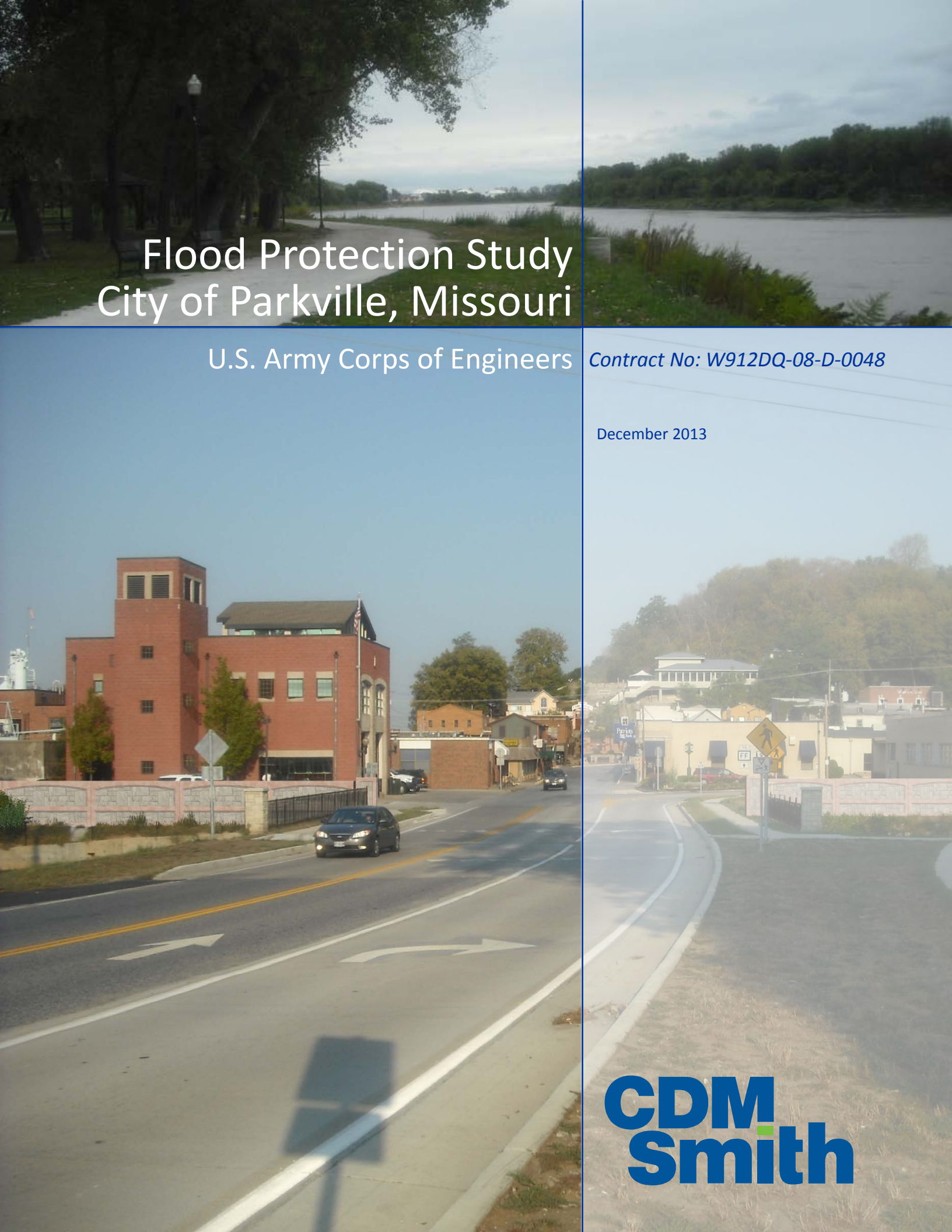

# Flood Protection Study
# City of Parkville, Missouri

U.S. Army Corps of Engineers

*Contract No: W912DQ-08-D-0048*

December 2013

CDM Smith

# Flood Protection Study

**City of Parkville, Missouri**

**USACE Contract No.: W912DQ-08-D-0048**
**Task Order: 0020**

**Prepared for:**

**U. S. Army Corps of Engineers, Kansas City District**
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**December 2013**

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# Acronyms

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation |
| BNSF | Burlington Northern Santa Fe |
| CDM Smith | CDM Federal Programs Corporation |
| CFR | Code of Federal Regulations |
| City | City of Parkville |
| D-FIRM | digital Floodplain Insurance Rate Map |
| Downtown | historic downtown business district |
| FEMA | Federal Emergency Management Agency |
| FEMA Study | Flood Study 290294V000 |
| FIS | Flood Insurance Study |
| HDR 1999 | Continuing Authorities 205 Study Parkville, Missouri Recommendation Report by HDR 1999 |
| HEC-RAS | Hydrologic Engineering Centers River Analysis System |
| LOMR | Letter of Map Revision |
| Park | English Landing Riverfront Park |
| SEMA | Missouri State Emergency Management Agency |
| SFHA | Special Flood Hazard Area |
| SFT | secure file transfer |
| Test Report | Flood Technology Test Report |
| USACE | U.S. of America Corp of Engineers |
| USGS | U.S. Geological Survey |
| WSE | water surface elevation |

# Report Synopsis

This study is being prepared through the U.S. Army Corps of Engineers (USACE) under the authority of Section 22 of the Water Resources Development Act (WRDA) of 1974. The purpose of this authority is to assist state, local and Tribal governments in the preparation of plans to address water resources and related problems. This Flood Protection Study was conducted by CDM Federal Programs Corporation (CDM Smith) on behalf of the USACE to develop flood protection recommendations that can be incorporated into an integrated, cost efficient, and effective flood protection plan for the City of Parkville (City). This study focused on two separate areas in Parkville for flood planning: the historic downtown business district (Downtown) and English Landing Riverfront Park (Park). The Downtown study area is north of the Burlington Northern Santa Fe (BNSF) railroad tracks and west of the White Aloe Branch. The Park area is south of the BNSF railroad tracks, east of the White Aloe Branch and extends adjacent to the Missouri River.

The height of flood protection for Downtown was determined using the difference between the base flood (commonly referred to as the 100-year flood or 1-Percent Annual Chance Flood) elevation and ground elevation. The height of flood protection for the Park consisting of a berm was analyzed using the difference between the 10-Percent Annual Chance Flood and ground elevations. Trail elevation to 749 feet was also considered. The ground elevation was determined using a combination of contour and survey information provided by the City.

