



FINDING OF NO SIGNIFICANT IMPACT

Washington, D.C., and Vicinity Flood Risk Management Project Improvements at the National Mall and Memorial Parks

Washington, District of Columbia

The U.S. Army Corps of Engineers (USACE), Baltimore District, in cooperation with National Park Service (NPS), has prepared a supplemental Environmental Assessment (EA) that examines alternatives actions and environmental impacts associated with the proposed Washington, D.C., and Vicinity Flood Risk Management Project Improvements (FRM) at the National Mall and Memorial Parks (NAMA or Park) in Washington, DC. The purpose of the proposed project is to improve reliability of the current levee system under extreme flood events. The project provides FRM for portions of the monumental core, portions of Pennsylvania and Constitution Avenues, and other public and private facilities located south of the U.S. Capitol to Fort McNair. Only those portions within NAMA are discuss within this document. The project would be constructed by USACE and maintained by the NPS. NAMA's existing FRM features include a levee between the Lincoln Memorial and Washington Monument adjacent to the reflecting pool (Potomac Park Levee); a post and panel closure system at 17th Street; and a temporary closure at 23rd Street (sandbags or inflatable bladders).

Proposed improvement to the FRM project components at the Potomac Park Levee and 23rd Street were evaluated in USACE environmental assessments (EA) prepared in 1992 and 1996. However, the improvements were not constructed due to lack of funding. In 2009, the NPS prepared an EA addressing construction of the 17th Street closure structure, which was constructed in 2011. Due to changes in environmental regulations, and the development of detailed project designs since the publications of the pervious EAs, the USACE has prepared the Washington, D.C., and Vicinity Flood Risk Management Project Improvements supplemental EA. The USACE and the NPS have each prepared Finding of No Significant (FONSI) to support of the supplemental EA.

The EA was prepared in accordance with the National Environmental Policy Act of 1969 (NEPA; 42 United States Code [USC] 4321 et seq.), and its implementing regulations of the Council on Environmental Quality (CEQ) for implementing NEPA (40 Code of Federal Regulations [CFR] 1500-1508.9), the Department of the Interior NEPA regulations (43 CFR Part 46); and with NPS Director's Order 12: Conservation Planning, Environmental Impact Analysis, and Decision-making (2011) and its accompanying handbook (2015). The statements and conclusions reached in this finding of no significant impact (FONSI) are based on documentation and analysis provided in the EA and associated decision file. To the extent necessary, relevant sections of the EA are incorporated by reference below.

After consultation with the USACE, review of the EA and other supporting documentation, the NPS, in accordance with 43 CFR 46.320, is adopting this EA and making its decision to allow the USACE to carry out the FRM projects improvement at the Potomac Park Levee and 23rd Street on land administered by the NPS. The EA fulfills the requirements of NEPA and applicable regulations, and it meets the policies set forth in the DO-12, Conservation Planning, Environmental Impact Analysis and Decision-making, and accompanying Handbook.

The Federal action that that will be undertaken by the NPS is the issuance of a Special Use Permit for the construction of the Potomac Park Levee FRM improvements. The decision considers impacts to the Park resources as expressed in statute, including the Park's enabling legislation, regulation, and policy.

SELECTED ALTERNATIVE

The EA analyzed two alternatives (no action and the action alternative/preferred alternative) and the associated impacts on the environment. Based on the analysis, the NPS has concurred with the USACE's selection of the action alternative/preferred alternative for implementation, see Section 3.0 of the EA for a complete, detailed description of the Selected Alternative.

Under the action alternative, the Potomac Park Levee FRM improvements would increase the levee crest elevation to approximately 18.7 feet elevation by adding up to 4 feet of earth along the approximately 2,450 feet of current levee crest. In addition, sluice gates would be constructed in sewer lines crossing under the levee to prevent floodwater from entering the sewer system. Approximately 55 trees and shrubs would be removed from the current Potomac Park Levee that threaten the levee physical integrity.

The 23rd and Constitution Avenue FRM improvements consist of the construction of an earthen berm to 20 feet elevation with gentle side slopes on the southwest side of the land parcel on the southwest side of the 23rd Street and Constitution Avenue intersection with anticipation of a gap at its tie-in to Constitution Avenue to protect the alley of American elms (*Ulmus americana*). An earthen berm would also be constructed between the east and west bound ramps of the Theodore Roosevelt Bridge at Constitution Avenue on the west side of the intersection.

RATIONALE FOR DECISION

The NPS concurred with the USACE's decision to construct improvements to the FRM project as the NPS recognizes the need to improve reliability of flood protection under extreme flood events to ensure increased protection of portions of the monumental core, portions of Pennsylvania and Constitution Avenues, and other public and private facilities located south of the U.S. Capitol and north of Fort McNair, without significantly impacting the cultural landscape, historic context or natural resources of the Park.

MITIGATION MEASURES

The NPS places a strong emphasis on avoiding, minimizing, and mitigating potentially adverse impacts to affected resources, whether under the jurisdiction of the NPS or as a result of an NPS decision. To help ensure the protection of cultural and natural resources and the quality of the visitor experience, the NPS will implement mitigation measures to avoid and/or minimize impacts.

The selected alternative incorporates the mitigation measures listed in Appendix A of this document. These mitigation measures will be included as conditions in the Special Use Permit issued to the USACE for construction.

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As documented in Section 3 of the EA, the selected alternative will result in beneficial and/or adverse impacts on several park resources, including historic structures, cultural landscapes, vegetation, aesthetics/visual resources and visitor use and experience. However, the NPS has determined that the selected alternative can be implemented without significant adverse effects, as defined in 40 CFR §1508.27.

The Selected Alternative will impact approximately 4.0 acres of turf and woody vegetation at the Potomac Park levee location, and 1.0 acres at the 23rd and Constitution Ave location. Turf would be re-established within several months following construction completion, and the land maintained consistent with Park turf plan and specifications. In addition, approximately 55 trees and shrubs along the existing Potomac Park levee that would be removed. Sites where trees are removed would be replanted with non-woody vegetation. The construction of the berm along the west/southwest side of the parcel at 23rd Street and Constitution Avenue would impact, many of the mature trees along the berm route. The alley of mature American elm trees are absent from the east/southwest side of the parcel, and it is anticipated that the project would cause no direct impacts to these trees. Depending on where the southern end of the berm ties-in to higher ground, the alley of American elm trees along 23rd Street could be stressed by soil

compaction during construction. In the future when the temporary emergency closure is installed at the north end of the berm along Constitution Avenue, soil compaction could occur, which could stress these trees in the immediate area.

Adverse impacts to recreation, visitor use and public safety, are also anticipated. During construction, appropriate best management practices would be taken to minimize public risk at both construction sites and on construction vehicle travel routes in the vicinity. This will include the use of fencing at the construction sites. Pedestrian and bicycle use would be restricted, detoured, or closed (depending on location) within the limits of disturbance and adjacent to both project sites. The ball fields in the vicinity of the 23rd Street/Constitution Avenue berm site would likely be closed during construction. Ball fields will be repaired/replaced at completion of earthen berm construction, the location may shift somewhat to the east/northeast. Visitor use of the sites during construction would be closed within the limit of disturbance at both sites for the entire construction period, on both weekdays and weekends. Construction vehicle traffic would intermittently affect visitor use on roads in proximal areas of the Park during daylight hours on weekdays.

