Analysis of Hydraulic Impacts on the Schuylkill River

Manayunk Sewer Basin Construction Project
and the
Venice Island Recreation Center Reconstruction Project

Venice Island, Manayunk, Philadelphia, PA

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Executive Summary

A Flood Hazard Analysis was performed to determine the potential impacts of the proposed Manayunk Sewer Basin Construction Project and the Venice Island Recreation Center Reconstruction Project on Venice Island, Manayunk, Philadelphia, PA.

The analysis used the HEC-RAS (River Analysis System) computer model and cross-sections from a Flood Insurance Study (FIS) for Philadelphia, PA by the Federal Emergency Management Agency (FEMA, 1996). Four (4) cross-sections were added to provide more detail in the proposed project area, between Lock Street and Cotton Street. The model included a 4,000 foot segment of the Schuylkill River.

The HEC-RAS model was calibrated to the 100-year water surface elevations established in the 1996 FIS. The 100-year flood flow in the Schuylkill River is 109,000 cubic feet per second (cfs). Future conditions were modeled by modifying the cross-sections to represent proposed conditions. The maximum increase in water surface elevation upstream from the project site was 0.01 feet (less than 1/8 inch). The maximum increase in velocity and shear stress were 0.71 feet per second (fps) and 0.02 pounds per square foot (psf) respectively. The changes in water surface elevation, velocity and shear stress between existing and future conditions were less than the error of model prediction. Therefore the proposed projects will result in no significant impact to the flooding potential in the Schuylkill River under 100-year flood conditions.

Introduction and Background

The Upper Schuylkill East Side Interceptor (42" diameter) conveys separate sanitary sewer along the north side of the Schuylkill River, crossing the Manayunk Canal at the west end of Venice Island through a siphon and traveling the length of the island before crossing back over to the mainland area of Manayunk at the Lock Street Bridge. Due to chronic surcharging in the Manayunk area during wet weather flow periods, a relief overflow that discharges into the Schuylkill River was constructed at Main Street and Shurs Lane (R_20). The interceptor has a slotted overflow, approximately 2'-6" wide by 6'-0" long, that is located 1" above the crown of the pipe, enabling the surcharging sewage to overflow into a storm outlet structure and discharge into the Schuylkill River. The Philadelphia Water Department (PWD), under it's Combined Sewer Overflow Long Term Control Plan, has committed to the elimination of the relief overflow at R_20.

The proposed site for the Manayunk CSO detention facility is on the eastern end of Venice Island, between Cotton Street and Lock Street in the Manayunk section of the City. Venice Island is a small body of land that is approximately 1.8 miles long, varies in width from 180' – 600' and is situated between the Schuylkill River and the Manayunk Canal. The eastern end of Venice Island has the following land uses:

1. Commercial/industrial - Connelly Container has a vacant 3 acre site west of the Cotton Street Bridge that is slated to be a condominium development by Realen Properties.

2. Recreational – The Philadelphia Department of Recreation owns and operates the Venice Island Recreation Center Building and surrounding facilities that include a playground, hockey court, basketball court and swimming pool.

3. Parking – The Manayunk Development Corporation leases and operates a 200± car parking lot that provides off-street parking for the Main Street shopping district.

4. Railroad – Norfolk Southern owns & operates a railroad track system that runs along the northern side of Venice Island, parallel to the Manayunk Canal, and crosses over the Schuylkill River at the southern tip of the island. Norfolk Southern provides regular service to the remaining industry located on Venice Island – Smurfit-Stone, which is located on the western end of the island.

Over the years, the Manayunk Canal has fallen into a state of disrepair and is no longer considered navigable. At the southern end of the canal, the inoperable lock system and an on-grade concrete slab bridge at Lock Street prevent the use of the canal, except for the smallest of recreational boats. The Venice Island Recreation Center Building, playground, pool and hockey/basketball courts appear to be in fair to poor condition. The parking lot, which takes up a majority of the land in the eastern end of Venice Island, is in serviceable condition, although there are areas where the bituminous is beginning to break up and/or settle. Along the southern edge of the parking lot, there is a steep bank

down to the Schuylkill River that consists of an abundance of mature trees and vegetative overgrowth that obscures the view of the Schuylkill River during the growing season.