Flood protection systems considered included traditional levee/floodwall systems and innovative flood protection concepts that have been developed and installed over the last decade. Additionally, this study reviewed the regulatory floodway and base flood protection restrictions from the Federal Emergency Management Agency (FEMA) and the effect it could have on the City's Flood Protection Plan.

The evaluation of flood protection technologies used the following considerations (parameters): effectiveness, constructability, cost/affordability, and maintenance and storage requirements. Additional points of considerations included physical constraints along the proposed flood protection alignment; equipment, people, and time requirements for installation; response planning; safety; and servicing the system under potentially prolonged flood conditions.

The Downtown study area is a commercial use area with various businesses. Therefore, vehicular and pedestrian access, location of existing buildings, and location of existing utilities, including an active railroad, restrict the available width for flood protection construction and implementation. In the Park, the location of large mature trees and the banks of the Missouri River and White Aloe Branch affect construction of any flood protection technology.

The City's preferred flood protection alignment for Downtown runs along the west side of White Aloe Creek to the north side of the BNSF tracks, then westerly along the tracks. The required height of flood protection along this alignment ranges from 7 to 10 feet.

The types of flood protection systems evaluated for Downtown included concrete walls, fabric membrane dams, metal panels, water-inflated tubes, and water-inflated baffled bladders. Specific benefits were found related to installation of each technology and in meeting the FEMA freeboard criteria. Since the width of the flood protection is determined by the desired height of the flood protection, the narrower base requirement for both the metal panel and concrete wall technologies is an important factor. Table RS-1 summarizes the results of each technology reviewed.

**Table RS-1 Summary of Flood Protection Technologies Evaluated for Downtown Flood Protection**

| Technology | Parameter | Advantages | Disadvantages |
|---|---|---|---|
| <br>Concrete Floodwall<br>(Photo Source: CDM Smith) | Maintenance | ▪ Reduces long-term maintenance (annual inspection may be required) | ▪ Limits dry side drainage<br>▪ Potential for graffiti |
| | Installation | ▪ Requires minimal base width<br>▪ Reduces time needed for flood fighting effort versus temporary efforts<br>▪ Can be built in any configuration<br>▪ Permanent protection (possibly lead to Letter of Map Revision [LOMR]) | ▪ Requires adequate space for construction |
| | Cost | ▪ Reduces long-term maintenance cost<br>▪ No storage costs<br>▪ No repeated installation costs | ▪ Initial installation more expensive |
| <br>Fabric Membrane Dam<br>(Photo Source: Portadam) | Maintenance | ▪ City personnel familiar with maintenance process from 2011 experience | ▪ Can be punctured<br>▪ Must be continually inspected during operation<br>▪ Must be thoroughly cleaned prior to storage after each use |
| | Installation | ▪ City personnel familiar with installation process<br>▪ 1/10th the weight of standard sandbags<br>▪ Does not require permanent foundation<br>▪ Does not require prepared surface<br>▪ Can be installed in any configuration | ▪ Requires sandbag supplementation<br>▪ Wind effects (until weight of floodwater stabilizes)<br>▪ Equipment required to move pallets of material to installation spots |
| | Cost | N/A | ▪ Most expensive of the fabric flood protection technologies (material cost) |
| <br>Metal Panel Flood Protection<br>(Photo Source: EKO Flood Systems USA, LLC) | Maintenance | ▪ Minimal Maintenance Easily stored (stackable) | ▪ Must be cleaned with pressure washer after each use |
| | Installation | ▪ Quick Installation (Example: 1 person can install 1,000 square feet in five hours)<br>▪ Multiple configuration options (footer, stem wall)<br>▪ Greater height does not require a greater above surface base width<br>▪ Can be used with permanent stem wall (reduces time needed for installation of flood protection) | ▪ Seepage occurs<br>▪ Equipment required to move pallets of material to installation spots<br>▪ Requires permanent footer<br>- Size of footer dependent upon soil structure and wall height<br>- Requires adequate space for initial construction of footer |
| | Cost | ▪ Additional panels can be purchased in future to increase height of flood protection | ▪ Most expensive of temporary applications |

**Table RS-1 Continued**

| Technology | Parameter | Advantages | Disadvantages |
|---|---|---|---|
| <br>Water-Inflated Tubes<br>(Photo Source: US Flood Control Corporation) | Maintenance | ▪ Can withstand up to 2,680 pounds of lateral pressure (depending on anchor diameter)<br>▪ Punctures do not necessarily result in loss of flood protection | ▪ Must be thoroughly cleaned prior to storage after each use<br>▪ Can be punctured<br>▪ Must be continually inspected during operation |
| | Installation | ▪ Quick Installation<br>▪ Stackable (to achieve greater height)<br>▪ Can be installed in many configurations<br>▪ Does not require permanent foundation | ▪ Greater height requires a wider base (approximate 1V:1H)<br>▪ Equipment required to move pallets of material to installation spots<br>▪ Limited turning radius |
| | Cost | ▪ Least expensive of reviewed flood protection | N/A |
| | Maintenance | ▪ Limited maintenance during installation | ▪ Can be punctured<br>▪ Must be continually inspected during operation<br>▪ Must be thoroughly cleaned prior to storage after each use |
| | Installation | ▪ Quick Installation<br>▪ Stable (will not roll)<br>▪ Does not require permanent foundation | ▪ Greater height requires a wider base (1V:2.25H)<br>▪ Limited height (protects up to 6-foot Water Surface Elevation (WSE)<br>▪ Limited configuration (Does not bend like Water-Inflated tubes)<br>▪ Not stackable<br>▪ Equipment required to move pallets of material to installation spots |
| | Cost | N/A | N/A |

Flood protection technology cost estimates obtained from vendors were used to perform a cost comparison of the technologies on a cost per linear foot basis. The concrete wall unit cost included installation, as this is a one-time expense. Both the concrete wall and the metal panel unit cost include an estimate of a typical footer cost, installed, as required for installation. All other technologies included material cost only, as installation cost will be required for each flood event in use. Fabric membrane, water-inflated tubes, and water-inflated baffled bladders all require more labor and time for installation when compared to the concrete floodwall or metal panel systems. These systems also cannot meet the height requirements through the entire alignment due to the required base width for installation. The costs of the technologies were within $200 per linear foot at a height of 8-feet.

