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Technical Memorandum

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Section 1: Introduction

In April 2008, the Seattle Public Utilities (SPU) Asset Management Committee approved a Stage Gate 2 to develop and select a preferred option for the South Park Pump Station (PS) and Water Quality Facility (WQF). The hydraulic grade line (HGL) for the South Park storm drain system is below the Duwamish Waterway water surface elevation for parts of the tidal cycle, and the current South Park basin stormwater outfall cannot discharge during these periods. A Tideflex check valve prevents waterway water from backing up into the system at higher tides. During these periods, surface water runoff backs up in the 72-inch-diameter stormwater pipeline immediately upstream of the check valve. Flooding in the lower basin is a persistent problem, and collection system improvements in the basin will not be effective until a means to drain the pipeline at higher tides is in place. The PS will facilitate flood control in the lower South Park basin by pumping runoff around the check valve. This will allow effective collection system improvements in the basin, improving flood control.

Earlier South Park project planning had assumed that the PS and WQF would be built simultaneously as a single construction project. By 2013, a 90 percent design had been developed for the project. The 90 percent WQF design assumed the use of 1,000 StormFilter® cartridges, a passive filtration technology.

Following completion of the 90 percent design, new information about the higher-than-expected cost of future operation and maintenance (O&M) requirements for StormFilter® cartridge technology led SPU to shift to an active treatment technology. Additionally in 2014, SPU submitted an Integrated Plan (IP) to the Washington State Department of Ecology (Ecology), which included an active-treatment South Park WQF as an alternative to deferring combined sewer overflow (CSO) projects. The change to active treatment has extended the technology selection, design, and construction cycle for the WQF, and as a result introduced the idea of phasing the project by building a flood control PS in advance of the WQF. Simultaneously, updated modeling of the required capacities for the PS and WQF has resulted in a wider disparity between the flood control PS capacity and the WQF capacity than that of the original, passive filtration design. As a result of this disparity, the idea of separate WQF feed pumps was introduced.

The purpose of this technical memorandum is to evaluate project design and construction options and pump station configuration options.

This technical memorandum evaluates two options for design and construction of the PS and WQF:

- **Joint Option**. Simultaneous design and construction of PS and WQF
- **Phased Option.** Design and construction of the PS followed by design and construction of the WQF).

This technical memorandum also evaluates three configuration options for the PS:

- **Option 1**. Single PS and wet well with dual-purpose pumps (similar to the original design);
- **Option 2**. Single PS and wet well with dedicated flood control pumps and WQF influent pumps; and
- **Option 3**. Flood control PS with a separate WQF PS.

This technical memorandum is organized as follows:

- Section 2 summarizes the original design, summarizes the results of modeling since the original design, and describes the flood control benefits provided by the PS
- Section 3 discusses the project phasing
- Section 4 compares the schedules, costs, benefits, and risks for phased project approach and the recommendation
- Section 5 introduces three PS options
- Section 6 compares the benefits of the PS options
- Section 7 discusses the design status and steps required to bring the PS design to construction

- Section 8 presents recommendations on the PS option

Section 2: Prior Design and Flood Control Modeling

This section describes the prior PS and WQF design for reference, and describes the flood control benefit conferred by the PS based on hydraulic modeling. Modeled HGLs, flood return periods, and inundation maps are presented to quantify the benefit of building the pump station. For additional background information for Sections 2.2 and 2.3, please see the *South Park Hydraulic Modeling Report*, dated September 2014.

2.1 Prior Design

A design for the PS and WQF was completed to the 90% level. The PS consisted of a 28.5-ft by 26.5-ft wet well and building with four pump bays. The pump capacity for this design was 44-cubic foot per second (cfs), expandable to 88-cfs. Each bay was sized to accommodate a pump with a capacity of up to 22-cfs pump. Initially, two 11-cfs pumps and one 22-cfs pumps would have been installed, giving the station a maximum capacity of 44-cfs. Eventually, a second 22-cfs pump would have been installed and the two 11-cfs pumps would have been replaced with 22-cfs pumps, giving the station a firm capacity (capacity with one pump out of service) of 66-cfs and maximum capacity of 88-cfs.

Modeling to size the previous PS design was performed in 2007 used the SPU XP-SWMM model for the 7th Avenue South basin. Because of the prohibitive computational requirements needed to run the full 158-year synthetic rainfall record with XP-SWMM, a simplified model was first constructed in EPA SWMM5 to approximate runoff predicted by the detailed model. The simplified model was used to identify and rank the largest flow events in the 158-year record, based on peak flow and volume. (See Section 2.3 below for a discussion of the 158-year synthetic and 35-year real rainfall records.) These events were then matched to tide. Design storms were used to size the PS, and the 33 largest events from the simplified screening model were used to verify sizing and LoS. This resulted in a 44-cfs PS initially, expandable to 88-cfs for the future increased size basin and increased imperviousness. In addition to the methodology changes, the future basin size modeled in the previous effort was slightly smaller, and the flood control pump sizing in the previous effort did not take into account future tidal increase.

Sizing for the WQF for the previous design was based on results of the Hydrologic Simulation Program – Fortran (HSPF) continuous simulation model. The goal in sizing was to treat, or come as close as possible to treating, 91% of the average annual runoff from the 7th Avenue South basin. Per City's NPDES municipal stormwater permit and City Stormwater Code, new/redevelopment projects are required to treat 91% of the total runoff.. The WQF was sized for 11-cfs, which corresponded to 83% of the average annual runoff. This was determined to be the maximum volume that could be treated with the StormFilter® system given the size and constraints of the project site.

In the prior WQF design, force mains from all four pumps discharged to an elevated headbox and influent channel at the WQF. Flows up to the 11-cfs capacity of the WQF would be routed from the influent channel, through the StormFilter® treatment media, and to an effluent channel. Flows in excess of 11-cfs would bypass the treatment media and rejoin the treated stormwater at the effluent channel. The combined flow from the effluent channel would be discharged to an effluent manhole downstream of the tidegate vault, and would flow to the Duwamish waterway through the outfall. This design was selected in part because of the close match between the treatment system capacity and the capacity of the individual flood control pumps. For many runoff events, only one of the small pumps would need to operate, and all of the pumped flow would be treated with no bypass.

2.2 Modeling Update

Hydraulic model refinements for the current analysis included a slightly larger future basin area and the incorporation of a 2' tidal increase per SPU guidelines on climate change. The model was converted to the PC-SWMM package, which allowed the complete rainfall record time series to be run. Flood control pumps sizes and start/stop elevations were selected iteratively in the model to give no more than one exceedance of the LoS water surface elevation (6.81 feet, or 8.81 feet above the pipe invert at South Holden Street) when run with the 35-year rainfall record (1978-2013 at Rain Gage RG16 for the lower 7th Avenue South basin and Rain Gauge RG17 for the upper 7th Avenue South basin). This resulted in four 18-cfs pumps, or a firm station capacity of 54-cfs. During the vast majority of runoff events, three pumps were sufficient for drainage. There were 7 events in the 35-year record where the 4th pump had to turn on, or an average of once every 7 years.

The model was then run with the full 158-year rainfall record for confirmation (*South Park Hydraulic Modeling Report*, 2014). Several adjustments were made to start/stop levels. The result was 7 exceedances of the LoS elevation in the 158-year record, or a 25-year LoS.

The flood control pump sizing increased from the original design. This is in part due to increases in the size of the basin and the incorporation of a 2' tidal increase, and in part due to the improved modeling methodology that allowed the full 158-year time series to be run for the detailed model. The previous modeling effort required the selection of specific events, selected primarily based on peak flow, for the detailed model.

The model assumed built-out drainage improvements in the basin. While this is an accurate assumption for the build out (future condition) model, it is an approximation for the existing conditions since the drainage improvements have not been constructed for much of the basin. This approximation was necessary since little is known about how surface runoff enters the trunk line. Adding overland runoff to the model would require a number of very rough assumptions. Since there is not sufficient flow monitoring data to calibrate the lower basin portion of the model, there would have been no reliable means of tuning the model overland flow assumptions. The combined effect would have been reduced confidence in the model.

As a result of this approach, the flood control impact of the PS immediately following construction, but before construction of the lower basin drainage improvements, cannot be modeled. The impact is estimated qualitatively in Section 2.3.2 below.

WQF pumps were sized using the runoff time series files at the PS generated by the PC-SWMM model. A spreadsheet model was developed that calculated the annual volume treated based on an input WQF capacity and operating parameters, including the startup flow rate (the flow rate at which the WQF would start treating runoff) and an inter-event duration (the period after runoff drops back below the start threshold during which the system would continue running). Sizing and parameters were adjusted iteratively to find a combination that would treat, on average, the 74 million gallons per year (Mgal/yr) required by the IP. It was found that a 6-cfs facility, with facility startup at 2.5-cfs and 2 hour inter-event duration, would treat 75 Mgal/year. The 6-cfs system can treat more than 100 Mgal/year by reducing the startup level and increasing the inter-event duration, although this comes at the expense of more treated base flow. This adds to the operating cost while not significantly contributing to the pollutant removal benefit.

2.3 Flood Control

This section discusses flooding and flood control in the lower 7th Avenue South basin under existing conditions, the expected conditions following construction of the PS, and the modeled conditions at buildout.

2.3.1 Existing Conditions

Currently the South Park neighborhood experiences flooding during rain events that correspond with tides that are greater than the elevation of the storm drain outfall pipe. Based on the hydraulic model, flooding occurs 2-3 times per year. This is consistent with SPU staff observations. The HGL along the main outfall pipe is shown in Figure 2-1 and a map showing the limits of the highest level of inundation during the last 25 years (11.9 feet) is shown in Figure 2-2. The inundated area coverage shown was produced by SPU based on the model HGL developed by Brown and Caldwell (BC). During high tide periods, the tidal elevation and closed tide gate controls the HGL; this results in the flat HGL seen in Figure 2-1.