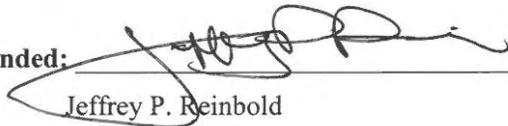
The cultural landscapes and historic structures within the Area of Potential Effect (APE) includes the National Mall and East and West Potomac Parks Historic Districts; Washington Monument; Lincoln Memorial; Lincoln Memorial Reflecting Pool, Korean War Veterans Memorial; Vietnam Veterans Memorial, and World War II Memorial. The selected alternative will result in detectable adverse impacts to cultural resources. Construction activities would cause a minor and temporary negative impact to cultural landscape conditions in the Park. These effects may be mitigated in coordination with the NPS by installing visual barriers, traffic routing, or undertaking other means to reduce visibility of project actions. Construction would temporarily impact lawns of the cultural landscape. It is anticipated that final designs would either avoid or minimize impacts that would trigger extensive or intrusive stormwater Best Management Practices (BMPs) and thus not adversely affect the cultural landscape. Following construction and reestablishment of turf, the increase in height to the Potomac Park Levee would cause impacts due to the removal of many trees and shrubs and the increase in height. The proposed 23rd Street and Constitution Avenue earthen berm would be more visible in that a grass-covered curvi-linear berm at the site with gentle relief would exist where only a flat lawn exists now. During leaf-on conditions in the growing season, trees at various locations in the Park would limit visibility of the raised levee and berm to only limited vista points on the ground and to various vantage points on monuments where trees do not obstruct the view. During leaf-off conditions, both topographic features would be visible from more vantage points. Although possessing positive relief and visibility, both features would be consistent with the pre-project gentle topography and lawn character of the area. It is intended that neither structure would change scenic vistas, scenic resources, or visual character or quality of the site and its surroundings. It is intended that neither structure would detrimentally impact important visual corridors. The effects of the project would be detectable, but only slightly, and would minimally diminish overall integrity, or affect the character-defining feature(s) of the cultural landscape. Landscape shrubs and trees would be planted along (but not on) the levee and berm as appropriate to partially restore the cultural tree-lined corridor landscape setting consistent with the cultural landscape inventory and meet other NPS specifications.

CONCLUSION

As described above, the selected alternative does not constitute an action meeting the criteria that normally requires preparation of an environmental impact statement (EIS). The selected alternative will not have a significant effect on the human environment in accordance with Section 102(2)(c) of NEPA.

Based on the foregoing, it has been determined that an EIS is not required for this project and, thus, will not be prepared.

Recommended:



Jeffrey P. Reinbold
Superintendent
National Mall and Memorial Parks
Region 1 – National Capital Area

3/4/2021

Date

Approved:

KIMBERLY HALL
Digitally signed by KIMBERLY HALL
Date: 2021.03.09 15:55:44 -05'00'

Kym A. Hall
Area Director
Region I – National Capital Area

Date

Appendix A: Mitigation Measures

Appendix B: Non-Impairment Determination

Appendix C: Section 106 Programmatic Agreement

APPENDIX A: MITIGATION MEASURES

Cultural and Historic Resources

A Programmatic Agreement (PA) (Appendix C) was developed to ensure cultural and historic resources are not adversely affected by the proposed action. Several stipulations are outlined in the PA to mitigate any potential for adverse effect. The design and construction efforts shall be consistent with the *Secretary of Interior's Standards for the Treatment of Historic Properties* and the *Guidelines for the Treatment of Cultural Landscapes*. After construction is complete, will be undertaken in a way that is consistent with the *NAMA Turf Plan*. Construction routes and methods will be planned to avoid damage to large trees and to minimize vegetation disturbance.

Natural Resources

Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, the Corps determined that the recommended plan may affect but is not likely to adversely affect the following federally listed species or their designated critical habitat: northern long-eared bat. The U.S. Fish and Wildlife Service (FWS) concurred with the Corps' determination on 31 January 2020. However, as recommended by the Park, to avoid/minimize impacts to nesting birds and roosting bats, any tree removal or trimming would occur to the greatest extent possible during the period August 16th through March 14th.

Recreation, Visitor Use, Experience and Public Safety

During construction, appropriate best management practices would be taken to minimize public risk at both construction sites and on construction vehicle travel routes in the vicinity. These include the anticipated use of limit of disturbance fencing at the construction sites and conducting construction in accordance with an equipment and traffic management plan. Pedestrian and bicycle use would be restricted within the limits of disturbance at both project sites. Walkways across the levee would be closed, and pedestrian and bicycle travel routes would need to detour around these closures. In the event a closure berm at 23rd Street and Constitution Avenue with a gap to protect American elms is constructed, use of ball fields in the vicinity of the 23rd Street/Constitution Avenue berm site would likely be restricted during construction. It is anticipated that the ball fields would be repaired at completion of earthen berm construction. It is possible that ball fields would be shifted somewhat to the east/northeast. The earthen berm along the western/southwestern edge of the parcel would effectively serve to define the limits of play. Visitor use during construction would be restricted within the limit of disturbance at both sites for the entire construction period, on both weekdays and weekends. Construction vehicle traffic would intermittently affect visitor use on roads in proximal areas of the Park during daylight hours on weekdays. However, construction vehicle traffic would not be expected to impact visitor use during non-business hours nor on weekends or holidays.

APPENDIX B: NON-IMPACT DETERMINATION

By enacting the National Park Service (NPS) Organic Act of 1916 (Organic Act), Congress directed the U.S. Department of the Interior and the NPS to manage units “to conserve the scenery and the natural and historic objects and wild life therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations” (54 U.S.C. 100101). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that NPS must conduct its actions in a manner that will ensure no “derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress” (54 USC 100101).

NPS Management Policies 2006, Section 1.4 explains the prohibition on impairment of park resources and values. While Congress has given the Service the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally enforceable by the Federal courts) that the NPS must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the NPS. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities for enjoyment of them.

The NPS has discretion to allow impacts on park resources and values when necessary and appropriate to fulfill the purposes of a park (NPS 2006, Section 1.4.3). However, the NPS cannot allow an adverse impact that will constitute impairment of the affected resources and values (NPS 2006, Section 1.4.3). An action constitutes an impairment when its impacts “*harm the integrity of Park resources or values, including the opportunities that otherwise will be present for the enjoyment of those resources or values*” (NPS 2006, Section 1.4.5). To determine impairment, NPS must evaluate “*the particular resources and values that will be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts*” (NPS 2006, Section 1.4.5).

This determination on impairment has been prepared for the selected alternative described in this Finding of No Significant Impact. An impairment determination is made for the resource topics of cultural and historic resources, and vegetation. These resources are considered fundamental to the National Mall and Memorial Parks, and the NPS as a whole. An impairment determination is not made for visitor use and experience because impairment findings relate back to park resources and values, and these impact areas are not generally considered to be park resources or values according to the Organic Act and cannot be impaired in the same way that an action can impair park resources and values. This determination on impairment has been prepared for the preferred alternative described in Section 3 of the EA. The summary of impacts described below show that the selected alternative does not run counter to the Park's establishing legislation, nor would it inhibit opportunities to see and interpret the historic and cultural resources of the Park.

CULTURAL AND HISTORIC RESOURCES

The cultural landscapes and historic structures within the Area of Potential Effect (APE) includes the National Mall and East and West Potomac Parks Historic Districts; Washington Monument; Lincoln Memorial; Lincoln Memorial Reflecting Pool, Korean War Veterans Memorial; Vietnam Veterans Memorial, and World War II Memorial. Implementing the selected alternatives would have a detectable adverse impact on both the cultural landscapes and historic structures. However, the design and construction efforts shall be consistent with the *Secretary of Interior's Standards for the Treatment of Historic Properties* and the *Guidelines for the Treatment of Cultural Landscapes*. After construction is complete, will be undertaken in a way that is consistent with the *NAMA Turf Plan*. Construction routes and methods will be planned to avoid damage to large trees and to minimize vegetation disturbance. As such, the overall integrity of these resources will remain full intact, and no impairment will occur.

VEGETATION

The preferred alternative would cause a short-term adverse impact to lawn vegetation. Construction would disturb or destroy existing lawn within the limits of disturbance at each site. Lawns would re-establish within several months following construction completion, and the land maintained consistent with other lawns of the Park. At the levee construction area, 4.0 acres of lawn would be impacted. If an earthen berm is constructed along the south/southwest side of the parcel at 23rd Street and Constitution Avenue, perhaps 1 acre of lawn would be impacted (impact area cannot be accurately determined until designs are prepared).

