CHAPTER 10
Water System Operations Strategies (Contiguous Service Area)

Over the last several years the City has invested significantly in new water system infrastructure projects, such as the North Tank and Pump Station, the West Tank and Pump Station, the Tier 1 and Tier 2 Downstream Improvements from the MID transmission mains, and several large diameter transmission mains, among other projects. These capital improvement projects provide City Operations staff with increased flexibility to conjunctively meet the varying demands of the City’s customers. However, during this same time period, due to extended drought conditions and unprecedented mandates from the SWRCB to reduce per capita water use, the City’s water use has plummeted, particularly during the winter (low demand) period.

Traditionally, due to operational constraints (as reported by MID Staff), MID has not been able to provide the City with treated water supplies of less than about 11.5 mgd, and MID’s preference is to provide a constant minimum supply at a pressure of approximately 60 psi. Given this minimum winter-time supply from MID, and the number of City wells that must continue to operate for water quality reasons, and to meet local system pressure needs, it would be informative to use the City’s calibrated and verified water system hydraulic model to evaluate existing winter and summer demand conditions to better understand the operational challenges, and evaluate potential operational strategies.

This Chapter provides a description of the operational challenges that the City Operations staff are facing, and describes potential operational strategies to provide guidance to City Operations staff on how the new capital improvement projects can be better integrated into the City’s operational strategies to ensure the reliable distribution and use of available water supplies within the City’s contiguous water service area.

10.1 BACKGROUND

As described in Chapter 4 Existing Water Supply, prior to 1995, the City relied exclusively on groundwater supplies to meet demands and the City’s water distribution system was primarily designed to locally distribute water from each well to surrounding customers (i.e., the water system consisted of smaller diameter, looped distribution pipelines with no need for larger diameter transmission pipelines to convey water from one region of the system to another).

In January 1995, Phase One of the MRWTP became operational, and the City began receiving an annual average of 30 mgd (33,600 af/yr) of treated surface water from MID. In early 2016, the MRWTP Phase Two Expansion was completed, which will ultimately provide the City with up to an additional 30 mgd of treated surface water supply, for a total annual average supply of up to 60 mgd (67,200 af/yr). As discussed in Chapter 4 Existing Water Supply, treated surface water produced at the MRWTP is used in the City’s North Modesto, Salida and Empire service areas, and is supplemented with groundwater.

Treated surface water from the MRWTP is delivered to the City via MID’s Terminal Reservoir facilities (a pump station and two 5 MG storage tanks located on the east side of the City) and 20 to 25 active turnouts constructed as part of the City’s Tier 1 and Tier 2 Downstream Improvements that have the ability to control water supplied from the MID transmission mains at various points within the City’s water distribution system (see Figure 2-3 in Chapter 2). These turnouts are currently being operated in the fully open position without flow or pressure control.
10.2 WATER SYSTEM CAPITAL IMPROVEMENT PROJECTS

With the introduction of treated surface water supplies, the City needed to make several “downstream” improvements to allow for the transmission and distribution of treated surface water supplies throughout the City’s entire contiguous service area. Recommended improvements which have been completed, or are in progress, include the following:

- Three new storage tanks and associated pump stations;
  - North Tank (Tank 11)
  - West Tank (Tank 12)
  - Industrial Tank (Tank 13)
- Control valves and meters at the MID turnouts; and
- New City water transmission mains along major corridors within the City.

These new facilities were intended to assist the City in better integrating and delivering treated surface water throughout the City’s North Modesto service area to meet required minimum pressures and flows under existing and future buildout demand conditions. The recommended improvements are described in more detail below.

10.2.1 New Storage Tanks

Three new storage tanks were recommended as part of the City’s downstream improvements. They are summarized as follows:

- North Tank (Tank 11)
  - Capacity: 6 MG
  - Status: Constructed, going through operational “shakedown,” expected to be online by April 2017.
  - Purpose/Benefits: The northwestern portion of the City has been predominantly served by wells, and groundwater quality issues have resulted in the loss of groundwater production capacity and low system pressures in localized areas. The installation of a storage tank in this area will help mitigate these low pressures and provide City Operations staff with increased flexibility to meet existing and future demands if additional wells must be taken out of service due to water quality issues, and/or to meet new customer demand that are predicted to come online along the northern boundary of the City’s existing sphere of influence.
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- West Tank (Tank 12)
  - Capacity: 4 MG
  - Status: Completed and operational
  - Purpose/Benefits: The City re-dedicated Tank 6 and the associated pump station for the exclusive use in meeting the demands in the South Modesto service area. The West Tank was constructed to replace Tank 6 and help maintain pressures in this part of the North Modesto service area which has traditionally experienced low pressure issues.