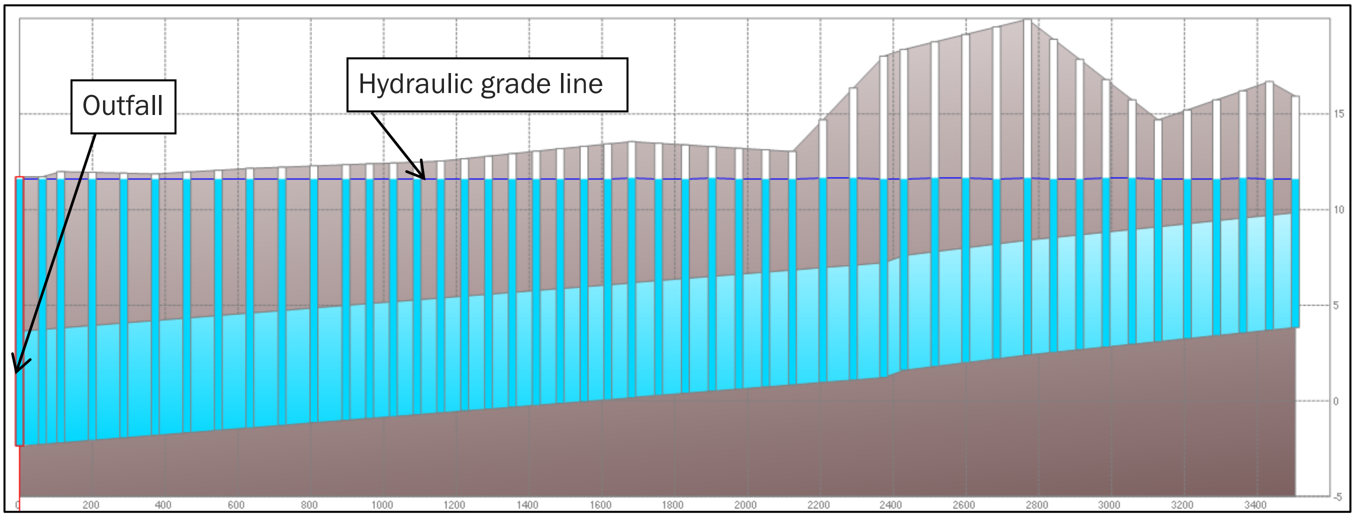

Figure 2-1. Existing hydraulic grade line along 72-inch-diameter storm drain

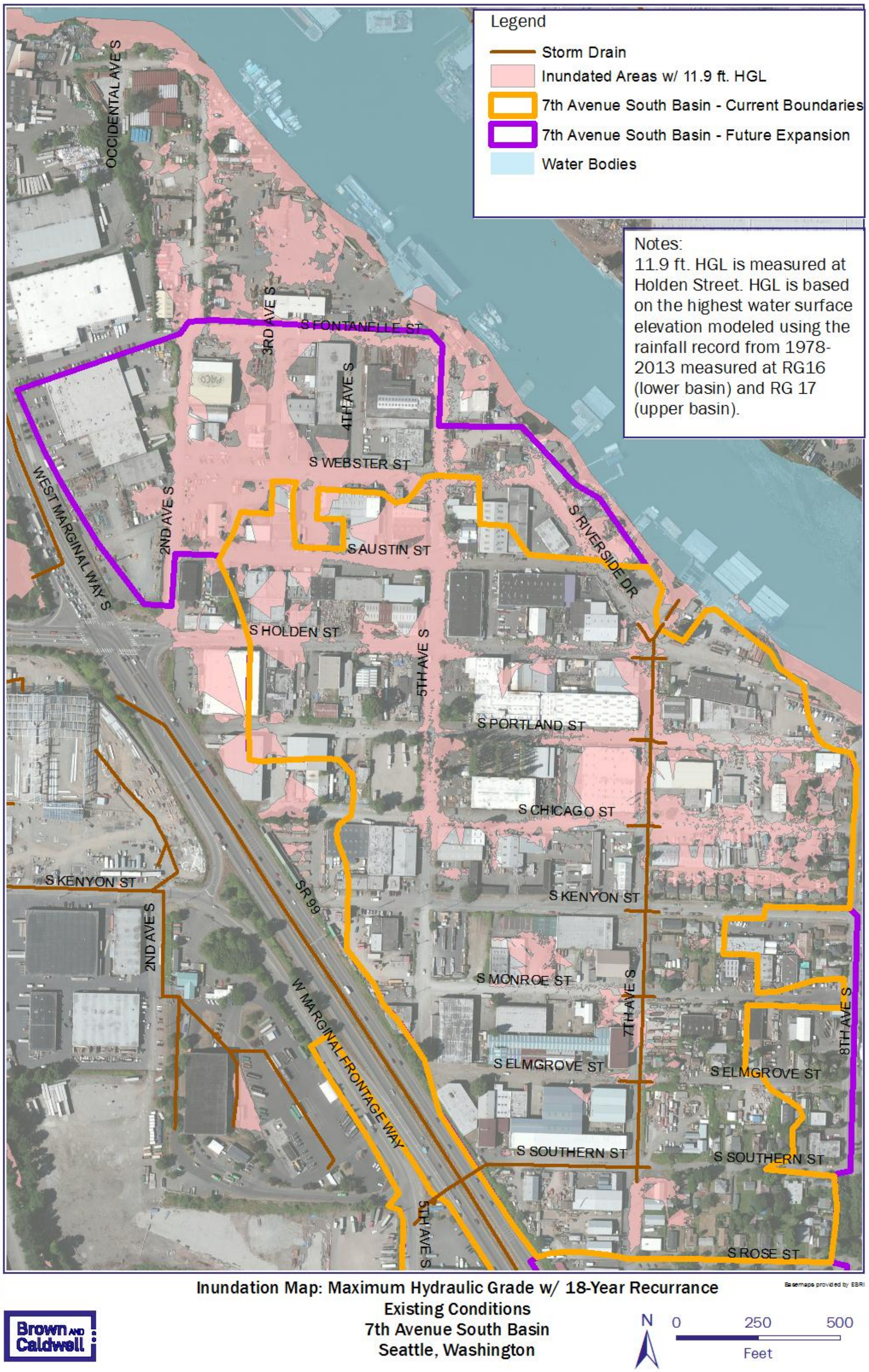

Figure 2-2. Existing inundation map

2.3.2 Future Conditions (Post-Pump Station Construction)

As discussed above, the existing condition model is an approximation that, while it does not include the PS, relies on the buildout drainage model to convey flow. Therefore, the model cannot account for the conditions following PS construction but before the drainage improvements. Modifying the model to eliminate the buildout drainage would require a number of rough assumptions, with no reliable way to calibrate the resulting model.

To estimate the flood control benefit of the PS following construction, the inundation map and drainage improvements were evaluated qualitatively. It was assumed that within approximately 1/2 a block of the Portland Street drainage improvements (which will be in place when the PS is constructed) and the 7th Avenue trunk line would be drained by the PS. Other lower basin areas would see the same inundation as they currently do without the PS. The resulting inundation map is shown in Figure 2-4.

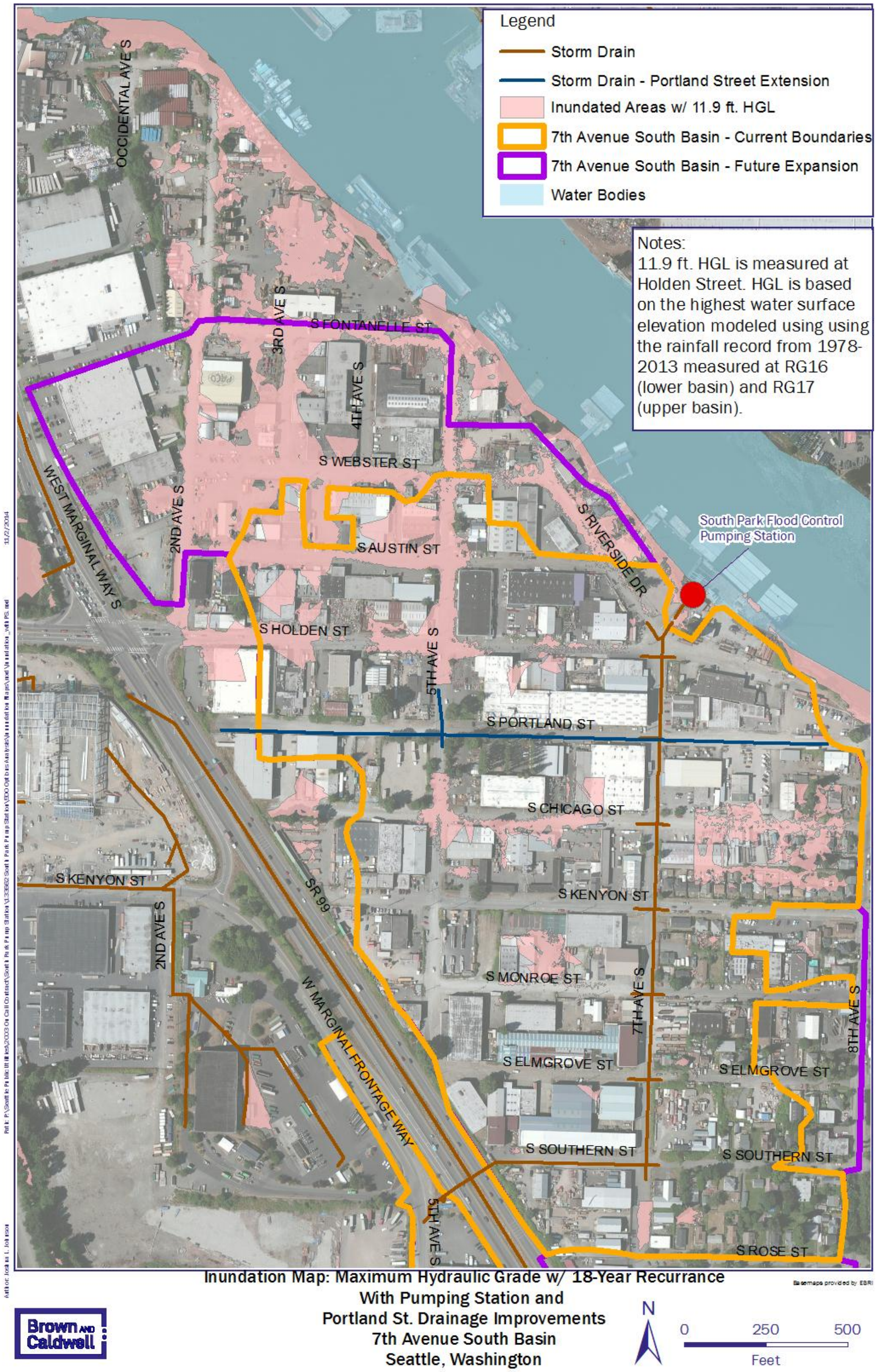

Figure 2-4. Post-PS construction inundation map.

2.3.3 Future Conditions (Basin and Conveyance System Buildout)

The pump station will be designed to provide protection (with 3 feet of surcharge in the 72-inch-diameter stormwater pipeline at Holden Street) at a 25-year level-of-service (LoS). Verification that the pump station meets the LoS is based on modeling of the future basin boundaries and imperviousness and the built-out conveyance system to select pumps that show no more than seven events in the 158-year synthetic record that exceed a 3-foot surcharge (corresponding to a 9 foot water surface elevation) as measured at the South Holden Street trunk line maintenance hole, and no more than one event in the last 35 years of actual basin rainfall record. The 35-year real rainfall record was used to size the pumps and set the start/stop levels, while the 158-year synthetic rainfall record was used to confirm LoS.

Updated modeling indicates that four 18-cfs pumps are required for the flood control LoS. Based on modeling, about once every 10 years all four pumps will have to operate simultaneously to provide adequate protection. The 25-year recurrence LoS HGL along the main outfall pipe is shown in Figure 2-3. Because the pump station is designed for a 25-year LoS, no flooding or inundation is caused by the 72-inch-diameter stormwater pipeline backing up.

At an unknown time in the future with more impervious surface, higher tides, and potentially larger storms, the flood control PS may need to be upgraded to four 24 cfs pumps. This assumes that a berm would be built to prevent overland flooding from the Duwamish Waterway onto the PS site.

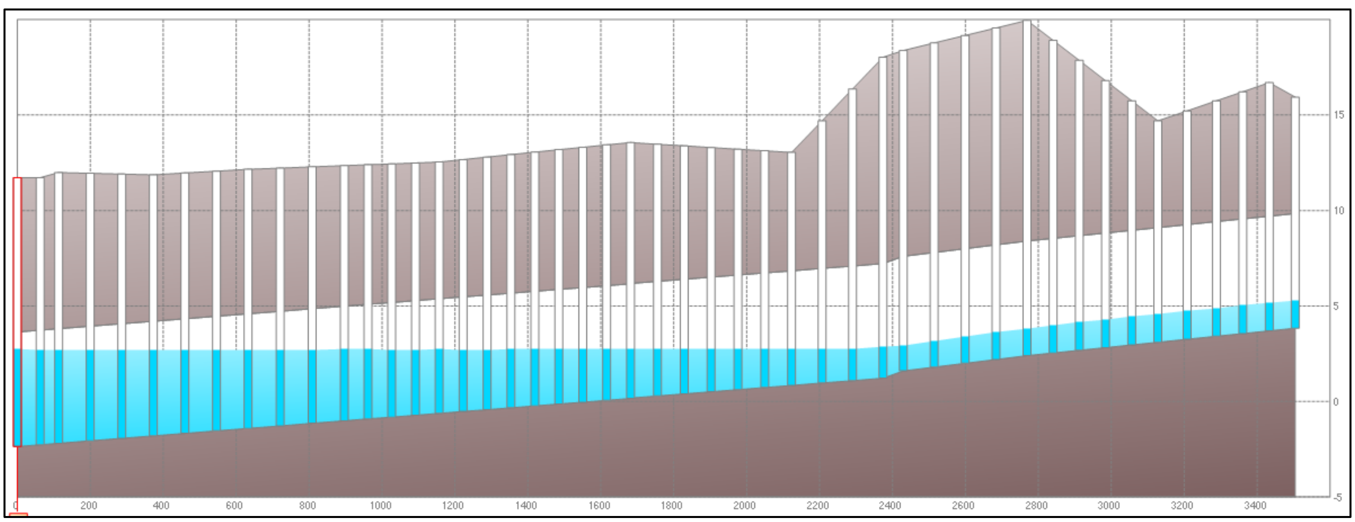

Figure 2-5. Buildout HGL.

2.3.4 Flood Control Summary

As discussed in the Introduction, flooding in the lower basin is a persistent problem, and collection system improvements in the basin will not be effective until a means to drain the pipeline at higher tides is in place. Conversely, the PS will not provide its full benefit until lower basin drainage improvements are in place. Based on the existing conditions model and the qualitative analysis of the system following PS construction, but before buildout of the drainage improvements, the PS will provide an immediate benefit only to limited areas near Portland Street and the 7th Avenue trunk line where drainage improvements will be in place.

Section 3: Project Phasing Rationale

This section discusses the rationale for phasing the flood control PS and WQF as separate projects, impacts to the WQF resulting from phasing, and risks associated with the phased approach. For a discussion of PS configuration options, including a discussion of dual-use pumps (similar to the original design) versus dedicated pumps for flood control and WQF influent pumping, see Sections 5 through 8 below.

After considering the higher-than-expected cost of future O&M of a passive filtration system (i.e. StormFilter®), SPU elected to use an active treatment technology. The change to active treatment and the change in modeling methodology described in Section 2 above resulted in a change in the WQF capacity from 11 cfs to 6 cfs and a change in the capacity of the individual PS pumps from 11-cfs to 18-cfs. In the original design, the same pumps were to be used for the PS and WQF. The potential to use separate pumps for flood control and WQF influent flow was introduced as a result of the disparity between required capacities for flood control and the WQF.