The preferred alternative would cause a long-term adverse impact to woody landscape vegetation. Based on plans completed in 2013, approximately 55 trees and shrubs along the existing Potomac Park levee that would pose a threat to the structural integrity of the levee would be removed. However, it is expected that this number is an overestimate because removal of some trees from the levee has occurred since 2013. Sites where trees are removed would be planted with non-woody vegetation Washington, D.C., Local Flood Protection 5-5 such as grass. If the berm along the west/southwest side of the parcel at 23rd Street and Constitution Avenue is constructed, mature trees along the berm route would be impacted. Mature American elm are absent from the west/southwest side of the parcel, and it is anticipated that the project would cause no direct impacts to American elm. Depending on where the southern end of the berm ties-in to higher ground, American elms along 23rd Street could be stressed by soil compaction during construction. In the future when the emergency closure temporary is installed at the north end of the berm along Constitution Avenue, soil compaction could occur, which could stress American elms in the immediate area. Stress to American elms from compaction would be an impact. As such, best management practices to avoid this stress would be to keep heavy equipment outside the canopy drip line. Further coordination with NPS will also be undertaken to determine how best to avoid stress to the American elms. Shrubs or trees may be planted elsewhere in the vicinity if determined to be necessary to meet NPS or Washington, D.C., aesthetic or tree cover initiatives. The permanent impacts on vegetation will not impede the purpose of the park nor inhibit the continued use of the area. There would be no impairment to vegetation from the implementation of the selected alternative.

CONCLUSION

The NPS has determined that the adoption and implementation of the USACE's of selected alternative will not constitute an impairment of the resources or values of the National Mall and Memorial Parks. As described above, implementing the selection alternative is not anticipated to impair resources or values that are essential to the purposes identified in the establishing legislation of the park, key to the natural or cultural integrity of the park, or identified as significant in the park's relevant planning documents. This conclusion is based on the consideration of the Park's purpose and significance, a thorough analysis of the environmental impacts described in the EA, relevant scientific studies, the comments provided by the public and others, and the professional judgment of the decision maker guided by the direction of the NPS Management Policies 2006.

APPENDIX C: PROGRAMMATIC AGREEMENT

**PROGRAMMATIC AGREEMENT
AMONG
THE U.S. ARMY CORPS OF ENGINEERS
THE NATIONAL PARK SERVICE
THE NATIONAL CAPITAL PLANNING COMMISSION
AND
THE DC STATE HISTORIC PRESERVATION OFFICER
REGARDING
COMPLETION OF THE LEVEE IMPROVEMENTS PROJECT
WASHINGTON, D.C.**

WHEREAS, the Potomac Park Levee (Levee) is an earthen berm extending from the Potomac River to the Washington Monument that provides flood protection to central Washington D.C.; and

WHEREAS, the National Park Service (NPS) is the Federal agency that controls, operates, and maintains the Levee as well as the agency responsible for issuing permits for work to be constructed in the subject location; and

WHEREAS, the U.S. Army Corps of Engineers, Baltimore District (USACE) is the Federal agency responsible for providing flood risk management (FRM) in the subject location; and

WHEREAS, the National Capital Planning Commission (NCPC) is the Federal agency with approval authority over Federal projects in the subject location pursuant to the National Capital Planning Act of 1952, 40 U.S.C 8722 (b)(1) and (d); and

WHEREAS, in 1992, USACE recommended that the Levee improvements be designed to a greater height that would provide a 700,000 cubic feet per second level of protection as originally authorized by Congress in the Flood Control Act of 1936 (Congressionally authorized level of protection); and

WHEREAS, USACE inspected the Levee in 2007 and rated it “unacceptable” due to post-Hurricane Katrina standards; and

WHEREAS, as a result of the unacceptable rating the Federal Emergency Management Administration (FEMA) considered issuing new 100-year floodplain maps that would have placed large new areas of central Washington within the flood risk area and required additional flood insurance, building upgrades, and other costly flood control measures; and

WHEREAS, the Government of the District of Columbia requested that FEMA delay issuing the new floodplain maps and FEMA agreed, provided that Levee improvements to contain a 100-year flood would be implemented by November 2009; and

WHEREAS, the USACE, NPS, NCPC, the Government of the District of Columbia, the District of Columbia State Historic Preservation Officer (DC SHPO), and the Advisory Council on Historic Preservation (ACHP) entered into a Programmatic Agreement in 2009 (2009 PA)

regarding a number of Levee improvements that were meant to achieve the Congressionally authorized level of protection and address related issues; and

WHEREAS, the Committee of 100 on the Federal City, the District of Columbia Office of Planning (DCOP), the District of Columbia Department of Transportation (DDOT), the General Services Administration, the National Trust for Historic Preservation, the National Coalition to Save Our Mall, and the Washington Metropolitan Area Transit Authority (WMATA) were listed as consulting parties in the 2009 PA; and

WHEREAS, the 2009 PA divided the Levee improvements into two phases. Phase I consisted of flood walls and a post and panel closure system across 17th Street, with permanent earthwork, permanent planting, and an on-site post and panel storage facility on the west side of 17th Street, as well as limited earthwork and planting on the east side. Phase II consisted of minor increases in grade along 23rd Street and Constitution Avenue, NW and the existing levee, final surface treatments of exposed portions of the flood walls, as well as final grading and planting on the east side of 17th Street to ensure that the Levee improvements were compatible with their surrounding natural and cultural environment; and

WHEREAS, all of the Phase I components were completed but only some of the Phase II components were completed prior to the May 1st, 2017 expiration of the 2009 PA; and

WHEREAS, if Congress increases the authorized project cost in a future Water Resources Reform and Development Act (WRRDA), USACE will request funding to complete the Project in the budget cycle following the respective WRRDA cost increase. The physical completion of the Project would be contingent on the receipt of funding to complete plans and specifications and execution of a construction contract; and

WHEREAS, USACE intends to use Congressional funding to complete the remaining Phase II Levee improvements, specifically minor increases in grade along the Reflecting Pool, a new proposal to redesign the existing accessible ramp at a mid-point along the Reflecting Pool, and increases in grade along 23rd Street and Constitution Avenue, NW (Project), as shown in Appendix A; and

WHEREAS, USACE also intends to utilize NPS funding to award a Fiscal Year 2019 contract for construction of the southern half of the semi-circular sidewalk on the west side of 17th Street which was originally planned as part of Phase II but this sidewalk will not require further consultation since it will be constructed in accordance with the previously approved plans shown in Appendix B; and

WHEREAS, two adjacent developments are also proposed along 23rd Street and Constitution Avenue, NW, including the National Desert Storm War Memorial and DC Water Potomac River Tunnel Project, and it may be possible to coordinate these projects so that they are designed to provide the minor increases in grade necessary to achieve the Congressionally authorized level of protection; and

WHEREAS, USACE, NPS, and NCPC have determined that implementation of the Project and the issuance of the necessary permits and approvals constitute “Undertakings” subject to Section 106 of the National Historic Preservation Act (NHPA), 54 U.S.C. 306108, and its implementing regulations, 36 CFR Part 800; and

WHEREAS, USACE, NPS and NCPC have consulted with the DC SHPO and, noting the potential for adverse effects, have requested ACHP to participate in the consultation; and

WHEREAS, ACHP determined that it would not participate in the consultation by e-mail dated July 2, 2018; and

WHEREAS, USACE, NPS and NCPC have elected to develop this Programmatic Agreement (PA) pursuant to 36 CFR 800.14(b)(1)(ii) because the Project is a complex undertaking whose effects on historic properties cannot be fully determined until funding to design and implement future work is secured and the DC SHPO, NCPC, and the U.S. Commission of Fine Arts (CFA) complete their respective reviews and approvals of the Project and the adjacent developments, as appropriate; and

WHEREAS, this PA acknowledges that the Project’s Area of Potential Effect, consulting parties, opportunities for comment and all other applicable requirements of 36 CFR Part 800 will be addressed in future consultation; and

WHEREAS, this PA acknowledges that some aspects of the Project, such as minor increases in Levee grade along the Reflecting Pool, may have “no adverse effect” on historic properties; and

WHEREAS, this PA also acknowledges that future consultation will encourage coordination of the Project with the adjacent developments in the 23rd Street and Constitution Avenue, NW area, and that cumulative effects of these coordinated reviews will be taken into account; and

WHEREAS, USACE, NPS, NCPC, and DC SHPO are the Signatories to this PA pursuant to 36 CFR 800.6(c)(1)(i); and

NOW, THEREFORE, USACE, NPS, NCPC and DC SHPO agree that the Project will be implemented in accordance with the following stipulations in order to take into account the effects of the Project on historic properties.

