized	St. Louis Metropolitan Area, Missouri and Illinois Summary Report published	Feasibility Study Completed	Chief's Report approves recommended plan in Feasibility Study	Construction approval (WRDA)	General Reevaluation Report (this study) initiated

Figure 1. Timeline of study authority events

[1] The capital letter "D" in River Des Peres used in this report is based on this 1990 WRDA language.

1.2. STUDY PURPOSE, NEED, AND SCOPE

This University City, Missouri General Reevaluation Report with integrated Environmental Assessment (EA) presents the results of a U.S. Army Corps of Engineers (USACE) flood risk management study for University City in St. Louis County, Missouri. This report is an interim response to the study authority. The general purpose of this study is to analyze alternatives to reduce the risk to life safety and economic damages from flooding of the upper River des Peres.

The need for this study is the ongoing flooding of the upper River Des Peres in University City, which has caused damage and risk since at least the 1980's, with major recent flooding events occurring in 2008, 2011, 2013, 2014, 2019, and 2020. Two fatalities occurred during the flood event in 2008. Flooding has caused significant damage to homes, businesses, parks, and public facilities. The city's dated sewer system is overtopped during flood events, which causes the system to discharge untreated sewage into the River Des Peres and eventually flows into the Mississippi River. These property, business, and infrastructure damages cause major economic loss, harm the environment, endanger the safety and health of residents, and strain municipal services.

The scope of this study is to complete a general reevaluation of the University City portion of the authorized project for the River Des Peres, Missouri. It is a single-purpose study for flood risk reduction. This reevaluation will result in a recommendation that will either update and confirm the authorized project or make a new recommendation. The study will evaluate and compare the benefits, costs, and impacts (positive or negative) of alternatives including the No Action Alternative. The study will identify whether a federal interest exists to reduce economic damages and life safety risk due to flooding. This report also satisfies the requirement of the National Environmental Policy Act (NEPA) to evaluate the proposed federal action.

1.3. ENVIRONMENTAL ASSESSMENT

An environmental assessment (EA) is integrated within this GRR. The purpose of this EA is to evaluate the potential environmental impacts of the proposed flood risk reduction project, determine if the environmental impacts rise to the level of significant, and to serve as a record of public and interagency coordination. This report has been prepared under the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. §§ 4321 et seq) to evaluate the proposed alternatives.

1.4. NON-FEDERAL SPONSOR

The Non-Federal Sponsor is the City of University City, Missouri.

On 31 January 2020 an amendment to the Design Agreement between the St. Louis District and University City, Missouri was executed to include the Non-Federal Sponsor's interest to contribute funds to be used by the Government. The 2020 resumption of the GRR is funded

entirely with non-federal dollars under an Amendment to the Design Agreement. Funding was received by USACE on 29 April 2020, at which time this study was initiated.

1.5 STUDY AREA

Figure 3 shows the study area as the 5,930-acre (9.3 square mile) upper River Des Peres watershed, located in eastern Missouri just to the west of the City of Saint Louis. The watershed contains approximately 11 miles (17 km) of streams. The upper River Des Peres headwaters flow west to east through the municipalities of Olivette and Overland before entering University City east of I-170. Per USACE policy, flood risk management study efforts may only occur on streams where the 10% Annual Exceedance Probability (AEP) flow exceeds 800 cfs. This point was identified at a location west of I-170 in the municipality of Olivette. All measures and alternatives examined are downstream of this point. The downstream extent of the study area is the point where the river goes underground into a large underground sewer system network known as "the Tubes" (see "River goes underground" in Figure 3. Figure 2 shows the entrance to the Tubes. Downstream of the study area, the River Des Peres is almost completely channelized, flowing through underground pipes and above ground channels until it finally reaches an outlet into the Mississippi River.

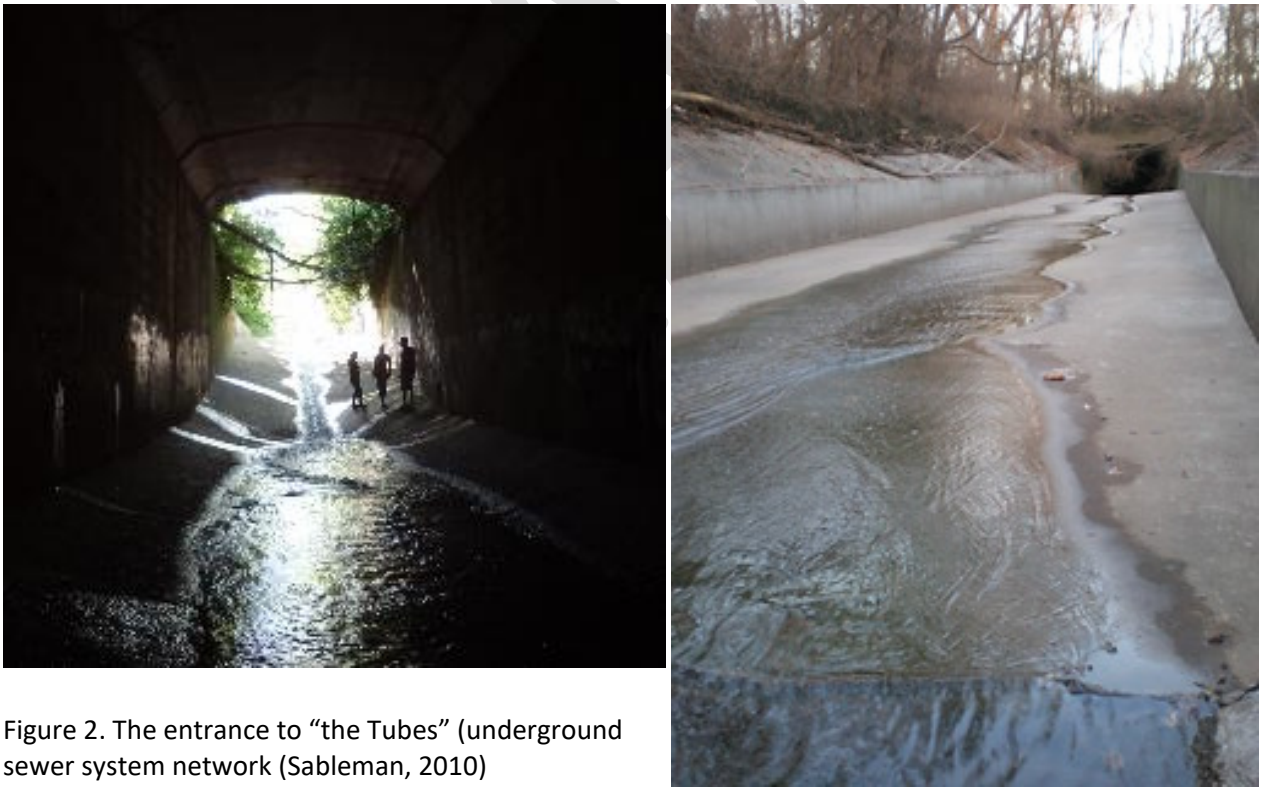

Figure 2. The entrance to "the Tubes" (underground sewer system network (Sableman, 2010)

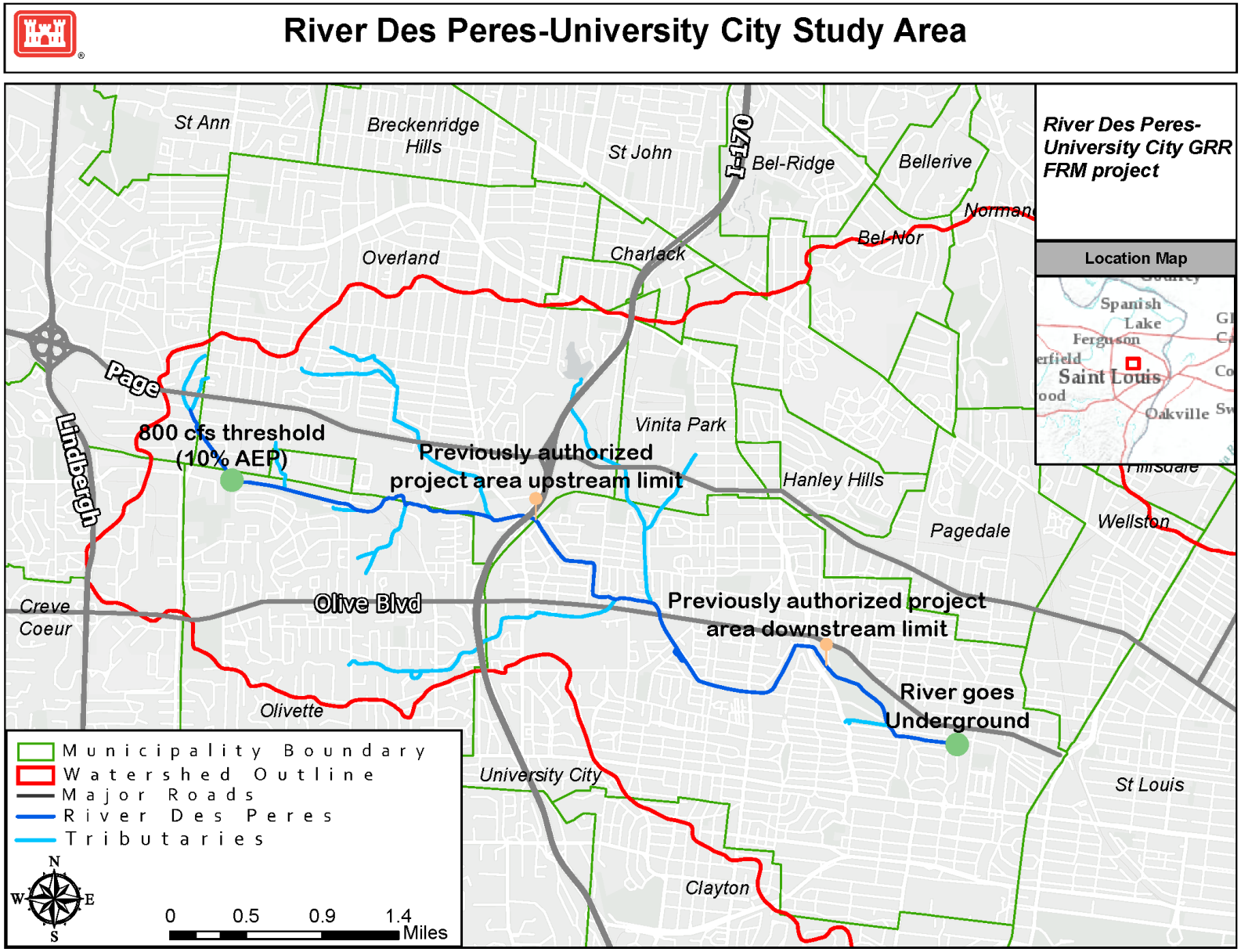

Figure 3. Map of the Study Area for the University City GRR.

The watershed is essentially completely developed. Its land uses are moderate to high density residential, light to heavy industrial, and open public land. Substantial flooding results during and after intense rainfall events. The most documented flooding in the project area is located along Mona Drive, Shaftsbury Avenue, and Wilson Avenue. Wilson Avenue is also the location of the Hazard Mitigation Grant Program buyouts that resulted after the 2008 flood event. Through model simulation, it was determined that the Wilson Avenue area falls within the 2-year floodplain (50% AEP area). This is the most serious stormwater problem in the watershed.

Along the River Des Peres, the land use is primarily low- and medium-density residential and commercial areas (including houses, apartments, businesses, and the campus of University City High School).

Previously Authorized Project Area

The project area from the 1988 Feasibility Study authorized in the 1990 WRDA extends along the River Des Peres from the 82nd Avenue bridge just east of I-170 upstream to the Purdue Avenue bridge in Heman Park downstream, a total of approximately 2.5 river miles. The project that was authorized in this area included channel modifications along the River Des Peres which defined the extent of the project area. Figure 4 shows the upstream and downstream extent of the previously authorized project area.

The project area for this report is the area potentially benefitted or impacted by the project, which will be determined based on the extent and impacts of the recommended plan. Since the plan recommended in this GRR is different than the plan recommended in the 1988 Feasibility Study, the project area is different. The project area that reflects the scope of the recommended alternative in this GRR is shown in Section 4.

1.5. PRIOR STUDIES AND REPORTS

- The 1977 USACE Metro Overview Study identified the River des Peres watershed as one of the "early action" areas to be studied in detail. This document contains a broad, comprehensive summarization of all water and land related resources in the St. Louis metropolitan area.
- The Water Resources Investigation, St. Louis Metropolitan Area, Missouri and Illinois, River Des Peres, Missouri, Survey Report for Flood Control and Allied Purposes, Reconnaissance Report and Appendix published in April 1980. This report recommended channel modification consisting of 1.88 miles of riprap channel enlargement and one (1) bridge replacement in University City.
- The 1988 USACE River Des Peres, Missouri Feasibility Report, Environmental Assessment and Finding of No Significant Impact (FONSI) resulted in a 1989 Chief's Report supporting the recommended plan, including a structural flood risk management solution of widening and stabilizing 2.53 miles of the upper River Des Peres channel within University City. The project was authorized for construction in 1990.

- The Flood Insurance Rate Maps (FIRMs) developed by FEMA from the Flood Insurance Studies (FISs) in 2015 are the effective flood maps for University City and St Louis County. An update to these maps is currently underway through the State Emergency Management Agency (SEMA); the 2019 preliminary Special Flood Hazard Area information was made available to USACE for this study.
- A GRR study was initiated in 2007 and a draft report and Integrated EA were created in 2009. The study was suspended due to lack of funding from the sponsor. The study was not publicly circulated and did not result in any action taken by University City.
- In 2013, USACE created a River Des Peres-University City Economic Update report to ensure that a viable project remained. The report includes updated economic and real estate analyses related to buyouts in the River Des Peres floodplain.
- Great Rivers Greenway (GRG) completed the Centennial Greenway: Heman Park to Groby Road – Conceptual Plan Update in 2014, which shows planned routes and landscaping for the Centennial Greenway along River Des Peres in University City.
- In 2019, the University City Storm Water Task Force produced the Storm Water Task Force Report, which summarizes six primary stormwater concerns for the city and highlights the "most important" mitigation projects, including a flood warning system. Additional University City Stormwater Task Force online resources include: task force meeting agendas, audio recordings, and minutes; planning guides and manuals; the STL County Phase II Stormwater Management Plan; information on stormwater ordinances and the MS4 program; informational pamphlets on flood damage, cleanup, and insurance; River Des Peres Watershed and Municipal boundaries map; and additional information on FEMA, Missouri DHSS, Missouri DNR, MSD, U.S. EPA, and USACE resources (University City, Missouri, 2020).

1.6. OVERVIEW OF PLANNING PROCESS/PLAN FORMULATION

This study will review the 1988 Feasibility Study with Integrated Environmental Assessment and its recommended plan. The project formulation process must adhere to laws, policies, and regulations that define the planning and design process to be followed and establish specific design criteria and requirements to ensure that the project features will perform reliably.

USACE General Planning Process Used

The planning process used in this study included the following steps: identification of the problems and opportunities; development of relevant information through public input, inventories, forecasts, and analyses; formulation of alternative plans; evaluation of the effects of the plans; comparison of the alternative plans; and selection of a recommended plan. The study involved several iterations of these steps to improve basic information or to refine alternative plans. Public and interagency involvement, scoping, and product reviews are sought throughout the process to keep the public informed and to receive and incorporate their ideas and concerns.

To effectively formulate a feasible flood risk reduction project and assess the effects of the project, a full array of potential flood risk reduction strategies and associated specific plans must be considered. Initial study efforts focus on determining if there is a potentially feasible plan that

is in the Federal and local interest to pursue. If Federal and local interest is found, then studies of a greater level of detail are completed in feasibility and/or reevaluation studies. Flood risk reduction plans found to be economically, environmentally, and socially feasible are evaluated further in a progressive screening process until a single National Economic Development (NED) plan is identified. This NED plan is the plan that reasonably maximizes net economic development benefits, consistent with the Federal Objective. If a different alternative than the NED plan is more feasible to the non-Federal sponsor, a Locally Preferred Plan (LPP) can be requested for approval. If the LPP is approved but more expensive than the NED plan, the sponsor must pay the difference.

1.6.1. Problems & Opportunities

1.6.1.1. Problems

The flooding problem in River Des Peres in University City poses the following risks:

- Risk to life safety;
- Risk of damage to property and infrastructure;
- National and Regional economic impacts;
- Risk to cultural heritage, population, other social effects;
- Risk of streambank erosion that damages private property and public infrastructure;
- Risk of negative impacts to water quality; and
- Risk of environmental damages and human health safety impacts from industrial flooding.

Intense brief rainfall or prolonged rainfall over the Upper River Des Peres watershed moves rapidly over urbanized surfaces into the stream channel. Due to the relatively small size of the watershed, the prevalence of impervious surfaces, and the lack of a warning system in the watershed, residents and businesses have limited warning in advance of overbank flows and up to 1,100 structures and 3,000 people in the floodplain can be at risk up to the 1% AEP area. The Annual Exceedance Probability (AEP) is defined as probability that flooding will occur in any given year considering the full range of possible annual floods. Major thoroughfares (Olive Blvd/Route 340, Midland Blvd) can be inundated by the 1% event, slowing evacuation and emergency response efforts. Those that don't attempt evacuation (likely the majority of the population, due to the short duration of most flood events) would have to shelter in place.

Generally speaking, current life risk from flooding in University City appears relatively low. The key risk drivers are potentially high velocities, relatively low warning time, and areas of flooding. However, the life risk appears low because the community is very aware of the flood hazard, has an Emergency Operations Plan that addresses flooding, monitors National Weather Service messages about storms and flash flooding, and evacuation distances are short.

USACE proposes to address the following over-arching problems in this study:

1. Risks to life safety associated with riverine flood inundation.
    a. This includes direct life loss, flooding of critical infrastructure, and flooding of evacuation routes
2. Economic damage resulting from riverine flood inundation.
    a. This primarily focuses on direct structure inundation (structure, content, and vehicles) but can also consider traffic disruption, emergency costs, etc.

Figure 4 shows images of residential flooding during storms in 2008 (due to Hurricane Ike) and 2014.

Figure 4. Images of flooding in University City. Left: Flood event in 2008 (Meekimus, 2008). Right: Flood event in 2014 (University City, 2014).

1.6.1.2. Opportunities

The following opportunities were identified for this study:

- Increased outdoor recreation;
- Improved risk communication;
- Reduce sewer backups;
- Improved water quality, including reduced sedimentation/turbidity;
- Re-establish natural wildlife habitat such as wetlands;
- Increased community resiliency to flood events; and
- Increased coordination with FEMA and other agencies to reduce flood risk and obtain grant funding for solutions.

1.6.2. Objectives and Constraints

1.6.2.1. Objectives

The following objectives have been developed for this GRR:

1. Reduce life safety risk due to flooding, including inundation of structures & public infrastructure, in University City over the period of analysis.
2. Reduce economic damage due to flooding in University City over the period of analysis.
3. Increase recreational opportunities associated with FRM features over the period of analysis.

The period of analysis is defined as the time horizon for project benefits, deferred installation costs, and operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs. For this study, the period of analysis is 50 years starting in 2025.

1.6.2.2. Constraints

In this study, constraints to be avoided and/or considerations while addressing the planning objectives include:

- Some previous buyouts in the study area were acquired through FEMA's Hazard Mitigation Grant Program. USACE is prohibited from constructing project features on lands previously acquired through this program.
- The project area contains cultural and historic resources such as two areas of concern identified in the SHPO database: (1) The University Heights subdivision on the east side of project area (e.g. Dartmouth, Yale Streets) and (2) University City High School and some of the houses around them (and even across the river). Impacts to these resources should be avoided or minimized.

1.7. INITIAL SCOPING AND COORDINATION

1.7.1. Agency Coordination

USACE conducted scoping and coordination with the following state and federal agencies, Federally-recognized Tribes, and other interested parties:

- City of University City, Missouri
- St. Louis County, Missouri
- Metropolitan Sewer District (MSD)
- Missouri Department of Transportation (MoDOT)
- Missouri Department of Natural Resources (DNR)
- Missouri Department of Conservation (MDC)
- State Emergency Management Agency (SEMA)

- East-West Gateway Regional Council of Governments
- River Des Peres Watershed Coalition
- Great Rivers Greenway
- U.S. Fish and Wildlife Service (USFWS)
- National Park Service (NPS)
- U.S. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)
- Missouri State Historical Preservation Office (SHPO)
- Tribes (23 tribes; see Section 2.16)

Study collaborators discussed problems, opportunities, and potential measures through numerous coordination meetings. While not comprehensive, the following meetings are examples of ongoing coordination:

- Planning Workshop (Charrette): June 2020
- Public Scoping Meeting: September 2020
- (Upcoming): Public Meeting accompanying release of Draft Report: July 2021

Further information on the dates and types of coordination with these agencies and parties may be found in Appendix 1.

1.7.2. Public Involvement and Review

A Public Scoping Meeting was held virtually on 30 September 2020 to present information and gather feedback from the public on the scope of this study. The information presented included an overview of the study process with preliminary findings and potential solutions. A summary of the questions and input received at this meeting is provided in Appendix J - Coordination. A Public Meeting accompanying the release of the Draft Report will be held in July 2021, and all comments received at this meeting and during the 30-day public comment period will also be provided in Appendix J.

2 EXISTING CONDITIONS AND FUTURE WITHOUT PROJECT CONDITIONS*

One of the first steps in the USACE planning process is to assess the existing conditions in the study area. This generally includes describing the factors that affect the study, as they exist during the study period. This section discusses the current condition of the study area, the hydrology and hydraulic conditions that affect the structures within the study area, the potential economic damages that will continue if no federal action is taken, and the potential life safety consequences that have and will continue to exist. University City, being adjacent to St. Louis and part of the larger city's metro area, is definitively urban and influenced primarily by human factors such as general urban development and major transportation networks.

This section will also review the Future Without Project (FWOP) Condition of the study area, which is developed to describe the most likely future conditions in the project area if no federal action is taken to address the identified problems. It forms the baseline for identifying the effects of the alternatives and is equivalent to the No Action alternative.

The future is inherently uncertain, and conditions change over time. To identify the FWOP condition to be used for evaluation purposes, the study team began with the existing conditions information and considered what potential changes could occur in the future. A forecast period of 50 years was selected as a reasonable timeframe for analyzing potential changes in the project area (per USACE policy). This section discusses potential changes during the 50-year period of analysis which the study team felt could result in a FWOP condition that differs from the existing conditions and, where needed, documents the differences.

2.1. TOPOGRAPHY, GEOLOGY, & SOILS

Existing Conditions

University City, and the City of St. Louis, are in the Dissected Till Plains Physiographic Region (Missouri Department of Natural Resources, 2018). The Dissected Till Plains were formed by pre-Wisconsin glaciations during the Pre-Illinoian Stage. Glacial scouring and deposition by the Laurentide Ice Sheet and the later accumulation of loess during the Wisconsin Stage left behind the rolling hills and rich, fertile soils found today in the region. The Dissected Till Plains is a sub-unit of the Central Lowlands in the Interior Plains of North America. It is centered on the Iowa-Missouri state line. The eastern border is the Mississippi River and bounded on the south by the Missouri River Valley across central Missouri.

The bedrock geology of the area consists essentially of flat-lying Pennsylvanian cyclical deposits of sandstones, shales, clays, and coal (Missouri Department of Natural Resources, 2008). Extensive deposits of Mississippian limestone lie under these formations. These limestone deposits can be seen at the Rock Hill Quarry, which discontinued mining operations in 1976 and has served as a landfill since 1979. Karst features associated with limestone occur in the area, and several sink clusters appear to be associated with the Deer Creek drainageway. A geo-structural feature called the Clayton Syncline trends northwest through the watershed. This feature is associated with the Cheltenham Syncline, a broad structural depression present within

much of the south and west portions of St. Louis County. The Clayton Syncline is responsible for the presence of Pennsylvanian deposits in the northeastern part of the watershed and is the controlling factor in the surface exposure of limestone in the southwest part of the watershed. The Black Creek tributary follows the syncline axis to the northwest.

Missouri, along with Nebraska and Kansas, is part of Segment 3 of the groundwater atlas of the United States (U.S. Geological Survey, 1997). St. Louis County rests upon Springfield Plateau aquifer equivalent rocks but is not part of the aquifer system. A large volume of freshwater is stored in the bedrock and alluvial materials underlying the St. Louis metro area. Groundwater can be found occurring along fractures in the bedrock, porous openings in the limestone and dolomite rock, and in voids between the grains in sandstone. The availability of groundwater from bedrock depends on the amount of fracturing and solution experienced by the rock and how interconnected the voids and porous spaces are. Water in the alluvial material is found in openings between the sand and gravel particles. The availability of water from the alluvium depends upon the degree of sorting of the material, its saturated thickness, and the amount of water contributed by surface infiltration.

Elevations in the watershed range from a high of 720 feet to a low of 301 feet at the mouth. Most of the area is fairly flat, with slopes between 1 and 4 percent. The Soil Conservation Service describes the area as having large, irregular-shaped urban soils, well-drained and gently sloping. A review of the Soil Web tool revealed that the soil types found along this segment of the River Des Peres are predominately an Urban land-harvester complex with 2-9 percent slopes because most of the watershed is urbanized extensively (U.S. Department of Agriculture, 2019). The area also includes Fishpot-Urban land-Freeburg complex with 0-2 percent slopes. The only soil types that aren't urban are a small amount of Winfield silt loam. The highly urbanized nature of the soils means the potential for erosion is very high. Flood plain soils present include Urban Land-Fluvents in the lower elevation areas of the major creeks and tributaries, and Belknap, found in the uplands along the major creeks and tributaries. These soils are somewhat poorly drained soils derived from alluvial materials.

Future Without Project Conditions

The geological formations beneath St. Louis County would not be altered from their present state in the FWOP condition. Soil types found along the River Des Peres would likely remain unchanged. Soil composition may be driven by the decisions made by public and private landowners who build features such as parks and landscaping. Similarly, the overall topography of the area is unlikely to change. Groundwater in the project area would not be affected by the FWOP condition. The general slope/relief of University City as a whole is unlikely to change in the next 50 years. The topography, geology, and soils in the project area are not expected to change in the FWOP condition.

2.2. LAND USE/LAND COVER

Existing Conditions

The land cover in the study area is definitively urban, with residential and commercial spaces (Missouri Department of Conservation, 2005). The land use in the project area is influenced primarily by human factors, including residential and commercial development and major transportation networks. A review of the 2005 Land Use/Land Cover imagery shows that the project area is predominately low intensity urban, with some high intensity urban as well (Figure 6). According to the University City Comprehensive Plan (2005), 82% of the city is devoted to single-family residential, with another 11% as high-density residential. Commercial properties account for 3% of the land area, concentrated mostly on Olive and Delmar Boulevards. There are no active commercial agriculture operations in the project area. The study area is significantly modified from its natural state, and it contains few to no natural or wild spaces. There are trace amounts of deciduous forest, mostly along the river in spots, and in public and private parks.

An additional land cover in the project area is a small wetland. A review of the National Wetland Inventory shows a 0.4 acre freshwater forested/shrub wetland in the project area (Figure 5) (U.S. Fish & Wildlife Service, 2020). This small wetland lies just west of the University City Fire Station on North and South Road, at approximately Lat 38.668 and Long -90.338. This wetland is palustrine and forested with broad-leaved deciduous trees. The water regime is temporarily flooded, with the water table well below the ground surface, for most of the year. The wetland is adjacent (and therefore connected to) the River Des Peres.

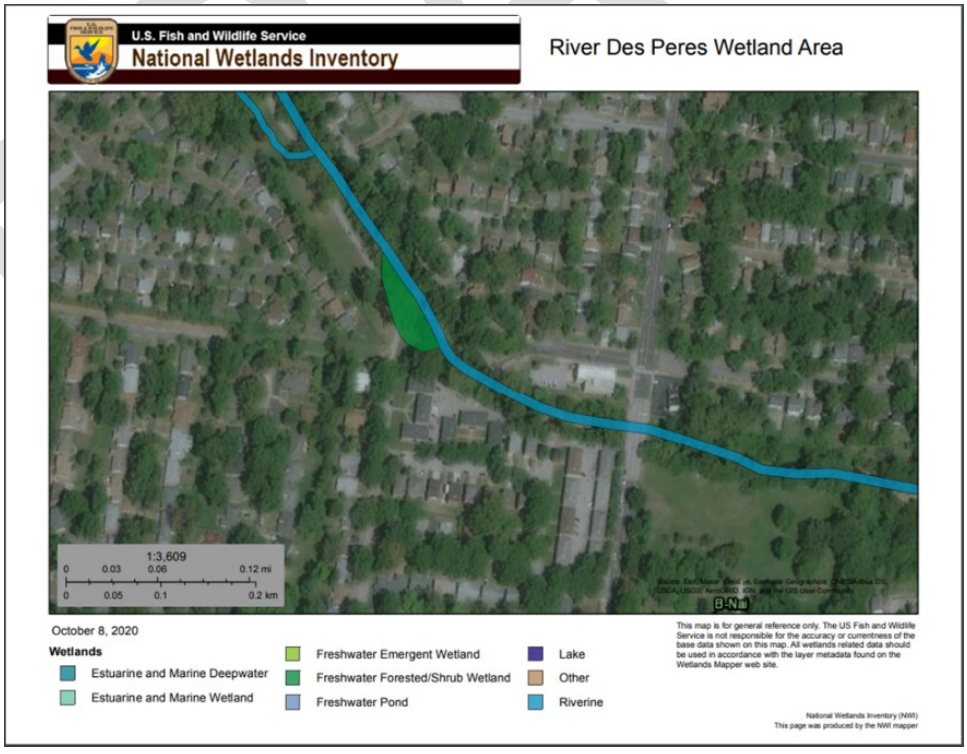

Figure 5. Location of the mapped wetland within the project area.