This allowed for the idea of phasing the projects; that is, to build the PS facility before the WQF. Phasing allows the PS to be constructed sooner than the WQF critical path would allow for. The phasing would still meet the timing requirements of the IP. The IP requires that load reductions be met starting in 2025. To allow sufficient time for startup and full-scale testing and optimization, SPU has targeted 2023 as the latest allowable operational date for the WQF. Phasing the two facilities is significantly simplified if the flood control pumping is independent from the WQF feed pumping.

While the previous 90 percent WQF design is generally not compatible with the active water quality treatment technologies currently under consideration or the IP targets, some portions of the previous PS design can likely be adapted to the project currently under consideration

Two design and construction options were developed for the PS and WQF. The Phased Option assumes design and construction of the PS and WQF as separate construction contracts. The Joint Option assumes design and construction of both facilities as a single construction contract.

Section 4: Phased PS and WQF

This section discusses the schedules, costs, benefits, and risks for the phased option.

4.1 Evaluation with PS Options

While this memorandum evaluates both options for the overall PS-WQF project and individual configuration options for the PS, this section is intended to limit discussion to the Phased Option and Joint Option for the overall PS-WQF construction contract. The benefits discussed below apply regardless of the PS configuration option selected. Where benefits apply specifically to configuration, it is indicated in the discussion. The present value comparison in this section develops present value for all the configuration and option combinations under consideration.

See Sections 5 through 7 for the configuration evaluation. Combined recommendations for both design and construction options and PS configuration are given in Section 8 below.

4.2 Schedule

This section discusses schedules for the Phased Option and for the Joint Option.

4.2.1 Joint Option Draft Schedule

The draft schedule for designing and constructing both facilities with a single construction contract is shown in Figure 4-1. The construction duration for the WQF (635 days) is based on the 2008 Stage Gate 2. In terms of schedule, the modeling/design/construction of a WQF was considered to the original passive system schedule. Further, it is assumed that the duration of construction would be similar for each of the alternative active treatment technologies.

Task Name	Duration	Start	Finish
Flood Control Pump Station and WQF	**2191 days**	**Fri 8/22/14**	**Fri 4/21/23**
Consultant/Contractor Selection	**170 days**	**Fri 8/22/14**	**Mon 4/27/15**
RDNC (develop and approve)	20 days	Fri 8/22/14	Fri 9/19/14
RFP	30 days	Mon 9/22/14	Fri 10/31/14
Selection Process	60 days	Mon 11/3/14	Mon 2/2/15
Contracting	60 days	Tue 2/3/15	Mon 4/27/15
Finish Options Analysis	**290 days**	**Tue 4/28/15**	**Fri 6/17/16**
Revise PMP1	1 mon	Tue 4/28/15	Tue 5/26/15
Draft Options Analysis Report	4 mons	Wed 5/27/15	Wed 9/16/15
Pilot testing	8 mons	Wed 5/27/15	Wed 1/13/16
Final Options Analysis Report	2 mons	Thu 1/14/16	Thu 3/10/16
Prepare Business Case	2 mons	Fri 3/11/16	Thu 5/5/16
Draft SG2 for WQ Phase	1 mon	Fri 5/6/16	Fri 6/3/16
Team and AMC Review of SG2	10 days	Mon 6/6/16	Fri 6/17/16
SG2 Approval by AMC	0 days	Fri 6/17/16	Fri 6/17/16
Design Phase	**823 days**	**Mon 6/20/16**	**Fri 9/20/19**
Contracting for design phase	8 mons	Mon 6/20/16	Mon 2/6/17
Design Phase	24 mons	Tue 2/7/17	Fri 1/4/19
Permitting	6 mons	Mon 1/7/19	Wed 6/26/19
Governance for Advertisement	2 mons	Thu 6/27/19	Thu 8/22/19
Advertisment	1 mon	Fri 8/23/19	Fri 9/20/19
Bid opening	0 days	Fri 9/20/19	Fri 9/20/19
Construction	**635 days**	**Mon 9/23/19**	**Fri 3/25/22**
Contracting for Construction	3 mons	Mon 9/23/19	Wed 12/18/19
NTP	0 days	Wed 12/18/19	Wed 12/18/19
Construction	454 days	Thu 12/19/19	Tue 10/5/21
Testing and Commissioning	6 mons	Wed 10/6/21	Fri 3/25/22
Substantial Completion	0 days	Fri 3/25/22	Fri 3/25/22
Post Construction Monitoring	12 mons	Mon 3/28/22	Fri 2/24/23
Closeout	2 mons	Mon 2/27/23	Fri 4/21/23

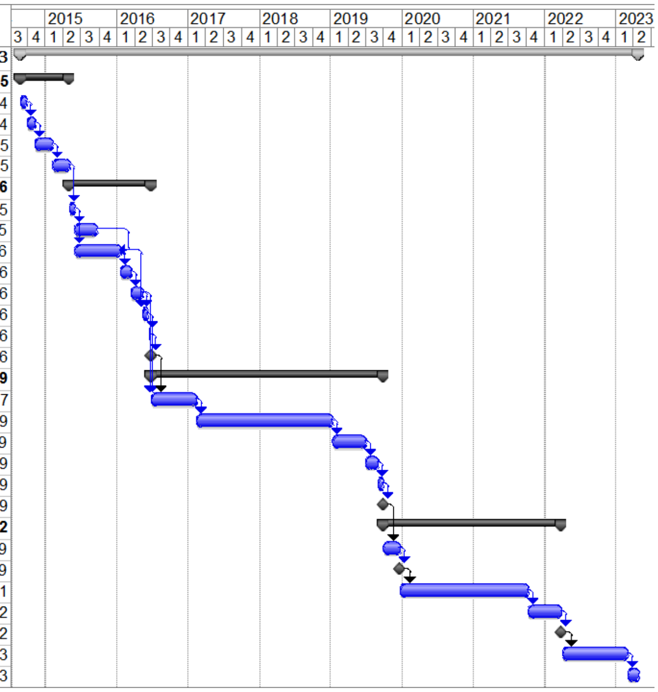

Figure 4-1. Draft Joint Option schedule

With the Joint Option, the start of construction for the PS is tied to the longer WQF critical path. Due to increase planning work, design duration, and longer construction duration, both the flood control PS and the WQF are estimated to be substantially completed by March 2022, with commissioning complete by 2023.

4.2.2 Phased Option Draft Schedule

The draft Phased Option schedule is based on a 3-year design/construction time period with design beginning in 2015 and construction completed in 2017. The piloting and modeling of the WQF would be done from 2015–17 with design starting in 2017 and completed in 2019. Construction would be complete in 2021 and project commissioning and optimization by 2022. The construction duration for the WQF is based on the 2008 Stage Gate 2. In terms of schedule, the modeling/design/construction of an active treatment WQF was considered to be similar to the original passive system schedule. The draft Phased Option schedule is shown in Figure 4-2.

Task Name	Duration	Start	Finish
Phased Construction of PS and WQF	**1963 days**	**Fri 8/22/14**	**Mon 5/30/22**
Pump Station	**841 days**	**Fri 8/22/14**	**Wed 12/20/17**
Consultant Contracting	**50 days**	**Fri 8/22/14**	**Fri 10/31/14**
RCEC	10 days	Fri 8/22/14	Fri 9/5/14
Consultant contracting	40 days	Mon 9/8/14	Fri 10/31/14
Design Phase	**402 days**	**Mon 11/3/14**	**Tue 6/7/16**
Pump Station Design	8 mons	Mon 11/3/14	Wed 6/24/15
Pump Station Permitting	6 mons	Thu 6/25/15	Tue 12/15/15
Governance for Advertisement	2 mons	Wed 12/16/15	Fri 2/12/16
Advertisment	1 mon	Tue 2/16/16	Mon 3/14/16
Bid opening	0 days	Mon 3/14/16	Mon 3/14/16
Contracting for Construction	3 mons	Tue 3/15/16	Tue 6/7/16
Construction	**389 days**	**Tue 6/7/16**	**Wed 12/20/17**
NTP	0 days	Tue 6/7/16	Tue 6/7/16
Construction	288 days	Wed 6/8/16	Thu 7/27/17
Substantial Completion	0 days	Thu 7/27/17	Thu 7/27/17
Commissioning	2 mons	Fri 7/28/17	Fri 9/22/17
Closeout	3 mons	Mon 9/25/17	Wed 12/20/17
WQF	**1963 days**	**Fri 8/22/14**	**Mon 5/30/22**
Consultant/Contractor Selection	**170 days**	**Fri 8/22/14**	**Mon 4/27/15**
RDNC (develop and approve)	20 days	Fri 8/22/14	Fri 9/19/14
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Governance for Advertisement	2 mons	Thu 6/27/19	Thu 8/22/19
Advertisment	1 mon	Fri 8/23/19	Fri 9/20/19
Bid opening	0 days	Fri 9/20/19	Fri 9/20/19
Construction	**402 days**	**Mon 9/23/19**	**Mon 4/26/21**
Contracting for Construction	3 mons	Mon 9/23/19	Wed 12/18/19
NTP	0 days	Wed 12/18/19	Wed 12/18/19
Construction	220 days	Thu 12/19/19	Thu 10/29/20
Testing and Commissioning	6 mons	Fri 10/30/20	Mon 4/26/21
Substantial Completion	0 days	Mon 4/26/21	Mon 4/26/21
Post Construction Monitoring	12 mons	Tue 4/27/21	Mon 4/4/22
Closeout	2 mons	Tue 4/5/22	Mon 5/30/22

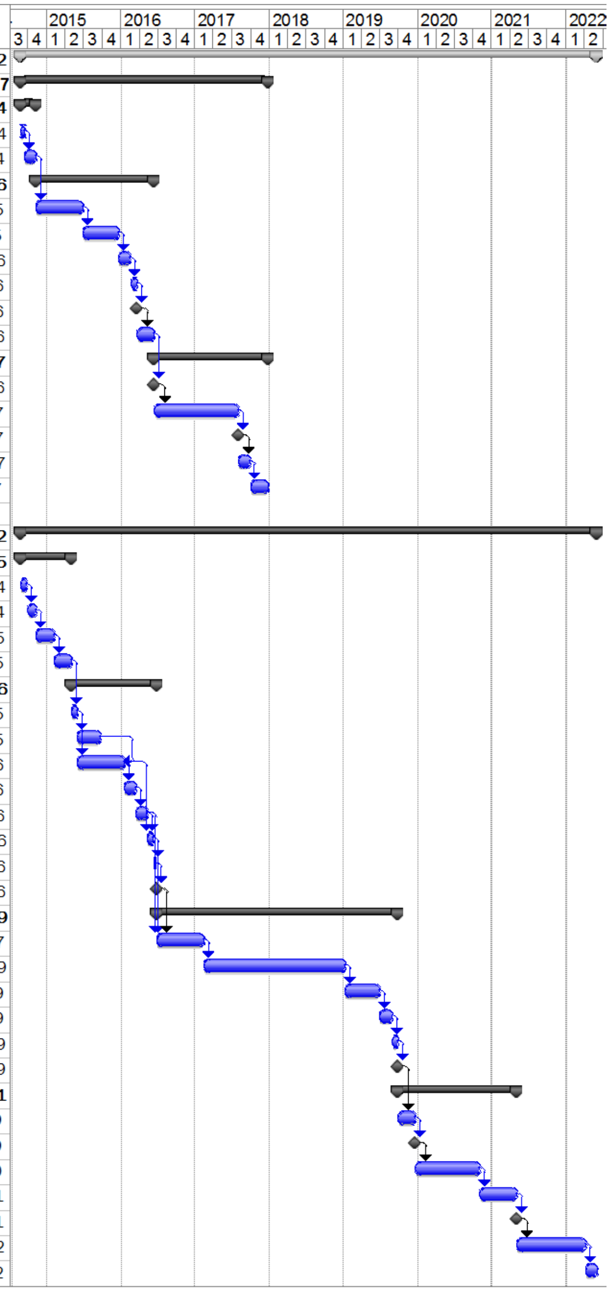

Figure 4-2. Draft Phased Option PS and WQF schedule

With separate projects and construction contracts, the flood control PS is estimated to be operational by December 2017. The WQF is estimated to be substantially completed by April 2021, with commissioning completed in 2022. This is nearly 1 year sooner than the WQF schedule for the Joint Option, as discussed below.

4.2.3 Schedule discussion

Two key differences between the Joint and Phased Options are:

1. The Joint Option delays the PS by nearly 4.5 years.

2. The Joint Option delays the WQF by nearly 1 year.

The Joint Option delays startup of the PS by putting the WQF options analysis and design on the critical path for PS construction. The Phased Option allows for earlier construction of the WQF by taking the contractor selection and design of the PS out of the WQF critical path.

