CITY OF BEVERLY HILLS

PUBLIC WORKS SERVICES DEPARTMENT

MEMORANDUM

TO: PUBLIC WORKS COMMISSION

FROM: Trish Rhay, Assistant Director, Public Works Services MCT for.

DATE: December 11, 2014

SUBJECT: Beverly Hills Emergency Water System Storage Capacity Evaluation

ATTACHMENTS:
1. TECHNICAL MEMORANDUM NO. 2 - City of Beverly Hills Emergency Storage Evaluation

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At a previous Commission meeting, Psomas was asked to review the City of Beverly Hills' water system capacity. Specifically, the Commission was interested in understanding how the City's system capacity compares to the Metropolitan Water District's (MWD's) recommended emergency storage capacity for water providers in their service area. Harvey Gobas from Psomas will present their findings.

PSOMAS

TECHNICAL MEMORANDUM NO. 2

To: Trish Rhay, Mark Cuneo

From: Mike Swan, PE, Harvey Gobas, PE and Neha Gajjar, PE

Date: December 4, 2014

Subject: City of Beverly Hills Emergency Storage Evaluation

EXECUTIVE SUMMARY

The City of Beverly Hills (CBH) has ten (10) active reservoirs within thirteen (13) pressure zones in its water distribution system. Approximately 90% of the CBH's water supply comes from two (2) connections off of Metropolitan Water District's (MWD) 54-inch diameter supply pipeline, which is typically fed from the Santa Monica feeder and occasionally from the Sepulveda feeder. The remaining 10% of the water supply is from wells pumped from groundwater, which is treated at CBH's reverse osmosis treatment plant.

Water distribution systems rely on stored water to help equalize fluctuations between supply and demand (operational storage), supply sufficient water for firefighting (fire storage) and meet demands during an emergency or an unplanned outage of a major source of supply (emergency storage). In assessing the system's significant reliance on imported water supply and as part of MWD's recommended guidelines to meet seven (7) days of regional storage, during shutdown of their feeders, the City authorized this evaluation to determine the amount of additional storage required to meet a seven (7) day MWD outage.

Total reservoir capacity and system demands were obtained from the City's 2002 Water System Master Plan and the 2010 Urban Water Management Plan, whereas emergency storage capacity was calculated using data from these reports. The following table summarizes the data used in this storage analysis.

Table A
Summary Water System Data

Data	Value
Reservoir	(in MG)
Fire Storage	3.78
Operational Storage	2.76
Emergency Storage	36.46
Total Volume	**43.00**
Demand	
Average Daily Demand (in MGD)	11.2
Maximum Daily Demand (in MGD)	18.4
Groundwater Supply	
Water Treatment Plant (WTP) (MGD)	1.1

Based on the Average Daily Demand (ADD) condition and maintaining operational and fire storage in the reservoirs, the time required to fully deplete the emergency storage (36.46 MG) is approximately 3½ days. This duration represents the amount of time the associated demands can be sustained using only production from the wells/treatment plant and emergency storage. If service is to be maintained beyond this 3½ day period, the system demands must be reduced or an alternative supply source must be employed to maintain service at ADD flows.

To increase system durability, two additional scenarios were considered. The CBH may increase the capacity of the existing WTP to its full output capacity. Based on the 2002 WMP (Page 4-26), the full capacity of the plant is 2.7 MGD. Also, mandatory conservation and thereby a significant reduction in demand may be implemented during such a short-term emergency condition. An estimated reduction of 40% of the ADD was used. Based on the results of these calculations, for the off-peak condition and utilizing emergency storage in the reservoirs, the duration of time available is 7.8 days which could meet and exceed MWD guidelines.

With this evaluation it is evident that though an increase in the WTP capacity contributes to the sustainability of service in the event of an MWD outage, a more significant effect can be achieved by reducing system demand. This could be accomplished by advising residential and business customers within the first day or two of an emergency to curtail irrigation for the duration of the outage.

If the City wishes to provide enough emergency reservoir storage capacity to meet a seven (7) day demand during peak demand periods, while still assuming a 40% reduction in demand due to conservation efforts and a doubling of the current WTP capacity, then consideration should be given to adding another 35 MG in storage to the existing system (i.e., in addition to the City's existing 43 MG in storage capacity).[1]

INTRODUCTION

The CBH supplies its water distribution system primarily from MWD's 54-inch diameter pipeline which is typically fed from the Santa Monica feeder and occasionally from the Sepulveda feeder. This water enters the Central Control Building (CCB) from two adjacent MWD connections (BH-1 and BH-2) with capacities of 40 cubic feet per second (cfs) and 40 cfs; capable of delivering 26 MGD and 26 MGD, respectively. Approximately 90% of the City's water supply comes from this imported, purchased water.