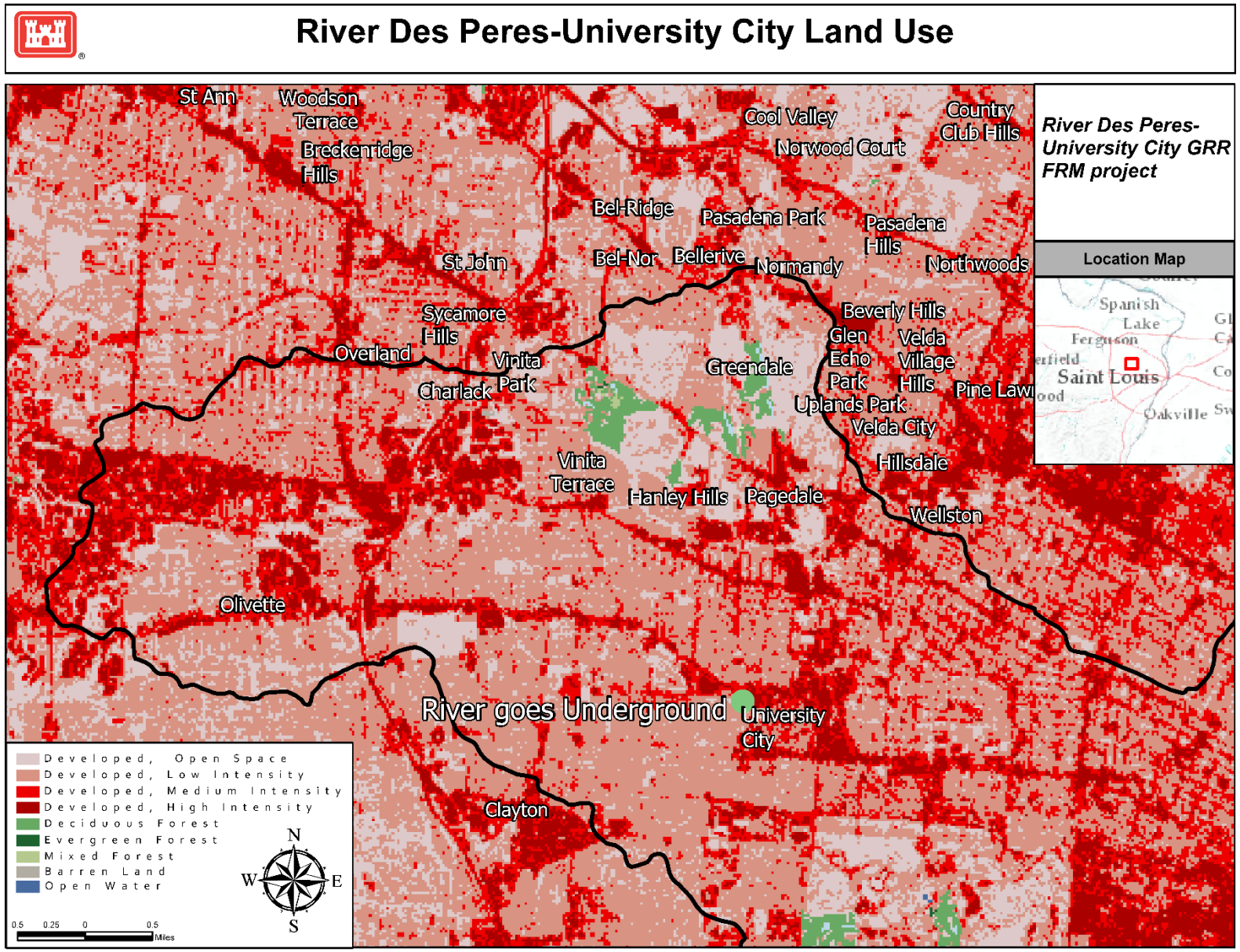

Figure 6. Land use in the study area

Future Without Project Conditions

The current dense development of the area makes further major land use changes, which would significantly alter stormwater runoff characteristics, unlikely. The 2005 University City Comprehensive Plan includes a proposed land use map which does not show much change from current land use in the project area. Neither the current nor proposed land use maps show the open space land use following the Wilson Avenue buyouts (these maps were made prior to the 2008 flood). The City is working on updating its Comprehensive Plan, which will likely include open space in the Wilson Avenue area along River Des Peres.

If flooding continues unabated, the 20% AEP area (5-year floodplain) is likely to have somewhat less residential and commercial development due to the continuing damages brought about by flood events. It is likely that some land would change from residential and commercial uses to barren urban land (vacant lots) or other uses that are not impacted by frequent flooding. Additionally, some new residential development is anticipated at Delmar and I-170, according to development plans shared by University City; the changes in land use accompanying these projects are likely to be somewhat minimal.

1) Crown Center for Senior Living, which currently has 244 units but will reduce to 238 units after final construction;
2) The Avenir project, which has proposed 258 units; and
3) The proposed Delcrest Plaza Development, which has proposed 252 units.

The specifics of the expected decline in development and the new planned development are not known at this time and have not been incorporated into the H&H analysis in this study. Changes in land use due to new development and buyouts/conversion to open space are expected to be minimal. Therefore, land use in the project area is not expected to change in the FWOP condition.

2.3. CLIMATE

Existing Conditions

University City and St. Louis lie in USDA Hardiness Zone 6a and have a Koppen Classification as Humid Subtropical climate. The following precipitation and temperature data were obtained from the National Weather Service's 2019 annual summary (National Weather Service, 2014). The normal annual rainfall in the St. Louis region is 40.96 inches. 2019 was the 5th wettest year on record for the St. Louis Region. There were 15 days which saw at least an inch of rain and 88 days with at least 0.1 inches of rain. The greatest 24-hour total was 3.3 inches on 22 July 2019. The average temperature is 57.1 degrees Fahrenheit in St. Louis, with the average max being 66.2F and the average min of 48.1F. In 2019, there were 50 days with a max temp of at least 90F, and 18 days with a max temp of no greater than 32F. There were 88 days with a minimum temperature below freezing and 1 day below 0F.

The nearest climate gaging station to University City, Missouri is at the Airport in Bridgeton, Missouri. Bridgeton, Missouri, has a continental climate characterized by cold winters and hot summers. The average annual rainfall is 40.96 inches with May being the month of highest rainfall

(U.S. Climate Data, 2020). However, precipitation is highly variable from year to year with the statewide average ranging as low as 25.52 inches in 1901 and as high as 51.18 inches in 1993. The driest 5-year period in history was from 1952 to 1956 and the wettest 5-year period ranged from 2007 to 2011. The average annual snowfall is 11 inches with the majority falling in December through February (monthly average 3 to 4 inches). Figure 7 shows the monthly climate patterns for Bridgeton Missouri (U.S. Climate Data, 2020).

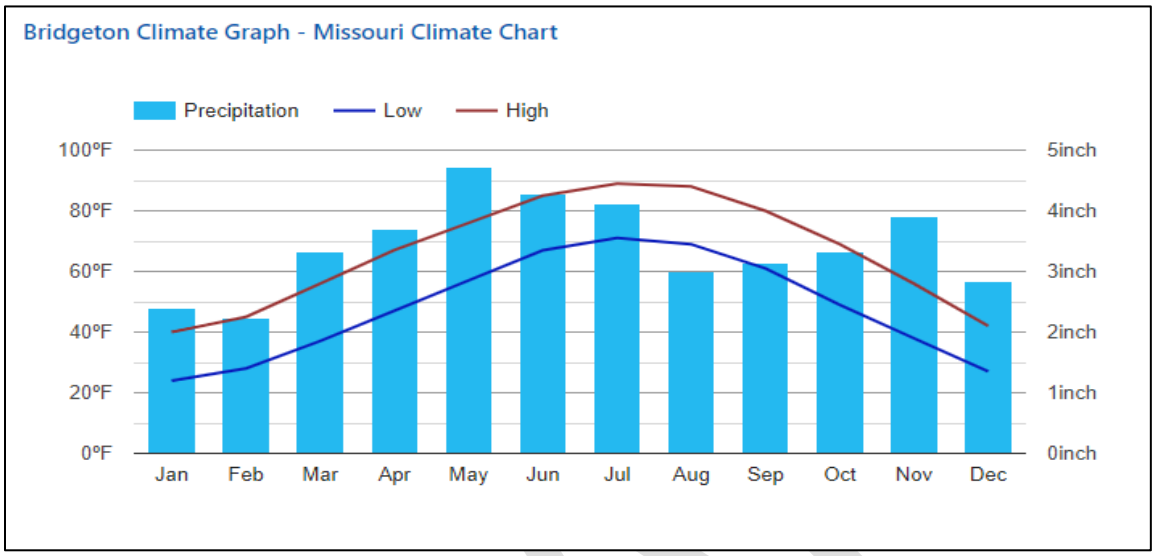

Figure 7. Climate data for Bridgeton, Missouri, 2020.

Future Without Project Conditions

A qualitative climate change analysis was undertaken in accordance with the USACE Engineering and Construction Bulletin No. 2018-14 (USACE, 2018) and Engineering Technical Letter 1100-2-3, *Guidance for Detection of Nonstationarities in Annual Maximum Discharges*. This analysis included both a literature review and analysis of USGS gauges near the project site (Appendix B – Climate Change).

Climate change characteristics that could impact the River Des Peres GRR reliability include temperature, precipitation, stream flow and changes in seasonality.

The literature review indicates:

1. The consensus in recent literature points toward moderate increases in temperature and precipitation in the Upper Mississippi Region over the past century.
2. In some studies, and some locations, statistically significant trends have been quantified. In other studies, and locales within the Upper Mississippi Region, apparent trends are observed graphically, but are not statistically quantified.
3. Some evidence points to an increased frequency in the occurrence of extreme storm events (Villarini et al., 2013).
4. Multiple authors identified a transition point in climate data trends in 1970 where rates of increase changed significantly.

Project-specific results generated using USACE tools indicate the following:

1. Nonstationarity analysis and monotonic trend analysis of annual peak streamflow records observed at sites in the vicinity of the project area showed the gages to behave as stationary. Note that period of record was less than 20 years which does not yield a high enough accuracy in the nonstationarity analysis results.
2. The HUC4 basin containing the River Des Peres shows the indicator that contributes the most to the climate risk is flood risk magnification. This would be indicative of positive increase in runoff over time.
3. Two of the observed stream gage records showed statistically significant results ($p < 0.05$). Both displayed an upward trend in flow. Climate change and land use changes yielding higher runoff are potential drivers for the upward trends in higher magnitude flow observations.

Based on analysis, upward trends in temperature, precipitation, and runoff in the River Des Peres watershed are expected, which would further exacerbate existing flooding problems. The FWOP condition of the study area may be impacted by changes in climate at some point in the future.

2.4. AIR QUALITY

Existing Conditions

The Clean Air Act of 1963 requires the U.S. Environmental Protection Agency (USEPA) to designate National Ambient Air Quality Standards (NAAQS). The USEPA has identified standards for six criteria pollutants: ozone, particulate matter (PM10 = less than 10 microns; and PM2.5 = less than 2.5 microns in diameter), sulfur dioxide, lead, carbon monoxide, and nitrogen dioxide. As of 2020, St. Louis County is in non-attainment for 8-hour ozone only (U.S. Environmental Protection Agency, 2020).

Future Without Project Conditions

Air quality in the project area would likely improve as the area continues to work towards attainment standards. These attainment standards are unrelated to the flooding in University City, and therefore would be expected to be met regardless. Air quality in the project area is not expected to change in the FWOP condition.

2.5 NOISE

Existing Conditions

The National Institute for Occupational Safety and Health (NIOSH) is responsible for conducting research and making recommendations for the prevention of work-related injury and illness. The NIOSH has set a limit of 85 decibels (dBa measure of loudness) on the A scale (the most widely used sound level filter) for eight hours of continuous exposure to protect against permanent hearing loss (Figure 8) (Center for Disease Control, 2014). The existing noise conditions are ambient urban noise sources along the River Des Peres in University City. Ambient urban noise could include traffic, construction, lawnmowers, and other noise sources

commonly associated with an urban area. These noise sources typically have noise levels in the range of 34-70dB.

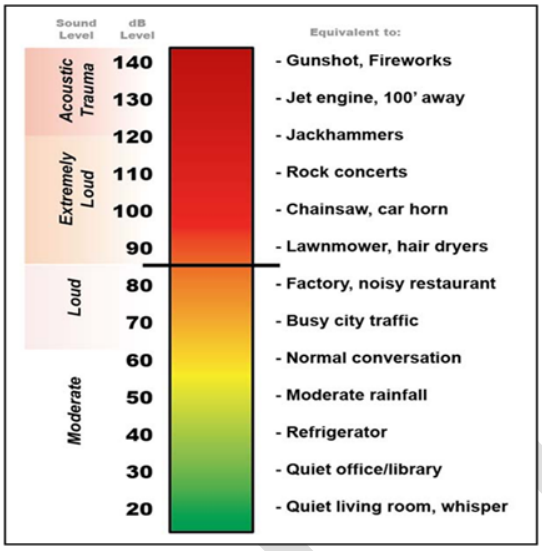

Figure 8. Examples of the sound level and decibel (dB) level of various sources.

Future Without Project Conditions

Urban development over the next five decades may slightly increase the ambient noise levels along the river in University City. The types of noises related to urban life would rise in relation to the amount of development. These changes are unrelated to the flooding problem in University City and would be expected to occur regardless. Noise in the project area is not expected to change much in the FWOP condition.

2.6 HYDRAULICS AND HYDROLOGY

Hydrologic simulations used in this study were conducted using PCSWMM 7.2 for the hydrology and HEC-RAS 5.0.7 for the hydraulics. Using a recent flood event, existing models were recalibrated, and the flood of record results were verified for accuracy.

The PCSWMM model extents encompass the entire River Des Peres watershed. The model includes both the open channel hydraulics mixed with a large number of closed conduits, combined sewers with overflow, and flow splits throughout the River Des Peres watershed. Specific attention was given to the hydrology in the upper River Des Peres.

The modeling extents for the HEC-RAS model start upstream at Warson Road in Olivette, MO. The reach flows downstream until it reaches the entrance of the underground sewerage system in the areas between Vernon and Dartmouth Avenues in University City, MO. The start of the underground network is referred to as the River Des Peres “Tubes”. For the purposes of this project, PCSWMM will be used to generate the anticipated HEC-RAS inflow.

The existing condition model problem areas were compared against conditions documented in the prior USACE studies for the upper River Des Peres in University City. The model results are

presented using frequency rainfall events and the resulting river levels/depth grids on the River Des Peres in University City, MO.

Existing Conditions

The River Des Peres is a mixed-use sewer and storm drainage system with some outfalls and ditches draining into the stream along the segment as it flows through University City. The extents of the study area along the University City Branch of the River Des Peres and key H&H features are illustrated in Figure 9.

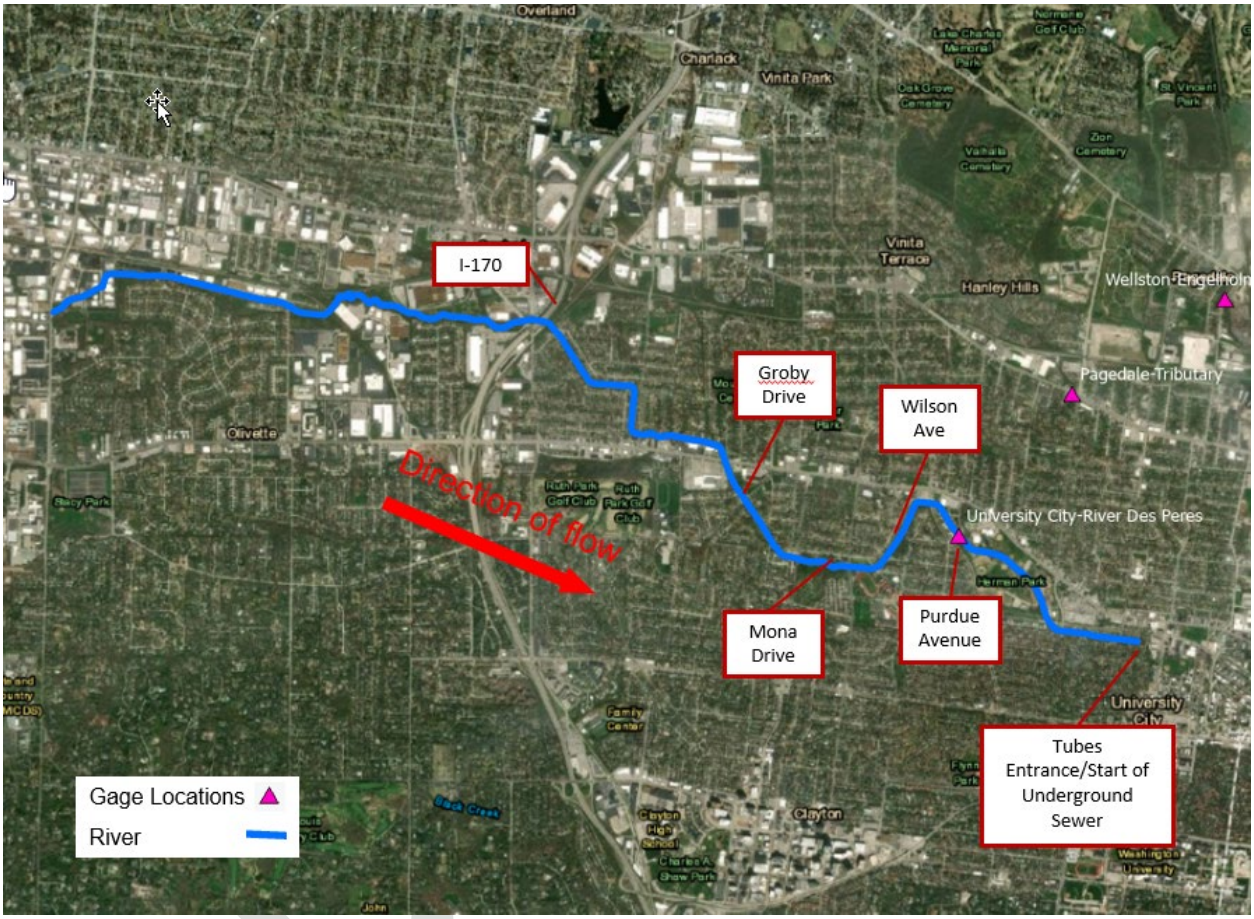

Figure 9. River Des Peres study area overview of key H&H features

The River Des Peres is considered a natural channel along much of its length in the study area. However, the existing channel of the River Des Peres has previously been modified by straightening, reshaping, and enlarging the channel using channel linings such as concrete, hand laid rock, and gabion.

For the sewered section of the River Des Peres, the storm water runoff is managed by the Metropolitan Sewer District (MSD). MSD governs all stormwater as it pertains to the surrounding area as prescribed by the district's stormwater management plans. The River Des Peres goes underground at the east end of Dartmouth Avenue in University City. The tunnels that take the water underground to and through Forest Park are referred to by MSD as the "Tubes". The

entrance to the Tubes from the University City Branch of the river is 20 feet wide by 21.5 feet tall box culvert. Construction of these tubes took place over three years, between 1927 and 1930.

The University City 2019 Storm Water Task Force Report identified segments of the River Des Peres with undersized and debris-clogged bridges and culverts causing water to backup upstream. As a result, overbank flooding is aggravated, leading to unusual flow patterns or hydraulic forces that can cause scour and damage structures. The Storm Water Task Force examined conditions under four bridges in the study area and measured the approximate cross sections available for flow conveyance. Three out of four of the bridges examined had adequate conveyance to pass a 2-year storm, but the Groby Avenue bridge near Olive Blvd did not. The Storm Water Task Force members' conclusion was that significant problems with reduced conveyance and clogging of stream channels exists along the River Des Peres and its tributaries.

Hydrologic and Hydraulic Modeling

The models used in this study were assembled from a Zone AE designated streams hydrology study prepared for the Missouri State Emergency Management Agency by Wood Environment and Infrastructure Solutions (June 2017). The study analyzed several watersheds in the Cahokia North Watershed of which the River Des Peres is part. Particular to this project study area, the River Des Peres watershed hydrology was analyzed using PCSWMM. See Appendix 2 for documentation of the PCSWMM analysis of the River Des Peres watershed. The watershed and pipe network geometry of the River Des Peres watershed is illustrated in Figure 10.

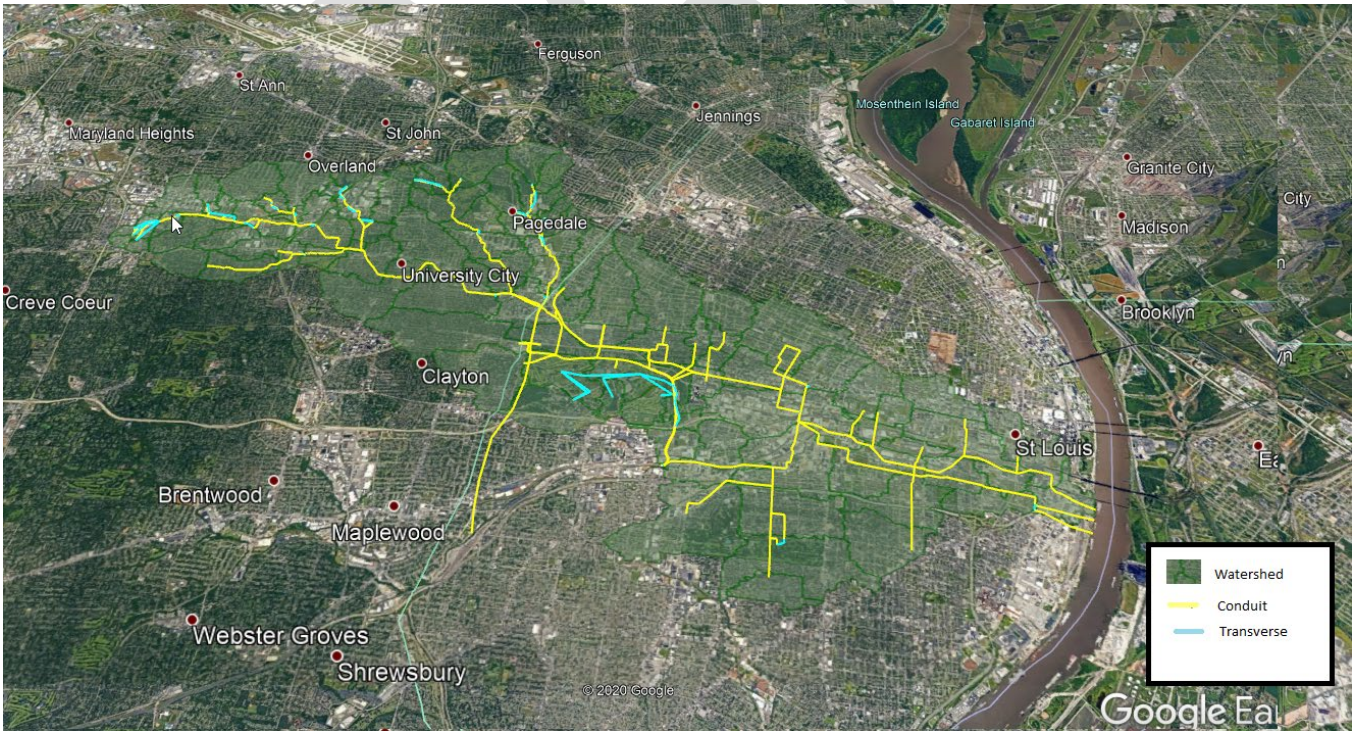

Figure 10. PCSWMM geometry for the River Des Peres watershed

In tandem with the Cahokia North Watershed analysis, Wood Environment and Infrastructure Solutions created or updated several hydraulic models for a FEMA FIS update of St. Louis County, Missouri. The model used to capture the Upper River Des Peres was constructed using HEC-RAS. The cross-section geometry of the River Des Peres study reach is shown in Figure 11.

Information on PCSWMM calibration and validation, HEC-RAS model configuration, and HEC-RAS calibration and validation is provided in Appendix A – Hydrology and Hydraulics.

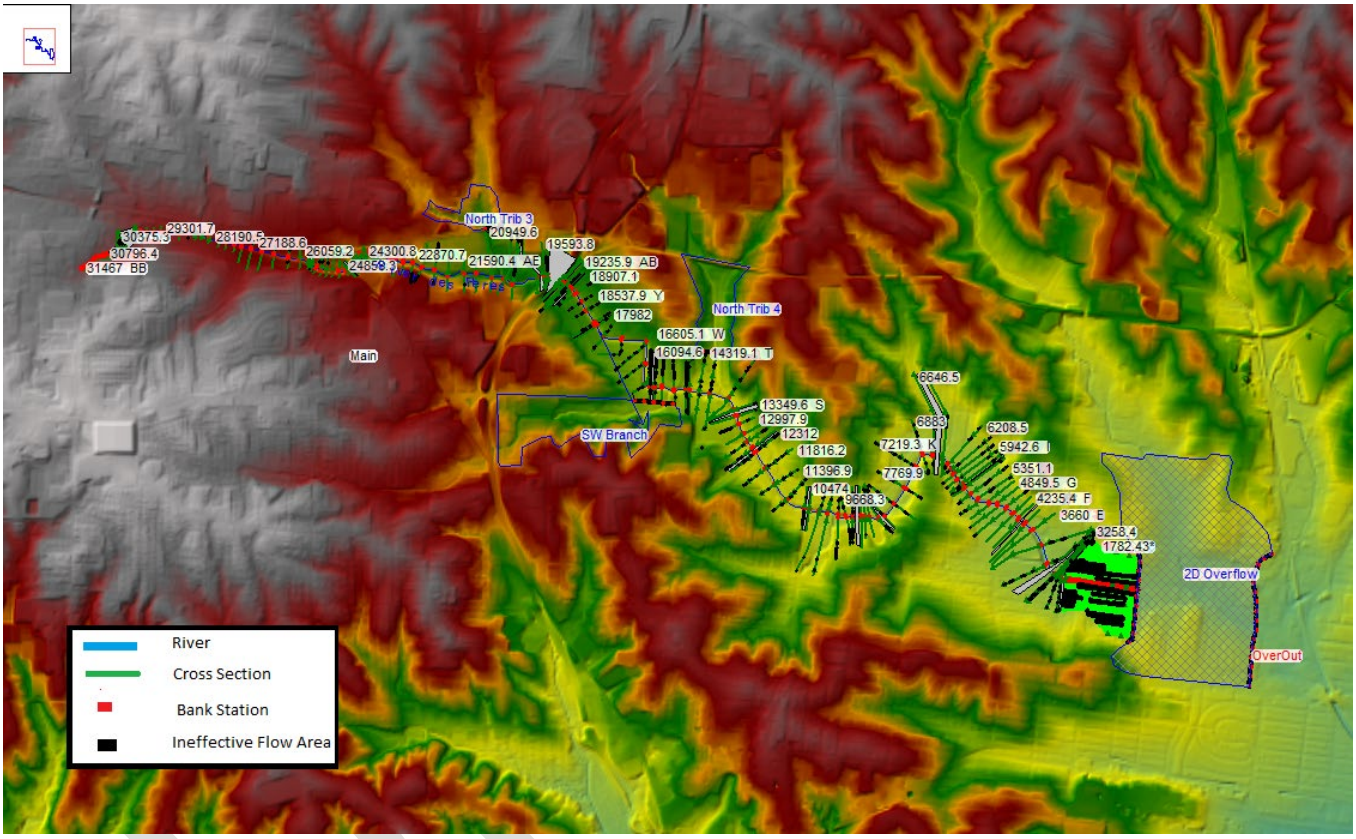

Figure 11. HEC-RAS geometry for the Upper River Des Peres

Flooding History

The Upper River Des Peres in University City has been the cause of significant damage in University City. Past damaging floods noted in the 1988 River Des Peres FONSI occurred in June 1957, April 1970, April 1973, July 1978, April 1979, September 1980, June 1981, July 1982 and September 1986. The most recent flooding events occurred in September 2008, June 2011, June 2013, September 2014, July 2019, and August 2020.

Areas of notable flooding documented in a recent Storm Water Committee study of the River Des Peres are adjacent to the channel along Groby Drive, Wilson Avenue, and Mona Drive. Locations of the roads are identified in Figure 9. Two fatalities occurred during the flood event in June 2008 along Wilson Avenue. Wilson Avenue is also the location of the Hazard Mitigation Grant Program buyouts that resulted after the 2008 flood event. Through model simulation, it was determined that the Wilson Avenue area falls within the 50% AEP area (2-year floodplain). Table 1 tabulates

the top five floods of record that were observed on the River Des Peres at the University City gage.

Table 1. Peak Stage and Flow for Period of Record at University City Gage

Date	Elevation (feet) NAVD88	Flow (cfs)
14-Sep-2008	509.01	5050
9-Sep-2014	508.04	4500
17-Jun-2013	508.03	4500
9-Aug-2020	508.00	4480
22-Jul-2019	507.85	4400

Frequency Analysis

Using the existing conditions hydrologic models, stage and flow frequency estimates were computed at the University City gage located on the Purdue Avenue foot bridge. Using the NOAA Atlas 14 point precipitation frequency estimates and assuming a 24 hour rainfall duration, the PCSWMM model was used to simulate inflow into the HEC-RAS model. The HEC-RAS model was next used to simulate frequency stage and flow relationships at the University City gage on the River Des Peres. The resulting precipitation estimates, stages, and flows at the University City gage are tabulated in Table 2.

Table 2. Frequency analysis

Annual Exceedance Probability (AEP) (%)	Precipitation (in) 24-hour Duration	Elevation NAVD 88 (ft)	Flow (cfs)
0.2	10.3	513.82	9709
1	7.66	512.20	8419
2	6.68	511.51	7757
4	5.77	510.46	6776
10	4.69	509.40	5594
20	3.98	508.70	5008
50	3.20	507.51	4049

Future Without Project Conditions

Over time, the riverbank protection (such as concrete walls) and culverts under roads are expected to deteriorate in condition, possibly resulting in increasing bank erosion and blockages of bridges and culverts. University City will work with St. Louis County, MODOT, and other entities to maintain and replace this infrastructure, and may replace existing culverts with those of a larger size. With proper study, modifications can be made in a manner as to not worsen the current flooding situation.

The study area is already largely developed, and future changes in development are not expected to significantly change its hydrologic characteristics in future. However, as discussed in the Climate section in this report, the consensus in recent literature points toward moderate increases in precipitation in the Upper Mississippi Region over the past century. Some evidence

shows an increased frequency in the occurrence of extreme storm events (Villarini et al., 2013). Project-specific analysis shows upward trends in precipitation and runoff in the River Des Peres watershed which will only further exacerbate existing flooding problems. Climate change impacts to flood risk in the example study area are ambiguous with respect to future flood risk. While there is a reasonable chance that some storm events may occasionally deliver large quantities of precipitation to the watershed, the likelihood and magnitude of this change cannot be assessed with the current information. What the literature suggests is that storms may become more intense in the future. This unknown variability will be considered further during the feasibility level design stage of the study.

MSD, over the next 20 years has plans that focus mainly on reduction of sewage overflow into the River Des Peres. These overflows are points where a combination of stormwater and wastewater discharges into local waterways from the sewer system during moderate to heavy rainstorms. These sewer overflow points act as relief valves when too much stormwater enters the sewer system. MSD identified 55 projects funded by the Operation Maintenance Construction Improvement (OMCI) program within the River Des Peres-University City watershed. An incomplete list of University City OMCI projects upstream of the previously authorized project area is provided in Appendix 2.

Although beneficial to water quality, the reduction in sanitary sewer flow would have minimal effect on future flood conditions. MSD anticipates that even if all these projects are constructed within the 50-year period of analysis, these future projects combined will not impact flow in the River Des Peres to the extent that the difference would be significant enough to affect USACE's H&H modeling (Riepe, 2020).

Considering all of these factors, the future flow frequency distribution is expected to be similar to existing conditions at the University City gage.

2.7 WATER QUALITY

Existing Conditions

Water Quality Standards (WQS) are the foundation of the Clean Water Act. Water quality standards protect such beneficial uses of water as whole-body contact (such as swimming), maintaining fish and other aquatic life, and providing drinking water for people, livestock and wildlife. In Missouri, the standards define the water quality goals for a waterbody by designating its beneficial uses (Missouri Department of Natural Resources, n.d.). The WQS also set maximum allowable concentrations for up to 100 contaminants for each of those beneficial uses. In addition, section 303(d) of the federal Clean Water Act requires that each state identify waters that are not meeting water quality standards and for which adequate water pollution controls have not been required. This segment of the River Des Peres has been on the 303(d) list for *Escherichia coli* (*E. coli*) contamination from urban runoff since 2006 (Missouri Department of Natural Resources, n.d.). The River Des Peres designated uses include: warm water habitat, irrigation, and livestock and wildlife protection (Missouri Department of Natural Resources, n.d.). The River Des Peres is not designated as drinking water supply nor industrial water supply. The

river is not approved for direct bodily contact, including submergence, but is approved for secondary contact recreation (e.g. boating).

