Hydrologic and Hydraulic Analysis Report

Jones Point Park Drainage Study

Volume 1 of 2

City of Alexandria, Virginia

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Executive Summary

A study of existing and proposed drainage conditions for Jones Point Park (Park) in Alexandria, Virginia, was performed to determine if proposed Park improvements will cause flooding of the local residences adjacent to the Park. Jones Point Park is to be improved as part of the Woodrow Wilson Bridge Project.

Under existing drainage conditions, storm flows frequently overtop Lee Street and Jones Point Park Drive. Existing drainage facilities consist of a 24" concrete pipe culvert (Culvert A) under Lee Street that is currently half filled with sediment. Discharge from Culvert A flows to the southwest to a twin 21" corrugated metal pipe culvert (Culvert B) under Jones Point Park Drive and the existing Woodrow Wilson Bridge. Two drainage areas were delineated for existing conditions. Area 1 drains through the two culverts (A & B) and discharges into Hunting Creek south of the existing bridge. Area 2 drains to the northeast through existing wetlands, under a Mount Vernon Trail footbridge and discharges directly into the Potomac River.

Under proposed conditions, there will be three areas contributing drainage to the area north of the new bridge. After the new Woodrow Wilson Bridge is complete, the area under the bridge is anticipated to be sloped gently toward the north. Under proposed conditions drainage Area 1 will be slightly larger in size, increased by a portion of the area beneath the new bridge. Drainage Area 2 will remain the same. Drainage Area 3, the remaining under bridge area, will drain to a shallow swale and discharge directly into the Potomac. It is not expected that the area under the new bridge will receive any significant precipitation since the new bridge deck will intercept any rainfall in that area. Deck drainage will be collected in a closed storm drainage system and will be conveyed and discharged directly into Hunting Creek through the existing Hunting Point bulkhead near the Virginia abutment.

Both drainage Areas 1 and 2 were evaluated for existing and proposed drainage conditions. Drainage Area 3 was not evaluated, as it drains directly to the Potomac and will not consist of significant discharge under proposed conditions. Drainage Area 1 will be larger under proposed conditions and will have more impervious area, therefore will have increased storm runoff. Drainage Area 2 will remain approximately the same size with similar characteristics as existing, and flow conditions will not change.

Based on separate hydraulic studies, the Park will be flooded during the ten-year storm or larger event by the Potomac River. Since the existing internal Park roadways will be overtopped at that storm event, culvert analysis was only conducted for storms at ten-year intervals and below. The existing culverts are

not adequate for conveying the ten-year flow using current design criteria, even if Culvert A under Lee Street is cleared of sediment. Both Culverts A and B will need to be upgraded for proposed conditions.

A new Park access roadway with a new culvert is proposed between existing Culverts A and B. Both culverts need to be upgraded to pass proposed ten-year storm event flows, and the new culvert will need to be designed to do the same. Hydraulic analyses of these culverts, under proposed conditions, were conducted and a solution developed. Culvert A is recommended to be upgraded to a twin 24" RCP pipe, the new access roadway culvert should be a twin 36" RCP pipe, and Culvert B should be a twin 2' high by 6' wide box culvert. This solution will allow storm flows under proposed improved conditions, equal to the ten-year storm event, to drain without backing up or overtopping Park roadways.

Introduction

Jones Point Park, located in the southeast corner of the City of Alexandria, Virginia is being improved as part of the Woodrow Wilson Bridge Project. Potomac Crossing Consultants (PCC) is assisting the National Park Services, in cooperation with the Federal Highway Administration (FHWA), the Virginia Department of Transportation (VDOT), the City of Alexandria and the local community to finalize preparation of an Environmental Assessment (EA) document for the proposed Park improvements. This report examines the existing site drainage condition in the Park, identifies drainage and hydrologic conditions and evaluates potential proposed drainage improvements. Peak Runoff Discharges associated with 2-, 5-, 10-, 25-, 50-, and 100-year return period storm events for both existing and proposed site condition were developed for the drainage areas north of the Woodrow Wilson Bridge.