Construction of the standalone PS is estimated to require 389 days and construction of the standalone WQF requires 402 days. For the Joint Option, it is assumed that only 156 of these construction days can overlap. This is based on the limited laydown and staging area at the site and a construction sequence that assumes the deep excavation, sheeting and shoring, and concrete work for the PS wet well needs to be complete before work on the WQF begins. This gives the combined construction contract a construction period of 635 days. This is the primary reason for the delay of the WQF in the Joint Option.

In summary, with the Phased Option, design and construction of the PS can overlap with the consultant selection, options analysis, and design of the WQF. In the Joint Option, however, a longer project duration is required because PS construction cannot begin before the design of both facilities is completed and construction of the two facilities can only partially overlap.

4.3 Comparison of Joint Option and Phased Option Costs

While it is clear from the analysis of schedules that a two-contract approach would result in earlier completion of the projects, the single-contract (Joint Option) may have offsetting benefits. These potentially include greater efficiencies in planning and management and economy in construction contract pricing. Given the draft schedules, Table 4-3 presents the cash flow comparison of the Joint and Phased Options; the costs for the joint option reflect the potential savings resulting from execution as a single construction contract. Development of PS configuration options referenced in the table (Option 2 and Option 3) and project costs for the PS are given in Appendix A and described in subsequent sections. Note that the total costs in Appendix A include markups for inflation and sales tax and contingency amounts that differ from SPU's standard estimating practices. To convert the estimates in Appendix A to SPU's standard format, crosswalk tables are included in Appendix B. Total costs for the PS, WQF, and joint projects are also given in Appendix B.

Table 4-3. Joint and Phased Option Present Value Comparison										
Joint Option		Spending by Year (Millions, 2014$)								
		2015	2016	2017	2018	2019	2020	2021	2022	2023
PS/WQF	Total Cost (Millions, 2014 $)	1%	2%	3%	4%	24%	25%	25%	13%	3%
Option 2: One PS[c]	$32.01	$0.32	$0.64	$0.96	$1.28	$7.68	$8.00	$8.00	$4.16	$0.96
Option 3: Two PS[d]	$33.38	$0.33	$0.67	$1.00	$1.34	$8.01	$8.35	$8.35	$4.34	$1.00

Phased Option		Spending by Year (Millions, 2014$)								
		2015	2016	2017	2018	2019	2020	2021	2022	2023
Pump Station	Total Cost (Millions, 2014 $)	4%	49%	37%	10%	0%	0%	0%	0%	0%
Option 2: One PS[a]	$11.37	$0.45	$5.57	$4.21	$1.14	$0.00	$0.00	$0.00	$0.00	$0.00
Option 3: Two PS[b]	$11.79	$0.47	$5.78	$4.36	$1.18	$0.00	$0.00	$0.00	$0.00	$0.00
WQF	Total Cost (Millions, 2014 $)	0%	1%	2%	4%	4%	12%	51%	16%	10%
WQF [c]	$19.72	$0.0	$0.20	$0.39	$0.79	$0.79	$2.37	$10.06	$3.16	$1.97
WQF + WQF Pump Station [d]	$20.46	$0.0	$0.20	$0.41	$0.82	$0.82	$2.46	$10.43	$3.27	$2.05
Total	Total Cost (Millions, 2014 $)	1%	19%	15%	6%	3%	7%	33%	10%	6%
Option 2: One PS[a]	$31.09	$0.31	$5.91	$4.66	$1.87	$0.93	$2.18	$10.26	$3.11	$1.87
Option 3: Two PS[b]	$32.25	$0.32	$6.13	$4.84	$1.94	$0.97	$2.26	$10.64	$3.23	$1.94

PS Estimates are AACE International Class 3 estimates. WQF and Joint project estimates are AACE International Class 5.

a. Single pump station/wet well with separate pumps for PS and WQF
b. Separate pump stations for flood control and water quality
c. Includes costs for WQF plus cost for installation of WQF influent pumps and associated electrical in PS wet well.
d. Includes costs for WQF plus cost for construction of WQF influent pump station.

Costs and assumptions for the PS options are discussed in Section 5. The total costs presented in Table 4-3 are shown in Appendix B and assume the percentage-based markups shown in Table 4-4, based on SPU's standard total cost estimating procedures.

Table 4-4. Estimating Markups.			
Item	Joint Option	Phased Option	
		PS	WQF
AFI	0%	20%	0%
Adjustment for market conditions	0%	5%	0%
Sales tax	9.5%	9.5%	9.5%
Crew construction costs	5%	5%	5%
Miscellaneous hard costs	5%	5%	5%
Soft costs	49%	27%	49%
Contingency reserve	35%	10%	35%
Management reserve	20%	10%	20%

AFI is based on the level of project progress; projects that have not reached predesign are not assigned an AFI percentage, AFI is intended to account for construction cost items not identified in the bid estimate. Prior to predesign, project uncertainties are considered to be accounted for in the project reserves. The soft costs are based primarily on project progress. Because the standalone PS design requires only a modification of the previous design, the portion of soft costs representing the design phase is lower than the comparable soft costs for the joint projects. The standalone WQF and joint WQF/PS projects would be completely new designs, and the soft costs percentage represents all soft costs from Stage Gate 2 approval through construction contract closeout. Contingency is based on the level of project progress.

Crew costs represent the cost for SPU staff to perform work not included in the soft costs. For example, SPU crews may be asked to go into the field to flush a line or survey an alignment as part of construction. Miscellaneous hard costs include permitting and other costs directly related to construction. Each of these costs was set at 5% of the construction contract amount based on discussions with SPU staff.

Note that the total costs in Table 4-3 are sensitive to the percentage assumptions applied to soft costs and reserves. Because the Joint Option estimate applies higher markups (49 percent for soft costs and 45 percent total for reserves) to the PS costs than are applied in the total cost estimate for the standalone PS in the Phased Option, the total cost for the Joint Option is higher than the sum of the total costs for the individual projects in the Phased Option. The markup percentages applied are the primary reason for the higher total cost of the Joint Option. Therefore, for comparison purposes, it can be assumed that costs are equivalent for the Joint/Phased Options.

Cash flow estimates assume that 15% of the total costs are incurred during the consultant contracting and design phases, 75% of the total costs are incurred during the construction window, and 10% of the costs are incurred in the final 12 months of the project to account for construction contract closeout, facility startup, testing, and commissioning. Costs incurred during the construction window include both construction contract costs as well as crew costs, miscellaneous hard costs, and soft costs related to construction management. Construction window costs are assumed to be evenly distributed throughout the construction window.

4.4 Phased Option Benefits

The Phased Option allows the PS to be constructed nearly 4.5 years sooner than the Joint Option. The following benefits to early construction of the PS as a standalone construction project have been identified:

- Provides a limited flood control benefit in the 7th Avenue South basin in areas where drainage improvements are in place. These include the area adjacent to Portland Street, and portions of the lower basin immediately adjacent to the 7th Avenue trunk line where catch basins are already in place.
- Allows collection of up to 1 year of flow data at the flood control PS that can be used to provide improved sizing information for the WQF during the WQF design period. Based on the Phased Option draft schedule, the PS will be online during a portion of the 2017-2018 wet weather season. Flow information collected during this period can be incorporated into the WQF design.
- Adds up to 1 year of schedule float for the WQF, allowing for schedule extensions or additional time to optimize the WQF before IP requirements must be met

4.5 Risks

The following summarizes potential risks of early construction of the PS as a standalone project:

- **Impacts on WQF design**. A PS designed and constructed while the WQF design has only been partially developed may impose limitations or constraints on the WQF if all coordination issues are not anticipated during the PS design. This includes issues such as utility or piping conflicts, etc. These would potentially add to the cost of the WQF or would require retrofits to the PS.

Section 5: Pump Station Options

This section discusses PS configuration options. All options assume that the PS will be constructed on the 7th Avenue South right-of-way (ROW) adjacent to the existing 72-inch-diameter stormwater pipeline and outfall.

Three PS options were considered. Option 1 consists of a single station with four bays and dual-purpose pumps. The same set of pumps would pump both for flood control and to feed the WQF. All flows would be pumped to the WQF, and flows above the WQF design capacity would bypass the treatment system. This design is similar to the WQF PS design. Option 2 consists of a single station with six bays. Four of the bays would contain dedicated flood control pumps, and two of the bays would contain dedicated WQF feed pumps. Option 3 consists of a flood control PS with four bays housing dedicated flood control pumps, and a separate WQF feed PS, built on the WQF site, housing WQF feed pumps.

Common to all pump station options is the requirement for the flood control discharge to be above tidal influence. If the pumps discharge to the outfall structure below the level of tidal influence, they would need to pump against a variable downstream head that would fluctuate based on the tide elevation in the Duwamish waterway. Placing the discharge point above tidal influence ensures the pumps will have a constant head to discharge against and is part of good pump station design practice. Based on preliminary modeling this elevation is equal to 16 feet considering a future tidal elevation increase of 4 feet.and average ground elevation of about 12.5 feet. Therefore, an aboveground discharge structure will be needed. This structure has tentatively been located adjacent to the pump station to facilitate vehicle traffic in the area; however, it could be located separate from the pump station. In addition, common to all alternatives is that the existing tide gate valve vault top will be elevated by 2 feet to provide additional flood protection to the device. Similar structures/adjustments were included in the 2008 Stage Gate 2 analysis.

5.1 Option 1: Single Station with Dual-Purpose Pumps

Option 1 has dual-purpose pumps that can pump for flood control and to the WQF. Pumps would discharge all influent flow to a headbox or channel at the WQF, and flows up to the capacity of the WQF would flow through the treatment trains. Flows in excess of the WQF capacity would bypass treatment and flow downstream of the Tideflex valve. This was the original design for the flood control PS, and was possible in part because small flood control pumps were matched to the WQF capacity. For large parts of the wet season, one 11-cfs pump would be sufficient for drainage. Since the original WQF capacity was 11-cfs, there would be no bypass under the majority of operating conditions.

Updated modeling has determined that total drainage capacity of the PS needs to be 54-cfs, increased from 44-cfs in the previous design (*South Park Hydraulic Modeling Report*, 2014). This change results in four 18 cfs flood control pumps , giving the PS a firm capacity of 54-cfs with one pump out of service. Updated modeling indicates that the WQF pumps can be reduced to 6 cfs, while still meeting the original goal of treating approximately 83 percent of the average annual runoff[1]. WQF pumps would would operate even when operation of the flood control pumps is not required. This flow range is too great to be pumped from one set of pumps. Based on discussions with pump manufacturers, the turndown for 18-cfs submersible pumps is, at maximum, 50% or 9-cfs. The pumps operate inefficiently at this operating point, and this turndown requirement may limit pump selection or require custom features. Using an 18-cfs pump to feed the 6-cfs WQF would require the bypass of 3 to 12-cfs, depending on the turndown achieved, and bypass would occur anytime the PS operated. This is an inefficient use of power. It also adds hydraulic complexity to the WQF, requiring hydraulic controls to split the bypass flow from the WQF influent flow, and a bypass channel.

With the previous hydraulic model and design, one 11-cfs pump was determined to be sufficient for drainage for more than 95% of the total annual operating period (1,683 hours out of a total of 1,765 operating hours per year). Thus, bypass of the water quality facility would occur less than 5% of the time the system operated. In contrast, with the new model and flood control and WQF flow rates, a similar configuration would require bypasses of the treatment system every time the system operated. This is generally considered a poor design practice for water treatment facilities. Based on analysis, Option 1 is eliminated from further development.

5.2 Option 2: Single Station with Separate Flood Control and WQF Pumps

This section discusses Option 2, consisting of a single structure with multiple pump bays that include both flood control pumps and WQF influent pumps.

5.2.1 Site Plan

A representative site plan for Option 2 is shown in Figure 5-1. A new diversion structure would be built on the 72-inch-diameter storm drain, upstream of the existing tide gate vault. Flow would be diverted to the new PS via a 54-inch-diameter pipe and one maintenance hole. The new PS would have four pumps for flood control and two pumps to supply flow to the WQF. A check valve vault would be required downstream of the wet well to prevent flows from backing up into adjacent pumps. These check valves were not required in the previous design, since the force mains pumped directly to an open channel. Note that the force mains would be constructed in the S Riverside Drive right-of-way. This is so that the WQF structure (not shown) can be shifted

[1] Water quality modeling report is not yet complete, however, the SWMM model predicts much lower design capacity (6 cfs versus 11 cfs) than previously estimated using the WWHM model.

closer to S Riverside Dr to provide room to maintain an access driveway around the waterward side of the WQF, between the structure and a presumed future berm along the Duwamish Waterway for protection against sea level rise.

For the flood control side, the discharge pipe would be routed to an elevated discharge structure to provide a consistent discharge head for the pumps versus the variable head that would be needed if discharging directly to the tidally influenced Duwamish Waterway. The elevated discharge structure would connect to a junction maintenance hole, which would join flow from the WQF. The combined flows would connect to the existing 72-inch-diameter storm drain via a 54-inch-diameter pipeline and new discharge maintenance hole.

