CDM Smith

Memorandum

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Subject: *Sunnyvale Primary Treatment Facility*
Peak Flow Handling Review

A recent storm event (December 11, 2104) that occurred during an otherwise dry year in 2014, produced high peak hour flows (PHF) into the treatment plant. The excessive flow is referred to as rainfall dependent inflow and infiltration (RDI/I). As a result of that storm event, Carollo Engineers conducted supplemental engineering analysis regarding the appropriate PHF for the primary project and the overall master plan of the plant (memo dated March 12, 2015). The Sunnyvale Program Management Consultant (PMC) prepared this memorandum which includes consideration of Carollo's input and offers recommendations regarding the selection of PHF design criteria and long-term strategies to manage peak flows at the plant.

Peak Flow Design Criteria

This section offers a summary of the previous engineering and planning work regarding peak design flow estimation, and puts the December 11, 2014 storm in context.

***Previous PHF Planning* -** To date, the plant has been planned for a buildout ADWF of 19.5 mgd and a PHF of 58.5 mgd (2035). The PHF was derived based on the following assumptions:

- A peaking factor (ratio of the PHF to the ADWF) of 3.0 or less, based on the following earlier work:
    - Historical data show the ratio of the PHF to the ADWF to be 2.57 (i.e., peaking factor or PF) [Carollo, Flows and Loads Evaluation, October 2013].
    - SIP recommended use of a 3.0 PF [Carollo, Flows and Loads Evaluation, October 2013].
    - Collection System Master Plan flow and load evaluation recommended a 3.0 PF [IEC, TM4, 11/17/2013].
    - Adjacent similar age collection systems in communities of Palo Alto and San José use PF of 2.9 and 2.7, respectively [Carollo, Flows and Loads Evaluation, October 2013].
- The peaking factor effectively provides for a maximum RDI/I of 39 mgd during periods of high rainfall.

- Prior to the December 11, 2014 storm, the highest RDI/I on record was 19.8 mgd (occurred on December 23, 2012, PHF was 34 mgd) [IEC, TM4, 11/17/2013]. This is approximately 50% of the 10-year design storm used in future flow projections.
- Groundwater infiltration (GWI) was estimated to be 2.2 mgd or less, during peak periods of high groundwater in the Sunnyvale collection system [IEC, TM4, 11/17/2013].

Based on the assumptions listed above, the PMC supports a Plant design PHF of 58.5 mgd for 2035, of which an allowance of 39 mgd for RDI/I remains a reasonable design criterion for long-term planning.

December 11, 2014 Storm in Context **-** The rain storm on December 11, 2014 caused peak flows into the plant which required the use of the APS. The storm resulted in two peak hour events of almost equal size separated by about 12 hours. Key findings about this event relative to the selection of peaking factors for future flow projection are summarized below:

- A precise total influent flow measurement during this storm was not obtained because the flow meter on the APS was non-functional. Carollo Engineers provided engineering analysis of the flow data during this event:
  - The total peak hour flow (PHF) was estimated to be approximately 48 mgd (average of consecutive clock hours) up to 50 mgd (60-minute running average of instantaneous flow data).
  - Of this total, however, the maximum flow conveyed to the headworks engine pumps was estimated to be about 45 mgd and the remainder was conveyed via short-term operation of the APS.
- This storm event occurred during a low flow year in 2014 when the average dry weather flow (ADWF) was only 12.3 mgd, as measured for the calendar year [Carollo, 3/12, 2015].
- For the preceding seven dry days prior to this storm event, the average day flow was 14.1 mgd, and the diurnal peak hour flow was 21.2 mgd [ME Hourly Flow Data file December 4-10, 2014].
- Infiltration was estimated to be minimal because the groundwater and soil were not likely to be saturated prior to the storm due to the on-going regional drought.
- The December 11th storm peaks coincided with the normal diurnal peak flow of 20 mgd [Carollo, 3/12, 2015].
- System surcharge upstream of the plant is known to occur but the actual quantity of storage available in the collection system is not specifically known. (Previous hydraulic and hydrologic modeling studies have not identified this.)
- Operation of the APS draws down stored flows and can drop the HGL below a surcharged condition.
- The ratio of the December 11th PHF to the 2014 ADWF is 45 mgd/12.3 mgd = 3.7 PF. (This ratio is higher than previously assumed PFs.)
- The ratio of the December 11th PHF to the preceding 7-day average daily flow (also a dry period) is 45 mgd/14.1 mgd = 3.2 PF.