Project Scope and Purpose

The Philadelphia Water Department (PWD), in partnership with the Philadelphia Recreation Department, the Manayunk Development Corporation (MDC), various community groups and interested parties is planning an ambitious project that will transform and increase the aesthetic value of the project site on Venice Island along the Schuylkill River. The proposed project includes the following:

- The demolition of the Recreation Department's Venice Island recreation building and all recreation facilities in order to construct the PWD'S CSO basin and Head House as required by it's Long Term Control Plan.
- The construction of a temporary parking lot at the site of existing recreation facilities to temporarily replace the existing parking lot.
- The construction of the Venice Island CSO Basin and Head House that will retain combined sewer overflow during significant rainstorm events, preventing surcharging and/or discharges to the Schuylkill River. The tank will be located below grade in the area of the existing parking lot between Lock Street and Rector Street. The proposed Head House will be located near the Lock Street end of the island. The PWD'S proposed Head House will house the mechanical equipment associated with the CSO Basin as well as provide access to the interior of the CSO Basin.
- The construction of a performing arts center to replace the existing recreation building, along with a new children's play area, spray ground, basketball court and hockey rink.
- The construction of a parking lot to connect the Cotton and Lock Street bridges to replace the existing parking lot.
- The construction of site landscaping and lighting to allow the site to be a safe and attractive destination for the community.

Since, by necessity, the proposed projects will be constructed within a 100-year floodplain the impact of this proposed development on the 100-year floodplain must be quantified. The purpose of this hydraulic analysis is to quantify the potential impacts of the proposed project on water surface elevations in the Schuylkill River under 100-year flood flow conditions.

Methods

The Philadelphia Flood Insurance Study (FEMA, 1996) is the basis for the water surface profiles developed in this study. The original FIS was developed using the HEC-2 computer model (USACE, 1991). The HEC-2 model has been replaced by the HEC-RAS (River Analysis System) model.

HEC-2 and HEC-RAS are 1-dimensional hydraulic models capable of simulating steady-state and dynamic (time-varying) flow conditions. HEC-RAS is well accepted by FEMA for the establishment of floodplain limits in Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs). The original HEC-2 computer model input used to generate the Philadelphia Flood Insurance Study (FIS) was purchased from FEMA's contractor, Dewberry & Davis. The HEC-2 model input was converted to HEC-RAS input format and the computations were done using the HEC-RAS program.

The numbering of the river cross-section stations in the Philadelphia FIS represents the distance, in feet, upstream from the confluence of the Schuylkill River and the Delaware River. The section of the Schuylkill River that is modeled in this study extends from station 70869 to 74545. The HEC-RAS model displays the results in terms of channel distance. Channel distance is referenced to the most downstream station (i.e., station 70869) being 0 feet. Both station values and channel distance increase in the upstream direction. Table 1 lists the stations, channel distances, and descriptions used in the HEC-RAS model. Figure 1 displays the cross-section locations across the project site.

Calibration to Existing Conditions

The Philadelphia FIS (USACE, 1996) is the basis for the hydraulic model calibration. The floodwater elevations established in the FIS are shown in Figure 2. The 100-year flow rate in the Schuylkill River of 109,000 cfs was used as the design flow rate.

The model included a 4,000 foot segment of the Schuylkill River. Only one (1) cross-section from the original Philadelphia FIS (station 72061) crossed the project area. Therefore, five (5) cross-sections were added to those used in the Philadelphia FIS to provide more detail for the hydraulic model in the proposed project area, between Lock Street and Cotton Street. The six (6) cross-sections passing through the proposed project area are shown in Figures 3 through 8. These figures show both existing and proposed ground elevations as well as the water surface at the 100-year flow in the Schuylkill River.

Figure 9 shows the model calibration to existing conditions over the modeled domain (section 70869 to 74545). The model was calibrated to the 100-year flow profile in the Philadelphia FIS. The three vertical bars in Figure 8 represent three bridges across the Schuylkill River; the Conrail (Reading) RR Bridge at station 71331, the Conrail (Penn Central) RR Bridge at station 73707, and the Green Lane Bridge at station 74186.

The hydraulic model was calibrated by adjusting the entrance and exit coefficients through the bridge openings and the Manning "n" values in the River channel and over banks. Computer runs were performed at the original USACE vertical datum (NGVD 1929). A value of 5.71 feet was subtracted from the modeled elevation values to convert to Philadelphia datum for comparison with site elevations.

Table 1 Cross-section Stations and Distances		
River Station	Main Channel Distance	Description
Feet	Feet	
74545	3676	Upper Boundary of Modeled Section, Upstream Transition to Green Lane Bridge
74224	3355	Upstream face of Green Lane Bridge
74186	3317	Green Lane Bridge Centerline
74148	3279	Downstream face of Green Lane Bridge
73933	3064	Downstream Transition of Green Lane Bridge and Upstream Transition of Conrail (Penn Central) RR Bridge
73739	2870	Upstream face of Conrail (Penn Central) RR Bridge
73707	2838	Conrail (Penn Central) RR Bridge Centerline
73675	2806	Downstream face of Conrail (Penn Central) RR Bridge
73395	2526	Downstream Transition of Conrail (Penn Central) RR Bridge
72666	1797	Cotton Street Centerline
72579	1710	Parking Lot – Western extent of construction
72174	1305	Proposed Performing Arts Center
72061	1192	Mid-site – West side of parking lot
71830	961	Mid-site – Middle of parking lot
71728	859	Proposed Head House Location
71669	800	Lock Street Centerline – Eastern edge of construction
71537	668	Upstream Transition to Conrail (Reading) RR Bridge
71341	472	Upstream Face of Conrail (Reading) RR Bridge
71331	462	Conrail (Reading) RR Bridge Centerline
71321	452	Downstream Face of Conrail (Reading) RR Bridge
70869	0	Lower Boundary of Modeled Section, Lower Transition from Conrail (Reading RR) Bridge