The recommended flood protection plan for the Downtown is a combination of permanent concrete walls and metal panels (with sill plate) at road crossings as shown on Figure RS-1. With this recommendation, the City could achieve protection of the Downtown area for the base flood elevation, while retaining its connection with the Missouri River and providing services to its residents. This recommendation has several benefits:

- **Maintenance.** Maintenance requirements for the concrete wall would be limited to annual inspections and items identified during these inspections. Metal panels can be stacked and stored at existing City facilities.
- **Installation.** With one-time installation for the concrete wall, there would be a decreased need for both City staff time and volunteer time for flood fighting activities in the Downtown study area. Installation would only be required during a flood event for the metal panels at the road crossings. While this will affect vehicular traffic in the area, Downtown would still be accessible from the north. In addition, this installation meets the width constraints present on the alignment.
- **Cost.** The cost incurred with construction of the recommended system would primarily be a one-time construction cost. Annual inspection and maintenance costs would also be required.
- **Regulatory.** Precedence has been set in FEMA Region VII for use of concrete walls and metal panels in updating the flood insurance study. The City could pursue a LOMR to remove the protected areas from the special flood hazard area zone.
- **Aesthetics.** A permanent concrete floodwall can incorporate with current Downtown historical features, as shown on Figure RS-2 (view heading west along Highway 9) and Figure RS-3 (view south on Main Street).

The estimated conceptual cost for this recommendation is $2.4 million. This cost is a feasibility level estimate and could vary significantly based on geotechnical investigations and decisions on final aesthetics of the proposed concrete wall.

The flood protection review for the Park took into consideration both the City's goals and the different physical, design criteria, and regulatory constraints specific to the Park. The City's goals for flood protection of the Park include:

- Building a berm to achieve a level of protection that will protect the Park from frequent floods that damage the park, generally within the 5- to 25-year event range
- Retaining existing large mature trees
- Retaining trail alignment
- Retaining the trail width of twelve feet and
- Retaining the parks connection with the Missouri River (aesthetic views)

Items considered for the Park flood protection included the Missouri River flood elevation estimates, ground elevations in the park and along the trail, opportunities for flood protection tie-in based on natural and manmade high ground (such as the railroad embankment), constraints due to mature tree location along the proposed berm or trail elevation alignment, and the City's goals for flood protection.

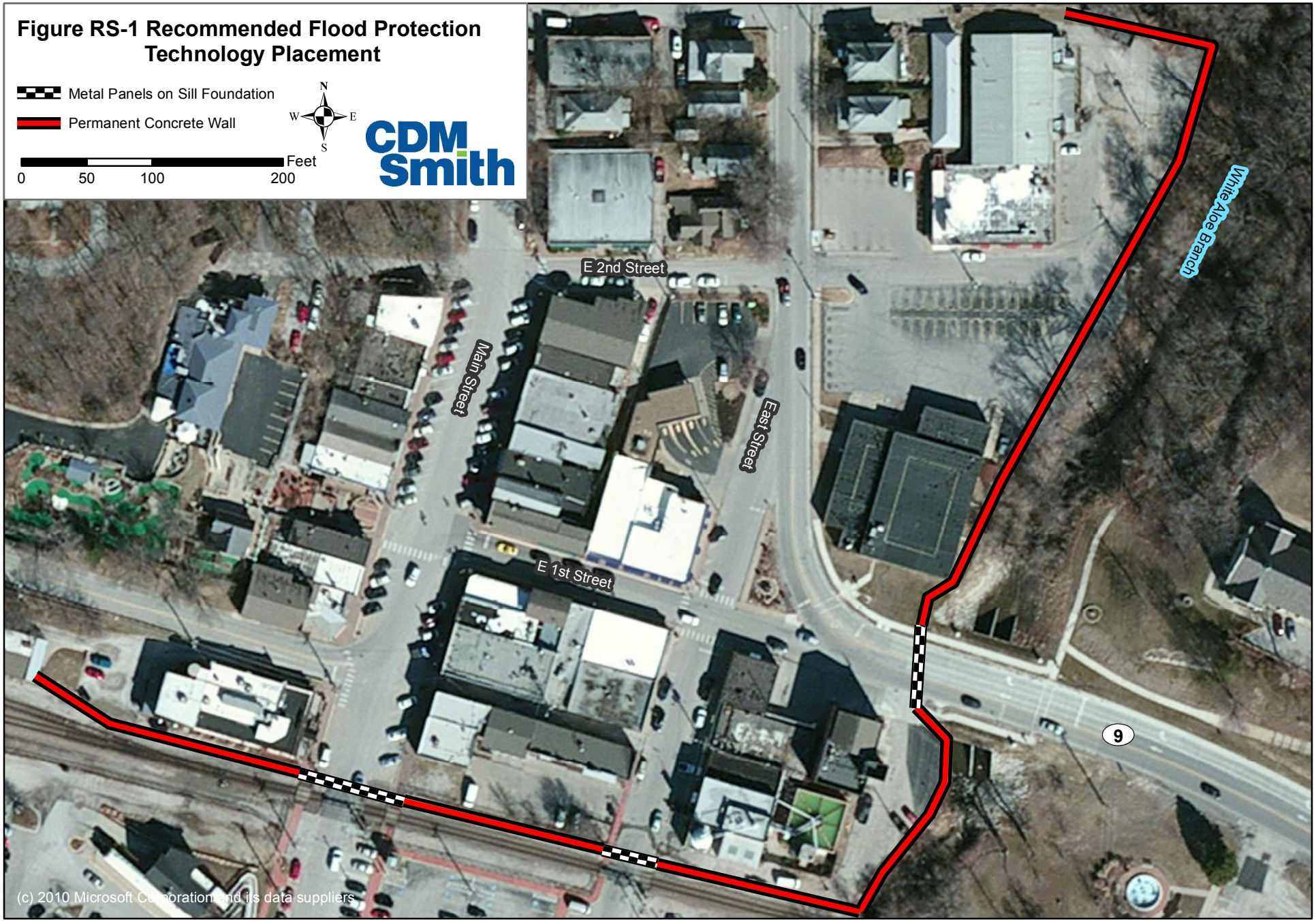
Figure RS-1 Recommended Flood Protection Technology Placement
Metal Panels on Sill Foundation
Permanent Concrete Wall
N
W
E
S
Feet
0
50
100
200
CDM Smith
E 2nd Street
Main Street
East Street
E 1st Street
White Aloe Branch
9
(c) 2010 Microsoft Corporation and its data suppliers

**Figure RS-2 View of Simulated Concrete Floodwall, Facing West along Highway 9**

**Figure RS-3 View of Simulated Concrete Floodwall, Facing South along Main Street**

The current trail is approximately 6 feet lower than the 10-Percent Annual Chance Flood event water surface elevation (WSE). Since the scope of work for this project states that overtopping of the flood protection system is considered acceptable, no freeboard was included in this estimation (44 CFR recommends no less than 2 feet of freeboard). Taking into consideration the proximity and multi-purpose function of the trail to the river in conjunction with the steepness of the slope of the sides of the berm, the American Association of State Highway and Transportation Officials' (AASHTO) design criteria is recommended for any trail modifications. For the purposes of this analysis, a 10- to 12-foot trail width was assumed. For the portions of the trail east of the Park road cul-de-sac, a 2-foot wide shoulder on the dry side of the trail and a 5-foot wide shoulder on the river side of the trail were assumed as part of any modification.