STIPULATIONS

USACE, NPS and NCPC shall ensure that the following measures are carried out:

1. Review of Minor Increases in Levee Grade along the Reflecting Pool
 - a. The Signatories shall consult pursuant to 36 CFR Part 800, regarding the minor increases in the Levee’s grade along the Reflecting Pool and related improvements in this area.

- b. To address potential effects on the WWII Circle of Remembrance (Circle), USACE shall provide digital photographs of the portion of the Levee footprint that approaches the Circle. The photographs will document how close in proximity the Levee is to the Circle and will serve as an aid for effect determinations. USACE shall also provide scaled cross-section drawings with associated photographs revealing any possible visual effects that the Levee raising may have on the Circle.
 - c. To address potential effects of the proposed redesign of the existing accessible ramp and walkway located at a mid-point along the Reflecting Pool, USACE shall provide proposed plans and digital photographs of the area showing existing conditions and incorporate any comments regarding design, materials, or other aspects of the ramp and walkway that will avoid adverse effects on historic properties.
 - d. To identify any archaeological resources that may be affected, the USACE shall consult early with the NPS and DC SHPO.
 - e. USACE shall also develop any other materials and take any additional steps necessary to comply with 36 CFR Part 800.
 - f. After the Signatories consult pursuant to Stipulations 1.a through 1.e above, the NPS shall review the USACE's proposed final design for minor increases in Levee grade along the reflecting pool and make the determination of effect in consultation with the DC SHPO. No further action will be necessary if the plans are determined to have no adverse effect. If adverse effects are identified, the Signatories will consult further to develop alternatives to avoid, minimize or mitigate the adverse effects and will amend this PA accordingly. Any such amendment will be addressed in accordance with Stipulation 8.
2. Review of Levee Improvements at 23rd Street and Constitution Avenue, NW and Related Developments
- a. The Signatories shall consult pursuant to 36 CFR Part 800 regarding the Levee improvements proposed at 23rd and Constitution, NW.
 - b. USACE shall proactively consult with the other Signatories and the proponents of the adjacent National Desert Storm War Memorial and DC Water Potomac River Tunnel Projects to encourage incorporation of the Levee improvements into those developments and avoid and minimize any adverse effects by limiting the overall visual and physical changes to the historic context.
 - c. If USACE does not receive funding for the Project, and any adjacent developments are proposing to implement Levee improvements, the NPS must apply for a Section 408 permit as codified at 33 U.S.C 408. As part of the Section 408 permit review process, USACE shall make a good faith effort to review, comment, and provide relevant feedback on plans for the adjacent developments. The NPS and USACE may elect to use this PA to meet their respective Section 106 responsibilities for the Section 408 permit and shall notify the other Signatories of their decisions in this regard.

- d. Upon receipt of funding, USACE shall specifically review and comment on plans for the adjacent projects and develop and revise Levee improvements plans and related information in a timely manner; seek to coordinate the reviews of the adjacent projects with the reviews required by this PA; consider and respond to any cumulative effects; and make all other reasonable efforts to ensure successful and appropriate coordination to the maximum extent feasible.
 - e. To assist USACE to comply with Stipulation 2.b. above, NPS, as landowner, shall work with the proponents of the adjacent National Desert Storm War Memorial and DC Water Potomac River Tunnel Projects to notify USACE of relevant meetings, review timeframes, and provide USACE with project plans and related information.
 - f. To address any archaeological resources that may be affected, the USACE shall consult early with the NPS and DC SHPO.
 - g. USACE shall also develop any other materials and take any additional steps necessary to comply with 36 CFR Part 800.
 - h. After the Signatories consult pursuant to Stipulations 2.a through 2.g above, the NPS shall review the USACE's proposed final design for Levee improvements at 23rd and Constitution Avenue and related developments and make the determination of effect in consultation with the DC SHPO. No further action will be necessary if the plans are determined to have no adverse effect. If adverse effects are identified, the Signatories will consult further to develop alternatives to avoid, minimize or mitigate the adverse effects and will amend this PA accordingly, noting that some or all of the adverse effects may be adequately mitigated through implementation of other Section 106 agreement documents executed specifically for the related developments. Any such amendment to this PA will be addressed in accordance with Stipulation 8
3. Status of USACE Project Funding
- a. If USACE receives funding to implement the Project:
 - i. USACE shall immediately notify the other consulting parties to this PA in email and in writing.
 - ii. USACE shall meet with the other consulting parties of this PA within sixty (60) days of the notification above to coordinate and clarify how it will comply with this PA.
 - b. In the event USACE does not receive funding to implement the Project, its signature on this PA will not commit USACE to any provisions set forth in this PA.
4. Documentation of the Completed Levee Improvements Project

Within thirty [30] days of the completion of the Project, the USACE shall evaluate and provide adequate documentation showing that the Levee meets the Congressionally authorized level of protection. Documentation shall be provided to the Director of the

District of Columbia Department of Energy and Environment and any Signatory that requests a copy.

5. Dispute Resolution

- a. Should any Signatory to this PA object in writing to the other Signatories regarding any action carried out in accordance with this PA, the Signatories shall consult to resolve the objection. If, after making a good faith effort the Signatories are unable to resolve the disagreement, USACE shall forward its proposed resolution of the dispute and any other documentation relevant to the dispute to ACHP. Within forty five (45) days after receipt of all pertinent documentation, ACHP will either:
 - i. Provide USACE with recommendations, which USACE will take into account in reaching a final decision regarding the dispute; or
 - ii. Notify USACE that it will comment pursuant to 36 CFR 800.7(c), and proceed to comment. Any ACHP comment provided in response to such a request shall be taken into account by USACE in accordance with 36 CFR 800.7(c)(4). Any ACHP recommendation or comment will be understood to pertain only to the subject of the dispute; USACE's responsibility to carry out all actions under this PA that are not subjects of the dispute will remain unchanged.
- b. In reaching a final decision, USACE shall prepare a response that takes into account any timely comments regarding the dispute and notify the Signatories in writing of its decision.

6. Reporting and Notifications

USACE shall update the other Signatories, consulting parties, and the public on the status of the Project via electronic notification on at least an annual basis, no later than the anniversary date of the last signature on this PA. Updates will be posted on USACE's public website at <https://nab.usace.army.mil>.

7. Duration

This PA shall be in effect for a period of fifteen (15) years from the date of the last signature on this PA.

8. Amendments

This PA may be amended when an amendment is agreed to in writing by all Signatories. The amendment shall be effective on the date a copy signed by all of the Signatories is filed with ACHP.

9. Termination

If any Signatory to this PA determines that the terms of the PA cannot or are not being carried out, that objecting party shall so notify the other Signatories in writing and consult with them to seek amendment of the PA. If within sixty (60) days, an

amendment cannot be reached, any Signatory may terminate the PA upon written notification to the other Signatories. Once the PA is terminated, and prior to work continuing on the Project, USACE must (a) either execute a new PA pursuant to 36 CFR 800.14(b) or (b) comply with 36 CFR Part 800 for any uncompleted aspects of the Project. USACE will notify the Signatories as to the course of the action it will pursue.

10. Unanticipated Discoveries

Should any activity that takes place as a result of this PA result in unanticipated or post-review archaeological discoveries, work in the area shall immediately stop, the area will be secured, and the NPS and DC SHPO shall be notified. NPS will determine if significant resources are present and will be adversely affected by resuming work. If avoidance of the resources is not possible, appropriate minimization and/or mitigation measures will be determined in consultation with the DC SHPO and shall be carried out before activity in the location resumes. If the identified resources include human remains, MPD (Metropolitan Police Dept.), and OCME (Office of the Chief Medical Examiner) shall also be contacted under DC Statute DC ST § 5-1406 so they can determine whether the resources are of medico-legal (crime scene-related) interest. If the human remains are non-Native American Indian in origin then NPS will consult with the DC SHPO, and if Native American Indian in origin NPS shall proceed following NAGPRA protocols.