Figure 1 Site Map of Venice Island

Figure 2 Floodwater Elevations used for Model Calibration

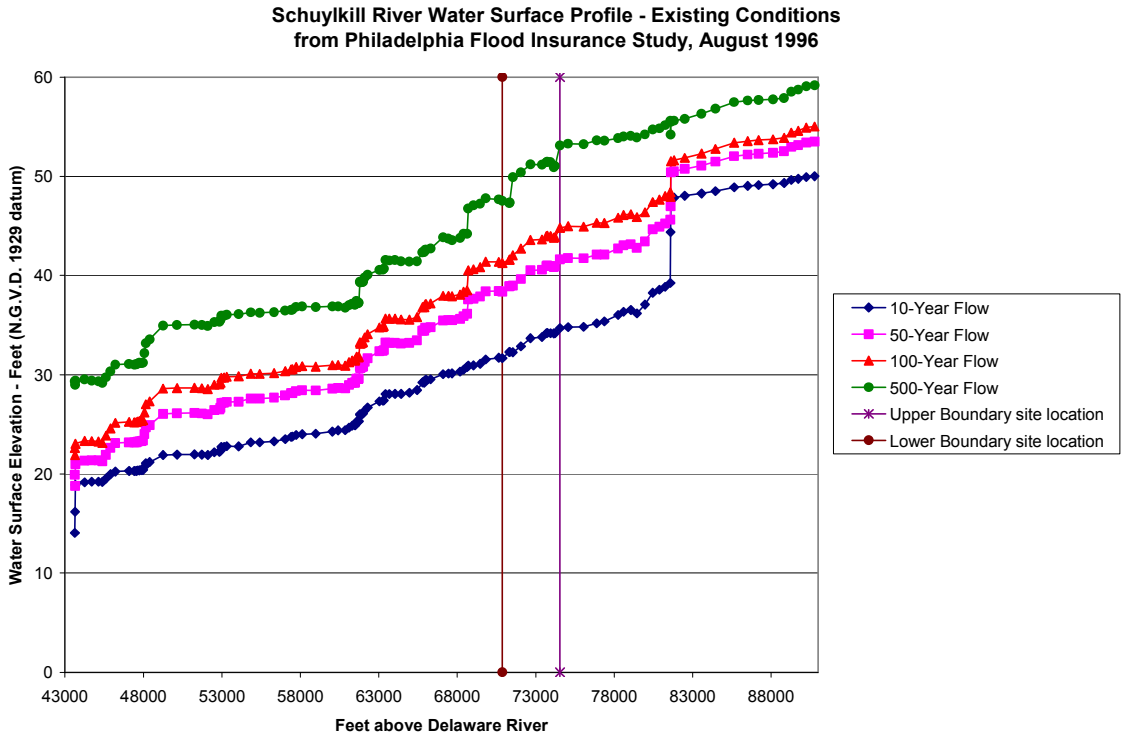

Figure 3 Section 71669 Lock Street Centerline,
Eastern Edge of Construction