A second supply source is groundwater from the Hollywood Subbasin. The City operates four (4) wells (Nos. 2, 4, 5 and 6) that pump water from the basin to its reverse osmosis WTP facility before it enters the distribution system. Approximately 10% of the City's yearly water supply is groundwater from this source.

The water from these supply sources is transferred via booster pumping stations or pressure reducing valves to ten (10) active reservoirs throughout the water system to distribute to customers. In assessing the City's current storage capacity and as part MWD's guideline to meet

[1] To avoid nitrification issues associated with large storage reservoirs, the 35 MG should be spread over several storage reservoirs.

the City's supply for seven (7) days with the MWD supply eliminated, this technical memorandum evaluates the system's ability to sustain this potential event.

BACKGROUND

Imported Water Supply and Capacity

Table 1 shows the MWD connection capacities at each of the two turnout locations. The total import capacity is 80 cfs (or 52 MGD) at an operating pressure of 154 psi when the source is the Santa Monica feeder. When there is an outage of the Santa Monica feeder, the 54-inch diameter pipeline is supplied by the Sepulveda feeder. However, when this occurs the operating pressure decreases to 85 psi affecting the deliverable zones in the distribution system, requiring CBH to operate pumps to boost water from Zone 4 to Zone 6.

Table 1
Summary of MWD Connection Data

MWD Connection	Capacity (cfs)	Capacity (MGD)	Operating Pressure (psi)	Zones Served
From Santa Monica Feeder				
BH-1	40	26	154	3, 4 and 6
BH-2	40	26	154	3, 4 and 6
From Sepulveda Feeder				
BH-1	40	26	85	3 and 4
BH-2	40	26	85	3 and 4

Groundwater Basin

The Hollywood Basin (Basin) underlies western Los Angeles County and is an un-adjudicated water supply currently managed by the CBH through municipal ordinances. Historically, CBH is one of three water agencies that have pumped groundwater from the Basin. Per the 2010 Urban Water Management Plan (UWMP), the sustainable yield of the Basin was estimated to be about 3,000 acre-feet/year (or 2.7 MGD). Since the basin does not receive artificial recharge, the annual pumping limits are equivalent to the sustainable yield.

Due to elevated concentrations of total dissolved solids, hydrogen sulfide, iron and manganese, the four active wells (Nos. 2, 4, 5 and 6) draw groundwater from the deep aquifer, which is treated in CBH's WTP before it is distributed into the water distribution system. The reverse osmosis treatment process loses approximately 25% of the volume due to the generation of reject water (brine). Therefore, the maximum output capacity of the WTP would be approximately 2.2 MGD. Per discussions with CBH's operations staff, the treatment facilities are currently running at approximately 50% capacity due to limited operational use (5 days a week) and reduced well production from drawdown towards the end of each week. This reduces the inflow of groundwater water supply to approximately 1.1 MGD.

Table 2 shows the total annual production by source from 2005 to 2014.

Table 2
Annual City-Wide Production by Source

Year	Annual Production (acre-feet)[1]		
	Imported from MWD	GW/WTP	Total
2005[2]	11,918	1,281	13,199
2006[2]	12,046	1,142	13,188
2007[2]	12,776	1,357	14,133
2008[2]	12,179	884	13,063
2009[2]	11,801	1,311	13,112
2010	10,473	1,089	11,562
2011	10,249	819	11,068
2012	10,495	944	11,439
2013	11,114	779	11,893
2014	11,632	637	12,269
Average	**11,468**	**1,024**	**12,493**

[1] Annual production is measured by fiscal year (July 1 to June 30)
[2] Source: Total historic purchases and groundwater production from City of Beverly Hills 2010 UWMP (Table 2.1 and Table 2.3). Data for Years 2010 through 2014 were obtained from CBH Summary of Water Production and Consumption spreadsheets.

Water Demand

As noted in Table 2, over the last ten years the average annual water demand fluctuated from a high of 14,133 acre-feet (12.6 MGD) in 2007 to a low of 11,068 acre-feet (9.9 MGD) in 2011 with an average usage of 12,493 acre-feet per year (11.2 MGD). The projected Year 2025 annual water demand is projected to be 11,313 acre-feet (10.1 MGD), based on complying with the City's SBx7-7 target.[2] Though the future demand is approximately 1 MGD less than the average ADD, the higher value of 11.2 MGD is used for the calculations in this memorandum.