- After the second peak during this storm, flows to the plant decreased rapidly signaling that the majority of the peak flow was RDI/I.
- During the peak one-hour of this event, the RDI/I appeared to be about 25 mgd (i.e., 45 mgd total – 20mgd normal diurnal peak = 25 mgd).
- While future RDI/I *could increase* due to collection system aging and/or storm intensity due to climate change, it *could also potentially decrease* due to asset management and redevelopment projects which repair, rehabilitate, and replace sewers and laterals within the service area. These counter-balancing future scenarios support a continued assumption that RDI/I is likely to remain approximately consistent with historic levels (i.e., in the range of 25-32 mgd).

The PMC concludes that the December 11th storm was largely within the range of previous planning level estimates. While the storm PHF/2014 ADWF peaking factor calculation does appear high, the lower 2014 ADWF is viewed as a contributing factor. The PMC recommends continuing with the design criterion of 58.5 mgd PHF, which allows for up to 39 mgd of RDI/I.

Maximum Flows

To date, previous studies have not identified the maximum possible instantaneous hydraulic flow possible into the plant, or how to address an emergency flooding scenario. Brief consideration of the maximum flow into the plant is offered here.

The current influent junction structure design includes connecting the two 48-inch interceptors. With a flooded collection system (e.g., 10 feet of surcharge with HGL up to elevation 97.5, and a maximum flow velocity of 8 fps) these two lines could deliver about 65 mgd each, but the next section of 60-inch diameter pipe limits the total flow to about 100 mgd. While this is significantly more than could be accommodated by the total capacity of the Influent Pump Station (IPS), it would only occur for a relatively short period of time (e.g., less than 1 hour).

The current headworks design criteria from the 30 percent set (Sheet G04) are as shown in Table 1. Table 2 provides a summary of the IPS capacity.

- Initially, if two smaller pumps plus four larger pumps are installed in the IPS as planned and if one large pump is out of service, the firm capacity of the station will be limited to 53 mgd under the current design. The total capacity (all six pumps operating) will be approximately 65 mgd.
- The design assumes that eventually the two smaller pumps will be replaced with similar larger units to meet the projected 2035 build-out peak flow capacity. The firm capacity will increase to 58.5 mgd, and the total station capacity (six pumps operating) will be 70.2 mgd. These capacities are at the design wet well level of EL 87.5.

Table 1. Design Criteria from the 30 Percent Submittal [Carollo, G04, January 2015]

DESIGN CRITERIA	UNITS	VALUE
INFLUENT FLOWS		
START-UP		
MINIMUM	MGD	4.8
AVERAGE DRY WEATHER FLOW (ADWF)	MGD	13.2
AVERAGE ANNUAL FLOW (AAF)	MGD	13.8
MAXIMUM MONTH (MM)	MGD	20.5
PEAK DAY	MGD	31.2
PEAK HOUR FLOW (PHF)	MGD	39.6
BUILD-OUT		
MINIMUM	MGD	7.1
AVERAGE DRY WEATHER FLOW (ADWF)	MGD	19.5
AVERAGE ANNUAL FLOW (AAF)	MGD	20.4
MAXIMUM MONTH (MM)	MGD	26.2
PEAK DAY	MGD	40.0
PEAK HOUR FLOW (PHF)	MGD	58.5
INFLUENT PUMP STATION		
TYPE OF INFLUENT PUMPS	-	DRY-PIT SUBMERSIBLE NON-CLOG
NUMBER OF INLUENT PUMPS (DUTY/STANDBY)	-	6 (5/1)
PUMP CAPACITY		
FOUR LARGE PUMPS, EACH	MGD	11.7
TWO SMALL PUMPS, EACH	MGD	9.0
DRIVE TYPE	-	VFD
DRIVE MOTOR, EACH (LARGE/SMALL)	HP	170/135