Drainage Area Description

The drainage areas for the Park were delineated using two-foot topographic contours obtained from the City of Alexandria GIS sources, and were supplemented with 1-foot contours provided for the Project in the Park by Air Survey Corporation in 1996. Under existing conditions the Park has two distinct existing drainage areas north of the Woodrow Wilson Bridge. These two drainage areas are 15.07 acres (Area 1) and 21.71 acres (Area 2) in size (see Appendix A for drainage area maps). Under proposed conditions, there will be three drainage areas. The area under the bridge will be graded to slope towards the northern section of the park. A drainage divide will be created by this grading to prevent any drainage from the south side of the bridge to drain towards the north. Area 1 will extend southward to and under the bridge, and will encompass approximately 16.54 acres in size Area 2 will remain the same size as existing. Area 3 will include the area between Area 2 and the bridge and will be approximately 2.33 acres in size. Areas 1 and 3 will also include part of the area under the bridge. The bridge surface will intercept rainfall and collect and convey deck drainage to an outfall away from the Park. Therefore the area under the new bridge will not generate significant runoff into the Park, so this area was not included in drainage area calculations.

Drainage Area 1 drains through an existing 24” RCP culvert under Lee Street and then to a twin 21” CMP culvert under the existing Woodrow Wilson Bridge. Under proposed conditions there may be an additional culvert between these two culverts under a proposed new entrance roadway. Drainage Area 2 drains to the northeast to an open channel and under a footbridge to ultimately discharge directly into the Potomac River. Proposed drainage Area 3 will drain through a swale directly into the Potomac River.

Hydrologic Soil Groups (Based on Natural Resources Conservation Service classifications)

Soils for the park were estimated to be in hydrologic soil group D. Several sources were used to make this assumption. Fairfax County does not have soils maps for Jones Point Park, only the surrounding County areas. The City of Alexandria has not yet completed a soil survey. In the old and new Fairfax County surveys, the areas surrounding Alexandria, closest to Jones Point Park, were mostly Group C in origin, with poor drainage, along with some Group D soils. Prince George's County, MD soil information for soils on the Maryland side of the Woodrow Wilson Bridge show soils that are Group C and D. Other information used was obtained from Dyke Marsh located just to the south of Jones Point Park, in the City of Alexandria. Soils were poorly drained in that location. To be conservative, Group D was used for all of Jones Point Park soils, based on all sources available.

Land Use

A small area of residential properties drains toward Jones Point Park. The park itself has some impervious areas (roads, parking lots and pedestrian paths), many wetland areas, wooded areas, and grassed areas. The wetlands were redelineated in 2005 by PCC in conjunction with the Corps of Engineers. The redelineation increased the wetlands east of the Lee Street Community Gardens and all are now considered jurisdictional wetlands.

Under the proposed conditions, the existing 80-space temporary parking lot will be removed, and new permanent parking lots will be constructed. Public accessible parking will consist of 110 spaces in the park, and roadways to access them. One or two playing fields will be built at a raised elevation to provide adequate drainage for multi-purpose type athletic activity. Some portions of the existing Mount Vernon Trail within the Park will be relocated to fit in with the overall Park improvements. Unrestricted Public parking will not be allowed under the new bridge due to security restrictions. This area under the new bridge will be available for event parking when security is provided. Several options for unrestricted access improvements are being considered. For this report, Alternative 2, with the most impervious area, was chosen to determine ultimate proposed Park drainage. Both Alternatives 1 and 2 include a road accessing the park that will require a culvert to be placed in the channel in drainage Area 1 between the two existing culverts under Lee Street and the bridge. Appendix A shows the existing and proposed Alternative 2 land use conditions. Tables 1 and 2 show the land uses for drainage areas 1 and 2.