Under the phased option, none of the WQF pipelines, pumps, or valves would be constructed in the flood control construction phase. Spacing and pipe stubs would be constructed in the first phase to facilitate future construction. An above-grade electric panel/cabinet and separate instrumentation and control panel/cabinet would be constructed for the flood control PS. It is assumed that for the WQF pumps, only an electric panel/cabinet would be constructed in the future and that all instrumentation and controls would be housed in the WQF electrical building.

5.2.2 Hydraulic Profile

The hydraulic profile for Option 2 is shown in Figure 5-2. The elevations of the WQF are not known at this time, as a preferred technology has not been selected.

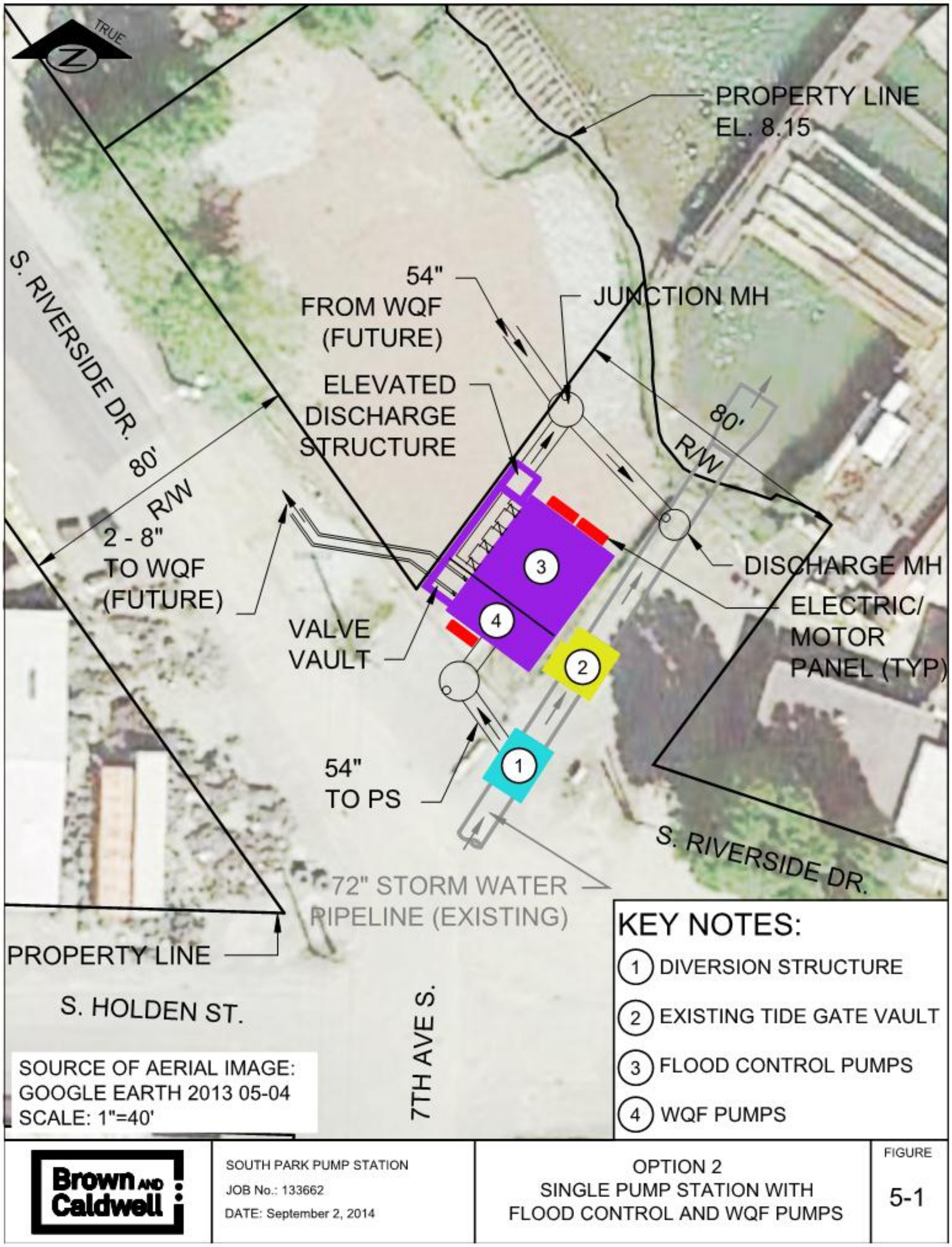

Figure 5-1. Option 2 single station with dedicated pumps site plan

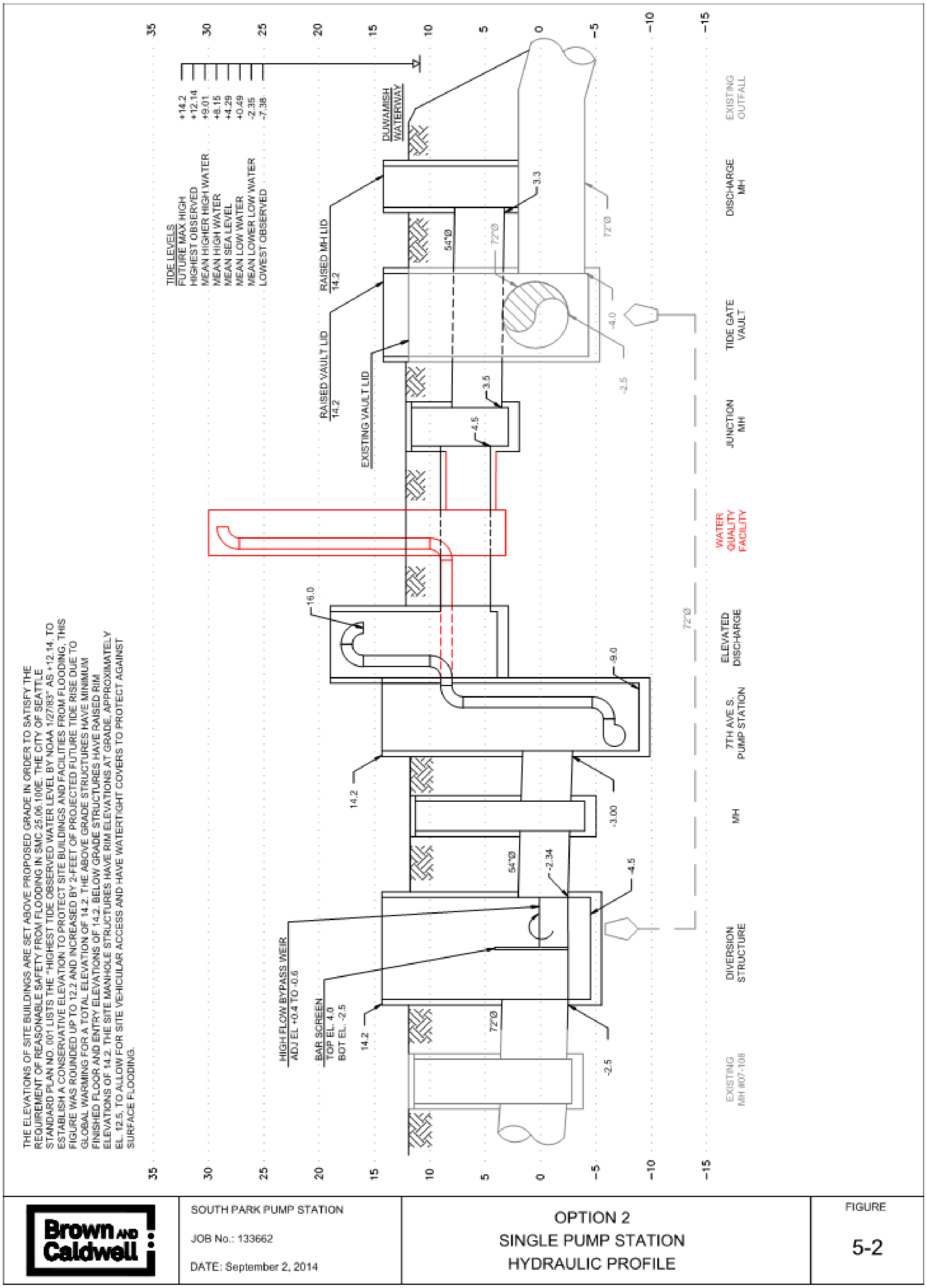

Figure 5-2. Option 2 single station with dedicated pumps hydraulic profile

5.2.3 Pump Selection and Major Equipment

The pump station layout from the previous design was used as a basis in sizing this alternative. For sizing purposes, 18-inch Fairbanks Morse model D5731MV (100-horsepower [hp]) submersible pumps were selected, which have the same physical dimensions as the pumps selected for the original PS design. Two additional bays, sized to house the WQF pumps, were added to the previously designed pump station. The selected pumps for the WQF are 8-inch Fairbanks Morse model 5434LMV (W) (30 hp) submersible pumps. Each pump station bay has room to upgrade the flood control pumps to 24-cfs and the WQF pumps to 11-cfs. The single pump station is approximately 40 feet long by 30 feet wide (the previous PS wet well was 28.5 feet long by 26.5 feet wide). The portion of the wet well dedicated to flood control pumps is approximately the same size as the previous PS design, since the pump bays in the previous PS design were sized to accommodate pumps as large as 22-cfs. The remainder of the wet well is dedicated the WQF influent pumps. Table 5-1 shows major equipment associated with Option 2.

Table 5-1. Option 2 Major Equipment

Item	Quantity	Capacity	Power	Dimensions
Flood control pumps	4	18 cfs initial, 24 cfs future	100 hp	NA
WQF pumps	2	6 cfs (expandable to 11 cfs)	30 hp	NA
Pump station	1	NA	NA	40' long x 30' wide

5.2.4 Risks and Benefits

Risks of the Option 2 configuration include the following:

- **Contracting and Delivery.** The contracting and delivery method for the WQF has not been selected, and the WQF may be completed as a design-build-operate (DBO) contract. In this situation the separation of lines between what is SPU's responsibility and what is the DBO's responsibility is less clear with Option 2 than Option 3. This could result in conflicts if contractor operations of the WQF encroach on SPU operations of the flood control pumps, or vice-versa. Additionally, the operational lead for the WQF pumps (SPU or a contractor) would need to be established. The responsibilities of each party would need to be more clearly defined for a DBO contract for Option 2.
- **Expansion.** If the WQF is constructed in the future as a separate project, the WQF flows may differ from what is currently estimated with the PC-SWMM model. This risk can be mitigated through design. There is not a significant difference in the physical footprint required for 11-cfs pumps as compared to 6-cfs pumps, and the WQF pump bays would be designed to accommodate up to 11 cfs pumps.

Operational simplicity is the major benefit of Option 2. Having all the flows go to one wet well reduces hydraulic complexity in the operation of the combined facilities by not having to split flows to two separate pump stations. Option 2 also minimizes the duplication of associated equipment (e.g., alarms and other monitoring equipment, SCADA) that would need to be operated and maintained.

5.2.5 Schedule

SPU prepared a project schedule for the entire South Park project for the 2012 change business case report. The portions relevant to pump station contracting, design, construction, and closeout were extracted to create the schedule shown in Figure 5-3. BC's construction scheduling department estimated the duration of construction.

Task Name	Duration	Start	Finish
Option 2	**830 days**	**Fri 8/22/14**	**Tue 12/5/17**
Consultant Contracting	**50 days**	**Fri 8/22/14**	**Fri 10/31/14**
RCEC	10 days	Fri 8/22/14	Fri 9/5/14
Consultant contracting	40 days	Mon 9/8/14	Fri 10/31/14
Design Phase	**402 days**	**Mon 11/3/14**	**Tue 6/7/16**
Pump Station Design	8 mons	Mon 11/3/14	Wed 6/24/15
Pump Station Permitting	6 mons	Thu 6/25/15	Tue 12/15/15
Governance for Advertisement	2 mons	Wed 12/16/15	Fri 2/12/16
Advertisment	1 mon	Tue 2/16/16	Mon 3/14/16
Bid opening	0 days	Mon 3/14/16	Mon 3/14/16
Contracting for Construction	3 mons	Tue 3/15/16	Tue 6/7/16
Construction	**378 days**	**Tue 6/7/16**	**Tue 12/5/17**
NTP	0 days	Tue 6/7/16	Tue 6/7/16
Construction	277 days	Wed 6/8/16	Wed 7/12/17
Substantial Completion	0 days	Wed 7/12/17	Wed 7/12/17
Commissioning	2 mons	Thu 7/13/17	Thu 9/7/17
Closeout	3 mons	Fri 9/8/17	Tue 12/5/17

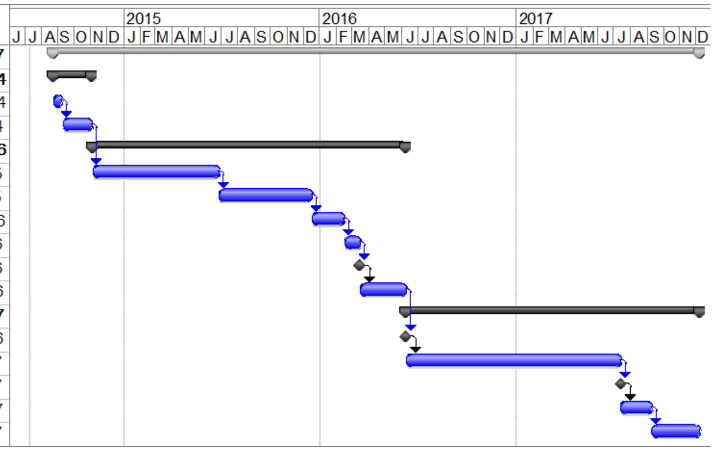

Figure 5-3. Option 2 (single PS with dedicated pumps) schedule

5.2.6 Cost Estimate

The cost estimate completed for the previous 90 percent PS design (2009) was used as the basis for this cost estimate. The cost estimate was revised to update cost numbers and to remove unneeded items like the WQF and associated site improvements. The summary of the cost estimate is found in Table 5-2. The full cost estimate is found in Attachment A, and cost estimate crosswalk tables and the total project cost calculation is found in Appendix B. The cost estimate includes other required work like construction of the new diversion structure and discharge structure, and modifications to the tide gate vault; the estimate assumes the WQF influent pumps would be installed as part of the WQF project. The estimate tabulated below presents the cost of the PS as a standalone project; see Section 4 above for a discussion of the phasing of Option 2 costs and of Option 2 costs as part of a joint project.

