REPORT TO CITY COUNCIL

Approved by:

Department Director

Arnoldo Rodriguez, City Manager

Council Meeting of: May 15, 2019

Agenda Number: A-1

SUBJECT: **Presentation of Technical Memorandum 1 Demand Analysis, Tank Configuration, Material Evaluation, Pipeline Routing and Budgetary Estimate for the Proposed Northeast Water Storage Tank, Pump Station and Transmission Mains**

RECOMMENDATION:

Staff recommends that the City Council (Council) consider the information within the Draft Technical Memorandum 1 and provide direction to staff regarding course of future activity for the proposed Northeast Water Storage Tank, Pump Station and Transmission Mains (the "Project").

SUMMARY:

This item was tabled from the May 1, 2019 Council meeting.

The City's consultant, Carollo Engineers, Inc., has completed Technical Memorandum 1 addressing the preliminary engineering and design considerations for the Project. A copy is attached to this Staff Report and has been further summarized in this Staff Report. The technical memorandum presents discussion and recommendations for tank sizing, materials and phasing as well as supporting infrastructure. Preliminary cost estimates sufficient for budgeting for completion of the Project are included. Following acceptance of Technical Memorandum 1, with Council's concurrence the project will move into the next steps of the preliminary design phase. Activities include finalizing tank location, initiating the environmental document, and preparation of more detailed estimates based on the selected location.

DISCUSSION:

Construction of a new master planned northeast water storage tank was proposed in 2015 to address drought conditions (loss of several wells over a short period of time) and also to address current reliability and redundancy within the water system in the northeast quadrant of Madera. Phasing of a new northeast water storage tank to expand capacity as growth occurs or as additional production well capacity is developed is recommended. This recommendation is made to ensure ratepayers do not carry the full burden of a water storage tank designed for 30 years build out. The initial phase is a ten-year project, with growth being reassessed as development conditions change.

The information and recommendations in Technical Memorandum 1 are presented to guide the City toward an official "project definition" – a tank of certain size and material to be constructed at an identified location within a specified timeframe. A formal project definition provides the springboard for the environmental review, applications for funding assistance, and final design. Completion of the environmental document is a precursor for several funding application processes and therefore time sensitive.

Highlights of Technical Memorandum 1 are discussed below.

Demand Analysis – Tank Size

What are the City's water demands, or needs, today? 10-12 years from now? At buildout of the General Plan planning area? The answers to those questions drive the recommendations for water storage and system infrastructure needs for the near term and future growth. Akel Engineering is the City's hydraulic modeling consultant that provided the water demand analysis for the Project. The results are included in the Appendix A to Technical Memorandum 1.

Several assumptions were presented to Council during a workshop at the December 18, 2018 meeting. The demand analysis from the 2014 Water System Master Plan was updated using a reduced per capita water usage of 155 gallons per capita per day. Population projections have been reduced reflecting the actual and projected trends for the City in the next 10 years. The compounded reduction of both population and per capita usage significantly reduces the projected water demand at build-out, year 2047 in the Water System Master Plan model; the recommended ultimate tank capacity for the northeast location is 5 million gallons (MG). This value replaces the recommendation in the 2014 Water System Master Plan of 6.75 MG.

For a phased project the hydraulic analysis prepared by Akel Engineering concludes two tank sizes are feasible to consider for current operations and for operations within the 10-year planning horizon. The sizes were determined through an iterative process that involved evaluating the ability to deplete and replenish the storage reservoir with the maximum day demand, provide relief during drought periods, as well as the need to service future growth in the eastern portion of the City. These sizes are documented as follows:

- **2.5 MG Storage Reservoir:** This size meets maximum day demand requirements, as well as providing good turnover during maximum day conditions. There is approximately 20% reserve capacity for additional volume during drought periods and/or accommodate future growth.
- **3.25 MG Storage Reservoir:** This size meets maximum day demand requirements, as well as providing additional volume during drought periods to relieve supply wells. However, this tank size may require additional operational efforts to utilize the full volume.

Hydraulic Design Criteria

Once the final tank size and location are selected, Akel's hydraulic model will generate values for hydraulic design parameters. The key items are:

- Tank Volume Requirements (this is not the Tank Sizing but other elements of the tank design and operation):
    - The volume of water required for Peak Hour Demand minus the Max Day Demand
    - Emergency Storage for Fire Flows
    - Drought Tolerance
- Pump Station – the system must be able to meet Fire Flow Demand

Volume requirements are unaffected by the tank location. The variable associated with tank location is amount of transmission main required.

Tank Material Comparison

Beginning on page 3 of Technical Memo 1 is a detailed life cycle cost analysis of welded steel versus prestressed concrete storage tanks. For each material, the analysis considered initial cost of construction and recurring maintenance and inspection costs over the life of a tank, 100 years. For all three sizes being considered, prestressed concrete was the lowest life cycle cost and therefore the recommended material.