- Industrial Tank (Tank 13)
  - Capacity: 4 MG
  - Status: Construction beginning March 2017, expected completion in Fall 2018
  - Purpose/Benefits: There are currently several wells in the southeast portion of the City available to help maintain system pressures during high demand periods. However, with the large demands in the area, and the continued loss of groundwater production capacity due to groundwater degradation, the addition of a tank would improve system reliability and pressures.

10.2.2 Control Valves and Meters at the MID Turnouts

When Phase One of the MRWTP was completed in 1994, it included MID transmission mains with numerous turnouts into either the Del Este or City water distribution system. Each turnout was to be equipped with a butterfly valve, flow control valve, and meter. However, these flow control valves and meters were only installed on the Del Este turnouts, and when the City acquired the Del Este system, the former Del Este flow control valves and meters were removed because of maintenance issues. Thus, each turnout was only equipped with a butterfly valve, which did not allow for flow or pressure to be regulated to the degree necessary to control a hydraulic system of the City’s complexity.

Subsequently, the City has completed the Tier 1 and Tier 2 Downstream Improvements Program, to install control valves and meters on the MID turnouts. Within the contiguous service area, there are currently 14 active turnouts that were constructed as part of the Tier 1 Downstream Improvements (completed in early 2008), and an additional 11 turnouts that were recently constructed (as of late 2015/early 2016) as part of the Tier 2 Downstream Improvements. These turnouts now have the ability to control the surface water supply from the MRWTP via MID transmission mains at various points within the City’s water distribution system. Each turnout is equipped with a hydraulically-operated control valve, which can be operated to maintain a predetermined set point pressure or flow. However, these control valves are currently operating in the fully open position.

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1 Since 1994, the City has purchased the Del Este Water Company and integrated that system into the City’s contiguous water system.
10.2.3 Water Transmission Mains

The City generally has a well-looped network of 8- and 10-inch diameter water distribution pipelines, which was adequate for a water system built solely on distributing groundwater supply (i.e., groundwater wells). However, as the City continues to utilize more treated surface water, particularly with the recent completion of the MRWTP Phase Two Expansion, a minimum 16-inch diameter transmission system, and 12-inch diameter distribution grid is recommended to provide enhanced system operational flexibility and redundancy, and to better integrate, distribute, and conjunctively use available treated surface water and groundwater supplies. To improve the distribution of treated surface water supplies within the City’s water system, water transmission mains along the Virginia Corridor, Orangeburg Avenue and portions of the Yosemite Boulevard were constructed by the City as part of the downstream improvements.

As described in Chapters 8 and 9, additional recommendations have been made in this WMP to further enhance the City’s transmission grid. These recommendations are further described in Chapter 11 Recommended Capital Improvement Program.

10.3 CURRENT OPERATIONAL CHALLENGES

Per our discussions with City Operations staff, their efforts to optimize system operations and efficiently turnover tank storage are made more challenging by the large constant supply being provided to the City from MID via the Terminal Reservoir and pump station which is set at a constant supply pressure of about 60 psi. This rather large percentage of supply being provided by MID, coupled with the City’s low existing winter demands, makes local operations difficult, especially given the number of wells that must continue to be operated due to water quality and treatment facility operational issues, and current pressure cluster settings.

There is also the desire to optimize system operations during the upcoming high demand summer period (summer of 2017), particularly with respect to which wells should be operating and which should be off, and how the control valves on the MID transmission mains should be operated and integrated into the City’s operational strategies.

10.4 POTENTIAL OPERATIONAL STRATEGIES

As part of this WMP, a number of operational scenarios have been identified for evaluation. These analyses will help develop and define strategies to provide guidance to City Operations staff for how the new capital improvement projects can be better integrated into the City’s operational strategies to ensure the reliable distribution and use of available water supplies within the City’s contiguous service area.