Table 5-2. Option 2 Cost Estimate (Class 3)		
Cost item description	Quantity	Estimated cost
Pump station Class 3 estimate	---	$4,915,000
Allowance for indeterminates	20%	$983,000
Pump station line item pricing	---	**$5,898,000**
Adjustment for market conditions	5%	$295,000
Construction bid amount	---	**$6,192,000**
Sales tax	9.5%	$588,000
Construction contract amount	---	**$6,781,000**
Crew construction costs	5%	$339,000
Miscellaneous hard costs	5%	$339,000
Construction cost total	---	**$7,459,000**
Soft costs	27%	$2,014,000
Property acquisition costs	---	$0
Base cost total	---	**$9,473,000**
Contingency reserve	*10%*	*$947,000*
Management reserve	*10%*	*$947,000*
Project reserves	---	$1,895,000
Total cost	---	**$11,367,000**

5.3 Option 3: Separate Flood Control and Water Quality Facility Pump Stations

This section discusses Option 3, consisting of a dedicated flood control PS and a smaller dedicated WQF influent PS.

5.3.1 Site Plan

A representative site plan for Option 3 is shown in Figure 5-4. This option would require an additional diversion structure to separate flows to the flood control PS and the WQF PS. Like Option 2, , the WQF force mains are routed in the S Riverside Drive right-of-way to preserve space around the waterward side of the WQF structure for an access driveway.

A new diversion structure would be built on the 72-inch-diameter storm drain, upstream of the existing tide gate vault. Flow would be diverted to the new pump stations via a 54-inch-diameter pipe and the additional diversion structure to split flows to each pump station. The new flood control PS would have four pumps for flood control. A check valve vault would be required downstream of the wet well to prevent flows from backing up into adjacent pumps. These check valves were not required in the previous design, since the force mains discharged to an open channel.

For the flood control side, the discharge pipe would be routed to an elevated discharge structure to provide a consistent discharge head for the pumps versus the variable head discharging to the tidally influenced

Duwamish Waterway. The elevated discharge structure would connect to a junction maintenance hole, , which would join flow from the WQF. The combined flows connect to the existing 72-inch-diameter storm drain via a 54-inch-diameter pipeline and new discharge maintenance hole.

Under the phased option, none of the WQF pipelines, pumps, or valves would be constructed in the flood control construction phase. The 12-foot inner diameter junction maintenance hole, intermediate piping, and pipe stubs would be constructed in the first phase to facilitate future construction. An above-grade electric panel/cabinet and separate instrumentation and control panel/cabinet would be constructed for the flood control PS. It is assumed that for the WQF pumps, only an electric panel/cabinet would be constructed in the future and that all instrumentation and controls would be housed in the WQF electrical building.

5.3.2 Hydraulic Profile

The hydraulic profile for Option 3 is shown in Figure 5-5. The elevations of the WQF are not known at this time, as a preferred technology has not been selected.

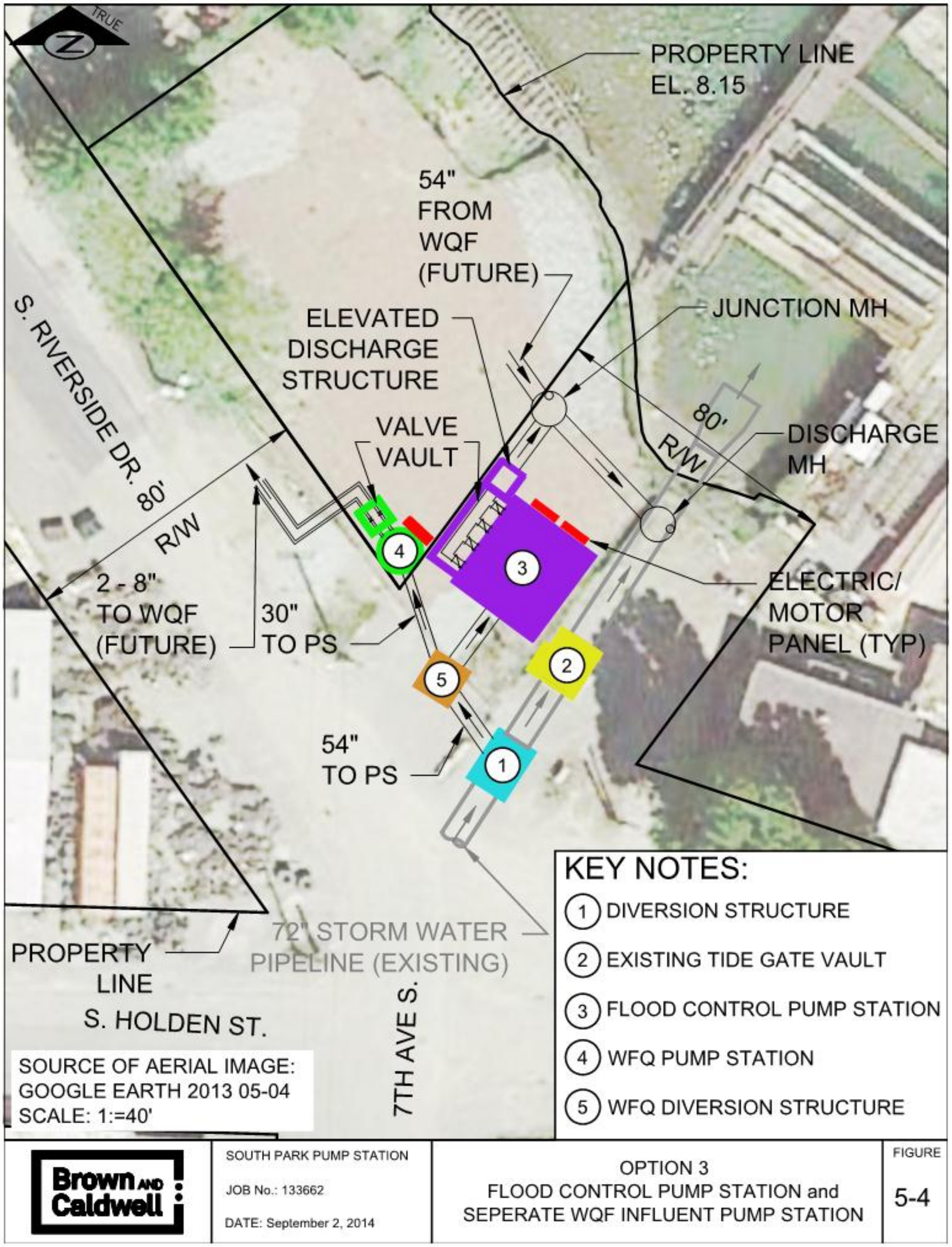

Figure 5-4. Option 3 separate WQF pump station site plan

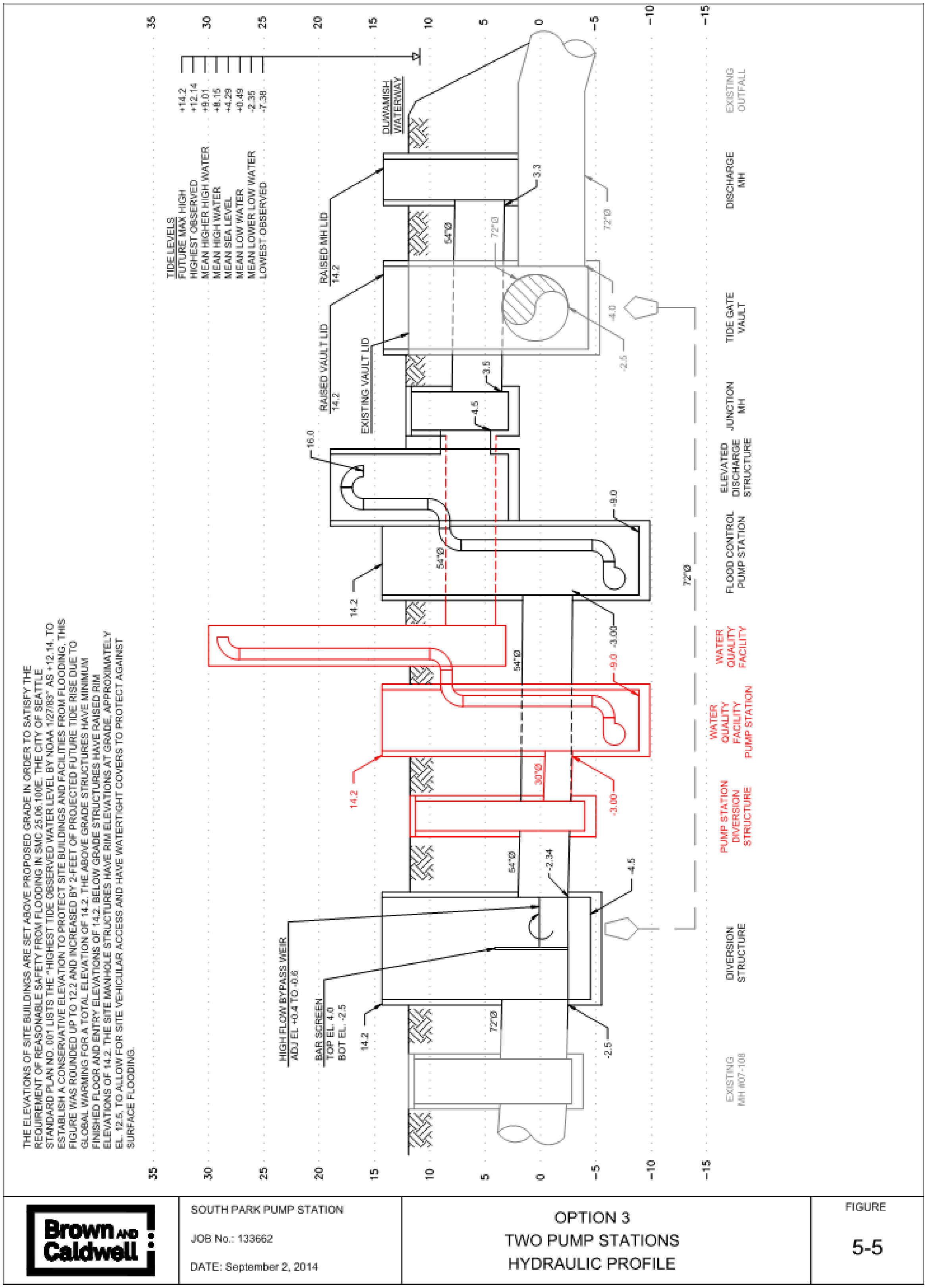

Figure 5-5. Option 3 separate WQF pump station hydraulic profile

5.3.3 Pump Selection and Major Equipment

The pump station from the previous design was used as a basis in sizing the flood control pumps for this alternative. In fact, no major modifications are anticipated because the pumps are similar size and the existing design had four pump bays. For sizing purposes, 18-inch Fairbanks Morse model D5731MV (100 hp) submersible pumps were selected. The dimensions of the pump station are approximately 30 feet long by 30 feet wide; since the previous design was sized to accommodate up to four 22-cfs pumps, the flood control PS wet well is not expected to be significantly different than the previous design.

The WQF PS consists of a 12-foot inner diameter package pump station with two (one operational, one standby), 6 cfs submersible pumps. The selected pumps for the WQF are 8-inch Fairbanks Morse model 5434LMV (W) (30 hp) submersible pumps. To get flows to the WQF PS, an additional diversion structure will be required to divert flows to both pump stations. Table 5-3 shows major equipment associated with Option 3.