Pipeline Routing

The initial concept and budget for the tank project included 3,450 linear feet of large diameter transmission main along Lake Street at a 2014 cost of $700,000. However, the hydraulic analysis concluded that additional transmission main in the northeast quadrant (as identified in the 2014 Water Master Plan) is needed to support the operation of the tank. Approximately 3 miles of new 24-inch diameter transmission mains will be needed to move the water from the west side of the City to the east. Figure 1 (attached) shows the minimum amount of transmission main in light blue and additional transmission main in orange if the tank is located further to the east. The mains will connect the new Well 38 (Love's Well) to existing 12-inch water mains in Ellis Street. This is an added cost to the project; however, the costs are offset considering a smaller tank size is now recommended. Even without the tank, installation of the 24-inch transmission mains from Well 38 to Ellis Street provides substantial benefit to the water system offering options for construction phasing. The segment along Lake St. is no longer recommended and those costs/budgets would be transferred to other parts of the pipeline.

Appendix B of Technical Memo 1 summarizes the research and conclusions of possible routes for the large diameter water mains. The alignment assumed for purposes of Technical Memorandum 1 and shown in Figure 1 follows a route established by the sewer mains installed for Love's Truck Stop paralleling Hwy. 99 southeast along Sharon Blvd. to Ellis and then easterly along Ellis Street. Easements will be required from 3 properties. Table 10 of Technical Memo 1 explains the pipeline route and specific details for each segment. The costs range from $2.5 million to $3.0 million depending on the tank location.

Tank Location

The ideal location for the new storage tank will be along Ellis Street. Moving the tank south from the proposed location of Avenue 17 & Road 27 (Lake Street) best utilizes existing and imminent infrastructure being installed for Love's Truck Stop, the Matilda Torres High School, and the Successor Agency (the Successor Agency has a project to install master plan utilities along Adell St. between Lake St. and Country Club Dr). Figure 1, attached, highlights eight (8) potential sites of 2.5 acres or larger that have received a preliminary "passing" evaluation - no visible biological constraints and all accessible to utilities and access points. In the next phase of preliminary engineering for the project, the project team will further evaluate the sites and provide a recommendation for Council's consideration. Factors influencing desirable site selection include the owner's willingness to sell, land cost, proximity to storm drainage facilities, proximity to water transmission main, impact on overall project costs, and compatibility with surrounding land uses. Other factors may come in to play when entering negotiations.

Tank Site Configuration

Preliminary site configurations have been presented for three tank sizes, a 2.5 MG, 3.25 MG and a 5 MG tank. The 2.5 MG and 3.25 MG tank sites consist of constructing one tank first and constructing a second future similar tank size on the same site and allow for future expansion of the pump station. For the 5 MG tank, a future tank is not included; only expansion of the pump station is planned. The sites will have a landscape buffer. Architectural enhancements for the tank will be addressed later in the design phase.

Budgetary Cost Estimate

The original budget for land acquisition, transmission main, pump station, and tank included in the Water Rate Study in 2015 was $17.4 million. Cost figures presented in Technical Memorandum 1 evaluate not only the two smaller tanks but also the ultimate 5 MG tank. There are several tables presenting cost analyses for the various size tanks and locations. The Project budgetary cost estimates for each size tank are below. Range in budget represents difference in tank location and additional transmission main costs.

- 2.5 MG = $18.4 to $18.9 million
- 3.25 MG =$20 to $20.5 million
- 5 MG = $23 to $23.5 million

Recommendations & Next Steps

Staff concurs with the recommendation by Carollo Engineers to construct a 2.5 MG tank on a site that will accommodate a second 2.5 MG tank when needed for growth. At Council's direction, staff will proceed with tank site selection. Upcoming items will also include presentation of Technical Memorandum 2 – Project Delivery and Funding Options Analysis.

FINANCIAL IMPACT:

The water storage tank, pump station, and transmission mains will be paid out of the water utility fund, using a combination of "PayGo" and debt financing. As currently planned, the City will pursue debt financing, including a bond issue or alternative mechanism, in 2020. Specific funding strategies will be presented as the project nears design completion and costs are better identified.

CONSISTENCY WITH THE VISION MADERA 2025 PLAN:

Action 101.6 – This entire effort supports this strategy to ensure infrastructure can sustain population growth in the development of the General Plan.

ALTERNATIVES:

As an alternative, Council may consider the information provided, accept the Technical Memorandum No. 1 and direct Staff not to complete the preliminary design phase. However, water system pressure in the northeast quadrant of the City will continue to be a potential issue and future drought conditions are inevitable. Delaying engineering design and/or construction of recommended facilities will add additional future costs to the same improvements. Considering the recommendations from the 2014 Master Plan and the additional information presented herein, Staff is confident that a current investment in the Northeast Storage Tank and Transmission Mains is the best proactive approach to addressing current and future water system needs.