This is a flood risk reduction project; there is no ecosystem restoration component. Water quality is included as an opportunity in this project, outside of but related to the main flood risk reduction purpose of the project. It was identified as an important consideration by project partners at the planning workshop in June 2020. The ability of measures to incidentally address water quality will be considered.

The Missouri 303(d) List for 2020 lists River Des Peres in the project area and the unnamed tributary that meets River Des Peres just east of the intersection of Olive Blvd and 82nd Blvd as impaired for both Chloride and *E. coli*. The source of these pollutants is listed as urban runoff/storm sewers. The *E. coli* may come from combined sewer overflows (CSOs), and the chloride may come from the application of road salt. MSD was entered under a consent decree with the U.S. Environmental Protection Agency (EPA) and the Missouri Coalition for the Environment in 2012, which commits MSD to infrastructure improvement projects that will eliminate CSO pollutants over a 23-year period.

Volunteers for Missouri's Stream Team program collected data from 1994-2013 on macroinvertebrates, water chemistry, visual information, and stream discharge at 12 sites in the study area (seven of which were in the project area). Some of this data has not gone through MDNR Quality Control processes and is considered provisional. The data includes values for nitrate-nitrogen (NO3-N), dissolved oxygen (DO2), and chlorides from this sampling.

A USGS gage is present at the downstream edge of the project area (USGS 07010022 River Des Peres near University City, MO). Sixty-eight (68) water quality samples were taken at this site between 1997 and 2000; this data will be analyzed.

Future Without Project Conditions

Water quality in the project area is likely to improve because of actions taken by the MSD within the next 50 years. Some of these actions are discussed in section 2.6.2. The MSD is working to separate combined sewers, which will reduce the amount of *E. coli* in the river from raw sewage mixing with the river water. MSD is also promoting projects such as rain gardens that individual homeowners and landowners can construct that will improve the water quality of stormwater reaching the River Des Peres through grant programs and educational outreach activities (see www.msdprojectclear.org). As a result, water quality is likely to improve in the project area in the FWOP condition if such measures are taken. Water Quality is likely to experience a beneficial effect in the FWOP condition.

2.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

Existing Conditions

USACE St. Louis performed a review of the findings of the Phase I conducted for this project area in 2005. A site visit was conducted on August 30, 2005, and the subsequent Phase I report was

completed on September 7, 2005. This Phase I environmental site assessment consisted of a records review, site reconnaissance, interview, and review of historical documents for the River Des Peres corridor from Purdue Avenue to Olive Boulevard. No additional investigation or analysis for the presence or absence of HTRW was conducted. The 2005 Phase I report concluded that the project area contained no major sites of interest which pose significant environmental concerns. The environmental records search and site visit found minimal data suggesting environmental concerns to be present in the study area.

A review of available satellite imagery from the period 2005 to present (2020) day was conducted to assess any significant land use changes. This review found no significant land use changes. The project area has remained mostly unchanged from 2005, featuring a primarily urban area of residential properties and few commercial properties. One obvious change was observed in the satellite imagery available. Between 2011 and 2013 the row of residences flanked by Wilson Avenue and the River Des Peres were removed.

In addition, environmental records from the Missouri Environmental Emergency Response Tracking System (MEERTS) were reviewed in the immediate project vicinity for the period 2005 to present. This review revealed no major sites of interest which pose a significant environmental concern.

Future Without Project Conditions

HTRW concerns in the project area are currently low and are not expected to increase in the period of analysis. It is possible that improper storage of chemicals, leaking equipment, urban waste, and improperly dumped materials would wash into the river or contaminate soils during flood events. Even if potentially hazardous materials are properly stored, floods can destroy containers and wash contaminants downstream. However, the project area currently has no major sites of interest which pose a significant environmental concern, and known planned development is residential or commercial (not industrial) and would not add any new hazards to the watershed. HTRW conditions in the project area are not expected to change in the FWOP condition.

2.9 FISH & WILDLIFE

2.9.1. Existing Conditions

2.9.1.1 Aquatic Habitat

The primary aquatic resource for fish and wildlife in the study area is the River Des Peres. The River Des Peres, as it runs through the greater St. Louis metro area, is highly impacted, developed, channelized, and a segment even runs through underground pipes. The River Des Peres receives sewer overflows and stormwater drainage; outfalls and ditches drain into the river as it flows through University City. There are no other major defined water bodies within University City. Upstream of Heman Park, the River Des Peres provides some marginal fish habitat for those species adapted to the degraded conditions. Grass Carp (*Ctenopharyngodon idella*), Buffalo Sucker (*Ictiobus cyprinellus*), and Shortnose Gar (*Lepisosteus platostomus*) might be found here

when floodwaters increase the water levels. The degraded nature of the river in the project area is not suitable for mussels, and no mussel species have been found in the project area.

In addition to the riparian habitat, wetlands provide aquatic habitat and resources for fish and wildlife as well. Wetlands, as defined, share three characteristics: have hydric soils, are flooded during some portion of the year (hydrology), and where plant life adapted to these conditions is present (William J. Mitsch, 2015). Wetlands provide valuable water quality functions such as reducing excessive dissolved nutrient levels, filtering waterborne contaminants, and removing suspended sediment (William J. Mitsch, 2015). Wetlands also provide important habitat for a variety of plants and animals, some of which can only survive if wetland habitat is present. The small wetland found within the project area could provide a place for amphibians and insects to breed in the spring, when this wetland is likely to be inundated. Sedges, smartweeds, and other wetland plants may also find habitat in this small wetland.

2.9.1.2 Terrestrial Habitat

The major terrestrial resources in the project area are public parks, backyards, and other urban green spaces. The riparian corridor (vegetated zone adjacent to the streambank) is the primary terrestrial habitat available in the project area. This riparian corridor is sparsely vegetated because the area is a highly developed urban area. Along the streambank occur trees and shrubs common to residential areas and city parks. Bush Honeysuckle (*Lonicera maackii*) and Common Privet (*Ligustrum vulgare*) comprise the understory. Trees found along the river include, but are not limited to, Silver Maple (*Acer saccharinum*), Red Maple (*Acer rubrum*), Cottonwood (*Populus deltoides*), American Sycamore (*Platanus occidentalis*), Sweet Gum (*Liquidambar styraciflua*), Box Elder (*Acer negundo*), Honey Locust (*Gleditsia triacanthos*), American Elm (*Ulmus americana*), and Green Ash (*Fraxinus pennsylvanica*). The highly urbanized area provides only marginal habitat for terrestrial organisms.

2.9.1.3 Wildlife

The St. Louis Metro Area is home to a variety of wildlife adapted to urban conditions. City parks, streams, lakes, and even backyards can provide marginal habitat for a variety of mammals, amphibians, birds, and invertebrates. Common mammals found within the study area include gray squirrel (*Sciurus carolinensis*), rabbit (*Oryctolagus cuniculus*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), little brown bat (*Myotis lucifugus*), red bat (*Lasiurus borealis*) and big brown bat (*Eptesicus fuscus*). Uncommon wildlife would be white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), and striped skunk (*Mephitis mephitis*). It should be noted that urban habitats are often poor at providing the full needs of wildlife during all stages of their life-cycle. In addition, patches of habitat are often isolated from each other and separated by manmade barriers such as roads, walls, and fences.

2.9.2 Future Without Project Conditions

2.9.2.1 Aquatic Habitat

The hydraulic conditions and chemical and biological pollution in the River Des Peres are the main factors that could render the water uninhabitable for fish and wildlife. It is likely that future

efforts by MSD would improve the water quality of the river. Improvements in water quality would have a beneficial impact on the aquatic habitats in the project area. Therefore, the aquatic habitat is expected to improve minimally in the FWOP condition.

2.9.2.2 Terrestrial Habitat

As University City develops, the amount of green space in the project area may decrease. Urban development may slightly reduce the available parks, backyards, gardens, and other green spaces that provide marginal terrestrial habitat in urban areas. Urban development is also expected to increase fragmentation and decrease the connectivity of these marginal terrestrial habitats, resulting in an adverse impact to terrestrial resources. However, if flood damages continue to impact structures in the area of 20% AEP inundation, the amount of development directly adjacent to the river may decrease as people relocate outside of flood-prone areas. Some of these areas may be developed into parks and other urban green spaces if other developments become too costly due to flooding. This would have a beneficial impact on terrestrial resources. Since significant land use change is not expected, a large shift in terrestrial habitat is not expected.

2.9.2.3 Wildlife

The presence of wildlife in the project area in the FWOP condition depends on the area of habitat available, as discussed in the Section 2.9.2.2. Urban development in the University City area could decrease the amount of habitat, while new city parks and urban green spaces may be created which increase habitat. These backyard habitats could also provide some resources for other common urban wildlife, depending on the planting and landscaping decisions by landowners. Overall wildlife habitat in the study area is not expected to change in the FWOP condition.

Bald Eagles and Migratory Birds

Existing Conditions

The U.S. Fish and Wildlife Service (USFWS) developed the National Bald Eagle Management Guidelines to provide landowners, land managers, and others with information and recommendations regarding how to minimize potential project impacts to Bald Eagles, particularly where such impacts may constitute disturbance (U.S. Fish & Wildlife Service, 2018). Bald Eagles (*Haliaeetus leucocephalus*) occur regularly in Missouri as migrants and breeders, with some populations of year-round residents along the Missouri and Mississippi Rivers. The Bald Eagle was removed from the federal list of threatened and endangered species in 2007, but it continues to be protected under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act (U.S. Fish & Wildlife Service, 2018). This Act prohibits unregulated take of Bald Eagles, including disturbance. The nearest records of Bald Eagle nests would be approximately 10 miles to the west along the Missouri River and 10 miles to the east along the Mississippi River.

Future without Project Condition

The urban setting would continue to limit Bald Eagle nesting opportunities in University City. The life cycle needs of Bald Eagles and other migratory birds would not change much from existing conditions to the FWOP condition because insignificant changes in habitat are expected.

Migratory Birds

Existing Conditions

The Migratory Bird Treaty Act protects all but two migratory bird species that occur in North America from harm and disturbance (U.S. Fish & Wildlife Service, 2020). The riparian habitat would provide habitat for migrating perching birds (i.e. songbirds) as they migrate up and down the Mississippi Flyway. The Mississippi Flyway is one of the major migratory bird flight corridors in North America. The North American Waterfowl Management Plan recognized the mid-migration habitat as a habitat of major concern with more than 300 species of migratory birds using the flyway (Audubon, n.d.). In addition to migrants, the trees and shrubs along the riparian corridor could provide habitat for year-round residents that breed in Missouri. In all, over 400 migratory bird species are known to occur in Missouri.

Future Without Project Condition

Existing urban development will continue to present difficulties to migratory birds as a result of limited habitat, light pollution, and window-strikes, although backyard bird feeders and gardens provide some habitat. The life cycle needs of migratory birds would not change in the FWOP condition because insignificant changes in habitat are expected.

Federally Listed Threatened and Endangered Species

Existing Conditions

In compliance with Section 7(c) of the Endangered Species Act of 1973, as amended, a list of species and critical habitat was acquired from the USFWS IPaC website on 23 April 2021 for the study area (Table 3). The species included Indiana bat, Northern Long-eared Bat, Gray Bat, and Decurrent False Aster. There is no Critical Habitat found in the area.

Table 3. List of federal threatened and endangered species from an IPaC report (Consultation Code: 03E14000-2020-SLI-2677, Event Code: 03E14000-2021-E-00180)

Common Name (Scientific Name)	Classification[2]	Habitat
Indiana Bat (*Myotis sodalis*)	Endangered	Hibernates during winter in caves or abandoned mines. In summer, roosts under loose tree bark on dead or dying trees. Forages near sources of water.
Northern Long-eared Bat (*Myotis septentrionalis*)	Threatened	Hibernates during winter in caves or abandoned mines. In summer, roosts under loose tree bark on dead or dying trees. Forages near sources of water.
Gray Bat (*Myotis sodalis*)	Endangered	Lives in caves year-round. During the winter, uses deep, vertical caves. In the summer, uses caves scattered along rivers.
Decurrent False Aster (*Boltonia decurrens*)	Endangered	River floodplain, moist ditches and oldfields, disturbed wet areas.

Indiana Bat
The Indiana Bat is an endangered species that occurs in several Illinois and Missouri counties. Indiana Bats migrate seasonally between winter hibernacula and summer roosting habitats (U.S. Fish & Wildlife Service, 2019). Winter hibernacula include caves and abandoned mines. During the summer, Indiana Bats roost in trees. At night, the bats forage for insects in a variety of habitats including along stream corridors, within the canopy of forests, over clearings with early successional vegetation (old fields), along the borders of croplands, along wooded fence rows, and over farm ponds and in pastures (U.S. Fish & Wildlife Service, 2019). The rural areas of Missouri and Illinois are a mosaic of these habitats, but the project area is highly urbanized and would only have trace, marginal habitat available. The riparian corridor in the study area might have some suitable trees for roosting scattered here and there and may also represent foraging habitat for bats.

Northern Long-Eared Bat
The Northern Long-eared Bat is a threatened species that occurs in many counties in Missouri and Illinois (U.S. Fish & Wildlife Service, 2020). Northern long-eared bats spend winter hibernating in large caves and mines. During summer, this species roosts in crevices of both live and dead trees. Foraging occurs in a variety of common habitats that largely overlap with both the Indiana and Gray Bat.

Gray Bat
The Gray Bat occurs in several Illinois and Missouri counties where it inhabits caves during both summer and winter (U.S. Fish & Wildlife Service, 2019). With rare exceptions, gray bats sleep in caves year-round. During the winter, gray bats hibernate in deep, vertical caves. In the summer, they roost in caves which are scattered along rivers. These caves are in limestone karst areas of the southeastern United States, like Missouri. There are no caves in the study area. Foraging occurs in a variety of common habitats that largely overlap with both the Indiana and Northern Long-eared Bat.

Decurrent False Aster
This plant is found on moist, sandy, floodplains and prairie wetlands along the Illinois, Missouri, and Mississippi rivers (U.S. Fish & Wildlife Service, 2019). Although not very tolerant to prolonged flooding, this plant relies on periodic flooding to scour away other plants that compete for the same habitat. Habitat destruction and excessive silting are contributing factors to the decurrent false aster's decline. Highly intensive agricultural practices have increased topsoil runoff, which smothers seeds and seedlings. The project area is highly developed and urbanized but may contain trace and marginal habitat for Decurrent False Aster in scattered areas along the River Des Peres that are not routinely mowed.

State Listed Species
Existing Conditions:
A Level 2 Natural Heritage Review from MDC was generated on 14 June 2021. Natural Heritage records indicate several Peregrine Falcons (*Falco peregrinus*, state-listed endangered) within 5 miles of the project area. Peregrine Falcons were introduced to downtown buildings in the St.

Louis and Kansas City areas in the 1990s, and populations of this state endangered-list species have been increasing since. They nest 15 April to 15 July on natural bluffs, building ledges and bridges. Work should be avoided within 1500 feet of nests when nest-building or active nests (eggs or hatchlings) are present.

Natural Heritage records indicate the following state-ranked species/natural communities near the project area: Mississippi Kite (*Ictinia mississippiensis*), Alligator Snapping Turtle (*Macrochelys temminckii*), Primrose Willow (*Ludwigia leptocarpa*), and a moss (*Trematodon longicollis*). To avoid impacts to state listed species, further coordination with MDC will be carried out as alternatives are selected.

Future Without Project Condition

Federally listed T&E Species and State-listed Species

The amount of habitat for these listed species is currently very limited to nonexistent in the project area and this is unlikely to change in the future. For example, no tree clearing is anticipated in the FWOP condition. Therefore, FWOP conditions for listed species are expected to be like the existing conditions.

2.10 INVASIVE SPECIES

Existing Conditions

Presidential Executive Order 13112 addresses the prevention of the introduction of invasive species and provides for the control and minimization of the economic, ecological and human health impacts caused by invasive species. Missouri's invasive species list includes 353 forb species, 85 shrub species, 92 grasses, 44 vine species, 47 hardwood tree species, 32 species of aquatic plants, 12 fish species, 7 types of crops, 3 mammals, 7 aquatic mammals, 2 species of conifers, 2 snails/slugs/mussels, 4 bird species, and 1 amphibian species. Missouri's most common invasive animals include feral hog (identified in 53% of MO counties), American bullfrog (*Rana catesbeiana*, 16%), red-eared slider (*Trachemys scripta elegans*, 11%), and common carp (*Cyprinus carpio*, 9%). Top state invasive plants consist of common ragweed (*Ambrosia artemisiifolia*, 100%), giant ragweed (*Ambrosia trifida*, 99%), eastern poison-ivy (*Toxicodendron radicans* (L.) Kuntze, 99%), common mullein (*Verbascum thapsus*, 99%), Shepherd's-purse (*Capsella bursa-pastoris*, 99%), and common pokeweed (*Phytolacca americana*, 98%). St. Louis County has the highest number of invasive species in the state.

MDC current and potential invasive species of concern include silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*), Asian long-horned beetle (*Anoplophora glabripennis*), emerald ash borer (*Agrilus planipennis*), European wood wasp (*Sirex noctilio*), gypsy moth (*Lymantria dispar*), rock dove (*Columba livia*), European starlings (*Sturnus vulgaris*), zebra mussel (*Dreissena polymorpha*), and feral hogs.

Common carp (*Cyprinus carpio*) and grass carp (*Ctenopharyngodon idella*) can be found in downstream sections of the River Des Peres, which could indicate their presence upstream in the project area. These invasive fishes are planktivorous, which means they compete with native

freshwater mussels for phytoplankton food. Zebra mussels and Asian clams are likely to be found in the River Des Peres, given its connection to the Mississippi, which is infested with these invasive species.

Future Without Project Condition

The advancement of invasive species in the FWOP condition would depend on the degree of invasive species control measures taken by both the city and private landowners. Increasing awareness and education about the harmful effects of invasive species could lead to a reduction in their spread in the next few decades. As the urban area develops around the River Des Peres, more impervious surfaces (e.g. pavement) would be expected to displace more vegetation, invasive or otherwise. This development would likely mean that remaining green spaces are maintained public parks, trails, and backyard areas. It is likely that public areas would have a greater degree of invasive species management than private green spaces, where it is up to the individual to remove them. Therefore, the spread of invasive species is expected to be somewhat reduced in the FWOP condition.

2.11 CULTURAL RESOURCES

Existing Conditions

There are no previously recorded archaeological sites within the University City Branch, River Des Peres authorized project area. There are two National Register Districts made up of multiple contributing Historic Properties within the 10% AEP area of the River Des Peres in University City: University Heights Subdivision Number 1, and the University City Education District.

University Heights Subdivision Number 1 was listed on the National Register of Historic Places (NRHP) on September 23, 1980 as State Significant for Community Planning and Landscape Architecture. From the National Register Form:

> "University Heights was the first portion of the new town of University City, which was developed by publisher and entrepreneur Edward Gardner Lewis from 1902 onward. In plan it reflects the romantic suburban designs of Frederick Law Olmsted, while at the same time, it incorporates the local St. Louis concept of the private street. The houses in University Heights represent the best that was being built for middle-middle-class families through the 1920's, and many of the homes are associated with Lewis and his colleagues. University Heights is important as an exceptionally well-planned, well-built and well-preserved example of an early twentieth-century suburban development" (Lennahan, 1977).

The University City Education District was listed on the National Register of Historic Places on November 29, 1984 as Locally Significant for Architecture and Education. The University City Education District is eligible for listing on the NRHP under Criterion C as a work of high artistic value. The three schools in the district were designed by noted local architectural firms. University City High School was designed by Trueblood & Graf, and both Jackson Park Elementary School and Hanley Junior High School were designed by William B. Ittner & Assoc. The latter firm was the foremost designer of schools in the Midwest during this period. More important than

the design of the individual buildings, however, is the overall plan of the complex, a late example of City Beautiful civic design. The high school and the elementary school sit at right angles to each other, diagonally oriented to Balson Avenue, which runs between them, and facing the circular park at the intersection of Balson and Jackson. Hanley Junior High School stands on axis to Balson, closing the western vista from the circle. The ensemble as ultimately achieved was the result of incremental decision making rather than a fully developed long-range plan, but it was encouraged by Harland Bartholomew and Associates, at the time the leading planning firm in the nation (Hamilton, 1984).

In addition to these two National Register Districts, the homes located at 7479, 7483, 7487 and 7491 Shaftesbury Avenue have been determined eligible as a historic district on July 22, 2014. This district has not been nominated for the National Register; however, it meets the criteria to be listed. The SHPO log number associated with this tract of homes is 166-SL-14 (Missouri Department of Natural Resources, n.d.).

There are also six structures within a mile of the project area that are listed on the NRHP. None of these falls within the 10% AEP area.

The Works Progress Administration (WPA) portion of the River Des Peres is the lower six miles of the river channel (American Society of Civil Engineers, 1988). The river was channelized in the 1920s and 1930s. It is not on the National Register.

Future Without Project Conditions

Continued flooding in the FWOP condition would result in further damages to the existing historic properties in the project area. Additionally, more structures in the project area will also become eligible to be listed as historic properties during the period of analysis. Therefore, the cultural resources in the project area would likely experience a minor adverse effect in the FWOP condition.

2.12 TRIBAL

Existing Conditions

Although there are no previously recorded Native American sites within the 10% AEP, Saint Louis County was occupied by indigenous people from early prehistory through the 18th Century. The study area is located is within the territory ceded by the Osage Tribe in an 1808 treaty between the Unites States and the Great and Little Osage. As part of this treaty the Great and Little Osage ceded all their land in the state of Missouri below the Missouri River. In addition to the Osage Nation there are twenty-two (i.e. 23 tribes contacted, cumulatively) other federally recognized tribes who officially wish to be consulted on matters that could potentially affect prehistoric and historic Indian sites within Saint Louis County. In an effort to avoid or minimize adverse effects to Tribal resources, final project site selection and design may be altered as a result of consultation with these Tribes or as a result of any newly discovered cultural resources located by cultural resource surveys which may take place in the future.

Future Without Project Condition

There are no identified archeological sites in the project area. Continued flooding in the FWOP condition would result in further damages to the existing but undiscovered archeological sites. Therefore, the Tribal resources in the project area would likely experience a minor adverse effect in the FWOP condition.

2.13. RECREATIONAL & AESTHETIC RESOURCES

Existing Conditions

Based on water quality standards, the Missouri Department of Natural Resources lists designated uses for the River Des Peres as secondary contact recreation (SCR), which includes some recreational activities, including boating, fishing, and wading. The river functions as a sewer and storm drainage facility for thousands of residents. The segment of the river in the project area often exudes a powerful methane odor and is not often waded or fished for this reason. However, local anglers do fish some parts of the river downstream of Forest Park, seeking carp, gar, and other fish that are adapted to the river's water quality.

The general aesthetic of the area is highly urban and residential, with associated commercial zones. The river, as it flows through the project area, is not completely channelized upstream of Heman Park, and has some trees and natural features, but is bordered completely by residential areas before being piped under Forest Park downstream. The structures located within the 20% AEP area (as well as the AEP area for smaller, more frequent storms) are showing signs of wear from the frequent flood events and some have been condemned, lowering the aesthetic value of the area.

Future Without Project Conditions

Recreational opportunities in the River Des Peres as it flows through University City would not be affected in the FWOP condition, because no actions would be taken that might limit or enhance recreational opportunities along the river corridor (such as a structural alternative that reduces fishing or boating opportunities).

Flood damages could result in minor adverse effects on the aesthetics of the project area in the FWOP condition. These damages would result in dilapidated, condemned buildings and vacant lots, which would negatively impact the aesthetics of the area.

2.14. ECONOMIC CONDITIONS

Existing Conditions

Structure inventory

An inventory of structures was derived from the National Structure Inventory 2.0 (NSI 2.0) database. The study area includes 1,156 structures, 996 of which are residential and 160 are non-residential. All structures that indicate inundation in the 0.2% AEP area (500-year floodplain) were included, to cast a wide net that includes structures with infrequent flooding.

One structure, the University City Fire Department, is on the critical infrastructure inventory.

A structure survey utilizing Google Maps satellite and street views were utilized to refine structure attributes in ArcGIS Pro 2.3.0. Structure locations were confirmed using an overhead satellite view of all structures in the study area. Structure damage category, foundation type, number of stories, and foundation height were confirmed by street view. Structure square footage estimates were determined using Microsoft Footprints in ArcGIS pro. Structure values were derived from RS Means at 2021 price levels.

Depth-Damage Relationships and Uncertainty

Uncertainty associated with first floor stage is defined by a normal distribution with a standard deviation of 0.5 foot for all structures. Uncertainty estimates for structure values were defined by triangular distributions and were determined using RS Means with unique values for each damage category.

Damages to individual residential structures and contents were estimated by depth-damage relationships defined in Economic Guidance Memorandum (EGM) 01-03 and EGM 04-01. Damages to individual non-residential structures and contents were estimated by depth-damage relationships defined by the draft report Solicitation of Expert Opinion Depth-Damage Function Calculations for the Benefit-Cost Analysis Tool (URS Group, 2008). Other damages, including damages to vehicles, are estimated using customized damage curves produced from the 2011 Fargo-Moorhead Metro Area Flood Risk Management Report Economic Appendix.

Damage reaches

The study area was divided into reaches, which were designed by the economist in coordination with the hydraulics and hydrology (H&H) engineer to contain areas that experienced similar hydraulic conditions and for measuring localized impacts of the focused array of alternatives. The reaches begin with Reach 1, which is the furthest downstream, and increase while moving upstream and ending with reach 11. Table 4 shows the structure count by reach and structure type (residential and non-residential). Non-residential structures include commercial, industrial, and public structures. The study area has a total of 1,156 structures. Figure 12 shows the study area reach boundaries.

Table 4. Structure count by structure type and reach

Reach	Residential Count	Non-Residential Count	Total
1	223	88	311
2	162	0	162
3	249	22	271
4	22	1	23
5	63	0	63
6	112	3	115
7	5	2	7
8	5	9	14
9	90	7	97
10	48	0	48
11	17	28	45
Total	996	160	1,156

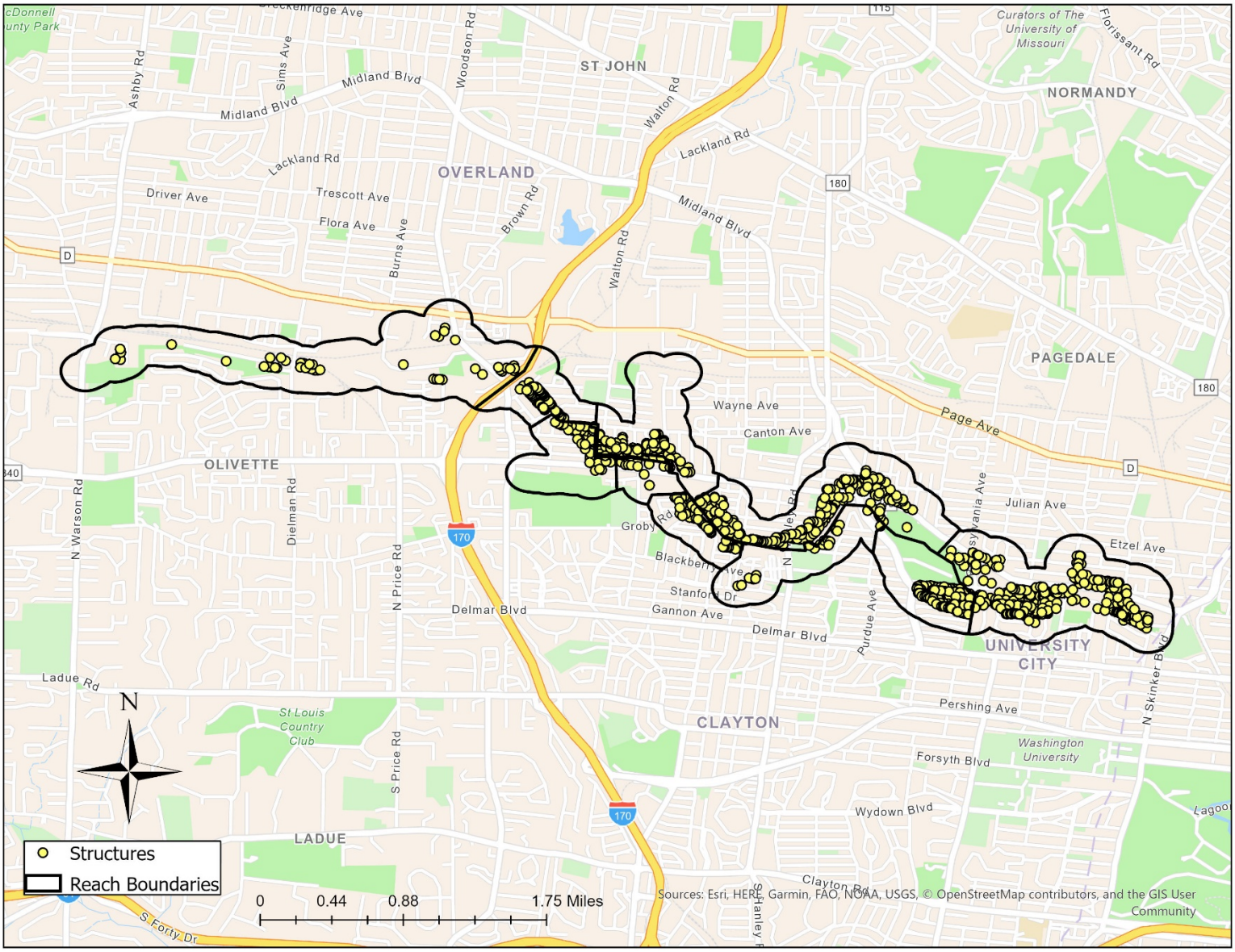

Figure 12. Study area reaches for economic analysis

Water Surface Profiles

The USACE St. Louis District Hydraulics & Hydrology (H&H) PDT member provided geospatial data outputs from HEC-RAS for eight flood probability events, including flood depths for the 50%, 20%, 10%, 4%, 2%, 1%, 0.5%, and 0.2% AEP events. Flood depths for each of the eight probability events were then geo-referenced to the structures in the structure inventory using ArcGIS Pro 2.3.0. A unique flood depth relative to the first floor was then determined for each structure for purposes of estimating damages.

Water surface profiles containing flood depths for each of the eight probability events provided by H&H were generated for every structure in the structure inventory. H&H provided eight rasters containing flood elevations for the probability events in the study area. The flood

elevation values were then extracted to each structure in the structure inventory. The flood elevation for each structure were then compared to the structure's ground surface elevation and foundation height to determine depth of flooding relative to first floor for estimating damages.

The 50% and 20% AEP events were assumed to have no flood damages. It was assumed that flooding this frequent would either result in the occupants vacating the structure or occupants would be unable to restore the structure to its full depreciated replacement value. This adjustment is consistent with the FEMA floodplain regulations that require residents to rebuild above the base flood elevation after a structure receives greater than 50 percent damage to the structural components as a result of a flood.

Exceedance probabilities and index stations were chosen from the water surface profiles. The water surface profile station with the greatest amount of flooding at the most frequent flooding event in each reach was used to generate the index stations and exceedance probabilities for each reach. The equivalent record length for the exceedance probability functions was set to 50 years.

Flood Damage Assessment (FDA) 1.4.2 Modeling

Stage-Damage Functions with uncertainty (1,000 Monte Carlo simulations) were computed in FDA, followed by the evaluation of plans by analysis year with risk (0.01 Event Exceedance Probability, 5% Residual Damage). The result is an estimate of approximately $5.8 million expected annual economic damages in the existing condition. Table 5 shows expected annual damages by reach and damage category.

