Preliminary Engineering Report Amendment for RiverRenew

Prepared for
Virginia Department of Environmental Quality

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RIVERRENEW IS AN INITIATIVE TO ACHIEVE CLEANER, HEALTHIER WATERWAYS IN ALEXANDRIA BY UPGRADING OUR CENTURY-OLD COMBINED SEWER SYSTEM. A NEW NETWORK OF TUNNELS WILL CONNECT TO THE EXISTING SEWER SYSTEM TO PREVENT MILLIONS OF GALLONS OF SEWAGE MIXED WITH RAINWATER FROM REACHING OUR RIVERS AND STREAMS. OUR SHARED GOAL IS TO CREATE A BRIGHTER FUTURE FOR OUR FAMILIES, BUSINESSES, AND WATERWAYS

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Section 1

Summary of Amendment

The RiverRenew Preliminary Engineering Report (PER) approved by the Virginia Department of Environmental Quality (VDEQ) on June 11, 2019 recommended a technically preferred alternative for the RiverRenew facilities to meet the performance requirements established by the 2018 Long Term Control Plan Update (LTCPU). Since the approval of the PER, several concepts associated with the technically preferred alternative have been modified due to the advancement of the design process. To capture these modifications, AlexRenew is submitting an amendment to the approved PER.

Table 1-1 summarizes the amendments to the RiverRenew facilities and the primary driver for each change.

Table 1-1. Summary of Amendments to the Technically Preferred RiverRenew Facilities in the PER

RiverRenew Facility	PER Technically Preferred Alternative	Amended Technically Preferred Alternative	Reason for Modification
Tunnel Dewatering Pumping Station (TDPS)	Submersible pumping station in a single shaft	Drywell/wet well pumping station with a dual shaft configuration	• Operation and maintenance
Wet Weather Pumping Station (WWPS)	Utilize Nutrient Management Facility (NMF) as the WWPS	WWPS is co-located with the TDPS in a Pumping Shaft	• Operation and maintenance • Constructability
Wet Weather Treatment (WWT) Facility	Dual-use Wet Weather Treatment Facility in existing primary settling tanks	Existing UV Disinfection system to be utilized for wet weather treatment	• Operation and maintenance • Constructability

Section 2

Amended Technically Preferred Alternative

The purpose of this section is to summarize the amendments to the recommended technically preferred alternative in the PER.

2.1 Diversion Rates

The hydraulic and hydrologic model (model) was used to determine the peak diversion rates that must be conveyed from the existing combined sewer system into the proposed tunnel system to meet the performance requirements set by the Hunting Creek Total Maximum Daily Limit (TMDL) and the 2018 LTCPU. The peak diversion rates were established using 15-minute rainfall data collected from Ronald Reagan Washington National Airport (DCA). A safety factor of 1.2 was applied to each peak diversion rate established by the model to develop design diversion rates used for the tunnel system. The safety factor was used to account for uncertainties associated with the model. The peak diversion rate and design diversion rate for each of the existing outfalls is provided below in Table 2-1.

Table 2-1. Design Diversion Rates

Existing Outfall	Peak Diversion Rate (MGD)	Safety Factor	Design Diversion Rate (MGD)
001	155	1.2	186
002	100	1.2	120
003	45	1.2	54
004[1]	18	1.2	22

Note: 1. The existing Outfall 004 flows are fully intercepted by the Hooffs Run Interceptor downstream of the diversion chamber near Duke Street.

2.2 Tunnel Dewatering Pumping Station and Wet Weather Pumping Station

2.2.1 Technically Preferred Alternative in the PER

The Tunnel Dewatering Pump Station (TDPS) is to be located in the vicinity of the current location of Building J on the east side of Hooffs Run. The TDPS was a submersible type pump station to receive and pump flows from the 001/2 tunnel (now referred to as the Waterfront Tunnel), and the 003/4 diversion sewer (now referred to as the Hooffs Run Interceptor) to Alexandria Renew Enterprises' (AlexRenew) Water Resource Recovery Facility (WRRF) for full treatment and to the Wet Weather Treatment (WWT) Facility for high rate disinfection. The Wet Weather Pump Station (WWPS) was to be located in the existing Nutrient Management Facility (NMF) on the west side of Hooffs Run. The WWPS was a submersible type pump station to receive and pump flow from the Hooffs Run Interceptor to the TDPS.

For further details regarding the technically preferred alternative for the TDPS and WWPS, refer to Section 4.1.2 in the PER.

2.2.2 Technically Preferred Alternative Challenges

As the design of RiverRenew progressed from the conceptual phase, several challenges associated with construction and operation of the TDPS and WWPS were identified, which are summarized as follows:

- The PER recommended submersible type pumps for the TDPS to minimize the cost and footprint of the TDPS. Submersible pumps must be removed for maintenance, and these pumps are more difficult to remove in deep pump station applications.
- The PER recommended two pipelines (one 72-inch gravity sewer and one 60-inch force main) to be installed from the Hydraulic Grade Line Control Structure (HGL-CS) to the WWPS. Both pipelines were to be installed with trenchless technologies to minimize the impacts of excavating under Dominion Energy's high voltage wires and impacts to numerous other existing utilities. The depth of the pipelines led to unfavorable geotechnical conditions for a microtunneling operation (fill, silt, organics) and the need for ground improvement during construction. There is also limited construction staging areas available to perform the trenchless excavation work making construction more difficult.
- The existing pumps in the NMF currently experience vibrations/harmonics issues. Mitigation of these issues would be required for the installation of any new pumps at this facility.

2.2.3 Amended Technically Preferred Alternative

In order to mitigate the identified challenges, the design of the TDPS was modified to a dry well/wet well style pumping station, and the WWPS was relocated to be installed within the drywell of the new TDPS in a single Pumping Shaft. The amended technically preferred alternative, shown in Figure 2-1 and Figure 2-2, offers several benefits which are summarized below:

- Co-locating the TDPS and WWPS into a single 65-ft inside diameter Pumping Shaft provides a centralized location for all tunnel system pumping facilities.
- Dual-shaft configuration (Pumping Shaft and Screening Shaft) allows for the construction of a Hydraulic Institute (HI) compliant pumping station and trench style wet well, while also maintaining the integrity of the expedited construction schedule. The smaller 35-ft inside diameter Screening Shaft may be constructed first and utilized to launch the tunnel boring machine for construction of the Waterfront Tunnel, to preserve the critical path of the construction schedule.
- Pumps are more easily accessible for operation and maintenance staff.
- Avoidance of a trenchless excavation in unfavorable geotechnical conditions. (New pipelines to the WWPS may be installed via open cut with minimal impacts to utilities.)
- Flow to the Wet Weather Treatment (WWT) Facility would only need to be pumped once.
- Pump vibrations/harmonics will be minimized due to sufficient concrete mass in the shaft.