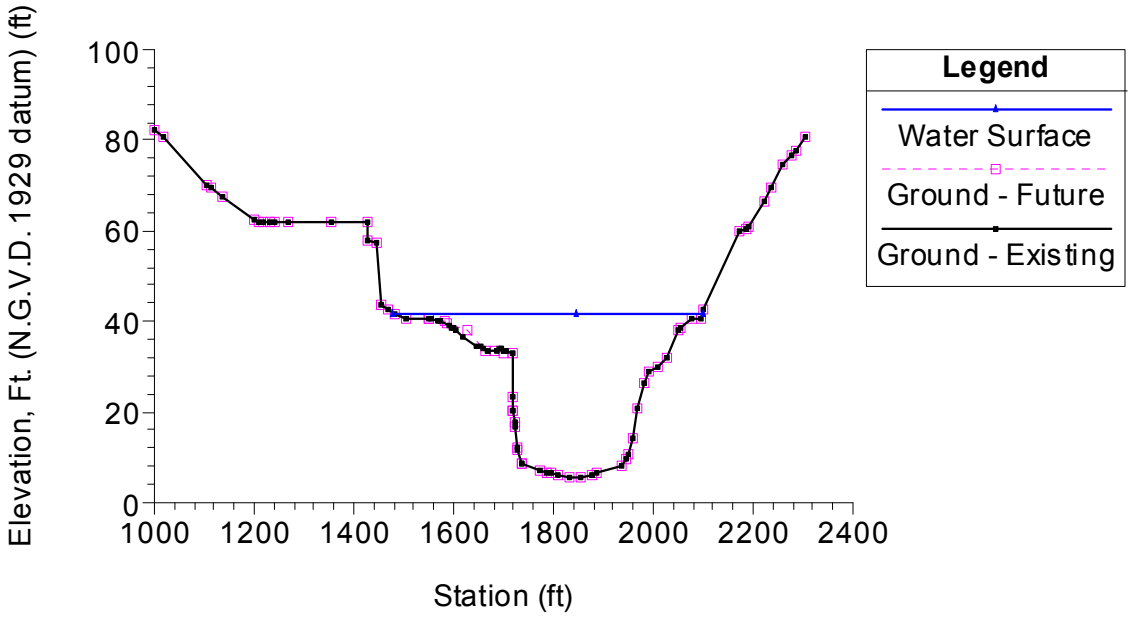

Figure 4 Section 71728 Future Head House Location

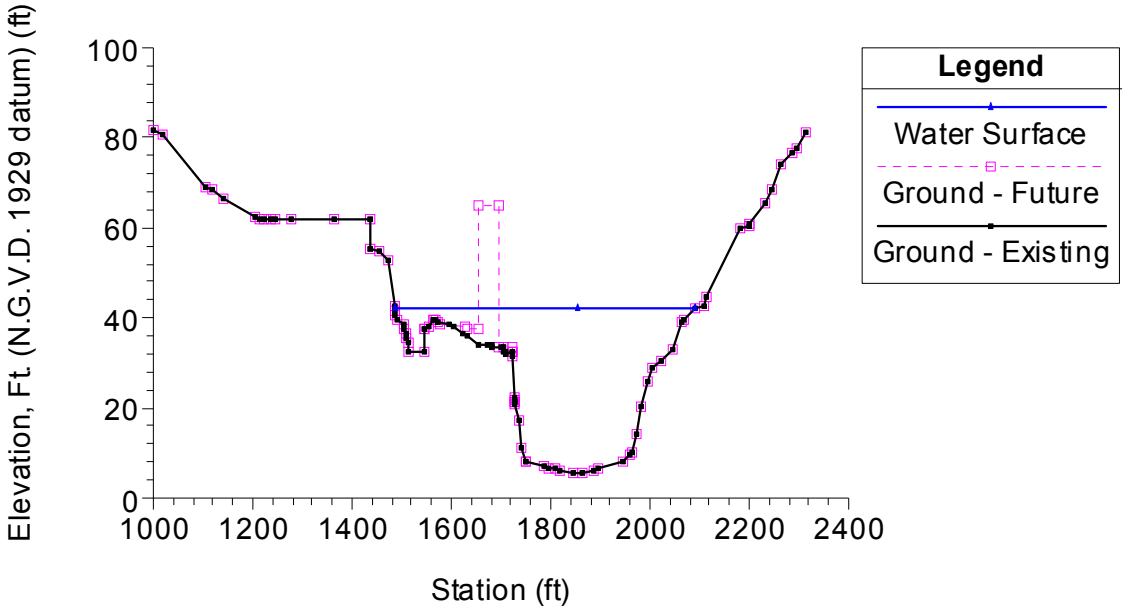

Figure 5 Section 71830 Mid-Site Location
Middle of Parking Lot

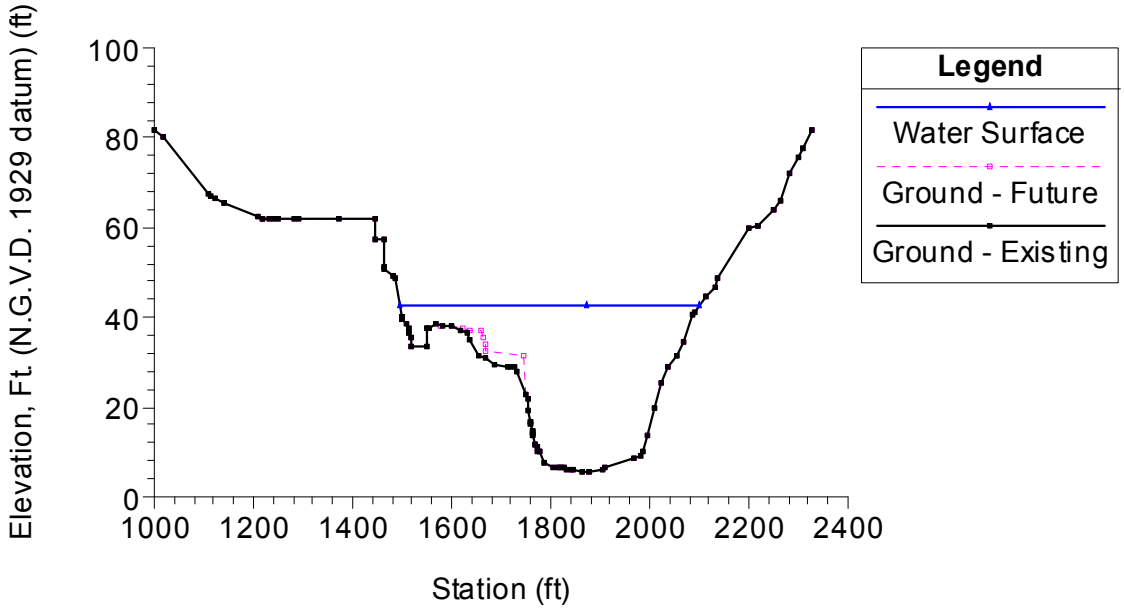

