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)

18 April 2022

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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 eight alternatives.

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 Alternative 3b – Detention Basin 4 (DB4) Only. Alternative 3b was selected as the TSP.

Alternative 3b includes a detention basin located at Woodson Road Park in the City of Overland. It has high net average annual 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) 2022 discount rate, the total project first cost of the TSP is approximately $9.9 million. The benefit-cost ratio for the TSP and NED Plan is 3.42, and the annual net benefits of the plan are estimated at $842,000, 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 April 2021. 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 risk to life safety and damage to properties and infrastructure 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.

Throughout this report, flood events and their resultant inundation will be referred to by Annual Exceedance Probability (AEP), which is the probability that this level of flooding may be realized or exceeded in any given year. For example, a flood event with a 1% AEP would have a 1% probability of occurring every year. This is a change in terminology from the recent commonly used term "annual chance of exceedance" (ACE). Additionally, in the past, flood events have often been described by their "return period" – or the estimated average length of time between flood events of a similar magnitude. A 1% AEP event would have been referred to as having a 100-year return period or being a 100-year event. This terminology is no longer used because it falsely conveys a sense of time and lowers public risk perceptions. Table 1 provides a list of AEP flooding events that were considered during the study, with their equivalent "return period." It is important to note that all AEP references in this report are for expected water levels, not the AEP of meteorological events (i.e. a 1% flood event is not the same as, nor does it necessarily occur as a result of, a 1% storm event).

Table 1. Comparison of AEP, ACE, and Return Period Terminology

AEP/ACE	Return Period ("x-year flood")*
20%	5-year
10%	10-year
4%	25-year
2%	50-year
1.3%	75-year
1%	100-year
0.5%	200-year
0.2%	500-year
*Note: Return Period is a term that can be misleading, is often misunderstood, and is no longer used by USACE (see ER 1110-2-1450).	

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 cubic feet per second (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.

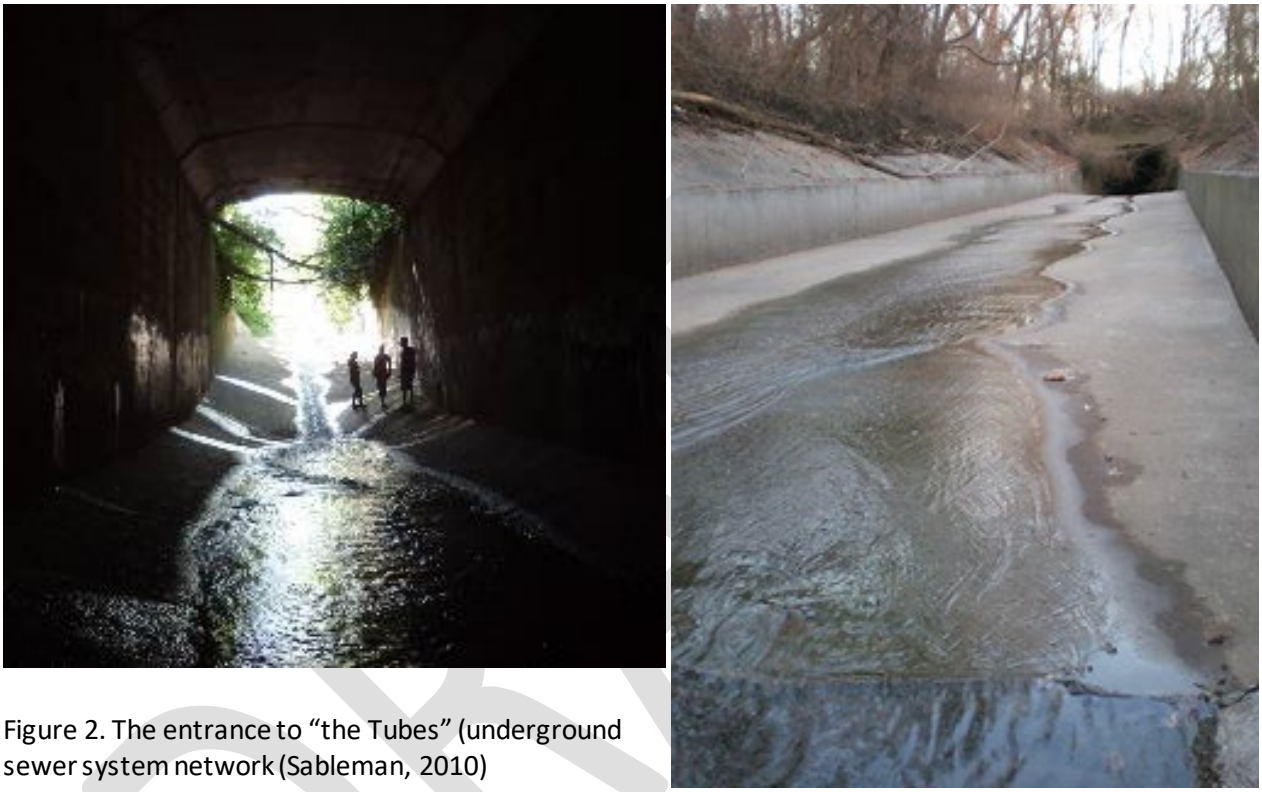

Figure 2. The entrance to "the Tubes" (underground sewer system network (Sableman, 2010)

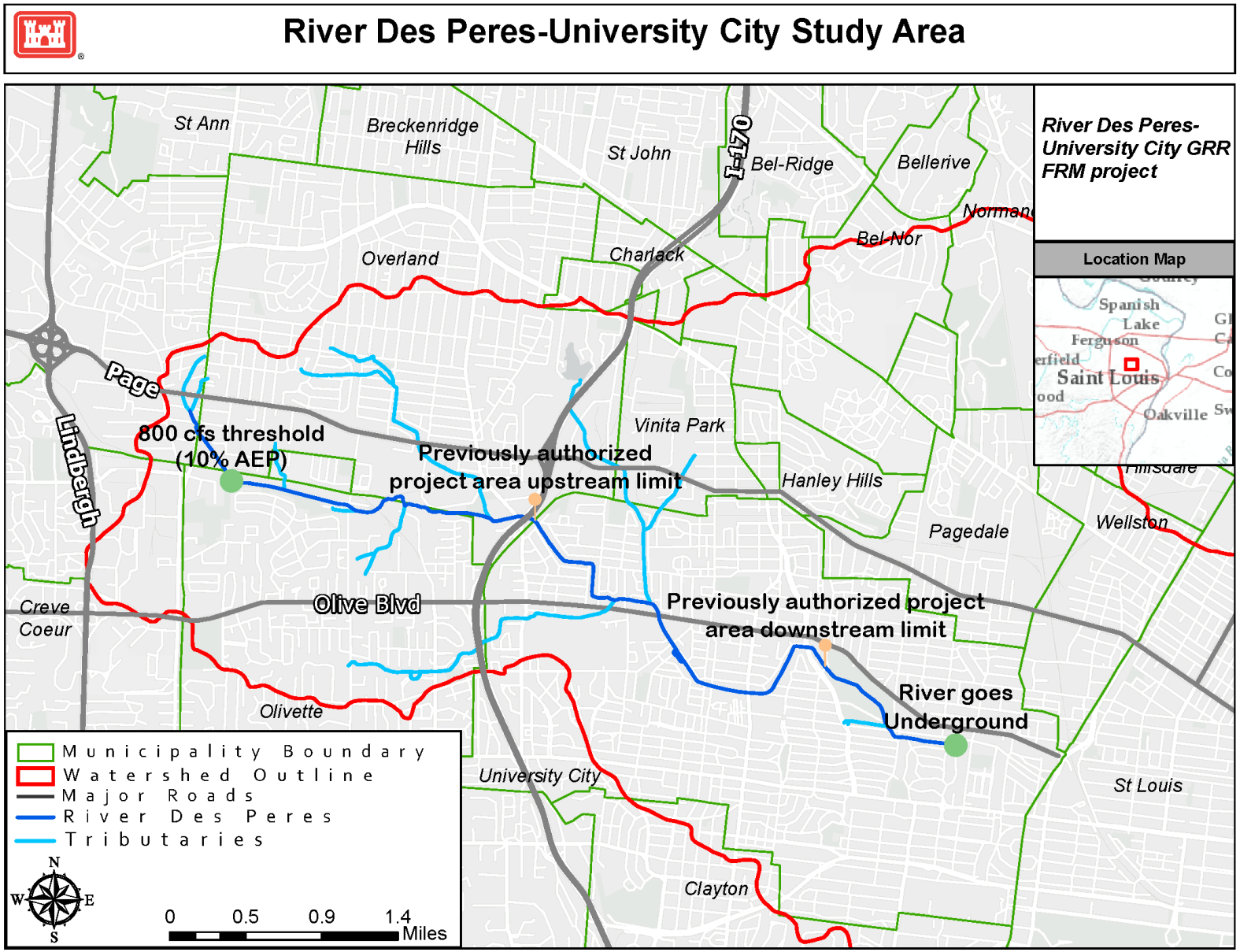

Figure 3. Map of the Study Area for the University City GRR.

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 50% AEP area. This is the most serious stormwater problem in the watershed.

Adjacent to 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 3 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 (measure U-12). It also includes recreation features comprising 1.85 miles of trail and

a small park (measure R-2, see Section 3.1.2.8) and a flood warning system. 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. Environmental Protection Agency (USEPA), 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 investigations 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 much of the population, due to the short duration of most flood events) would have to shelter in place.

Current life safety 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. The one known life loss event from the River Des Peres in University City occurred in the 2008 flood as two individuals attempted to wade through waist-deep flood water to rescue their car but were swept away and lost their lives. Overall, the life safety 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 repair/response 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:

- Increase outdoor recreation;
- Improve risk communication;
- Reduce sewer backups;

- Improve water quality, including reduced sedimentation/turbidity;
- Re-establish natural wildlife habitat such as wetlands;
- Increase community resiliency to flood events; and
- Increase 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.

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, which are also listed in the National Register: (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 was held in July 2021, with a subsequent meeting to engage additional attendees held in August 2021. An additional public review period will be held in April 2022 to present the updated TSP. All comments received during the public comment periods will 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 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 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 (approximately 38.668°, -90.338° latitude and longitude). 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.

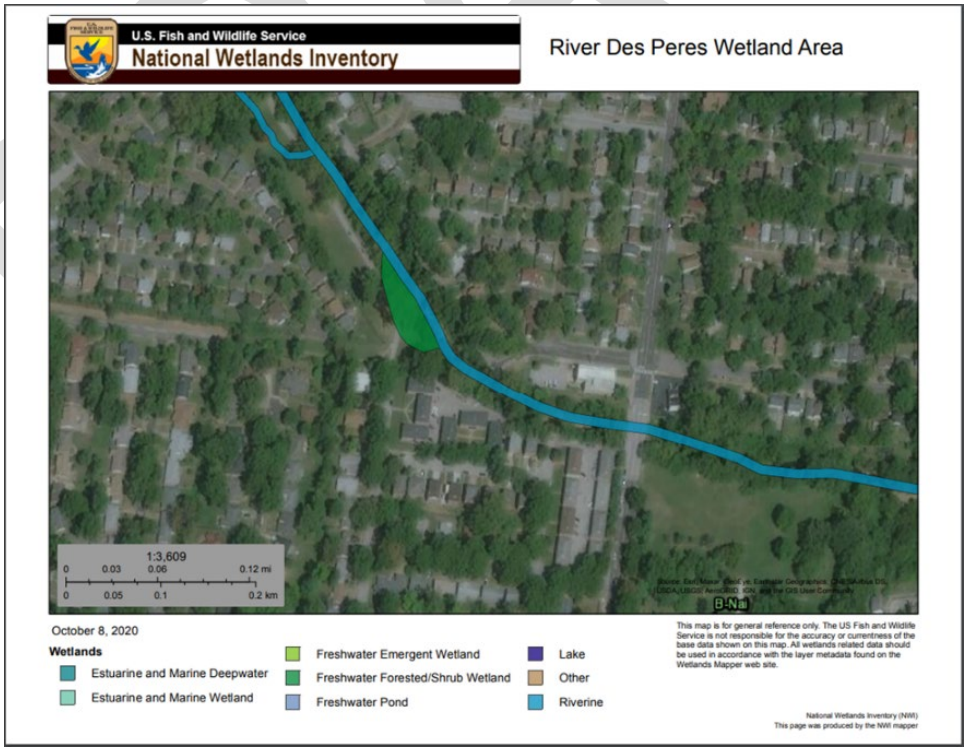

Figure 5. Location of the mapped wetland within the project area.

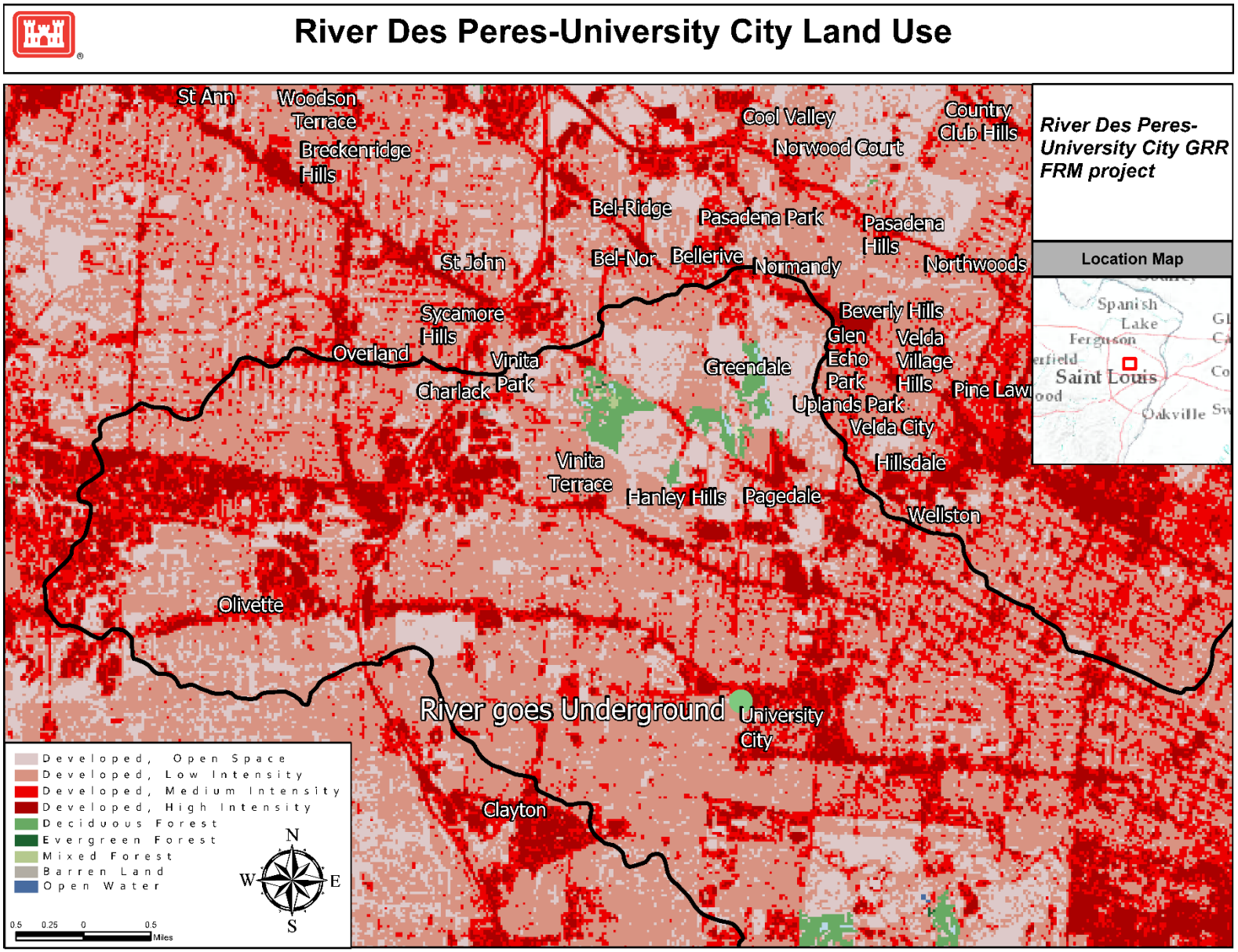

Figure 6. Land use in the study area

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 significant 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 enhancing recreation features in the Wilson Avenue area along River Des Peres.

If flooding continues unabated, the 20% AEP area 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, 2019). 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 66.2°F and the average min of 48.1°F. In 2019, there were 50 days with a max temp of at least 90°F, and 18 days with a max temp of no greater than 32°F. There were 88 days with a minimum temperature below freezing and 1 day below 0°F.

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). The figure illustrates monthly high and low temperature and precipitation averages.

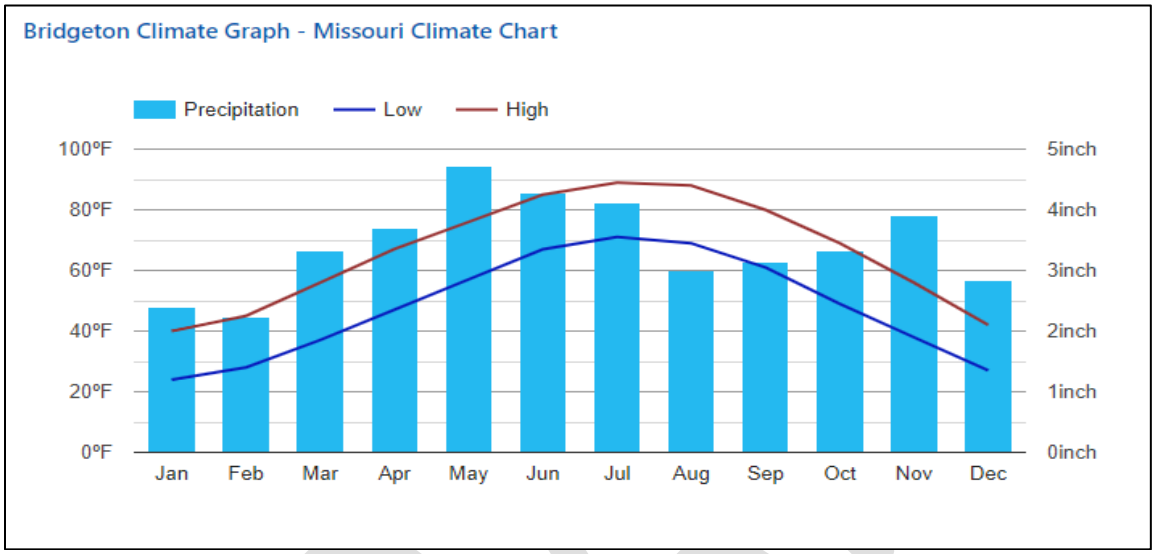

Figure 7. Average high and low temperature and precipitation averages for Bridgeton, Missouri, 2020.

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

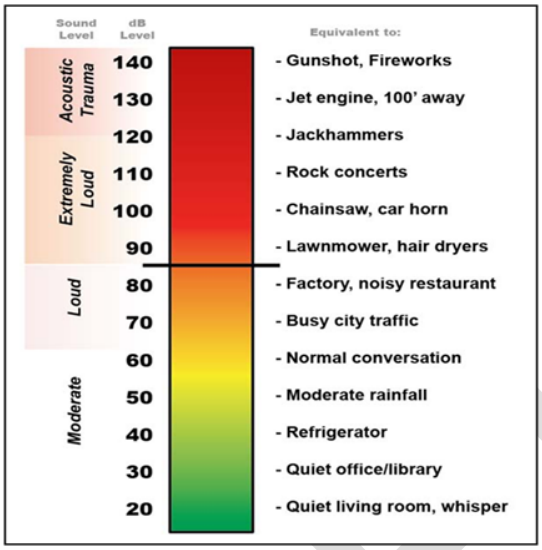

Figure 8. Examples of the sound level and decibel (dB) level of various sources.