Table 5-3. Option 3 Major Equipment

Item	Quantity	Capacity	Power	Dimensions
Flood control pumps	4	18 cfs initial, 24 cfs future	100 hp	NA
WQF pumps	2	6 cfs (expandable to 11 cfs)	30 hp	NA
Flood control PS	1	NA	NA	30' long x 30' wide
WQF PS	1	NA	NA	12' inner diameter
Diversion structure	1	Flow up to 11 cfs	NA	NA

5.3.4 Risks and Benefits

Risks for the Option 3 configuration include the following:

- **Site Footprint**. Option has the potential to complicate site development for the WQF, since the WQF influent PS reduces the site footprint available. The influent PS and piping would require an approximately 20’ by 10’ footprint area on the WQF site. This can be mitigated through design; the influent PS can be southern corner of the WQF site as shown in Figure 5-4, an area that, due to the shape of the property, would be difficult to use for the WQF. Based on preliminary design layouts, all WQF options under consideration will fit on the site with the Option 3 configuration.
- **Hydraulic Complexity**. Option 3 requires that flows be split between two pump stations. The design of the diversion system is beyond the scope of this analysis, but the system will require additional weirs and, potentially, motorized valves. This adds to the O&M requirements and complicates the control strategy for operating the WQF.

The primary benefit of the Option 3 configuration is in its impact on the contracting and delivery methods should SPU elect to use a DBO contract for the WQF. Having a separate WQF PS provides a clear separation between SPU’s responsibility and the DBO contractor’s responsibility.

5.3.5 Schedule

SPU prepared a project schedule for the for the 2012 change business case report.. The portions relevant to pump station contracting, design, construction, and closeout were extracted to create the schedule shown in Figure 5-6. BC’s construction scheduling department estimated the duration of construction.

Task Name	Duration	Start	Finish
Option 2	**841 days**	**Fri 8/22/14**	**Wed 12/20/17**
Consultant Contracting	**50 days**	**Fri 8/22/14**	**Fri 10/31/14**
RCEC	10 days	Fri 8/22/14	Fri 9/5/14
Consultant contracting	40 days	Mon 9/8/14	Fri 10/31/14
Design Phase	**402 days**	**Mon 11/3/14**	**Tue 6/7/16**
Pump Station Design	8 mons	Mon 11/3/14	Wed 6/24/15
Pump Station Permitting	6 mons	Thu 6/25/15	Tue 12/15/15
Governance for Advertisement	2 mons	Wed 12/16/15	Fri 2/12/16
Advertisment	1 mon	Tue 2/16/16	Mon 3/14/16
Bid opening	0 days	Mon 3/14/16	Mon 3/14/16
Contracting for Construction	3 mons	Tue 3/15/16	Tue 6/7/16
Construction	**389 days**	**Tue 6/7/16**	**Wed 12/20/17**
NTP	0 days	Tue 6/7/16	Tue 6/7/16
Construction	288 days	Wed 6/8/16	Thu 7/27/17
Substantial Completion	0 days	Thu 7/27/17	Thu 7/27/17
Commissioning	2 mons	Fri 7/28/17	Fri 9/22/17
Closeout	3 mons	Mon 9/25/17	Wed 12/20/17

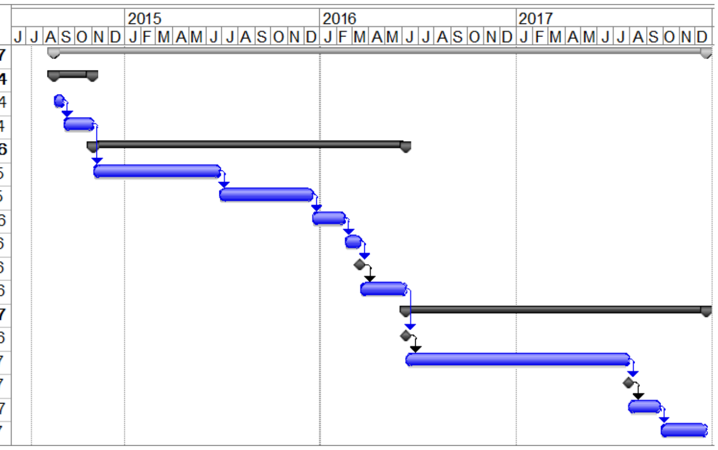

Figure 5-6. Option 3 schedule

5.3.6 Cost Estimate

The cost estimate completed for the South Park PS from the previous 90 percent design (2009) was used as the basis for this cost estimate. The cost estimate was revised to update cost numbers, add additional components, and remove unneeded items like the WQF and associated site improvements. The summary of the cost estimate is found in Table 5-4. The estimate shown includes the WQF PS, separate diversion structure and junction maintenance hole, and associated piping required for Option 3. The full cost estimate is found in Attachment A and the total project cost calculation is found in Appendix B. The cost estimate includes other required work like construction of the new diversion structure and modifications to the tidegate vault. The estimate tabulated below presents the cost of the PS as a standalone project; see Section 4 above for a discussion of the phasing of Option 3 costs and of Option 3 costs as part of a joint project.

Table 5-4. Option 3 Cost Estimate (Class 3)		
Cost item description	Quantity	Estimated cost
Pump station Class 3 estimate	---	$5,095,000
Allowance for indeterminates	20%	$1,019,000
Pump station line item pricing	---	**$6,115,000**
Adjustment for market conditions	5%	$306,000
Construction bid amount	---	**$6,420,000**
Sales tax	9.5%	$610,000
Construction contract amount	---	**$7,030,000**
Crew construction costs	5%	$352,000
Miscellaneous hard costs	5%	$352,000
Construction cost total	---	**$7,733,000**
Soft costs	27%	$2,088,000
Property acquisition costs	---	$0
Base cost total	---	**$9,821,000**
Contingency reserve	*10%*	*$982,000*
Management reserve	*10%*	*$982,000*
Project reserves	---	$1,964,000
Total cost	---	**$11,785,000**

Section 6: Pump Station Options Evaluation

This section evaluates the two pump station options under consideration.

6.1 Evaluation with WQF Scenarios

Much of the rationale for design changes from the previous 90% PS design results from changes in the WQF planning status. At this point, there is still considerable uncertainty surrounding the WQF, including the treatment technology, the contracting and delivery method, and the construction date. Design preferences for the PS may change depending on what is assumed for the WQF. The evaluation presented below considers two scenarios: one scenario where the WQF is built by 2025, and a second scenario where the WQF is not built by 2025.

6.2 Evaluation Criteria

Four evaluation criteria were identified that differentiated between the two PS options either for the scenario where the WQF is built by 2025, or for the scenario where the WQF is not built by 2025. These criteria are discussed below:

- **Wet well sized appropriately.** This criterion evaluates risk of oversizing the PS wet well, the construction of the wet well is a major cost component of the PS, and an oversized wet well is a waste of resources.

- **WQF built by 2025.** In the scenario where the WQF is built by 2025, the wet well is appropriately sized for both options. For Option 2, four pump bays are used for flood control pumps and two are used for WQF influent pumps, and the wet well is fully utilized. For Option 3, the flood control PS is fully utilized for the four flood control pumps.
- **WQF not built by 2025.** In the scenario where the WQF is not built by 2025, the wet well is oversized for Option 2. If WQF feed pumps are not required, the wet well would have two extra bays. For Option 3, since the wet well is only sized for four pumps, the wet well is appropriately sized.

- **Minimizes O&M effort**. This criterion evaluates the effect of the design on the required O&M effort.
  - **WQF built by 2025.** In the scenario where the WQF is built by 2025, Option 2 minimizes the O&M effort required since there is only a single PS and wet well to maintain. Option 3 adds O&M effort due to the second PS. At this time it is not certain what entity would be responsible for O&M of the WQF influent PS; if DBO delivery is selected for the WQF, SPU staff may still be responsible for the WQF influent PS depending on the specific provisions of the DBO contract. Additionally, SPU operators could become responsible for the WQF influent PS in the future.
  - **WQF not built by 2025**. In the scenario where the WQF is not built, the two options are equivalent. Each option requires O&M for a single PS and wet well.
- **Flexibility to control base flow**. Base flow consisting largely of infiltrated ground water will flow to the PS at a rate of 0.5-0.6 cfs (*South Park Hydraulic Modeling Report,* 2014). To drain the wet well, base flow will need to be pumped 1-2 times per day depending on the tidal cycle, regardless of rainfall. This criterion evaluates the best approach for managing base flow.
  - **WQF built by 2025.** In the scenario where the WQF is built by 2025, small 6-cfs pumps are installed in the same wet well as the flood control pumps. These pumps can be used to control base flow. This is preferable from an asset management standpoint, as it puts wear and tear from daily drainage of base flow on the smaller, less costly asset. For Option 3, the flood control pumps would may to drain base flow at high tide conditions, since the WQF influent pumps would be in a separate station and would only pump flow that had already been split off at the diversion structure.
  - **WQF not built by 2025.** In the scenario where the WQF is not built by 2025 both options are equivalent. The Option 2 PS would have only the large, flood control pumps; the smaller WQF influent pumps would not be installed. Both the Option 2 and Option 3 PS would need to use the large flood control pumps to control base flow.
- **Operator holds liability if WQF does not perform due to pump failure**. Alternate contracting and delivery methods such as DBO have been proposed for the WQF. If DBO delivery is selected for the WQF, there are likely to be performance-based contract provisions for meeting specific treatment targets. If influent flows are not delivered to the WQF for reasons outside the operations contractor's control, the result is the potential for a contract claim. This criterion evaluates how well each PS option mitigates this risk.
  - **WQF built by 2025.** For the scenario where the WQF is built by 2025, it is not certain who would be responsible for O&M of the WQF influent pumps under Option 2. If SPU is responsible, there is the potential for a claim as described above in the event of a pump failure or other PS issue. Even if the WQF contract operator is responsible for influent pump O&M, there is still a potential for a claim if an issue with the flood control pumps or common PS wet well affects the WQF influent pumps. Option 3 mitigates this risk, in that operational responsibility of the WQF influent PS could be given to the WQF contract operator. The liability for any failure to meet WQF performance metrics due to a pump failure or other PS issue would then rest with the WQF operator.
  - **WQF not built by 2025**. This criterion is not applicable if the WQF is not constructed.

Table 6-1 summarizes the results of the pump station options evaluation, with the preferred option for each criteria and WQF construction assumption marked with a ✓.

Table 6-1. Evaluation Criteria Summary				
Characteristic	WQF Built by 2025		WQF Not Built by 2025	
	Option 2: One PS	Option 3: Two PS	Option 2: One PS	Option 3: Two PS
Wet well sized appropriately (not oversized)	Options Equivalent	Options Equivalent		✓
Minimizes O&M effort	✓		Options Equivalent	Options Equivalent
Flexible for SPU control of base flow	✓		Options Equivalent	Options Equivalent
Operator holds liability if WQF does not perform due to pump failure.		✓	Not Applicable	Not Applicable
Total	2	1	0	1

Section 7: Design Status

This section describes the current design status of each component of each option. For each option, there is no change to the primary diversion structure from the 72-inch-diameter stormwater pipeline or the modifications to the tidegate vault top.

7.1 Option 2 (single PS with separate flood control and water quality pumps)

Option 2 increases the size of the pump station (from 30 ft by 30 ft to 40 ft by 40 ft); therefore, it must be redesigned. A portion of the existing design can be reused, but with the greater width; there must be a structural review, which may modify structural components and limits of soil stabilization. The previous design did not include a valve vault or separate elevated discharge structure (it was integral with the WQF in the prior design); therefore, they must be designed from scratch. The previous design had an electrical control room building. The current options include only construction of aboveground panels to contain the required electrical equipment. This will have to be fully designed. Table 7-1 shows the design status of Option 2 in tabular format.

Table 7-1. Option 2 Design Status			
Feature	Full design required	Small redesign required	Minimal redesign required
Diversion structure to PS			✓
WQF and flood control PS	✓		
Valve vault and elevated discharge structure	✓		
Tide gate vault modifications			✓
Junction chamber (WQF/PS discharge to 72")			✓
Electrical components	✓		

7.2 Option 3 (separate flood control and water quality pump stations)

Option 3 completely reuses the same pump station configuration for the flood control pumps. Therefore, minimal structural and mechanical redesign work is anticipated. Similar to Option 2, items that will need full design include the valve vault, elevated discharge structure, and electrical control components. In addition, Option 3 requires the design of the diversion to the WQF influent pumps and a separate WQF PS. Table 7-2 shows the design status of Option 3 in tabular format.

Table 7-2. Option 3 Design Status			
Feature	Full design required	Small redesign required	Minimal redesign required
Diversion structure to PSs			✓
Diversion structure to WQF influent pumps	✓		
Flood control PS		✓	
WQF PS	✓		
Valve vault and elevated discharge structure	✓		
Tide gate vault modifications			✓
Junction chamber (WQF/PS discharge to 72")			✓
Electrical components	✓		

Section 8: Recommendations

Although it is not the lowest cost option, BC recommends the Phased Option with flood control PS Option 2.