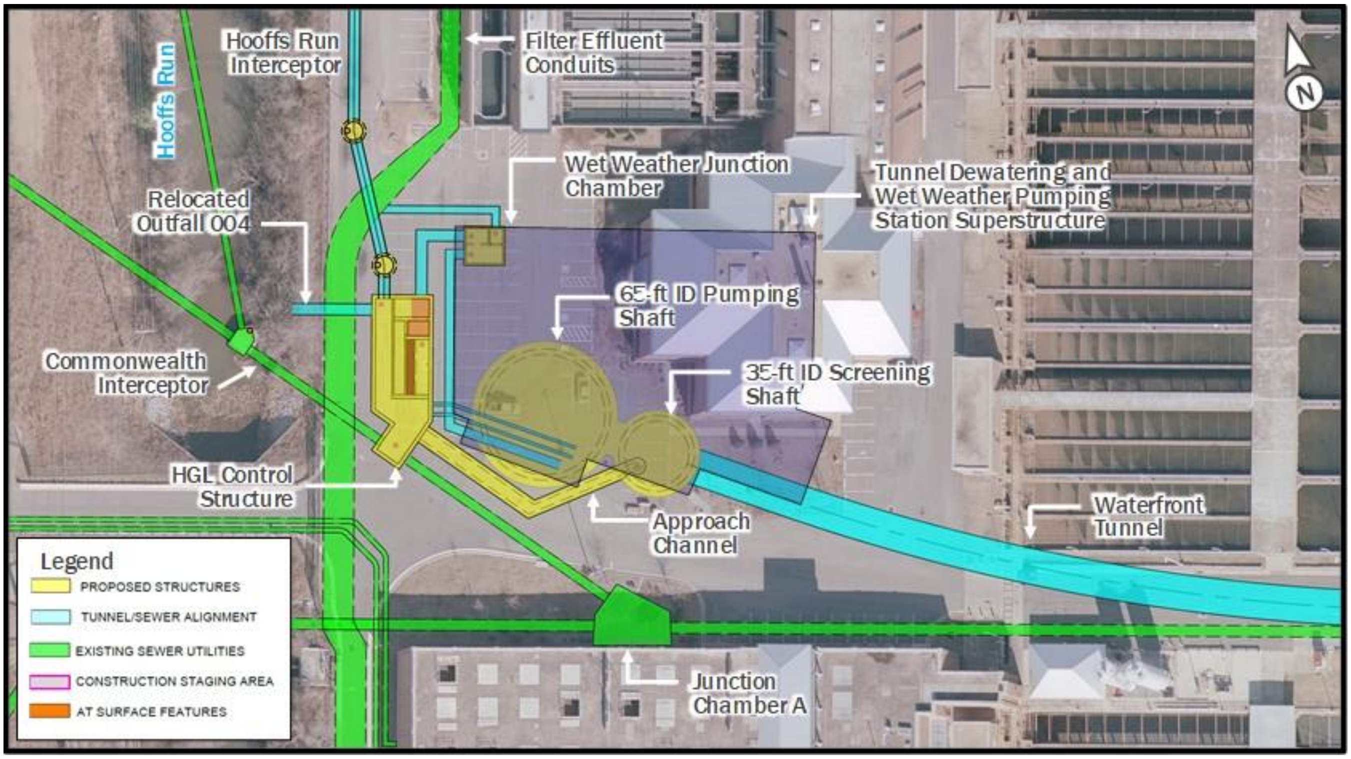

Figure 2-1. Dual-Shaft TDPS and WWPS Configuration

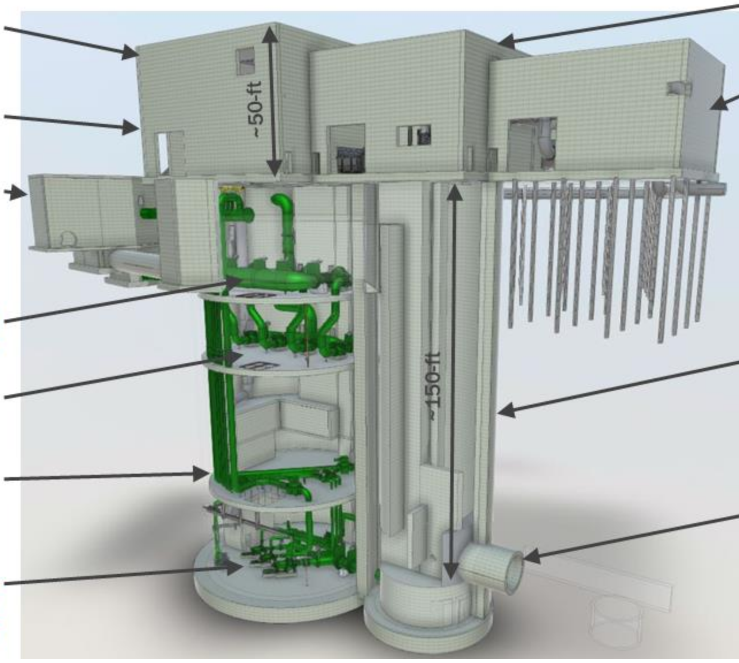

Figure 2-2. TDPS and WWPS 3D View

2.2.4 Design Basis

The basis of design of the shafts, pumps, and screening equipment for the amended technically preferred alternative have been updated and are detailed in the following tables.

Table 2-2. Shaft Requirements

Parameter	Pumping Shaft	Screening Shaft
Inside Diameter	65’	35’
Top Elevation	15’	15’
Invert Elevation	-135’	-135’

Table 2-3. Pump Requirements

Parameter	TDPS		WWPS
	Solids Handling Pumps	Dewatering Pumps	
Pump Type	Dry Pit Submersible	Dry Pit Submersible	Dry Pit Submersible
Quantity	3	2	4
Number of Duty Pumps	1	1	3
Calculated Horsepower	122	466	305
Horsepower for Electrical Service planning (hp)	185	645	385
Static Head, ft	128	128	28
Total Dynamic Head, ft	140	133	46
Flow (Each Pump), mgd	5	20	44
Total Flow, mgd	5	20	130

Table 2-4. Screening Requirements

Parameter	Screen Requirements
Number of Screens	1
Screen Dimensions	30'-0" x 7'-0"
Max Bar Spacing	3-inches
Inclination	90˚ (Vertical)

2.3 Wet Weather Treatment Facility

2.3.1 Technically Preferred Alternative in the PER

The WWT Facility was to be located in the existing Primary Settling Tanks (PSTs) No. 1 and 2 at the WRRF. In typical dry weather operations, the tanks would continue to operate as primary settling tanks. In significant wet weather events, the tanks would operate as a WWT Facility, where combined sewage would be pumped via a 48-inch forcemain from the WWPS to the PSTs and sodium hypochlorite would be dosed for high rate disinfection. For further details regarding the technically preferred alternative for the WWT Facility, refer to Section 4.1.3 in the PER.