Table 10-1 provides a summary of the potential winter and summer operational scenarios which have been identified for evaluation.
Table 10-1. Potential Winter and Summer Operational Scenarios

<table>
<thead>
<tr>
<th>Scenario</th>
<th>MID Pressure/Supply at Terminal Reservoir</th>
<th>Other Operational Variables</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter Demand Conditions (based on December 2015 Demand)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>60 psi</td>
<td></td>
<td>“Baseline Winter Condition”</td>
</tr>
<tr>
<td>2A</td>
<td>55 psi</td>
<td></td>
<td>Alternative “Baseline Winter Condition” with reduced flows from MID to provide increased system operational flexibility</td>
</tr>
<tr>
<td>2B</td>
<td>55 psi</td>
<td>Reduced City Well Pressure Cluster Settings --and-- “Time of Use” Operational Strategy for West Tank and North Tank</td>
<td>Same as Scenario 2A, but with additional operational adjustments to help balance use of available supplies and promote “turnover” of water stored in the City’s tanks</td>
</tr>
<tr>
<td>3</td>
<td>60 psi</td>
<td>Use of Control Valves at MID Turnouts</td>
<td>Same as Scenario 1, but with additional control of pressure/flow from MID turnouts to regulate supply of treated surface water in various parts of the City’s contiguous water system</td>
</tr>
<tr>
<td>Summer Demand Conditions (based on July 2013 Demand)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>60 psi</td>
<td></td>
<td>“Baseline Summer Condition”</td>
</tr>
<tr>
<td>5A</td>
<td>65 psi</td>
<td></td>
<td>Alternative “Baseline Summer Condition” with increased flows from MID to provide increased system operational flexibility</td>
</tr>
<tr>
<td>5B</td>
<td>65 psi</td>
<td>Reduced City Well Pressure Cluster Settings --and-- “Time of Use” Operational Strategy for West Tank and North Tank</td>
<td>Same as Scenario 5A, but with additional operational adjustments to help balance use of available supplies and promote “turnover” of water stored in the City’s tanks</td>
</tr>
<tr>
<td>6</td>
<td>60 psi</td>
<td>Use of Control Valves at MID Turnouts</td>
<td>Same as Scenario 4, but with additional control of pressure/flow from MID turnouts to regulate supply of treated surface water in various parts of the City’s contiguous water system</td>
</tr>
</tbody>
</table>

Based on the level of effort authorized by the City for this task of the WMP, only Scenarios 1 and 2A (the “Baseline Winter Condition” and the alternative “Baseline Winter Condition”) and Scenario 4 (the “Baseline Summer Condition”) have been evaluated as part of this WMP and are described below. The other operational scenarios, and/or combinations of operational scenarios, are mentioned below, but will be addressed in subsequent, separate evaluations as requested and authorized by the City.
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10.4.1 Scenario 1: Winter Demand Conditions - MID Providing a Constant Pressure/Supply of 60 psi – Baseline Winter Condition

10.4.1.1 Scenario Description

Under this scenario, MID will continue to deliver a constant supply of treated surface water into the City’s existing water system infrastructure at a pressure of approximately 60 psi at MID’s Terminal Reservoir under winter demand conditions. This scenario is intended to establish a “baseline winter condition”, under which City Operations staff currently operate to:

- Meet the needs of existing City customers,
- Try to prevent storage in their tanks from losing too much residual, and
- Continue to operate wells to meet localized demands and treatment requirements.

This scenario was verified as part of the hydraulic model verification (i.e., the 12/15/2015 verification day) as described in Chapter 7.