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 many 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.

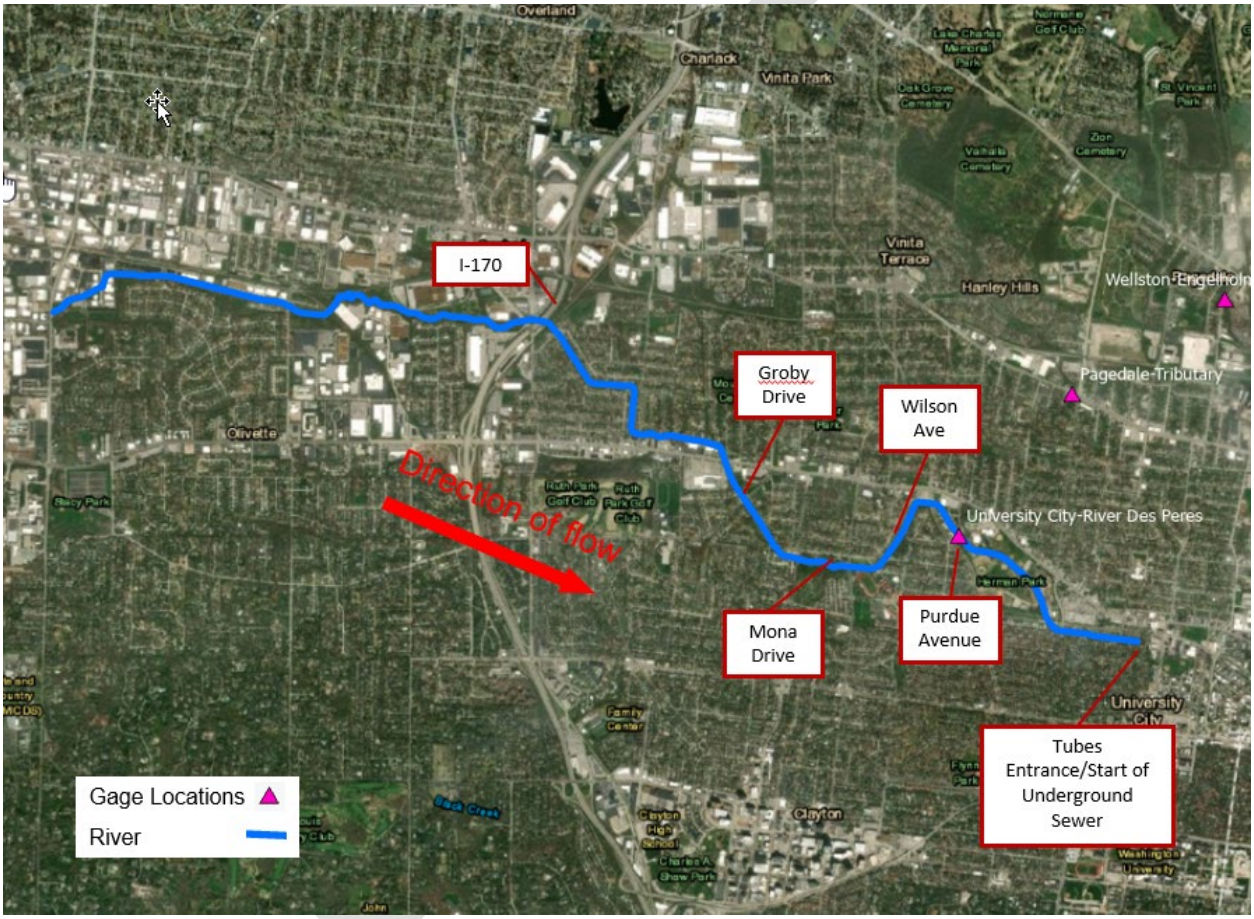

Figure 9. River Des Peres study area overview of key H&H features

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.

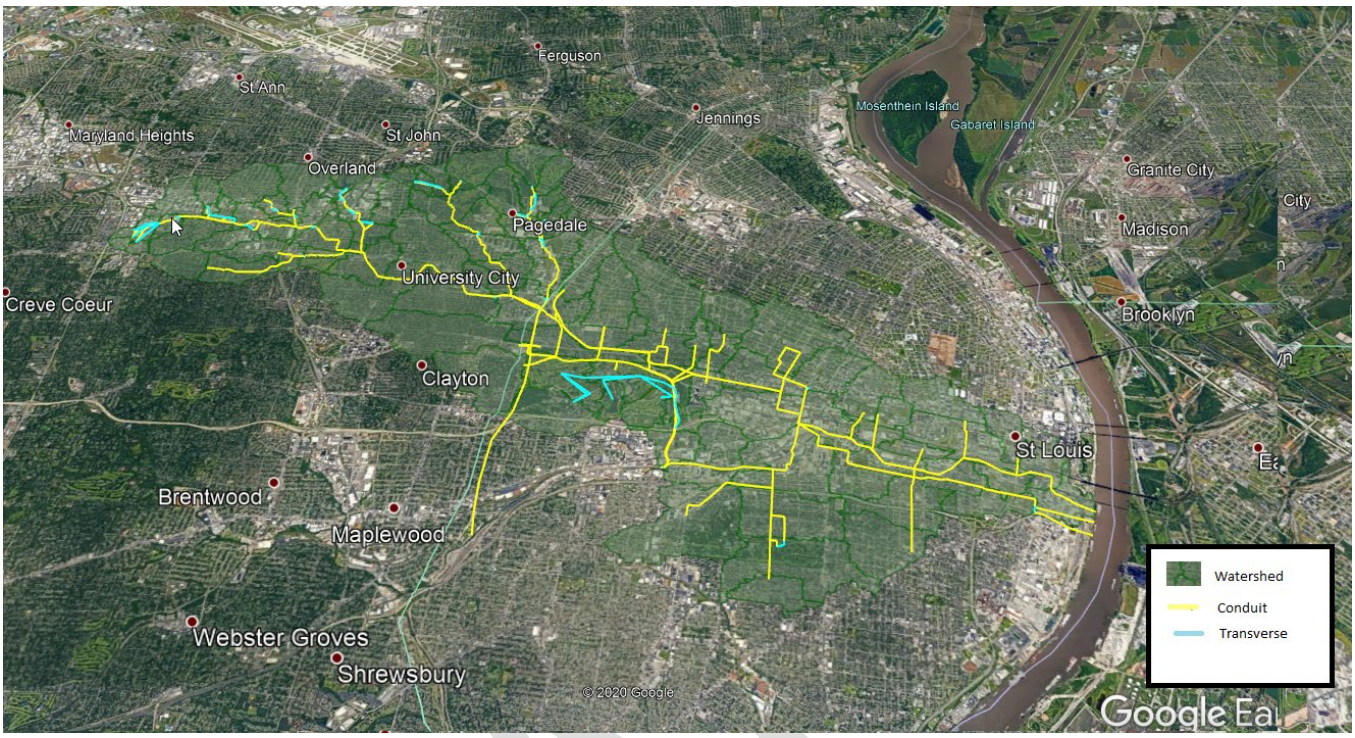

Figure 10. PCSWMM geometry for the River Des Peres watershed

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.

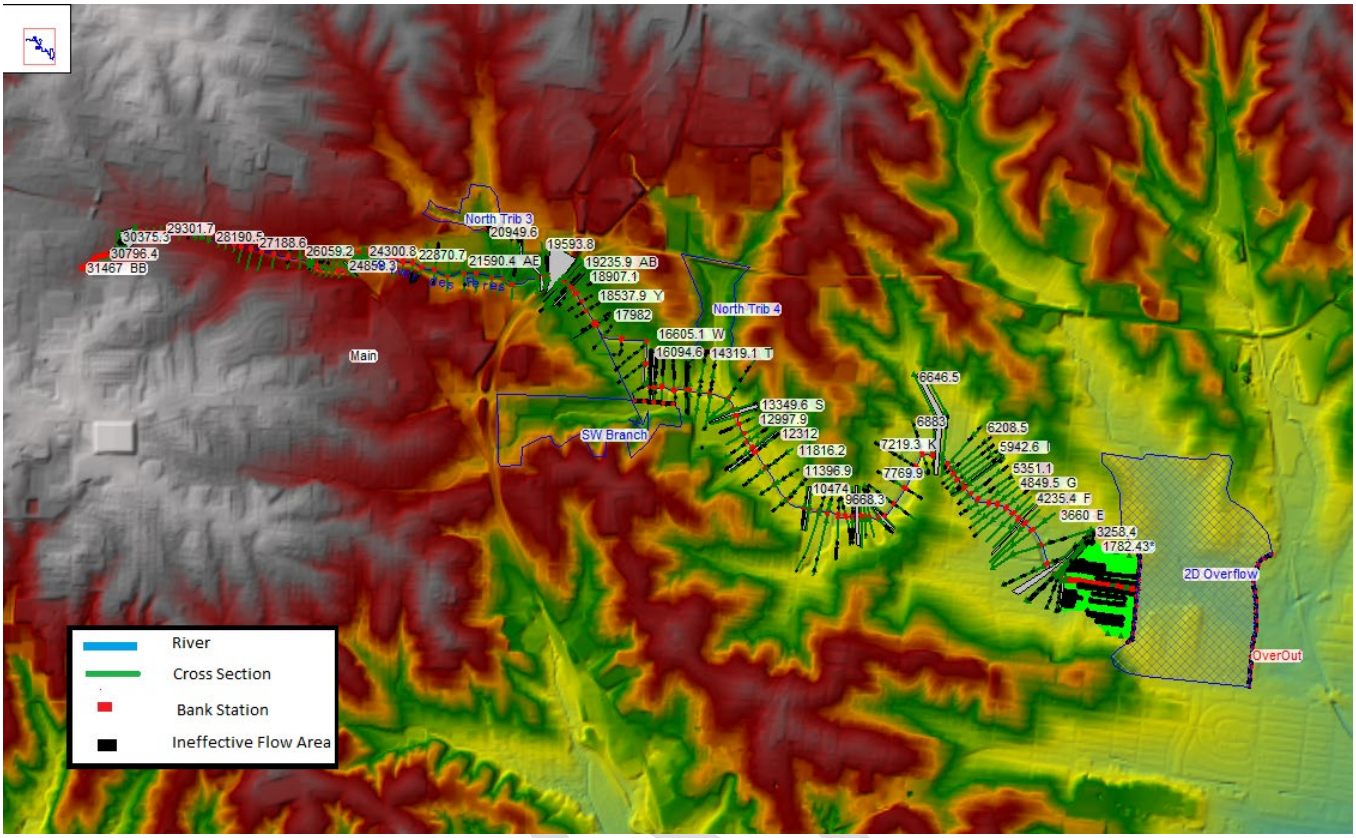

Figure 11. HEC-RAS geometry for the Upper River Des Peres

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. Table 2 tabulates the top five floods of record that were observed on the River Des Peres at the University City gage.

Table 2. 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 3.

Table 3. 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 the 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 these factors, the future flow frequency distribution is expected to be like 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 of impaired waters 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). The unnamed tributary that flows west to east and reaches its confluence with the River Des Peres just north of Olive Blvd and 82nd Street is listed for E. coli and chloride. The other tributaries to the River Des Peres within the study area were not listed.

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 (NO_3-N), dissolved oxygen (DO), 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*) comprises 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 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.

2.10 BALD EAGLES AND MIGRATORY BIRDS

2.10.1 Existing Conditions

2.10.1.1 Bald Eagles

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.

2.10.1.2 Migratory Birds

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. The River Des Peres Greenway is a popular birding hotspot for local bird watchers. The River des Peres Greenway is a wide-open green space that wraps around the River Des Peres as it winds its way to the Mississippi River. This green space begins downstream of the project location, however.

2.10.2 Future Without Project Condition

2.10.2.1 Bald Eagles

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.

2.10.2.2 Migratory Birds

Existing urban development will continue to present difficulties to migratory birds because 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.

2.11 THREATENED AND ENDANGERED SPECIES

2.11.1 Existing Conditions

2.11.1.1 Federal Listed Species

In compliance with Section 7(c) of the Endangered Species Act (ESA) of 1973, as amended, a (updated) list of species and critical habitat was acquired from the USFWS IPaC website on 1 April 2022 for project area (Table 4) (Project Code: 2022-0027028). The species included: Gray Bat, Indiana Bat, Northern Long-eared Bat, and Decurrent False Aster. There is no Critical Habitat found in the proposed project area.

Table 4. List of federal threatened and endangered species from an IPaC report (Project Code: 2022-0027028)

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 grisescens*)	Endangered	Lives in caves year-round. During the winter, uses deep, vertical caves. In the summer, uses caves scattered along rivers.
Monarch Butterfly (Danaus plexippus)	Candidate	Found in Missouri during migration. Uses host milkweed plants for reproduction.
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. Habitats and foraging opportunities would remain the same as current conditions in the FWOP. Therefore, Indiana Bat would be unaffected by the FWOP condition.

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 bats. Habitats and foraging opportunities would remain the same as current conditions in the FWOP. Therefore, Northern Long-eared Bat would be unaffected by the FWOP condition.

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 bats. Habitats and foraging opportunities would remain the same as current conditions in the FWOP. Therefore, Gray Bat would be unaffected by the FWOP condition.

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. Any known or unknown available Decurrent False Aster habitat would remain the same as current conditions in the FWOP. Therefore, the St. Louis District has determined that Decurrent False Aster would be unaffected by the FWOP condition.

Monarch Butterfly

The Monarch Butterfly is a large orange butterfly that is a candidate for listing on the Endangered Species List. Monarch populations of eastern North America have declined 90%. Much of the monarch butterfly's life is spent migrating between Canada, Mexico, and the U.S. Monarchs do not overwinter in Missouri (U.S. Fish & Wildlife Service, 2021). The Monarch occurs in a variety of habitats where it searches for its host plant, milkweed. Of the over 100 species of milkweed that exist in North America, only about one fourth of them are known to be important host plants for monarch butterflies. The main monarch host plant is Common Milkweed (Asclepias syriaca) (Kaul & Wilsey, 2019). Other common hosts include Swamp Milkweed (Asclepias incarnata), Butterflyweed (Asclepias tuberosa), Whorled Milkweed (Asclepias verticillata), and Poke Milkweed (Asclepias exaltata) (U.S. Fish & Wildlife Service, 2021). Three factors appear most important to explain the decline of Monarchs: loss of milkweed breeding habitat, logging at overwintering sites, and climate change and extreme weather. In addition, natural enemies such as diseases, predators, and parasites, as well as insecticides used in agricultural areas may also contribute to the decline. There is no milkweed in the project area. Habitat would remain the same as current conditions in the FWOP. Therefore, Northern Long-eared Bat would be unaffected by the FWOP condition.

Note - the monarch is a candidate species and not yet listed or proposed for listing. Consultation with U.S. Fish and Wildlife Service under section 7 of the Endangered Species Act is not required for candidate species.

2.11.1.2 State Listed Species

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-listed endangered 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.

2.11.2 Future Without Project Conditions

2.11.2.1 Federal 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.

2.12 INVASIVE SPECIES

Existing Conditions

Presidential Executive Order 13112 (*Invasive Species*), amended by Executive Order 13751 (*Safeguarding the Nation from the Impacts of Invasive Species*), 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 (*H. 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.

2.13 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 fall 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; it is possible that it may be added in future.

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.

2.14 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 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. To avoid or minimize adverse effects to Tribal resources, final project site selection and design may be altered because of consultation with these Tribes or because 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 any existing but undiscovered archeological sites. Therefore, the Tribal resources in the project area would likely experience a minor adverse effect in the FWOP condition.

2.15. 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.

2.16. 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 1,692 structures, 1,462 of which are residential and 230 are non-residential. All structures that indicate inundation in the 0.2% AEP area 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 2022 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 full USACE team and the Flood Risk Management Planning Center of Expertise (FRM-PCX), with a focus on nonstructural aggregation (see criteria on page 8). The reaches begin with Reach 1, which is the furthest upstream, and increase while moving downstream and ending with reach 20. Table 5 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 1,692 structures. Figure 12 shows the study area reach boundaries.

Table 5. Structure count by structure type and reach

Reach	Residential Count	Non-Residential Count	Total
1	17	16	33
2	7	18	25
3	12	13	25
4	172	1	173
5	219	3	222
6	6	20	26
7	90	0	90
8	23	0	23
9	28	3	31
10	200	2	202
11	14	18	32
12	97	1	98
13	201	0	201
14	5	27	32
15	123	0	123

16	54	11	65
17	75	18	93
18	3	53	56
19	72	1	73
20	44	25	69
Total	1462	230	1692

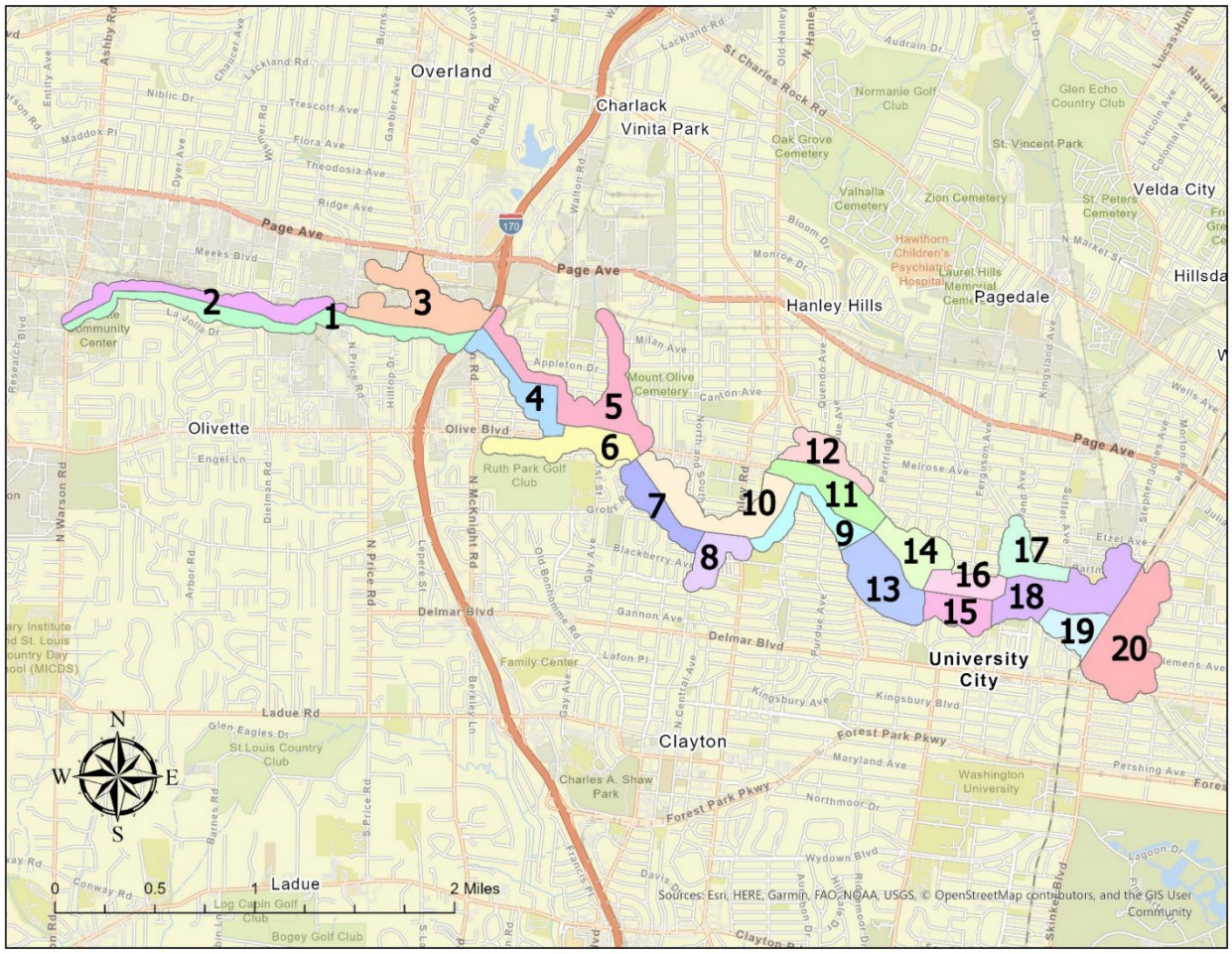

Figure 12. Study area reaches for economic analysis

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 elevations 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 because 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) 1.4.3 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 $4.9 million expected annual economic damages in the existing condition. Table 6 shows expected annual damages by reach and damage category.