2.3.2 Technically Preferred Alternative Challenges

As the design of RiverRenew progressed from the conceptual phase, several challenges associated with construction and operation of the WWT Facility were identified, which are summarized as follows:

- The WWT Facility is only expected to be operated on average, twice per year, for a total of 11 annual operating hours. The infrequent usage of this facility presented multiple operational and maintenance concerns including the following:
    - Startup/conversion of the PSTs to the WWT Facility during a storm event would require the pre-chlorination of the tank contents prior to isolation for WWT. This provides a risk of sending chlorinated primary effluent to the biological reactor basins.
    - Infrequent operation may lead to limited exercise of the equipment and use of chemicals, which degrade over time.
    - More complicated control scheme for operation of the WWT Facility
- The 48-inch forcemain from the WWPS to the WWT would need to navigate multiple existing facilities and utilities, both of which are pile supported.
- Increased hydraulic loading on the PSTs that remain in service while the WWT Facility is in operation (6 tanks at 116 MGD).

2.3.3 Amended Technically Preferred Alternative

In order to mitigate the identified challenges, the design of the WWT Facility was modified to send the combined sewage to the existing WRRF's Ultraviolet (UV) Disinfection System, located in Building N, for wet weather treatment. Currently there are six (6) UV reactors in Building N designed to disinfect up to 115 MGD (19 MGD per reactor) with a minimum UV transmittance value of 65%. The existing system is capable of providing a dose of 50 mJ/cm2. The reactors are dose paced controlled to module the lamp power based on the influent flow and UV Transmittance value. Hydraulic flow through the reactors is controlled utilizing automated downstream weir gates.

The following evaluations were conducted to determine the existing UV Disinfection System's feasibility to provide WWT for an additional 40 MGD of flow:

- Conveyance of flow to the UV Disinfection System: The WWPS would pump a maximum of 130 MGD to the Wet Weather Junction Chamber (WW-JC), which is a new flow splitting structure. In the WW-JC, 40 MGD would be split and discharged to the existing Filter Effluent Conduits, where it would then be conveyed to the UV Disinfection System in Building N. The remaining 90 MGD, would be discharged to Outfalls 001 and 004 to overflow to the Potomac River and Hooffs Run, respectively.
- Hydraulic Capacity Analysis of the existing UV Disinfection System: A hydraulic capacity analysis was conducted to understand if the existing UV reactors could handle the additional flow without creating surcharging and overflow problems in the upstream facilities. With a 10-year flood elevation in Hunting Creek, the hydraulic analysis showed that the existing facilities have the capacity to handle the additional 40 MGD of flow. Therefore, the total flow to the UV reactors would be approximately 148 mgd. The water surface elevation at the UV reactors is controlled using downstream weir gates to minimize the risk of flooding the units and provides greater operational flexibility.
- Disinfection Performance Evaluation: Samples were collected during wet weather events and bench testing was conducted to determine the expected performance of the UV reactors with three types of water quality, including CSO, filter effluent, and filter effluent with CSO. The results from the wet weather event most representative of the conditions when the WWT Facility would be in use are summarized in Table 2-5.

Table 2-5. Summary of UV Testing Results for Combined Sewage

UV Dose (mWs/cm^2)	E. coli / 100 mL for Test Event: 7/8/2019 (1,2)		
	Precipitation: 3.3-inches		
	CSO	Filter Effluent	Filter Effluent with CSO
0	470,000	2,000	290,000
5	59,000	400	58,000
10	2,200	5	8,400
20	740	2	2,400
40	530	4	3,300
80	100	<4	400

(1) Raw combined sewage should have a higher E. coli value than the blended combined sewage and Filter Effluent Sample. Variability is due to TSS in the combined sewage sample.

(2) Samples were received at an elevated temperature and past the 48-hour hold due to delayed shipping flights. E. coli levels may be elevated.

  - It is expected that a dose of 40 mWs/cm^2 may be achieved from the existing UV Disinfection system while operating as the WWT Facility. An approximate 2-log E. coli reduction may be achieved with the mixed combined sewage and filter effluent sample.

The amended technically preferred alternative for the WWT Facility offers several benefits which are summarized as follows:

- Operational requirements of the WWT Facility have been simplified.
- All six UV reactors will be operated at full power, and the downstream weir gates will modulate automatically (in accordance with their current control logic) to prevent the flooding of any equipment.
- Pumped combined sewage may be sent to the existing UV Disinfection System through the Filter Effluent Conduits, which are in close proximity to the TDPS and WWPS, with no major utilities or pile supported facilities to navigate.

Section 3

RiverRenew Operating Conditions

The objective of this section is to describe the operating conditions of the amended technically preferred RiverRenew facilities, which are summarized in Table 3-1 and further detailed in the subsequent sections.

Table 3-1. Summary of Operational Conditions

Operational Condition	Estimated Events per Year	Flow Rates (MGD)		
		Existing System to WRRF	TDPS	WWPS
1. Dry Weather Flow	N/A	0	0	0
2. Typical Wet Weather Flow	40-50	116	20	0
3. Large Wet Weather Flow	6-8	116	0	0
4. Wet Weather Treatment	1-4	116	0	40
5. Transfer Flow to Outfall 001	1-3	116	0	80
6. Discharge from Outfall 004	<1	116	0	130
7. Tunnel Dewatering	60-70	54	20	0
8. Tunnel Cleaning	60-70	54	5	0

3.1.1 Condition 1: Dry Weather Flow

During the Dry Weather mode, shown in Figure 3-1, all flows will be contained within the Hooffs Run Interceptor, which flows through the Hydraulic Grade Line Control Structure (HGL-CS) to the Commonwealth Interceptor. From there, flow eventually reaches the AlexRenew Water Resource Recovery Facility (WRRF) for treatment. No flow is conveyed from the HGL-CS to the TDPS or the WWPS. Normal dry weather flow from the Hooffs Run Interceptor is approximately 30-40 million gallons per day (mgd), resulting in a maximum of 54 mgd at the WRRF Headworks when combined with flows from the Jones Point Trunk Sewer. One 5 mgd solids pump in the Tunnel Dewatering and Wet Weather Pumping Station (TD/WWPS) shall be used to remove any leakage from the Waterfront Tunnel. Leakage flows shall be conveyed to the HGL-CS and combined with flow entering the Commonwealth Interceptor for treatment at the WRRF.