10.4.1.2 Findings, Conclusions and Recommendations

The baseline winter demand scenario was evaluated in the hydraulic model with identical operating parameters observed on 12/15/2015, which are summarized in Table 10-2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Operating Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Contiguous Service Area Demand</td>
<td>• Average Demand = 27.8 mgd; • Peak Demand = 34.1 mgd</td>
<td>• Demands calculated based on SCADA data on 12/15/2015</td>
</tr>
<tr>
<td>MID Terminal Reservoir</td>
<td>• Discharge Pressure ~ 60 psi • Average Supply ~ 13 mgd</td>
<td>• Operating in flow-through-mode, no bypass</td>
</tr>
<tr>
<td>MID Turnouts</td>
<td>• Turnouts were assumed to be operating wide open, without pressure or flow control</td>
<td>• Tier 2 Turnouts assumed to be on-line and open</td>
</tr>
<tr>
<td>Tanks and Booster Pump Stations</td>
<td>• Tank 7 was out of service • Tank 12 did not operate • Tank 3 operated from midnight to 1:30 AM • The remaining tanks operated throughout the day</td>
<td>• Tanks that operated throughout the entire day pumped while filling</td>
</tr>
<tr>
<td>Groundwater wells</td>
<td>• Provided ~14.5 mgd of supply</td>
<td>• 36 wells operated at some point throughout the day, depending on diurnal demand, with 9 wells operating continuously</td>
</tr>
</tbody>
</table>

(a) Based on City’s operating data from 12/15/2015, provided to West Yost by the City.
Figure 10-1 summarizes average system pressures throughout the contiguous service area with the operating conditions described in Table 10-2. As shown on Figure 10-1, the majority of the system operates at system pressures ranging from 60 to 70 psi. The western extreme of the City operates at higher pressures (i.e., greater than 75 psi) and the eastern extreme of the system operates at relatively lower pressures (i.e., 55 to 60 psi), consistent with the topography of the City’s contiguous service area. It is interesting to note that there is an elevation change of approximately 42 feet mean sea level (msl) from the MID Terminal Reservoir to West Tank (or an 18 psi increase).

During this evaluation, MID Terminal Reservoir supplies about half of the system demands, while the City’s wells make up the difference. The majority of the wells that operate during this scenario are located in the eastern portion of the system. Wells throughout the system are grouped and controlled by a pressure cluster scheme. Each pressure cluster has a corresponding pressure point, and wells turn on as needed to maintain the pressure point at its associated set point. As discussed above, pressures in the eastern portion of the system are lower due to higher elevations; therefore, wells within the eastern portion of the system will turn on first. Similarly, wells in the western portion of the system do not come on during this scenario due to the higher system pressures in this portion of the service area (due to lower elevations), which generally exceed the pressure cluster set point pressure causing these wells to remain off.

Results from this scenario show that pressures downstream of West Tank ranged between 68 to 74 psi. Based on discussions with City Operations staff, the pressure set point for West Tank, which triggers the West Tank booster pumps to turn on is 59.5 psi. Since pressures downstream of West Tank remain above 59.5 psi during this evaluation, the West Tank booster pumps will not automatically come on, which confirms the City’s concerns about having difficulties in turning over their tanks. To force turnover in West Tank, the pump station must be forced to turn on. As shown on Figure 10-1, pressures in the immediate vicinity of West Tank range from 70 to 75 psi. If the West Tank booster pump station is forced to come on, discharge pressures would need to exceed the observed system pressures mentioned above. This may cause system pressures in the vicinity of West Tank to approach or exceed 80 psi, and therefore exceed the City’s maximum pressure criterion. Additionally, pipelines in this area are older and an increase in operating pressure could potentially cause pipelines to break.

One possible operational change that could achieve increased turnover of the City’s tanks under a winter demand condition is to reduce the overall MID supply into the system and force tank turnover through a “Time-of-Use Operations” strategy. Reducing surface water supply from MID Terminal Reservoir could be achieved by either reducing the discharge pressure set point at the Terminal Reservoir pump station or by controlling the various MID turnouts. These operational changes would result in lower pressures throughout the City, particularly in the western portion of the contiguous service area.

The City’s pressure cluster settings for the groundwater wells have varying hydraulic gradients due to the varying pressure settings at different elevations. The average hydraulic gradient of key well clusters is 235 feet msl. The resulting hydraulic gradient at the MID Terminal Reservoir pump station operating at a downstream pressure set point of 60 psi is 253 feet msl. Since the hydraulic gradient from the Terminal Reservoir pump station is greater than the “average” gradient set by the City’s wells in the different pressure clusters, the supply from MID will dominate and explains why several wells and tanks do not come online, as described above. This issue is exacerbated
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during low demand conditions (i.e., winter demands) where system headlosses are low, and therefore, the overall hydraulic gradient is similar to the Terminal Reservoir hydraulic gradient throughout the entire contiguous service area. If the MID Terminal Reservoir pump station was operating at a downstream pressure set point of 55 psi, the resulting hydraulic gradient would be 242 feet msl, which is closer to the desired operations of the City’s key well clusters.