11. Availability of Federal Funds / Anti-Deficiency Act

The obligations of USACE under this PA are subject to the availability of appropriated funds, and the stipulations of this PA are subject to the provisions of the Anti-Deficiency Act and other applicable provisions of federal fiscal law. USACE shall make a reasonable and good faith effort to secure the necessary funds to implement its obligations under this PA. If compliance with the Anti-Deficiency Act or other applicable provisions of federal fiscal law alters or impairs USACE's ability to implement its obligations under this PA, USACE shall consult in accordance with Stipulation 8 (Amendments) and, if necessary, Stipulation 9 (Termination).

12. Electronic Copies

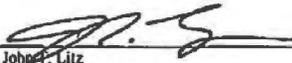
Within one week of the last signature on this PA, USACE shall provide each Signatory with one high quality, legible, color, electronic copy of this fully-executed PA and all of its attachments fully integrated into one, single document. Internet links shall not be used as a means to provide copies of attachments since web-based information often changes. If the electronic copy is too large to send by e-mail, USACE shall provide each Signatory with a copy of this PA on a compact disc or other appropriate means.

Execution of this PA and implementation of its terms evidences that USACE, NPS and NCPC have taken into account the effects of their Undertakings on historic properties and afforded ACHP a reasonable opportunity to comment.

Signatures Follow on Separate Page

**SIGNATURE PAGE
PROGRAMMATIC AGREEMENT
REGARDING
COMPLETION OF THE LEVEE IMPROVEMENTS PROJECT
WASHINGTON, D.C.**

U.S. ARMY CORPS OF ENGINEERS



COL John P. Litz
Commander
U.S. Army Corps of Engineers, Baltimore District

11 Dec 18

Date

NATIONAL PARK SERVICE

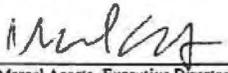


Patricia S. Trap, Acting Superintendent
National Park Service

12.17.18

Date

NATIONAL CAPITAL PLANNING COMMISSION

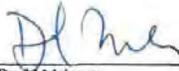


Marcel Acosta, Executive Director
National Capital Planning Commission

12/12/18

Date

DC STATE HISTORIC PRESERVATION OFFICER



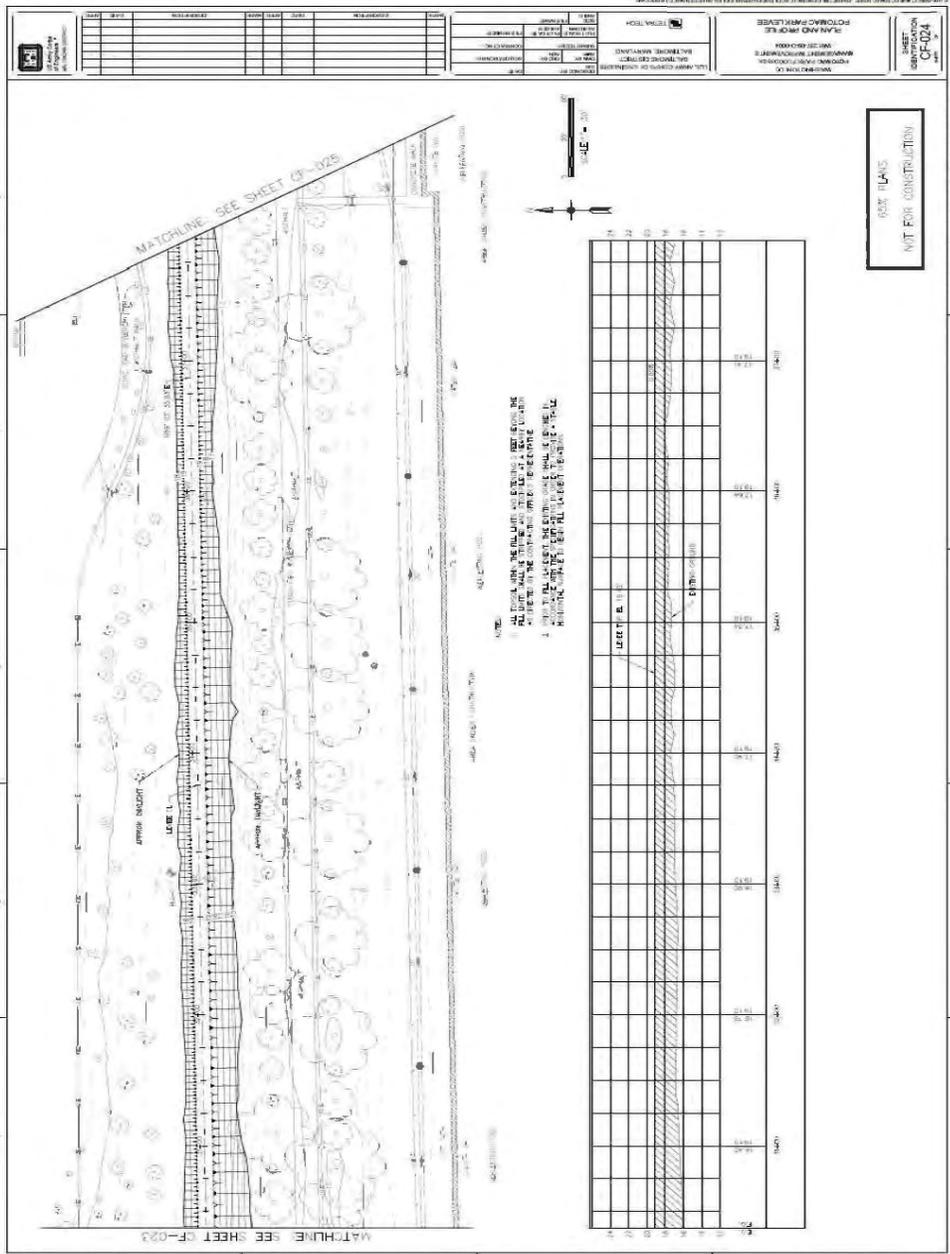
David Maloney
District of Columbia State Historic Preservation Officer

12/13/2018

Date

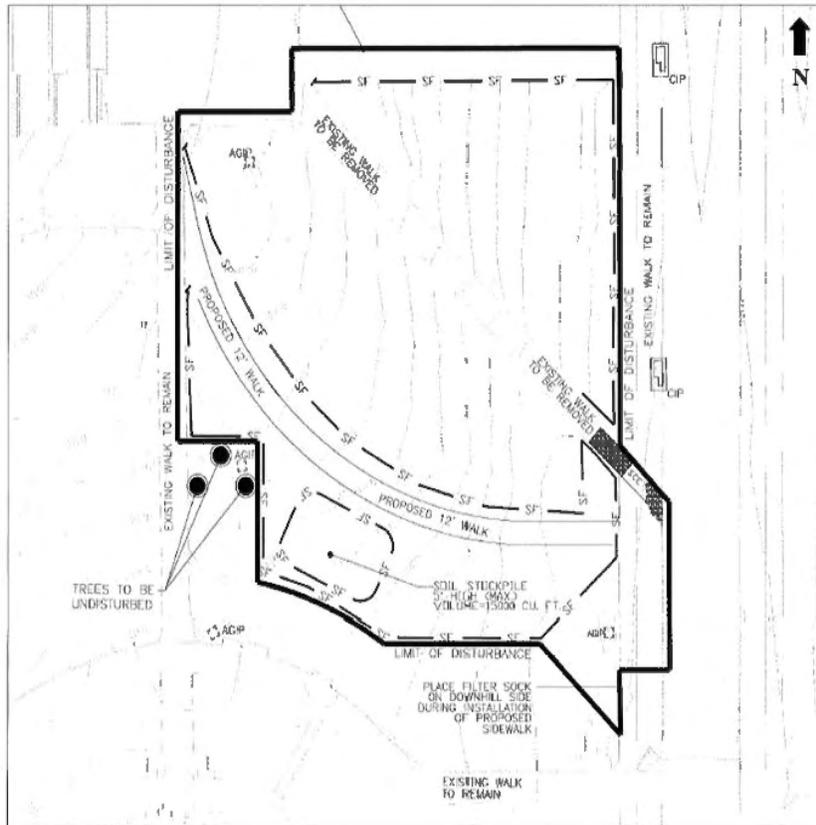
**APPENDIX A
PROJECT MAP AND 65% PLANS**





**APPENDIX B
SEMI-CIRCULAR SIDEWALK PLANS**





C. INTERIOR DRAINAGE ANALYSIS

An interior drainage analysis was performed to assess the residual flooding in the area protected by the Potomac Park Levee system. This analysis looks at both the impacts of rainfall within the District of Columbia (the interior area) and flood stages on the Potomac River and the interaction between the interior and exterior conditions.