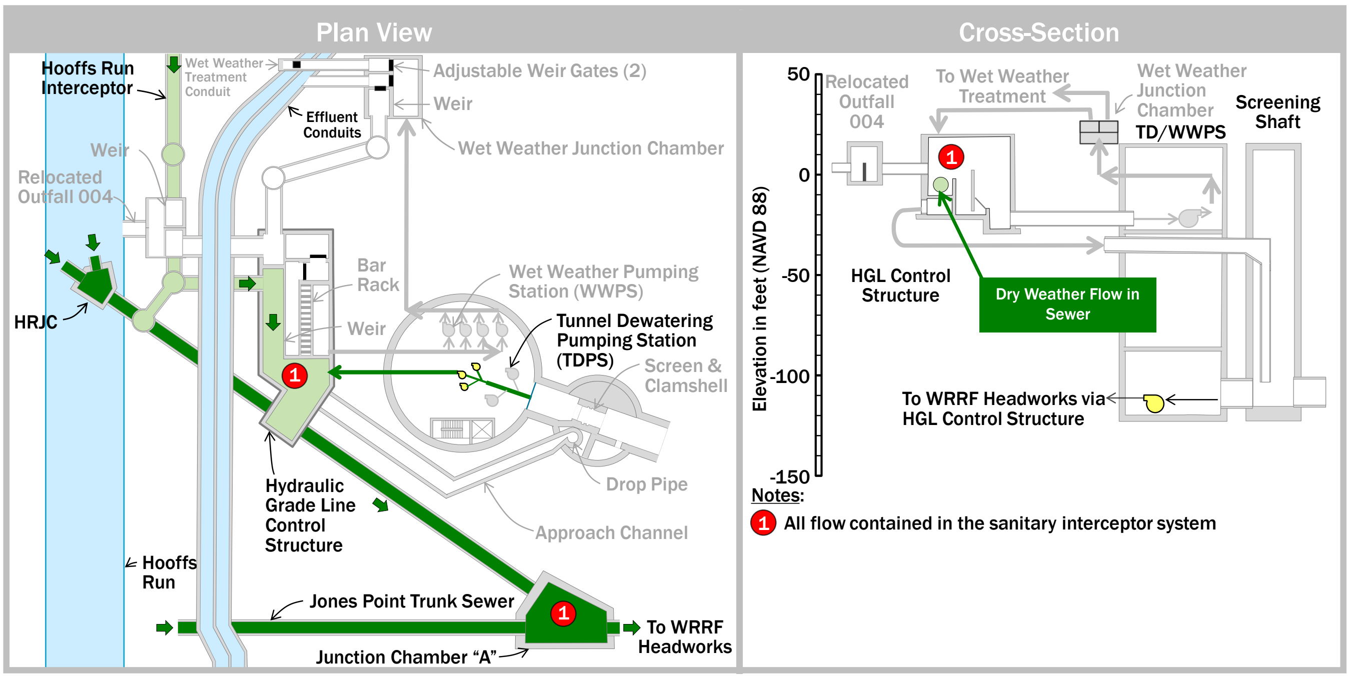

Figure 3-1. Condition 1 - Dry Weather Flow

3.1.2 Condition 2: Typical Wet Weather Flow (40 - 50 times per year)

During a typical small wet weather event, shown in Figure 3-2, which occurs 40-50 times a year, combined dry weather and Outfalls 003/4 flows are contained within the Hooffs Run Interceptor and conveyed to the WRRF for treatment. Flows from Outfalls 001/2 are conveyed via the Waterfront Tunnel to the Screening Shaft. From there, flow is pumped using a combination of solids pumps and a tunnel dewatering pump to the HGL-CS and combines with flow entering the Commonwealth Interceptor to maximize the flow going to the WRRF Headworks. The solids pumps will turn on first to handle the higher debris and grit levels expected in the initial flush. The screen/rake system will be operational during this mode to remove debris entering the Screening Shaft from the Waterfront Tunnel.

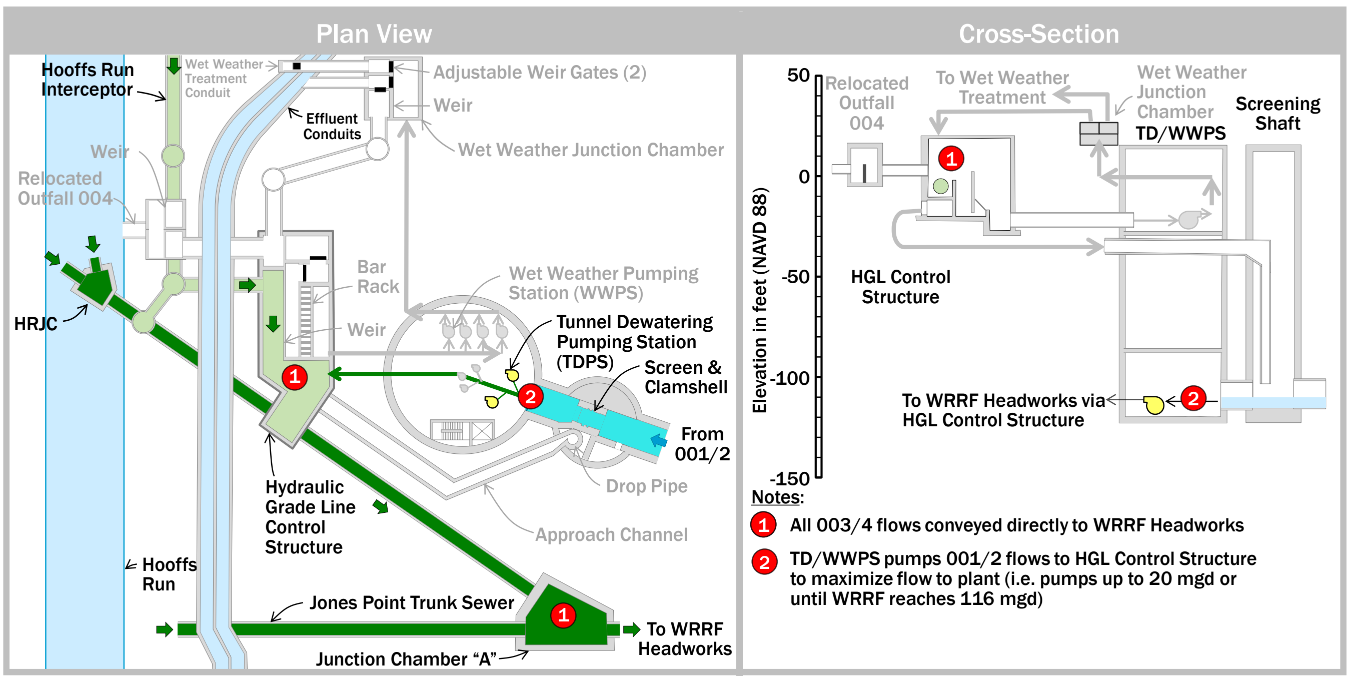

Figure 3-2. Condition 2 - Typical Wet Weather Flow

3.1.3 Condition 3: Large Wet Weather Flow (6 – 8 times per year)

When the WRRF reaches treatment capacity, the tunnel dewatering pumps will turn off, and the tunnel will enter storage mode. No additional flows from the TDPS will be conveyed to the WRRF at this point. Flows from the Hooffs Run Interceptor will overtop a weir at elevation -4 ft in the HGL-CS, flow through two tide gates, and be conveyed to the Screening Shaft for storage via a drop pipe. Flows from Outfalls 003/4 will continue to enter the Screening Shaft for storage via the Waterfront Tunnel. This mode is expected to occur six to eight times a year and is shown in Figure 3-3.