Figure 6 Section 72061 Mid-Site Location
West Side of Parking Lot

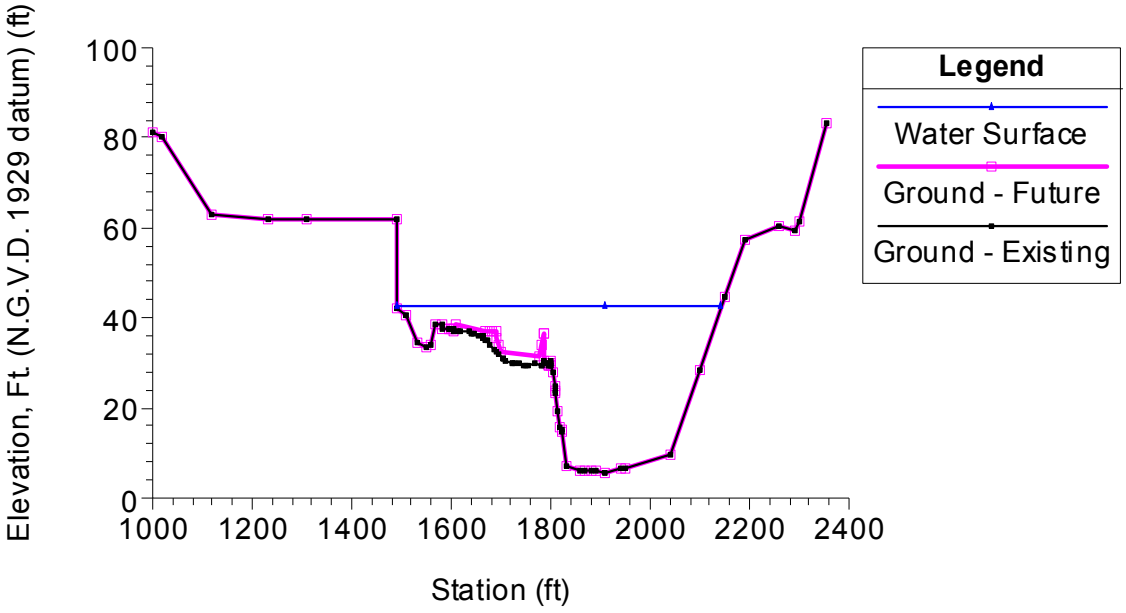

Figure 7 Section 72174 Existing Conditions, Future Performing Arts Center Site

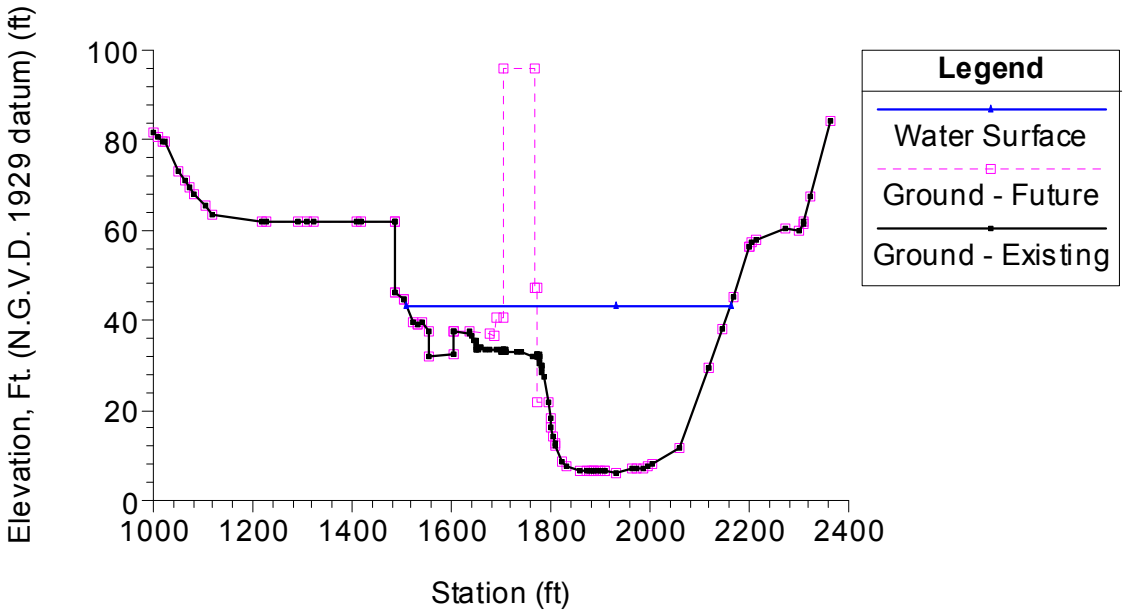