ATTACHMENTS:

1. Figure 1 Proposed Transmission Main and Tank Sites

2. Technical Memorandum No. 1 Demand Analysis, Tank Configuration, Material Evaluation, Pipeline Routing, and Budgetary Estimate for the Northeast Water Storage Tank

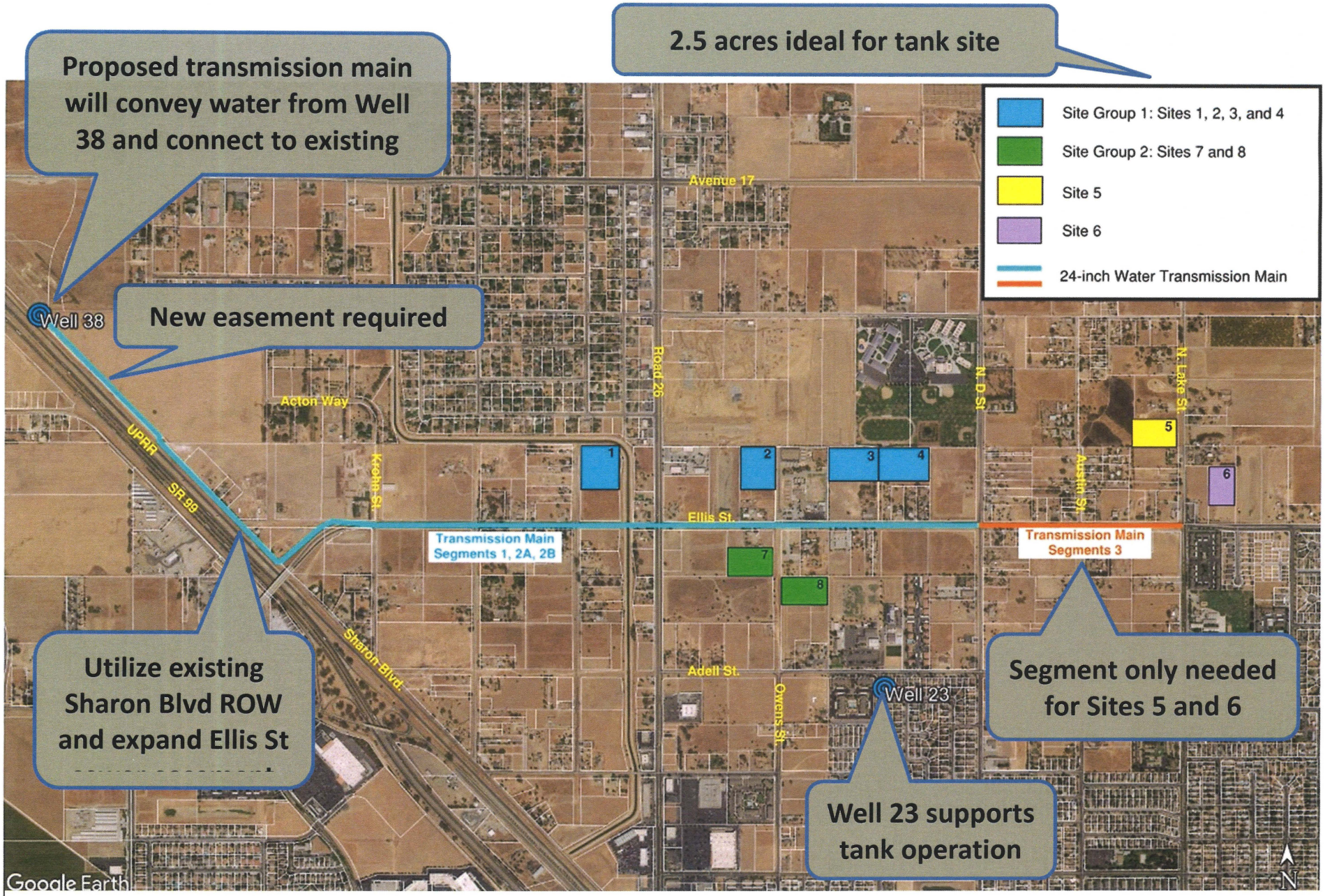

Figure 1 Proposed Transmission Main and Tank Sites

City of Madera
Northeast Water Storage Tank

Technical Memorandum 1
DEMAND ANALYSIS, TANK CONFIGURATION, MATERIAL EVALUATION, PIPELINE ROUTING, AND BUDGETARY ESTIMATE

FINAL | April 2019

City of Madera
Northeast Water Storage Tank

Technical Memorandum 1
DEMAND ANALYSIS, TANK CONFIGURATION, MATERIAL EVALUATION, PIPELINE ROUTING, AND BUDGETARY ESTIMATE

FINAL | April 2019

This document is released for the purpose of information exchange review and planning only under the authority of Paul Amico, March 4, 2019, California 64648.