This Park is renowned for its many festivals (Arts, Blues, Jazz, and RiverJam, Parkville Days, Turkey Trot and Christmas on the River). Many people visit the Park to enjoy its "scenic walking trails" which provide a unique connectivity to the Missouri River (City of Parkville English Landing Webpage, 2012). The height of the berm at 6 feet will block the view of the Missouri River from within the Park as shown on Figure RS-4. An additional negative impact would be the loss of over 50 mature trees. The study concluded that the height and width of the Park berm would have a negative impact on the aesthetic nature of the Park. The study identified that the preferred alignment was located within the regulated FEMA floodway for the Missouri River.

A cost analysis was performed to evaluate flood protection options for the Park. The analysis utilized a historical flood analysis of Park, conceptual costs of building and maintaining a berm, and the historical flood repair costs from the City. The cost analysis resulted in four options.

### Option #1 No Action: Budget for Park Clean Up

With flooding occurring at the Park less than 2.5-percent of the time based on the historical Missouri River gauge data, one approach to addressing flood repair costs incurred is for the City to proactively budget for these anticipated costs using a pay-as-you-go sinking fund approach. This type of fund accumulates revenues until sufficient money is available for an identified project, or, in this case, a known cost incurred by the City on a regularly occurring basis. This would assist the City in building a fund to specifically address the Park flood recovery effort costs, when they are incurred.

### Option #2 Six-Foot Berm Construction: Raise Trail Elevation to 752 feet

The City has expressed a desire to construct a berm to provide flood protection of the Park as described previously. Figure RS-5 shows an approximate alignment of this berm, which would be at a height of 6 feet. The berm is estimated to provide the Park protection from a 10-year flood event. Annual costs are still incurred with routine inspection and maintenance of a berm. Because the berm would only be constructed to provide a 10-year level of protection for the Park, flooding would still occur and, therefore, the City would still incur flood repair and clean-up costs to the Park.

**Figure RS-4 Superimposed 6-foot High Berm along West Side of Park**

### Option #3 Temporary Flood Protection: Water-Filled Tubes

In lieu of a permanent berm, the City could pursue a temporary flood protection option for the Park. The summary of technologies reviewed discussed advantages and disadvantages of three temporary flood protection options: fabric membrane, water-inflated tubes, and baffled bladders. Of these, water-filled tubes would allow the City the flexibility of choosing the best alignment to protect resources within the Park, while also allowing the City to purchase additional material, as funds are available. This would allow the City to adjust flood protection of the Park to a desired level for future flood events. Similar to the permanent berm, annual costs are still incurred with temporary flood protection technologies (storage, etc.).

### Option #4 Three-Foot Berm Construction: Raise Trail Elevation to 749 feet

An additional alternative could include the City pursuing incremental flood protection of the Park by elevating the trail approximately 1 to 3 feet, to elevation 749 feet. Appendix C includes conceptual plan and profile views of what this trail elevation could look like. Annual costs are still incurred with routine inspection and maintenance of trail elevation. Flooding would occur less frequently, but the City would still incur flood repair and clean-up costs to the Park.

### Evaluation of Options for Flood Protection of English Landing Park

Table RS-2 summarizes the estimated initial (construction and/or material acquisition) costs and estimated annual costs for each option.

**Table RS-2 Estimated Costs Summary for Flood Protection of English Landing Park**

| Option | Description | Estimated Cost (2012) [1] | |
|---|---|---|---|
| | | Initial Cost | Annual Cost [2] |
| Option #1 No Action | Budget for Park Clean Up | $0 | $230,000 |
| Option #2 2 Six-Foot Berm Construction | Raise Trail Elevation to 752 feet | $1,820,000 | $280,000 |
| Option #3 Temporary Flood Protection [3] | ~~3 Foot High Water Filled Tubes~~ | ~~$270,000~~ | ~~$250,000~~ |
| | ~~6 Foot High Water Filled Tubes~~ | ~~$520,000~~ | ~~$260,000~~ |
| Option #4 Three-Foot Berm Construction | Raise Trail Elevation to 749 feet – Contract Construction | $670,000 | $260,000 |
| | Raise Trail Elevation to 749 feet – City Self Perform Construction | $510,000 [4] | $230,000 [5] |

[1] Estimated costs have been rounded up to the nearest $10,000.

[2] Annual costs do not include intangible costs that cannot be quantified (i.e. loss of use).

[3] Use of water-filled tubes is considered infeasible and is not recommended for further consideration.

[4] Assumes City cost to construct is 75% of contracted cost.

[5] Assumes City would self-perform annual maintenance and flood repair.

Under the "No Action" option, no initial cost would be incurred by the City. Instead, the City would proactively budget for anticipated future flood repairs in the Park.

The annual costs for Options #2 and #4 include building the berm, repairing the berm after minimal flood events, and annual maintenance of the berm. These costs do not included loss of use during flood events, the impact of any berm construction adjacent to established trees, modification to existing light poles and benches, and a reduction of the river view from the Park (particularly from the River Stage Park Shelter). Raising the trail along the southern edge of the Park reduces accessibility to the

trail and increased maintenance tasks. Currently the trail is accessible from any point in the Park for physically challenged people. Adding additional areas of accessibility to the trail would increase the financial costs associated with the berm. The additional maintenance tasks include inspecting for damage from burrowing animals, inspecting for scouring from high WSE events, and repairing noted damages.