Table 1: Drainage Area 1 Land Uses, Alternative 2

Land Use	Existing Conditions		Proposed Conditions	
	Area (ac)	Percent	Area (ac)	Percent
Forest	5.960	40%	3.573	22%
Open Urban	5.681	38%	8.704	53%
Impervious	2.432	16%	3.459	21%
Wetlands	0.995	7%	0.798	5%

Table 2: Drainage Area 2 Land Uses, Alternative 2

Land Use	Existing Conditions		Proposed Conditions	
	Area (ac)	Percent	Area (ac)	Percent
Forest	9.086	42%	7.511	35%
Open Urban	4.316	20%	6.067	28%
Impervious	2.687	12%	2.476	11%
Wetlands	5.616	26%	5.651	26%

Runoff Curve Number Determination

Runoff curve numbers were assigned based on TR-55 (NRCS, 1986), in accordance with each soil-land cover complex, and averaged by area to obtain a composite curve number for the watershed. The existing curve number for drainage Area 1 is 83 and for drainage Area 2, 86 is used.

Proposed curve numbers were updated using the proposed Park improvements. The City of Alexandria data remained the same for existing and proposed conditions, only the Park areas changed. The proposed curve number for drainage Area 1 is 84; for drainage Area 2, 86. Drainage area 3 was not analyzed because water will drain directly to the Potomac River. Curve number computations are located in Appendix B.

Hydrologic Analysis

The SCS TR-20 model was used to compute the peak discharges for both existing and proposed conditions. Each drainage area was modeled as a single unit in TR-20. Storage routing was included for drainage Area 1 behind the first culvert under Lee Street. Table 3 lists the rainfall totals, obtained from a NOAA Atlas 14 gage, based at the Washington-Reagan National Airport. The 2-, 5- and

10-year storms were based on the 6-hour rainfall totals, while the larger storms were based on 24-hour totals.

Table 3: Rainfall Totals

Storm (Yr)	Rainfall Total (inches)
2	2.23
5	2.81
10	3.29
25	5.99
50	7.05
100	8.26

Existing times of concentration were computed using the NRCS Segmental Method, documented in TR-55 (NRCS 1986). Overland (sheet) flow was limited to 100 feet, and 2-year, 24-hour rainfall was used for determination of sheet flow velocities for all return periods, according to NRCS recommendations. Roughness estimates were developed from field visits and topographic mapping. The same values were used for proposed conditions, as the path is not expected to change. Times of concentration can be found in Appendix A (graphic) and Appendix B (computations).

The TR-20 model for proposed conditions reflect the same information outside of the park boundaries, with curve numbers and times of concentration updated to reflect proposed park improvements. The same storm events were used. Table 4 shows the differences between existing and proposed flows for drainage Areas 1 and 2. TR-20 model results are located in Appendix C.

Table 4: TR-20 Discharges

Return Period (yrs)	Rainfall Totals (in)	Existing TR-20 Discharges (cfs)		Proposed TR-20 Discharges (cfs)		Percent Increase of Proposed Discharge	
		Area 1	Area 2	Area 1	Area 2	Area 1	Area 2
2	2.23	29	46	34	46	17.2	0.0
5	2.81	45	68	52	68	15.6	0.0
10	3.29	59	87	69	87	16.9	0.0
25	5.99	78	114	88	114	12.8	0.0
50	7.05	97	139	108	139	11.3	0.0
100	8.26	117	167	131	167	12.0	0.0

As illustrated above, peak discharges under proposed conditions through Area 1 will increase, ranging from 11.3 percent to 17.2 percent, depending on storm

frequency. There will be no additional discharge increase associated with Area 2. The subsequent sections of this report describe the potential storm drainage structure improvements needed to improve the existing site drainage conditions and adequately handle the discharge increases in the proposed conditions.

Hydraulic Analysis

Jones Point Park, due to the proximity to the Potomac River, will be flooded during the 10-year storm event. Earth Tech completed a Jones Point Park Hydraulic Review Study in April 2005. This report was completed to demonstrate that the construction of two multi-purposed fields in Jones Point Park would not affect the Potomac River flood elevations. Earth Tech used FEMA flood flows that were used in the Maryland State Highway Administration Conditional Letter of Map Revision process. These flows showed that at the 10-year flood, the water surface elevation would be 6.8 feet, which will flood the park and will just begin to flood the residents northwest of the park.