Table 6. 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	$0	$0	$0
2	$39	$1	$40
3	$439	$3	$442
4	$16	$141	$157
5	$58	$635	$693
6	$304	$16	$320
7	$8	$86	$94
8	$0	$1	$1
9	$5	$23	$28
10	$52	$413	$465
11	$219	$50	$269
12	$14	$84	$98
13	$28	$344	$372
14	$195	$35	$230
15	$69	$395	$464
16	$76	$150	$226
17	$8	$11	$19
18	$324	$4	$328
19	$12	$106	$118
20	$467	$5	$472
Total	$2,336	$2,501	$4,837

*FY2022 price levels

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.

2.17. 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. Summary of the Environmental Justice E-screen results.). 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 is comprised of 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.

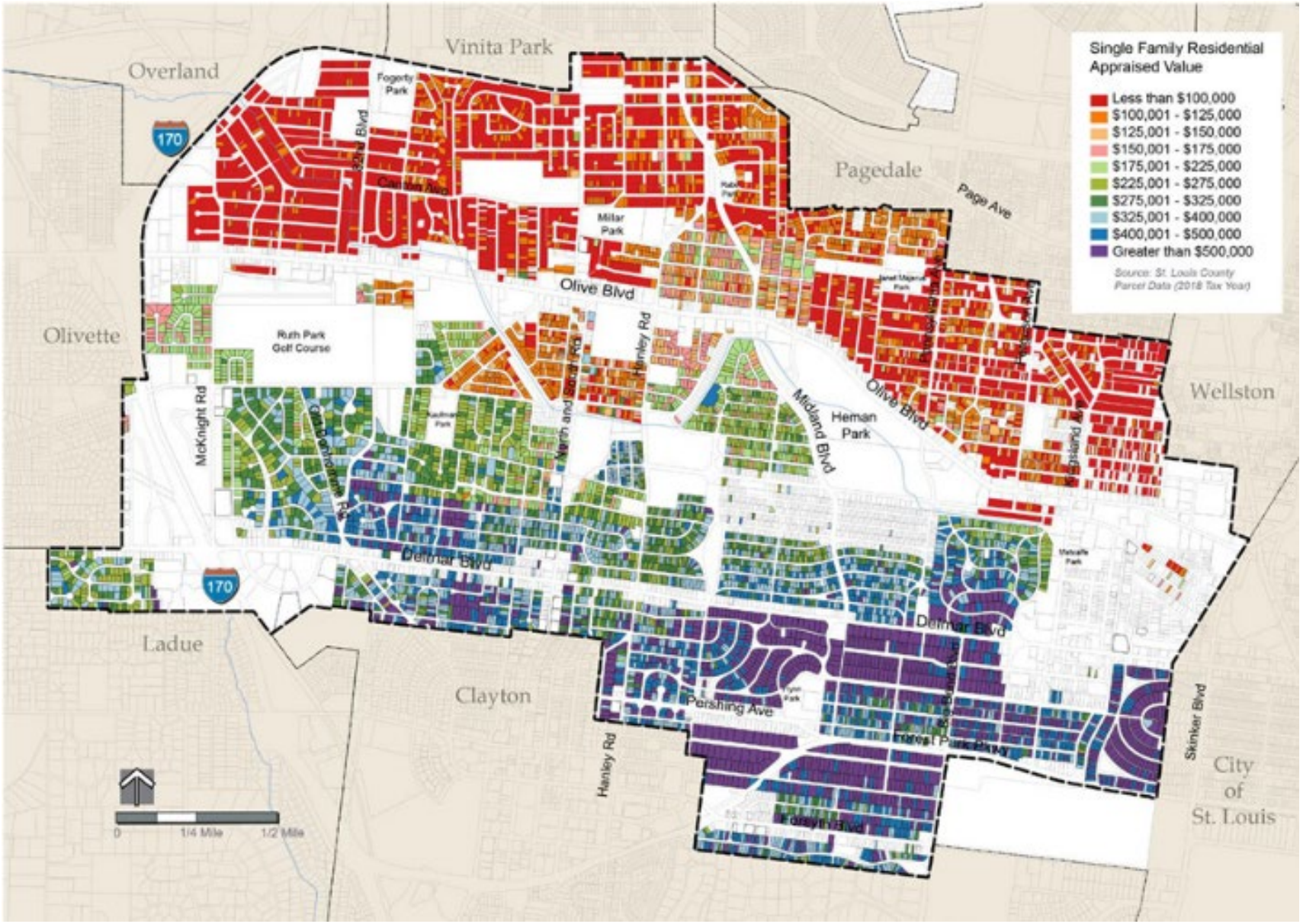

Figure 14. Single Family Residential appraisal values in University City.

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.

2.18. 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 night (of which approximately 500 are over 65 years of age) and 2,000 during the day. When the River Des Peres floods, residents that do not attempt evacuation (probably much 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 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 risk reduction 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 vehicles on the road during 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 1983 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. An example of detention basin design from the USACE Valley Creek FRM project is shown in Figure 15. 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 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 [from the original 71] 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."

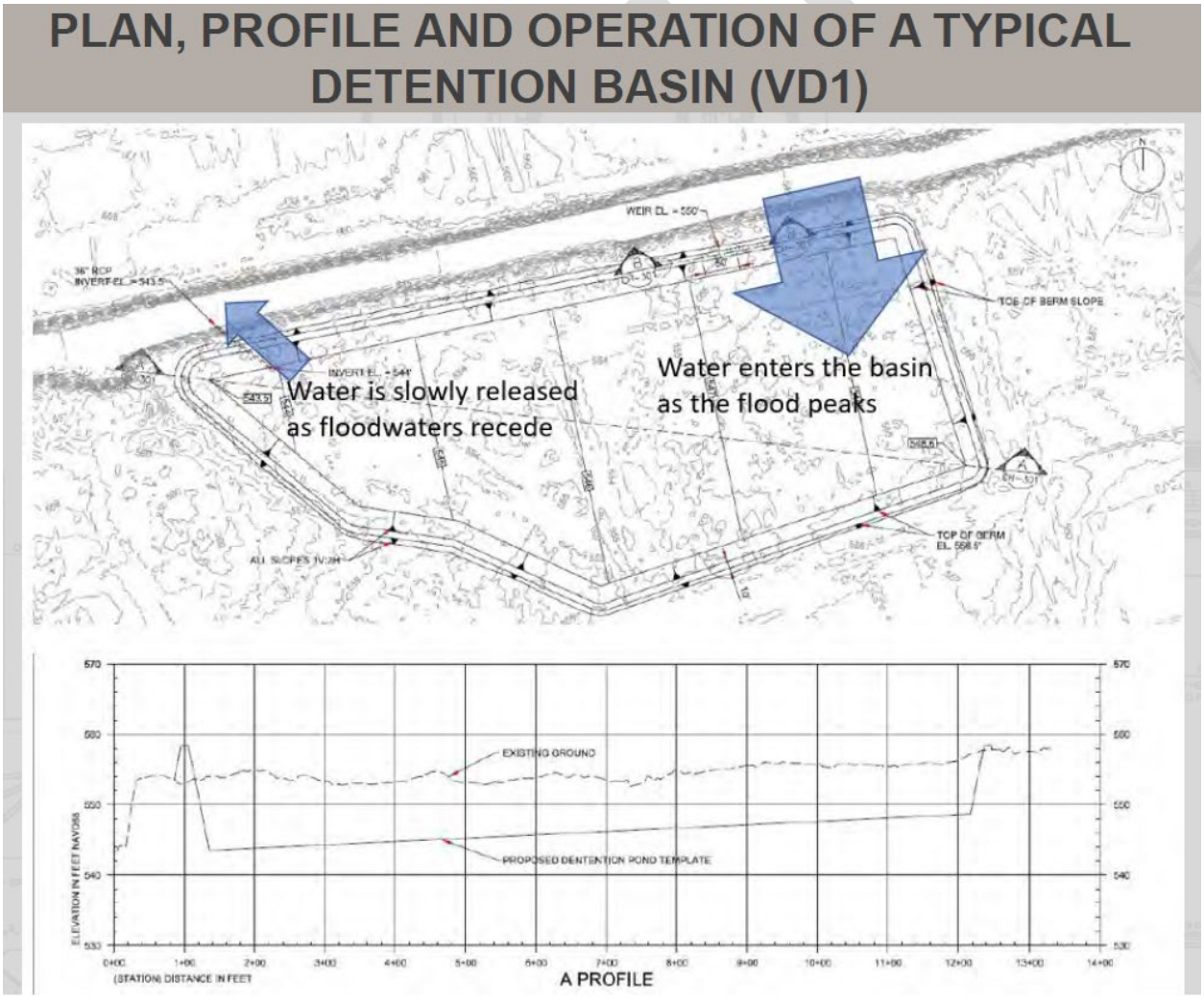

Figure 15. Example of detention basin design from the ADM slides from the Valley Creek FRM study ADM, created by Kansas City District.

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. For the purposes of this study, diversion of the River Des Peres was examined in the context of the highly urbanized surrounding area; any diversion of the river would require significant acquisition and relocation costs in addition to construction costs, and would displace homes/structures and potentially transfer water and flood risk to another watershed.

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. Floodwalls were assessed similarly to levees in this study because of their similar function and design considerations.

Figure 17. Floodwall (image: USACE).

3.1.1.5 Channel Modifications

Modifications to river channels can include many types of structural features that modify the flow characteristics of the river. 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).

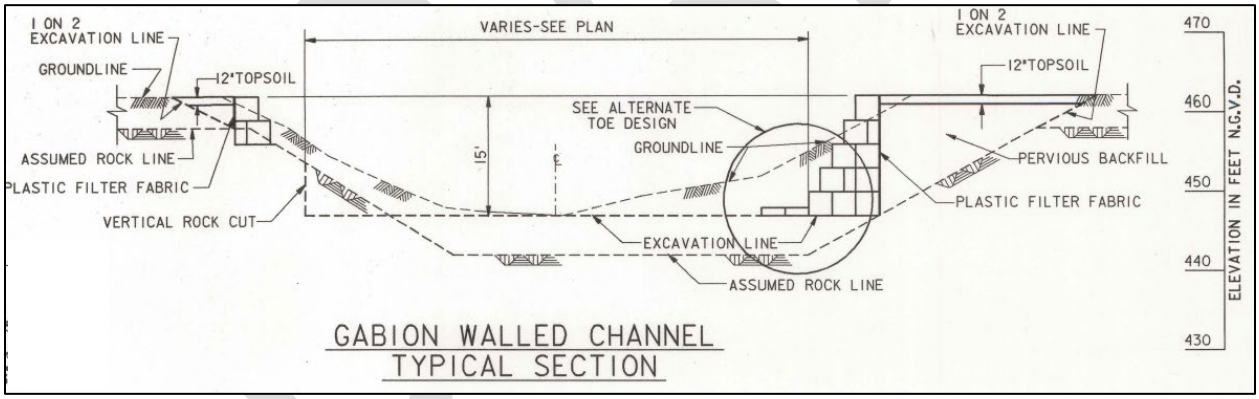

Figure 18. Gabion walled channel cross section (channel modification) from 1988 Feasibility Study.

3.1.1.6 Bridge Modifications

Modifications to bridges for the purpose of reducing flood risk can include widening the bridge opening and reinforcing the structure. 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. For this study, all types of dry floodproofing were included in analysis.

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).

For this study, all types of wet floodproofing, including basement fill and elevation of utilities, were included in analysis.

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. For this study, elevation of both residential and nonresidential structures was considered in analysis.

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 USACE 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, per Planning Bulletin 2016-01. For this study, acquisition was included in analysis; the PDT also referred to the 2013 USACE River Des Peres-University City Economic Update, which assessed the benefits and costs of buyouts in the study area.

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, per Planning Bulletin 2016-01. For this study, relocation was examined in the context of available space within the same parcels and neighborhoods; the further away a structure is relocated to, the more expensive and inefficient the relocation.

3.1.2.5 Flood Forecasting/Warning System

A flood forecasting/warning system collects precipitation or river gauge data and triggers a warning that is disseminated to people in areas that may be impacted by flooding. There are four factors that influence the effectiveness of an alert system: (1) technology or approach to issue the warning (i.e., mass notification, police door to door, sirens, etc.), (2) channels to issue the warning (physical, electronic, noise, etc.), (3) disruption to infrastructure, and (4) delivering the warning message multiple times.

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. A 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. Eventually, the Commission hopes to include a warning announcement system such as CodeRed.

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. The City and Commission have committed to developing a flood warning system that works effectively to provide advance warning in spite of this challenge.

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 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. 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.

3.1.2.8 Recreation Features

Recreation features can sometimes be added to flood risk management measures. 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. Natural and nature-based measures assessed for this study included floodplain storage, removal of invasive species, and constructed wetlands.

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	Non-structural	No
Acquisition (buyouts)	1, 2	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
Flood forecasting/warning system	1, 2	Non-structural	No
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.

Flood forecasting/warning system	No	Incomplete	Commission on Storm Water Issues has committed to providing Sponsor with an effective flood warning system, preferring to develop it outside the scope of this study; any flood warning system developed as part of this study would be incomplete solution per Sponsor's own needs for system development and oversight.
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, resulting in the initial array of alternatives (Table 9).

3.4.2. Initial Array and Alternative Plans Screened

The initial array of alternatives included the alternatives shown in Table 10.

Table 10. Initial array of alternatives and alternatives screened

Initial Array of Alternatives	Screened or Retained
No Action Plan	Retained
Authorized Plan from 1988 Feasibility Study	Screened
Maximum Implementation of Levees/Floodwalls	Screened
Maximum Implementation of Detention Basins	Screened
Detention Basin 3	Screened

Detention Basin 4C (Commercial location)	Screened
Authorized Plan with Modifications (DB3 & DB4)	Retained
Detention Basins 3 & 4, and DB4 alone	Retained
Levee/Floodwall with DB3 & DB4	Retained
Nonstructural – Acquisition	Retained
Nonstructural – Floodproofing & Elevation	Retained
Nonstructural – Elevation Only	Retained
Nonstructural – DB4 & Elevation	Retained

The following alternatives were 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 11). The area downstream of the Tubes was not hydraulically modeled as a part of this study (HEC-RAS channel geometry was not available). Since the area downstream of the Tubes along the River Des Peres within the City of St. Louis is highly developed/urbanized, induced flooding in this area is assumed to cause flood damages to homes, businesses, and infrastructure. Therefore, this alternative is not an acceptable plan, as is, per USACE planning guidance.

Table 11. 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

The following alternatives were retained and developed into the final array.

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 either 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 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.

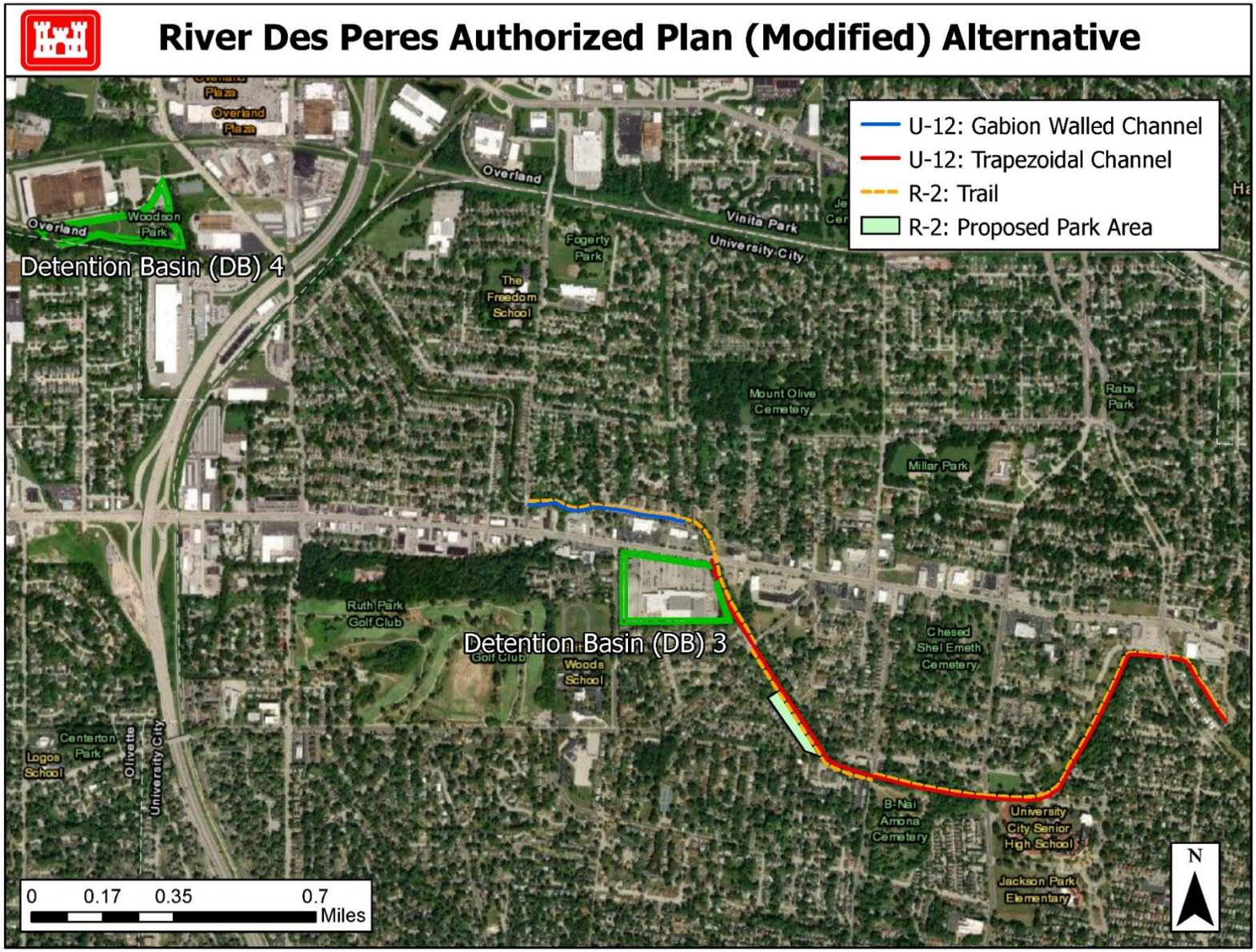

Figure 21. Alternative 2 – Authorized Plan with Modifications (DB3 and DB4).

3.5.1.3. Alternative 3a – Detention Basins 3 and 4

Alternative 3a 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.

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 event to the 10% AEP 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 is located adjacent to the River Des Peres directly south of Olive Blvd. The 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. It is approximately 15.0 acres in size. 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, Woodson Road Park, in the City of Overland. The detention basin is approximately 7.9 acres in size and is located to the northwest of the confluence of an unnamed tributary with the River Des Peres. The DB4 footprint is located on land owned by the General Services Administration (GSA) on the west side and the City of Overland on the east side. The portion of the park included in the DB4 footprint includes a dog park, restrooms, gazebo, picnic areas, and parking lot.