Figure 8 Section 72579 Future Parking Lot,
Western Extent of Proposed Project

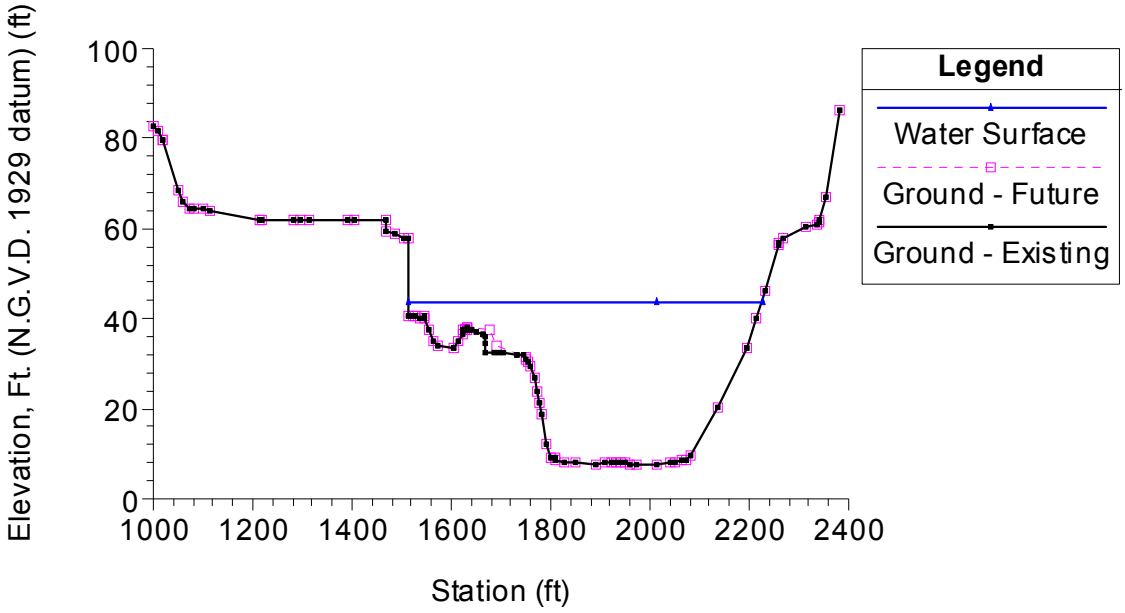

Figure 9 Profile of Water Surface Calibration to 100-year Flow, Existing Conditions