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Abbreviations

AC	acre
AFY	acre feet per year
Akel	Akel Engineering Group
AWWA	American Water Works Association
Carollo	Carollo Engineers, Inc.
CM	construction management
City	City of Madera
ft	feet
gpcd	gallons per capita day
gpm	gallons per minute
MDD	maximum day demand
MG	million gallons
O&M	operation and maintenance
PHD	peak hour demand
PS	pump station
sq ft	square foot
WSMP	Water System Master Plan

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Technical Memorandum 1

DEMAND ANALYSIS, TANK CONFIGURATION, MATERIAL EVALUATION, PIPELINE ROUTING, AND BUDGETARY ESTIMATE

1.1 Background

The City of Madera (City) currently utilizes groundwater as its sole source of supply, and all but a small fraction of peak demands are met using production wells. The City operates a 1-million gallon (MG) elevated water storage tank located in downtown Madera, but the aquifer provides the vast majority of storage volume required to maintain service levels. In the past, the City has had difficulty meeting peak demands with the existing wellfield during extended dry periods, and the stress on the system has resulted in well failures and low system pressures. Consequently, the City is improving the reliability of its water supply, and is moving forward with the design and construction of a new water storage tank, pump station, and transmission main that was proposed in the 2014 Water System Master Plan (WSMP) to be located in the vicinity of Avenue 17 and Lake Street. The WSMP project included a 6.75-MG storage facility with a booster pumping station capable of pumping up to 17,200 gallons per minute (gpm) through a 24-inch diameter transmission main that will extend approximately one-half mile to the south and connect to the City's existing distribution system. The project was identified in the WSMP as being needed for reliability and redundancy purposes to meet current peak hour demands, and the overall storage and pumping capacity was established to also meet future growth demands to the north and east. At this time, the City is interested in focusing this project on addressing the reliability and redundancy issues and potentially phasing the project to expand capacity as growth occurs or as additional production well capacity is developed.

The City retained Carollo Engineers, Inc. (Carollo) to design the tank, booster pumping station, and transmission main, and at this time only the preliminary design task has been authorized. Carollo's current scope of work for preliminary design includes reviewing the system demands and analysis that are used to calculate storage, booster pumping, and conveyance capacities, establishing project design criteria, recommending tank material and construction phasing, and routing the transmission main. Carollo is working with the City's hydraulic modeling consultant, Akel Engineering Group (Akel), on the demand analysis and tank and booster pump sizing.

This technical memorandum (TM) summarizes the results of the demand analysis and results, presents the tank material, construction phasing, and tank site evaluation, and provides budgetary cost estimates for the proposed alternatives.

1.2 Demand Analysis

This section summarizes the demand and hydraulic modeling conducted by Akel. Akel's scope of work included the following tasks:

- Update and calibrate the water system hydraulic model to reflect 2018 conditions.
- Establish planning criteria for scenario analysis.
- Conduct hydraulic modeling scenarios to identify tank and booster pumping capacities for different operational and growth scenarios.

Akel's TM that describes the results of the analysis is included in Appendix A. Key findings from the analysis and modeling include:

- Future demands in the 2014 WSMP were calculated using a population growth rate of 3.5 percent and a water use of 190 gallons per capita per day (gpcd).
- Since 2014, the growth rate for the City has been approximately 0.9 percent per year and the water use has decreased to approximately 124 gpcd.
- The City, Akel, and Carollo agreed that the tank and booster pump capacities be based on a 2.0 percent growth rate between 2018 and 2030 and 3.5 percent thereafter, with a water use per capita of 155 gpcd.
- Growth in the next 10 years is anticipated to occur mainly in four areas on the north side of Madera, resulting in a system-wide demand of 20,000 gpm in 2030 and 15,430 gpm when the new tank comes online in 2022.
- Revising the growth rates and water use per capita and forecasting water demands in the identified growth areas resulted in potential storage requirements of 2.5 or 3.25 MG initially, with 5.0 MG or 6.75 MG needed at buildout, depending on whether the City mandated watering restrictions during drought periods (the larger tank volumes are needed if watering restrictions are not mandated).
- New 24-inch diameter transmission mains will be needed to move water west to east from the City's new Well 38 (Love's Well) and connect to existing 12-inch water mains along Ellis Street, and the ideal location for the new storage tank will be along the Ellis Street transmission main alignment.
- The total length of new transmission main will depend on the specific site selected, but at a minimum the new transmission main will need to extend east from Well 38 to D Street. If the tank site is located east of D Street, the new transmission main will need to extend east to Lake Street.
- Approximately 2.0 MG of operating storage volume and 5,000 gpm of booster pumping capacity will be needed starting in 2022.
- A 2.5-MG storage tank will meet maximum day demand requirements, and will provide good turnover during maximum day conditions.
- 3.25- and 5.0-MG storage tanks will meet maximum day demand requirements, and will provide additional volume during drought periods to relieve supply wells and provide excess storage for future growth. These tank sizes will require additional supply capacity to meet the future demands and utilize the full tank volume.

Based on the above results, Carollo evaluated capital and life cycle costs, and construction phasing for 2.5-, 3.25-, and 5.0-MG storage tanks. The results of the evaluation are described in the following sections.