The approach for the interior drainage analysis relies on an assessment of a range of scenarios to quantify the anticipated extent of flooding associated with the interior ponding area. In several of these scenarios the impact of the pumping stations were not directly considered. This was deemed necessary because of the fact that the system serves an area much larger than the Federal Triangle area. As such, the ability of the pumping stations to evacuate floodwaters from the Federal Triangle area depends on the geographical distribution of rain and the timing of runoff produced by areas distant from the Federal Triangle and the pumping stations. Therefore, the operating procedures for the pumping stations do not completely address flooding in the Federal Triangle area in a way that would satisfy FEMA requirements. In other words, these pump stations will be triggered by more frequent storm events prior to the 1% annual exceedance probability flood required by FEMA.

D. WATERSHED DATA

To support the analysis, WASA provided a map delineating the Federal Triangle Basin Catchments. This map is provided in Attachment B (Part 1 – Sewershed Catchment Areas) and identifies the individual sewersheds associated with each combined sewer outflow (CSO). Following the sewershed map is a schematic that shows the layout of the sewer system in the study area. These two maps in conjunction with Figure 12 illustrate that the boundary of the watershed on the ground surface changes once flow is conveyed into the pipe system.

Throughout the watershed stormwater is picked up by catch basins distributed within the system. WASA provided information for each sewershed regarding the number of catch basins and the capacity of those catch basins to convey flow into the pipe network system.

E. PONDING AREAS

Runoff that is not conveyed into the pipe system via the catch basins will flow down the streets to the low point of the watershed which is the Federal Triangle area. Once water reaches this area, it will collect and pond. Elevation-volume curves for the Federal Triangle area were generated using the 2008 LIDAR data that was provided through the Office of the Chief Technology Officer (OCTO). Contours and subsequent 3D TIN surfaces were created from the LIDAR points which were spaced at approximately 100-ft intervals, allowing 2-ft contours to be generated. Some areas of the topo are distorted due to 'blurring' of the data in areas of high national security priority such as around the White House, Washington Memorial, and the Capital. The data was assembled and analyzed in ArcGIS 9.2 with Spatial Analyst and 3D Analyst. The storage-elevation curve is included in Part 2 of Attachment B.

The storage available in the three tunnels located in the project area – 12th Street, 9th Street, and 3rd Street / Highway 395 – were incorporated into the HEC-HMS model. The 12th Street and 9th Street tunnels provide minimal storage. Both tunnels begin to store water once the pond reaches an elevation of 6 feet and water flows south beyond Constitution Avenue. The 3rd Street / Highway 395 includes a significant depression area to the south of the tunnel. Unlike the 12th Street and 9th Street tunnels, the 3rd Street / Highway 395 tunnel does provide significant flow storage as does the depression south of the tunnel. The storage in this tunnel and depression area is available once the pond elevation reaches 10 feet. The Elevation-Storage Curve incorporated into the HEC-HMS model accounts for these storage features. Details of the development of this curve are included in Part 2 of Attachment B.

Separate ponding areas were developed for the area north of Highway 395, and for the combined area north and south of Highway 395. Topography of the area indicates that when the ponding elevation is below 12', walls located on both side of the highway eastbound connector road will limit the flow that can be conveyed to the south. During high flow conditions the flood water could leak through or overtop the walls, only two gaps in the wall on the southern side of the parking area will allow flow to escape to the south. A survey topographic map superimposed on an aerial photograph in the vicinity of Highway 395 is included in Part 2 of Attachment B.

A significant number of buildings are located throughout the ponding area. In the area north of Highway 395 many of these large buildings have open courtyards that could store floodwaters. In addition, reports following the June 2006 storm event indicate that a significant number of buildings flood during large events. The DEM used in this study largely removes the buildings from the data set. This allows the footprint of the building to become inundated with floodwaters, which approximates the 2006 storm event condition where the buildings flooded.

In addition, the Constitution Gardens Pond that collects surface runoff from the adjacent area to the west (see Figure 11) was included as a separate ponding area.

F. INTERIOR DRAINAGE OUTLETS

The interior drainage of the Federal Triangle can be drained in two ways: (1) the Constitution Avenue gravity storm drain and (2) the B Street / New Jersey combined sewer system.

The Constitution Avenue gravity storm drain ranges in diameter from 57" to 72". It runs for approximately one mile along Constitution Avenue from 6th Street NW to 15th Street NW. The storm drain then turns south, crosses the National Mall, and discharges to the Potomac River at the Tidal Basin. Part 2 of Attachment B includes an analysis of the outlet capacity of this pipe under different tailwater conditions.

The B Street / New Jersey combined sewer flows to the O Street and Main Pumping Stations. The combined sewer also contains two gravity overflow points that discharge into the Anacostia River. The two pump stations

are both separated into a sanitary and stormwater side. The sanitary side of both pump stations pumps flows to the Blue Plains Treatment Plant. The stormwater side of both pump stations discharges into the Anacostia River. The stormwater side of the O Street Pump Station contains 6-100 MGD pumps [design capacity is 500 MGD (750 cfs) with one pump held in reserve.] The stormwater side of the Main Pumping Station contains 6-80 MGD pumps [400 MGD (620 cfs) capacity with one pump held in reserve.] While O Street and Main Pumping Stations are both connected to the B Street / New Jersey combined sewer line, the sewer is primarily drained by the O Street Pump Station. The sanitary pumps have a capacity of 60 MGD (93 cfs) and 300 MGD (464 cfs) at the O Street and Main Pump Station, respectively.

According to the "Standard Operating Procedure for Main and "O" Street Sewage Pumping Stations" (O'Brien and Gere Engineers, 1993), the stormwater pumps at the Main Station will be activated when the elevation of flow is at +3.0 feet at Structure #14 (the inflatable dam in the sewer system). It should be noted that this structure is located downstream of the Federal Triangle area and receives flow from the entire sewer system. It is reasonable to assume that this elevation will be reached at the dam well before the interior pond at the Federal Triangle reaches this elevation.

The Potomac Park Levee drainage area can be drained by the Easby Point Trunk Sewer with flow diversion to B Street / New Jersey combined sewer system and/or Potomac Pumping Station and by the Lake Drain at Constitution Gardens Pond. It should be noted that the outfall of Easby Trunk Sewer is located upstream of Arlington Memorial Bridge and the expected 2-year water surface elevation is between 4.4 and 4.7 feet (between stations 35260.17 and 40293.68 of Table 7). This will back up the Easby Point Trunk Sewer if the inflatable dam upstream of structure 34 (Figure 13), located near the intersection of 23rd Street and Constitution Avenue, is not activated. For this reason, the Easby Point Trunk Sewer outfall was considered inactive and the flow is assumed to be diverted to the B Street / New Jersey combined sewer system in this analysis.

G. INTERIOR DRAINAGE MODEL

Using the U.S. Army Corps of Engineers (USACE) HEC-HMS software, a model of the Federal Triangle watershed was developed. The following describes the drainage basin parameters that were used in the model. Summary HEC-HMS data is provided in Part 2 of Attachment B. All input and output files are included on the CD attached to this memorandum. Output data is included in Part 3 of Attachment B.

The HEC-HMS model was used to generate runoff throughout the watershed area, route the flows down to the low points (the Federal Triangle and Constitution Gardens Pond) and through the detention basins using various outlet scenarios. The model was also used to determine the elevations of the interior ponding.

i. Drainage Area

A sewershed shapefile, provided by WASA, was used as the basis for the subwatersheds in the HEC-HMS model. The sewersheds were clipped to match the extent of the Federal Triangle overland flow drainage area, also provided by WASA as a shapefile. The subsequent clipped sewersheds were used to calculate drainage areas and assist in delineating flow routes for the HEC-HMS model. Sewershed processing was done in ArcGIS 9.2.