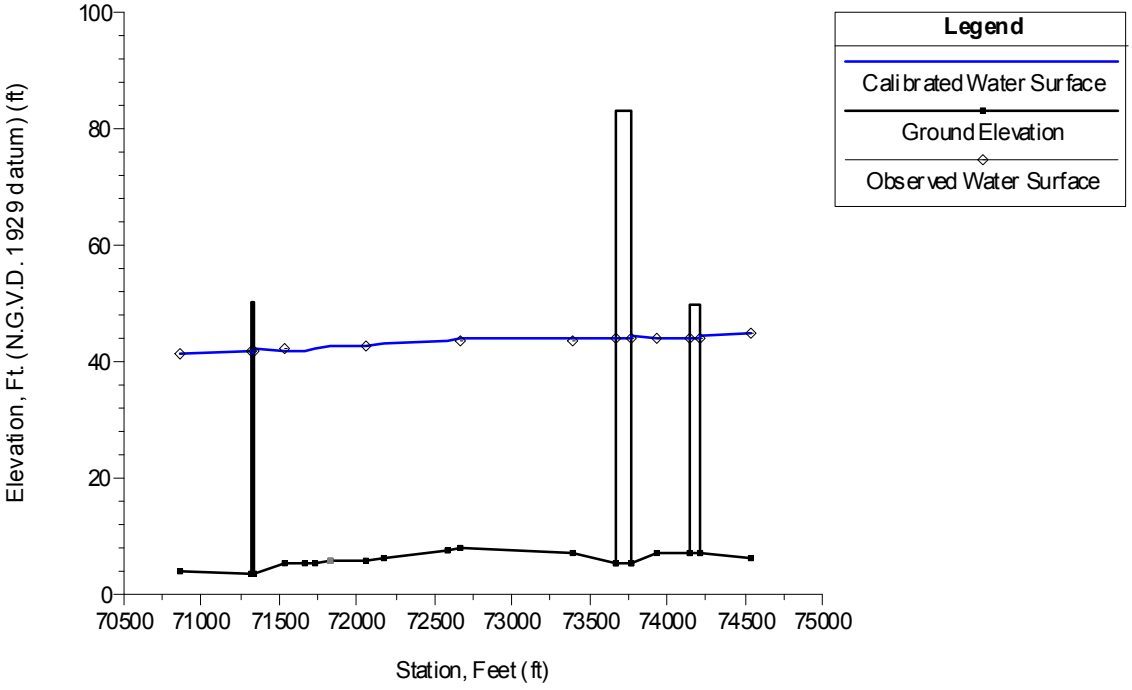

Table 2 lists the 100-year flow water surface elevation data from the Philadelphia FIS along with the HEC-RAS computer model predictions based upon existing ground profiles.

Table 2 Calibration to 100-year Flood Flow in Schuylkill River						
Station	1996 FIS Water Surface Elevations		HEC-RAS Calibration Water Surface Elevations		Difference	Percent Error
	Feet	Feet	Feet	Feet	Feet	%
	N.G.V.D. 1929	Philadelphia Datum	N.G.V.D. 1929	Philadelphia Datum		
70869	41.27	35.56	41.27	35.56	0	0%
71321	41.58	35.87	41.71	36	0.13	0%
71341	41.62	35.91	42.06	36.35	0.44	1%
71537	42.05	36.34	41.96	36.25	-0.09	0%
72061	42.71	37	42.68	36.97	-0.03	0%
72666	43.59	37.88	43.83	38.12	0.24	1%
73395	43.62	37.91	43.8	38.09	0.18	0%
73675	43.98	38.27	44.22	38.51	0.24	1%
73739	44.01	38.3	44.3	38.59	0.29	1%
73933	43.97	38.26	44.17	38.46	0.2	0%
74148	43.82	38.11	44.04	38.33	0.22	1%
74224	43.88	38.17	44.28	38.57	0.4	1%
74545	44.81	39.1	44.82	39.11	0.01	0%

Proposed Future Conditions

Future conditions are represented in the HEC-RAS model by the construction of a CSO holding tank and head house, a performing arts center, parking lot, spray park, playground, basketball court, hockey rink and recreation facilities.

These proposed features were accounted for in the model by modifying cross-sections 71728 (CSO head house), 72096 (mid site), 72174 (performing arts center), and 72579 (parking lot). The cross-sections representing the proposed future conditions are included in Figures 3 through 8. The only changes made to the model input to represent future conditions were the cross-section profiles for the six (6) cross-sections in the project area.

There is no significant change in the future water surface elevations as a result of the proposed constructions. The calculated water surface elevations for existing and future conditions under 100-year flow conditions are listed in Table 3. The maximum increase in water surface elevations is 0.01 feet (0.12 inch). At some locations, the hydraulic model calculates a decrease in water surface elevations under proposed conditions. The greatest decrease in water surface elevation is 0.20 feet (2.4 inches) at station 71830 (Mid-Site, 102 feet upstream from the head house).

These drops in water surface elevation are accompanied by an increase in velocity. The water velocities under 100-year flow conditions and existing and future site profiles are listed and compared in Table 4. The maximum increase in velocity under future conditions is 0.58 feet per second (fps) at the proposed Performing Arts Center (station 72174). This represents a 7% increase in flow velocity. This is not a significant increase under 100-year flood conditions. Since the main impact of increased velocities is to increase the erosive force (shear stress) on the river bed and bank, the impact of the proposed project on shear stresses was evaluated.

The shear stresses calculated for existing and future conditions are compared in Table 5. The maximum change in shear stress for future conditions is 0.02 pounds per square foot (psf). This is not a significant increase in shear stress and will not result in increased erosion.