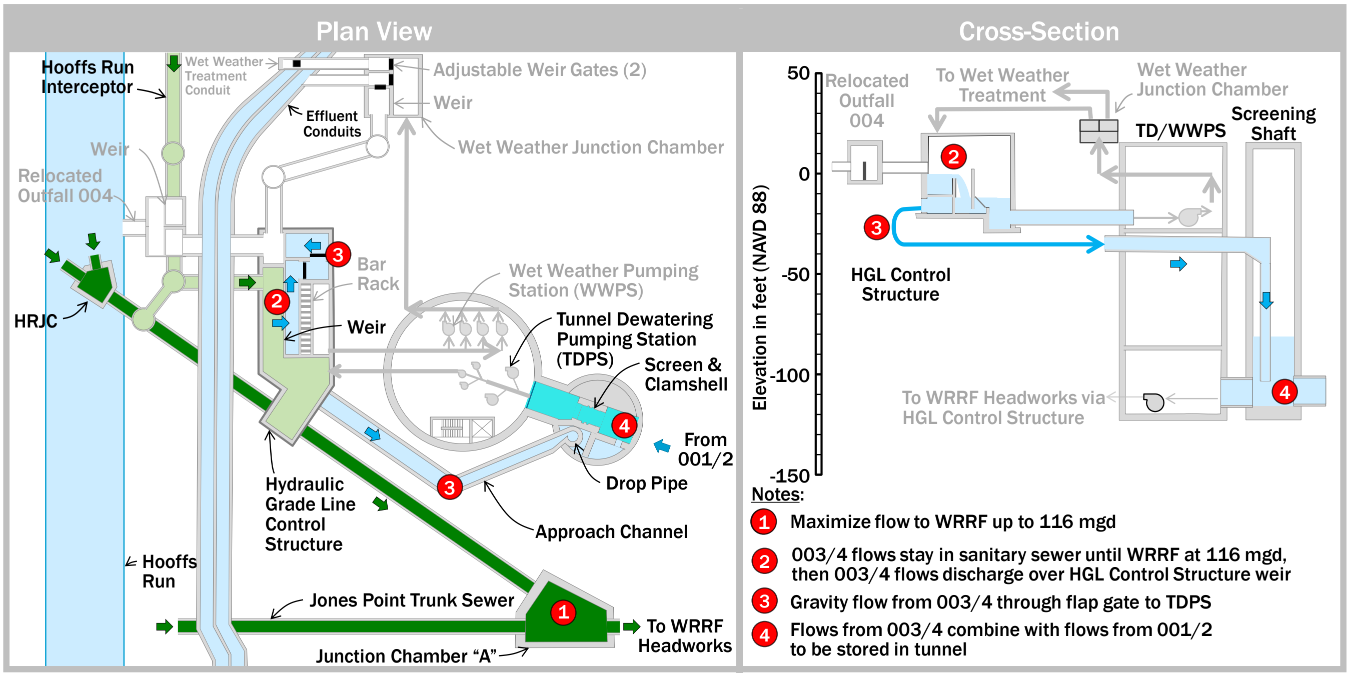

Figure 3-3. Condition 3 – Large Wet Weather Flow

3.1.4 Condition 4: Wet Weather Treatment (1 - 4 times per year)

As the stored water within the Screening Shaft continues to rise, the hydraulic grade line within the shaft eventually reaches high enough to close the tide gates within the HGL-CS and prevent further flow from entering the Screening Shaft. That causes the hydraulic grade line in the HGL-CS to rise and the WWPS will operate to send up to 40 mgd of flow to the WWT Facility via the Wet Weather Junction Chamber (WW-JC). To get to the WWT Facility, flow will pass through a weir gate at elevation +20 ft in the WW-JC. This mode is expected to occur one to four times a year and is shown in Figure 3-4.