10.4.2 Scenario 2A: Winter Demand Conditions - MID Providing a Constant Pressure/ Supply of 55 psi

10.4.2.1 Scenario Description

Under this scenario, it will be assumed that MID can lower the delivery pressure to the City to a constant pressure of about 55 psi at MID’s Terminal Reservoir under winter demand conditions. Under this lower pressure/supply scenario from MID, we will evaluate how this MID supply reduction would impact and/or enhance the City’s operational flexibility, and possibly help alleviate current operational concerns. This scenario is intended to provide City Operations staff with an alternative “baseline winter conditions operations plan”, identifying the benefits to the City’s local operations if supplies from MID can be reduced during the low demand winter period.

10.4.2.2 Findings, Conclusions and Recommendations

The baseline winter demand scenario was evaluated in the hydraulic model with identical operating conditions as described in the section above, except the downstream pressure set point at MID’s Terminal Reservoir was reduced to 55 psi (see Table 10-3). Results are discussed in more detail below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Operating Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Contiguous Service Area Demand</td>
<td>• Average Demand = 27.8 mgd; Peak Demand = 34.1 mgd</td>
<td>Demands calculated based on SCADA data on 12/15/2015</td>
</tr>
<tr>
<td>MID Terminal Reservoir</td>
<td>• Discharge Pressure ~ 55 psi</td>
<td>Operating in flow-through-mode, no bypass</td>
</tr>
<tr>
<td>MID Turnouts</td>
<td>• Turnouts were assumed to be operating wide open, without pressure or flow control</td>
<td>Tier 2 Turnouts assumed to be on-line and open</td>
</tr>
<tr>
<td>Tanks and Booster Pump Stations</td>
<td>• Tank 7 was out of service</td>
<td>Tanks that operated throughout the entire day pumped while filling</td>
</tr>
<tr>
<td>Groundwater wells</td>
<td>• Provided ~17 mgd of supply</td>
<td>36 wells operated at some point throughout the day, depending on Diurnal Demand, with 9 wells operating continuously</td>
</tr>
</tbody>
</table>
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As summarized in Table 10-3 above, decreasing the downstream pressure set point at MID’s Terminal Reservoir to 55 psi results in an average reduction of MID supply of approximately 3 mgd (from 13 mgd to 10 mgd). Supply from wells increased by roughly the same amount (from 14.5 mgd to 17 mgd) to make up for the reduction of supply from the MID Terminal Reservoir.

Figure 10-2 summarizes the average pressure differences from the base winter condition (i.e., Scenario 2A minus Scenario 1). As shown on Figure 10-2, there is an overall pressure difference of approximately 4 to 5 psi throughout the northern portion of the contiguous service area. Pressures in South Modesto remain largely unchanged, since South Modesto is essentially hydraulically isolated from North Modesto. The North Ceres area experiences a 1 to 3 psi drop since this area has a 12-inch diameter connection to North Modesto along River Road, and is largely unaffected due to its local supply. Pressures downstream of West Tank ranged from 64 to 68 psi.

As the results indicate, reduction of the downstream pressure set point at MID’s Terminal Reservoir results in an overall supply reduction from MID and a reduction in pressures throughout North Modesto by roughly the same amount of the pressure reduction applied to the MID supply. Though there is an overall pressure reduction in North Modesto, pressures still remain above the pressure set point of the West Tank booster pumps. Therefore, the West Tank booster pumps are still not expected to operate under pressure control and would need to be forced on through the implementation of a “Time-of-Use” strategy. The “Time-of-Use” strategy would involve establishing a preset number of pumps to automatically operate at a defined start time and specific duration period. It is recommended that the defined start times be concurrent with typical peak demand periods, which for the City generally occur between 4:00 AM to 9:00 AM and 6:00 PM to 10:00 PM to potentially alleviate high pressure concerns. The number of pumps and duration should be selected such that approximately 25 percent of the storage volume is utilized during these two “tank drawdown” periods, which is the City’s current operational storage requirement (see Chapter 6). At the start of the “Time-of-Use” period, the selected pumps will automatically operate to maintain a pre-specified pressure set point for the pump station discharge. This set point pressure will need to be set high enough to ensure that pump back to the system occurs (e.g., approximately greater than 75 psi). Dropping the downstream pressure set point at MID Terminal Reservoir (and/or limiting groundwater supply) would allow for the West Tank booster pumps to be forced on with a lower discharge pressure and would help maintain pressures below the City’s maximum pressure criterion of 80 psi.