Table 3 Water Surface Elevations for Existing and Future Conditions at 100-year Flood Flow

Station	Existing Conditions		Future Conditions		Difference	Description
	Feet	Feet	Feet	Feet	Feet	
	NGVD 1929	Philadelphia Datum	NGVD 1929	Philadelphia Datum		
74545	44.82	39.11	44.83	39.12	0.01	
74224	44.28	38.57	44.28	38.57	0.00	
74148	44.04	38.33	44.05	38.34	0.01	
73933	44.17	38.46	44.18	38.47	0.01	
73739	44.30	38.59	44.31	38.60	0.01	
73675	44.22	38.51	44.22	38.51	0.00	
73395	43.80	38.09	43.81	38.10	0.01	
72666	43.83	38.12	43.83	38.12	0.00	
72579	43.74	38.03	43.73	38.02	-0.01	Parking Lot (Proposed)
72174	43.11	37.40	43.00	37.29	-0.11	Performing Arts Center
72061	42.68	36.97	42.58	36.87	-0.10	Mid-Site West Side of Parking Lot
71830	42.50	36.79	42.30	36.59	-0.20	Mid-Site Middle of Parking Lot
71728	42.19	36.48	42.08	36.37	-0.11	CSO Head House
71669	41.87	36.16	41.87	36.16	0.00	Lock Street Centerline
71537	41.96	36.25	41.96	36.25	0.00	
71341	42.06	36.35	42.06	36.35	0.00	
71321	41.71	36.00	41.71	36.00	0.00	
70869	41.27	35.56	41.27	35.56	0.00	

Table 4 Water Velocities for Existing and Future Conditions at 100-year Flood Flow				
Station	Existing Conditions	Future Conditions	Difference	Description
	Feet/Second	Feet/Second	Feet/Second	
74545	7.02	7.02	0.00	
74224	8.48	8.48	0.00	
74148	8.57	8.56	-0.01	
73933	7.59	7.59	0.00	
73739	6.77	6.76	-0.01	
73675	6.79	6.79	0.00	
73395	7.40	7.40	0.00	
72666	6.70	6.69	-0.01	
72579	6.86	6.93	0.07	Parking Lot (Proposed)
72174	8.11	8.69	0.58	Performing Arts Center
72061	8.72	9.04	0.32	Mid-Site West Side of Parking Lot
71830	9.08	9.52	0.44	Mid-Site Middle of Parking Lot
71728	9.68	10.16	0.48	CSO Head House
71669	10.40	10.44	0.04	Lock Street Centerline
71537	10.04	10.04	0.00	
71341	9.60	9.60	0.00	
71321	9.74	9.74	0.00	
70869	10.35	10.35	0.00	

Table 5 Shear Stresses for Existing and Future Conditions at 100-year Flood Flow

Station	Existing Conditions	Future Conditions	Difference	Description
	lb/sq ft	lb/sq ft	lb/sq ft	
74545	0.24	0.24	0.00	
74224	0.44	0.44	0.00	
74148	0.32	0.32	0.00	
73933	0.21	0.21	0.00	
73739	0.18	0.18	0.00	
73675	0.18	0.18	0.00	
73395	0.19	0.19	0.00	
72666	0.16	0.16	0.00	
72579	0.17	0.17	0.00	Parking Lot (Proposed)
72174	0.24	0.25	0.01	Performing Arts Center
72061	0.28	0.27	-0.01	Mid-Site West Side of Parking Lot
71830	0.29	0.30	0.01	Mid-Site Middle of Parking Lot
71728	0.30	0.32	0.02	CSO Head House
71669	0.31	0.31	0.00	Lock Street Centerline
71537	0.32	0.32	0.00	
71341	0.41	0.41	0.00	
71321	0.43	0.43	0.00	
70869	0.39	0.39	0.00	

Summary and Conclusions

The HEC-RAS hydraulic model was calibrated to match the established 100-year flood elevations along the Schuylkill River in a 4,000 feet long segment of the river along Venice Island. The cross-sections in the model were modified to represent elevation changes by the proposed Manayunk Sewer Basin Construction and Venice Island Recreation Center Reconstruction project. The proposed project results in insignificant changes in the water surface elevations under 100-year flow conditions of 109,000 cfs. Specifically, the maximum increase in water surface elevation was 0.01 feet (0.12 inch), the maximum increase in velocity was 0.58 fps and the maximum increase in the shear stress was 0.02 psf. As these changes are less than the error of estimation by the hydraulic model, we conclude that the proposed project will not result in any significant changes in water surface elevation, velocity, or shear stress.

References

Federal Emergency Management Agency (FEMA), 1996. Flood Insurance Study, City of Philadelphia, Pennsylvania, Philadelphia County. Community Number 420757, Revised August 2, 1996.

U.S. Army Corps of Engineers, Institute, for Water Resources, Hydrologic Engineering Center 2002. HEC-RAS River Analysis System Ver. 3.1 November 2002. Davis CA

U.S. Army Corps of Engineers, Institute, for Water Resources, Hydrologic Engineering Center, 1991. HEC-2 Water Surface Profiles, Ver. 4.6 February 1991