Any fill placed for a berm or trail elevation should be compacted to meet USACE standards. This fill should be placed in 6 to 10 inch lifts. With the significant number of trees adjacent to the existing trail alignment, an arborist should be consulted to determine fill allowable near trees or design requirements for tree protection. Existing stormwater conveyance paths through the Park to the river are critical to retain. In addition, tie-in of a trail elevation or berm could pose challenges at the railroad tracks. Additional requirements may be required from BNSF to place any fill adjoining the railroad embankment. It should be noted that the entirety of the Park is within the FEMA regulated floodway of the Missouri River and will require a City floodplain permit for any land modifications.

Sandbag closures would be required at certain points where berm construction or trail elevation is not feasible. These locations include the Park road entrance, existing boat ramp, and Park road cul-de-sac, as well as potentially the connection adjacent to the railroad. A one to two day lead time would most likely be required to construct these measures prior to flooding. The Park would be closed leading up to and during any flood event. During the flood event, the berm and/or trail elevation area would require continuous monitoring to assess the structural integrity as well as the dewatering needs within the Park. Following any flood event, a full inspection of any berm and/or trail elevation should be completed with repairs completed as identified.

Due to the current lack of available water at the Park, the use of water-filled tubes (Option #3) as a temporary means of flood protection is considered infeasible. It is also uncertain how well the tubes would hold up under prolonged flooding conditions of the Missouri River as their placement would be in an area of higher flow velocity.

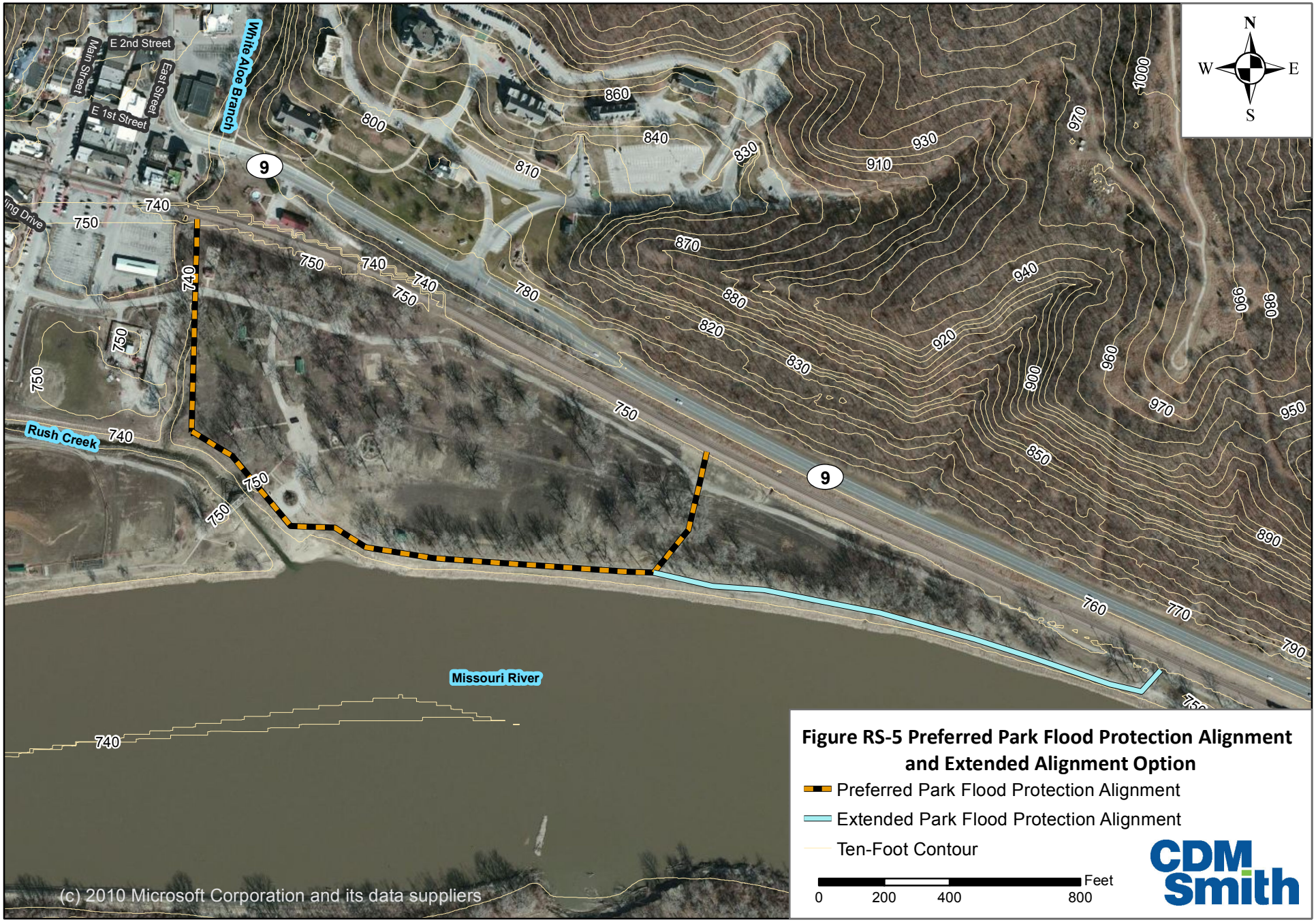


**Figure RS-5 Preferred Park Flood Protection Alignment and Extended Alignment Option**

Preferred Park Flood Protection Alignment

Extended Park Flood Protection Alignment

Ten-Foot Contour

0 200 400 800 Feet

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# Section 1
# Introduction

## 1.1 Authority

This study is being prepared through the U.S. Army Corps of Engineers (USACE) under the authority of Section 22 of the Water Resources Development Act (WRDA) of 1974. The purpose of this authority is to assist state, local and Tribal governments in the preparation of plans to address water resources and related problems.

## 1.2 Purpose

This Flood Protection Study was conducted by CDM Federal Programs Corporation (CDM Smith) on behalf of the USACE to develop flood protection recommendations that can be incorporated into an integrated, cost efficient, and effective flood protection plan for the City of Parkville (City).

Flood protection systems considered included traditional levee/floodwall systems and innovative flood protection concepts that have been developed and installed over the last decade. The newer concepts include both new technical approaches to flood protection and selected measures that are classified as semi-permanent/permanent flood protection concepts. Additionally, this study reviewed the regulatory floodway and base flood protection restrictions from the Federal Emergency Management Agency (FEMA) and the effect it could have on the City's Flood Protection Plan.