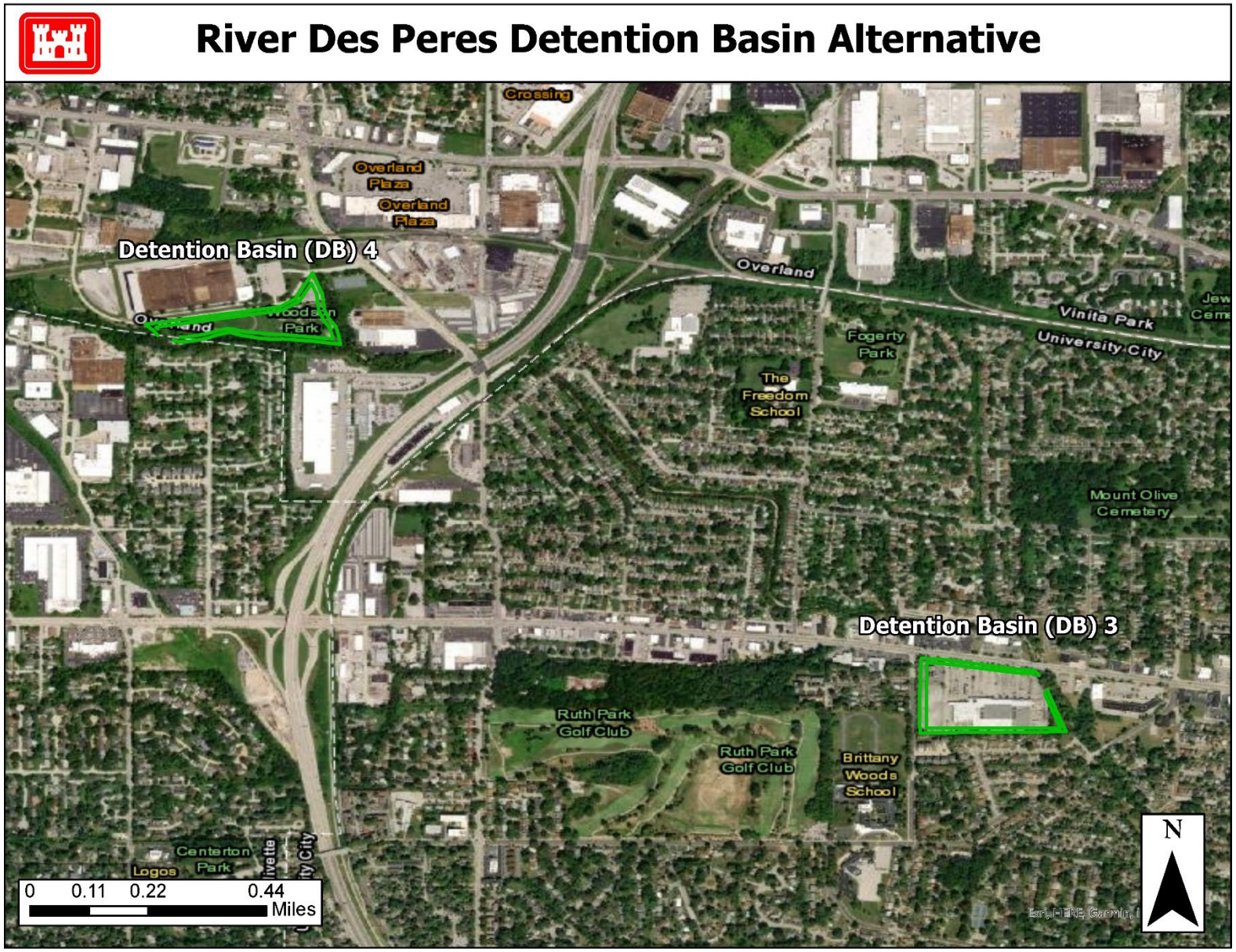

Figure 22. Detention basins in Alternative 3a (DB3 and DB4) and Alternative 3b (DB4).

3.5.1.4. Alternative 3b – Detention Basin 4

Alternative 3b consists of DB4 alone. DB4 is located at the site of a public park, Woodson Road Park, in the City of Overland. The detention basin is approximately 7.9 acres in size and is located to the northwest of the confluence of an unnamed tributary with the River Des Peres (Figure 23). The DB4 footprint is located on land owned by the General Services Administration (GSA) on the west side and the City of Overland on the east side.

Due to the restriction of available useable real estate the level of risk reduction provided by the basin is in the range of the 50% AEP event to the 10% AEP event, based on the capacity of the basin per design constraints. The basin is designed for dry detention, so that it has maximum storage capacity during storm events.

The portion of Woodson Road Park included in the DB4 footprint includes a gazebo that sits up to 40 people, a dog park, a BBQ pit, playground, picnic areas, and public restrooms. Because the Woodson Road Park site was designated for recreation use in the land agreement with the Department of the Interior, the City of Overland will need to relocate these features to ensure no net loss of recreation, so may create or enlarge a park with potentially the same amenities, resulting in a net zero change in recreation. Nearby parks may be used to relocate these features, such as Legion Park. The City of Overland is currently in support of moving these features, since the current location is prone to saturated soils and the features are in need of funding for maintenance.

Based on soil and historic aerial photographs, it appears that in the past the DB4 area has been disturbed and therefore the presence of intact archaeological sites is very unlikely. A series of auger tests were placed throughout the park on 4 March 2022 to confirm the area was previously disturbed by construction, that there is no natural stratigraphy (layers) remaining, and that there are no significant intact archaeological sites present. Additionally, it has been determined that the Legion Park site, where the dog park could be relocated, was disturbed by construction in the past. The potential dog park relocation area was the site of a municipal swimming pool that was removed sometime between 2006 and 2008. The study team submitted a letter, 8 March 2022, to the State Historic Preservation Office (SHPO) to continue consultation on the project and ask them to concur that this project will have no adverse effects on historic properties (archaeological sites). Concurrence from the SHPO was received on April 4, with a determination of No Historic Properties Affected, satisfying this study's compliance with the National Historic Preservation Act.

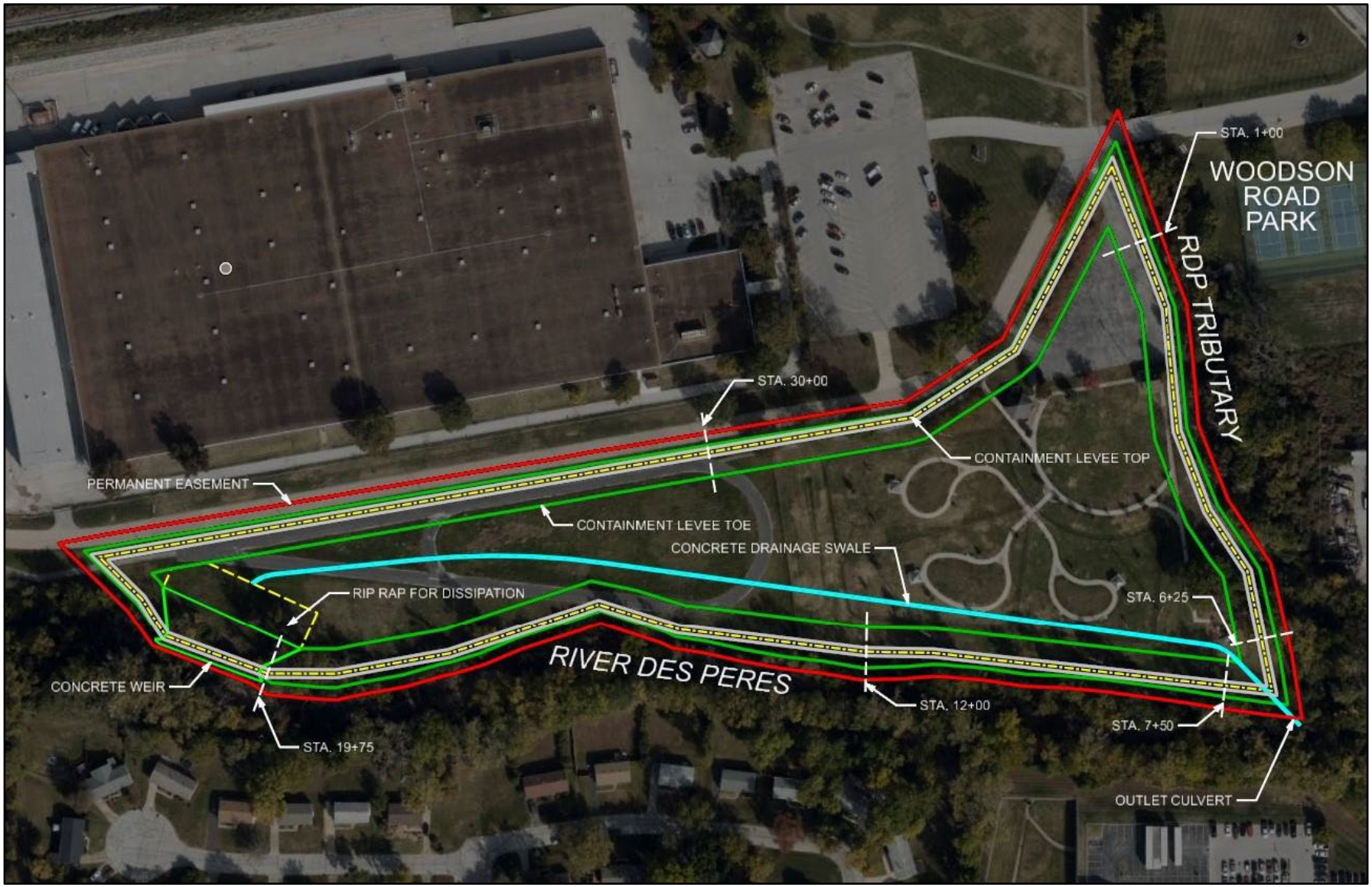

Figure 23. Alternative 3b – Detention Basin 4, DB4

3.5.1.5. 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 24). 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.

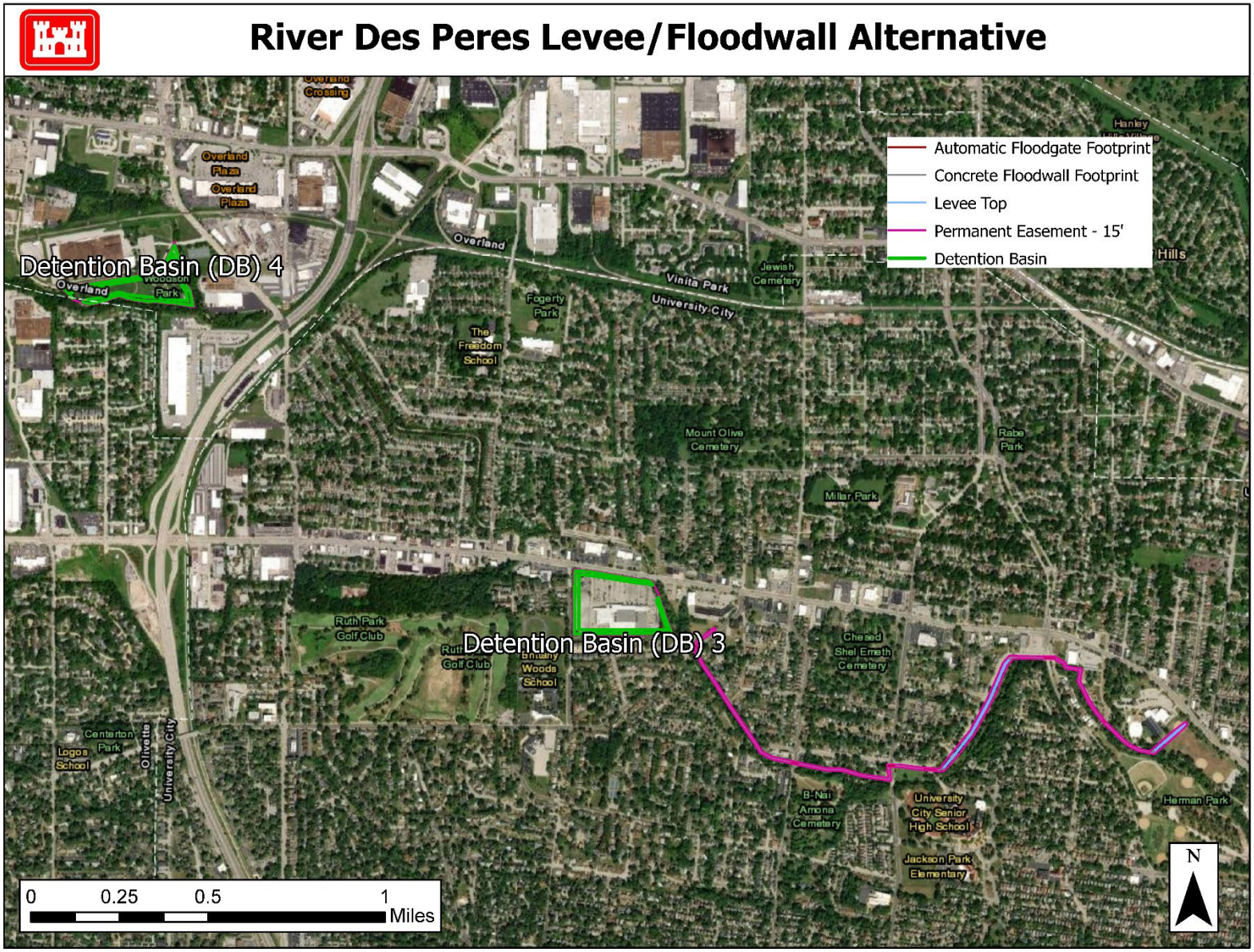

Figure 24. Alternative 4 – Levee/Floodwall with DB3 and DB4.

3.5.1.6. Alternative 5 – Nonstructural – Acquisition

Alternative 5 consists of the acquisition of 520 structures in the 4% AEP area and the relocation of the people and businesses associated with those structures (Figure 25). The 4% AEP event was used following analysis of the 4% AEP, 2% AEP, and 1.3% AEP events which showed the greatest net annual benefits for the structures impacted by the 4% AEP event. The aggregation methodology for the structures may be found in Appendix I – Economics.

Included in the 520 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.

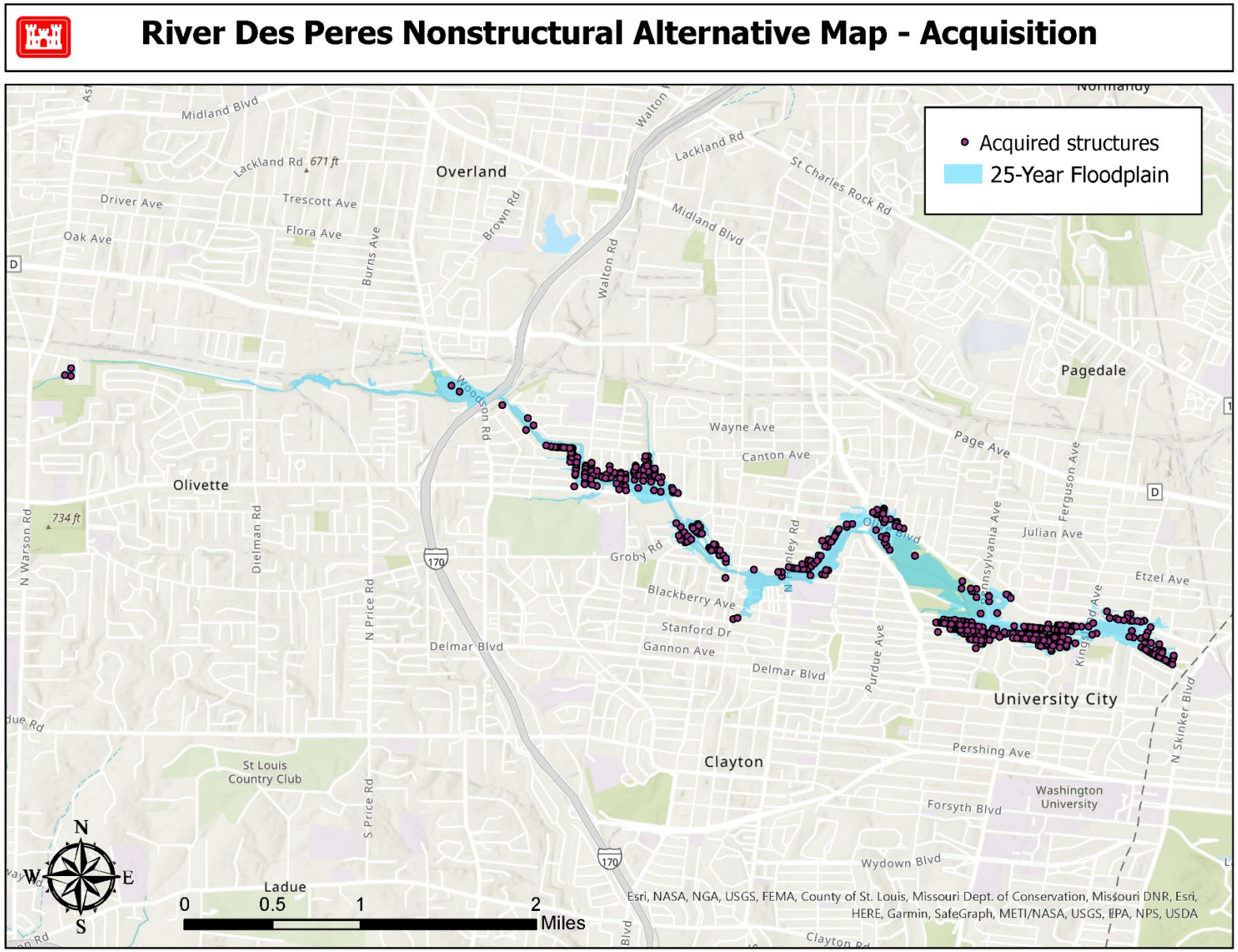

Figure 25. Alternative 5 – Nonstructural – Acquisition

3.5.1.7. Alternative 6 – Nonstructural Only (Optimized)

Previously, when the Draft version of this report was released for public review in July 2021, Alternative 6 was the NED Plan and the TSP. At that time, Alternative 6 consisted of floodproofing and elevation of 520 structures with flood damage in the 4% AEP floodplain, and a flood warning system. The 4% AEP floodplain was used following analysis of the 4%, 2%, and 1% AEP events which showed the greatest net annual benefits for the structures impacted by the 4% AEP event. Many of these structures (513) would be floodproofed (64 commercial and 449 residential), and approximately 7 structures would be elevated. Dry floodproofing was used in the analysis as the type of floodproofing, using a dry floodproofing depth of 3 feet. The structures to be elevated would be raised to the 1% AEP event level of risk reduction. Acquisition was considered, but the analysis showed it was not as cost-effective as floodproofing or elevation for the structures assessed.

Subsequent refinement of this alternative by the study team led to significant changes. Following the public review and internal reviews of the Draft Report in summer 2021, the study team continued to work with the USACE Flood Risk Management Planning Center of Expertise (FRM-PCX) and the National Nonstructural Committee (NNC) to refine Alternative 6 and Alternative 8 by aggregating the structures in the study area into specific reaches along the river and applying nonstructural measures to those structures in a more nuanced way, in order to improve the flood risk management solution and optimize the net benefits. For each reach, the AEP event (or no action) that reasonably maximized net benefits was chosen to be applied, thus maximizing overall net NED benefits. See Appendix I – Economics for more detail.