1.3 Hydraulic Design Criteria

The hydraulic design criteria developed from the demand analysis consisted of the following key items:

- Tank Volume Requirements:
  - The volume of water required for Peak Hour Demand minus the Max Day Demand
  - Emergency Storage for Fire Flows (MDD + 2,000 gpm)
  - Drought Tolerance
- Pump Station able to meet Fire Flow Demand

Specific values for each of the above criteria will be provided by Akel's hydraulic modeling analysis once the City selects a tank size and location.

1.4 Construction Material Analysis

The American Water Works Association (AWWA) has developed standard guidance documents that are used for the design, manufacture, and construction of welded steel tanks and prestressed concrete tanks. This section describes the analysis of the following tank construction materials:

- AWWA D100 Welded Carbon Steel Tanks for Water Storage.
- AWWA D110 Type I Wire and Strand-Wound, Circular, Prestressed Concrete Water Tanks.

Capital and life cycle costs for these tanks were developed based on standard construction and operation and maintenance (O&M) practices for each of the tank materials. Capital costs were estimated based on discussions with and estimates from tank constructors, and life cycle costs were estimated using industry best practices for routine, proactive maintenance activities that are performed to maximize the life of the tank.

1.4.1 Welded Steel Tank Evaluation

Welded steel is a common material used for water storage tank construction. Welded steel tanks are sensitive to corrosion from natural elements and, at a minimum, require a coating system be applied to protect the steel from corrosion. A cathodic protection system may be required if the tank is constructed on corrosive soils. Steel tanks require routine inspection, coating repairs, and periodic recoating to maximize the tank's service life, and additional operating costs if an impressed current cathodic protection system is needed.

1.4.1.1 Construction Costs

The tank site construction costs are presented in Table 1. These costs include all on-site costs associated with the tank. The following assumptions were used in this analysis to estimate welded steel tank construction costs:

- The tank will be a welded steel tank constructed in accordance with AWWA D100 and include a knuckle roof and standard appurtenances such as access hatches, roof vent, overflow pipe, tank drain, sample nozzle, and ladders with safety climb devices as shown in Figure 1.
- Soil conditions will allow for a ring wall foundation constructed at ground level.

- The tank will require an impressed current cathodic protection system for both the underside and inside of the tank. Soil investigations will be performed in the detailed design phase to confirm if cathodic protection will be required.
- Interior and exterior of the tank will receive a coating system.
- Roof and structure will include seal welding.

Table 1 Welded Steel Tank Construction Costs

	Tank Size (MG)		
	2.5	3.25	5.0
Welded Steel Tank	$2,953,000	$3,341,000	$4,050,000
Tank Appurtenances	$150,000	$150,000	$150,000
Civil - Earthwork, Grading	$875,000	$1,138,000	$1,750,000
Yard Piping	$1,066,000	$1,183,000	$1,395,000
5,000 gpm Pump Station	$600,000	$600,000	$600,000
E&IC Cost	$1,375,000	$1,375,000	$1,375,000
Landscaping	$250,000	$250,000	$250,000
Cathodic Protection	$50,000	$50,000	$50,000
Subtotal	**$7,319,000**	**$8,087,000**	**$9,620,000**
General Conditions & Permit Fees	$385,000	$385,000	$385,000
Utility Connections	$193,000	$193,000	$193,000
Mobilization	$366,000	$405,000	$481,000
Land Acquisition	$300,000	$300,000	$300,000
Subtotal	**$8,563,000**	**$9,370,000**	**$10,979,000**
20% Construction Contingency	$1,713,000	$1,874,000	$2,196,000
Total Onsite Costs	**$10,276,000**	**$11,244,000**	**$13,175,000**

Figure 1 Welded Steel Tank

1.4.1.2 Routine Maintenance Activities

Welded steel tanks require routine maintenance to maintain both the exterior and interior coating system to prevent corrosion. Corrosion can potentially create holes and leaks in the welded steel tank sidewall and floor and degrade the tank's structural integrity. Typical routine maintenance activities include:

- Tank appurtenance inspection: routine inspection of tank appurtenances by the City is recommended to ensure that all tank appurtenances are in working order and functional. These inspections will be performed as a normal course of tank and booster pump operation.
- Annual visual inspection of coating system by City staff: routine visual inspections of the coating system are recommended to identify any signs of coating deterioration or corrosion.
- Structural and coating inspection: detailed structural inspections and evaluation of the coating system are recommended every 20 years to ensure that corrosion has not degraded structural elements of the tank.
- Tank re-coating: re-coating the tank interior and exterior is recommended every 20 years to maintain the integrity of the coating system and protect the tank against corrosion.

Table 2 lists the recoating and inspection assumptions used to develop the approximate recurring costs presented in Table 3, assuming that inspection and coating occurs every 20 years. The engineering, construction management (CM), and inspection are taken as a percentage of the blasting and recoating total cost.