The phased project approach confers several benefits:

- 4.5 additional years of flood control in limited areas of the 7th Avenue South basin where drainage improvements have been constructed.
- Collection of up to 1-year of operational data that can inform the WQF design and sizing
- Completion of the WQF 1 year earlier, allowing for additional schedule float.

PS Option 2 confers several benefits compared to PS Option 3, assuming the WQF is built by 2025:

- Minimizes O&M effort.
- Flexibility for control of base flow.

The risks of the Phased Option – Option 2 combination include the following:

- If the WQF is built by 2025, Option 2 increases the potential for claims if a WQF influent pump failure results in a contract operator of the WQF not meeting performance metrics.
- If the WQF is not built by 2025, the Option 2 wet well will be oversized.

The lowest-cost option is the Joint Option – Option 2 combination. The difference in present value between the recommended option ($32.01 million, 2014 dollars) and the lowest-cost option ($31.09 million, 2014 dollars) is $920,000. The accuracy of the Class 3 PS estimates is -15% / +20%, while the accuracy of the Class 5 WQF and joint project estimates is up to -50%/+100%. The difference between the recommended option and the lowest-cost option is therefore within the range of accuracy of the estimates.

The PS could be completed by late 2017, with the WQF completed by 2022.

References

South Park Hydraulic Modeling Report. Brown and Caldwell, 2014.

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Attachment A: Detailed Cost Estimates

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Attachment B: Total Project Cost Calculations

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Table B-1. Option 2 Estimate Crosswalk Table

	Category	Item		Labor	Materials	Subs	Equip.	Other	Net Costs	Reference
Brown and Caldwell Estimate *Line item entries correspond to BC estimate or are calculated using BC estimate markups*	Line Item Pricing	Pump Station		$417,782	$447,263	$0	$131,110	$570,000	$1,566,155	Option 2 - 30% Design Estimate, p. 29-36 of 37
		General Conditions		$445,688	$44,387	$759	$56,994	$57,255	$605,083	
		Site Civil		$275,255	$472,933	$185,406	$72,371	$0	$1,005,965	
		Valve Vault		$127,977	$34,660	$0	$63,253	$2,741	$228,631	
		Elevated Discharge Structure		$10,256	$5,178	$0	$997	$343	$16,774	
		Electrical and Instrumentation		$0	$0	$695,215	$0	$0	$695,215	
		Diversion Structure		$163,572	$233,926	$0	$75,495	$3,324	$476,317	
		Line Item Subtotal		**$1,440,530**	**$1,238,347**	**$881,380**	**$400,220**	**$633,663**	**$4,594,140**	
	Contractor Markups	Labor	10.00%	$144,053					$144,053	Basis of Estimate p. 4
		Materials	8.00%		$99,068				$99,068	
		Equipment	8.00%				$32,018		$32,018	
		Subcontractors	5.00%			$44,069			$44,069	
		Material Shipping and Handling	2.00%		$24,767				$24,767	
		Contractor Markup Subtotal		**$144,053**	**$123,835**	**$44,069**	**$32,018**	**$0**	**$343,974**	
	Gross Cost Markups	**Line Item plus Contractor Markups**		**$1,584,583**	**$1,362,182**	**$925,449**	**$432,238**	**$633,663**	**$4,938,114**	
		Startup, Training, O&M	2.00%						$98,762	
		Subtotal							**$5,036,877**	
		Insurance	2.00%						$100,738	
		Subtotal							**$5,137,614**	
		Bonds	1.50%						$77,064	
		Line Item plus Contractor and Gross Cost Markups							**$5,214,678**	
Adjustment for Phased Project (Installation of WQF pumps deferred until construction of WQF)									-$300,000	
SPU Cost Estimate Template *Line item entries correspond to SPU estimate template*	**Option 2 PS Unit Price**								**$4,914,678**	SPU Cost Estimating Guidelines
	Allowance for Indeterminates		20.00%						$982,936	
	Construction Line Item Pricing								**$5,897,614**	
	Adjustment for Market Conditions		5.00%						$294,881	
	Construction Bid Amount								**$6,192,495**	
	Sales Tax		9.50%						$588,287	
	Construction Contract Amount								**$6,780,782**	
	Crew Construction Costs		5.00%						$339,039	
	Miscellaneous Hard Costs		5.00%						$339,039	
	Construction Cost Total								**$7,458,860**	
	Soft Costs		27.00%						$2,013,892	
	Property Costs								$0	

Base Cost Total			**$9,472,752**
Contingency Reserve	10.00%		$947,275
Management Reserve	10.00%		$947,275
Project Reserves			$1,894,550
Total Cost			**$11,367,302**

Table B-2. Option 3 Estimate Crosswalk Table										
	Category	Item		Labor	Materials	Subs	Equip.	Other	Net Costs	Reference
Brown and Caldwell Estimate *Line item entries correspond to BC estimate or are calculated using BC estimate markups*	Line Item Pricing	Pump Station		$389,975	$413,512	$0	$120,501	$676,372	$1,600,360	Option 2 - 30% Design Estimate, p. 29-36 of 37
		General Conditions		$445,688	$44,387	$759	$56,994	$57,255	$605,083	
		Site Civil		$275,255	$472,933	$185,406	$72,371	$0	$1,005,965	
		Valve Vault		$211,634	$52,965	$0	$111,918	$4,530	$381,047	
		Elevated Discharge Structure		$10,256	$5,178	$0	$997	$343	$16,774	
		Electrical and Instrumentation		$0	$0	$665,215	$0	$0	$665,215	
		Diversion Structure		$245,358	$350,889	$0	$113,243	$4,986	$714,476	
		Line Item Subtotal		**$1,578,166**	**$1,339,864**	**$851,380**	**$476,024**	**$743,486**	**$4,988,920**	
	Contractor Markups	Labor	10.00%	$157,817					$157,817	Basis of Estimate p. 4
		Materials	8.00%		$107,189				$107,189	
		Equipment	8.00%				$38,082		$38,082	
		Subcontractors	5.00%			$42,569			$42,569	
		Material Shipping and Handling	2.00%		$26,797				$26,797	
		Contractor Markup Subtotal		**$157,817**	**$133,986**	**$42,569**	**$38,082**	**$0**	**$372,454**	
	Gross Cost Markups	**Line Item plus Contractor Markups**		**$1,735,983**	**$1,473,850**	**$893,949**	**$514,106**	**$743,486**	**$5,361,374**	
		Startup, Training, O&M	2.00%						$107,227	
		Subtotal							**$5,036,877**	
		Insurance	2.00%						$109,372	
		Subtotal							**$5,137,614**	
		Bonds	1.50%						$83,670	
		Line Item plus Contractor and Gross Cost Markups							**$5,661,643**	
Adjustment for Phased Project (Construction of WQF pump station deferred until construction of WQF).									**-$566,164**	
SPU Cost Estimate Template *Line item entries correspond to SPU estimate template*	**Option 2 PS Unit Price**								**$5,095,479**	SPU Cost Estimating Guidelines
	Allowance for Indeterminates		20.00%						$1,019,096	
	Construction Line Item Pricing								**$6,114,575**	
	Adjustment for Market Conditions		5.00%						$305,729	
	Construction Bid Amount								**$6,420,304**	
	Sales Tax		9.50%						$609,929	
	Construction Contract Amount								**$7,030,232**	
	Crew Construction Costs		5.00%						$351,512	
	Miscellaneous Hard Costs		5.00%						$351,512	
	Construction Cost Total								**$7,733,256**	
	Soft Costs		27.00%						$2,087,979	
	Property Costs								$0	

Base Cost Total		**$9,821,235**
Contingency Reserve	10.00%	$982,123
Management Reserve	10.00%	$982,123
Project Reserves		$1,964,247
Total Cost		**$11,785,482**

Table B-3. Project Cost Calculations									
#	Cost item description	Unit	Unit price	Standalone PS		Standalone WQF		Joint project	
				Option 2	Option 3	WQF Only (Phased w/ Option 2 PS) [a]	WQF + WQF PS (Phased w/ Option 3 PS) [b]	Option 2	Option 3
1	Option 2 PS	LS	$5,214,678	$4,914,678		$300,000			
2	Option 3 PS	LS	$5,661,643		$5,095,479		$566,164		
3	WQF	LS	$6,789,986			$6,789,986	$6,789,986		
4	Joint Option 2 PS: WQF	LS	$11,507,279					$11,507,279	
5	Joint Option 3 PS: WQF	LS	$11,998,872						$11,998,872
6	AFI (standalone PS)	%	20.00%	$982,936	$1,019,096				
7	AFI (standalone WQF and joint projects)	%	0.00%			$0	$0	$0	$0
Construction line item pricing				$5,897,614	$6,114,574	$7,089,986	$7,356,150	$11,507,279	$11,998,872
Adjustment for market conditions				5.00%	5.00%	0.00%	0.00%	0.00%	0.00%
Construction bid amount				$6,192,494	$6,420,303	$7,089,986	$7,356,150	$11,507,279	$11,998,872
Sales tax				9.50%	9.50%	9.50%	9.50%	9.50%	9.50%
Construction contract amount				$6,780,781	$7,030,232	$7,763,535	$8,054,985	$12,600,471	$13,138,765
Crew costs: 5% of construction contract amount				$339,039	$351,512	$388,177	$402,749	$630,024	$656,938
Miscellaneous hard costs: 5% of construction contract amount				$339,039	$351,512	$388,177	$402,749	$630,024	$656,938
Construction cost total				$7,458,859	$7,733,255	$8,539,888	$8,860,483	$13,860,518	$14,452,641
Soft cost %				27.00%	27.00%	49.00%	49.00%	49.00%	49.00%
Soft costs				$2,013,892	$2,087,979	$4,184,545	$4,341,637	$6,791,654	$7,081,794
Property acquisition costs				$0	$0	$0	$0	$0	$0
Base cost total				$9,472,751	$9,821,234	$12,724,433	$13,202,120	$20,652,171	$21,534,436
Contingency reserve %				10.00%	10.00%	35.00%	35.00%	35.00%	35.00%
Contingency reserve				$947,275	$982,123	$4,453,552	$4,620,742	$7,228,260	$7,537,052
Management reserve %				10.00%	10.00%	20.00%	20.00%	20.00%	20.00%
Management reserve				$947,275	$982,123	$2,544,887	$2,640,424	$4,130,434	$4,306,887
Total cost				$11,367,302	$11,785,481	$19,722,872	$20,463,286	$32,010,865	$33,378,375

PS estimates are AACE International Class 3. WQF and Joint project estimates are AACE International Class 5.
a. WQF cost includes installation of WQF influent pumps and upgrade of electrical in PS wet well.
b. WQF cost includes construction of WQF influent pump station.

Table B-4. Cash Flow

Phased option			Spending by year (millions, 2014$)								
			2015	2016	2017	2018	2019	2020	2021	2022	2023
PS	Total cost (millions, 2014 $)		4%	49%	37%	10%	0%	0%	0%	0%	0%
Option 2	$11.37		$0.45	$5.57	$4.21	$1.14	$0.00	$0.00	$0.00	$0.00	$0.00
Option 3	$11.79		$0.47	$5.78	$4.36	$1.18	$0.00	$0.00	$0.00	$0.00	$0.00
WQF	Total cost (millions, 2014 $)		1%	2%	4%	4%	12%	51%	16%	10%	0%
WQF [a]	$19.72		$0.20	$0.39	$0.79	$0.79	$2.37	$10.06	$3.16	$1.97	$0.00
WQF + WQF Pump Station [b]	$20.46		$0.20	$0.41	$0.82	$0.82	$2.46	$10.43	$3.27	$2.05	$0.00
Phased Total	Total cost (millions, 2014 $)		2%	21%	17%	6%	7%	31%	10%	6%	0%
Option 2	$31.09		$0.62	$6.53	$5.29	$1.87	$2.18	$9.64	$3.11	$1.87	$0.00
Option 3	$32.25		$0.65	$6.77	$5.48	$1.94	$2.26	$10.00	$3.23	$1.94	$0.00
Joint option			Spending by year (millions, 2014$)								
			2015	2016	2017	2018	2019	2020	2021	2022	2023
Joint PS/WQF Total	Total cost (millions, 2014 $)		1%	2%	3%	4%	24%	25%	25%	13%	3%
Option 2	$32.01		$0.32	$0.64	$0.96	$1.28	$7.68	$8.00	$8.00	$4.16	$0.96
Option 3	$33.38		$0.33	$0.67	$1.00	$1.34	$8.01	$8.35	$8.35	$4.34	$1.00

PS Estimates are AACE International Class 3 estimates. WQF and Joint project estimates are AACE International Class 5.

a. Includes costs for WQF plus cost for installation of WQF influent pumps and associated electrical in PS wet well.

b. Includes costs for WQF plus cost for construction of WQF influent pump station.

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