The topographic data base used is the 2008 LIDAR dataset (provided by OCTO) because it is the most recent available data. Spot checks were done between this dataset and the previous OCTO data that was generated in 2004. These spots were chosen in areas free of tree canopy as the 2004 data was not corrected for vegetation. This verification resulted in elevation discrepancies on the order of 2.5 feet. The 2008 data was corrected to remove the effects of vegetation, while this was not done in the 2004 data. The 2004 data has a smaller grid (1 meter) as compared to the 100-foot grid in the 2008 data. Data from the U.S. Coastal and Geodetic (USCG)

Survey (2009) were obtained for several benchmarks in the study area and compared with elevations from both 2004 and 2008 data at the same locations. Several of these points are shown in Table 9.

Table 9. Elevation Comparison

Point	USCG elevation	2004 elevation	2008 elevation	Location
1	11.02'	10.12'	11.2'	Capitol Grounds
2	6.23'	6.58'	4.21'	Constitution & 9 th
3	6.49'	6.74'	4.00'	Pennsylvania & 9 th
4	12.30'	12.83'	12.69'	Constitution & 15 th
5	14.56'	14.56'	14.05'	Pennsylvania & 13 th
Note: elevation in NAVD 88.				

An analysis of the data indicates that 3 out of 5 data sets are in agreement except 2 data sets along Constitution Avenue. In this area the USCG and 2004 data are approximately 2' to 2.5' higher than the 2008 data. However preliminary analyses were performed to assess the likely range of impact if elevations along Constitution Avenue were increased by 2.5'. The results of this analysis show that the ponding elevations and footprint are unaffected due to the relatively small volume of storage in question. Therefore, the higher elevations along Constitution Avenue were used in estimating the elevation storage curve.

ii. Rainfall

Various rainfall frequency events were defined in the HEC-HMS model. The rainfall amounts were obtained from the NOAA Atlas 14, Volume 2, Version 3 for the Washington DC area and are shown in Table 10. The SCS 24-hour Type II rainfall distribution was used in the HEC-HMS model.

Table 10. Precipitation Depth

Frequency	Precipitation (inches)
500-year	11.8
200-year	9.67
100-year	8.30
50-year	7.09
25-year	6.01
10-year	4.81
5-year	4.02
2-year	3.13

iii. Losses

Using the SCS method, a curve number was defined for each of the sewersheds. Table 11 shows the values that were used for the land types found in the watershed. These values are based on soil type D which is the

prevalent soil type in the area and yields the most conservative curve numbers. Based on visual inspection of the aerial photography, a composite for the sewershed was developed using the Table 11 values. The final curve numbers ranged from 86 to 95. Part 2 of Attachment B includes a table identifying the percent of land type assumed in each sewershed.

Table 11. SCS Curve Numbers

Land Type Description	SCS CN
Urban: Commercial	95
Residential: 1/8 acre or less	92
Open Space: Good	80

iv. Routing

The lag time for each individual sewershed was calculated using the formula (USDA 2010):

$$T_{LAG} = L^{0.8} * (S+1)^{0.7} / 1900 * Y^{0.5}$$

where T_{LAG} is the lag time in hours, L is the hydraulic length of the sewershed in feet, Y is the sewershed slope in percent, and S is the maximum retention in the sewershed in inches as defined by:

$$S = (1000 / CN) - 10$$

where CN is the SCS curve number used for land cover type. The minimum sewershed lag time used was 3.5 minutes.

Lag times for individual routing reaches were determined by dividing the reach length to the velocity of flow along that reach. The flow velocity was calculated based on the Manning's equation:

$$V = (1.49/n) * R^{0.67} * S^{0.5}$$

A Manning's n -value of 0.013 was used to represent asphalt, a typical street cross section was used to determine the hydraulic radius (R), and the slopes (S) were identified from the topographic data. The length of each reach was determined from the topographic maps as well as the CSO network information.

Lag times for each sewershed and the routing reaches are shown in Part 2 of Attachment B.

v. Reservoir

The reservoir component of the HEC-HMS model was used to determine the depth of ponding that would result from the watershed runoff.

vi. Pond Outlet

As described previously, flow can be discharged from the pond via a gravity drain or through the pump stations. Various HEC-HMS simulations were set up to analyze the impacts of the possible outlets.

H. INTERIOR DRAINAGE SCENARIOS

Scenario 1 – no gravity outflow or pump discharge

In this simulation the total runoff from a 100-year storm was routed down to the Federal Triangle area and Constitution Gardens Pond. The river stage was assumed to be at the 100-year level in which case the gravity drain outlet has negligible impact on the interior ponding elevations. The pumps were not used to drain the interior in order to reflect the uncertain operational procedures. Thus, this scenario is a conservative estimate of the interior ponding area and was generated to establish a maximum extent of the expected inundated area. The elevations of the ponded areas were calculated based on the elevation-storage curve to be 13.1 and 11.8 feet NAVD88 for the Federal Triangle Area and Constitution Gardens Pond, respectively.

The footprint of the Federal Triangle ponding area (shown on Exhibit 1) extends south of Highway 395 and the footprint of the Constitution Gardens Pond ponding area is limited by the high grounds adjacent to the Pond.

In the 2009 Tetra Tech analysis, an additional iteration of the model was made that did not include the area south of Highway 395. In this model run, the pond reached an elevation of 14.2 feet which would sufficiently breach the high point under the highway to allow water to drain south beyond the highway. Flooding associated with the 12th and 9th Street tunnels are also shown on Exhibit 1 and are located south of the main pond area.

Scenario 2 – catch basin diversions and pump discharge

In this simulation the runoff from a 100-year storm was generated for the Federal Triangle and Constitution Gardens Pond watersheds. The capacity of the catch basins was modeled to divert flow out of the watershed. It is assumed that the water will be conveyed through the combined sewer pipe system and the pump stations will discharge the flow to the Blue Plains Treatment Plant or the Anacostia River. The flow not collected by the catch basins was routed to the Federal Triangle area and allowed to pond in the low areas. The river stage was assumed to be at the 100-year level in which case the gravity drain outlet has negligible impact on the pond elevation. The elevation of the ponded area was calculated based on the elevation-storage curve. The interior pond elevation in this scenario is 10.0 feet NAVD88 for the Federal Triangle Area. The footprint of the ponding area is shown on Exhibit 2. The flooding is contained north of Highway 395 because the pond elevation does not significantly exceed the 10-foot high ground under the highway for a sustained duration. Flooding areas shown associated with the tunnels are located south of the main pond area. The ponding area of Constitution Gardens Pond remains the same as in Scenario 1 due to absence of catch basins in the tributary drainage area and the assumed high river stage which prevents gravity drain outflow from affecting the pond elevation.

The Scenario 2 flooded area of Federal Triangle is smaller compared to Scenario 1 due to significant diversion of flow that was assumed to occur through the catch basins. The analysis of the catch basins (included in Attachment B, Part 1 – Catch Basin Capacity Analysis) assumes that 25% of the catch basins are clogged and accept minimal flow while the remaining catch basins are fully operable under orifice flow. Flow that bypasses the catch basins in the originating watershed was not allowed to enter the system at a downstream catch basin, but was routed to the Federal Triangle. An underlying assumption of this analysis is that the pipes have sufficient capacity to convey the flow collected by the catch basins. The ability of the pipes to convey that capacity is in part dependent on the operation of the combined system contributing to the pump stations and the operation of the pump stations themselves. This scenario provides possible inundation extents that could result under a certain pumping operation.

Scenario 3 – pump discharge only

In this simulation the total runoff from a 100-year storm was routed down to the Federal Triangle area and Constitution Gardens Pond. No diversion of flow through the combined sewer system in the watershed was considered. The pumping capacity of the Main and O Street pump stations was used to drain the ponded areas. Based on the design capacity of the pump stations, a constant pumping rate of 900 MGD was used. The river stage was assumed to be at the 100-year level in which case the gravity drain outlet has negligible impact on the

pond elevation. The maximum elevations of the ponded interior in this scenario are 11.2 and 11.8 feet NAVD88 for the Federal Triangle area and Constitution Gardens Pond, respectively.