10.4.3 Scenario 4: Summer Demand Conditions - MID Providing a Constant Pressure/Supply of 60 psi – Baseline Summer Condition

10.4.3.1 Scenario Description

Under this scenario, MID will continue to deliver a constant supply of treated surface water into the City’s existing water system infrastructure at a pressure of about 60 psi at MID’s Terminal Reservoir under summer demand conditions. This scenario is intended to establish a “baseline summer condition”, under which City Operations staff currently operate to:
• Meet the needs of existing City customers,
• Provide sufficient storage in their tanks to meet peak hour demand conditions, and
• Continue to operate wells to meet localized demands and treatment requirements.

This scenario was verified as part of the hydraulic model verification (i.e., the 7/9/2013 verification day) as described in Chapter 7.

10.4.3.2 Findings, Conclusions and Recommendations

The baseline summer demand scenario was evaluated in the hydraulic model with identical operating parameters observed on 7/9/2013, which are summarized in Table 10-4.

<table>
<thead>
<tr>
<th>Table 10-4. Summary of Summer Baseline Operational Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td>Overall Contiguous Service Area Demand</td>
</tr>
<tr>
<td>MID Terminal Reservoir</td>
</tr>
<tr>
<td>MID Turnouts</td>
</tr>
<tr>
<td>Tanks and Booster Pump Stations</td>
</tr>
<tr>
<td>Groundwater wells</td>
</tr>
</tbody>
</table>

Figure 10-3 summarizes average system pressures throughout the contiguous system with the operating conditions described in Table 10-4. As shown on Figure 10-3, the majority of the system operates between 50 to 60 psi. During this scenario, MID Terminal Reservoir supply ranges from 32 to 49 mgd depending on diurnal demand, and groundwater supply makes up the difference. During peak demand periods, wells are depended on heavily since they provide local support to areas with low pressure.

Contrary to the winter scenario, groundwater wells throughout the entire contiguous service area operate to support system pressures due to increased demands in the summer scenario. Pressures in the eastern portion of the system are lower due to higher elevations; and therefore, wells within the eastern portion of the system will turn on first and generally operate continuously throughout the day. Pressures in the western portion of the system are similar to the eastern portion, but are not as high as shown in the winter scenario. Pressures are lower in the western portion of the system under summer demand conditions because of the increased headlosses across the system.
As a result, during this scenario, wells in the western portion operated for most of the day, though not continuously.

Tanks throughout the contiguous service area generally operated continuously throughout the entire day during this scenario, reflective of 7/9/2013 operations. As mentioned in the winter scenario, West Tank booster pumps did not come online due to the high pressures experienced downstream. However, for this summer scenario, West Tank booster pumps were operated continuously at their associated set point pressure (maintaining 62 psi) throughout the day on 7/9/2013, except for the late morning/early afternoon where the demands were generally lower. This results in the City being able to supply the contiguous area with more treated surface water, but still relying on wells to provide local support to various areas (i.e., pressure clusters) based on diurnal demands.

Results from this summer scenario indicate that during increased demand conditions headlosses across the City system are much greater, and in effect help balance treated surface water supply from MID Terminal Reservoir and groundwater supply. The increased headlosses also result in lower pressures at tanks and pump stations making them easier to turnover as compared to winter demand conditions. However, as noted above, tanks appeared to be operating at their set-point pressure during this day with adequate turnover. However, lowering incoming supply, either from MID Terminal Reservoir and pump station or from various groundwater wells, would also help facilitate more turnover from the tanks.