Table 5. Total Economic Damage (Expected Annual Damages) by Reach and Structure Type for 2025 ($1,000s)

	Expected Annual Damages (Existing Condition)		
Reach	Non-Residential	Residential	Total
1	$774	$735	$1,509
2	$0	$870	$870
3	$332	$515	$847
4	$4	$41	$45
5	$0	$79	$79
6	$0	$637	$637
7	$21	$424	$444
8	$330	$18	$348
9	$11	$199	$210
10	$0	$49	$49
11	$846	$1	$847
Total	$2,318	$3,569	$5,886

Future Without Project Conditions

As noted in the Land Use section of this report, no new major construction, and no large-scale acquisition of structures in the floodplain are expected to occur in the study area in the 50-year period of analysis. No substantial change to the structure inventory is expected from the existing condition to the future without project condition. No changes in hydraulics are expected in the future condition.

With-Project Expected Annual Damages

Each of the focused array's plans were run through HEC-FDA, which allows for determining damages reduced by damage category. Table 6 shows the damages reduced and residual damages for each plan. The 4% AEP Acquisitions and Nonstructural alternatives are most efficient at reducing damages, while Detention Basin 4 and the 4% AEP Residential Elevations show the greatest remaining residual risk.

Table 6. Focused Array With-Project Expected Annual Damages (Residual Risk) by Damage Category ($1,000's)

Plan Description	Residential	Non-Residential	With-Project Damages	Damages Reduced
No Action	$3,569	$2,318	$5,886	$0
Modified 1988 Authorized Plan	$1,571	$1,253	$2,824	$3,063
Detention Basins 3 and 4	$1,753	$1,223	$2,977	$2,910
Detention Basin 4	$2,664	$1,416	$4,080	$1,807
Levee/Floodwall	$1,727	$1,221	$2,948	$2,939
4% AEP Acquisitions	$379	$216	$596	$5,291
4% AEP Nonstructural - Floodproofing and Elevations	$826	$897	$1,723	$4,163
4% AEP Nonstructural - Residential Elevations	$2,815	$2,318	$5,133	$754
Detention Basin 4 and 4% AEP Residential Elevations	$2,214	$1,416	$3,630	$2,257

The FY 2021 Federal interest rate of 2.5 percent was used to discount the costs and benefits to the base year and then amortize the costs over the 50-year period of analysis

2.15. SOCIO-ECONOMICS & DEMOGRAPHICS

Existing Conditions

University City is a municipality in St. Louis County in an inner-ring suburb of St. Louis. Its population was estimated at 34,165 in 2019. The city is highly developed and is surrounded by other cities. Table 7 provides census population estimates for University City, Olivette, and Overland from 2000 to the most recent estimate available (2017). The data show a decrease in population in University City and Overland over this period, and a slight increase in population in Olivette.

Table 7. Population estimates for project area municipalities.[3]

Municipality	Population Estimates					
	2000	2005	2006	2010	2017	2019
University City	37,737	36,718	36,405	35,266	34,460	34,165
Olivette	7,431	7,546	7,563	7,756	7,831	7,822
Overland	16,782	16,466	16,359	16,044	15,693	15,551
Total	61,950	60,730	60,327	59,066	57,984	57,538

Source: U.S. Census Bureau, Population Division

As of the 2010 Census, there are approximately 15,000 households in University City, with an average of 2.22 persons per household. Roughly 51% of residential occupants own their home.

In University City, as of the 2010 Census, 5.9% persons are under 5 years of age, 17.7% are under 18 years of age, and 16.9% are over 65 years old. The U.S. EPA's Environmental Justice Screening Tool, EJSCREEN, was used to generate information for the larger study area (Figure 13). The age range of the population within the study area is about the same as the state average. Similar age demographics were returned for the study area as for University City, with 6% of the population under 5 years of age and17% is over 64 years of age. The state averages for these metrics are 6% and 16%, respectively.

As of the 2010 Census, University City comprised 56% White, 35% African American, 0.5% Native American, 4.6% Asian, and 3% Hispanic populations. Similarly, the minority population within the study area is 47%, which is much greater than the state average of 20%. The low-income population is slightly less than the state average of 34%, at 30%. The linguistically isolated population is 2%, slightly higher than the state average of 1%. The population within the target area with less than a high school education is slightly less than the state average of 11%, at 6%.

[3] For 2010 and post-2010 data: Bureau, US Census. "City and Town Population Totals: 2010-2019." Census.gov, 7 May 2020, www.census.gov/data/tables/time-series/demo/popest/2010s-total-cities-and-towns.html . For pre-2010 data: Bureau, US Census. "City and Town Intercensal Datasets: 2000-2010." The United States Census Bureau, US Census Bureau, 2 Dec. 2016, www.census.gov/data/datasets/time-series/demo/popest/intercensal-2000-2010-cities-and-towns.html .

EPA United States Environmental Protection Agency

EJSCREEN Report (Version 2019)

the User Specified Area, MISSOURI, EPA Region 7

Approximate Population: 34,663

Input Area (sq. miles): 5.99

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Environmental Indicators							
Particulate Matter (PM 2.5 in µg/m^3)	9.28	8.29	93	7.77	97	8.3	77
Ozone (ppb)	46.6	43.1	92	42.5	96	43	77
NATA* Diesel PM (µg/m^3)	0.932	0.447	96	0.367	95-100th	0.479	90-95th
NATA* Cancer Risk (lifetime risk per million)	38	32	90	27	95-100th	32	70-80th
NATA* Respiratory Hazard Index	0.52	0.42	93	0.36	95-100th	0.44	70-80th
Traffic Proximity and Volume (daily traffic count/distance to road)	820	370	88	330	90	750	78
Lead Paint Indicator (% Pre-1960 Housing)	0.72	0.29	89	0.34	88	0.28	88
Superfund Proximity (site count/km distance)	0.092	0.099	61	0.1	68	0.13	63
RMP Proximity (facility count/km distance)	1.3	0.63	85	0.94	75	0.74	82
Hazardous Waste Proximity (facility count/km distance)	4	0.99	93	0.8	96	4	88
Wastewater Discharge Indicator (toxicity-weighted concentration/m distance)	0	1.6	N/A	0.97	26	14	37
Demographic Indicators							
Demographic Index	39%	27%	80	26%	81	36%	62
Minority Population	47%	20%	87	19%	88	39%	65
Low Income Population	30%	34%	46	32%	52	33%	51
Linguistically Isolated Population	2%	1%	86	2%	80	4%	59
Population With Less Than High School Education	6%	11%	32	10%	39	13%	32
Population Under 5 years of age	6%	6%	54	6%	51	6%	54
Population over 64 years of age	17%	16%	61	15%	61	15%	66

* The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

Figure 13. Summary of the Environmental Justice E-screen results.

Figure 14 shows single family home appraisal values in University City (from St. Louis County data developed for University City as part of its Economic Development Strategy). There is a general increase in home values from north to south, with the expensive homes in the south close to Washington University. The River Des Peres cuts through low- to medium-value areas.

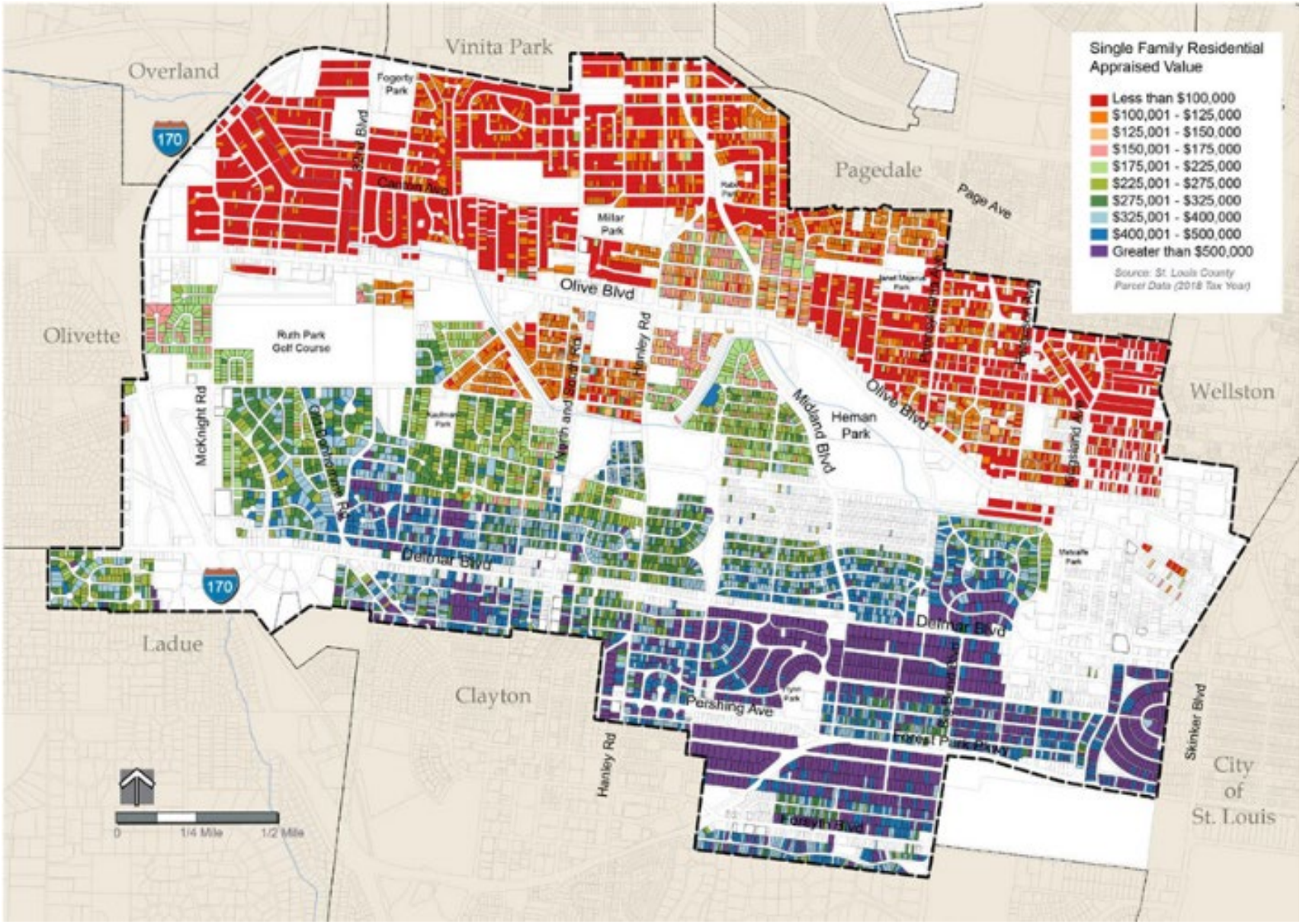

Figure 14. Single Family Residential appraisal values in University City.

Future Without Project Conditions
Repeated flood damage in the 20% AEP area, condemned buildings, dilapidated structures, and vacant lots would become more common in the FWOP condition. These damages would result in minor adverse socioeconomic impacts for residents living in the project area in the FWOP condition.

2.16. POPULATION AT RISK AND CRITICAL INFRASTRUCTURE

Existing Conditions
The University City Fire Station is the only identified critical infrastructure that is at risk to flooding, though flood depths are expected to remain at or just below the foundation in the 0.2% AEP area. University City Senior High School is near, but not within, the 0.2% AEP area.

The Population at Risk (PAR) is about 3,000 at 2 a.m. (of which approximately 500 are over 65 years of age) and 2,000 at 2 p.m. When the River Des Peres floods, residents that do not attempt evacuation (probably the majority of the population) would have to shelter in place. Those that are not able to evacuate vertically may be at risk of hypothermia from floodwater. However, flood water recedes quickly, and it is unlikely that there would be extended exposure concerns. While the FEMA effective Flood Insurance Rate Maps (FIRMs) are dated 2015, this study bases its recommendations on the more recent 2019 Preliminary St. Louis County maps obtained by USACE through the State Emergency Management Agency (SEMA).

To estimate the risk of life loss on roads, depth times velocity (DxV) grids were georeferenced to roadways (see Appendix I – Economics). The road segments identified with varying potential for life loss for the 1% AEP (100-year) area in the existing condition include portions of Groby Rd, Glenside Pl, Mona Dr, Shaftesbury Ave, Wilson Ave, N Hanley Rd, Midland-Olive intersection, Vernon Ave, Pennsylvania Ave, and Cabanne Ave.

Future Without Project Conditions
The population at risk would continue to be at risk into the future in the FWOP condition because no flood protection measures would be taken. Critical infrastructure in the 0.2% AEP area would be continuously threatened by major flood events, which may erode the infrastructure over time. Life safety risk due to road flooding would continue to exist as determined by future without project H&H conditions.

3 FORMULATION OF ALTERNATIVE PLANS AND FUTURE WITH PROJECT CONDITIONS*

Plan formulation is the process of building alternative plans that meet planning objectives and avoid planning constraints. Alternative plans are a set of one or more management measures functioning together to address one or more planning objectives. Measures and alternatives were developed in consideration of study area problems and opportunities as well as study objectives and constraints with respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability).

3.1 MEASURES DEVELOPED

A management measure is a feature or activity that can be implemented at a specific geographic site to address one or more planning objectives. The study team developed and screened the following measures utilizing information on existing infrastructure, existing reports, and subject matter expertise. Numerous risk reduction measures can be combined to form alternative plans.

3.1.1 Structural Measures

Structural measures are physical modifications designed to reduce the frequency of damaging levels of flood inundation. Structural measures can be designed to act as a physical barrier between floodwaters and structures at risk of being damaged by those floodwaters. Examples of structural measures include dams with reservoirs, dry dams, channelization measures, levees, walls, diversion channels, pumps, and bridge modifications.

3.1.1.1 Detention Basins

A detention basin is a storage area designed to mitigate adverse impacts of excess water by holding that water and gradually releasing it downstream. For the purposes of this study, detention basin designs consisted of a containment levee, weir control structure, culvert, and concrete swale. Due to the lack of open space available, developed sites were considered for utilization, though the PDT tried to avoid impacts to structures. Considerations for detention basin site selection included area and elevation: sites of more than 10 acres were desirable to retain a substantial volume of water, and high existing ground elevation was preferable as it meant greater volume of storage was possible once the basin was excavated. The basins were designed as dry detention areas which would remain dry during non-flood conditions, so that maximum storage would be available during storm events.

Detention Areas were not recommended in the 1988 Feasibility Study:

> "A total of 71 potential detention sites throughout the watershed were identified during the course of this study: 8 in the Upper River des Peres; …. The criterion for site selection was very simple: any open area which appeared to be in a geologically and hydraulically favorable location was selected for consideration. Through a series of

iterative screening steps, this large number of potential sites was narrowed to 11 for which costs and benefits were estimated. The screenings of each site were conducted using remote sensing techniques followed up with thorough in-field investigations. The principal criterion for accepting or rejecting a site was whether obvious and expensive significant structure relocations would be required."

"Of the 11 [detention dam] sites investigated in detail [in the entire watershed, not just upper River Des Peres], none generated a benefit-cost-ratio greater than 0.69 in spite of the fact that each was treated as a first added component with infinite storage capability and zero outflow. As a result, no further action regarding this measure was taken."

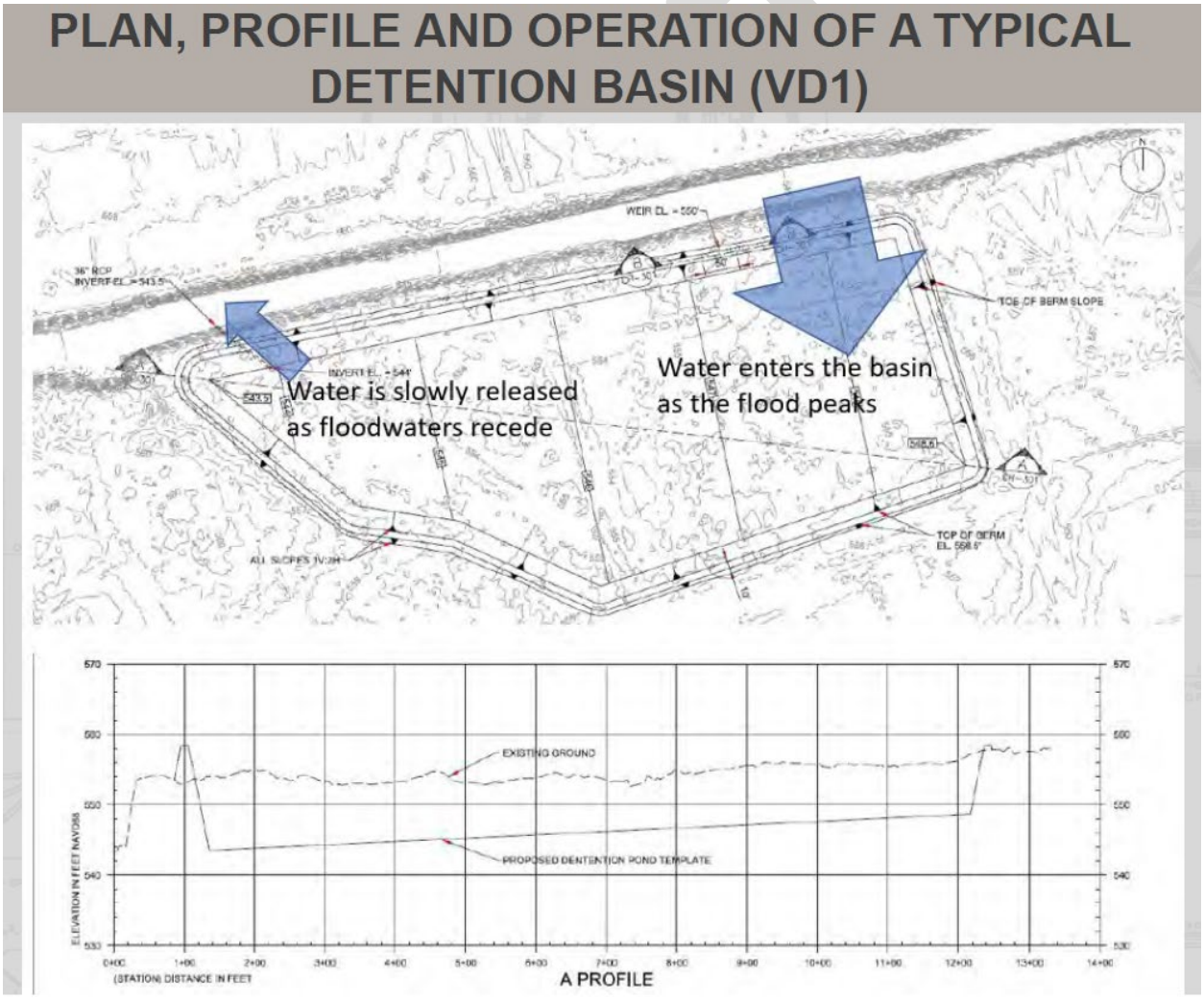

Figure 15. Example of detention basin design from the ADM slides from the Valley Creek FRM study ADM, created by Kansas City District.

3.1.1.2 Diversion

Excess flood water may be diverted from the main river channel by a permanent diversion or bypass structure to reduce flood flows and river levels. These permanent structures are usually located in floodplains, where river slopes are relatively flat, and adjacent to the main river channel to divert water into the auxiliary channels. Many structures pass only insignificant amounts of water, but significant streamflow could be diverted during flooding. The diversion of water may be managed through use of control gates, pumps, or other methods, or the structure may be designed for uncontrolled operation, depending on the water level in the main river. The capacity of the structure is determined by engineering studies of desired flood stage reduction and downstream channel capacities in the main river and in the auxiliary channels, in connection with the overall plan of flood risk management.

3.1.1.3 Levees

A levee is a man-made structure, usually an earthen embankment, designed and constructed to contain, control, or divert the flow of water so as to provide reasonable assurance of excluding temporary flooding from the leveed area (the lands from which flood water is excluded) (Figure 16). Levees interrupt interior drainage, and levee benefit analysis should reflect any residual damages. Interior damages can be mitigated by ponding areas or pumping.

Low level levees were found to be infeasible in the 1988 Feasibility Study:

> "These levees would be designed not to exceed three feet in height so as to preclude catastrophic consequences should they be over-topped. This measure was found to be infeasible for one or more of the following reasons: a lack of space between the damageable property and the channel; topographical conditions requiring high levees which themselves, are infeasible measures for this study; unstable foundations; and physical development/encroachment within the potential levee alignment."

However, despite various constraints and difficulties with levee design in the River Des Peres study area, the PDT considered levees worthy of further analysis. Alignment of the levee segments along the upper River Des Peres were directed by site topography, adjacent development, and closure structures needed.

Figure 16. Levee in an urban area (image: USACE).

3.1.1.4 Floodwalls

Floodwalls are a structural risk reduction measure to reduce flood risk by acting as physical barriers against floodwaters. They function in the same way as a levee and can be considered a type of levee. They are constructed from steel or concrete (Figure 17). Floodwalls take up a smaller footprint than levees and as such are more appropriate for densely developed areas with space limitations.

Figure 17. Floodwall (image: USACE).

3.1.1.5 Channel Modifications

For this study, the channel modification features in the authorized plan based on the 1988 Feasibility Study recommendation were considered. These features include bank stabilization, grade control, gabion walled channel, and trapezoidal channel (Figure 18).

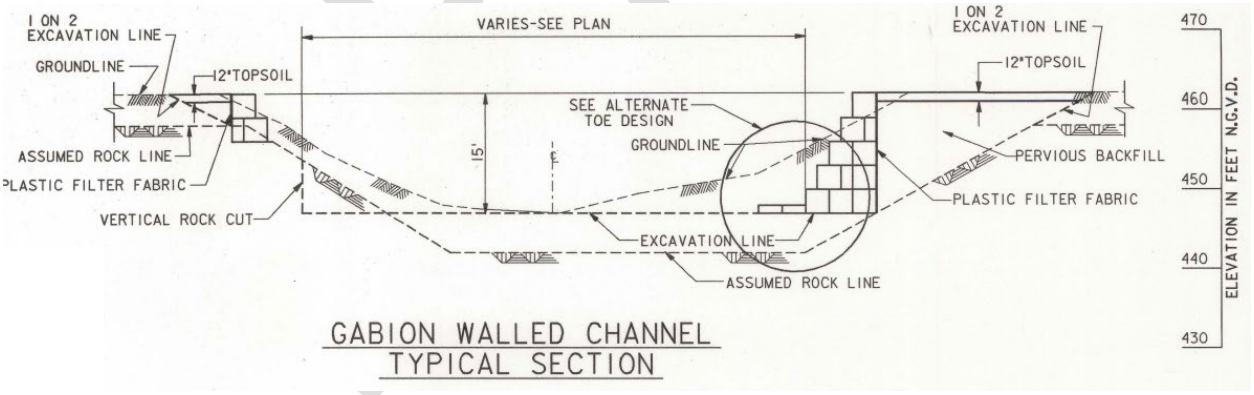

Figure 18. Gabion walled channel cross section (channel modification) from 1988 Feasibility Study.

3.1.1.6 Bridge Modifications

The University City Storm Water Task Force identified several bridges that impeded flow during flood conditions (in some cases due to debris) in its 2019 report, such as the Groby Ave bridge and the Pennsylvania Ave bridge over the River Des Peres near Vernon Street (University City Storm Water Task Force, 2019). The authorized plan also included bridge modifications for

bridges in the project area. Bridge modifications and road elevations could alleviate the impediments at these locations and reduce flood risk to the surrounding areas.

3.1.2 Nonstructural Measures

Nonstructural measures reduce flood damages without significantly altering the nature or extent of flooding. Damage reduction from nonstructural measures is accomplished by changing the use of the floodplains, or by accommodating existing uses to the flood hazard. Examples are flood proofing, relocation of structures, flood warning and preparedness systems (including associated emergency measures), and regulation of floodplain uses. Section 73 of the Water Resources Development Act of 1974 requires consideration of nonstructural alternatives in flood damage reduction studies. They can be considered independently or in combination with structural measures.

3.1.2.1 Floodproofing

3.1.2.1.1 DRY FLOODPROOFING

Dry floodproofing consists of waterproofing the structure to make it watertight below the level of floodwater. It can be applied to residential homes as well as commercial and industrial structures. Based on laboratory tests, a "conventional" built structure can generally be dry floodproofed up to 3 feet. Structural analysis of the strength of the walls would be required if a higher level of protection is desired. Making the structure watertight requires sealing the walls with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete. A sump pump and/or French drain system should also be installed as part of the measure. Closure panels are used at openings such as windows and doors. Dry floodproofing is not recommended for basements or crawlspaces due to excessive costs of reinforcing the exterior walls, preventing seepage, and the possibility of making the whole structure buoyant. Excessive velocities can damage the floodproofing materials, and unless a passive system is incorporated into the design, there may not be adequate time to install closures during a flash flood event.

3.1.2.1.2 WET FLOODPROOFING

Wet floodproofing allows water to move into the enclosed parts of a structure (e.g., crawlspace or unoccupied area) and then move out when the water recedes. Construction materials and finishing materials need to be water resistant and all utilities must be elevated above the design flood elevation. Wet floodproofing is generally not applicable in large flood depths which could create large forces on interior walls, or in high velocity flows or flashy conditions which will not allow hydrodynamic pressures to equalize quickly. Wet floodproofing may be applied to commercial and industrial structures when combined with a flood warning and flood preparedness plan.

Wet floodproofing may reduce National Flood Insurance Program (NFIP) premium rates if certain conditions are met including the lowest floors being elevated to or above the base flood elevation ("BFE"), i.e., if the basement is filled or converted to a crawlspace (FEMA, 1993).

3.1.2.2 Elevation of Structures

Elevation is the lifting of an existing structure to an elevation which is at least equal to or greater than the 1% annual chance flood elevation. The final elevation should place the first floor and associated ductwork, plumbing, mechanical and electrical systems above the design water surface elevation. In many elevation scenarios, the cost of elevating a structure an extra foot or two is less expensive than the first foot, due to the cost incurred for mobilizing equipment. Elevation can be performed using fill material, on extended foundation walls, on piers, post, piles and columns. Elevation is also a very successful measure for reinforced slab on grade structures. It is possible that the structure being assessed has an existing crawlspace or basement which would require abandoning to reduce future flood damages and to implement the structural supports for the elevation. Abandonment would consist of filling in the existing basement or crawlspace with clean run fill material and possibly capping with concrete. If the basement or crawlspace is abandoned, a small addition to the structure may need to be constructed on the side of the structure above the projected water surface elevation to contain utilities and mechanical equipment. If the addition could not be implemented because of limited space within the parcel or because the owner did not want it, partial compensation for the lost space would be due to the owner.

Whether a structure may be elevated depends on several factors including the foundation type, wall type, size of structure, and condition. Elevation of a structure most commonly applies to smaller residential and commercial buildings. Residential and commercial property owners can get reduced flood insurance premiums under the NFIP if the first floor of their structure is at or above the Base Flood Elevation (BFE) (or higher if specified by local regulations) after elevation occurs. University City has a freeboard requirement of 2 feet.

Figure 19. Elevation of a residential structure. Image: USACE.

3.1.2.3 Acquisition (Buyouts)

Property acquisition consists of acquiring the at-risk structure and land that the structure sat upon. The structure is either demolished or is sold to others and relocated to a site outside of the floodplain. The land where the structure was originally located is purchased, becoming deed

restricted to prevent development from occurring in the future, and becomes available for open space management as stipulated by the NFIP. Property acquisition and structure removal are usually associated with frequently damaged structures. Implementation of other measures may be effective but if a structure is subject to repeated storm damage, this measure may represent the best alternative to eliminating risks to the property and residents. Acquisition and conversion to open space reduces the opportunity for flood damages, causes no increase in flood potential elsewhere, and improves the natural riparian environment. Authority to acquire property for a cost shared project is contained in the overall project authority. The Corps of Engineers follows guidelines outlined in the 'Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970' in providing relocation assistance to those affected by property acquisitions. If included as part of a USACE recommended plan, acquisition would be mandatory rather than voluntary.

Figure 20. Acquisition (buyout) of a residential structure and property converted to open space

3.1.2.4 Relocation of Structures

Relocation requires physically moving the existing at-risk structure away from the flood hazard area to a location which is completely outside of the floodplain. The land where the structure had been originally located is purchased, becoming deed restricted to prevent development from occurring in the future, and becomes available for open space management as stipulated by the NFIP. Relocation makes the most sense when at-risk structures can be relocated from a high flood risk area to a location of no flood risk. Where possible, relocating a structure within its existing community continues to support the local tax structure which could otherwise be adversely impacted by a significant number of acquisitions, and provides societal cohesion for the displaced residents. Permanent relocation and conversion to open space reduces the risk for flood damages, causes no increase in flood potential elsewhere, and improves the natural riparian environment. If included as part of a USACE recommended plan, relocation would be mandatory rather than voluntary.

3.1.2.5 Flood Forecasting/Warning System

A flood warning system is a recommendation in the original 1988 Feasibility Study. The University City Stormwater Task Force recommended such a system in its 2019 Report and has been discussing how to design and implement this system in meetings of the Commission on Storm

Water Issues. A flood forecasting and warning system would allow people more time to move themselves and their property from areas that would be flooded, increase community resiliency, and improve public awareness and responsibility.

The University City Commission on Storm Water Issues is developing its own municipal system for flood forecasting and warning. The Commission includes members with expertise in flood modeling and prediction algorithms. Commission member built an extensive database and developed statistical protocols for flood prediction based on the actual measurements from rain gages in the watershed. The data available for the flood forecasting and warning system is: >20 years of 5-minute-interval data from USGS stream gage at Purdue Ave, and >10 years of mostly 5-minute-interval data from 6 MSD rain gages in or proximal to the watershed. The components of the warning system are 3 NexSens G2-RAIN Alert Systems with solar power packs (2 already installed) in the watershed, with gages configured to report at 5-minute intervals at the onset of rainfall. The data is then transmitted to the city's account at the NexSens WQDataLIVE cloud-based data center. Alarms will be issued when rainfall exceeds a predetermined threshold that is predictive of flooding. A public portal (currently under development) is available to show rainfall data in real time, at https://www.wqdatalive.com/public/1473.

A major concern with the proposed flood warning system is whether the greatest possible warning time for this watershed would be long enough to allow risk reduction actions to be taken. Depending on the location, the advanced warning time for structures would be from 30 minutes to several hours. The short warning time limits the warning and response options available.

3.1.2.6 Risk Communication/Education

The communication of flood risk to the public can take many forms, including materials such as brochures hosted on local government websites, mailers sent to areas at risk of flooding, and educational events or programs. The University City Commission on Storm Water Issues communications committee is developing materials for public outreach, engagement and education on stormwater and flooding issues, and on the flood warning system. If the planned flood warning system is fully implemented, the City will provide outreach materials to notify residents and businesses about the type of warnings to expect and actions to take.

3.1.2.7 Ordinances/Regulations

Floodplain ordinances that comply with the National Flood Insurance Program requirements are in effect in University City, the City of Overland, and St. Louis County. These ordinances restrict or control development that would significantly increase flood levels and are particularly restrictive in floodway areas that include the stream and a high velocity flood area adjacent to the stream. Development is normally allowed in the floodplain area outside of the designated floodway (in the floodway fringe), but this development must be elevated on fill or by some other method so that it would not be damaged by a 1% AEP flood event. Communities and counties have the option of passing more restrictive floodplain ordinances or development regulations such as those that would earn points in FEMA's Community Rating System program.

3.1.2.8 Recreation Features

This study evaluates recreation features that could accompany or enhance flood risk management measures.