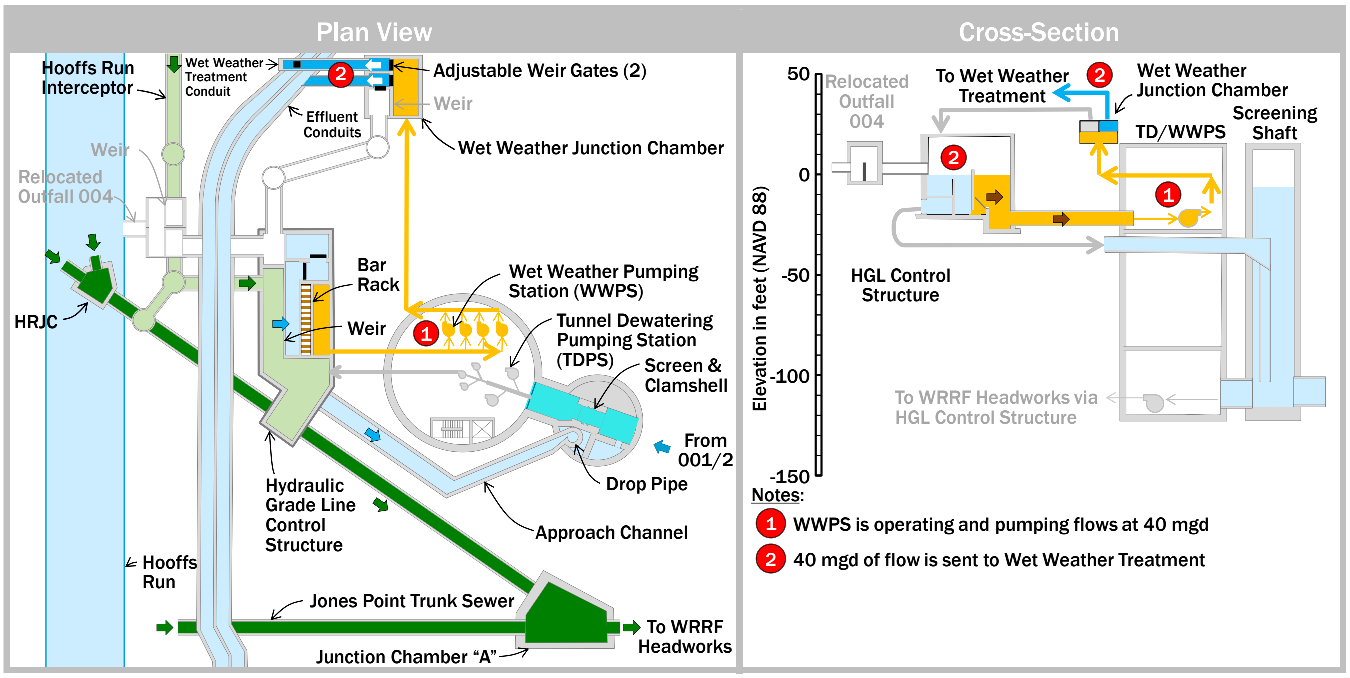

Figure 3-4. Condition 4 - Wet Weather Treatment

3.1.5 Condition 5: Transfer Flow to Outfall 001 (1 – 3 times per year)

Rising level in the HGL-CS causes additional wet weather pumps to turn on, which causes the WW-JC level to rise further. Eventually, flow will overtop a fixed weir at elevation 22.13 in the WW-JC and be sent back to the HGL-CS downstream of the tide gates. From there, flow will be conveyed to the Screening Shaft. The hydraulic grade line in the Screening Shaft will increase and cause a reverse flow in the Waterfront Tunnel and will overflow at Outfall 001. This mode is expected to occur one to three times a year and is shown in Figure 3-5.

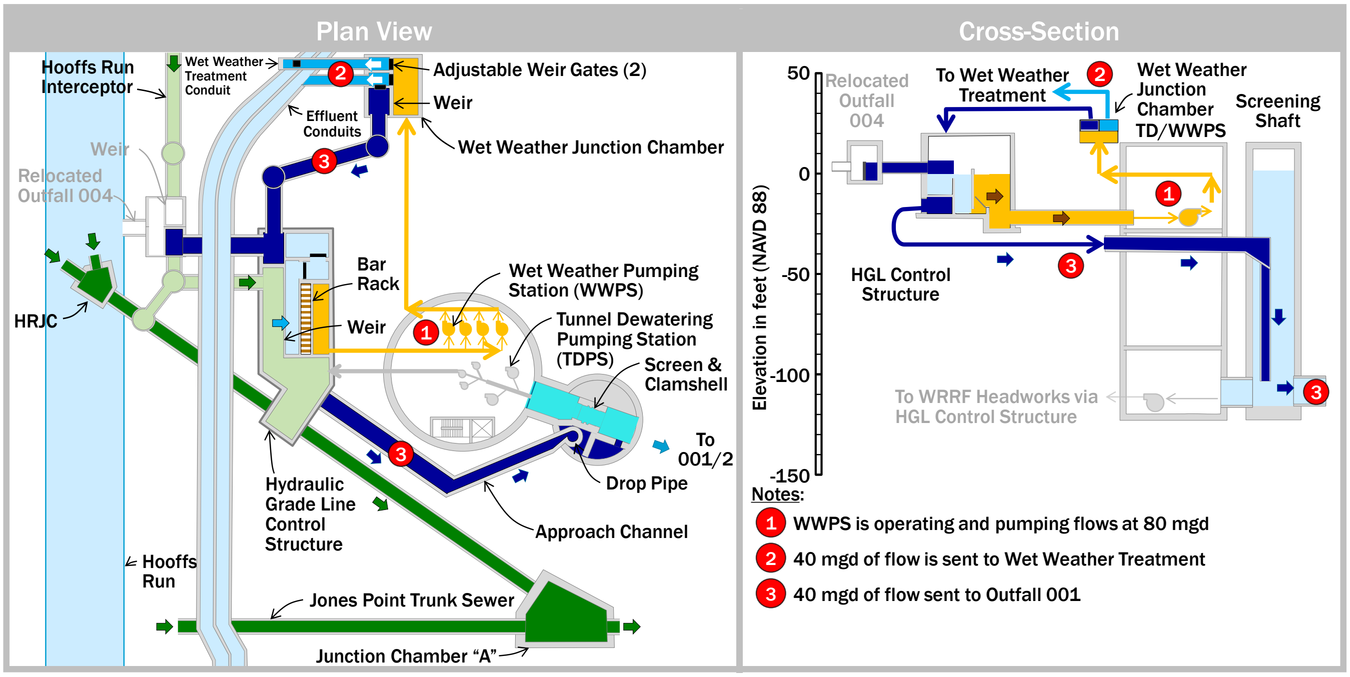

Figure 3-5. Condition 5 – Transfer Flow to Outfall 001

3.1.6 Condition 6: Discharge from Outfall 004 (Less than 1 time per year)

Flows from the WW-JC shall continue to raise the water elevation within the HGL-CS downstream of the tide gates, which will send flow to the relocated Outfall 004 Overflow Structure. When the WWT Facility capacity of 40 mgd has been reached and an additional 40 mgd of flow to Outfall 001 has been reached, flows within the Relocated Outfall 004 Overflow Structure shall overtop the weir at elevation +5.5 ft and overflow at Outfall 004. A maximum of 50 mgd shall be sent out Outfall 004 for a total wet weather pumped flow rate of 130 mgd. This mode is expected to occur less than once a year, and is shown in Figure 3-6.