10.4.4 Other Potential Operational Scenarios

The operational scenarios listed in Table 10-1, and/or combinations of operational scenarios, will be addressed in subsequent evaluations as requested and authorized by the City. However, it is worth noting that the proposed Scenarios 2B and 5B would evaluate the potential to limit groundwater well supply by reducing the pressure cluster settings. Decreasing supply from the City’s wells would maximize the use of treated surface water from MID. Though these more detailed hydraulic evaluations will be conducted separately, a preliminary analysis was conducted to illustrate the effect of limiting groundwater supply and maintaining current MID Terminal Reservoir and turnout operations. This is a much different approach as compared to Scenario 2A, which dropped the supply pressure at MID Terminal Reservoir pump station while maintaining current groundwater well operations.

A preliminary steady state evaluation was conducted for an existing average day demand condition (64 mgd) assuming the majority of the City’s wells were offline while maintaining MID Terminal Reservoir at its current downstream pressure set point of 60 psi and with all turnouts wide open. All wells were assumed to be offline except for wells in South Modesto and Wells 62 and 63 in North Modesto. Table 10-5 summarizes operational results from this steady state evaluation.
Table 10-5. Summary of Average Day Operational Conditions with Limited Well Supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Operating Conditions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Contiguous Service Area Demand</td>
<td>• Average Demand = 63.9 mgd;</td>
<td>• Existing Average Day Demands, see Table 8-1</td>
</tr>
<tr>
<td></td>
<td>• North Modesto Demand = 59 mgd, South Modesto Demand = 4.9 mgd</td>
<td></td>
</tr>
<tr>
<td>MID Terminal Reservoir</td>
<td>• Discharge Pressure ~ 60 psi</td>
<td>• Operating in flow-through-mode, no bypass</td>
</tr>
<tr>
<td></td>
<td>• Average Supply ~ 53.8 mgd</td>
<td></td>
</tr>
<tr>
<td>MID Turnouts</td>
<td>• Turnouts were assumed to be operating wide open, without</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>pressure and flow control</td>
<td></td>
</tr>
<tr>
<td>Tanks and Booster Pump Stations</td>
<td>• All Tanks offline except Tank 6, which provides 1.1 mgd of</td>
<td>• Tank 6 is filling at the same rate as it is pumping out to reflect</td>
</tr>
<tr>
<td></td>
<td>groundwater supply from North to South Modesto</td>
<td>the transfer of groundwater supply from North to South Modesto</td>
</tr>
<tr>
<td>Groundwater wells</td>
<td>• Well 62 and 63 provide 6.0 mgd of supply</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>• South Modesto Wells (49, 216, 217, 284, 287) provide 4.0 mgd</td>
<td></td>
</tr>
</tbody>
</table>

Figure 10-4 presents the system pressures throughout the contiguous service area with the operating conditions mentioned above. As shown on Figure 10-4, pressures throughout the distribution system vary between 40 to 65 psi. Pressures in South Modesto are generally higher since this area operates independently from North Modesto and because wells in this area are assumed to remain online and provide local support. Pressures in the north and eastern portions of North Modesto operate between 45 to 50 psi because elevations are generally higher. Pressures in the Salida Area range from 40 to 50 psi and are relatively lower because this area is the farthest away from the MID Terminal Reservoir supply.

Results from this analysis indicate that pressures throughout the contiguous service area can be maintained above 40 psi while being supported almost entirely from the MID Terminal Reservoir and pump station. Under these conditions, pressures in North Modesto are lower than what the City currently experiences and some groundwater wells are still required to provide local support, particularly near the Salida Area. However, operating at these lower pressures would help facilitate turnover of all tanks and increase the use of treated surface water. For example, the pressure downstream of West Tank is approximately 60 psi, which is much closer to its pressure set point than it currently experiences.