Recreation features associated with measure U-12 from the 1988 Feasibility Study and the authorized plan for the upper River Des Peres are as follows:

> "Recreation alternative R-2 is associated with U-12 and consists of 1.85 miles of trail plus one small park area located near Mona Drive adjacent to the right streambank in the vicinity of river miles 2.0 to 2.1. Although the small park area would not be on flood control lands, it was included for consideration because of its proximity to the proposed trail system as well as local interest. These alternative outdoor recreation measures are shown on PLATES 31 and 32.
>
> "The trail would be a crushed stone path about seven feet wide located on the channel modification right-of-way. This path would extend along one side of the channel and have a four foot high chain link fence between it and adjacent properties. The idea is to capture outdoor recreational opportunities on land which normally would be used only for channel access to maintenance crews.
>
> "The second measure, a small park area, would consist of a shelter, tables and an open play area for soccer. Each of these measures were found to be economically justified on the basis of a comparison between recreation benefits versus costs, as long as the land costs were assigned to the flood control aspects of a plan."

Recreation features associated with detention basins could include trails on the berm or inside the basin and sports fields inside the basin. Recreation features associated with levees could include a trail on the crown of the levee. Recreation features that could be installed in the open space made available by acquisition could include trails, sports fields, and shelters. Great Rivers Greenway (GRG) created a Conceptual Plan Update for the Centennial Greenway in 2014 featuring trails, native grasses, edible fruit trees and other features along the River Des Peres between Heman Park and Groby Road (Great Rivers Greenway, 2014).

3.1.3 Natural and Nature-Based Measures

The team also considered natural and nature-based measures. Natural measures are created through the action of biochemical and physical processes operating in nature. Nature-based measures are products of planning, engineering design, and construction incorporating natural processes that contribute to flood risk reduction and resilience.

3.1.3.1 Floodplain Storage

Storage within the floodplain can attenuate the flood hydrograph and, to some extent, delay the flood wave. The design can be cross sectional storage (similar to a "floodplain bench"

discussed at the Scoping Charrette), overbank storage, or off-line storage. With overbank storage, water is taken out of the rising side of the flood wave and returned on the falling side. After the peak flow passes, the water begins to come out of the storage in the overbank and increases the flow on the falling side of the flood wave.

3.1.3.2 Removal of Invasive Species

Invasive species can be plants, animals, or other organisms. They can seriously impact the stability of streambanks and soil in the watershed. It is possible that invasive plants along the upper River Des Peres are contributing to streambank erosion and that removal of these plants would improve bank stability. Establishing non-invasive vegetation with a root structure that assists in reducing erosion would be beneficial. Detention Basins should be planted with non-invasive, native vegetation and routinely managed to limit the spread of invasive species. Likewise, the bare soil on newly constructed levees should be restored by planting a native seed mix.

3.1.3.3 Constructed Wetlands

Constructed wetlands are human-made treatment systems that use the natural processes that take place in wetland vegetation and soils to improve water quality, create wildlife habitat, and in some cases provide recreation opportunities.

3.2. PRINCIPLES AND GUIDELINES CRITERIA

Evaluation of measures is based on the four Principles and Guidelines (P&G) criteria: completeness, acceptability, efficiency, and effectiveness. While the definitions of these criteria refer to alternatives, the USACE planning process first uses them to help in screening measures.

Effectiveness

Effectiveness is defined (in ER 1105-2-100) as the extent to which an alternative plan contributes to achieving the planning objectives. It is the extent to which a measure alleviates the specified problems and achieves the specified opportunities. An effective measure is responsive to the identified needs and makes a significant contribution to the solution of the problem or to the realization of an opportunity.

Efficiency

Efficiency is defined as the extent to which an alternative plan is the most cost-effective means of achieving the objectives. In other words, whether it is the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the Nation's environment.

Acceptability

Acceptability is defined as the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies.

Completeness

Completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. To establish the completeness of a plan, it is helpful to list those factors beyond the control of the planning team that are required to make the plan's effects (benefits) a reality.

3.3. EXCLUDED MEASURES

The PDT developed and screened the measures as seen in Table 8. Screening criteria qualitatively applied included whether the measure meets planning objectives and avoids constraints, as well as qualitative assessments of effectiveness, efficiency, and acceptability. Table 9 provides more detail on the rationale for elimination of specific measures.

Table 8. Measures and Screening.

Measure	Meets Objective	Type	Retained for further evaluation
Detention basin	1, 2	Structural	Yes
Diversion	1, 2	Structural	No
Levees/floodwalls	1, 2	Structural	Yes
Channel modifications	1, 2	Structural	Yes
Bridge modifications	1, 2	Structural	Yes
Modifying the Tubes	1, 2	Structural	No
Floodproofing	1, 2	Non-structural	Yes
Elevating structures	1, 2	Non-structural	Yes
Permanent relocation of structures	1, 2, 3	Non-structural	No
Acquisition (buyouts)	1, 2, 3	Non-structural	Yes
Flood forecasting/warning system	1, 2	Non-structural	Yes
Risk communication/education	1, 2	Non-structural	Yes
Ordinances/Regulations	1, 2	Non-structural	Yes
Outdoor recreation	3	Non-structural	Yes
Floodplain storage	1, 2	Nature-based/Natural	No
Removal of invasive species	n/a	Nature-based/Natural	No
Constructed wetlands	n/a	Nature-based/Natural	No

Table 9. Screening rationale.

Measure	Retained for further evaluation	Screening Criteria	Additional Explanation
Modifying the Tubes	No	Inefficient	Allowing more volume into the Tubes would cause downstream impacts outside the study area; cost to construct and address downstream impacts would be extremely high vs other measures; MSD and Sponsor do not support
Diversion	No	Inefficient	Highly urbanized environment would require significant acquisition and relocation costs in addition to construction costs. Would displace homes/structures and potentially transfer water and flood risk to another watershed.
Dry floodproofing (ACTIVE)	No	Ineffective	Flood warning time of ~30 minutes not long enough to implement active floodproofing measures; only passive systems would be effective to reduce flood risk.
Relocation of structures	No	Inefficient	Buyouts would be more efficient since no need to relocate the structure; also, there is no space for relocated structures within same parcels or neighborhoods.
Floodplain storage	No	Inefficient	Similar to detention basins but less effective due to lower elevation (less storage); also high value RE in floodplain locations; native floodplain vegetation may be added to DBs later as natural feature
Removal of invasive species	No	Ineffective	Does not address the planning objectives; invasive species not a major concern for bank stability affecting flooding problems in the study area
Constructed wetlands	No	Ineffective	Limited open space to restore wetlands; not enough locations to attenuate peak flows.

3.4. ALTERNATIVE PLANS DEVELOPED

3.4.1. Alternative Plan Formulation

This section summarizes the strategies utilized to identify the initial array of structural and non-structural alternative plans based on initial data collection and professional judgment. At this early stage of the planning process, the designs of the potential alternatives do not include a high level of detail. Particular features were developed further for the alternatives that were not screened and moved forward to the final array, as discussed in the next section.

Four formulation strategies were initially proposed for the alternatives: (1) Authorized plan (required because this is a reevaluation study); (2) Primarily nonstructural plan (required by USACE policy); (3) Reduce flows through the University City reach; and (4) Focus on life safety. As formulation continued, the planning team also created measures-focused alternatives (and re-named alternatives based on the primary measure) to capture the range of solutions.

3.4.2. Alternative Plans Screened

The initial array of alternatives included the following alternatives which were subsequently screened:

- Authorized plan from the 1988 Feasibility Study: The measures for the University City Branch of the River Des Peres in the authorized plan from the 1988 Feasibility Study include measure U-12, comprised of approximately 2.5 miles of channel modification (including bridge replacement, bank stabilization, and grade control with gabion-walled channel and trapezoidal channel), as well as a flood forecasting and warning plan and recreation features (R-2, a trail and a park area). Review of the original report and recomputation of the measure U-12 with current conditions showed that the plan would cause increased flow and higher water stages going into the Tubes, which would induce flood damages downstream of the project (Table 10). Therefore, this alternative is not an acceptable plan, as is, per USACE planning guidance.

Table 10. Increases in flow and stage at the entrance to the Tubes caused by measure U-12 (part of the authorized plan in the 1988 Feasibility Study).

AEP (%)	U-12 difference from existing condition	
	Flow (cfs)	Stage (ft)
0.2	+770	+0.63
0.5	+589	+0.51
1	+655	+0.64
2	+680	+0.76
4	+566	+0.71
10	+593	+0.86
20	+217	+1.59
50	+124	+0.78

- Maximum Implementation of Levees/Floodwalls: Six levee segments were initially identified along three reaches of the river. Segment 1 extended to the downstream end of the study area along the south side of Heman Park. Segments 2a and 2b were aligned along the north and south banks of the river along Wilson Ave, respectively. Segments 3a, 3b, and 3c were aligned along the river between approximately I-170 and Olive Blvd. Upon further development of the levee designs with consideration of topography, road crossings, and changes to flood characteristics, five of the levee segments were screened as ineffective. Segment 2a was considered viable and was advanced into an alternative in the final array.
- Maximum Implementation of Detention Basins: Five potential detention basin locations were identified in the study area, including one at Heman Park and one at Wilson Avenue adjacent to the river. However, based on professional judgment and the H&H modeling, the three downstream detention basins were located too far downstream and would not

remove enough volume from flood inundation to be worthwhile. (DB3 and DB4 were found to be hydraulically feasible and were advanced into alternatives in the final array.)

- Detention Basin 3 (DB3): On its own, DB3 was not incrementally justified; it had a BCR of a little less than 1.0. An alternative consisting of DB3 alone was screened as inefficient with the assumption that DB4 alone would be a stronger alternative that was incrementally justified with greater net benefits and a BCR of more than 1.0.
- Detention Basin 4 (DB4C) Commercial Location: The site at which DB4 was initially identified was located between Woodson Road and the tributary entering the River Des Peres 0.2 miles to the west of I-170. The site includes two commercial buildings currently in use by a restaurant supply business and a car museum, and tennis courts and parkland belonging to the City of Overland. The entire site is within the jurisdiction of the City of Overland. DB4C was screened as inefficient; the PDT determined that the site directly west of this location on the west side of the tributary would be better suited for DB4 despite being a slightly smaller site, because it is currently in use as open space and would therefore have a lower cost.

3.5. Final Array of Alternative Plans

3.5.1.1. Alternative 1 – No Action Plan

Alternative 1, the No Action alternative, is a scenario with no Federal flood reduction project. The future condition with the No Action plan is the same as the Future Without Project condition. It will not address any of the planning objectives. Flood-related damages and life safety risk is unlikely to change significantly in the future. The City will continue to offer buyouts as funding becomes available following flood events, but these will continue to be voluntary. The community would continue to rely on any existing emergency/temporary flood warning system, emergency flood fighting measures, and flood insurance to provide flood damage protection. Some floodproofing actions by individuals are also likely under this scenario. It is likely that large flood events of the magnitude of the 2008 flood would not be able to be successfully fought under these conditions. At some point, flood damages to the existing structures would exceed 50 percent of their value. Then, those homes would need to be demolished or relocated out of the floodplain and reconstruction on that site would only be allowed if certain costly design features were included in the reconstruction. As this progressively occurred over time, many existing neighborhoods would have vacant lots and/or degraded housing.

3.5.1.2. Alternative 2 – Authorized plan with modifications (inclusion of DB3 and DB4)

Alternative 2 is comprised of the measures for the University City Branch of the River Des Peres in the authorized plan from the 1988 Feasibility Study. It includes measure U-12, comprised of approximately 2.5 miles of channel modification (including bridge replacement, bank stabilization, and grade control with gabion-walled channel and trapezoidal channel), as well as a flood forecasting and warning plan and recreation features (R-2, a trail and a park area). (A 65-foot-wide gabion walled channel from the upstream end of the existing Olive St. improvement upstream to the 82nd Ave. bridge was also proposed in the authorized plan for

the University City Branch but has since been constructed by MSD). The AEP event area for which the U-12 measures would reduce flood risk was not determined. To mitigate the induced flooding and make this an acceptable alternative, DB3 and DB4 were modeled together with the channel and bridge modifications in HEC-RAS separately and together. It was determined that DB3 and DB4 in combination with the channel and bridge modification features in the authorized plan would mitigate the induced flooding. Figure 21 shows the locations of the measures in Alternative 2.

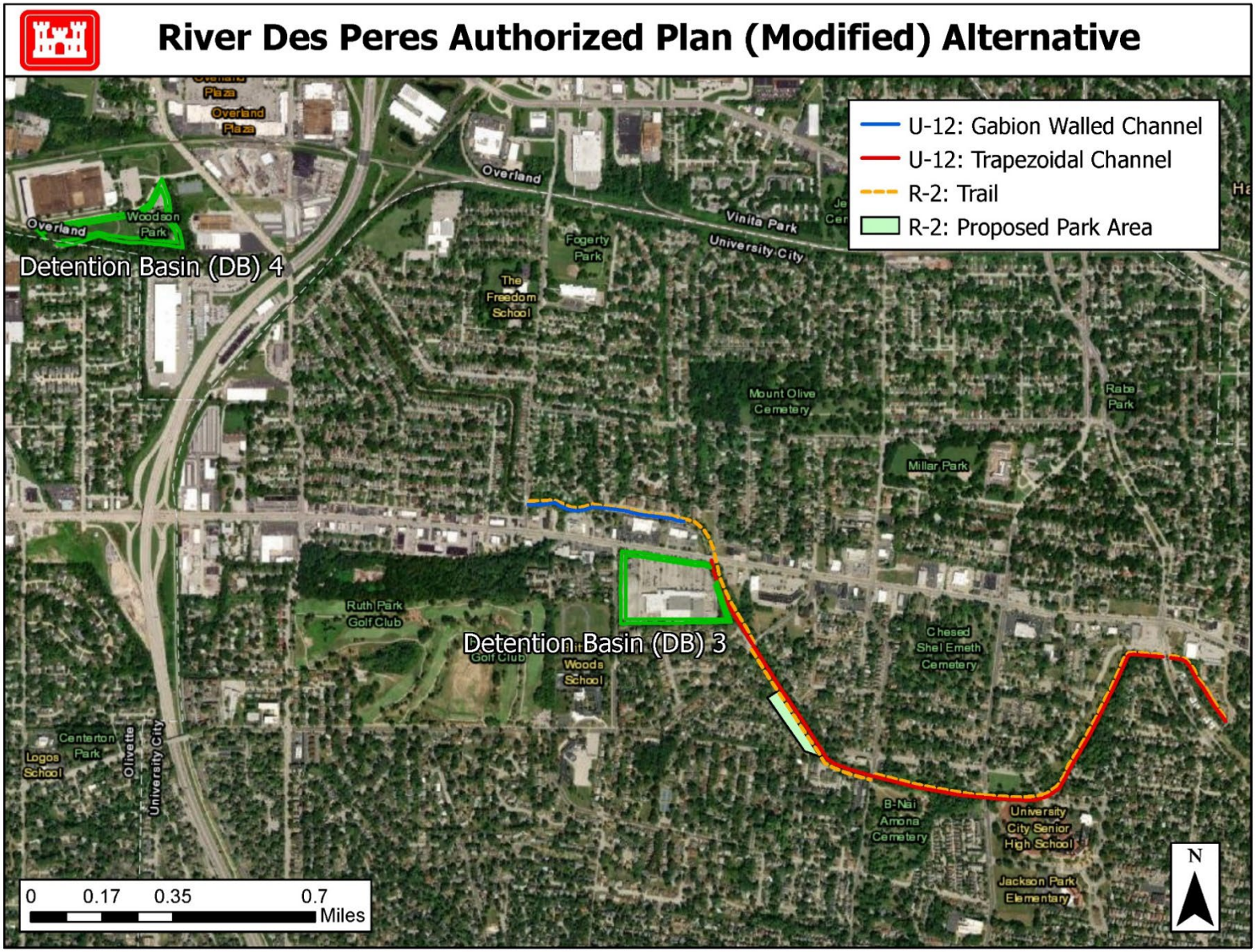

Figure 21. Alternative 2 – Authorized Plan with Modifications (DB3 and DB4).

3.5.1.3. Alternatives 3a and 3b – Detention Basins

Alternative 3 consists of two detention basins strategically located within the watershed. Of the five locations initially identified, two were found to be hydraulically feasible: detention basin 3 (DB3) and detention basin 4 (DB4) (Figure 22). Alternative 3a includes both DB3 and DB4, and Alternative 3b consists of DB4 alone.

Due to the restriction of available useable real estate the level of risk reduction provided by the basins is in the range of the 50% AEP (2-year) event to the 10% AEP (10-year) event, based on the capacity of the basins per design constraints. The basins are designed for dry detention, so that they have maximum storage capacity during storm events.

The DB3 site includes a large seafood supply store, a small restaurant, and a large parking lot; these businesses are an amenity for the Asian food corridor along Olive Blvd. DB3 is the same detention area as the "Olive Detention Area" identified in the 2009 draft GRR, for which some H&H analysis was done.

DB4 is located at the site of a public park in the City of Overland; coordination would be needed with the City of Overland to have University City acquire the property or an easement.

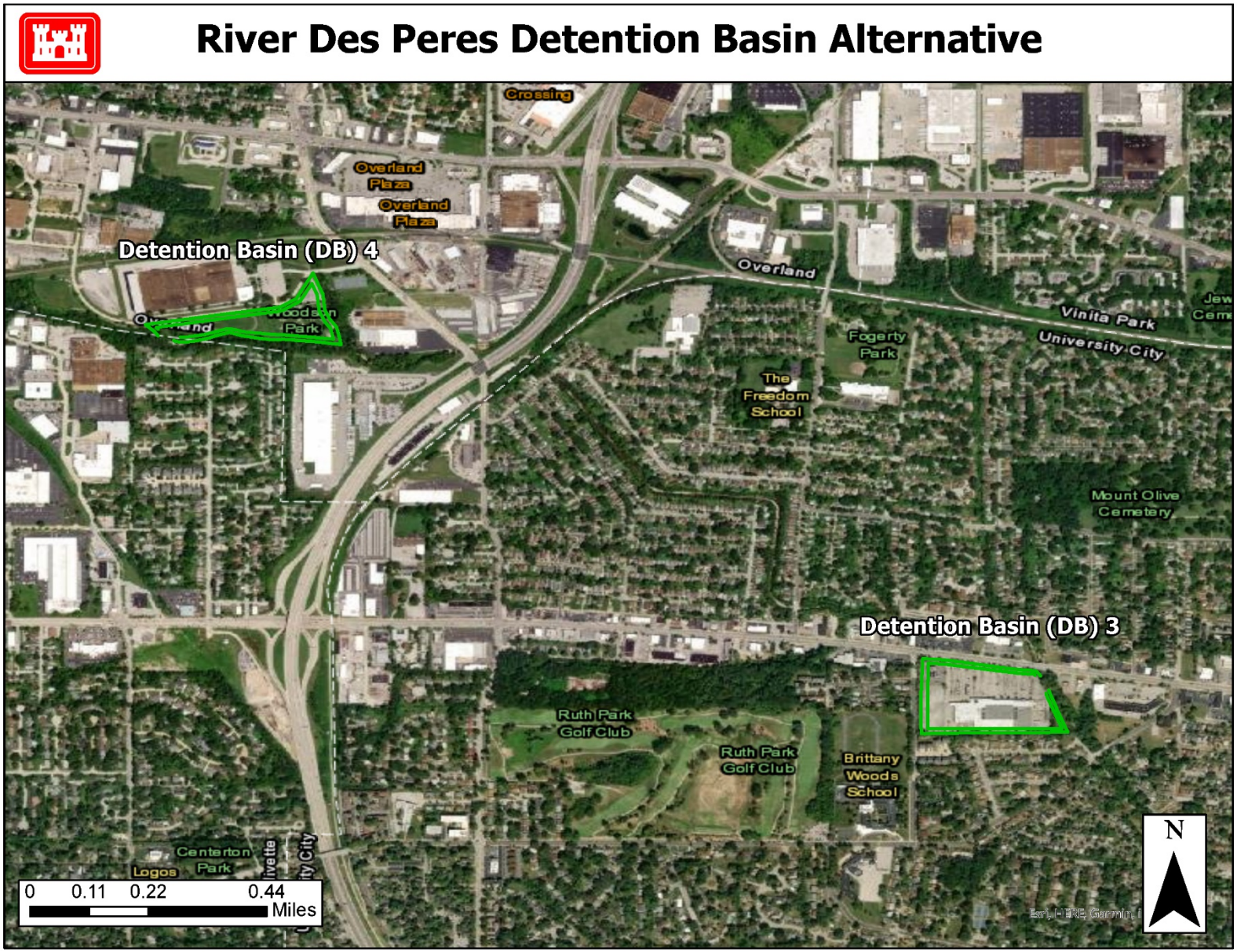

Figure 22. Detention basins in Alternative 3a (DB3 and DB4) and Alternative 3b (DB4).

3.5.1.4. Alternative 4 – Levee/Floodwall with Detention Basins 3 & 4

Alternative 4 consists of levee/floodwall segment 2a, located along the north bank (left descending bank) of the River Des Peres between Groby Road to the west and the Heman Park Swimming Pool to the east (Figure 23). The levee/floodwall was assessed to be constructed for risk reduction from the 1% AEP event; this level of risk reduction is typical for initial alternative design and evaluation.

On its own, the levee/floodwall would reduce flood risk for the area behind it, but it would also cause induced flooding and increase discharges into the Tubes. As a result, DB3 and DB4 were incorporated into the alternative to mitigate these impacts.

The portion of segment 2a aligned along the east side of Wilson Ave would be located on lands acquired by University City with funding from FEMA's HMGP program.

The segment would largely consist of floodwall rather than levee due to space considerations. A trail as a potential recreation feature that could be located on top of a levee, but not a narrow floodwall, would therefore be limited or impossible.

Figure 23. Alternative 4 – Levee/Floodwall with DB3 and DB4.

3.5.1.5. Alternative 5 – Nonstructural – Acquisition

Alternative 5 consists of the acquisition of approximately 500 structures in the 4% AEP (25-year event) area and the relocation of the people and businesses associated with those structures (Figure 24). The 4% AEP (25-year) event was used following analysis of the 4% AEP (25-year), 2% AEP (50-year), and 1.3% AEP (75-year) events which showed the greatest net annual benefits for the structures impacted by the 4% AEP event.

Included in the 500 structures are 100 homes within the University Heights Subdivision No. 1 National Historic District (out of 258 houses in the district). Of note, according to the National Register Form, among these 100 homes: there are 2 State Significant Homes, 6 locally significant homes, 56 homes considered "Essential to the Fabric of the Neighborhood", and 36 that are considered to have no special significance.

The acquired land would be converted to open space that could provide recreation opportunities through features such as trails. Natural features such as trees and wetland plantings could also be added to enhance the aesthetics of the riverside corridor.

This nonstructural alternative would not create any incremental risk or change the flood characteristics.

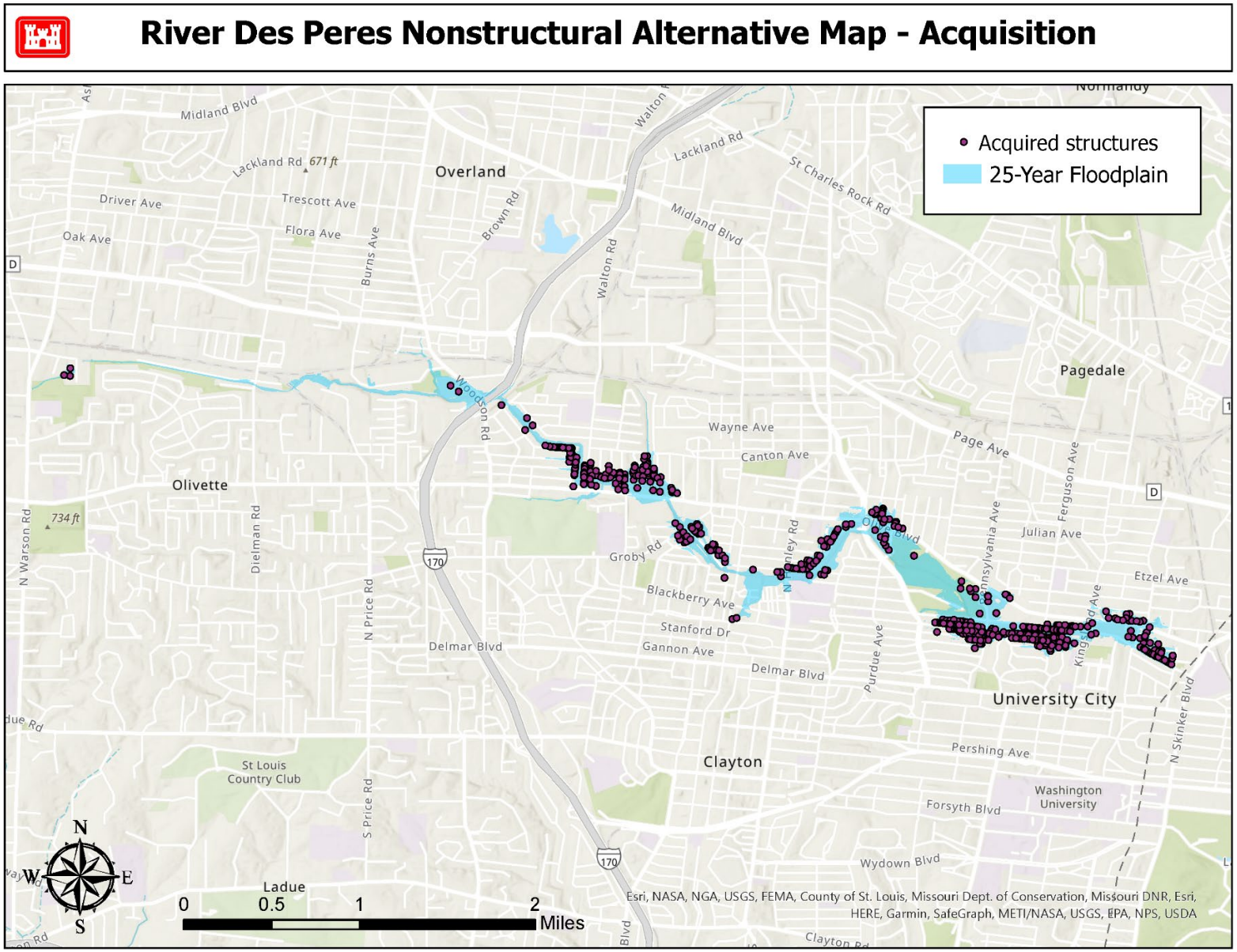

Figure 24. Alternative 5 – Nonstructural – Acquisition

3.5.1.6. Alternative 6 – Nonstructural – Floodproofing and Elevation

Alternative 6 consists of floodproofing and elevation of approximately 500 structures with flood damage in the 4% AEP (25-year floodplain) (Figure 25). The 4% AEP (25-year) floodplain was used following analysis of the 4% AEP (25-year), 2% AEP (50-year), and 1.3% AEP (75-year) events which showed the greatest net annual benefits for the structures impacted by the 4% AEP event. Most of these structures would be floodproofed and approximately 7 structures would be elevated. Dry floodproofing was used in the analysis as the type of floodproofing. The structures to be elevated would be raised to the 1% AEP event (100-year) level of risk reduction. Acquisition was considered for inclusion in this alternative, but the analysis showed it not to be as cost-effective as floodproofing or elevation for the structures assessed.

The same 100 homes in the University Heights Subdivision No. 1 National Historic District impacted by Alternative 5 would also be impacted by Alternative 6, although to a lesser extent; floodproofing and elevation would allow the structures to remain in place and alter only some features.

This nonstructural alternative would not create any incremental risk or change the flood characteristics.

In the analysis for the development of this alternative for the final array, 100% participation was used, with the assumption that this would be refined later in the study process.

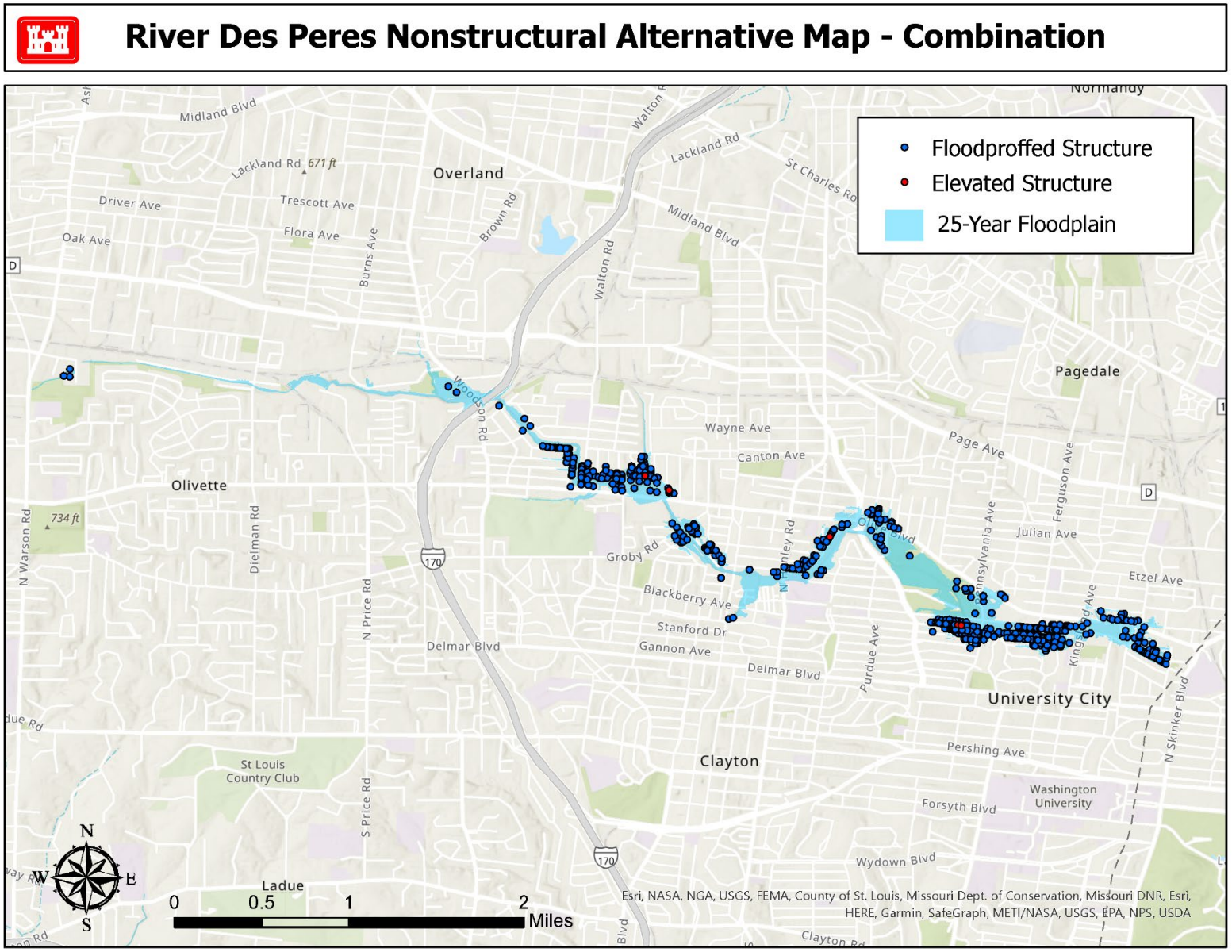

Figure 25. Alternative 6 – Nonstructural – Floodproofing and Elevation

3.4.3.7. Alternative 7 – Nonstructural Plan – Elevation only

Alternative 7 is a refinement of Alternative 6. It consists of the elevation of approximately 90 residential structures with flood depth above the first floor in the 4% AEP (25-year) event (Figure 26). The homes would be elevated to the height of the 1% AEP (100-year) event. This alternative was developed as a scenario in which dry floodproofing was not possible (due to short flood warning times) and wet floodproofing was not accepted (leading to 0% participation).