Table 2. Influent Pump Station Design Summary

Initial IPS Capacity:		
Firm (largest unit out of service)	MGD	53.1
Total (all pumps)	MGD	64.8
Ultimate IPS Capacity:		
Firm (largest unit out of service)	MGD	58.5
Total (all pumps)	MGD	70.2

The 30-percent design is based on maintaining a wet level of approximately EL 87.5 and pumping up to the grit basin influent channel EL 125. Two pumps are manifold into a single 30-inch discharge. With this design, 80 percent of the pump total discharge head is static lift and independent of flow. The pumping capacity could be substantially increased by letting the wetwell and screen channel level rise and surcharge the interceptors. If all six large pumps (e.g., Flyte 3400 model) are operating and the wetwell was allowed to rise 10 feet above its current control level (e.g., to EL 97.5), the pump station total capacity could increase to approximately 86 mgd. Similarly, with the initial installation of two smaller and four larger pumps, the increased wetwell elevation could increase to approximately 83 mgd with all pumps operating. (Operating under these conditions, the new pump station would convey higher flows than the Plant's current maximum pumping capacity, which is estimated to be 18 mgd each for the three primary pumps, plus 20 mgd for the APS, i.e., total of 74 mgd.)

Of the estimated 100 mgd system maximum flow capacity, therefore, approximately 15 mgd would remain. Under this scenario, approximately 11 feet of freeboard would still remain in the wet well, and the HGL would still be about 10 feet below the average ground surface at the plant. This 10 feet translates to storage capacity in the collection system. However, if the storm event causing the 100 mgd flow is associated with local flooding, it is likely that City staff will be removing manhole covers to help drain the flooded area into the collection system. In this case there will likely be no storage capacity available in the collection system to accommodate the remaining 15 mgd peak.

Alternatives for emergency peak flow management may include the following options.

- **Option 1 – Allow surcharging upstream of the new IPS and control flows into the plant with the IPS pumps.** Proceed to make minor modifications to the planned design which would include designing the new junction structure to be pressurized and sealed, and include sluice gates into the screen structure influent channels. Use these gates to throttle the flow, allowing the HGL to surcharge upstream to take advantage of collection system storage. (The City would need to provide direction about risk tolerance with respect to the design collection system HGL at the acceptable surcharged condition. A pump station system curve should be developed for this scenario. *This approach will likely require a minor change to the current design but this is the time to do it without risk of a more significant delay the headworks and primary project.)*

- **Option 2 – Retain the APS and Utilize the Existing Gravity By-pass Line**. APS could be used to pump a portion of the flood flow as an emergency pump station. A gravity bypass exists from Manhole N that could be retained. This pipeline to the primary effluent could come into play as the collection system nears full surcharge and has the capacity of approximately 10-15 mgd. However, the level in the interceptor would be EL 108 or near the ground surface outside the plant and this pipeline around the existing primary clarifiers conflicts with future secondary clarifier facilities. *The use of this bypass could only be an interim, partial solution to handling peak flows and would not offer sufficient freeboard. Also, the APS structure is in the way and slated for demolition.*

Based on the information available, the PMC recommends the City consider Option 1 listed above. This would allow a flow management strategy that throttles flow at the influent pump station and continues to utilize collection system storage upstream of the plant.

Supporting recommendations are as follows:

1. Maintain the approach of using isolation gates and sealed structures in the IJB and influent manholes.
2. Include level monitoring that would allow Operations to throttle down the isolation gates to limit the flow to the pumps.
3. Develop a control strategy that allows the wet well to rise to increase pumping capacity.
4. Carollo to identify pump make/model options and confirm motor sizes selected for the pumps are non-overloading or pumps under-perform at any place on their pump curves, including operation at extreme conditions (i.e., surcharge wetwell conditions).
5. Evaluate the peak flow handling capacity of the downstream system under the surcharged wetwell pumping scenario, i.e., 86 mgd extreme pumping condition.