## 1.3 City of Parkville Historical Flood Information

In 1999, under the continuing authority of Section 205 Flood Control Act, a preliminary assessment study was conducted for the USACE. The study evaluated non-structural land use zoning, floodplain management and flood-warning emergency response systems, and traditional structural levee/floodwall systems. This study determined that conventional structural alternatives were too costly to protect the downtown area and undesirable in terms of impacts to the aesthetics, historic assets/buildings, environmental habitat, and connectivity to the river.

A Flood Insurance Study (FIS) for Parkville completed in August 1977 documented the existence and severity of flood hazards within the study area. Flood hazard boundary maps of the City were re-evaluated and updated in 1978 for the National Flood Insurance Program. Although the Missouri River Basin has been studied extensively, no previous reports or studies specific to the Parkville area have been conducted. FEMA recently performed a flood study along the Missouri River from which preliminary digital Floodplain Insurance Rate Maps (D-FIRMs) and models were created. Currently, this preliminary information has not been adopted by FEMA as effective. One significant change noted on the preliminary maps and models is the reduction in the Missouri River base flood elevation. The base flood elevation for the Missouri River and White Aloe Branch in the study area changes from 762 feet to 760 feet.

## 1.4 Study Area

This study focuses on two separate flood planning areas in Parkville: the historic downtown business district (Downtown) and English Landing Riverfront Park (Park). As shown on Figure 1-1, the Downtown study area is north of the Burlington Northern Santa Fe (BNSF) railroad tracks and west of the White Aloe Branch. The Park area is south of the BNSF railroad tracks, east of the White Aloe Branch, and extends adjacent to the Missouri River.

The flood water source for both study areas is the Missouri River. Flood events occur in the Park first, due to the Park's low ground surface elevation and proximity to the Missouri River. Currently, most of the Downtown area receives minor flood protection from the railroad track embankment. There is approximately a 20-foot elevation increase between the edge of the Park and the railroad embankment.

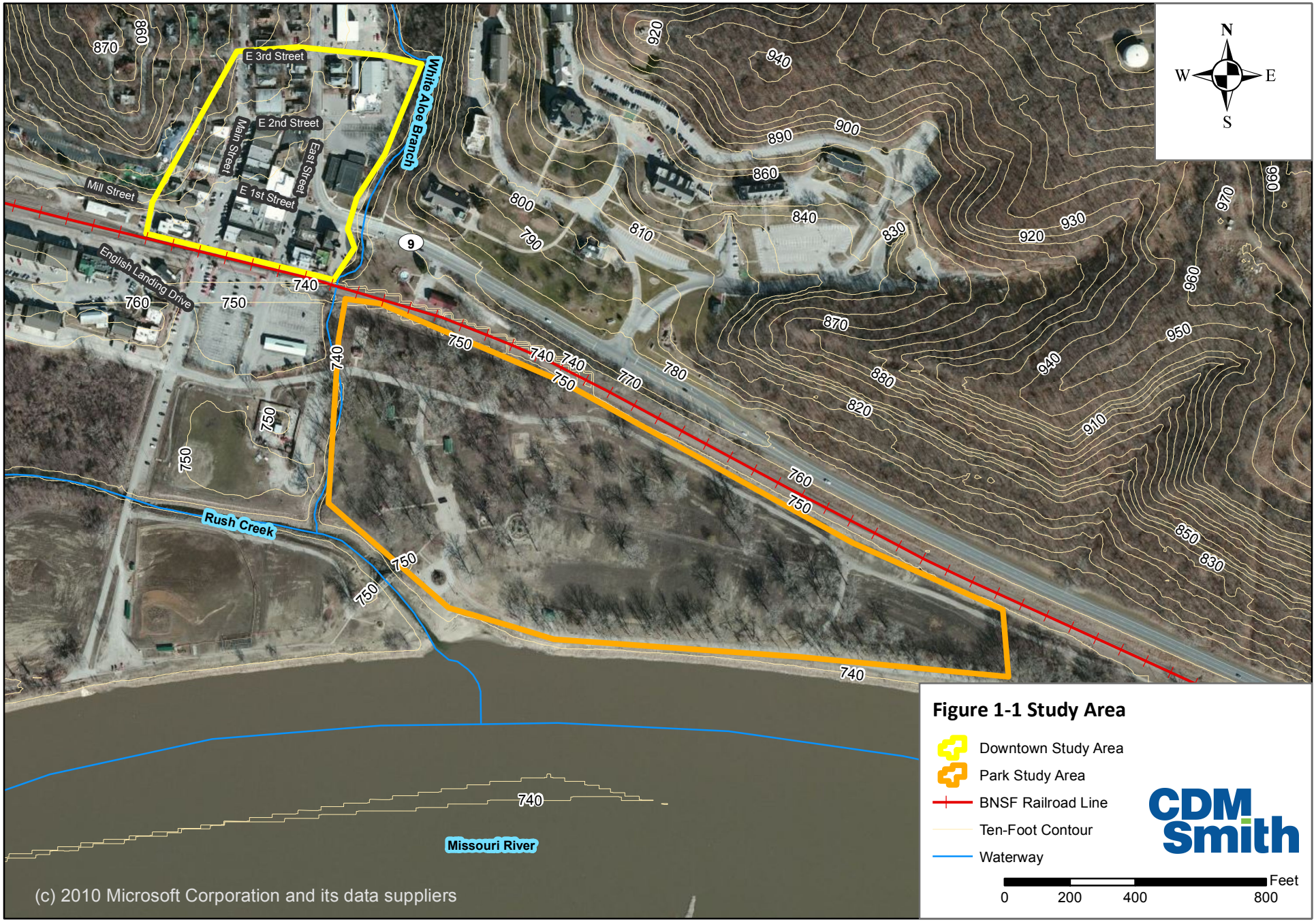


**Figure 1-1 Study Area**

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# Section 2
# Data Collection

An inventory of available information was completed for the Downtown and Park study areas to identify and characterize a recommended flood protection alignment and technology. The previous study was reviewed for baseline hydrology and hydraulic information. Data was collected from the City, FEMA, Missouri State Emergency Management Agency (SEMA), USACE, the Internet, and field visits. Data collected included historical flood events information, including site-specific flood depths, and volunteer numbers and hours.

## 2.1 Data from USACE

During the kick-off meeting USACE staff provided contact information for USACE flood fighting staff as a source of information for the flood protection system utilized by the City in 2011. The USACE flood fighting staff were interviewed by phone in August 2012. The USACE flood fighting staff also provided (e-mail) information about the flood protection systems currently being utilized by the USACE. The data provided by the USACE is listed on Table 2-1.