These measures would not create any incremental risk or change the flood characteristics. For the initial analysis, 100% participation in elevation was assumed; this will be refined in the next phase of the study with a sensitivity analysis and, potentially, input from the survey administered by University City.

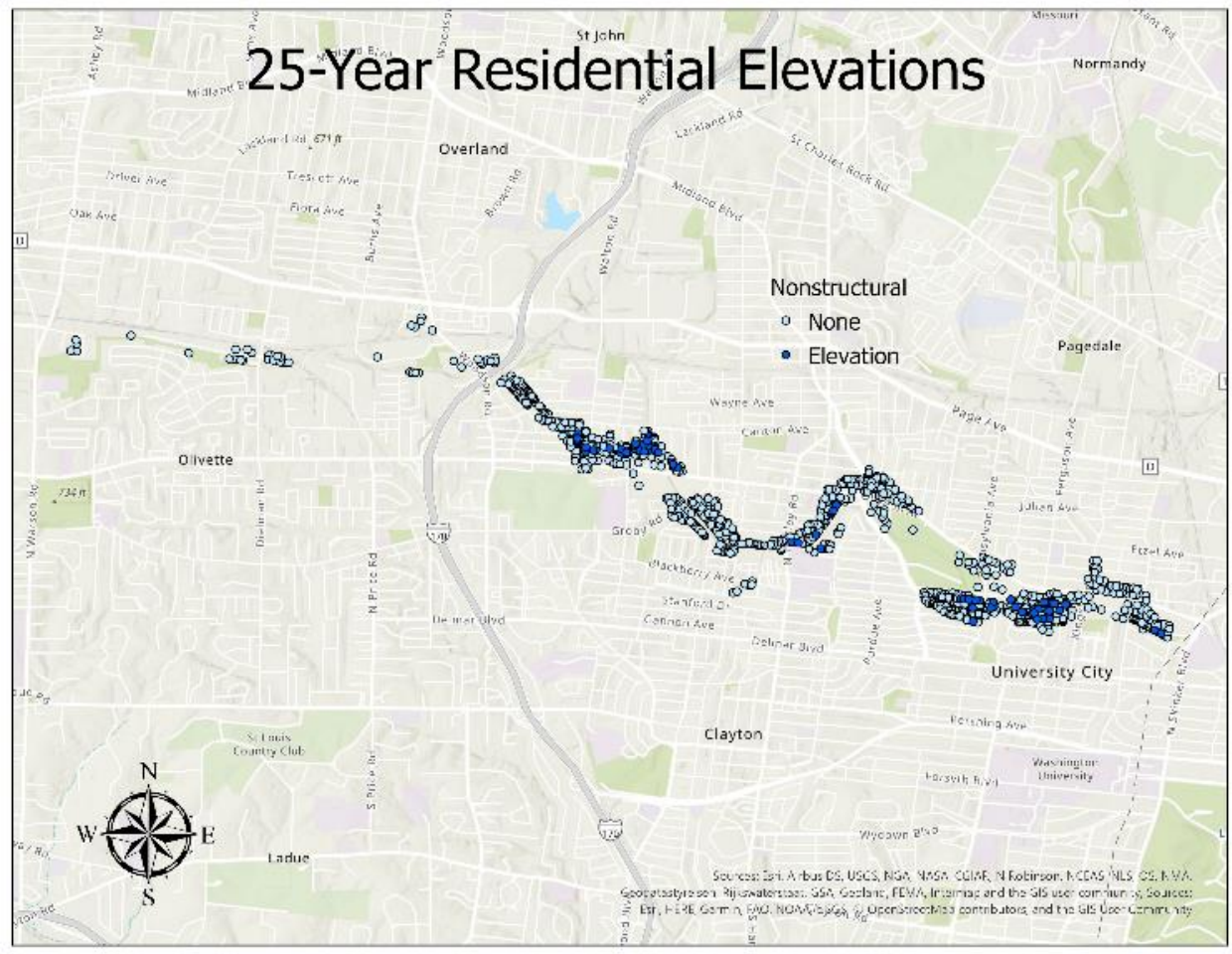

Figure 26. Alternative 7 – Nonstructural – Elevation only (refinement of Alternative 6)

3.5.1.7. Alternative 8 – Combination Plan – DB4 and Elevation

Alternative 8 is a refinement of Alternative 6. It consists of a combination of structural and nonstructural measures: DB4 and the elevation of approximately 56 residential structures with flood depth above the first floor in the 4% AEP (25-year event) (Figure 27). The homes would be elevated to the height of the 1% AEP (100-year event).

For the initial analysis, 100% participation in elevation was assumed; this will be refined in the next phase of the study with a sensitivity analysis and, potentially, input from the survey administered by University City.

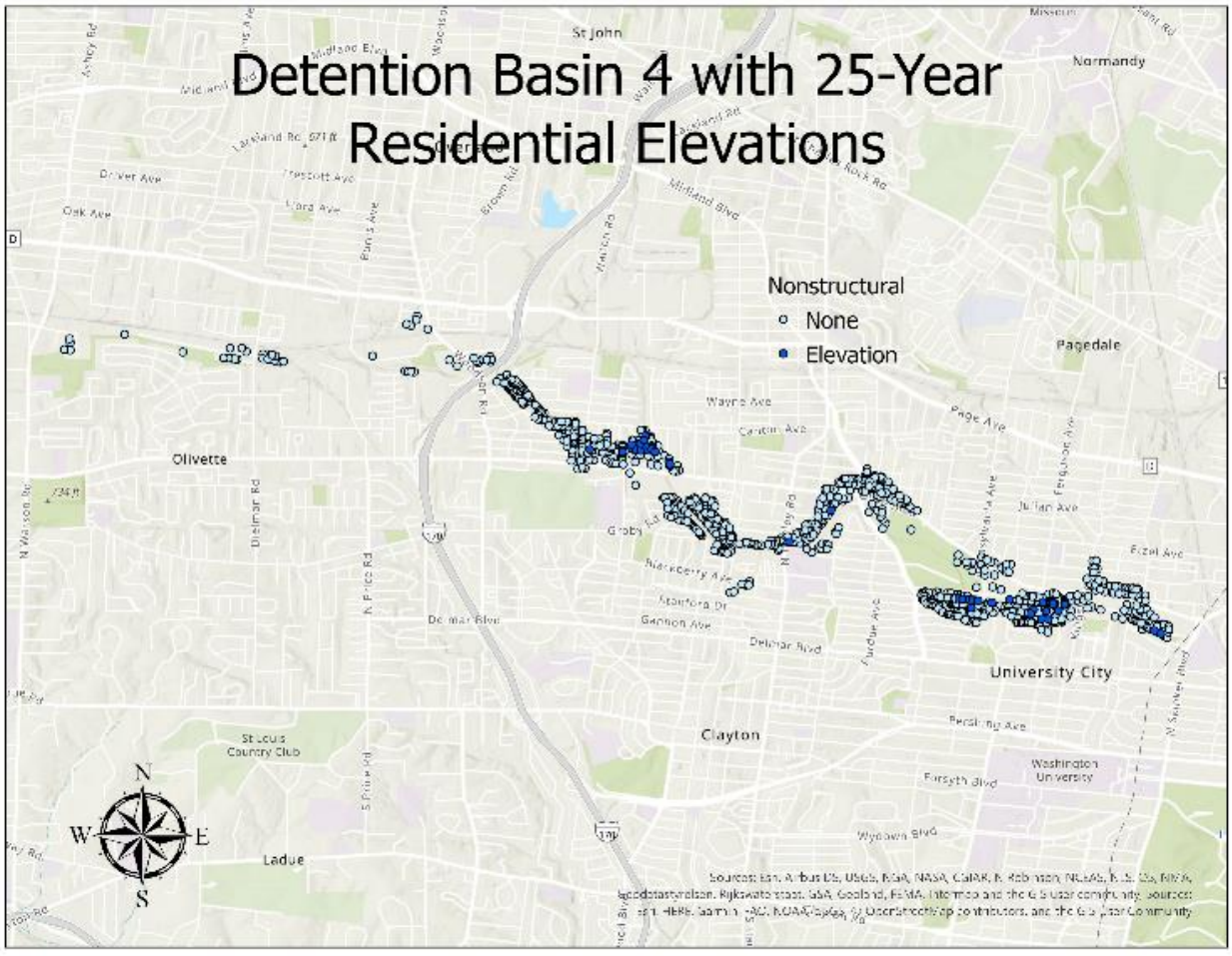

Figure 27. Alternative 8 – Nonstructural – DB4 and Elevation (refinement of Alternative

4 EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

This section evaluates and compares the final array of alternatives. This evaluation and comparison step was based on a conceptual level of design and associated cost estimates (approximately 10% level of design).

4.1 EVALUATION OF COMPREHENSIVE BENEFITS

The final array of alternatives was assessed to identify benefits across four categories: NED, Regional Economic Development, Other Social Effects, and Environmental Quality.

a) The National Economic Development or **NED** account displays changes in the economic value of the national output of goods and services.
b) The Environmental Quality or **EQ** account displays non-monetary effects on significant natural and cultural resources.
c) The Regional Economic Development or **RED** account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
d) The Other Social Effects or **OSE** account registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

Table 11 presents a summary of the comprehensive benefits evaluation across these four categories for future with project conditions in each of the alternatives. The NED and RED accounts include quantitative evaluation of each alternative using traditional NED and RED evaluation criteria (e.g., net benefits, number of full-time equivalent jobs, etc.) while the OSE and EQ accounts include a qualitative ranking (i.e., high, medium, and low) for the final array. Additional information supporting evaluation of NED, RED, OSE, and EQ is also presented in the following sub-sections.

Table 11. Comprehensive costs and benefits for final array of alternatives. Not shown: Alternative 1 – No Action Plan. Green indicates high benefit, orange indicates medium benefit, and red indicates low benefit.

Benefits Category	Alternative							
	2-Auth. Plan & Detention Basin 3&4	**3a-Detention Basin 3&4**	**3b-Detention Basin 4**	**4-Levee/ Floodwall & Detention Basin 3&4**	**5-Buyouts**	**6-Dry floodproof /Elevation**	**7- Elevation**	**8- Detention Basin 4 /Alt. 6**
National Economic Development (NED)								
Total Project First Cost ($1,000s)	$58,547	$43,330	$8,476	$84,589	$222,591	$68,836	$26,498	$25,650
Net Annual Benefits ($1,000s)	$20	$724	$1,201	-$1,096	-$2,754	$1,675	-$204	$1,030
BCR	1.01	1.33	2.98	0.73	0.66	1.67	0.79	1.84
Regional Economic Development (RED)								
Gross Regional Product	$57M	$42M	$8M	$82M	[not calculated]	$65M	[not calculated]	[not calculated]
Full-Time Equivalent Jobs Created	704	521	102	1,018	[not calculated]	644	[not calculated]	[not calculated]
Environmental Quality (EQ)								
Wetlands	None	None	None	None	None	None	None	None
Threatened and Endangered Species	None	None	None	None	None	None	None	None
HTRW Impacts	None	None	None	None	None	None	None	None
Open (green) Space Created	Low	Low	None	Low	High	None	None	None
Cultural Resources Impacts	Low	Low	Low	Low	High	Medium	Medium	Medium
Other Social Effects (OSE)								
Life Safety Risk Reduced	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium
Critical Infrastructure Risk Reduced	High	High	Medium	High	Low	Low	*Low (likely)*	*Medium (likely)*
Impacts to Low Income Neighborhoods	Medium	None/Low	None/Low	Medium	Low	Low	*Low (likely)*	*Low (likely)*
Recreational Opportunities	Medium	Medium	Low	Medium	High	Low	Low	Low
Other: HMGP Land Impacts	High	None	None	High	None	None	None	None

4.1.1 National Economic Development

The National Economic Development (NED) Plan is the plan that reasonably maximizes net economic development benefits, consistent with the Federal Objective. The benefits and costs of the alternatives were annualized over the 50-year period of analysis. The expected annual benefits attributable to the alternatives were measured by subtracting the total equivalent annual damages for proposed alternatives from the total equivalent annual damages without project conditions. The net benefits for the alternatives were calculated by subtracting the annual costs from the equivalent annual benefits. Table 12 identifies the first costs and benefits of the final array alternatives by account and includes contingencies. Contingencies were determined by performing an abbreviated cost risk assessment for each action alternative, which considered uncertainties related to each input to the cost estimate. These costs are preliminary and were used to compare plans. Once the recommended plan is identified, it will undergo additional detailed cost estimating. Alternatives 2, 3a, 3b, 5, 6, and 8 possess a BCR greater than 1.0 and have positive annual net benefits.

Table 12. Costs and benefits of the final array of alternatives (2021) price level

Alternatives	**Total Cost (incl. RE)***	**Annualized Project Costs**	**Annual OMRR&R****	**Net Annual Benefits (benefits - costs)**	**BCR (annual benefits/costs)**
1 - No Action	$ -	$ -	$ -	$ -	0
2 - Authorized Plan with Modifications (DB3 & DB4)	$ 58,547,000	$ 2,143,000	$ 900,000	$ 20,000	1.01
3a - Detention Basins (DB3 and DB4)	$ 43,330,000	$ 1,586,000	$ 600,000	$ 724,000	1.33
3b - Detention Basin 4 (DB4)	$ 8,476,000	$ 306,000	$ 300,000	$ 1,201,000	2.98
4 - Levee/Floodwall (with DB3 & DB4)	$ 84,589,000	$ 3,135,000	$ 900,000	$ (1,096,000)	0.73
5 - Nonstructural – Acquisition	$ 222,591,000	$ 8,045,000	$ -	$ (2,754,000)	0.66
6 - Nonstructural – FP & elevation	$ 68,836,000	$ 2,488,000	$ -	$ 1,675,000	1.67
7 - Nonstructural (elevation only)	$ 26,498,000	$ 958,000	$ -	$ (204,000)	0.79
8 - DB4 + Nonstructural (elevation only) (25yr)	$ 25,650,000	$ 927,000	$ 300,000	$ 1,030,000	1.84

*The FY 2021 Federal interest rate of 2.5 percent was used to discount the costs and benefits to the base year and then amortize the costs over the 50-year period of analysis

**OMRR&R: Operations, Maintenance, Repair, Replacement, and Rehabilitation

The National Economic Development Plan is the alternative that reasonably maximizes net benefits while remaining consistent with the Federal objective of protecting the environment. Alternative 6 was identified as the NED Plan.

As described in Section 3.2, efficiency is one of the P&G criteria and is defined (in ER 1105-2-100) as the extent to which an alternative plan is the most cost-effective means of achieving the objectives. Net benefits and the BCR are measures of efficiency. Costs of the various alternatives are summarized in Table 12 (Alternative Costs). The NED plan (alternative 6) is the most efficient.

4.1.2 Regional Economic Development

The RECONS model was used to estimate RED benefits for alternative plans. Based on the RECONS results, Alternative 4 has the highest RED benefits for the final array of alternatives. Nearly 1,018 full-time equivalent jobs would be produced for the region with a local direct impact (gross regional product) of approximately $83 million. Based on the analysis presented above, Alternative 4 maximizes benefits in the RED category.

4.1.3 Environmental Quality

For most environmental resources in the study area, all the alternatives would have minimal or no impact or benefit. The alternatives that include detention basins (Alternatives 2, 3a, 3b, 4, and 8) all include DB4, the footprint of which includes a very small area with trees adjacent to a tributary. Alternative 4 would potentially affect the one small (0.4 acre) wetland to the west of the river during construction of the levee/floodwall. The impacts to these areas were considered negligible with regard to wetland mitigation since the estimated acreage that would be impacted is so small.

No critical habitat for threatened and endangered species was found in the study area, so all the alternatives had no impact on this criterion. Since there are no known HTRW concerns in the area, all alternatives had no impact on this criterion. Alternatives 2, 3a, and 4 would enable the creation of some green space, through the conversion of the DB3 location from developed land to a vegetated detention basin. Alternative 5 would have the most open space created, where land that was acquired would be converted to green space along the river. More detail on the environmental effects of the alternatives and the TSP, Alternative 6, is presented in Section 6 of this report.

4.1.3.1 Cultural Effects

Cultural effects were also assessed. All of the structural alternatives, 2, 3a, 3b, and 4, had a low risk of impacting known historic properties in the study area. However, the nonstructural alternatives 5, 6, 7, and 8 all included removal, floodproofing or elevation of many historic structures. Historic buildings which are subject to nonstructural alternatives may no longer be considered eligible for the National Register due to the diminished historic integrity of the property's design, setting, and feeling. This would be considered adverse effects to historic

properties and would require further consultation with the SHPO to resolve the adverse effects in accordance with 36 CFR Part 800.6.

Based on the analysis presented above, including cultural impacts, Alternative 5 maximizes benefits in the EQ category, though the case could be made for other alternatives as well based on the weighting of the criteria; there is no clear winner.

4.1.4 Other Social Effects

Primary OSE benefits for the alternatives derive from life safety risk reduction and critical infrastructure risk reduction.

The structural alternatives (Alternatives 2, 3a, 3b, and 4) all contain detention basins which would act to delay the peak of the flood and reduce water surface elevation and velocities. Each of the structural alternatives are expected to reduce the risk of life loss on roads. Life safety concerns regarding the detention basins (i.e. risk and consequences of a potential breach) are applicable to all the structural alternatives as well. A breach in the levee/floodwall (Alternative 4) would cause additional life safety impacts that have not yet been quantified. The nonstructural alternatives (Alternatives 5, 6, 7, and 8) would all improve life safety primarily by reducing flood impacts to structures and the people inside them. Of the nonstructural alternatives, Alternative 5 – Acquisition has the greatest life safety benefit because it removes impacted structures and their inhabitants from the area of inundation. All alternatives would include a flood forecasting and warning system which would improve life safety. Conservatively, all alternatives were considered to have either low or medium improvement to life safety. Further analysis of life safety will be conducted on the recommended plan.

Critical infrastructure, specifically, a fire station adjacent to the River Des Peres, is currently impacted by the 1% AEP event. The fire station would remain impacted by the 1% AEP event under alternatives 5 and 6 (and likely 7), partially impacted by the 1% AEP event under Alternative 3b and would not be impacted by the 1% AEP event under alternatives 2, 3a, and 4.

Social vulnerability and environmental justice were qualitatively evaluated by looking at the evenness and extent of the impacts of alternatives on low-income neighborhoods (assumed synonymous with home values; see Figure 14. Alternatives 3a and 3b would have no/low impact in this category. Alternative 2 – Authorized Plan with Modifications would have moderate impacts to properties along the river including high, medium, and low-income neighborhoods. Alternative 4 – Levee/Floodwall would primarily impact medium and high-income neighborhoods towards the downstream end of the study area and would reduce flood risk to these neighborhoods as well. The nonstructural alternatives included structures for participation from low-, medium-, and high-income neighborhoods. Generally, the impacts and benefits of all the alternatives in this category do not appear disproportionate.

Recreational opportunities would be increased significantly by Alternative 5, increased somewhat by alternatives 2, 3a, 3b, and 4, and not at all by alternatives 6, 7, and 8 (see also Table 14). HMGP lands would be impacted under alternatives 2 and 4; the structural measures would take up some of the open space and make it unusable for recreation.

Based on the analysis presented above, no one alternative clearly maximizes benefits in the OSE category.

4.2 FULFILLMENT OF OBJECTIVES (EFFECTIVENESS)

Each alternative plan carried into the final analysis was compared to the project's flood risk management objectives. As described in Section 3.2, effectiveness is one of the P&G criteria and is defined (in ER 1105-2-100) as the extent to which an alternative plan contributes to achieving the planning objectives. The effectiveness of each plan can be seen in Table 13 (Fulfillment of Objectives). Three key themes of the objectives (reduce life safety risk, reduce economic damage due to flooding, and increase recreational opportunities) were used to rate each alternative on a scale of 0 to 3 according to its fulfillment of that objective. A score of 0 indicates that the alternative does not meet the objective. A score of 1 indicates that it minimally meets the objective; 2 indicates that it moderately meets the objective; and 3 indicates that it fully meets the objective. Because recreational opportunities are considered a much less important objective than the first two objectives, the scores under this objective are not included in the total score.

Table 13 demonstrates that all the alternatives contribute to the project's objectives to some degree, except for the No Action alternative. The most effective alternatives based on this scoring are the nonstructural acquisition and floodproofing and elevation alternatives. The least effective of the final alternatives would be DB4 on its own.

Table 13. Fulfilment of Objectives.

Alternative	**Objective**			**Total Score (excluding recreational opportunities score)**
	Reduce life safety risk due to flooding	**Reduce economic damage due to flooding (& residual risk)***	***Increase recreational opportunities associated with FRM features***	
1 - No Action	0 – Does not reduce life safety risk	0 – Does not reduce economic damage	*0 – Does not increase recreational opportunities*	0
2 - Authorized Plan with Modifications (DB3 & DB4)	2 – Risk reduction through range of flood events	2 – Residual risk $2.8M	*1 – DB3 and DB4 may incorporate trails, other features*	4
3a - Detention Basins (DB3 and DB4)	1- Risk reduction for 50% AEP	2 – Residual risk $3.0M	*1 – DB3 and DB4 may incorporate trails, other features*	3
3b - Detention Basin 4 (DB4)	1- Risk reduction for 50% AEP	1 – Residual risk $4.0M	*0 – DB4 may incorporate trails, other features to replace existing features*	2
4 - Levee/Floodwall (with DB3 & DB4)	2 – Risk reduction for 1% AEP	2 – Residual risk $3.0M	*2 – Levee, DB3 and DB4 may incorporate trails, other features*	4
5 - Nonstructural - Acquisition	2 – Risk reduction for 4% AEP	3 – Residual risk $595,000	*3 – Open space in acquired property likely to incorporate recreation features*	5
6 - Nonstructural – Floodproofing and Elevation	2 – Risk reduction for 4% AEP	3 – Residual risk $1.7M	*0 – Does not increase recreational opportunities*	5
7 - Nonstructural – Elevation only	2 – Risk reduction for 4% AEP	1 – Residual risk $5.1M	*0 – Does not increase recreational opportunities*	3
8 - Combination – DB4 and Elevation	2 – Risk reduction for 4% AEP	2 – Residual risk $3.6M	*0 – DB4 may incorporate trails, other features to replace existing features*	4

* Residual risk is the amount of annual economic damage remaining after the alternative is implemented.

4.3. ACCEPTABILITY AND COMPLETENESS

As described in Section 3.2, the P&G criteria of acceptability is defined as the extent to which the alternative plans are acceptable in terms of applicable laws, regulations, and public policies. All the alternatives are acceptable in these terms, with the possible exception of the levee/floodwall (Alternative 4), which would impact lands purchased under FEMA's Hazard Mitigation Grant Program (HMGP). FEMA has a Memorandum of Agreement with USACE regarding the HMGP and

USACE flood damage reduction projects which states, “The use of lands acquired using HMGP funds is restricted to open space, including those activities designed for ecosystem preservation, restoration, or enhancement.” Therefore, the use of lands along Wilson Avenue that were acquired using HMGP funds might not permit the placement of a levee/floodwall in that location. The PDT had planned to coordinate further with FEMA on this question if the levee/floodwall alternative had been selected as the TSP.

As described in Section 3.2, the P&G criteria of completeness is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. To establish the completeness of a plan, it is helpful to list those factors beyond the control of the planning team that are required to make the plan’s effects (benefits) a reality. For the alternatives including floodproofing and elevation alternatives to be complete, the homeowners must agree to participate (participation is voluntary). If implemented as planned with a reasonable participation rate as determined by the sensitivity analysis, these alternatives are complete and requires no additional action by others to realize the plans’ benefits.

5 FUTURE WITH PROJECT CONDITIONS: COMPARISON OF ENVIRONMENTAL AND CULTURAL EFFECTS OF ALTERNATIVES*

This chapter provides analysis of the future condition of the study area for each of the resources described in Section 2 that could be affected by the No Action Alternative or the final array of alternatives. This environmental review analyzes the environmental effects of the proposed alternatives using a conservative approach that looked at typical designs and considerations for the alternatives. As planning proceeds, USACE and the non-federal sponsor will continue to refine project elements with the intention of further reducing adverse impacts identified in this chapter. If the project is approved and funded, USACE would then do a site-specific analysis during the PED phase to support detailed design construction. This would include appropriate biological and cultural resources site surveys and site-specific engineering. Any refinements to project elements that occur during the PED or the construction phase would be reviewed and compared to what was evaluated in this FR/EA to determine if supplemental NEPA documentation would be required. CEQ regulations specify that supplements are required if: (i) the Corps makes substantial changes in the proposed action that are relevant to environmental concerns; or (ii) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

5.1. TOPOGRAPHY, GEOLOGY, AND SOILS

Alternative 2 – Authorized plan with modifications (DB3 and DB4): The geology characteristics of the land on which University City was built will not be affected by the construction of the basins. Over time, the soils in the basins would likely become hydric in nature because of the persistent flooding. The topography of the land on which the basins would be built would be

slightly modified to allow water to pool in the area, but much of the detention will be accomplished via an earthen embankment, rather than excavation. The channel modifications would slightly alter the topography of the land around the stream to accommodate the changes in channel width. Topography, geology, and soils would not be adversely impacted by Alternative 2.

Alternatives 3a and 3b – Detention Basins: As mentioned above, the soil in the basins would be expected to eventually become hydric in nature. The topography around the basins would change to reflect the earthen embankments. Topography, geology, and soils would not be impacted by Alternative 3a/b.

Alternative 4 – Levee/Floodwall: The floodwall would not alter the underlying geology of the area. The soils under the proposed floodwall would also not be affected or changed. The topography of the area would be slightly altered to build the levee and floodwall structures but would otherwise remain unchanged. Topography, geology, and soils would not be adversely impacted by Alternative 4.

Alternative 5 – Nonstructural – Acquisition: This non-structural alternative would not change existing topography, geology, or soils. No construction would take place that might alter topography or induce changes in soil types. Topography, geology, and soils would not be adversely impacted by Alternative 5.

Alternative 6 – Nonstructural – Floodproofing and Elevation: The topography, geology, and soils characteristics of the land on which University City was built will not be affected by this alternative. It is non-structural in nature, so the overall topography would remain unchanged, even on a small scale. There will be no earthwork or soil disturbance with a non-structural alternative, so the underlying soils would not be altered. Likewise, the underlying geology of St. Louis County would not be affected by a non-structural alternative. Topography, geology, and soils would not be adversely affected by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): This non-structural alternative would not change existing topography, geology, or soils. No construction would take place that might alter topography or induce changes in soil types. Topography, geology, and soils would not be adversely impacted by Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): The non-structural elements of this alternative would not alter existing topography, geology, and soils. DB4 would slightly alter the topography via the earthen embankment and would alter the soil chemistry in the basin. The soils would be expected to become hydric over time. Topography, geology, and soils would not be adversely impacted by Alternative 8.

5.2. LAND USE/LAND COVER

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Construction of the two proposed detention basins would alter existing land use. The existing land cover would remain urban – a mix of residential properties, commercial businesses, and other urban uses. The detention basins would replace a commercial business (DB3) and a recreational park (DB4). The channel modifications would not significantly alter existing land use, as they wouldn't require clearing existing residential, commercial, or public land. Minimal land use/land cover changes would occur with Alternative 2.

Alternatives 3a and 3b – Detention Basins: As with Alternative 2, the construction of the two proposed detention basins would alter existing land use. The detention basins would replace a commercial business and a recreational park. Alternative 3a would require both basins, and, therefore, would see both land use changes. Alterative 3b would require only the change from recreational park to detention basin. The existing land cover would remain urban-a mix of residential properties, commercial businesses, and other urban uses. Minimal land use/land cover changes would occur with Alternative 3a or 3b.

Alternative 4 – Levee/Floodwall: The floodwall would be built on lands acquired by University City. The current land cover is urban and would remain urban after this alternative is built. Some residential property would be acquired to build the floodwall, but no homes would need to be removed. Land use/land cover would be minimally impacted by Alternative 4.

Alternative 5 – Nonstructural – Acquisition: This non-structural alternative would not change existing land use or land cover. Land cover would remain urban in nature. Very localized land use/land cover changes would occur with Alternative 5 since houses would be removed.

Alternative 6 – Nonstructural – Floodproofing and Elevation: While structural alternatives can displace residences and commercial properties, this non-structural alternative would not change current land uses. Existing residences and businesses could remain operational with the flood-proofing measures that are part of the alternative. Land cover in the project area would remain urban. This project would not increase development in the floodplain. Any development that does occur in the floodplain during the period of analysis cannot be incorporated into the benefits calculation for this study. Land use/land cover would not be affected by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Like Alternatives 5 and 6, this non-structural alternative would not change existing land use or land cover. Land cover would remain urban in nature. Land use/land cover would not be impacted by Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): The non-structural elements of this alternative would not alter existing land use or land cover. The construction of DB4 would change the existing land away from public recreation to the basin. Overall land use/land cover would be minimally impacted by Alternative 8.

5.3. CLIMATE

All Alternatives: The general climate in University City and the greater St. Louis metropolitan area would not be affected by any of the proposed structural and non-structural alternatives. No actions taken for these alternatives could be tied to changes in the climate of University City and the surrounding area. Climate would not be affected by any of the alternatives.

5.4. AIR QUALITY

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Construction of the channel modifications and the detention basins would generate temporary, minor impacts to air quality via vehicle and equipment emissions. No permanent adverse impacts to air quality would be expected from these alternatives. Air quality would experience temporary, minor adverse impacts because of Alternative 2.

Alternatives 3a and 3b – Detention Basins: Construction of the two basins would generate emissions, resulting in temporary, minor impacts to air quality. No permanent adverse impacts to air quality are anticipated. Air quality would experience temporary, minor adverse impacts because of Alternatives 3a or 3b.

Alternative 4 – Levee/Floodwall: Construction of the levee and floodwall would generate vehicle and equipment emissions, and, therefore, would result in temporary, minor adverse impacts to air quality. No permanent adverse impacts to air quality are anticipated. Air quality would experience temporary, minor adverse impacts because of Alternative 4.

Alternative 5 – Nonstructural – Acquisition: Acquired structures are either demolished or relocated. The demolition would cause temporary minor adverse impacts to air quality.

Alternative 6 – Nonstructural – Floodproofing and Elevation: The actions proposed in this non-structural alternative would not be expected to impact the surrounding air quality. The floodproofing construction may produce temporary minor adverse impacts to air quality.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Elevation of existing structures would generate minor temporary adverse impacts to air quality.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): The construction of the DB4 may generate temporary, minor adverse impacts from vehicle and equipment emissions. Air quality would experience temporary, minor adverse impacts because of Alternative 8.

5.5. NOISE

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Construction of the channel modifications and the detention basins would generate temporary, minor adverse impacts to noise air quality via vehicle, equipment, and construction disturbance. No permanent adverse impacts to noise would be expected from these alternatives. Noise would be temporarily, minorly adversely impacted by Alternative 2.

Alternatives 3a and 3b – Detention Basins: Construction of the two basins would generate noise, resulting in temporary, minor impacts to noise pollution. No permanent adverse impacts to noise are anticipated. Noise would be temporarily, minorly adversely impacted by Alternative 3a or 3b.