The footprints of the ponding areas associated with this scenario are shown on Exhibit 3. No flooding is shown south of Highway 395. The pond elevation is sufficient to allow some shallow flooding (less than 1 foot in depth) to be conveyed to the south. This area will be shown as a Zone X shaded area as a result of the 500-year flooding and/or to denote an area protected by a levee. No additional delineation of the shallow flooding associated with flow being conveyed south of Highway 395 was made.

Flooded areas associated with the 12th and 9th Street tunnel are shown on Exhibit 3. These flooded areas are south of the main pond area.

A simplifying assumption made in this analysis is that the full pumping capacity of the Main and O Street pump stations is available to drain the Federal Triangle area. These pump stations are part of a larger system as shown in the schematic of the system (included in Attachment B, Part 1 – Sewer System Schematic) and could be used to pump stormwater from different parts of the system. If the pumps collect water from other parts of the system, they are still removing water from the Federal Triangle watershed at some point. Therefore, the effect of timing was not important as the runoff volume remains the same.

The Standard Operating Procedures manual for the pump stations is included in Part 1 – Standard Operating Procedures of Attachment B. This document identifies the stormwater operation of the pump stations during high flow conditions. The stormwater pumps are activated once the inflatable dams are deflated. The deflation point (3.0') is sufficiently low to ensure that, at the ponding elevation determined in this scenario, the stormwater pumps will be fully utilized. In particular, Section 2.3 of the operations manual discusses stormwater operations.

Scenario 4 – gravity outflow only, no pump discharge

This scenario analyzes the flooding resulting from a 100-year rainfall in the interior and a relatively low (2-year) river stage. At this river stage the gravity drain outlet is more effective than at higher river stages. The resulting ponding elevations are 13.0 and 11.1 feet NAVD88 for the Federal Triangle area and Constitution Gardens Pond, respectively. The small difference between the pond elevation in this scenario and in Scenario 1 (13.1' and 11.8') indicates that even at low river stages, the gravity drain is not effective at evacuating floodwaters. This same conclusion was reached in the 1992 USACE study.

No direct benefit of the pumping stations is considered in this scenario. However an indirect benefit considered is that the pumping capacity will provide enough relief to the combined sewers such that no surcharging of the B St / NJ Avenue line will occur through the Federal Triangle area.

Due to this relatively high ponding elevation, flow is expected to be conveyed south of Highway 395 for this scenario. Earlier model iterations not considering the volume south of Highway 395 resulted in ponding elevations in the range of 14.0 to 14.2 feet, more than sufficient to breach high ground under the highway. Additional ponding is shown associated with the 12th and 9th Street tunnels south of the main pond area (see Exhibit 4).

Coincident Frequency (Joint Probability) Analysis

The HEC Statistical Software Package (HEC-SSP) was used to perform a coincident frequency analysis to determine the stage-frequency relationship for interior ponding in the Federal Triangle Area and Constitution Gardens Pond. Unlike scenarios 1 through 4, where a single river stage was assumed as the external boundary condition for analyzing the interior drainage system performance, a coincident frequency analysis uses joint probability to account for the percentage of time the Potomac River is at various stages. An initial step is to generate "response tables" depicting the ponding elevations reached for combinations of various recurrence interval flood events on the interior and exterior of the levee. Note that coincident frequency analysis is only

necessary under conditions where the effects of gravity drains are to be considered because pumping stations can generally operate regardless of the external river stage.

For joint probability analysis, HEC-HMS flood routings were performed that accounted for the interior ponding storage-elevation relationship and gravity drain outflow vs. external river stage for a set of recurrence interval flood events (2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year). The computed ponding elevations corresponding to the N-year flood events are shown in Tables 12 and 13 for the Federal Triangle area and Constitution Gardens Pond. These response tables quantify the capability of the gravity drain system to convey runoff to the river under various river stages. This scenario is similar to Scenario 4 in that the combined sewer system is not assumed to be conveying surface runoff from the areas tributary to the Federal Triangle and Constitution Pond to the pumping stations for discharge to the river.

The Potomac River at Little Falls Pump Station discharge frequency curve (Figure 5 and Table 4) and duration-frequency relationship (Figure 6 and Table 4) are used in combination with the Table 12 and Table 13 response tables to compute the joint probability for the ponding stage-frequency curves. Given the disparity in drainage area size and watershed response time between the Potomac River at Washington, DC (11,560 square miles) and the drainage areas tributary to the Federal Triangle area (total of about 5.21 square miles) and Constitution Gardens Pond (0.55 square miles), the runoffs from these two areas are assumed to be statistically independent of the Potomac River flow.

The results of the coincident frequency analysis for the Federal Triangle area and Constitution Gardens Pond are presented in Figures 14 and 15, respectively. The computed 100-year water surface elevations for the Federal Triangle area and Constitution Gardens Pond are 13.0 and 11.4 feet, respectively.

Table 12. Federal Triangle Area Response Table

Frequency (yr)	Variable A Peak inflow of interior drainage area (cfs)	Variable B (feet)							
		Water surface elevation (feet) at Potomac River at HEC-RAS Station 26195.54							
		2-year	5-year	10-year	25-year	50-year	100-year	200-year	500-year
		B1 = 4.08	B2 = 5.54	B3 = 7.38	B4 = 9.31	B5 = 10.44	B6 = 11.43	B7 = 12.46	B8 = 13.75
Frequency (yr)	Variable A (cfs)	Variable C (feet)							
		Maximum ponding elevation of interior drainage area at coincident event							
		C = f(A,B1)	C = f(A,B2)	C = f(A,B3)	C = f(A,B4)	C = f(A,B5)	C = f(A,B6)	C = f(A,B7)	C = f(A,B8)
500	22288.0	14.9	14.9	15.0	15.0	15.0	15.0	15.1	15.1
200	18070.7	13.8	13.8	13.8	13.9	13.9	13.9	14.0	14.0
100	15346.1	13.0	13.0	13.0	13.1	13.1	13.1	13.2	13.2
50	12929.8	12.2	12.2	12.3	12.3	12.4	12.4	12.5	12.5
25	10763.9	11.4	11.5	11.5	11.6	11.6	11.7	11.7	11.7
10	8346.9	10.5	10.5	10.6	10.7	10.7	10.7	10.7	10.7
5	6750.9	9.9	9.9	9.9	10.0	10.0	10.0	10.0	10.0
2	4953.7	9.6	9.6	9.6	9.7	9.7	9.7	9.7	9.7

Note: elevation in NAVD 88.

Table 13. Constitution Gardens Pond Response Table

Frequency (yr)	Variable A Peak inflow of interior drainage area (cfs)	Variable B (feet)							
		Water surface elevation (feet) at Potomac River at HEC-RAS Station 3S260.17							
		2-year	5-year	10-year	25-year	50-year	100-year	200-year	500-year
		B1 = 4.41	B2 = 6.14	B3 = 8.10	B4 = 10.91	B5 = 11.54	B6 = 12.80	B7 = 14.10	B8 = 15.92
		Variable C (feet)							
		Maximum ponding elevation of interior drainage area at coincident event							
		C = f(A,B1)	C = f(A,B2)	C = f(A,B3)	C = f(A,B4)	C = f(A,B5)	C = f(A,B6)	C = f(A,B7)	C = f(A,B8)
500	416.4	11.8	11.8	11.9	12.5	12.5	12.5	12.5	12.5
200	328.4	11.4	11.4	11.4	12.1	12.1	12.1	12.1	12.1
100	271.6	11.1	11.1	11.2	11.8	11.8	11.8	11.8	11.8
50	221.5	10.9	10.9	10.9	11.4	11.4	11.4	11.4	11.4
25	176.9	10.7	10.7	10.7	11.1	11.1	11.1	11.1	11.1
10	128.0	10.5	10.5	10.5	10.8	10.8	10.8	10.8	10.8
5	96.9	10.3	10.4	10.4	10.6	10.6	10.6	10.6	10.6
2	62.7	10.2	10.2	10.2	10.4	10.4	10.4	10.4	10.4

Note: elevation in NAVD 88