**Table 2-1 Data Provided by USACE**

| Data Description | Format |
|---|---|
| Continuing Authorities 205 Study Parkville, Missouri Recommendation Report by HDR 1999 (HDR 1999) | PDF |
| Hydrologic Engineering Centers River Analysis System (HEC-RAS) hydraulic models (KCLeveesPh1 - 2006 and MoR100yrFldwy – 2007) | HEC-RAS files |
| Temporary Flood Protection System Information | e-mail (September 2012)<br>verbal (August 2012) |

## 2.2 Data from City

The 2011 flood event resource contact information was provided by the City during the kick-off meeting. Contacts included the City Manager, Police Department, and Public Works personnel. Data from the City was provided through meetings, phone and e-mail communication, and via a field visit/computer download. Table 2-2 lists the information provided by the City.

**Table 2-2 Data Provided by City**

| Data | File Type |
|---|---|
| Geographic Information System files:<br>City Limit<br>Contours<br>Sanitary Sewer System<br>Stormwater System<br>Trees<br>2011 Flood Protection System Alignment | GIS Shapefiles<br>(Received September 2012, creation date unknown) |
| 2011 High Water Observations | Excel Spreadsheet |
| 2011 Volunteer count and hours | Database Hardcopy |
| 2011 Flood Fighting Costs | Meeting Record |
| Survey Points (November 2012) | PDF |

## 2.3 Data from SEMA

The SEMA office was contacted to determine if there was digital flood information available for the Missouri River and White Aloe Branch within the study area. The preliminary hydraulic modeling information and the D-FIRM created on behalf of FEMA were downloaded from the SEMA secure file transfer (SFT) website.

In review of this data it was noted that, while the effective Floodplain Insurance Rate Maps (FIRM) and preliminary D-FIRMs currently refer to White Aloe Branch as White Aloe Branch, the hydraulic modeling files and profiles refer to White Aloe Branch as White Branch.

## 2.4 FEMA Data

Information regarding FEMA floodplain regulations as found in the Code of Federal Regulations (CFR), CFR 44 revised as of October 1, 2010 and the online electronic CFR (e-CFR) was gathered for flood protection design criteria reference.

## 2.5 Data from Flood Protection Vendors

Utilizing the initial list of flood protection types and manufacturers from the scope of work, the Internet was used to collect data and contact information for multiple flood protection manufacturers. In order to perform a direct comparison of vendor cost estimates, each vendor was provided the following assumptions for this conceptual level estimate by e-mail:

- Estimated length and height of flood protection needed as related to four flood events (Significant Damage, Base Flood, 1993 Event and 500-Year, and HDR 1999)
- Three road crossings in the area for the flood protection system
- Option of recommending use of a mix of flood protection technologies

The following manufacturers provided cost estimate information for this study:

- Architecture Metals Ltd.
- EKO Flood Systems USA, LLC
- Flood Control America
- Hydrological Solutions, Inc.
- Portadam Inc.
- US Flood Control Corp.

The information provided by each manufacturer reflected sole source installation of each flood protection technology and is included in Appendix A.

## 2.6 Site Visit Material

Site visits occurred in September and November of 2012 to collect photos for visual aids and measurements at minimum width points on potential flood protection alignments. Photos were taken in the vicinity of the BNSF railroad tracks, the Downtown area, and the Park. The minimum width points of the Downtown flood protection alignment occur beside the U.S Post Office Building (approximately 8 feet between the edge of building and the White Aloe Branch bank) and between the railroad and buildings on the west side of Main Street (approximately 14 feet between the edge of railroad fence and building).

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# Section 3

# Flood Protection Technologies and Technology Evaluation

This evaluation consisted of a brief review of various technologies available for flood protection. The review focused on five flood protection technologies. The goal of this evaluation was to provide a basis for the recommended flood protection system for the City.

## 3.1 Flood Protection Technologies Considerations

The evaluation of flood protection technologies used the following considerations (parameters): effectiveness, constructability, cost/affordability, preliminary alignment constraints, and maintenance and storage requirements. Additional points of considerations included equipment, people and time requirements for installation, response planning, safety, and servicing the system under potentially prolonged flood conditions.

### 3.1.1 Aspects Considered

Specific aspects considered for each of the flood protection technologies included:

- Effectiveness
  - Length of time to set up the system (how much warning time is needed)
  - Function of the system during extended flood events (durability)
- Constructability
  - Labor requirements for installation (ease of constructability)
  - Special equipment requirements for installation
- Affordability
  - Cost of system per linear foot of alignment
  - Initial and recurring costs
- Alignment Constraints
  - Foundation requirements
  - Available area for installation (width and height)
  - Existing utility impacts

- Maintenance and storage
  - Inspection and maintenance requirements during extended flood conditions
  - Maintenance requirements during non- and post flood conditions

### 3.1.2 Aspects Not Considered

The evaluation of flood protection technologies did not consider the following information:

- Potential relocation of existing utilities
- Geotechnical design for any foundations or embankments
- Hydrologic and hydraulic analysis of the drainage area to each study area
- FEMA floodway analysis
- Under seepage protection or permanent pump stations
- Required right-of-way or easement acquisitions
- Temporary technologies supplemental costs, including shipping and labor to install

### 3.1.3 Flood Protection Technologies

The types of flood protection systems evaluated included permanent, temporary, and combined system solutions. The evaluated flood protection technologies include:

- Concrete walls
- Fabric membrane dams
- Metal panels
- Water-inflated tubes
- Water-inflated baffled bladders

## 3.2 Evaluation Parameters

The evaluation process consisted of determining preliminary physical constraints found in the study areas. Specific constraints included minimum width availability as relates to proposed flood protection alignment and estimated existing ground surface elevation along proposed flood protection alignment. Additionally, the various technologies were reviewed utilizing standards listed in the scope of work, standards found in the USACE Flood Technology Test Report (Test Report), interviews with USACE flood fighting staff, interviews with flood protection technology vendors, and through Internet research.

### 3.2.1 Determination of Flood Protection Height and Width

*Height Determination*

The height of flood protection for the Downtown area was determined using the difference between the base flood elevation and ground elevation. This difference varies along the flood protection

alignment. The Missouri River base flood elevation (1-Percent Annual Chance Flood) of 760 feet is from the preliminary D-FIRM as shown on Figure 3-1 and on the preliminary profile as shown by the red dashed line crossing the solid red line on Figure 3-2. The preliminary D-FIRM indicates that the Downtown study area is within an AE Zone. FEMA defines an AE Zone as an area subject to inundation by the 1-Percent Annual Chance Flood event with base flood elevations shown (44 CFR 64.3 (a) (1) AE: area of special flood hazard with water surface elevation (WSE) determined).