Alternative 4 – Levee/Floodwall: Construction of the levee and floodwall would generate noise via construction disturbance. Noise would be temporarily, minorly impacted by the levee and floodwall construction. No permanent adverse impacts to noise pollution are anticipated. Noise would be temporarily, minorly adversely impacted by Alternative 4.

Alternative 5 – Nonstructural – Acquisition: Noise would be temporarily, minorly impacted by demolition. No permanent adverse impacts to noise pollution are anticipated. Noise would be temporarily, minorly adversely impacted by Alternative 5.

Alternative 6 – Nonstructural – Floodproofing and Elevation: The ambient noise in the 4% AEP (25-year floodplain) where the floodproofing and elevations are targeted would be expected to remain the same as existing conditions after completion of construction-related activities. During construction, noise would be temporarily, minorly adversely impacted by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Noise levels would be expected to remain the same as existing conditions. During construction, noise would temporarily minorly impacted by Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): The construction of the DB4 may generate temporary, minor adverse impacts from vehicle noise and construction disturbances. Noise would be temporarily, minorly adversely impacted by Alternative 8.

5.6. HYDRAULICS AND HYDROLOGY

Alternative 2 – Authorized plan with modifications (DB3 and DB4): The channel modifications would result in changes to downstream hydraulics and hydrology which, in turn, result in downstream flooding if not for the implementation of both detention basins which would mitigate downstream flooding. The detention would alter hydrology by reducing flow during high-water events. In this way, the detention basins would mimic a natural hydrologic process. Hydraulics and hydrology would be minorly benefitted by Alternative 2.

Alternatives 3a and 3b – Detention Basins: The detention basins would alter hydrology by reducing flow during high-water events by detaining water. In this way, the detention basins would mimic a natural hydrologic process. Hydraulics and hydrology would be minorly benefitted by Alternative 3a or 3b.

Alternative 4 – Levee/Floodwall: The levee and floodwall will slightly alter the hydraulics and hydrology by protecting the land on the left descending bank from floods up to a 1% AEP. However, constricting the flow with a levee or floodwall would not be mimicking a natural hydrologic process. Hydraulics and hydrology would be minorly adversely impacted by Alternative 4.
Alternative 5 – Nonstructural – Acquisition: Property acquisitions would not alter the hydraulics or hydrology of the River Des Peres. Hydraulics and hydrology would not be impacted by Alternative 5.

Alternative 6 – Nonstructural – Floodproofing and Elevation: Alternative 6 does not propose to alter the hydraulics or the hydrology of the River Des Peres. Therefore, the hydraulics and hydrology would not be affected by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Building elevations would not alter the hydraulics or hydrology of the River Des Peres. Hydraulics and hydrology would not be impacted by Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): DB4 would slightly alter the hydraulics/hydrology of the River Des Peres by detaining water during high-flow events, mimicking a natural hydrologic process. Hydraulics and hydrology would be minorly benefitted by Alternative 8.

5.7. WATER QUALITY

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Water quality would suffer temporary, minor adverse impacts via sedimentation during construction disturbance. Best management practices (BMPs) would be implemented during construction to reduce or eliminate these sedimentation impacts. The channel modifications would not cause permanent adverse impacts to water quality. The water quality in the stream could experience permanent minor benefits by allowing sediments in the detained water to settle out in the basin instead of being carried downstream. Water quality would be minorly benefitted by Alternative 2.

Alternatives 3a and 3b – Detention Basins: As previously stated, water quality would suffer temporary, minor adverse impacts via sedimentation during construction disturbance. BMPs would be implemented during construction to reduce or eliminate these sedimentation impacts. The water quality could experience permanent minor benefits by allowing sediments in the detained water to settle out in the basin instead of being carried downstream. Water quality would be minorly benefitted by Alternative 3 a or b.

Alternative 4 – Levee/Floodwall: Water quality in the stream would suffer temporary, minor adverse impacts via sedimentation during construction disturbance. BMPs would be implemented during construction to reduce or eliminate these sedimentation concerns. Water quality would be temporarily, minorly adversely impacted by Alternative 4.

Alternative 5 – Nonstructural – Acquisition: Acquisition involves demolition and relocation of structures. These actions can impact water quality, but they would take place above the ordinary high-water mark, therefore it is unlikely these actions would contribute to adverse impacts to water quality. Regardless, best management practices would be implemented to reduce soil erosion and runoff. Water quality would be minorly temporarily adversely impacted.
Alternative 6 – Nonstructural – Floodproofing and Elevation: Floodproofing and elevation involves some amount of construction. These actions can impact water quality, but they would take place above the ordinary high-water mark, therefore it is unlikely these actions would contribute to adverse impacts to water quality. Regardless, best management practices would be implemented to reduce soil erosion and runoff. Water quality would be minorly temporarily adversely impacted.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Elevating structures involves some amount of construction activities. These actions can impact water quality, but they would take place above the ordinary high-water mark, therefore it is unlikely these actions would contribute to adverse impacts to water quality. Regardless, best management practices would be implemented to reduce soil erosion and runoff. Water quality would be minorly temporarily adversely impacted.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): As previously detailed in the Alternative 2 and 3 sections, water quality would suffer temporary, minor adverse impacts via sedimentation during construction disturbance. BMPs would be implemented during construction to reduce or eliminate these sedimentation impacts. The water quality could experience permanent minor benefits by allowing sediments in the detained water to settle out in the basin instead of being carried downstream. Water quality would be minorly benefitted by Alternative 8.

5.8. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

All Alternatives: Hazardous, Toxic, and Radioactive Waste (HTRW) concerns were not identified for the project area in the prior 2005 Phase I or in the preliminary investigation in 2020. A Phase I ESA will need to be conducted prior to project implementation of any alternative. In addition, project measures which include floodproofing, elevation, buyouts, and demolition of houses or buildings would require individual Phase I investigations and lead and asbestos surveys. These investigations/surveys would be conducted on each building, including those located in the footprint of detention basins 3 and 4.

5.9. FISH & WILDLIFE HABITAT

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Fish and wildlife would experience temporary, minor adverse impacts during the channel modifications and during the construction of the basins. Minor adverse impacts would result from noise, equipment, soil disturbance, and sedimentation. No permanent adverse impacts are expected from the channel modifications. Naturalized features may be added upon further refinement of the designs, including native vegetation plantings. In any case, the detention basins would eventually grow some vegetation. The gradual development of hydric soils and the growth of vegetation would provide food and habitat for wildlife. Fish and wildlife would be minorly beneficially impacted by Alternative 2.

Alternatives 3a and 3b – Detention Basins: As previously detailed, Fish and Wildlife would experience temporary, minor impacts during the construction of the basins. The basins could also eventually provide food and habitat for fish and wildlife. Fish and wildlife would be minorly beneficially impacted by Alternative 3a and 3b.

Alternative 4 – Levee/Floodwall: In contrast to the detention basins, there are no natural features that could provide food and habitat. BMPs would be implemented during construction to reduce or eliminate sedimentation during construction. Fish and wildlife would experience temporary, minor adverse impacts during the construction of the levee and floodwall.

Alternative 5 – Nonstructural – Acquisition: Fish and Wildlife would experience temporary, minor impacts during the destruction or relocation of the structures.

Alternative 6 – Nonstructural – Floodproofing and Elevation: Floodproofing and elevations would cause temporary, minor impacts to existing fish and wildlife in the project area during construction. Therefore, fish and wildlife would be temporarily minorly adversely impacted.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Building elevations cause temporary, minor impacts to existing fish and wildlife in the project area during construction. Therefore, fish and wildlife would be temporarily minorly adversely impacted by the elevation.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): As previously detailed in the Alternative 2 and 3 sections, construction would cause temporary, minor adverse impacts to fish and wildlife. BMPs would be implemented during construction to reduce or eliminate these sedimentation concerns. Water quality could experience permanent minor benefits by allowing sediments in the detained water to settle out in the basin instead of being carried downstream. Fish and wildlife would be minorly benefitted by Alternative 8.

Bald Eagles

All alternatives: There are no Bald Eagle nests within the project area. Bald Eagles would not be impacted by any alternative. A more detailed review of Bald Eagle concerns is detailed in Section 2.9: Fish & Wildlife.

Migratory Birds

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Impacts to migratory birds would result from destruction of habitat used during migration and/or breeding attempts. Noise from construction disturbance can also present a temporary, minor adverse impact. The bridge replacements proposed for the channel modifications could result in adverse impacts to birds nesting on the bridges. Tree removal for the detention basins would also result in similar adverse impacts by destroying nests and foraging habitat. However, as the dry detention basins develop, they could be designed to provide food and habitat for migratory birds. Migratory bird concerns would be temporarily, minorly impacted by this alternative.

Alternatives 3a and 3b – Detention Basins: The detention basin construction would require tree removal. However, as previously detailed, the gradual establishment of vegetation in the detention basins could provide some food and habitat for migratory birds. Migratory bird concerns would be temporarily, minorly impacted by this alternative. Further refinements to the basin design, if implemented, would further reduce these adverse impacts.

Alternative 4 – Levee/Floodwall: The levee and floodwall construction would require some tree removal and construction disturbances. The levee and floodwall would not provide food and habitat like the detention basins. The levee and floodwall will not cause permanent adverse impacts, however. The main adverse impacts would take place during construction. Migratory bird concerns would be temporarily, minorly impacted by this alternative.

Alternative 5 – Nonstructural – Acquisition: The non-structural alternatives would not include any actions that could reasonably be shown to harm migratory birds. Migratory bird concerns would not be impacted by acquisition.

Alternative 6 – Nonstructural – Floodproofing and Elevation: The non-structural alternatives would not include any actions that could reasonably be shown to harm migratory birds. Migratory bird concerns would not be impacted by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): The non-structural alternatives would not include any actions that could reasonably be shown to harm migratory birds. Migratory bird concerns would not be impacted by structural elevation.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): As previously stated, the basins can provide food and habitat, if properly designed and maintained. Migratory bird concerns would be temporarily, minorly impacted by Alternative 8.

Threatened & Endangered Species Biological Assessment
Federal Threatened and Endangered Species

All Action Alternatives –

Indiana Bat
The project area is highly urbanized and has marginal habitat available. The riparian corridor in the study area likely has some suitable trees for roosting and may also represent foraging habitat for bats. Some tree-removal would be required for the detention basins and levee/floodwall alternatives. The tree removal would take place between 1 November to 31 March to minimize and avoid bat impacts. The St. Louis District has determined that the proposed actions "*May affect, but are not likely to adversely affect*" Indiana bats.

Northern Long-Eared Bat
The project area is highly urbanized and has marginal habitat available. The riparian corridor in the study area likely has some suitable trees for roosting and may also represent foraging habitat for bats. Some tree-removal would be required for the detention basins and levee/floodwall alternatives. The tree removal would take place between 1 November to 31 March to minimize and avoid bat impacts. However, this species has also been found rarely roost in structures, like barns and sheds, and thus may occupy vacant homes after acquisition, but prior to removal or relocation. Based on these site-specific conditions, the St. Louis District has determined that the proposed actions "*May affect, but are not likely to adversely affect*" *Northern Long-Eared Bats.*

Gray Bat
There are no caves in the study area. Foraging occurs in a variety of common habitats that largely overlap with both the Indiana and Northern Long-eared Bat. Based on these site specific conditions, the St. Louis District has determined that the proposed actions "*May affect, but are not likely to adversely affect*" Gray bats.

Decurrent False Aster
The project area is highly developed and urbanized, but may contain trace and marginal habitat for Decurrent False Aster in scattered areas along the River Des Peres that are not routinely mowed. Additionally, the construction and habitat surrounding the detention basins might provide future suitable habitat for the Decurrent False Aster, which prefers disturbed riparian soils. Based on these site-specific conditions, the St. Louis District has determined that the proposed actions "*May affect, but are not likely to adversely affect*" Decurrent False Aster.

The Service will provide Endangered Species Act Section 7 consultation during the public review period.

State Listed Species
All Action Alternatives –
A Level 2 Natural Heritage Review from MDC was generated on 14 June 2021. Natural Heritage records indicate several Peregrine Falcons (*Falco peregrinus*, state-listed endangered) within 5 miles of the project area. Peregrine Falcons were introduced to downtown buildings in the St. Louis and Kansas City areas in the 1990s, and populations of this state endangered-list species

have been increasing since. They nest between 15 April to 15 July on natural bluffs, building ledges and bridges. Work should be avoided within 1500 feet of nests when nest-building or active nests (eggs or hatchlings) are present. Natural Heritage records indicate the following state-ranked species/natural communities near the project area: Mississippi Kite (*Ictinia mississippiensis*), Alligator Snapping Turtle (*Macrochelys temminckii*), Primrose Willow (*Ludwigia leptocarpa*), and a moss (*Trematodon longicollis*).

Construction of the detention basins may provide some food and habitat if the basins are designed with natural features and maintained over time. In contrast, the tree removal required for the levee, floodwall, and basins would remove food and habitat. The acquisition actions would displace any nesting birds or roosting bats should the buildings be demolished or relocated. Similarly, the floodproofing and elevations would cause some temporary minor adverse impacts. To avoid impacts to state listed species, further coordination with MDC would be carried out as alternatives are selected. MDC would be invited to comment during the public review period.

5.10. INVASIVE SPECIES

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Construction disturbances can result in the spread of invasive species. Invasive species can "hitchhike" on construction equipment and be spread to new areas to colonize. Disturbed bare-soil areas can be readily colonized by some invasive species. Even if bare-soil areas are restored with seeding and watering, these actions can also inadvertently spread seeds and larvae of invasive species. If a suitable commitment to invasive species management is included with future design refinements, invasive species concerns would not be affected by the Alternative 2.

Alternatives 3a and 3b – Detention Basins: As previously detailed, construction disturbances can spread invasive species. The detention basins will have to be monitored for invasive species, and routine removal may be necessary to fully minimize invasive species concerns. Invasive species concerns would be minorly adversely impacted. If a suitable commitment to invasive species management is included with future design refinements, invasive species concerns would not be affected by the basins.

Alternative 4 – Levee/Floodwall: As with the detention basins, the levee and floodwall construction could spread invasive species. In contrast to the detention basins, the levee would need to be routinely mowed and maintained. The levee maintenance would minimize the likelihood of permanent invasive species impacts. Therefore, invasive species concerns would not be impacted by Alternative 4.

Alternative 5 – Nonstructural – Acquisition: If a structure is demolished or moved, the disturbed area may allow for the spread of invasive species, which readily colonize disturbed areas. Acquisition may be minorly adversely impacted by Alternative 5.

Alternative 6 – Nonstructural – Floodproofing and Elevation: Invasive species concerns would not be affected by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Invasive species concerns would not be affected by Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): Invasive species concerns will not be affected by the structure elevations. Invasive species concerns would not be impacted if the basin includes monitoring and maintenance in its design.

5.11. CULTURAL RESOURCES

This project has the potential to adversely affect historic properties within the NRHP Districts and therefore will require continued consultation with SHPO and other consulting parties, including Indian tribes, to develop and evaluate alternatives or modifications to the undertaking that could avoid, minimize, or mitigate adverse effects on historic structures in accordance with 36 CFR Part 800.6 – Resolution of Adverse Effect. A coordination letter was sent to the MO SHPO on 25 May 2021. A response was received 11 June 2021 assigning the SHPO log number of 076-SL-21 to the project. The SHPO will be invited to comment during the public review period. In the unlikely event that earthmoving activities associated with the proposed repairs did impact potentially significant archeological/historic remains, all construction activities and earthmoving actions in the immediate vicinity of the remains would be held in abeyance until the potential significance of the remains could be determined. The precise nature of such investigations would be developed by the USACE Saint Louis District in concert with the professional staff of the Missouri State Historic Preservation Office.

Alternative 2 – Authorized plan with modifications (DB3 and DB4): The structural alternatives would prevent many of the future flood events. The basins would increase protection from a 50% AEP to a 10% AEP. There are no historic properties that would need to be removed to construct the basins. Protection would be further increased with the proposed channel modifications. The alternative would result in decreased damages to any historical properties in the project area. Cultural resources would be benefitted by this alternative because it reduces flood risk to existing cultural resources.

Alternatives 3a and 3b – Detention Basins: The structural alternatives would prevent many of the future flood events, as previously detailed. Even without channel modification, the basins would increase protection from a 50% AEP to a 10% AEP level of risk reduction. There are no historic properties that would need to be removed to construct the basins. This would decrease damages to any historical properties in the project area. Cultural resources would be benefitted by this alternative because it reduces flood risk to existing cultural resources.

Alternative 4 – Levee/Floodwall: The structural alternatives would prevent many of the future flood events. The levee and floodwall combination would increase protection along the left descending bank to a 1% AEP level of risk reduction. This would decrease damages to any

historical properties on the landside of the. Cultural resources would be benefitted by this alternative.

Alternative 5 – Nonstructural – Acquisition: In the FWOP condition, continued flooding in the area would result in further damages to the existing historic properties in the project area. Included in the 500 structures are 100 homes within the University Heights Subdivision No. 1 National Historic District (out of 258 houses in the district). According to the National Register Form, among these 100 homes there are 2 State Significant Homes, 6 locally significant homes, 56 homes considered "Essential to the Fabric of the Neighborhood", and 36 that are considered to have no special significance. Under Alternative 5, the 100 homes in the District would be demolished. Historic Structures would be adversely affected by this alternative.

Alternative 6 – Nonstructural – Floodproofing and Elevation: The same 100 homes in the University Heights Subdivision No. 1 National Historic District impacted by Alternative 5 would also be impacted by Alternative 6, although to a lesser extent; floodproofing and elevation would allow the structures to remain in place and alter only some features. Floodproofing and elevation would protect historic structures from future flood damage, but would require alterations, which would result in an adverse impact.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Elevation would allow the structures to remain in place and alter only some features. Elevation would prevent future flood damages through alteration of the historic structure. The Historic Structures would be altered, which would result in an adverse impact from Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): Elevation would allow the structures to remain in place and alter only some features. There are no historic properties that would need to be removed to construct the basin. The basins would reduce flood-risk to existing historic structures, which would be a beneficial impact. In contrast, the elevations would propose to alter the historic structures, which would result in an adverse impact.

5.12. TRIBAL RESOURCES

All Alternatives – A coordination letter was sent to 23 Tribal interest groups seeking comment on 15 June 2021. Tribal interest groups would also be invited to comment during the public review period. An archival review indicates that there are no previously recorded archeological sites within the footprint of any of the alternatives. Tribal Resources are not expected to be adversely impacted by any of the alternatives. Any comments provided by Tribes during the public review period will be considered for the final report. In the unlikely event that earthmoving activities associated with the proposed repairs did impact potentially Tribally significant archeological/historic remains, all construction activities, and earthmoving actions in the immediate vicinity of the remains would be held in abeyance until the potential significance of the remains could be determined. The precise nature of such investigations would be developed by the Saint Louis District in concert with the affected Tribal entity.

5.13. RECREATIONAL & AESTHETIC RESOURCES

Alternative 2 – Authorized plan with modifications (DB3 and DB4): The structural alternatives would include construction disturbance, which would result in temporary, minor adverse impacts. The detention basin design could be further refined to include recreational features such as bike and walking paths. Their design could also be refined to include native vegetation plantings, a high ratio of vegetation to bare earth, and include regular maintenance of the vegetation, which would provide a more aesthetically pleasing space. DB4 would completely replace an existing public park: The City of Overland's Woodson Road Park. This would result in a permanent, adverse impact to recreation. In contrast, DB3 would convert a commercial area to a basin, which would increase recreational opportunities should design refinements include them. These refinements would reduce and balance adverse impacts to recreation and aesthetics. Recreation alternative R-2 is included with this alternative. It consists of 1.85 miles of trail plus one small park area located near Mona Drive adjacent to the right streambank in the vicinity of river miles 2.0 to 2.1.

Alternatives 3a and 3b – Detention Basins: Balancing the loss of the Woodson Road Park with the implementation of detention basin recreational and aesthetic features and the construction of Recreation Alternative R-2 would mean minimal overall effect on recreation and aesthetics.

Alternative 4 – Levee/Floodwall: Unlike the detention basins, adding recreational features to the levee and floodwall would not be possible due to limited space. However, the Woodson Road Park would also remain undisturbed. Some might find the floodwall and/or levee to be aesthetically unpleasing. Therefore, aesthetics and recreation would be minimally affected by the levee/floodwall alternative.

Alternative 5 – Nonstructural – Acquisition: This alternative would add green space and recreational features such as trails which would improve aesthetics on the acquired property by the river. Therefore, recreation and aesthetics would be benefitted by this alternative.

Alternative 6 – Nonstructural – Floodproofing and Elevation: Buildings in the 25-year floodplain would remain in place and be protected from future flood damages. This may result in fewer buildings eventually becoming condemned after flood damages. While aesthetics are subjective, fewer condemned buildings may be more aesthetically pleasing. Therefore, the aesthetics of the study area would experience minor beneficial impacts resulting from the TSP. Recreation opportunities in the project area would not be affected by the TSP.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): As with Alternative 5, this alternative does not propose to add any recreational features or improvements to aesthetics. Therefore, recreation and aesthetics would not be impacted by the elevation-only alternative.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): As with Alternative 7, the elevations would not impact recreation or aesthetics. Detention Basin 4 would, as previously detailed, completely remove and replace Woodson Road Park. This impact could be offset by recreational and aesthetic features in the basin. Recreation and aesthetics would be minimally affected by the combination plan.

5.14. ECONOMIC CONDITIONS

A detailed analysis of the existing economic conditions in the study area can be found in Section 2.13: Economic Conditions. The expected annual benefits attributable to the project alternatives were measured by subtracting the total equivalent annual damages for proposed alternatives from the total equivalent annual damages without project conditions. The net benefits for the alternatives were calculated by subtracting the annual costs from the equivalent annual benefits. Alternatives 2, 3a, 3b, 6, and 8 possess a BCR greater than 1.0 and have positive annual net benefits.

Alternative 2 – Authorized plan with modifications (DB3 and DB4): This plan would have a total cost of $58,547,000, net annual benefits of $20,000, and a benefit to cost ratio (BCR) of 1.01.

Alternatives 3a and 3b – Detention Basins: This plan would have a total cost of $43,330,000, net annual benefits of $724,000, and a BCR of 1.33.

Alternative 4 – Levee/Floodwall: This plan would have a total cost of $84,589,000, net annual benefits of $1,096,000, and a BCR of 0.73.

Alternative 5 – Nonstructural – Acquisition: This plan would have a total cost of $222,591,000, net annual benefits of $2,754,000, and a BCR of 0.66.

Alternative 6 – Nonstructural – Floodproofing and Elevation: This plan would have a total cost of $68,836,000, net annual benefits of $1,675,000 and a BCR of 1.67. Alternative 6 was identified as the NED Plan. The floodproofing provided would reduce flood damages in the affected area. The NED Plan represents the best method to reduce overall economic damages resulting from the floods. Therefore, the economic conditions in the study area would be benefitted by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): This plan would have a total cost of $26,498,000, net annual benefits of $204,000, and a BCR of 0.79.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): This plan would have a total cost of $25,650,000, net annual benefits of $1,030,000, and a BCR of 1.84.

5.15. SOCIO-ECONOMICS & DEMOGRAPHICS

All Alternatives: None of the proposed alternatives would result in a significant adverse impact to a minority or low-income population. These structural and non-structural alternatives would all benefit those living in the study area by reducing economic damages from future flood events. The socioeconomics and demographics would be minorly benefitted by the TSP.

5.16. POPULATION AT RISK AND CRITICAL INFRASTRUCTURE

Alternative 2 – Authorized plan with modifications (DB3 and DB4): All alternatives would include a flood forecasting and warning system and would reduce flood risk. The fire station adjacent to the River Des Peres that is currently impacted by the 1% AEP event would become not at all impacted under Alternative 2 due to the altered flood condition. The population-at-risk (PAR) and critical infrastructure would be benefitted by Alternative 2.

Alternatives 3a and 3b – Detention Basins: This alternative includes a flood forecasting and warning system and would reduce flood risk. The fire station would become not at all impacted under Alternative 3a, and less impacted (partially improved) under Alternative 3b due to the altered flood conditions. The PAR and critical infrastructure would be benefitted by Alternatives 3a and 3b.

Alternative 4 – Levee/Floodwall: This alternative includes a flood forecasting and warning system and would reduce flood risk. The fire station would become not at all impacted under Alternative 4 due to the altered flood condition. The PAR and critical infrastructure would be benefitted by Alternative 4.

Alternative 5 – Nonstructural – Acquisition: The properties proposed for acquisition within the 4% AEP area (25-year floodplain) do not include any critical infrastructure. Population-at-risk living in residential properties that are acquired would be protected by not being in the high flood-risk areas. This alternative includes a flood forecasting and warning system and would reduce flood risk. The fire station would remain impacted by the 1% AEP event under Alternative 5. The PAR and critical infrastructure would be benefitted by Alternative 5.

Alternative 6 – Nonstructural – Floodproofing and Elevation: Floodproofing and elevating structures would improve life safety for those sheltering in place and the PAR. This alternative includes a flood forecasting and warning system and would reduce flood risk. The fire station would remain impacted by the 1% AEP event under Alternative 6. The PAR and critical infrastructure would be benefitted by Alternative 6.

Alternative 7 – Nonstructural Plan – Elevation only (refinement of Alternative 6): Elevating structures would improve life safety for those sheltering in place and the PAR. This alternative includes a flood forecasting and warning system and would reduce flood risk. The fire station

would remain impacted by the 1% AEP event under Alternative 7. The PAR and critical infrastructure would be benefitted by Alternative 7.

Alternative 8 – Combination Plan – DB4 and Elevation (refinement of Alternative 6): The detention basin and structure elevations would reduce flood risk. Elevating structures would improve life safety risk for those sheltering in-place and the PAR. The fire station would likely become less impacted (partially improved) under Alternative 8 due to the altered flood conditions, although this has not yet been modeled. The PAR and critical infrastructure would be benefitted by Alternative 8.

5.17. CUMULATIVE IMPACTS ANALYSIS

NEPA requires a federal agency to consider not only the direct and indirect impacts of a proposed action but also the cumulative impacts of the action. Cumulative impacts are defined as those impacts that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes the actions. Representative past, present, and future regional projects were utilized in the cumulative impact analysis.

Cumulative impacts result from the proposed action when added to other past, present, and reasonably foreseeable projects or actions. Cumulative impacts are not caused by a single project but include the effects of a particular project in conjunction with other projects (past, present, and future) on the resource. Cumulative effects are studied to enable the public, decisionmakers and project proponents to consider the "big picture" effects of a given project on the community and the environment. In a broad sense, all impacts on affected resources are probably cumulative; however, the role of the analyst is to narrow the focus of the cumulative impacts analysis to important issues of national, regional and local significance (CEQ, 1997).

Step 1: Identify Potentially Affected Resources

In this step, each resource affected by the action alternatives are identified. Resources were not assessed for cumulative impacts if the analysis in the Affected Environment and Environmental Impacts Chapter determined there would be no impact to that resource from the action alternatives. Urban development in University City adjacent to the River Des Peres is the primary cumulative impact that would affect resources in the area. The structural solutions would contribute to cumulative impact because they propose to alter existing land use and land cover through the installation of detention basins, floodwalls, and levees. The non-structural resources would still generate cumulative impacts from construction disturbance. The neighborhoods where buildings are acquired and demolished/moved will be altered from existing conditions. Many smaller development projects, such as those outlined in the nine action alternatives, can contribute to cumulative impacts.

The River Des Peres is highly modified from its original natural state. Detention basins, floodwalls, and levees would further impact the hydraulics and hydrology of the River Des Peres by constricting the water and speeding up its flow rate. Urban development also increases the

area of impermeable surfaces. Impermeable surfaces generate excessive stormwater runoff. This runoff gathers sediment and pollutants before draining into the River Des Peres at temperatures which are unnaturally high compared to the waters in the river. These changes can impact water quality, aquatic habitat, and fish & wildlife using the river. Continuing urban development means increases in temporary noise and air pollution and more chance for invasive species to spread in areas of soil disturbance. Increases in impermeable surfaces equates to increases water runoff that would eventually drain into the River Des Peres, contributing to a cumulative impact to flood risk. A lack of stormwater management solutions in a growing University City, combined with a highly channelized/modified River Des Peres has likely contributed to the flood-risk problem in University City.

Step 2: Establish Boundaries (Geographic and Temporal)

In identifying past, present, and reasonably foreseeable actions to consider in the cumulative impact analysis, affected resource-specific spatial and temporal boundaries were identified. The spatial boundary is where impacts to the affected resource could occur from the action alternatives and therefore where past, present, and reasonably foreseeable future actions could contribute to cumulative impacts to the affected resource. This boundary is defined by the affected resource and may be a different size than project area.

The temporal boundary describes how far into the past and forward into the future actions should be considered in the impact analysis. The temporal boundary is guided by CEQ guidance on considering past action and a rule of reason for identifying future actions.
For each resource topic, the geographic and temporal boundaries were identified. For all resource topics, the consideration of past actions is reflected in the existing condition. A default future temporal boundary of 50 years from the baseline condition was used as an initial timeframe; however, the impacts are based on their likelihood of occurring and whether they can be reasonably predicted.

Step 3: Identify the Cumulative Action Scenario

In this step, past, present, and reasonably foreseeable future actions to be included in the impact analysis for each specific affected resource were identified. These actions fall within the spatial and temporal boundaries established in Step 2.

Step 4: Analyze Cumulative Impacts

For each resource, the actions identified in Step 3 are analyzed in combination with the impacts of the action alternatives being evaluated. This analysis describes the overall cumulative impact related to each resource and the contribution to this cumulative impact of each alternative being evaluated. None of the alternatives were determined to significantly adversely impact the resources discussed. Cumulative impacts to the various resources are summarized in Table 14.

Table 14. Cumulative Environmental Impact Assessment Matrix

No Action Alternative Future Effects Compared to Existing Conditions (Effects of Nature)							Symbols: X = Long-Term Effect T = Temporary Effect C = Cumulative Impact	**Proposed Alternatives, Effects of Action Alternatives to No Action Effects (Effects of Project)**						
BENEFICIAL				ADVERSE				BENEFICIAL				ADVERSE		
SIGNIFICANT	SUBSTANTIAL	MINOR	NO EFFECT	MINOR	SUBSTANTIAL	SIGNIFICANT	PARAMETER	SIGNIFICANT	SUBSTANTIAL	MINOR	NO EFFECT	MINOR	SUBSTANTIAL	SIGNIFICANT
							A. Natural Resources Effects							
			X				Topography, Geology, & Soils				X			
				X			Land Use/Land Cover			X				
			X				Climate				X			
			X				Air Quality				X			
			X				Noise				X			
					X		Hydraulics & Hydrology			X				
		C					Water Quality			C				
			X				Hazardous Waste				X			
			X				Fish & Wildlife				X			
			X				Threatened & Endangered Species				X			
			X				Terrestrial Habitat				X			
			X				Aquatic Habitat				X			
			X				Migratory Birds				X			
			X				Invasive Species				X			
							B. Social Effects							
				C			Recreation & Aesthetics		C					
					C		Economic Conditions		C					
					C		Socioeconomics & Demographics		C					
					C		Population at Risk & Critical Infrastructure		C					
							D. Cultural Resource Effects							
			X				Historic Properties				X			
			X				Tribal Interests				X			

6 TENTATIVELY SELECTED PLAN

6.1. DESCRIPTION

The Tentatively Selected Plan is Alternative 6, which consists of floodproofing and elevation of approximately 500 structures with flood damage in the 4% AEP (25-year floodplain) (Figure 28). Many of these structures would be floodproofed, and approximately 7 structures would be elevated (Table 15). Dry floodproofing, as opposed to wet floodproofing, was used in the analysis. The structures to be elevated would be raised to the 1% AEP event (100-year) level of risk reduction.