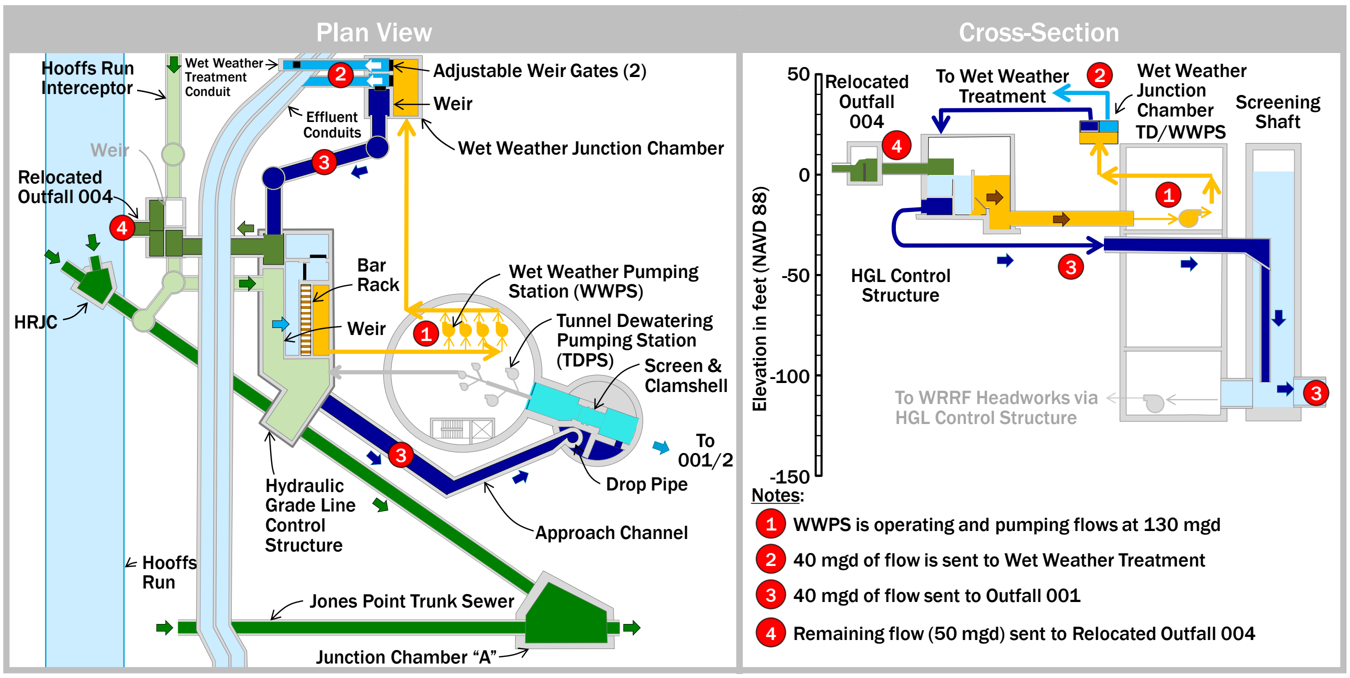

Figure 3-6. Condition 6 – Discharge from Outfall 004

3.1.7 Condition 7: Tunnel Dewatering (60 – 70 times per year)

When the wet weather event has passed the wet weather pumps shall be turned off. Later, when the WRRF has available treatment capacity, the tunnel dewatering pumps shall be used to reduce the water level in the Screening Shaft. The screen/rake system shall operate during active pumping to remove debris on the screen. Once the water level in the screening shaft has been reduced to an adequate level, the tunnel de-watering pumps shall turn off and the solids pumps shall turn on for the final dewatering process.

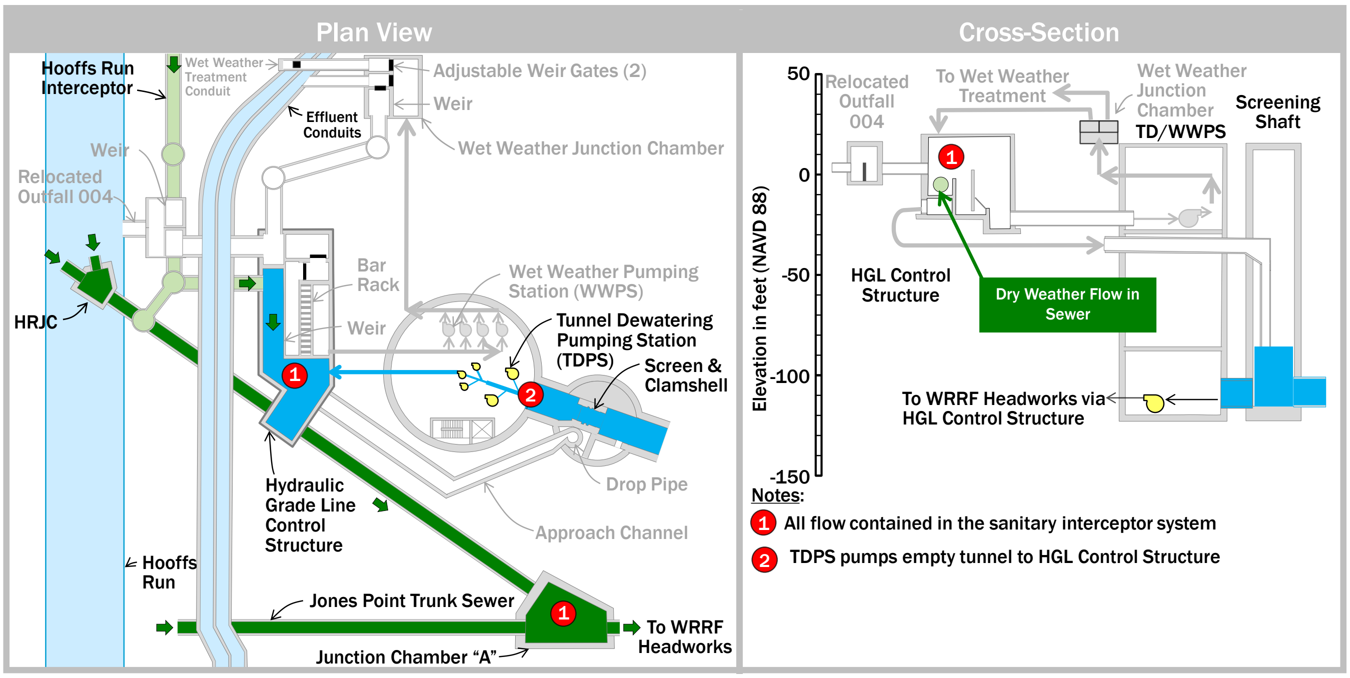

Figure 3-7. Condition 7 – Tunnel Dewatering

3.1.8 Condition 8: Tunnel Cleaning (60 – 70 times per year)

Once the solids pump has been turned off, the tunnel cleaning sequence will commence with an automatic drain of the wet weather pump manifolds (only after large storms), forward and backward flushing of each dewatering and solids handling pump, and filter effluent water will be sent to the Screening Shaft to flush the screen/rake system, Screening Shaft, and pumping system suction and discharge forcemains.

One 5 mgd solids pump shall be used to convey the flushed water to the HGL-CS where it flows by gravity to the WRRF Headworks for treatment. The clamshell bucket shall be operated during the flushing operation to remove grit and other debris accumulated in the debris sump. Manual cleaning of equipment and the sumps will be performed using reclaimed water.