Table 2 Welded Steel Structural Inspection and Recoating Assumptions

Item	Unit Price	Unit
Blast and Re-coating – exterior(1)	$8.00	per sq. ft
Blast and Re-coating – interior	$12.00	per sq. ft
Engineering Costs(2)	10 percent	
CM & Inspection(2)	10 percent	

Notes:
(1) Recoating includes cost of stripping and coating of interior and exterior of the tank.
(2) Percentage of the total re-coating application.

Table 3 Structural Inspection and Recurring Costs

Tank Size (MG)	2.5	3.25	5
Diameter (ft)	135	146	168
Approx. Internal Area (sq. ft.)	39,231	45,867	61,223
Approximate External Area (sq. ft.) (1)	24,917	29,126	39,056
Interior Blast and coating re-application	$471,000	$550,000	$735,000
Exterior Blast and Coating Re-application	$199,000	$233,000	$312,000
Engineering Costs	$67,000	$78,300	$104,700
CM & Inspection	$67,000	$78,300	$104,700
Total 20-Year Recurring Cost	**$804,000**	**$939,600**	**$1,256,400**

Notes:
(1) Excludes Tank Floor Re-Coating

1.4.1.3 Life Cycle Costs

The life cycle costs for a welded steel tank option include tank site capital costs and the recurring costs presented in Table 3. The service life of the tank is assumed to be 100 years, with the recurring inspection and recoating performed at 20, 40, 60, and 80 years of service. Tank replacement is assumed to occur after 100 years of service so no inspection or recoating is assumed to be performed at that time. The total tank site capital and the total value of the recurring costs are presented in Table 4.

Table 4 Total Cost of Welded Steel Tank Ownership

Tank Size	2.5 MG	3.25 MG	5 MG
Tank Site Costs	$10,276,000	$11,244,000	$13,175,000
Recurring Inspection and Coating	$3,216,000	$3,760,000	$5,024,000
Total Life Cycle Cost	**$13,492,000**	**$15,004,000**	**$18,199,000**

Notes:
(1) Recurring inspection and coating costs do not include inflation.

1.4.2 Concrete Tank Evaluation

Prestressed concrete tanks have proven to be a competitive alternative to welded steel tanks for tanks larger than 2 MG. For these large tanks, concrete has the ability to be completely or partially buried if visual impacts are a concern, or if there are development codes or standards that limit the height of structures constructed in an area. Concrete tanks typically carry a higher up-front capital cost but are more cost competitive across the entire life cycle due to savings related to re-coating and cathodic protection. However, for tanks larger than two million gallons, concrete and steel can be competitive and a life cycle analysis is typically conducted to compare the two materials.

1.4.2.1 Construction Costs

The tank site construction costs are presented in Table 5. These costs include all of the on-site improvements. The following assumptions were used in this analysis to estimate concrete tank construction costs:

- The tank will be a prestressed concrete tank constructed in accordance with AWWA D110 and have standard appurtenances such as access hatches, roof vent and safety rails, overflow pipe, tank drain, sample nozzle, and ladders with safety climb devices. A shotcrete cover will be applied over the entire tank and architectural finishes or exterior coatings were not included in this analysis.
- Soil conditions will allow for a conventional spread footing and concrete base foundation.
- Tank will be recessed five feet below grade and uniformly backfilled.
- Tank will have a flat roof. Concrete tanks have the option to either have a domed or flat roof, and flat roof construction was assumed for this analysis. Domed roofs carry a slightly lower capital cost.

Table 5 Total site costs for Concrete Tanks

Tank Size (MG)	2.5	3.25	5.0
Prestressed Concrete Tank	$2,500,000	$2,925,000	$3,700,000
Tank Appurtenances	$150,000	$150,000	$150,000
Civil - Earthwork, Grading	$875,000	$1,138,000	$1,750,000
Yard Piping	$930,000	$1,058,000	$1,290,000
5,000 gpm Pump Station	$600,000	$600,000	$600,000
E&IC Cost	$1,375,000	$1,375,000	$1,375,000
Landscaping	$250,000	$250,000	$250,000
Cathodic Protection	$-	$-	$-
Subtotal	**$6,680,000**	**$7,496,000**	**$9,115,000**
General Conditions & Permit Fees	$365,000	$365,000	$365,000
Utility Connections	$183,000	$183,000	$183,000
Mobilization	$334,000	$375,000	$456,000
Land Acquisition	$300,000	$300,000	$300,000
Subtotal	**$7,862,000**	**$8,719,000**	**$10,419,000**
Construction Contingency (20 percent)	$1,573,000	$1,744,000	$2,084,000
Onsite Costs Subtotal	**$9,435,000**	**$10,463,000**	**$12,503,000**

Figure 2 Concrete Tank and Booster Pump Station Under Construction

1.4.2.2 Routine Maintenance Activities

As with steel tanks, some annual visual inspection and cleaning will be required to ensure that no structural issues have occurred since the last visual inspection and to maintain the tank's appearance. Typical recurring maintenance activities for a concrete tank include:

- Tank appurtenance inspection: routine inspection of tank appurtenances by the City is recommended to ensure that all tank appurtenances are in working order and functional. These inspections will be performed as a normal course of tank and booster pump operation.
- Annual visual inspection by City staff: routine visual inspections of the tank walls and roof are recommended to identify any signs deterioration or cracking.
- Structural inspection: detailed structural inspections are recommended every 20 years to check for cosmetic cracks, grout deterioration, wall spalling, or structural deficiencies to ensure that the tank will continue to perform as designed.
- Tank cleaning: Prior to the structural inspection, pressure washing the tank is recommended to clear any potential build-up or deposits that may impede the ability of the structural engineer to inspect the tank.

Table 6 lists the maintenance and inspection assumptions used to develop the approximate recurring costs presented in Table 7, assuming that inspection and maintenance is performed every 20 years. The engineering, CM, and inspection are taken as a percentage of the repair and cleaning total cost.

Table 6 Concrete Structural Inspection and Cleaning Assumptions

O&M and Inspection Assumptions		
Power Washing and Routine Maintenance	$30,000.00	Lump Sum
Engineering Costs(1)	10 percent	
CM & Inspection(1)	10 percent	

Notes:
(1) Percentage of total coating re-application cost

Table 7 Structural Inspection and Recurring Costs

Tank Size (MG)	2.5	3.25	5
Diameter (ft)	114	129.5	161
Approximate Internal Area (sq. ft.)	33,039	40,684	58,419
Approximate External Area (sq. ft.)	23,708	28,462	39,157
Minor Repair and Cleaning	$30,000	$30,000	$30,000
Engineering Costs	$3,000	$3,000	$3,000
CM & Inspection	$3,000	$3,000	$3,000
Total 20-Year Recurring Cost	**$36,000**	**$36,000**	**$36,000**

1.4.2.3 Life Cycle Costs

The life cycle costs for a concrete tank include capital and recurring costs over the life span of the tank. The service life of the tank is assumed to be 100 years, with the recurring inspection and recoating performed at 20, 40, 60, and 80 years of service. Tank replacement is assumed to occur after 100 years of service so no inspection or cleaning is assumed to be performed at

that time. The total tank site capital and the total value of recurring costs are presented in Table 8.

Table 8 Total Life Cycle Costs of Concrete Tanks

Tank Size	2.5 MG	3.25 MG	5 MG
Tank Site Capital Costs	$9,435,000	$10,463,000	$12,503,000
Recurring Inspection and Maintenance	$144,000	$144,000	$144,000
Total Life Cycle Costs	**$9,579,000**	**$10,607,000**	**$12,647,000**

Notes:
(1) Recurring inspection and cleaning costs do not include inflation.

1.5 Comparison of Welded Steel to Concrete

Table 9 lists the life cycle costs for each size of welded steel and concrete tank evaluated.

Table 9 Life Cycle Cost Comparison

Tank Size	2.5 MG	3.25 MG	5 MG
Total Life Cycle Costs Steel	$13,492,000	$15,004,000	$18,199,000
Total Life Cycle Costs Concrete	$9,579,000	$10,607,000	$12,647,000

Based on the life cycle cost analysis, Carollo recommends that the City construct a prestressed concrete tank.

1.6 Pipeline Routing

As described in Section 1.2, new 24-inch diameter transmission mains will be needed to move water west to east from the City's new Well 38 and connect to existing 12-inch water mains along Ellis Street. The total length of new transmission main will depend on the specific tank site selected, but at a minimum the new transmission main will need to extend east from Well 38 to D Street. If the tank site is located east of D Street, the new transmission main will need to extend east to Lake Street. The routing analysis considered the longer alignment between Well 38 and Lake Street.

Capital costs for the transmission main were developed using the following assumptions:

- Pipeline will be buried 42 inches below the existing grade.
- Pipeline will be constructed of 24-inch Class 250 ductile iron with restrained joints as necessary and buried in accordance with County of Madera Standard Drawing W-9.
- Crossing of the Madera Irrigation District's Lateral 24.2 Canal will be constructed using a bore and jack construction method and the 24-inch transmission main is in a 36-inch steel casing pipe.

A utility search, preliminary environmental permitting analysis, and assessment of potential easement acquisition was performed by QK Inc. (QK) for the route shown in Figure 3 and is provided in Appendix B. The analysis determined that there are minimal existing utilities that will be problematic for the proposed alignment. Figure 4 and Table 10 below identify the potential conditions and construction challenges expected along the proposed alignment.