The height of flood protection for the Park was determined using the difference between the 10-Percent Annual Chance Flood elevation (as shown at the blue dashed line crossing the solid red line on Figure 3-2), or 752 feet, and the ground elevation, an average of 746 feet. The preliminary D-FIRM indicates that the entire Park is within an AE Zone, as shown on Figure 3-1. Additionally the majority of the Park is located within a defined floodway, also shown on Figure 3-1.

Preliminary D-FIRM data was determined to be the most appropriate for all flood technology evaluation and for recommendations. If the preliminary D-FIRMs do not become effective, the effective based flood elevation for the Missouri River is 762 feet.

A comparison of the elevation contours and the November 2012 City provided survey points found the survey point recorded at the low water bridge in the northwest corner of the park was within 0.07 of a foot of the contour line elevation. The level of accuracy of the elevation contours was determined acceptable for the conceptual level of this study; therefore, the elevation contours provided an estimate of the ground elevation throughout the study area.

*Width Determination*

Width constraints affect flood protection of both the Downtown and the Park. The Downtown study area is a commercial use area with various businesses. Therefore, vehicular and pedestrian access, location of existing buildings, and location of existing utilities, including an active railroad, restrict the available width for flood protection construction and implementation. In the Park, the location of large, mature trees, and the banks of the Missouri River and White Aloe Branch affect construction of any flood protection technology. Key width constraints include:

- Downtown Study Area:
  - Limited width between White Aloe Branch and the U.S. Post Office Building (approximately 8 feet).
  - Limited width between railroad and buildings (approximately 14 feet).
- Park Study Area:
  - Limited width between the large mature trees and the bank of the Missouri River (average 37 feet).

## 3.2.2 Review Federal Design Standard

Flood protection installed in each study area must meet local, state, and Federal design criteria, including USACE and FEMA design standards. For the flood protection evaluation, the USACE Test Report provided flood protection evaluation criteria. In the USACE Test Report, the USACE tested three of the available flood protection technologies: Rapid Deployment Flood Wall (plastic grid device and granular material), Portadam (fabric dam) and Hesco Bastion Concertainer (geotextile lined metal mesh container and granular material).

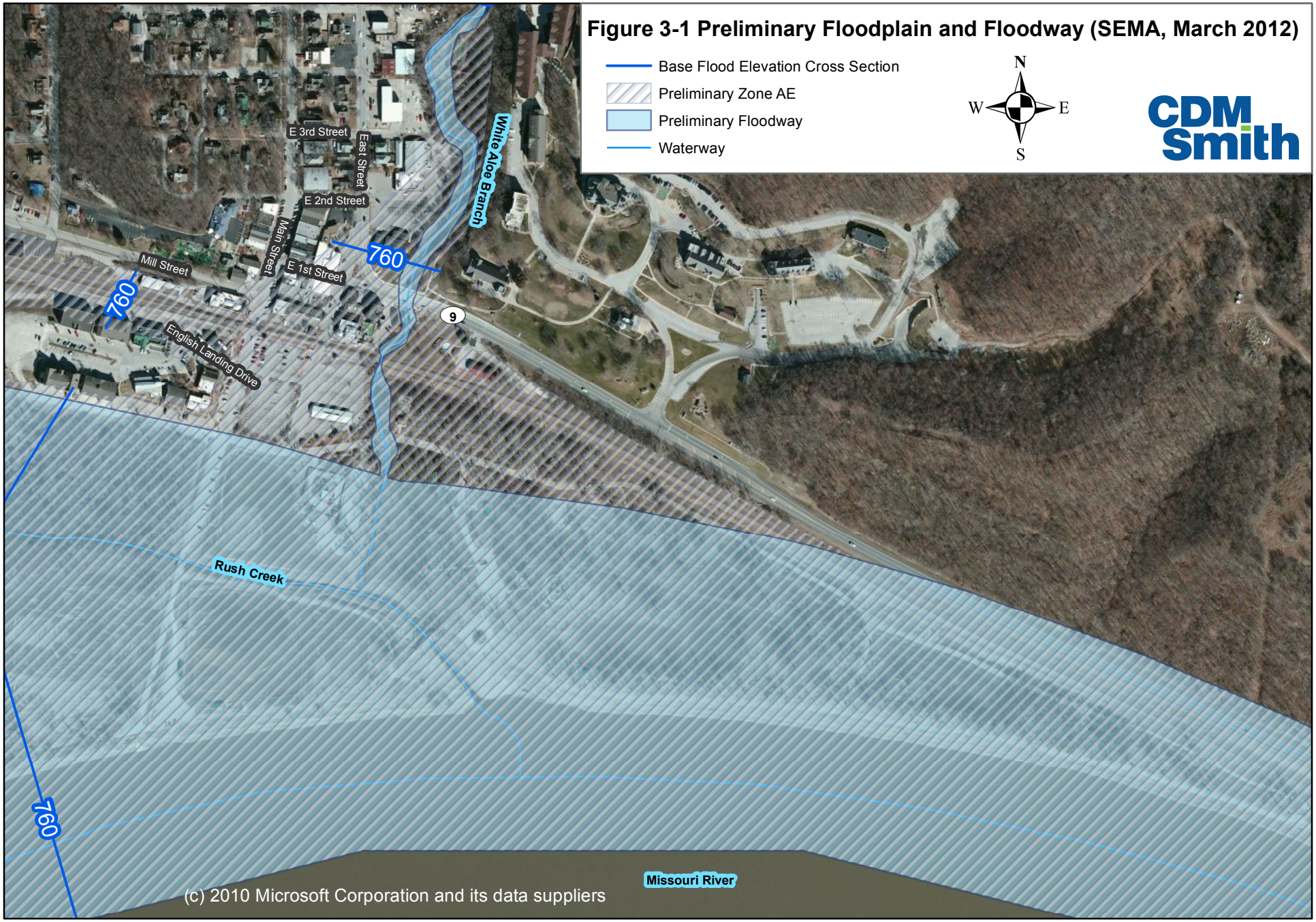


**Figure 3-1 Preliminary Floodplain and Floodway (SEMA, March 2012)**