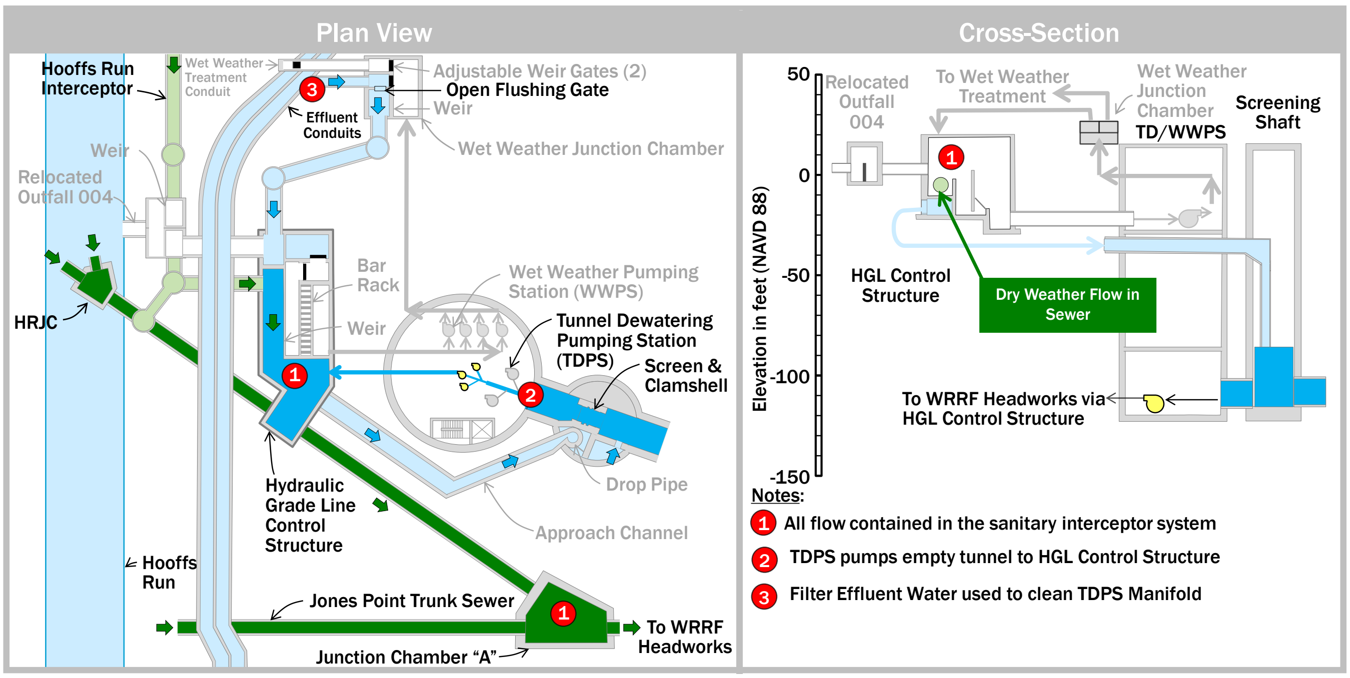

Figure 3-8. Condition 8 – Tunnel Cleaning

Section 4

RiverRenew Costs

This section provides the opinion of probable costs for the technically preferred alternative recommended in the PER and the amended technically preferred alternative for comparison.

4.1 Opinion of Probable Cost Comparison

A comparison of capital costs between the technically preferred alternative recommended in the PER and the amended technically preferred alternative are shown in Table 4-1. Major changes affecting program cost since the issuance of the PER include:

- Modified tunnel dewatering pumping station to a drywell/wet well configuration
- Inclusion of the WWPS in the TDPS Pumping Shaft
- Advanced design and developed further definition for tunnel dewatering pumping station superstructure

Table 4-1. Escalated Capital Cost Comparison of Technically Preferred Alternatives

Major Component	PER Technically Preferred Alternative	Amended Technically Preferred Alternative	% Change from PER
Waterfront Tunnel (001/2)	$ 203 M	$ 215 M	6%
Tunnel Dewatering Pumping Station	$ 81 M	$ 145 M	80%
Hooffs Run Interceptor (003/4)	$ 60 M	$ 72 M	20%
108-116 MGD Expansion	$ 3 M	$ 5 M	63%
Building J Facilities Relocation and Decommissioning	$ 22 M	$ 26 M	19%
Wet Weather Treatment Facility	$ 2 M	Included in Tunnel System Costs	
WRRF Site Security and Access Project		$ 2 M	
Totals	$ 370 M	$ 465 M	25%

Section 5

RiverRenew Schedule

This section provides an updated critical path schedule for the amended technically preferred alternative.

5.1 RiverRenew High-Level Critical Path Schedule

The RiverRenew planning, design and construction activities will be in performed in close coordination with other projects at AlexRenew. AlexRenew will be in various stages of design and construction of the projects as illustrated in Figure 5-1. The amended technically preferred alternative is still on schedule to be constructed by May 2025.

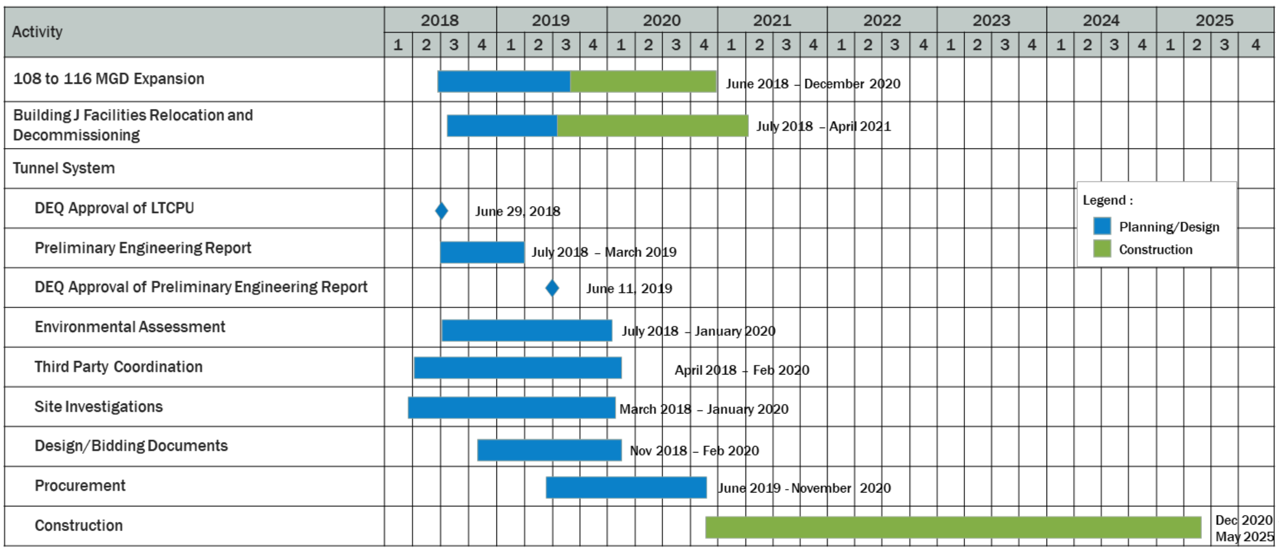

Figure 5-1. Projects Scheduled in Coordination with RiverRenew