The following criteria were applied to identify structures eligible for nonstructural measures. Residential structures with depth of flooding greater than two feet above the first floor (+2 ft or more) were eligible for elevation. Residential structures with basements with substantial flooding below the first floor (-1 to 0 ft) were eligible for basement fill. Non-residential structures with up to three feet of flooding (0 to 3 ft) were eligible for dry floodproofing. Structures eligible for nonstructural treatment for which the costs of treatment exceeded that of acquisition were indicated for acquisition. Ultimately, no structures were designated for elevation as it was too costly in all cases of eligibility.

For Alternative 6, the additional structure aggregation and application of nonstructural criteria led to a large decrease in the number of structures included; the number fell from 520 structures to 75 structures (Table 12).

Table 12. Number of structures and type of nonstructural measure applied – Alternative 6

Nonstructural Measure	# Structures
Floodproofing (Commercial)	39
Basement Fill (Residential)	19
Acquisition	17
Total	75

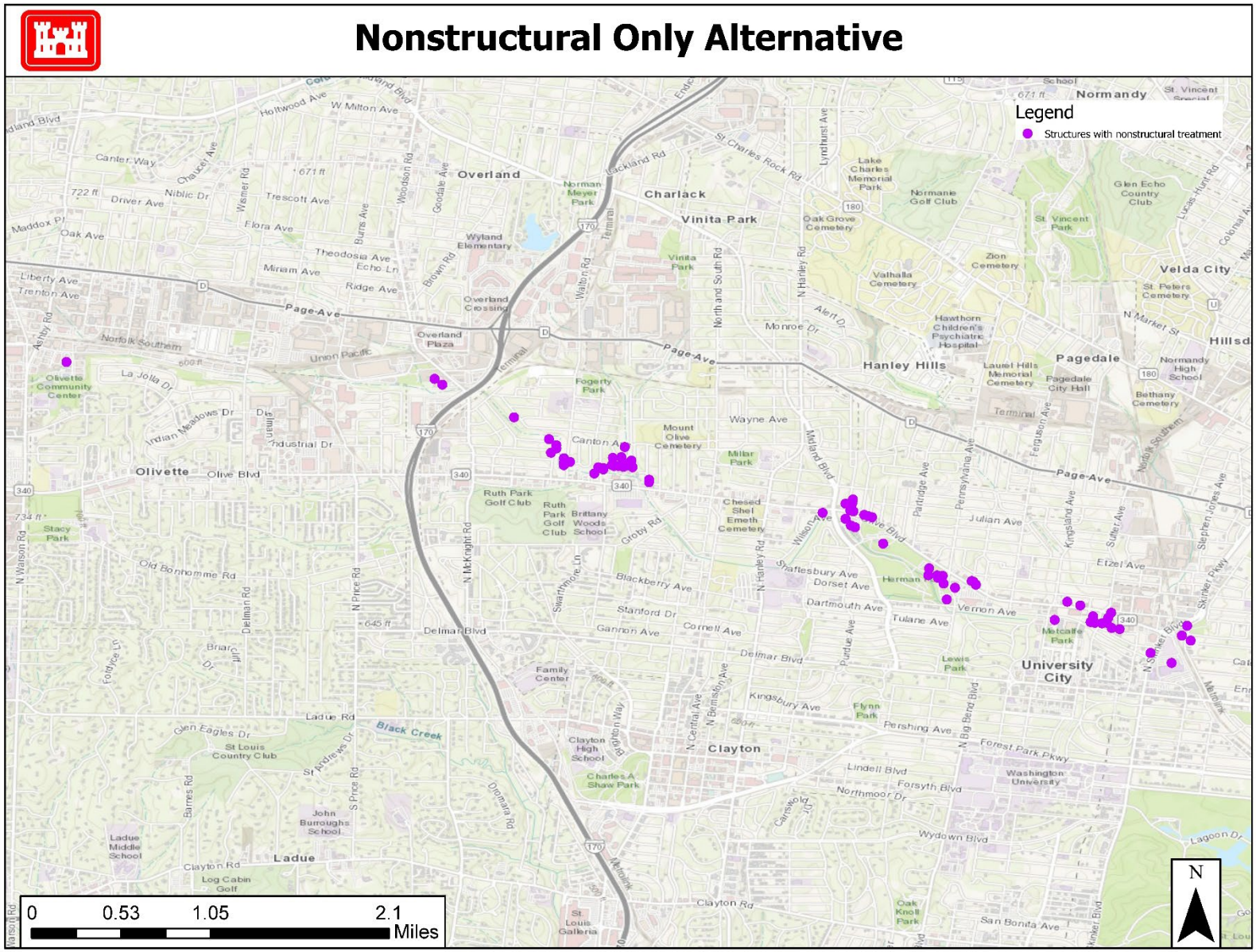

Figure 26. Alternative 6 – Nonstructural Only (Optimized)

3.5.1.8. 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 event (Figure 27). The aggregation methodology for the structures may be found in Appendix I – Economics. The homes would be elevated to the height of the 1% AEP 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).

Alternative 7 includes 17 homes that fall within one of the National Register Historic Districts (NRHDs) and 2 homes that are not in a district but are considered eligible for the National Register, for a total of 19 historic structures. The two furthest east homes to be elevated fall within the Delmar Loop-Parkview Gardens NRHD boundary (not yet mentioned in this report); it has not yet been determined whether these two homes are contributing structures to this NRHD.

These measures would not create any incremental risk or change the flood characteristics. For the initial analysis, 100% participation in elevation was assumed.

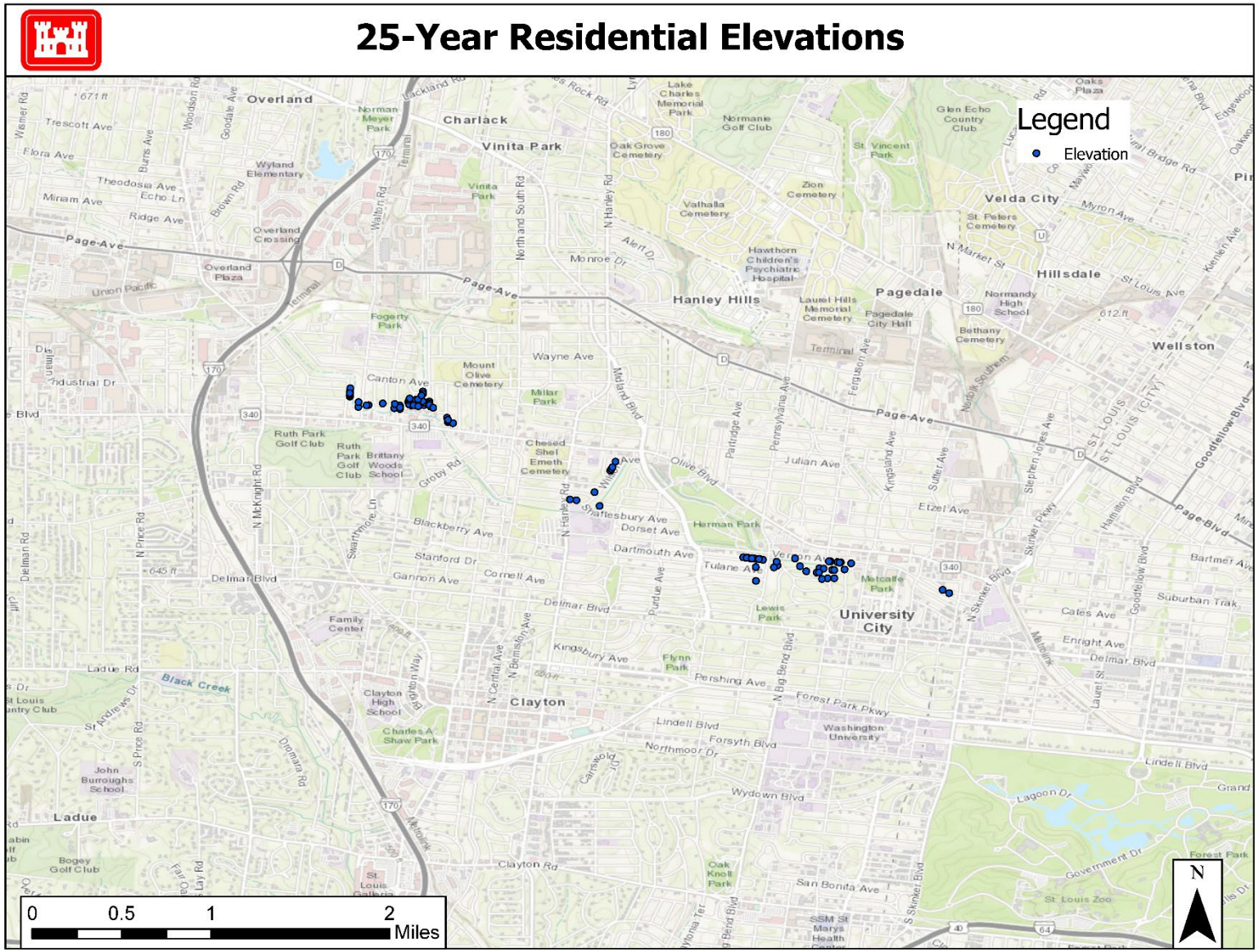

Figure 27. Alternative 7 – Nonstructural – Elevation only (refinement of Alternative 6)

3.5.1.9. Alternative 8 – DB4 and Nonstructural (Optimized)

Previously, when the Draft version of this report was released for public review in July 2021, Alternative 8 consisted 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 (Figure 28), as well as a flood warning system. The homes would be elevated to the height of the 1% AEP. As was noted in the Draft Report at the time, the study team planned to assess another configuration of DB4 with nonstructural in a way that would maximize net benefits. This alternative was developed as the most promising combination of structural and nonstructural measures, because DB4 had the greatest net benefits out of the structural measures. The presence of DB4 greatly reduced the number of structures requiring flood risk reduction treatments.

Subsequent refinement of this alternative by the study team led to significant changes. Following the public review and internal reviews of the Draft Report in summer 2021, the study team continued to work with the USACE Flood Risk Management Planning Center of Expertise (FRM-PCX) and the National Nonstructural Committee (NNC) to refine Alternative 6 and Alternative 8 by aggregating the structures in the study area into specific reaches along the river and applying nonstructural measures to those structures in a more nuanced way, in order to improve the flood risk management solution and optimize the net benefits. For each reach, the AEP event (or no action) that reasonably maximized net benefits was chosen to be applied, thus maximizing overall net NED benefits. See Appendix I – Economics for more detail.

The following criteria were applied to identify structures eligible for nonstructural measures. Residential structures with depth of flooding greater than two feet above the first floor (+2 ft or more) were eligible for elevation. Residential structures with basements with substantial flooding below the first floor (-1 to 0 ft) were eligible for basement fill. Non-residential structures with up to three feet of flooding (0 to 3 ft) were eligible for dry floodproofing. Structures eligible for nonstructural treatment for which the costs of treatment exceeded that of acquisition were indicated for acquisition. Ultimately, no structures were designated for elevation as it was too costly in all cases of eligibility.

For Alternative 8, the additional structure aggregation and application of nonstructural criteria led to a change in the type and number of structures included; the number fell from 56 residential structures to 47 residential and non-residential structures (Table 13).

Table 13. Number of structures and type of nonstructural measure applied – Alternative 8

Nonstructural Measure	# Structures
Floodproofing (Commercial)	18
Basement Fill (Residential)	21
Acquisition	8
Total	47

None of the 47 structures included in the alternative have been determined eligible for the National Register, and in addition all of the affected structures fall outside of the two National Register Historic Districts (University City Education District and University Heights Subdivision Number 1). Consultation with the SHPO and other consulting parties regarding impacts to historic structures will occur prior to ADM, confirming whether or not historic structures would be adversely impacted by this alternative. DB4 would reduce flood risk to existing historic structures, which would be a beneficial impact.

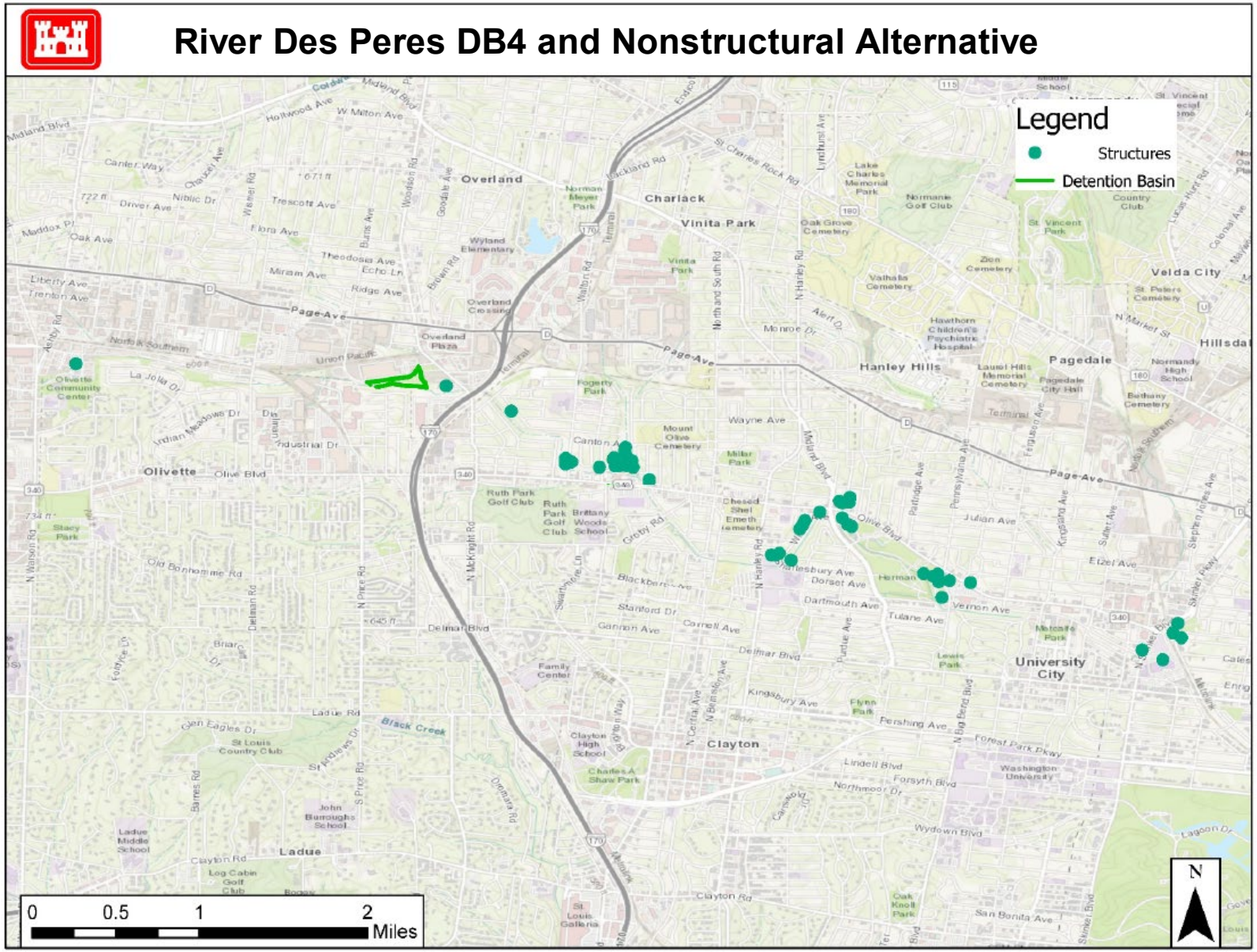

Figure 28. Alternative 8 – DB4 and Nonstructural (Optimized)

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 14 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 14. 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 (qualitative assessment for EQ and OSE accounts).

Benefits Category	Alternative							
	2-Auth. Plan & Detention Basin 3&4**	3a-Detention Basin 3&4**	3b-Detention Basin 4**	4-Levee/ Floodwall & DB3 & DB4*	5-Buyouts*	6-Nonstructural Only (Optimized)**	7-Elevation*	8- DB4 & Nonstructural (Optimized)**
National Economic Development (NED)								
Total Project First Cost ($1,000s)	$62,036	$46,481	$9,867	$84,589	$222,591	$28,584	$26,498	$30,450
Net Annual Benefits ($1,000s)	$421	$649	$842	-$1,096	-$2,754	$259	-$204	$788
BCR	1.19	1.40	3.42	0.73	0.66	1.27	0.79	1.75
Regional Economic Development (RED)								
Gross Regional Product	$56M	$41M	$9M	$82M	[not calculated]	$25M	[not calculated]	$28M
Full-Time Equivalent Jobs Created	1,008	741	160	1,018	[not calculated]	391	[not calculated]	479
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	Very Low	Very Low	None	Very Low	High	Very Low	None	Very Low
Cultural Resources Impacts	Low	Low	Low	Low	High	Low	Medium	Low
Other Social Effects (OSE)								
Life Safety Risk Reduced (Flooding)	Medium	Low	Low	Medium	Medium	Medium	Medium	Medium
Residual Life Safety Risk (Tornadoes)	None/Low	None/Low	None/Low	None/Low	None/Low	High	High	High
Critical Infrastructure Risk Reduced	High	High	Medium	High	Low	Low	*Low (likely)*	Medium
Impacts to Low Income Neighborhoods	Medium	None/Low	None/Low	Medium	Low	Low	*Low (likely)*	Low
Recreational Opportunities	Medium	Low	Low	Medium	High	Low	Low	Low
Other: HMGP Land Impacts	High	None	None	High	None	None	None	None

* FY 2021 Federal interest rate of 2.5% was used to discount costs and benefits to the base year, then amortize the costs over the 50-year period of analysis in 2021 price levels. ** FY 2022 Federal interest rate of 2.25% was used to discount costs and benefits to the base year, then amortize the costs over the 50-year period of analysis in 2022 price levels. These alternatives have updated costs because their net benefits showed further refinement was warranted after the TSP Milestone.

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 15 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, 6, and 8 possess a BCR greater than 1.0 and have positive annual net benefits. Refer to Appendix I for more details.

Table 15. Costs and benefits of the final array of alternatives

Alternative	Project First Cost	Average Annual Costs	Average Annual Benefits	Net Annual Benefits	Benefit to Cost Ratio
2 -Modified 1988 Authorized Plan	$62,036,000	$2,190,000	$2,611,000	$421,000	1.19
3a - Detention Basins 3 and 4	$46,481,000	$1,631,000	$2,280,000	$649,000	1.40
3b - Detention Basin 4	$9,867,000	$348,000	$1,190,000	$842,000	3.42
4 - Levee/Floodwall	$84,589,000	$4,035,000	$2,939,000	($1,096,000)	0.73
5 -.04 AEP Acquisitions	$22,591,000	$8,045,000	$5,291,000	($2,754,000)	0.66
6 - Nonstructural Only (Optimized)	$28,584,000	$969,000	$1,228,000	$259,000	1.27
7 - .04 AEP Residential Elevations	$26,498,000	$958,000	$753,670	($204,330)	0.79
8 - Detention Basin 4 and Nonstructural (Optimized)	$30,450,000	$1,046,000	$1,834,000	$788,000	1.75

Note: Costs and benefits for Alternatives 2, 3a, 3b, 6, and 8 developed with FY 2022 price levels and 2.25% discount rate. Costs and benefits for Alternatives 4, 5, and 7 developed with FY 2021 price levels and 2.5% discount rate (alternatives not developed beyond July 2021 Draft Report).
*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. At the TSP Milestone, Alternative 6 was identified as the NED Plan; however, subsequent cost updates led to the identification of Alternative 3b 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 15. The NED plan (Alternative 3b) is the most efficient.