To determine the water demands for conditions other than the average daily water use, a peaking factor for the Maximum Daily Demand (MDD) was calculated in the 2002 Water System Master Plan (WMP). The calculations were based on Year 1999's Supervisory Control and Data Acquisition (SCADA) records and yielded a MDD/ADD ratio of 1.64. However, Section 1.4.4 of the 2002 WMP indicates a peaking factor of 2.0 was utilized to provide a more conservative

[2] This 2009 legislative package requires a statewide 20% reduction in urban per capita water use by 2020. It requires that urban water retail suppliers determine baseline water use and set reduction targets according to specified requirements, and requires agricultural water suppliers prepare plans and implement efficient water management practices (definition extracted from the Association of California Water Agencies website).

hydraulic analysis. While this additional level of conservatism may be appropriate for analyzing transmission and distribution system piping sizing, it is deemed to be overly conservative in determining the appropriate amount of emergency storage in the system. Therefore this analysis utilizes the actual measured peaking factor of 1.64 for this emergency storage analysis, resulting in an existing MDD of 18.4 MGD (11.2 x 1.64).

EVALUATION

Available Storage Capacity

Water distribution systems rely on stored water to help equalize fluctuations between supply and demand (operational storage), supply sufficient water for firefighting (fire storage), and meet demands during an emergency or an unplanned outage of a major source of supply (emergency storage). CBH currently has ten (10) active reservoirs with a total nominal storage capacity of 43 MG. The reservoirs include above ground steel tanks and above ground and underground concrete storage tanks.

Table 3 shows the various reservoirs and their capacities.

Table 3
Summary of Reservoir Capacity

Reservoir	Type	Zone Served	Overflow Elevation	Capacity (MG)
7	Steel A/G[1]	15	1502	1.5
6	Steel A/G	13	1292	1.0
5	Steel A/G	11	1052	1.0
4B	Steel A/G	8	800	1.0
4A	Conc A/G	8	800	2.2
Greystone	Conc U/G[2]	6	628	19.4
3A	Steel A/G	6	628	0.81
Woodland	Conc A/G	4	454	1.71
Coldwater	Conc U/G	4	454	8.3
Sunset	Conc U/G	3	384	6.0
Total Capacity				**42.92**
Total Capacity (Rounded)				**43**

[1] A/G – Above Ground
[2] U/G – Under Ground

Storage Requirements

The 2002 WMP calculated the storage availability in each reservoir and then assessed the volume of emergency storage for the system by grouping the reservoirs into regions. Each region was then evaluated for emergency storage. However, this method is conservative in that it does not consider the ability of a storage reservoir in upper pressure zones to supply water resources to the lower pressure zones in the system.

For this analysis, the emergency storage volume is calculated by assessing the maximum fire flow volumes required to supply each pressure zone and then determining the required operational volume of the system. These volumes are then subtracted from the total volume of the reservoirs to estimate the emergency storage availability.

Evaluating the hydraulic profile of the CBH's system, it was determined that maintaining fire volume in four (4) reservoirs (3A, 7, Coldwater and Greystone) could serve the fire flow demands of any of the 13 pressure zones with the use of booster pumping stations and pressure reducing valves. Reservoirs 3A and 7 must have a fire volume of 0.24 MG to supply the maximum fire flow demands of Zone 9 and Zones 11/13/15/16, respectively. Coldwater reservoir must have a minimum fire volume of 1.5 MG to supply Zones 8 or WH3. Greystone reservoir must have a minimum fire volume of 1.65 MG to supply Zones 3, 4, 5 or WH 5.

Based on the 2002 WMP, the operational storage volume was calculated to be 15% of the MDD. However, Section 4.9.1 of the 2002 WMP indicates a more conservative allowance of 30% was used to account for the operational mode used at the Greystone and hillside reservoirs (4A, 4B, 5, 6 and 7) to mitigate nitrification. While this additional level of conservatism may be appropriate for analyzing the system for the long term, it may be too conservative to determine the appropriate amount of storage in the system during a short term emergency condition where nitrification is not expected to be a major concern. Therefore we have utilized the actual measured value of 15% of MDD to calculate the operational storage volume of 2.76 MG (0.15 x 18.4[3]). Table 4 on the next page, summarizes the fire and operational volumes and shows the resulting emergency storage volume of 36.5 MG.