Due to the fact that the park will be flooded by the rise of Potomac River during the storm event equal or greater than a 10-year storm, hydraulic analyses of the park drainage conditions were only performed for the 2- and 10-year storms. Since there will be no changes in runoff for drainage Areas 2 and 3, only Area 1 will be analyzed.

Federal Highway Administration's HY-8 culvert analysis computer program was used to evaluate the performance of the existing culverts and to size the proposed drainage structures. Site storage routing was computed in both HY-8 and TR-20. Appendix D contains the results of the HY-8 analyses for existing and proposed conditions.

Culvert A is located under Lee Street, and is a 24" RCP that is half filled with sediment. Lee Street has a low point at approximately the 6-foot elevation. Computations were completed in HY-8. Under existing, clogged conditions, the roadway overtops at 6.08 feet during the ten-year storm event. Even if the pipe is cleared, the roadway will continue to be overtopped under existing conditions at elevation 6.04 feet for the 10-year. The existing pipe is undersized and needs to be improved to current design standards to prevent flooding the roadway under existing conditions for the ten-year event. Appendix D has HY-8 computations.

Culvert B is located southwest of Culvert A, and flows under the proposed pedestrian paths and the new Woodrow Wilson Bridge, where it meets the Potomac River. This culvert is currently a twin 21" CMP culvert, and is under constant submerged tidal influenced (tailwater) condition. A constant tailwater of four feet (based on field observations and survey) was used to model it in HY-8.

The low point in the road is at an elevation of six feet, and is near the culvert. The roadway overtops under existing conditions at the ten-year storm event, at an elevation of 6.10 feet. As with Culvert A, this pipe should be upgraded to handle existing and additional future proposed flows. Computations are provided in Appendix D.

Under proposed conditions for both Alternatives 1 and 2, there will be another roadway and culvert between the two existing culverts. To size this pipe and to determine proposed pipes for Culverts A and B, several HY-8 models were run. It was determined that a drainage structure consisting of twin 2'x6' box culverts for Culvert B, twin 36" RCPs for the new culvert under the roadway, and twin 24" RCPs to replace existing Culvert A would pass proposed flows without overtopping any roadways for the 10-year storm event. Under proposed conditions, the flood level for Culvert A will be no higher than 5.75 feet. Appendix E has the proposed HY-8 computations.

Culvert A was also routed using a TR-20 program. This was done to determine if the loss in storage due to the proposed raised playing fields would affect flooding in Jones Point Park. The storage calculations were done using existing and proposed topography. The discharge calculations for TR-20 were calculated using the existing pipe flows, and using the proposed pipe size under proposed site conditions. Under existing, unclogged conditions, the 10-year flood elevation is 4.26 feet. This is assuming no tailwater conditions. Under proposed conditions (raised playing fields and twin culverts), the 10-year storm elevation is 4.20 feet. Appendix F contains the model results for the existing and proposed routing.

Conclusions

Table 5: Culvert Sizes

Culvert	Existing Size	Proposed Size
Culvert A	24" RCP	Twin 24" RCPs
Culvert B	Twin 21" CMPs	Twin 2'H by 6'W box culverts
New culvert	---------	Twin 36" RCPs

Jones Point Park is subjected to Potomac River flooding at storm events of ten years or greater. Currently, the existing culverts will cause the existing Park roadways to flood during storm events greater than a ten-year return frequency due to inadequate pipe sizes and existing clogged conditions. The proposed culverts as identified in this report will allow storm events up to the ten-year event to drain without overtopping the roads within the park. Though the park area will continue be subjected to the Potomac River flooding, with the proposed drainage

improvements listed in the Table 3, smaller local storm events will not flood over the roads. Upgrading Culvert A to a twin 24" RCP, building a new twin 36" culvert under the proposed road, if it is built, and replacing Culvert B with twin 2'H x 6'W box culverts (or equivalent drainage system) will allow proposed storm water runoff to pass under the Park roadways for the 2- through 10-year storm events. Ultimate planned improvements for Jones Point Park can correct the small storm event flooding conditions currently being experienced in the Park.