A sensitivity analysis was conducted on the participation in Alternative 8, showing the benefits and costs of 25%, 50%, 75% and 100% participation in the voluntary nonstructural portion of the NED plan. The participation sensitivity analysis showed that as nonstructural participation declines from 100%, total benefits for Alternative 8 decrease but net benefits increase. The results show that at 75% participation or less, Alternative 8 is likely to have greater net benefits than Alternative 3b, but there are significant limitations to how these costs were developed (see Appendix I), and several other considerations went into selecting Alternative 3b as the NED plan (Alternative 3b maximizes comprehensive benefits across the RED, EQ, and OSE accounts). Therefore, low participation is unlikely to change the selection of the NED plan. See Appendix I for more information. Alternative 8 contains DB4 in addition to the nonstructural measures, so essentially, net benefits increase more as the plan gets closer to DB4 by itself (i.e., Alternative 3b).

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.

The Economic Consequence Assessment Model (ECAM) is another RED model utilized by this study to measure the effects of unmitigated floodwaters on regional production and employment. Appendix I has more information.

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 is presented in Section 6 of this report.

4.1.3.1 Cultural Effects

Cultural effects were also assessed. 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, no one alternative clearly maximizes benefits in the EQ category. However, the alternatives with impacts to Cultural Resources (Alternative 5 and 7) are not expected to maximize benefits within this category.

4.1.4 Other Social Effects

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

The alternatives containing structural measures (Alternatives 2, 3a, 3b, 4, and 8) 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 been quantified. Life safety risk analyses were conducted for DB4, which is included in multiple alternatives (Alternatives 2, 3a, 3b, 4, and 8). The LifeSim analysis showed that life loss in the with-project condition in a breach and non-breach scenario is less than the without-project condition, so there is unlikely to be any additional risk of life loss from the detention basin. Indeed, the risk of life loss is likely reduced from the presence of the detention basin. Furthermore, incremental life loss is approximately zero, suggesting there is little-to-no additional risk of life loss due to failure of the detention basin. More information is included in Appendix K.

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. However, participation by homeowners and business owners in voluntary nonstructural measures such as filling the basement and dry floodproofing is not expected to be 100%, or close to 100%. The study team anticipates homeowners will be reluctant to lose their basements, and given that nonstructural implementation is fairly new to the St. Louis District, owners may be unsure about signing up. An additional consideration related to the removal of basements is that

people in this region use their basements as tornado shelters; therefore, the removal of basements from homes that will remain in place as part of alternatives 6, 7, and 8 would increase residual risk related to tornadoes. 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. 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. 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.

4.1.5. Summary: Comprehensive Benefits

In accordance with a 2021 policy directive, the USACE decision framework must consider, in a comprehensive manner, the total benefits of project alternatives, including equal consideration of economic, environmental and social categories. Based on a comprehensive evaluation of benefits across NED, RED, EQ, and OSE as summarized above, Alternative 3b maximizes total benefits across all benefits categories. Alternative 3b is the NED plan, provides positive regional economic benefits, and has a similar impact as other alternatives in the EQ and OSE categories. Therefore, it is reasonable to select Alternative 3b as the plan that comprehensively maximizes total benefits.

4.1 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 16 (Fulfillment of Objectives). Three key themes of the objectives (reduce life safety risk and reduce economic damage due to flooding) 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.

Table 16 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 alternatives 2, 4, 5, 6, and 8. Alternatives 3a, 3b, and 7 would be less effective.

4.2.1 Residual Risk

The plan that reduces the most amount of damages and has the least average annual residual risk is Alternative 5 (the 4% AEP acquisitions) (Figure 29); however, this alternative is prohibitively costly despite underestimated costs as described in section 4.0 of Appendix I - Economics. Alternative 2 has the next least residual risk, but is also extremely costly. Table 16 also includes reducing economic damage due to flooding (average annual residual risk) as a criteria for fulfilling study objective #2.

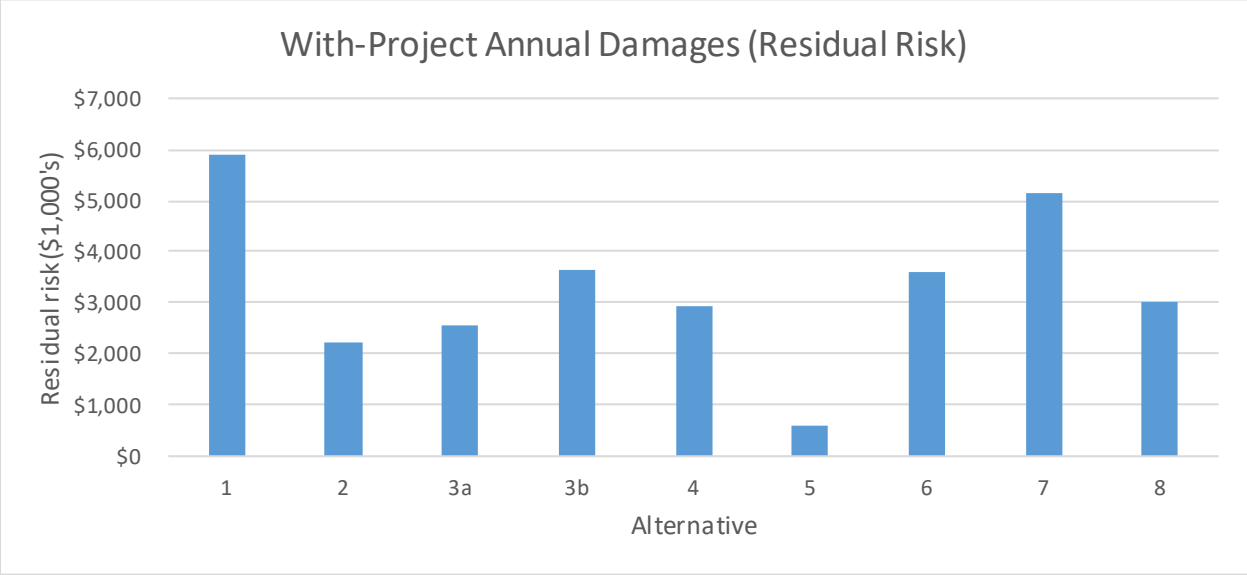

Figure 29. Residual risk (with-project average annual damages) for each alternative
Note: Damages for Alternatives 2, 3a, 3b, 6, and 8 developed with FY 2022 price levels and 2.25% discount rate. Damages for Alternatives 4, 5, and 7 developed with FY 2021 price levels and 2.5% discount rate (alternatives not developed beyond July 2021 Draft Report).

Table 16. Fulfilment of Objectives.

Alternative	Objective		Total Score
	Reduce life safety risk due to flooding	Reduce economic damage due to flooding (& average annual residual risk)*	
1 - No Action	0 – Does not reduce life safety risk	0 – Does not reduce economic damage	0
2 - Authorized Plan with Modifications (DB3 & DB4)	2 – Risk reduction through range of flood events	2 – Residual risk $2.2M	4
3a - Detention Basins (DB3 and DB4)	1- Risk reduction for 50% AEP	2 – Residual risk $2.6M	3
3b - Detention Basin 4 (DB4)	1- Risk reduction for 50% AEP	2 – Residual risk $3.7M	3
4 - Levee/Floodwall (with DB3 & DB4)	2 – Risk reduction for 1% AEP	2 – Residual risk $3.0M	4
5 - Nonstructural - .04 AEP Acquisition	2 – Risk reduction for 4% AEP	3 – Residual risk $595,000	5
6 - Nonstructural Only (Optimized)	2 – Risk reduction for range of AEP events	2 – Residual risk $3.6M	4
7 - Nonstructural – .04 AP Residential Elevation only	2 – Risk reduction for 4% AEP	1 – Residual risk $5.1M	3
8 - DB4 and Nonstructural (Optimized)	2 – Risk reduction for range of AEP events	2 – Residual risk $3.0M	4

* Residual risk is the amount of annual economic damage remaining after the alternative is implemented.
**2021 price levels

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 require 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 adversely 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 Only (Optimized): 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. 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 – Elevation: 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 – DB4 and Nonstructural (Optimized): 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 detention basins would replace a commercial business (DB3) and a recreational park (DB4). Where the detention basins are constructed, land use would change from 'developed – medium/high intensity / 'developed – open space' to 'barren land'. The change from 'developed – medium/high intensity / developed – open space' land use categories to 'barren land' is not considered a significant adverse impact to land use because the construction of the detention basins would reduce potential flood risk and impacts in the area. The existing land cover would remain urban – a mix of residential properties, commercial businesses, and other urban uses. The channel modifications would not

significantly alter existing land use, as they wouldn't require clearing existing residential, commercial, or public land. The channel area is currently designated as 'open water' land use category, and once modified would continue to be designated as 'open water'. Overall, insignificant land use 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 land use category where the detention basins would be constructed would change long-term from 'developed – medium/high intensity' to 'barren land'. However, this is not considered a significant adverse impact to land use because the construction of either one (i.e., 3b) or both (i.e., 3a) detention basins would reduce potential flood risk and impacts in the area. The existing land cover would remain urban-a mix of residential properties, commercial businesses, and other urban uses. Overall, insignificant land use changes would occur with Alternative 3a or 3b.

Alternative 4 – Levee/Floodwall: The floodwall would be built on lands acquired by University City. Some residential property would be acquired to build the floodwall, but no homes would need to be removed. Land use where the floodwall would be constructed is currently 'developed – medium/high intensity' and would change long-term to 'barren land'. However, this is not considered a significant adverse impact to land use because the construction of the flood wall would reduce potential flood risk and impacts in the area. The current land cover is urban and would remain urban after this alternative is built. Overall, insignificant land use changes would occur with Alternative 4.

Alternative 5 – Nonstructural – Acquisition: This non-structural alternative would result in long-term localized land use changes where dwellings would be removed from within the floodplain. Where residential houses are removed, land use would change from 'developed – medium/high intensity' to 'barren land'. Land cover, in general, would remain urban due to the developed nature of the area. The change from 'developed-medium/high intensity' land use category to 'barren land' is not considered a significant adverse impact to land use because dwellings would be removed from the floodplain and potential flood impacts would be reduced.

Alternative 6 – Nonstructural Only (Optimized): The acquisitions included in this alternative would result in long-term localized land use changes where dwellings would be removed from within the floodplain. Otherwise, there would be no change to land use. Therefore, land use within the area covered by the non-structural alternative would remain within the 'developed – medium/high intensity' land use designation. 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 – Elevation: Like Alternatives 5 and 6, this non-structural alternative would not change existing land use or land cover. Land use would remain within the 'developed – medium/high intensity' land use designation. Land cover would remain urban in nature. Land use/land cover would not be impacted by Alternative 7.

Alternative 8 – DB4 and Nonstructural (Optimized): The acquisitions included in this alternative would result in long-term localized land use changes where dwellings would be removed from within the floodplain. Otherwise, the nonstructural elements of the alternative would not change land use or land cover. The construction of DB4 would change the existing land away from public recreation to the basin. The land use designation from the construction of DB4 would change from 'developed – open space' to 'barren land'. The change from 'developed – open space' land use category to 'barren land' is not considered a significant adverse impact to land use because the construction of the detention basin would reduce potential flood risk and impacts in the area. Overall, insignificant impacts to land use would occur with 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. In the short-term, the emissions generated by construction of the structural alternatives and construction/demolition required for the non-structural alternatives would cause minor adverse cumulative impacts when considered alongside other construction emissions in the region. In the long-term, nothing would be constructed as part of this project that would passively generate GHG emissions and, therefore, climate would not accrue cumulative adverse effects.

5.4. AIR QUALITY

Alternative 2 – Authorized plan with modifications (DB3 and DB4): Construction of the channel modifications and the detention basins would generate localized temporary, minor impacts to air quality via vehicle and equipment emissions. As a best management practice, all equipment would be required to comply with current emissions and fuel regulations, which minimize the emissions impact. The use of earthmoving equipment could result in the release of particulates (dust) during the detention basin construction. As best management practices, the area of unstabilized soils exposed at any time would be minimized. The construction contractor would be required to control dust by water or other means. No long-term adverse impacts to air quality would be expected from these alternatives. Air quality would experience temporary, minor, direct, and indirect 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. These adverse impacts would be minimized using BMPs designed to reduce air pollution. Vehicles and equipment would comply with current fuel and emissions regulations. Areas of bare, disturbed soil would be stabilized to

reduce particulates and dust in the air. No long-term adverse impacts to air quality are anticipated because, once constructed, the basins would not contribute to air pollution. Air quality would experience temporary, minor, direct, and indirect 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. These adverse impacts would be minimized using BMPs designed to reduce air pollution. Vehicles and equipment would comply with current fuel and emissions regulations. Areas of bare, disturbed soil would be stabilized to reduce particulates and dust in the air. No long-term adverse impacts to air quality are anticipated because, once constructed, the structures would not contribute to air pollution. Air quality would experience temporary, minor, direct, and indirect 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. These adverse impacts would be minimized using BMPs designed to reduce air pollution. Vehicles and equipment would comply with current fuel and emissions regulations. Areas of bare, disturbed soil would be stabilized to reduce particulates and dust in the air. No long-term adverse impacts to air quality would occur after demolition. Alternative 5 would result in insignificant short-term indirect adverse impacts to air quality and no effect to air quality long-term.

Alternative 6 – Nonstructural Only (Optimized): Construction of the nonstructural measures may produce temporary minor, direct adverse impacts to air quality. These adverse impacts would be minimized using BMPs designed to reduce air pollution. Vehicles and equipment would comply with current fuel and emissions regulations. Areas of bare, disturbed soil would be stabilized to reduce particulates and dust in the air. No permanent adverse impacts to air quality would occur. Overall, Alternative 6 would result in insignificant short-term indirect adverse impacts to air quality and no effect to air quality long-term.

Alternative 7 – Nonstructural – Elevation: Elevation of existing structures would generate minor temporary adverse impacts to air quality due to use of construction equipment emissions. These adverse impacts would be minimized using BMPs designed to reduce air pollution. Vehicles and equipment would comply with current fuel and emissions regulations. Areas of bare, disturbed soil would be stabilized to reduce particulates and dust in the air. No permanent adverse impacts to air quality would occur. Overall, Alternative 7 would result in insignificant short-term indirect adverse impacts to air quality and no effect to air quality long-term.

Alternative 8 – DB4 and Nonstructural (Optimized): The construction of DB4 and the nonstructural measures may generate temporary, minor adverse impacts from vehicle and equipment emissions. These adverse impacts would be minimized using BMPs designed to reduce air pollution. Vehicles and equipment would comply with current fuel and emissions regulations. Areas of bare, disturbed soil would be stabilized to reduce particulates and dust in

the air. Air quality would experience temporary, minor, direct, and indirect 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 ambient noise levels via vehicle, equipment, and construction disturbance. Noise analysis from similar studies indicates that the overall average noise level generated on a construction site could be 89 dBA at 50 feet during excavation type activities. While this would be greater than the 85 dBA noise level set by NIOSH (refer to discussion in Section 2.5), exposure to this noise level by nearby sensitive receptors for 8 continuous hours any given day that construction is occurring would be unlikely. Instead, exposure to the 89 dBA noise level by construction equipment would be in intermittent any given day that construction is occurring. In addition, certain noise levels are not prohibited by University City, only construction during certain hours/days. Per the University City Noise Ordinance, *Alteration, Demolition, Etc., of Buildings* (Section 215.780 Noise (B)(7)), the erection (including excavation), demolition, alteration, or repair of any building or other structure between the hours of 10:00 P.M. and 7:00 A.M. and on Sunday, except in case of urgent necessity in the interest of public safety and then only with a permit from the Building Commission is prohibited. Implementation of Alternative 2 would adhere to the restrictions on construction in the Noise Ordinance to minimize noise impacts. No permanent adverse impacts to noise would be expected from this alternative. Noise would suffer temporary, minor, direct impacts from Alternative 2.

Alternatives 3a and 3b – Detention Basins: Noise analysis from similar studies indicates that the overall average noise level generated on a construction site could be 89 dBA at 50 feet during excavation type activities. While this would be greater than the 85 dBA noise level set by NIOSH (refer to discussion in Section 2.5), exposure to this noise level by nearby sensitive receptors for 8 continuous hours any given day that construction is occurring would be unlikely. Instead, exposure to the 89 dBA noise level by construction equipment would be in intermittent any given day that construction is occurring. In addition, certain noise levels are not prohibited by University City, only construction during certain hours/days. Per the University City Noise Ordinance, *Alteration, Demolition, Etc., of Buildings* (Section 215.780 Noise (B)(7)), the erection (including excavation), demolition, alteration, or repair of any building or other structure between the hours of 10:00 P.M. and 7:00 A.M. and on Sunday, except in case of urgent necessity in the interest of public safety and then only with a permit from the Building Commission is prohibited. Construction of the two basins would generate noise, resulting in temporary, minor, direct impacts to noise pollution. No permanent adverse impacts to noise are anticipated. Long-term adverse impacts to noise are not anticipated. The basins themselves would not generate noise once constructed. Noise would suffer temporary, minor, direct impacts from Alternative 3a or 3b.

Alternative 4 – Levee/Floodwall: Noise analysis from similar studies indicates that the overall average noise level generated on a construction site could be 89 dBA at 50 feet during

excavation type activities. While this would be greater than the 85 dBA noise level set by NIOSH (refer to discussion in Section 2.5), exposure to this noise level by nearby sensitive receptors for 8 continuous hours any given day that construction is occurring would be unlikely. Instead, exposure to the 89 dBA noise level by construction equipment would be in intermittent any given day that construction is occurring. In addition, certain noise levels are not prohibited by University City, only construction during certain hours/days. Per the University City Noise Ordinance, *Alteration, Demolition, Etc., of Buildings* (Section 215.780 Noise (B)(7)), the erection (including excavation), demolition, alteration, or repair of any building or other structure between the hours of 10:00 P.M. and 7:00 A.M. and on Sunday, except in case of urgent necessity in the interest of public safety and then only with a permit from the Building Commission is prohibited. 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 because the floodwall structure would not generate noise once constructed. Noise would suffer temporary, minor, direct impacts from Alternative 4.

Alternative 5 – Nonstructural – Acquisition: Noise analysis from similar studies indicates that the overall average noise level generated on a construction site could be 89 dBA at 50 feet during excavation type activities. While this would be greater than the 85 dBA noise level set by NIOSH (refer to discussion in Section 2.5), exposure to this noise level by nearby sensitive receptors for 8 continuous hours any given day that construction is occurring would be unlikely. Instead, exposure to the 89 dBA noise level by construction equipment would be in intermittent any given day that construction is occurring. In addition, certain noise levels are not prohibited by University City, only construction during certain hours/days. Per the University City Noise Ordinance, *Alteration, Demolition, Etc., of Buildings* (Section 215.780 Noise (B)(7)), the erection (including excavation), demolition, alteration, or repair of any building or other structure between the hours of 10:00 P.M. and 7:00 A.M. and on Sunday, except in case of urgent necessity in the interest of public safety and then only with a permit from the Building Commission is prohibited. Noise would be temporarily, minorly impacted by demolition. No permanent adverse impacts to ambient noise levels are anticipated because noise levels would be expected to decrease after demolition. Noise levels would resume to previous residential levels once new buildings are constructed, but given the flood risk in the area, new development is unlikely. Noise would suffer temporary, minor, direct impacts from Alternative 5.

Alternative 6 – Nonstructural Only (Optimized): Noise analysis from similar studies indicates that the overall average noise level generated on a construction site could be 89 dBA at 50 feet during excavation type activities. While this would be greater than the 85 dBA noise level set by NIOSH (refer to discussion in Section 2.5), exposure to this noise level by nearby sensitive receptors for 8 continuous hours any given day that construction is occurring would be unlikely. Instead, exposure to the 89 dBA noise level by construction equipment would be in intermittent any given day that construction is occurring. In addition, certain noise levels are not prohibited by University City, only construction during certain hours/days. Per the University City Noise Ordinance, *Alteration, Demolition, Etc., of Buildings* (Section 215.780 Noise (B)(7)), the erection

(including excavation), demolition, alteration, or repair of any building or other structure between the hours of 10:00 P.M. and 7:00 A.M. and on Sunday, except in case of urgent necessity in the interest of public safety and then only with a permit from the Building Commission is prohibited. The ambient noise in the 4% AEP where the floodproofing and elevations are targeted would be expected to remain the same as existing conditions after completion of construction-related activities. Long-term noise levels would be expected to remain the same after flood improvements are made. During construction, noise would suffer temporary, minor, direct impacts from Alternative 6.