[3] 18.4 MGD is the calculated MDD from the Water Demand Section of this TM

Table 4
Existing System Water Storage Requirements

	Fire Volume (MG)	Operational Volume (MG)	Total Volume (MG)	Available Emergency Volume (MG)*
Reservoirs				
Reservoir 3A	0.24			
Reservoir 7	0.24			
Coldwater Reservoir	1.65			
Greystone Reservoir	1.65			
Total System	**3.78**	**2.76**	**43**	**36.46**
Total System (Rounded)				**36.5**

* Available Emergency Volume = Total System Volume – (Operation Volume + Fire Volume)

ANALYSIS AND CONCLUSIONS

To determine the CBH's ability to meet MWD's guideline to maintain service during a projected seven (7) day outage, various potential scenarios were reviewed. The first scenario is if the event occurs during the average or off-peak demand periods (typically October through March). In this condition, the ADD was evaluated utilizing the availability of only emergency storage in the reservoirs. The second scenario evaluated was with the outage event occurring during the peak demand periods (typically April through September) where the MDD was used.

With MWD supplies unavailable during this period of time, the CBH's wells will be able to provide some of the required water supply. In this analysis, the groundwater treatment plant output of 1.1 MGD was used. The results of these calculations are shown in Table 5.

Table 5
Analysis Results for Emergency Scenarios 1 & 2

Scenario	Demand (MGD)	Available Supply from WTP (MGD)[1]	Emergency Storage Volume (MG)	Duration of Emergency Storage Available (Days)
1	ADD			
Off-Peak Months	11.2	1.1	36.5	3.6
2	MDD			
Peak Months	18.4	1.1	36.5	2.1

[1] Assumes 24/7 operation of the WTP; the plant is currently only being operated five days per week, therefore 1.1 MGD would not be available on days when the plant is not operational.

As seen in Table 5, the maximum amount of time available is approximately 3-1/2 days in the off-peak condition utilizing emergency storage in the reservoirs. This duration represents the

amount of time that the associated demands can be sustained using emergency storage and production from the wells. Prior to the end of this period, the system demands must be reduced or an alternative supply source must be employed to maintain service.

To increase system durability, three additional scenarios were considered. The first (Scenario 3A) is if the ADD was reduced by 40%. In this condition, the maximum duration of emergency storage available is a little over 6 days, which is reduced to almost 4 days if we use MDD and reduce it similarly by 40% (Scenario 4A).

The next set of scenarios (Scenario 3B and 4B) considers this demand reduction but also an increase in the capacity of the existing WTP to its full capacity of 2.2 MGD.[4] This condition resulted in meeting a little over 7½ days of emergency storage for average months, but during peak months we were only able to provide about 4 days of emergency storage.

The last set of scenarios (Scenario 3C and 4C), evaluates the conditions with the WTP capacity increased to 2.2 MGD, but with demands remain unchanged (no reduction based on communication to customers to curtail irrigation uses). These results yielded the shortest duration of emergency storage, 4 days for ADD and 2 days for MDD. Table 6 denotes the results of these additional analyses using 60% of ADD and 60% of MDD (or a demand reduction of 40 percent) based on early and effective communication with customers (A&B Scenarios) and with no reduction of ADD and MDD (C Scenarios).

Table 6
Analysis Results for Emergency Scenarios 3 & 4

Scenario	Demand (MGD)	Available Supply from WTP (MGD)	Emergency Storage Volume (MG)	Duration of Emergency Storage Available (Days)
3A	60% ADD			
Off-Peak Months	6.9	1.1	36.5	6.3
3B	60% ADD			
Off-Peak Months	6.9	2.2	36.5	7.8
3C	ADD			
Off-Peak Months	11.2	2.2	36.5	4.0
4A	60% MDD			
Peak Months	11.0	1.1	36.5	3.7
4B	60% MDD			
Peak Months	11.0	2.2	36.5	4.1
4C	MDD			
Peak Months	18.4	2.2	36.5	2.3

[4] The City has retained two other consultants (GHD and Hazen & Sawyer) to study feasibility and costs associated with increasing existing plant production from 1.1 MGD to full design capacity. This TM assumes it will be feasible to increase the WTP capacity to 2.2 MGD, but we defer to the other consultants for a final decision on that matter.

Based on the results of these calculations, it is evident that though an increase in the WTP capacity to full capacity contributes to the sustainability of the required regional storage, the most significant effect is to reduce the demand during such an outage by conducting a swift, effective communication campaign to curtail irrigation uses and other non-essential water uses.

RECOMMENDATIONS

CBH can effectively meet MWD's recommended guideline of providing seven (7) days of emergency storage during off-peak periods. However, assuming an outage occurs during peak periods, and demands during that period can be reduced through an effective public relations campaign to conserve water, CBH can only meet demands for approximately 3.7 to 4.1 days (with the latter figure assuming a doubling of the existing groundwater treatment plant capacity). If the City wishes to provide enough emergency storage to meet a seven day demand during peak demand periods, assuming a 40% reduction in demand due to conservation efforts and a doubling of the current WTP capacity, then consideration should be given to adding another 35 MG in storage to the existing system.