Table 14. Summary of the Nonstructural Features of the TSP

TSP Nonstructural Measure	Number of structures
Floodproofing (Commercial)	64
Floodproofing (Residential)	449
Elevation (Residential)	7
Total	520

It should be noted that the TSP is subject to refinement in the next phase of the GRR study. The number of structures included, the types of nonstructural measures applied to the structures included, and the benefits and costs of the TSP will change based on updated analysis. For example, wet floodproofing may be included in place of dry floodproofing for residential structures. Additionally, one or more detention basins will be assessed for inclusion. If the current TSP or refined TSP are not acceptable to the Sponsor, a Locally Preferred Plan (LPP) may be requested (see Section 6.17).

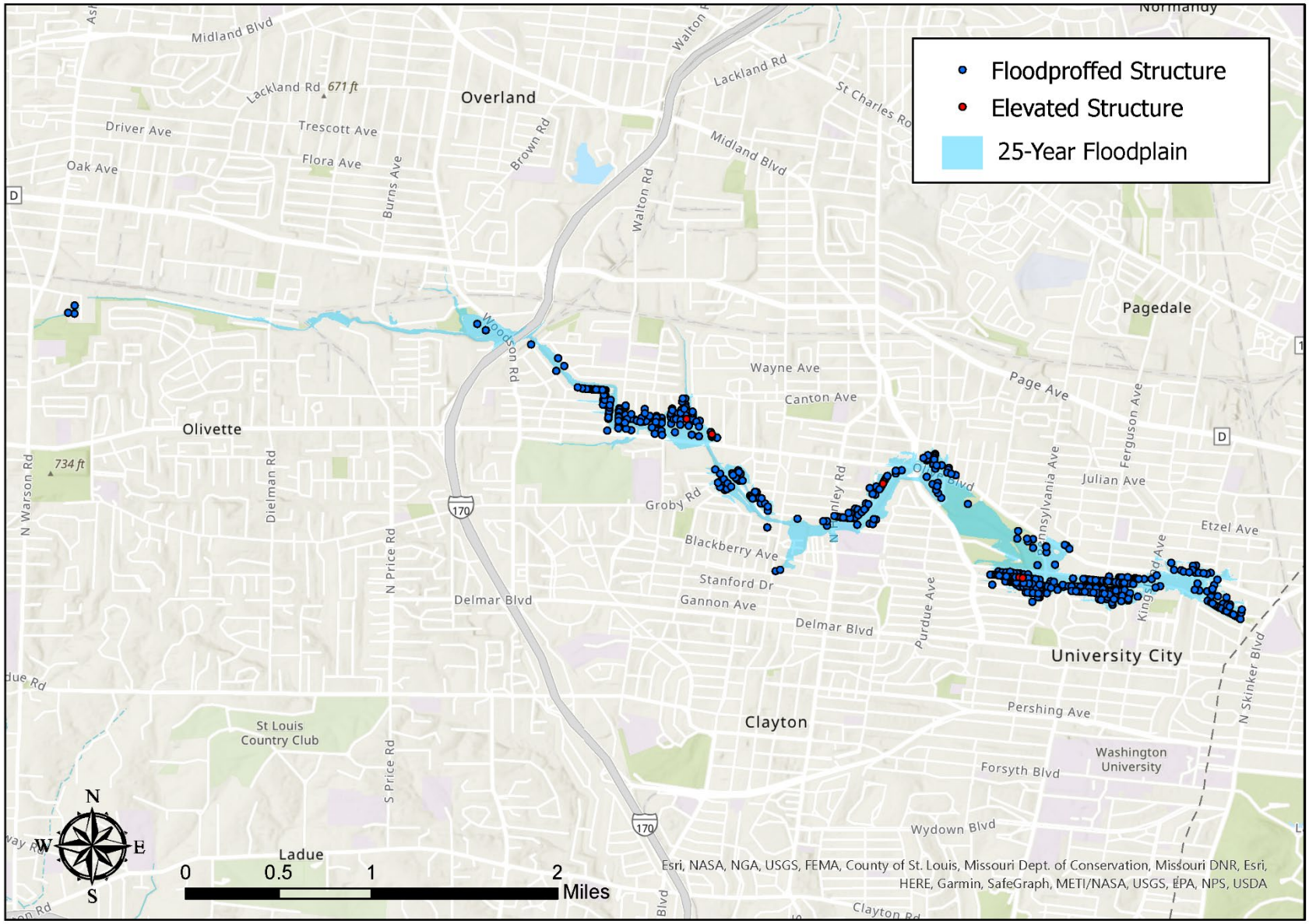

Figure 28. Tentatively Selected Plan (TSP): Alternative 6 – Nonstructural – Floodproofing and Elevation

6.2. PURPOSES, SCOPE, AND SCALE

The Tentatively Selected Plan (TSP) is Alternative 6, as described in Section 5. The purpose of the plan is to reduce the risk to life safety and economic damages from flooding of the upper River des Peres. The scope of the plan includes nonstructural measures including floodproofing and elevation as applied to approximately 500 structures with flood damage during the 4% AEP (25-year) event (Figure 28). The scale of the plan is the extent of the 4% AEP area (25-year floodplain). These nonstructural measures would not create any incremental risk or change the flood characteristics. The scope and scale of the TSP are likely to be refined as the structure inventory provides more detail on structure features and conditions, aggregation of structure groupings, and specific types of nonstructural features applied. Another additional refinement may be the addition of a detention basin, similar to Alternative 8.

If implemented, the TSP will reduce the flood damage of structures impacted by the 4% AEP (25-year) event, to the 1% AEP (100-year) event. The residents and owners of these structures will in most cases have reduced flood insurance premiums. For elevated structures, the flood insurance premiums will likely be eliminated.

6.3. PLAN COMPONENTS, INCLUDING MITIGATION

Dry floodproofing consists of waterproofing the structure to make it watertight below the level of floodwater. It can be applied to residential homes and commercial and industrial structures.

Elevation is the lifting of an existing structure to an elevation which is at least equal to or greater than the 1% annual chance flood elevation.

The TSP would not impact any environmental features, and as such would not require any environmental mitigation. The TSP would impact approximately 100 historic properties within the University City Subdivision Number One; mitigation requirements for these impacts are yet to be determined at the time of writing. These structures would remain in place; floodproofing and elevation would be implemented in a manner consistent with their historic features as much as possible.

6.4. COSTS

The total project first cost (at FY2021 price levels) of the Tentatively Selected Plan is $68,837,000 (Table 16). More information on project costs can be found in Appendix I.

Table 1615. Total Project Cost and Total Benefit-to-Cost Ratio of the TSP

Item	**Project First Cost (FY21 price level)**
Lands and Damages	$ -
Nonstructural	$ 43,023,000
Fish and Wildlife Activities	$ -
Contingency	$ 15,058,000
Planning, Engineering and Design*	$ 6,023,000
Construction Management	$ 4,733,000
Project First Cost Estimate	$ 68,837,000

*Includes $78,500 for Real Estate personnel to create Nonstandard Estate for nonstructural measures (see Appendix E)

6.5. BENEFITS

The total and net annual benefits are shown alongside the total and annualized costs for the TSP in Table 17.

Table17. Equivalent Annual Benefits and Costs of the TSP
FY2021 Price Level; 50-year Period of analysis, 2.5% Discount Rate

Total Project Costs		
First Cost	$	68,837,000
Interest During Construction	$	1,726,000
Total Investment Cost	$	70,563,000
Estimated Annual Costs		
Annualized Project Costs	$	2,488,000
Annual OMRR&R*	$	-
Total Annual Costs	$	2,488,000
Average Annual Benefits		
Total Annual Benefits	$	4,163,000
Net Annual Benefits	$	1,675,000
Benefit to Cost Ratio		1.67

*OMRR&R: Operations, Maintenance, Repair, Replacement, and Rehabilitation

6.6. DESIGN AND CONSTRUCTION CONSIDERATIONS

At this point in the study, structural engineers have not yet been engaged on the design risks and assumptions for the nonstructural options. This will be done in the next phase of the study. The following design and construction considerations are assumed.

Dry Floodproofing
Based on laboratory tests, a "conventional" built structure can generally be dry floodproofed up to 3 feet. Structural analysis of the strength of the walls would be required if a higher level of protection is desired. Making the structure watertight requires sealing the walls with waterproof coatings, impermeable membranes, or a supplemental layer of masonry or concrete. A sump pump and/or French drain system should also be installed as part of the measure. Closure panels are used at openings such as windows and doors. Dry floodproofing is not recommended for basements or crawlspaces due to excessive costs of reinforcing the exterior walls, preventing seepage, and the possibility of making the whole structure buoyant. Excessive velocities can damage the floodproofing materials, and unless a passive system is incorporated into the design, there may not be adequate time to install closures during a flash flood event. Dry floodproofing achieves flood risk reduction but is not recognized by the NFIP for any flood insurance premium rate reduction if applied to a residential structure, whereas a commercial structure may achieve

insurance premium reduction if dry floodproofed to at least 1 foot above the base flood elevation (BFE) in compliance with the NFIP (FEMA, 1993).

Elevation of Structures

The final elevation should place the first floor and associated ductwork, plumbing, mechanical and electrical systems above the design water surface elevation. Elevation can be performed using fill material, on extended foundation walls, on piers, post, piles and columns. Elevation is also a very successful measure for reinforced slab on grade structures. It is possible that the structure being assessed has an existing crawlspace or basement which would require abandoning to reduce future flood damages and to implement the structural supports for the elevation. Abandonment would consist of filling in the existing basement or crawlspace with clean run fill material and possibly capping with concrete. If the basement or crawlspace is abandoned, a small addition to the structure may need to be constructed on the side of the structure above the projected water surface elevation to contain utilities and mechanical equipment. If the addition could not be implemented because of limited space within the parcel or because the owner did not want it, partial compensation for the lost space would be due to the owner.

Whether a structure may be elevated depends on several factors including the foundation type, wall type, size of structure, and condition. Elevation of a structure most commonly applies to smaller residential and commercial buildings. Residential and commercial property owners can get reduced flood insurance premiums under the NFIP if the first floor of their structure is at or above the Base Flood Elevation (BFE) (or higher if specified by local regulations) after elevation occurs. University City has a freeboard requirement of 2 feet.

Further Considerations

As noted in Section 6.1, wet floodproofing or other nonstructural measures, or detention basins may be included in a refinement to the TSP. These measures have their own design and construction considerations that will be included in the final version of this report as needed.

6.7. REAL ESTATE REQUIREMENTS AND LERRD CONSIDERATIONS

The total Lands, Easements, and Rights-of-Way (LER) required for the TSP are the Non-Standard Estate Interests of approximately 513 structures for dry floodproofing (the majority of which are privately owned), and approximately 7 structures for elevation (privately owned). If detention basins, a structural measure, are included in the Recommended Plan, the non-Federal sponsor will be required to provide the lands, easements, rights-of-way, relocations (except existing railroad bridges and approaches thereto) and suitable borrow and dredged material disposal areas (referred to as LERRDs) to support the plan. Appendix E – Real Estate has more information.

6.8. OPERATION AND MAINTENANCE CONSIDERATIONS

Generally, nonstructural measures are sustainable over the long term with minimal costs for operation, maintenance, repair, rehabilitation, and replacement. The estimated annual OMRR&R costs for the TSP are currently estimated at $0, though this may be refined. OMRR&R is a non-Federal sponsor responsibility. If a detention basin is added to the TSP, it will have additional O&M considerations. Further details on O&M considerations will be developed in the next phase of the study.

The TSP complies with all applicable Federal environmental laws, statutes, and executive orders (EOs) (Table 18). Appendix F includes more information on environmental compliance activities, including relevant correspondence and supporting documentation.

Table 1816**.** Compliance of the TSP with environmental requirements, acts, and/or executive orders.

Environmental Requirement	Compliance*
Bald Eagle Protection Act, 42 USC 4151-4157	FC
Clean Air Act, 42 USC 7401-7542	FC
Clean Water Act, 33 USC 1251-1375	FC
Comprehensive Environmental Response, Compensation, and Liability Act, (HTRW) 42 USC 9601-9675	FC
Endangered Species Act, 16 USC 1531-1543	PC[1]
Farmland Protection Policy Act, 7 (Prime Farmland) USC 4201-4208	FC
Fish and Wildlife Coordination Act, 16 USC 661-666c	PC[1]
Food Security Act of 1985 (Swampbuster), 7 USC varies	FC
Land and Water Conservation Fund Act, (Recreation)16 USC 460d-4601	FC
National Environmental Policy Act of 1969, 42 USC 4321-4347	PC[2]
National Historic Preservation Act, 16 USC 470 et seq.	PC[1]
Noise Control Act of 1972, 42 USC 4901-4918	FC
Resource, Conservation, and Rehabilitation Act, (Solid Waste) 42 USC 6901-6987	FC
Rivers and Harbors Appropriation Act, (Sec. 10) 33 USC 401-413	FC
Water Resources Development Acts of 1986 and 1990 (Sec 906 – Mitigation; Sec 307 - No Net Loss - Wetlands)	FC
Floodplain Management (EO 11988 as amended by EO 12148)	FC
Federal Compliance with Pollution Control Standards (EO 12088)	FC
Protection and Enhancement of Environmental Quality (EIS Preparation) (EO 11991)	FC
Protection and Enhancement of the Cultural Environment (Register Nomination) (EO 11593)	FC
Protection of Wetlands (EO 11990 as amended by EO 12608)	FC

*FC = Full Compliance, PC[1] = Partial Compliance (on-going, will be accomplished prior to construction), PC[2] full compliance will be achieved upon signing of the NEPA document.

6.9. MEETING ENVIRONMENTAL OPERATING PRINCIPLES

Consistent with the National Environmental Policy Act (NEPA), USACE formalized its commitment to the environment by creating a set of "Environmental Operating Principles" applicable to all its decision making and programs (Box 1). These principles ensure environmental conservation and restoration are considered in all USACE activities.

Box 1. The USACE Environmental Operating Principles

1. Foster Sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all Corps activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

6.10. LESSONS LEARNED DURING HURRICANES KATRINA AND RITA

The TSP is consistent with each of the Chief of Engineers' Actions for Change for Applying Lessons Learned during Hurricanes Katrina and Rita issued 24 August 2006. The twelve actions are grouped into four themes.

Actions in the first theme, Comprehensive Systems Approach, include: employing integrated, comprehensive systems-based approach; employing adaptive planning and engineering systems; and focusing on sustainability. The USACE study team used a comprehensive systems approach through collaborative relationships with the Non-Federal Sponsor as well as MSD, NGO's, and interested stakeholders.

Actions in the second theme, Risk Informed Decision Making, include: employing risk-based concepts in planning, design, construction, operations, and major maintenance; and reviewing and inspecting completed works. The TSP was selected using a risk-informed decision-making process in general. The alternatives were evaluated regarding risk to minimize uncertainty within the scope of the study, including updated H&H modeling based on high water mark data provided by the Non-Federal Sponsor.

Actions in the third theme, Communication of Risk to the Public, include: effectively communicating risk; and establishing public involvement risk reduction strategies. The report establishes the current condition of the Upper River Des Peres including flood risk. The USACE

study team worked closely with the City and the Commission on Storm Water Issues to set up public meetings and outreach materials to help the public understand their flood risk.

Actions in the fourth theme, Professional and Technical Expertise, include: continuously reassessing and updating policy for program development, planning guidance, design and construction standards; dynamic independent reviews; assessing and modifying organizational behavior; managing and enhancing technical expertise and professionalism; and investing in research. The report was continuously reassessed during its development. The analysis has undergone DQC (District Quality Control) and ATR (Agency Technical Review), legal, public and policy reviews, as well as review by the Sponsor. Technical experts were used throughout the life of the study.

6.11. USACE CAMPAIGN PLAN

The USACE Campaign Plan provides goals, objectives, and actions for improving the USACE contribution to the nation in the areas of warfighting, civil works processes and delivery systems, risk reduction from natural events, and preparation for the future. The four primary goals are to 1) Support National Security, 2) Deliver Integrated Water Resource Solutions, 3) Reduce Disaster Risks, and 4) Prepare for Tomorrow. The University City Branch, River Des Peres, Missouri GRR supports the Campaign Plan with contributions to Goal 2, "Deliver Integrated Water Resource Solutions." The project does not make significant contributions to the other three goals.

Goal 2 (Deliver Integrated Water Resource Solutions) includes the following objectives: 2a - Deliver quality water resource solutions and services; 2b - Deliver the civil works program and innovative solutions; 2c - Develop the civil works program to meet the future needs of the Nation; and 2d - Manage the life cycle of water resources infrastructure systems to consistently deliver reliable and sustainable performance. This study supports Goal 2 by:

- Identification a plan to reduce flood risk in the Upper River Des Peres;
- Coordination with significant stakeholder groups throughout the study process; and
- Recommendation of a sustainable and resilient plan, with appropriate consideration of the long-term operation and maintenance of the plan features.

6.12. PLAN ACCOMPLISHMENTS

The TSP reduces economic impacts from flooding, has benefits for structures impacted with flooding from 4% AEP (25-year) events or smaller, and will not increase residual risk from the existing condition. Because it is a nonstructural solution that does not change flood characteristics, it will not reduce flood risk to structures impacted by floods larger than the 4% AEP (25-year) event.6.14. Risk and Uncertainty

The study team has used a risk-based strategy in its approach to formulating and evaluating alternatives. Key risks, uncertainties, or assumptions for the study are listed below along with risk management strategies.

Participation in Voluntary Nonstructural Measures
Low number of homeowners signing up for nonstructural measures like floodproofing and elevation is a risk for implementation of the TSP, because participation in these measures is voluntary. Homeowners' reluctance to implement floodproofing may result from not wanting to lose basements, and/or the possibility that their FEMA flood insurance premium would not be reduced. The consequence of low participation would be that the flood risk to these structures remains the same or worsens, and the expected benefits are much lower, which would change the NED plan. To manage this risk, the study team will: (1) conduct a sensitivity analysis on the participation rate to see how much the level of participation would change the annual net benefits, (2) use the results of the upcoming University City Floodproofing and Elevation Survey to inform the participation rate used in analysis.

Participation from City of Overland
The City of Overland would need to participate in approving DB4 if it is included in the recommended plan. Coordination is currently underway and is not finalized.

Impacts to Historic Properties
Multiple National Historic Register District properties are affected by the TSP. For affected properties, potential mitigation would be required and delays to the study may occur. To manage this risk, the study team has initiated early consultation with the SHPO (see Appendix F). If further coordination with the SHPO leads to a determination that impacts are unavoidable, time and cost will be added to the schedule to account for this coordination and mitigation.

Uncertainty in Hydrology and Hydraulic (H&H) Modeling
The H&H modeling for the study area was created from channel geometry provided by Wood Engineering and calibrated using stream gage data and high-water mark data (see Appendix A – Hydrology and Hydraulics). A model is a representation of reality, and there are always assumptions that must be made to provide inputs to the model. One such assumption is the degree of backwater from the Tubes; the risk is that the level used in the model may be over- or underestimated. If the amount of backwater is less than the conservative estimate used in the modeling, fewer structures are inundated, and the estimated benefits would decrease. To manage this risk, the study team conducted sensitivity analysis for a range of backwater impacts to determine the values to use. A second risk is that the data used to calibrate and verify the modeling is not sufficient for the purposes of this study. To manage the risk, the study team coordinated with the University City Commission on Storm Water Issues to incorporate high water mark data collected by Commission members using records from the 2008 flood. The study team also conducted quality control reviews on the modeling through District Quality Control and Agency Technical Review processes to ensure the modeling is sufficient for USACE standards.

Economics and Structure Assessment
Two risks in the economics analysis are that the first-floor elevations for structures in the study area may be over- or under-estimated, and that structures may be over- or undervalued. The

consequence of these risks is that damage calculations may be over- or underestimated, leading to a false justification/non-justification of alternatives. To manage the risks, the study team will appraise the structures and survey first floor elevations.

Uncertainty Associated with Significant Cost Features
Material and delivery costs are difficult to estimate early (i.e., during the feasibility phase), especially if materials are not available locally. The estimates for the quantities and costs of construction materials are based on designs developed to a low level of detail for comparison the exact types, quantities, and sources of construction materials have not yet been determined. To manage this risk, the study team referenced other USACE studies from the St. Louis region to create parametric costs for materials, and captured cost risks in the cost and schedule risk analysis so that the cost estimate includes a contingency associated with this risk. The study team will continue to monitor material cost and availability during PED and construction.

6.13. SPONSOR SUPPORT

University City has no objection to the TSP. The City and Commission would like to continue to coordinate on refinements to the TSP to decide whether to pursue a Locally Preferred Plan (LPP) (see following section).

6.14. POSSIBILITY OF A LOCALLY PREFERRED PLAN (LPP)

If the NED Plan or a justifiable departure from the NED Plan is not acceptable to the Sponsor, a Locally Preferred Plan (LPP) may be considered for Federal participation. It is possible that University City would not support the NED Plan and would prefer an LPP instead. Based on communication prior to the time of writing of this draft report, the LPP would likely include one or both detention basins and fewer structures with nonstructural solutions. The likely LPP would therefore be less costly and smaller in scope than the NED Plan, while still providing high-priority outputs. The recommended LPP would have greater net benefits than smaller scale plans, have a BCR greater than 1, and comply with all laws and policies.

The tradeoffs and consequences of lost opportunities associated with implementing a LPP including changes to residual risk and potential solutions to other water resource needs and opportunities that may be foregone will be documented in the final report as needed if an LPP is selected.

6.15. PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

USACE Planning Policy and NEPA emphasize public involvement in government actions affecting the environment by requiring that the benefits and risks associated with the TSP be assessed and publicly disclosed. Throughout the planning process, USACE has been coordinating with other Federal, state, and regional agencies, and other stakeholders. The Draft Report/EA will be released for a 30-day public review and comment period.

The Corps will continue to consult with federal and state agencies and groups during the plan formulation and environmental compliance of this feasibility study and preparation of the Integrated FR/EA. More information on coordination conducted so far, including a distribution list for the public review, may be found in Appendix J – Coordination.

6.15.1. Areas of Dispute

This section will be populated based on comments received during draft report review.

7 PLAN IMPLEMENTATION

7.1. INSTITUTIONAL REQUIREMENTS

The following sections outline the requirements of USACE and the Non-Federal Sponsor for implementation of the recommended plan.

7.2. IMPLEMENTATION SCHEDULE

This GRR is scheduled to be conclude and be approved with a Chief's Report in 2023. After this time, the recommended plan will need to be authorized for implementation. Once authorized, a project must have Federal funding before it can begin. Federal funding from the annual USACE appropriations will not be available for a specific study or project until the authorized study is included in either the President's Budget, which is submitted to Congress each February, or the Administration's work plan, which is submitted by the Office of Management and Budget. A newly authorized project may take years before it is included in the Construction General budget. The year 2025 was used in this study as the start date for construction of the recommended plan.

7.3. DIVISION OF PLAN RESPONSIBILITIES, COST SHARING, AND OTHER NON-FEDERAL RESPONSIBILITIES

The USACE-St. Louis District is responsible for project management and coordination with MSD and other affected entities. The USACE will submit the GRR, program funds, finalize plans and specifications, complete all NEPA requirements, complete all NHPA requirements, advertise and award construction contracts, and perform construction contract supervision and administration.

Federal implementation of the Recommended Plan would be subject to the Non-Federal Sponsor agreeing to enter into a written Project Partnership Agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation satisfactory to the Secretary of the Army. Entering into the PPA will ensure compliance with Federal laws and policies, including but not limited to:

a. Provide, during the periods of design and construction, funds necessary to make its total contribution for flood risk management equal to 35 percent of the total project cost;

b. Provide all lands, easements, rights-of-way, and relocations, including those necessary for the borrowing of material and placement of dredged or excavated material, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the construction or operation and maintenance of the project features;

c. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

d. Operate, maintain, repair, rehabilitate, and replace the project at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal government;

e. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

f. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

g. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

h. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under CERCLA, 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the construction or operation and maintenance of the project;

i. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the construction, operation, maintenance, repair, rehabilitation, or replacement of the project;

j. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA;

k. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;
l. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act;
m. Comply with all applicable Federal and state laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c));
n. Not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project; and
o. Not use funds from other Federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

The Federal share (65%) of the project first cost is estimated to be $44,744,050 and the non-Federal share (35%) is estimated to be $24,092,950. Table 19 provides the breakdown of the cost share.

Table 17. Cost Share of Estimated Total Project First Cost

Item	Federal Cost (65%)	Non-Federal Cost (35%)	Total Project First Cost
Nonstructural / Contingency	$37,752,650	$20,328,350	$ 58,081,000
PED/Construction Management	$ 6,991,400	$ 3,764,600	$ 10,756,000
LERRD	$ -	$ -	$ -
Total Project	$44,744,050	$24,092,950	$ 68,837,000
Associated Costs	$ -	$ -	$ -
Total with Associated Costs	$44,744,050	$24,092,950	$ 68,837,000

7.4. VIEWS OF THE NON-FEDERAL SPONSOR

University City is committed to finding flood risk management solutions along the Upper River Des Peres. The City has concerns about the implementation of the TSP as it is currently formulated, including (1) the level of participation that may be expected from property owners signing up for 100% voluntary nonstructural measures; and (2) a potentially very long timeframe over which these measures would be installed, leading to benefits that are a long way in the future. With regard to implementation of a flood risk management solution, the City currently favors a detention basin, which would be able to be installed in a relatively short timeframe and would start providing reductions in flood risk immediately. If a detention basin is not included in a refinement to the TSP, the City may request a plan with a detention basin as an LPP (see section 6.17).

8 RECOMMENDATIONS

Given the analysis presented in this GRR/EA, it was determined that Alternative 6 is the Tentatively Selected Plan. The nonstructural measures of dry floodproofing and elevation would reduce flood risk and flood damages to property owners and enhance quality of life for residents and business owners along the River Des Peres. Further analysis of additional nonstructural measures such as wet floodproofing and the incorporation of detention basin(s) is recommended to further refine the TSP and determine whether an LPP is preferred.

Federal implementation of the Recommended Plan would be subject to the NFS agreeing to enter into a written Project Partnership Agreement (PPA), as required by Section 221 of Public Law 91-611, as amended, to provide local cooperation as outlined in Section 7.3.

Disclaimer: The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding.

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10 FINDING OF NO SIGNIFICANT IMPACT

DRAFT
University City Branch, River Des Peres, Missouri
General Reevaluation Report (GRR)
with Integrated Environmental Assessment (EA)
A Flood Risk Management Study
St. Louis County, University City, MO

The U.S. Army Corps of Engineers, St. Louis District (Corps) has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) dated DATE OF IFR/EA, identifies and evaluates flood risk management (FRM) problems and opportunities for the River Des Peres in University City, Missouri. The GRR constitutes a reevaluation of the University City portion of the authorized project proceeding from the 1988 River Des Peres, Missouri Feasibility Report, EA, and Finding of No Significant Impact (FONSI). The 1988 study and this reevaluation are authorized by Section 101(a) (17) of the Water Resources Development Act of 1990. for the GRR project addresses flood risk management opportunities and feasibility in University City, MO.

The Final IFR/EA evaluated various alternatives that would reduce flood risk in the study area. The tentatively selected plan (TSP) includes:

- The TSP (Alternative 6) consists of floodproofing and elevation of approximately 500 structures with flood damage in the 4% AEP (25-year event). The 4% AEP (25-year) floodplain was used following analysis of the 4% AEP (25-year), 2% AEP (50-year), and 1.3% AEP (75-year) events which showed the greatest net annual benefits for the structures impacted by the 4% AEP event. Most of these structures would be floodproofed, and approximately 7 structures would be elevated. Dry floodproofing was used in the analysis as the type of floodproofing. The structures to be elevated would be raised to the 1% AEP (100-year) level of risk reduction.

In addition to a "no action" plan, eight other alternatives were evaluated.[4] Four of the eight alternatives were structural alternatives which included some combinations of detention basin, levee, and floodwall structures. Two alternatives were non-structural alternatives which included some combinations of real estate acquisition, floodproofing affected buildings, and elevating affected buildings. Two alternatives included a combination of both structural and non-structural elements. The formulation of these eight alternatives was discussed in Section 3 of the Integrated Report/EA. The National Economic Development (NED) Plan, which maximizes net benefits, is the TSP.

SUMMARY OF POTENTIAL EFFECTS:

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the Tentatively Selected Plan are listed in Table 1:

[4] 40 CFR 1505.2(b) requires a summary of the alternatives considered.

Table 1. Summary of Potential Effects of the Tentatively Selected Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Topography, Geology, and Soils	☒	☐	☐
Land Use/Land Cover	☒	☐	☐
Climate	☐	☐	☒
Air Quality	☒	☐	☐
Noise	☒	☐	☐
Hydraulics and Hydrology	☐	☐	☒
Water Quality	☒	☐	☐
Hazardous, toxic & radioactive waste	☐	☐	☒
Fish & Wildlife	☒	☐	☐
Invasive Species	☒	☐	☐
Bald Eagles	☐	☐	☒
Migratory Birds	☐	☐	☒
Cultural Resources	☐	☐	☒
Recreation and Aesthetics	☐	☐	☒
Economic Conditions	☐	☐	☒
Socio-economics and Demographics	☐	☐	☒
Population-at-risk and Critical Infrastructure	☐	☐	☒
Cumulative Impacts	☐	☐	☒

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the TSP. Best management practices (BMPs) as detailed in the IFR/EA will be implemented, if appropriate, to minimize impacts.[5]

COMPENSATORY MITIGATION:

No compensatory mitigation is required as part of the TSP.

PUBLIC REVIEW:

Public review of the draft IFR/EA and FONSI was completed on **DATE DRAFT EA AND FONSI REVIEW PERIOD ENDED**. All comments submitted during the public review period were responded to in the Final IFR/EA and FONSI.

OTHER ENVIRONMENTAL AND CULTURAL COMPLIANCE REQUIREMENTS:

ENDANGERED SPECIES ACT

NLAA*:* all species (Indiana Bat, Northern Long-eared Bat, Gray Bat, Decurrent False Aster).

[5] 40 CFR 1505.2(C) all practicable means to avoid and minimize environmental harm are adopted.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the TSP "**may effect but is not likely to adversely affect"** the federally listed species or their designated critical habitat. The listed species includes: Indiana Bat, Northern Long-eared Bat, Gray Bat, Decurrent False Aster.

NATIONAL HISTORIC PRESERVATION ACT

HISTORIC PROPERTIES ADVERSELY AFFECTED:

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that historic properties may be adversely affected by the TSP. A response was received 11 June 2021 assigning the SHPO log number of 076-SL-21 to the project.

CLEAN WATER ACT SECTION 404(B)(1) COMPLIANCE

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the TSP has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230).

FINDING

Technical, environmental, economic, and cost effectivenesseconomic, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives.[6] Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the TSP would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.[7]

_____ _____

Date

Kevin R Golinghorst
Colonel, U.S. Army
Corps of Engineers
District Commander

[6] 40 CFR 1505.2(B) requires identification of relevant factors including any essential to national policy which were balanced in the agency decision.

[7] 40 CFR 1508.13 stated the FONSI shall include an EA or a summary of it and shall note any other environmental documents related to it. If an assessment is included, the FONSI need not repeat any of the discussion in the assessment but may incorporate by reference.