Alternative 7 – Nonstructural – Elevation: Noise analysis from similar studies indicates that the overall average noise level generated on a construction site could be 89 dBA at 50 feet during excavation type activities. While this would be greater than the 85 dBA noise level set by NIOSH (refer to discussion in Section 2.5), exposure to this noise level by nearby sensitive receptors for 8 continuous hours any given day that construction is occurring would be unlikely. Instead, exposure to the 89 dBA noise level by construction equipment would be in intermittent any given day that construction is occurring. In addition, certain noise levels are not prohibited by University City, only construction during certain hours/days. Per the University City Noise Ordinance, *Alteration, Demolition, Etc., of Buildings* (Section 215.780 Noise (B)(7)), the erection (including excavation), demolition, alteration, or repair of any building or other structure between the hours of 10:00 P.M. and 7:00 A.M. and on Sunday, except in case of urgent necessity in the interest of public safety and then only with a permit from the Building Commission is prohibited. Noise levels would be expected to remain the same as existing conditions after flood improvements are made to the homes. During construction, noise would suffer temporary, minor, direct impacts from Alternative 7.

Alternative 8 – DB4 and Nonstructural (Optimized): The construction of DB4 and the nonstructural measures may generate temporary, minor adverse impacts from vehicle noise and construction disturbances. Again, the basin would not generate noise once constructed, so there will be no long-term adverse impacts to noise. 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 detention basins would result in changes to downstream hydraulics and hydrology. Erosion patterns and flow rates would be altered while the stream adjusts to its new conditions. The detention would alter hydrology by reducing flow during high-water events. Water in the river would enter the basins during flood events where it would be detained reducing the volume of water in the river downstream of the basin. In this way, the detention basins would mimic a natural hydrologic process by acting like a feature in a natural floodplain. Floodplains have areas along the bank that become flooded during high water events. The floodwaters slow down as they enter wide, flat areas, and are detained in depressions and low areas. In highly developed urban streams like the River Des Peres, the channel is constricted and floodwaters surge at high velocities and at volumes too great for the channel to hold. Flood water surging through a constricted,

channelized river system like the River Des Peres could be slowed and reduced by the detention basins. Mimicking natural processes would provide a beneficial impact. Hydraulics and hydrology would have minor, direct and indirect benefits from Alternative 2.

Alternatives 3a and 3b – Detention Basins: The detention basins would result in changes to downstream hydraulics and hydrology. Erosion patterns and flow rates would be altered while the stream adjusts to its new conditions. The detention would alter hydrology by reducing flow during high-water events. Water in the river would enter the basins during flood events where it would be detained reducing the volume of water in the river downstream of the basin. In this way, the detention basins would mimic a natural hydrologic process by acting like a feature in a natural floodplain. Floodplains have areas along the bank that become flooded during high water events. The floodwaters slow down as they enter wide, flat areas, and are detained in depressions and low areas. In highly developed urban streams like the River Des Peres, the channel is constricted and floodwaters surge at high velocities and at volumes too great for the channel to hold. Flood water surging through a constricted, channelized river system like the River Des Peres could be slowed and reduced by the detention basins. Mimicking natural processes would provide a beneficial impact. 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 have minor direct adverse impacts from Alternative 4.

Alternative 5 – Nonstructural – Acquisition: Property acquisitions would not alter the hydraulics or hydrology of the River Des Peres. After the acquired properties are demolished and removed, future flood events would not cause as much economic damage because there would be far fewer residences and businesses at risk. The open area where these buildings used to be could be flooded with less risk, mimicking a natural floodplain. Furthermore, if the open land is converted into a green space like a field or park, this would provide a long-term direct benefit to hydrology. Taking the acquisitions and demolitions alone, the hydraulics and hydrology would not be impacted by Alternative 5 because nothing would be built or lost that contributed to changes in to the hydraulics and hydrology of the river.

Alternative 6 – Nonstructural Only (Optimized): 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 – Elevation: 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 – DB4 and Nonstructural (Optimized): The detention basin would result in changes to downstream hydraulics and hydrology. Erosion patterns and flow rates would be altered while the stream adjusts to its new conditions. The detention would alter hydrology by reducing flow during high-water events. Water in the river would enter the basin during flood events where it would be detained reducing the volume of water in the river downstream of the basin. In this way, the detention basin would mimic a natural hydrologic process by acting like a feature in a natural floodplain. Floodplains have areas along the bank that become flooded during high water events. The floodwaters slow down as they enter wide, flat areas, and are detained in depressions and low areas. In highly developed urban streams like the River Des Peres, the channel is constricted and floodwaters surge at high velocities and at volumes too great for the channel to hold. Flood water surging through a constricted, channelized river system like the River Des Peres could be slowed and reduced by the detention basins. Mimicking natural processes would provide a beneficial impact. 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 minor temporary indirect adverse impacts via sedimentation during construction disturbance. Areas of bare soil can run off into the stream when it rains adding an excessive amount of sediment to the system. Best management practices (BMPs) (e.g., coir rolls, silt fencing, etc.) 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: Water quality would suffer minor temporary indirect adverse impacts via sedimentation during construction disturbance. Areas of bare soil can run off into the stream when it rains adding an excessive amount of sediment to the system. Best management practices (BMPs) (e.g., coir rolls, silt fencing, etc.) 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 would suffer minor temporary indirect adverse impacts via sedimentation during construction disturbance. Areas of bare soil can run off into the stream when it rains adding an excessive amount of sediment to the system. Best management practices (BMPs) (e.g., coir rolls, silt fencing, etc.) would be implemented during construction to reduce or eliminate these sedimentation impacts. No long-term permanent impacts to water quality would result from the levee or floodwall structures.

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, BMPs would be implemented to reduce soil erosion and runoff. No long-term permanent impacts to water quality would result from this alternative. Areas of bare soil would be stabilized during construction and restored with an appropriate seed mix. In this way, the risk of excessive sedimentation would be minimized.

Alternative 6 – Nonstructural Only (Optimized): Floodproofing and acquisition involve 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, BMPs would be implemented to reduce soil erosion and runoff. No long-term permanent impacts to water quality would result from this alternative.

Alternative 7 – Nonstructural – Elevation: 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, BMPs would be implemented to reduce soil erosion and runoff. No long-term permanent impacts to water quality would result from this alternative.

Alternative 8 – DB4 and Nonstructural (Optimized): 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 direct and indirect adverse impacts would result from disturbances caused by equipment noise and soil disturbance. The area around the inlet/outlet

may restrict access to bank habitat, but these structures are small and do not take up a substantial portion of the riverbank. Installation of the detention basin inlet/outlet would cause minor direct adverse impacts to those plants and animals that would be smothered by the structure. Naturalized features may be added upon further refinement of the designs, including native vegetation plantings and a detention basin seed mix that features native plants adapted to the conditions of the basins. 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. While the basins may only end up providing marginal habitat, they would be better for fish & wildlife than the existing conditions at detention basin 3 (a commercial business and parking lot). The detention basin 4 site is a city park, which is likely no better or worse than a detention basin. Long-term, minor, direct, and indirect impacts are expected from the channel modifications. The detention basins would cause short-term, minor, direct, and indirect adverse impacts to fish and wildlife. Given the degraded nature of the stream, impacts to fish and wildlife are expected to be minor. 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 the anticipated water quality improvement due to implementation of Alternative 2.

Alternatives 3a and 3b – Detention Basins: As previously detailed, the detention basins would cause temporary direct and indirect adverse impacts to fish and wildlife. Minor direct and indirect adverse impacts would result from disturbances cause by equipment noise and soil disturbance. The area around the inlet/outlet may restrict access to bank habitat, but these structures are small and do not take up a substantial portion of the riverbank. Installation of the detention basin inlet/outlet would cause direct adverse impacts to those plants and animals that would be smothered by the structure. Naturalized features may be added upon further refinement of the designs, including native vegetation plantings and a detention basin seed mix that features native plants adapted to the conditions of the basins. In any case, the detention basins would eventually grow some vegetation and develop hydric soils. The gradual development of hydric soils and the growth of vegetation would provide food and habitat for wildlife. While the basins may only end up providing marginal habitat, they would be better for fish & wildlife than the existing conditions at detention basin 3 (a commercial business and parking lot). Detention Basin 4 is a city park, which is likely no better or worse than a detention basin. Given the degraded nature of the stream, impacts to fish and wildlife are expected to be minor. 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 the anticipated water quality improvement due to implementation of Alternative 3a or 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. Long-term adverse impacts may occur due to the hardening of the channel banks, especially with the floodwall. The presence of the floodwall would make it difficult for wildlife to access the stream

channel. Abundance of wildlife within the area is minimal due to the highly urbanized nature of the stream corridor; therefore, the presence of the floodwalls is not expected to be a significant adverse impact to wildlife. Overall, there would be minor direct and indirect short-term and long-term adverse impacts to fish and wildlife with implementation of Alternative 4.

Alternative 5 – Nonstructural – Acquisition: Fish and Wildlife would experience temporary, minor impacts during the demolition or relocation of the structures. A potential long-term beneficial impact to fish and wildlife may occur due to the reduction in impervious surface. The demolition or relocation of structures within the floodplain, and the change of the habitat from impervious to pervious grass may have a minor beneficial impact on water quality by allowing infiltration of stormwater into the soil prior to entering the river. Appropriate seed mixes can be used to restore areas of soil disturbance.

Alternative 6 – Nonstructural Only (Optimized): The nonstructural measures would cause temporary, minor impacts to existing fish and wildlife in the project area during construction. The presence of construction equipment and personnel would likely disturb fish and wildlife and deter them from using the area while demolition and construction are occurring. Therefore, fish and wildlife would be temporarily minorly adversely impacted. A potential long-term beneficial impact to fish and wildlife may occur due to the removed acquired properties reducing the impervious surface. The demolition or relocation of structures within the floodplain, and the change of the habitat from impervious to pervious grass may have a minor beneficial impact on water quality by allowing infiltration of stormwater into the soil prior to entering the river. Once construction is complete, fish and wildlife would be expected to use the area again; therefore, no long-term impacts are anticipated.

Alternative 7 – Nonstructural – Elevation: Building elevations cause temporary, minor impacts to existing fish and wildlife in the project area during construction. The presence of construction equipment and personnel would likely disturb fish and wildlife and deter them from using the area while construction is occurring. Therefore, fish and wildlife would be temporarily minorly adversely impacted by the elevation. Once construction is complete, fish and wildlife would be expected to use the area again; therefore, no long-term impacts are anticipated.

Alternative 8 – DB4 and Nonstructural (Optimized): As previously detailed, the detention basin would cause temporary direct and indirect adverse impacts to fish and wildlife. Minor direct, and indirect adverse impacts would result from disturbances cause by equipment noise and soil disturbance. The area around the inlet/outlet may restrict access to bank habitat, but these structures are small and do not take up a substantial portion of the riverbank. Installation of the detention basin inlet/outlet would cause direct adverse impacts to those plants and animals that would be smothered by the structure. Naturalized features may be added upon further refinement of the designs, including native vegetation plantings and a detention basin seed mix that features native plants adapted to the conditions of the basins. In any case, the detention basins would eventually grow some vegetation and develop hydric soils. The gradual development of hydric soils and the growth of vegetation would provide food and habitat for

wildlife. While the basin may only provide marginal habitat, it could end up providing beneficial impacts to fish & wildlife relative to the existing conditions. Detention Basin 4 is a city park, which is likely no better or worse than a detention basin. 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. The nonstructural measures would cause temporary, minor impacts to existing fish and wildlife in the project area during construction. The presence of construction equipment and personnel would likely disturb fish and wildlife and deter them from using the area while demolition and construction are occurring. Therefore, fish and wildlife would be temporarily minorly adversely impacted. A potential long-term beneficial impact to fish and wildlife may occur due to the removed acquired properties reducing the impervious surface. The demolition or relocation of structures within the floodplain, and the change of the habitat from impervious to pervious grass may have a minor beneficial impact on water quality by allowing infiltration of stormwater into the soil prior to entering the river. Fish and wildlife would be minorly benefitted by the anticipated water quality improvement due to implementation of 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. As a BMP, removal, or destruction of structures upon which nest migratory birds could be restricted to the off-breeding season. Migratory bird concerns would be temporarily, minorly adversely 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 Only (Optimized): 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 – 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 structural elevation.

Alternative 8 – DB4 and Nonstructural (Optimized): As previously stated, the basins can provide food and habitat, if properly designed and maintained. The non-structural elements would not include any actions that could reasonably be shown to harm migratory birds. 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 to 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 bats. 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.

Monarch Butterfly
Missouri is not an overwintering site for Monarch Butterfly. There is no milkweed in the project area. The construction disturbance by cause temporary, minor impacts to Monarch Butterfly that are migrating through the area. The St. Louis District has made a *"may affect by not likely to adversely affect*" determination for Monarch Butterfly.

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 (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-listed endangered 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 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. Invasive species concerns may be minorly adversely impacted by Alternative 5.

Alternative 6 – Nonstructural Only (Optimized): For the few structures demolished or moved, the disturbed area may allow for the spread of invasive species, which readily colonize disturbed areas. Invasive species concerns may be minorly adversely impacted by Alternative 6.

Alternative 7 – Nonstructural – Elevation: Invasive species concerns would not be affected by Alternative 7.

Alternative 8 – DB4 and Nonstructural (Optimized): For the few structures demolished or moved, the disturbed area may allow for the spread of invasive species, which readily colonize disturbed areas. At DB4, invasive species concerns would not be impacted if the basin includes monitoring and maintenance in its design. Invasive species concerns may be minorly adversely impacted by Alternative 8.

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. A second letter was sent on 8 March 2022, verifying the previously disturbed landform at the proposed detention basin location, Woodson Road Park, and requesting concurrence of no effect on historic properties for this alternative. The SHPO responded on 4 April 2022 with a determination of No Historic Properties Affected. In the unlikely event that earthmoving activities associated with the proposed project did impact potentially significant archeological/historic properties, all construction activities and earthmoving actions in the immediate vicinity would be held in abeyance until the potential significance of the discovery 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 levee/floodwall. 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 520 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 Only (Optimized): None of the structures included in the alternative have been determined eligible for the National Register, and in addition all of the affected structures fall outside of the two National Register Historic Districts (University City Education District and University Heights Subdivision Number 1). Consultation with the SHPO and other consulting parties regarding impacts to historic structures will occur prior to ADM, confirming whether or not historic structures would be adversely impacted by this alternative.

Alternative 7 – Nonstructural – Elevation: 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 – DB4 and Nonstructural (Optimized): None of the 47 structures included in the alternative have been determined eligible for the National Register, and in addition all of the affected structures fall outside of the two National Register Historic Districts (University City Education District and University Heights Subdivision Number 1). Consultation with the SHPO and other consulting parties regarding impacts to historic structures will occur prior to ADM, confirming whether or not historic structures would be adversely impacted by this alternative. DB4 would reduce flood risk to existing historic structures, which would be a beneficial 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 project did impact potential tribally significant archeological/historic remains, all construction activities, and earthmoving actions in the immediate vicinity 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. In the interest of public safety, the detention basins should probably not be designed to include recreational features such as bike and walking paths because of the flashy nature of the flooding. The basin design could 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 almost completely replace an

existing public park: the City of Overland's Woodson Road Park. The construction of a detention basin within Woodson Road Park would result in the loss of 1 gazebo that sits up to 40 people, a dog park, a BBQ pit, playground, picnic areas, and public restrooms. Because the Woodson Road Park site was designated for recreation use in the land agreement with the Department of the Interior, the City of Overland will need to relocate these features to ensure no net loss of recreation, so may create or enlarge a park with potentially the same amenities, resulting in a net zero change in recreation. Nearby parks may be used to relocate these features, such as Legion Park. Also, all the amenities at Woodson Road Park are available at the existing King Park and Indian Meadows Park except the dog park. The nearest dog park to the project area outside Woodson Road Park is Irv Zeid Park in Olivette. The continued presence of King Park and Indian Meadows Park would provide recreational opportunities to the community and help minimize impacts to recreational resources.

In addition, Alternative 2 also includes recreation alternative R-2, which would construct 1.85 miles of trail plus a small park located near Mona Drive. Alternative R-2 would help to further minimize impacts to recreational resources within the area.

Alternatives 3a and 3b – Detention Basins: Regarding DB4, as noted under Alternative 2, because the Woodson Road Park site was designated for recreation use in the land agreement with the Department of the Interior, the City of Overland may create a new park with the acreage of land removed from recreation use and potentially the same amenities, resulting in a net zero change in recreation. This would mean a minimal overall effect on recreation and aesthetics.

Alternative 4 – Levee/Floodwall: Adding recreational features to the levee and floodwall would not be possible due to limited space. Regarding DB4, as noted under Alternative 2, because the Woodson Road Park site was designated for recreation use in the land agreement with the Department of the Interior, the City of Overland may create a new park with the acreage of land removed from recreation use and potentially the same amenities, resulting in a net zero change in recreation. 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 Only (Optimized): This alternative would add green space on the acquired land which would improve aesthetics. The floodproofed structures 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 beneficial impacts. Recreation opportunities in the project area would not be affected.

Alternative 7 – Nonstructural – Elevation: 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 – DB4 and Nonstructural (Optimized): As with Alternative 6, the acquired land would add green space which would improve aesthetics. The floodproofed structures would remain in place and be protected from future flood damages. This may result in fewer buildings eventually becoming condemned after flood damages. Detention Basin 4 would, as previously detailed under Alternative 2, remove recreation features from a portion of Woodson Road Park and relocate them at another site in the City of Overland, likely at Legion Park. 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 2.16: 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. Each of the action alternatives would create a minor temporary economic benefit during construction through contracting labor. Over the long-term, the flood risk in the area would be offset by each action alternative.

Alternative 2 – Authorized plan with modifications (DB3 and DB4): This plan would have a total cost of $62,036,000, net annual benefits of $421,000, and a benefit to cost ratio (BCR) of 1.19.

Alternative 3a – Detention Basins 3 and 4: This plan would have a total cost of $46,481,000, net annual benefits of $649,000, and a BCR of 1.40.

Alternative 3b – Detention Basin 4: This plan would have a total cost of $9,867,000, net annual benefits of $842,000, and a BCR of 3.42.

Alternative 4 – Levee/Floodwall: This plan would have a total cost of $84,589,000, negative 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, negative net annual benefits of ($2,754,000), and a BCR of 0.66.

Alternative 6 – Nonstructural Only (Optimized): This plan would have a total cost of $28,584,000, net annual benefits of $259,000 and a BCR of 1.27.

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

Alternative 8 – DB4 and Nonstructural (Optimized): This plan would have a total cost of $30,450,000, net annual benefits of $788,000, and a BCR of 1.75.

5.15. SOCIO-ECONOMICS & DEMOGRAPHICS

All Alternatives: None of the proposed alternatives would result in a significant adverse impact to a minority, low-income, or children population. While there is a significant minority population present within the study area, as compared to the state, the structural and non-structural alternatives would all benefit those living in the study area by reducing economic damages from future flood events. Therefore, the socioeconomics and demographics would be minorly benefitted by any of the alternatives.

5.16. POPULATION AT RISK AND CRITICAL INFRASTRUCTURE

Alternative 2 – Authorized plan with modifications (DB3 and DB4): All alternatives 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 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 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 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 would reduce flood risk. The fire station is not one of the structures included for acquisition, so would remain impacted by the 1% AEP event under Alternative 5. While the PAR would benefit long-term from the implementation of Alternative 5, critical infrastructure would continue to be adversely impacted under the 1% AEP event.