Although the scenario presented above is somewhat unrealistic, since the City has various wells that must be operated continuously for water quality reasons (i.e., wells equipped with GAC systems, etc.) and MID is supplying the system at a larger average flow rate than the existing peaking capacity of the MRWTP, which can be provided by the Phase II expansion of the MRWTP once it is operational, it still illustrates the important role that the various City well facilities have in balancing treated surface water supply and facilitating tank turnover. It also shows that decreasing or limiting groundwater supply, either by reducing pressure cluster settings or by forcing well facilities offline, has a similar effect as dropping the supply pressure from MID Terminal Reservoir and pump station (as shown by Scenario 2A) or to begin controlling the various turnouts.
As shown by the results of the scenarios presented above, it is likely that some combination of operational changes will need to be made to the City’s various wells, tanks and booster pump stations, and incoming MID supply to address current operational challenges and to better distribute water throughout the City, particularly during lower, winter demand periods. In addition, it will also be important for the City to develop clear over-arching objectives (e.g., power use efficiency, maximizing the use of surface water, water quality, ease of operation, etc.) to help the City identify which combination of operational changes would most closely align with the City’s overall operational objectives.
Notes
1. Model parameters based on 12/15/2015 operations.
2. Facilities and system pressures verified through SCADA, MPR, and model comparisons.
3. Results presented are based on a 24-hour extended period simulation (EPS).
4. Scenarios indicate that they did not operate at any point throughout the day.
5. Tank 7 was out of service, Tank 12 did not operate, and Tank 3 operated from hour 1 to hour 1.5. The remaining tanks operated throughout the day.
6. MID providing supply at approximately 60 psi.

LEGEND
- Well Operated Continuously
- Well Offline
- Active Well
- Out of Service Well
- Tank and Booster Pump Station
- Existing Pipes
- Coniguous Service Area

50 psi < Pressure ≤ 55 psi
55 psi < Pressure ≤ 60 psi
60 psi < Pressure ≤ 65 psi
65 psi < Pressure ≤ 70 psi
70 psi < Pressure ≤ 75 psi
75 psi < Pressure ≤ 80 psi
Notes
1. Model parameters based on 12/15/2015 operations.
2. Facilities and system pressures verified through SCADA, HPR, and model comparisons.
3. Results presented are based on a 24-hour extended-period simulation (EPS).
4. Wells identified as offline indicate that they did not operate at any point throughout the day.
5. Tank 7 was out of service, the remaining tanks operated throughout the day.
6. MID supply pressure dropped by 5 psi.
7. Tank 12 was set to maintain a downstream pressure of 66 psi.

FIGURE 10-2
City of Modesto
Water Master Plan
AVERAGE PRESSURE DIFFERENTIAL RESULTS DURING WINTER BASELINE (12/15/2015)
SCENARIO 1 vs. 2A

LEGEND
Well Operated Continuously
Well Offline
Active Well
Out of Service Well
Tank and Booster Pump Station
MID Turnout
Existing Pipes
Contiguous Service Area

Pressure Differential
- 4 to 5 psi Decrease
- 3 to 4 psi Decrease
- 2 to 3 psi Decrease
- 1 to 2 psi Decrease
- Less than 1 psi Decrease
1. Model parameters based on 07/09/2013 operations.
2. Facilities and system pressures verified through SCADA, HPS, and model comparisons.
3. Results presented are based on a 24-hour extended-period simulation (EPS).
4. Wells identified as offline indicate that they did not operate.
5. Wells operated for the majority of the day and "Tanks a" and "Tanks b" operated as needed.
6. MID providing supply at approximately 60 psi.

**LEGEND**
- Well Operated Continuously
- Well Offline
- Active Well
- Out of Service Well
- Tank and Booster Pump Station
- MID Turnout
- Existing Pipes
- Contiguous Service Area

**Notes**

- 40 psi < Pressure ≤ 45 psi
- 45 psi < Pressure ≤ 50 psi
- 50 psi < Pressure ≤ 55 psi
- 55 psi < Pressure ≤ 60 psi
- 60 psi < Pressure ≤ 65 psi
- 65 psi < Pressure ≤ 70 psi
- 70 psi < Pressure ≤ 75 psi
- 75 psi < Pressure ≤ 80 psi
1. Existing average day demand is approximately 63.9 mgd.
2. MID is supplying approximately 53.8 mgd at 60 psi.
3. MID turnout areas assumed to be wide-open and are not controlled.
4. Wells 62 and 63 provide additional supply in North Modesto.
5. Tank 6 is providing approximately 1.1 mgd of groundwater supply from North to South Modesto.