Alternative 6 – Nonstructural Only (Optimized): Floodproofing and filling basements would improve life safety for those sheltering in place and the PAR. Emergency evacuation would remain an issue since most structures and inhabitants would remain in place. This alternative

would reduce flood risk and improve timely emergency evacuation. The fire station is not one of the structures included for nonstructural treatment, so would remain impacted by the 1% AEP event under Alternative 6. While the PAR would benefit long-term from the implementation of Alternative 6, critical infrastructure would continue to be adversely impacted under the 1% AEP event.

Alternative 7 – Nonstructural – Elevation: Elevating structures would improve life safety for those sheltering in place and the PAR. This would reduce flood risk. The fire station is not one of the structures included for elevation, so would remain impacted by the 1% AEP event under Alternative 7. While the PAR would benefit long-term from the implementation of Alternative 7, critical infrastructure would continue to be adversely impacted under the 1% AEP event.

Alternative 8 – DB4 and Nonstructural (Optimized): The detention basin and nonstructural treatments would reduce flood risk. Floodproofing and filling basements would improve life safety risk for those sheltering in-place and the PAR. The fire station is not one of the structures included for nonstructural treatment, so would remain impacted by the 1% AEP event under Alternative 8. However, the fire station would likely become less impacted (partially improved) under Alternative 8 due to the altered flood conditions resulting from DB4, which would be a benefit compared to the No Action alternative, although this has not yet been modeled. The PAR and critical infrastructure would be benefitted by Alternative 8.

5.17. CUMULATIVE IMPACTS ANALYSIS

The 1978 CEQ Regulations, which this EA follows since it was started prior to September 14, 2020 (i.e., when the 2020 NEPA Rule went into effect), 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).

<u>Step 1: Identify Potentially Affected Resources</u>
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. Floodwalls, levees, and channel modifications that constrict the river are human-made alterations to a natural system. Therefore, they would cause adverse impacts to the hydraulics and hydrology of the River Des Peres by constricting the water and speeding up its flow rate. Detention basins, in contrast, mimic natural floodplain processes, and so would have a beneficial impact. A developing urban area can generate other cumulative adverse impacts to the hydraulics and hydrology of the river. Urban development increases the area of impermeable surfaces, which generate excessive stormwater runoff which eventually drains into the river, contributing to a cumulative adverse impact to flood risk. The 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. 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.

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 the 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.

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.

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).

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 17.

Table 17. 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					T		
			X				Air Quality					T		
			X				Noise					T		
					X		Hydraulics & Hydrology			X				
			X				Water Quality			X		T		
			X				Hazardous Waste				X			
			X				Fish & Wildlife					T		
			X				Threatened & Endangered Species				X			
			X				Terrestrial Habitat					T/X		
			X				Aquatic Habitat					T/X		
			X				Migratory Birds					T/X		
			X				Invasive Species				X			
							B. Social Effects							
				C			Recreation & Aesthetics		C			T/X		
					C		Economic Conditions		C	T				
					C		Socioeconomics & Demographics		C					
					C		Population at Risk & Critical Infrastructure		X					
							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 3b, consisting of DB4 (Figure 30). DB4 would function very effectively to reduce flood stages both upstream in Overland and downstream in University City, and it would reduce the number of structures flooded and the extent of the flooding.

Alternative 3b has the highest net average annual benefits by a margin of $54,000. It is the least cost alternative, with a project first cost of $9.9M (it is $20.6M less expensive than Alternative 8). It has by far the highest BCR of any alternative, at 3.42. It is also the alternative supported by the Sponsor; the City of University City provided a letter of support for DB4 only as the LPP in January 2021. The City of Overland also preliminarily supports the alternative.

In addition to high NED benefits, Alternative 3b also compares neutrally or favorably with the other alternatives in the RED, EQ, and OSE accounts (see Section 4). DB4 would improve life safety risk over the Future Without Project condition; the risk of life loss is less than the without-project condition in both a scenario where the detention basin functions correctly and in a scenario where the detention basin breaches (see Appendix K for more detail). The biggest difference in life safety risk between Alternative 3b and Alternative 8 is that the eight (8) residential structures that would be acquired in Alternative 8 would remove the flood risk for those inhabitants.

The average annual residual risk (remaining flood risk after the alternative is implemented) is valued at $3,647,000 annually after the plan is implemented, as compared with $4.9M annually if no plan is implemented (see Section 4.2.1). This is $644,000 greater residual risk than Alternative 8. Additionally, participation in the voluntary nonstructural measures in Alternative 8 is not expected to be 100% or close to 100%, which would realistically further increase the residual risk of Alternative 8 (making Alternative 3b appear more favorable).

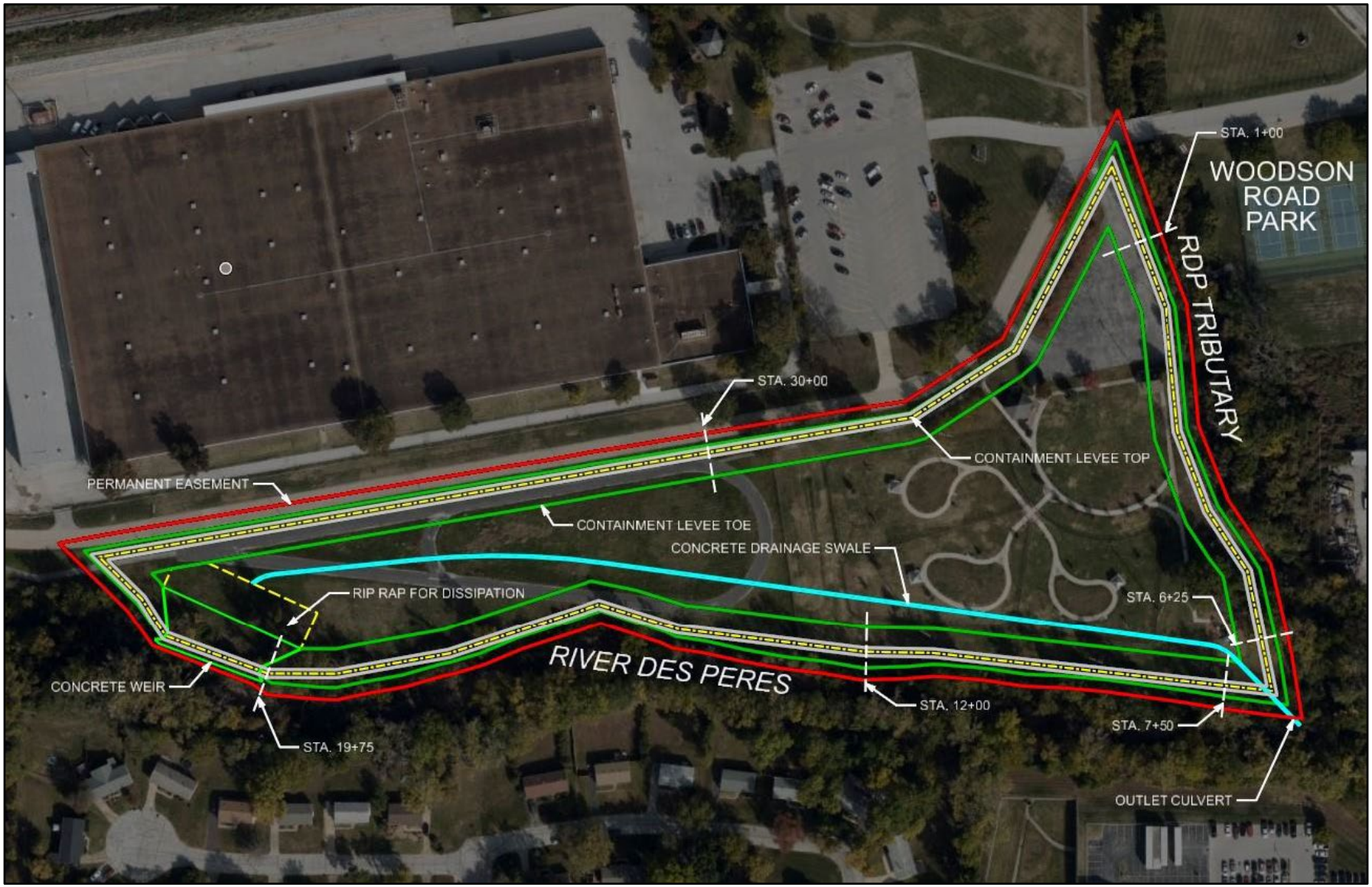

Figure 30. Tentatively Selected Plan (TSP): Alternative 3b – DB4

6.2. PURPOSES, SCOPE, AND SCALE

The Tentatively Selected Plan (TSP) is Alternative 3b, as described in Section 4. 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 comprises detention basin DB4.

If implemented, the TSP will reduce flood damage and flood risk from flood events of 50% AEP and larger. The detention basin will reduce peak flood elevation and flow downstream in University City and in the area around DB4.

6.3. PLAN COMPONENTS, INCLUDING MITIGATION

The detention basin is approximately 7.9 acres in size and is located on land owned by the General Services Administration (GSA) on the west side and the City of Overland (Woodson Road Park) on the east side. The portion of the park included in the DB4 footprint includes a dog park, restrooms, gazebo, picnic areas, and parking lot. However, the design may be modified to leave the restrooms and a portion of the parking lot in place; this design change would take place after the study is complete, in the Pre-Construction Engineering and Design (PED) phase.

The DB4 land is currently owned by the City of Overland and managed for recreation under an agreement with the National Park Service (NPS) (under the Department of the Interior). The preliminary opinion from USACE Real Estate is that while the deed itself states that the property cannot be used for anything other than a public park and recreation purposes, a request could be sent to the NPS from the City of Overland to repurpose the property for a higher public purpose, i.e. life safety, and that it is likely this would be granted.

The TSP would not impact any environmental features, and as such would not require any environmental mitigation. A 404(b)(1) evaluation was not done because the TSP does not propose to alter any stream or waterbody. 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. Uncertainty remains regarding the type of special considerations in the application of nonstructural measures on historic structures. This uncertainty will be reduced in the next phase of the study. At this time, no impediment to elevation or floodproofing historic structures has been identified; however, the PDT acknowledges that the costs associated with additional design features for historic structures may alter the net benefits.

6.4. COSTS AND BENEFITS

Table 18 shows the equivalent annual costs and benefits of Alternative 3b. The total project first cost (at FY2021 price levels) of Alternative 3b is $9,867,000. More information on project costs and benefits can be found in Appendix H and Appendix I.

Table 18. Equivalent Annual Costs and Benefits of Alternative 3b

Item Description	Alternative 3b – DB4 Only
Construction Costs	$ 7,718,010
Preconstruction Engineering/Design	$ 816,000
Construction Management	$ 453,000
Contingency	$ 1,919,000
Real Estate (LERRDs)	$ 2,148,660
Total Alternative Cost	**$ 9,867,000**
Interest During Construction	$ 223,000
Total Investment Cost[1]	**$ 10,090,000**
Annualized Investment Cost	$ 338,000
Annual O&M	$ 10,000
Total Annualized Investment Cost	**$ 348,000**
Annual Benefits	$ 1,190,000
Annual Net Benefits	**$ 842,000**
Benefit-Cost Ratio	3.42

FY 2022 price level; 50-year period of analysis, 2.25% Discount Rate

6.5. DESIGN AND CONSTRUCTION CONSIDERATIONS

At this point in the study, the design of DB4 is at a low level of detail. A Probable Failure Mode Analysis (PFMA) and breach scenario analysis were performed for DB4 as detailed in Appendix K – Life Safety Risk Assessment. Several geotechnical and design considerations are addressed in Appendix K.

The study team believes allowing recreation (such as a walking trail) within the detention basin is not safe for the public, given the flashy nature of the flooding and the potentially steep side slopes. However, if the side slopes are shallow enough, the crown is wide enough, other safety precautions are taken, and the Sponsor is in favor, then a walking trail could be installed on top of the embankment around DB4.

6.4. EXECUTIVE ORDER 11988 - FLOODPLAIN MANAGEMENT

Executive Order (EO) 11988 (24 May 1977), 42 Fed. Reg. 26,951, outlines the responsibilities of Federal agencies in the role of floodplain management. In accordance with this EO, USACE is required to evaluate the potential effects of actions on floodplains and does not undertake actions that directly induce growth in the floodplain, unless no practical alternative exists. Construction of structures and facilities on floodplains must incorporate flood proofing and other accepted flood protection measures. Agencies must attach appropriate use restrictions to property proposed for lease, easement, right-of-way, or disposal to non- Federal public or private parties.

The eight steps associated with the decision-making process in EO 11988 were considered in the evaluation of the TSP (Table 19).

Table 19. Eight Steps of Decision-Making Process in EO 11988

Determine if a proposed action is in the base floodplain.	Yes, the proposed alternatives are within the base floodplain.
Conduct early public review, including public notice.	A Public Scoping Meeting was held virtually on 30 September 2020. The first public meeting was held on July 26th 2021, and the second public meeting was held on Aug 16th 2021. A public review period for the updated Draft Report with Alternative 3b as the TSP will be held in March-April 2022. There will also be a 30-day public review period for this Environmental Assessment.
Identify and evaluate practicable alternatives to locating in the base floodplain, including alternative sites outside of the floodplain.	See Section 3.0, Formulation of alternative plans and future With Project Conditions, for description and evaluation of each alternative considered.
Identify impacts of the proposed action.	See Section 5.0 for description of impacts related to the TSP.
If impacts cannot be avoided, develop measures to minimize the impacts and restore and preserve the floodplain, as appropriate.	The TSP is non-structural and would not impact or disrupt natural floodplain processes.
Reevaluate alternatives.	See Section 3.0
Present the findings and a public explanation.	This document would serve as a tool to present the findings and would provide the public a detailed explanation of how the selected plan was chosen. Upon approval to release the draft report, the NEPA public comment period would occur and include additional public input.
Implement the action.	This action would follow final approvals of the TSP.

Based on the findings and determination discussed in this report, the TSP is in compliance with EO 11988. The proposed action would serve to reduce the damaging effects of flooding and improve overall quality of the floodplain; it would not be directly encouraging growth within the floodplain.

6.5. REAL ESTATE REQUIREMENTS AND LERRD CONSIDERATIONS

The Lands, Easements, and Rights-of-Way (LER) required for the TSP are those required for DB4. 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.

6.6. OPERATION AND MAINTENANCE CONSIDERATIONS

The estimated annual operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) costs for the TSP are currently estimated at $10,000, though this may be refined. OMRR&R is a non-Federal sponsor responsibility.

The TSP complies with all applicable Federal environmental laws, statutes, and executive orders (EOs) (Table 20). Appendix F includes more information on environmental compliance activities, including relevant correspondence and supporting documentation.

Table 20. 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[2]
Farmland Protection Policy Act, 7 (Prime Farmland) USC 4201-4208	FC
Fish and Wildlife Coordination Act, 16 USC 661-666c	PC[2]
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[2]
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.

6.7. 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

DB4 would function very effectively to reduce flood stages both upstream in Overland and downstream in University City, and it would reduce the number of structures flooded and the extent of the flooding. DB4 would reduce life safety risk and residual risk compared to the without-project condition.

6.13. 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. Each of these risks or uncertainties may impact the selection of the TSP and the way the TSP is refined or reformulated before being selected as the recommended plan.

Participation in Voluntary Nonstructural Measures

Low numbers of homeowners signing up for nonstructural measures like floodproofing and elevation is a risk for implementation, 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 conducted a sensitivity analysis on the participation rate to see how much the level of participation would change the annual net benefits. An even spread of participation rates was selected to provide decision-makers with a broad range of possible outcomes: 25%, 50%, and 75%. A random sample was selected among the structures indicated as eligible according to the established criteria for Alternative 8 at each of the participation rates. Net benefits and BC ratios were calculated to compare the different participation rates. The results show that at 75% participation or less, Alternative 8 is likely to have greater net benefits than Alternative 3b, but there are significant limitations to how these costs were developed (see Appendix I), and several other considerations went into selecting Alternative 3b as the NED plan (Alternative 3b maximizes comprehensive benefits across the RED, EQ, and OSE accounts). Therefore, low participation is unlikely to change the NED plan. See Appendix I for more information.

Participation from City of Overland

The City of Overland would need to participate in approving DB4 if it is included in the recommended plan. The DB4 site is currently under an agreement with the Department of the Interior (DOI) for public park or public recreational purposes. Coordination with DOI and the city is currently underway and is not finalized. At the November 8, 2021 City Council meeting, the Council passed a motion to continue exploration of the conversion of a portion of Woodson Road Park to DB4 as a part of this GRR. The consequence of non-participation from the City of Overland if DB4 is identified as a component of the NED plan is that DB4 would have to be removed from the plan and an alternative with the next highest annual net benefits used. Fortunately, there are other alternatives that also have positive annual net benefits, and the federal interest in the project would remain established.

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. The consequence if the amount of backwater is less than the conservative estimate used in the modeling is that 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 updated the materials costs during refinement of the TSP and will continue to monitor material cost and availability during PED and construction.

6.14. SPONSOR SUPPORT

University City has no objection to the TSP. A sponsor letter of support will be provided in the final report submittal package.

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. 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. Two public meetings were also held in 2021, the first on July 26th and the second on Aug 16th. A public review period will be held for the updated Draft Report describing Alternative 3b as the TSP in March-April 2022. Throughout the planning process, USACE has been coordinating with other Federal, state, and regional agencies, and other stakeholders. The Draft Report/EA will also be released for a 30-day public review and comment period.

USACE 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

No comments were received during draft report review which indicated areas of dispute.

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 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 $6,414,000 and the non-Federal share (35%) is estimated to be $3,453,000. Table 21 provides the breakdown of the cost share.

Table 21. Cost Share of Estimated Total Project First Cost in 2021 price levels

Item	Federal Cost (65%)	Non-Federal Cost (35%)	Total Project First Cost
Contingency	$1,244,750	$670,250	$1,915,000
PED/Construction Management	$530,400	$285,600	$816,000
LERRD	0	$2,148,660	$2,148,660
Total Project	$6,413,550	$3,453,450	$9,867,000
Associated Costs	$ -	$ -	$ -
Total with Associated Costs	$6,413,550	$3,453,450	$9,867,000

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 supports the implementation of DB4 as a means to reducing flood risk to the city. The City had concerns about the implementation of nonstructural measures, 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. By contrast, a detention basin would be able to be installed in a relatively short timeframe and would start providing reductions in flood risk immediately.

8 RECOMMENDATIONS

Given the analysis presented in this GRR/EA, it was determined that Alternative 3b is the Tentatively Selected Plan. 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, incorporated herein by reference, evaluated various alternatives that would reduce flood risk in the study area. The tentatively selected plan (TSP) is the National Economic Development Plan and includes:

- The TSP (Alternative 6) consists of Detention Basin 4 (DB4). DB4 is located at the site of a public park, Woodson Road Park, in the City of Overland. The detention basin is located to the northwest of the confluence of an unnamed tributary with the River Des Peres.

In addition to a "no action" plan, eight other alternatives were evaluated. 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.

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:

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

	Insignificant effects	Insignificant effects because 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.

No compensatory mitigation is required as part of the TSP.

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.

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 following federally listed species or their designated critical habitat: Indiana bat, northern long-eared bat, gray bat, decurrent false aster. The U.S. Fish and Wildlife Service is expected to concur with the Corps' determination after public review of the Draft IFR/EA.

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that the TSP will have no adverse effect on historic properties. The

Corps has received concurrence with these findings from the Missouri State Historic Preservation Office (SHPO).

FINDING

Technical, environmental, economic, 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. 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.

_____ _____

Date

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