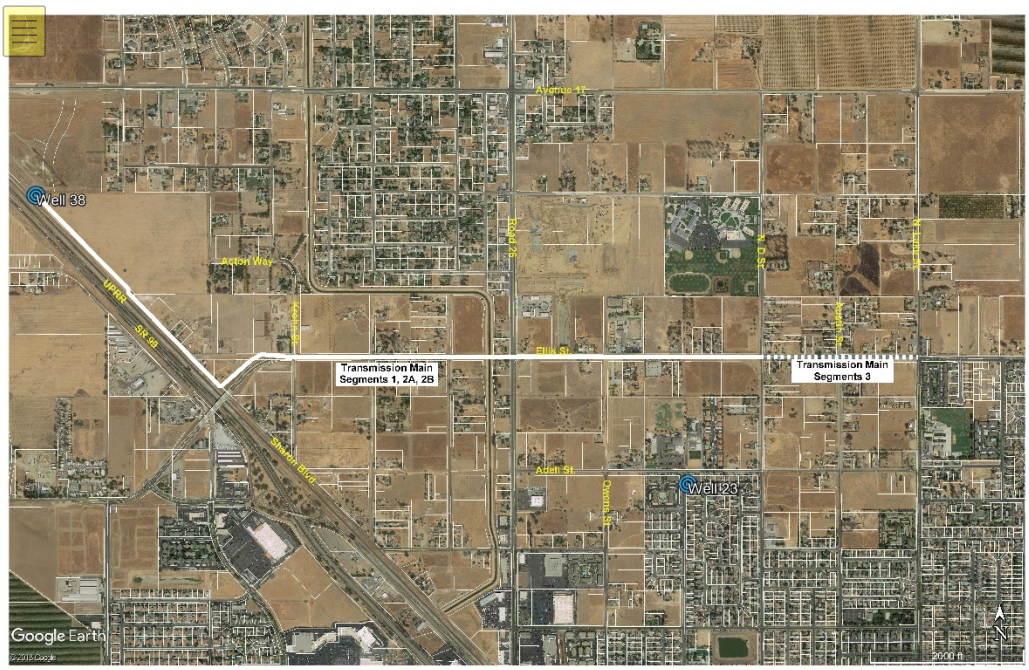


Figure 3 Proposed Transmission Line Alignment

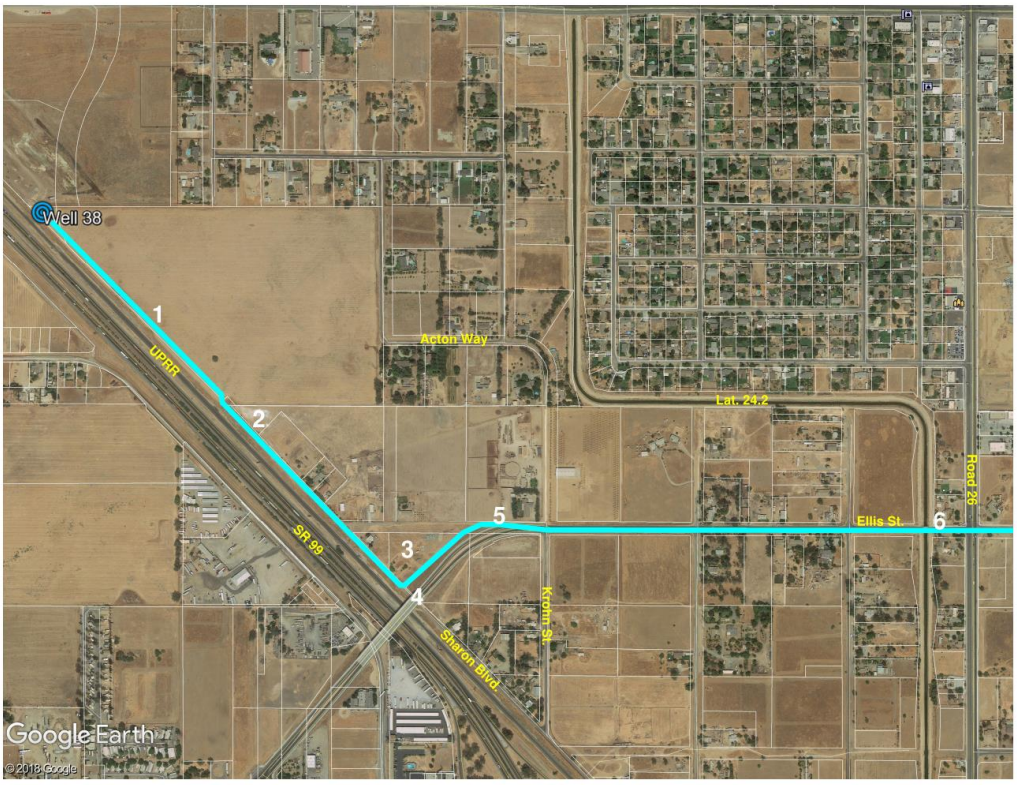


Figure 4 Transmission Main Alignment Conditions

Table 10 Transmission Main Alignment Conditions

Item	Description
1	Confirm if existing public utility easement through APN 038-040-007 has enough space for addition of future transmission main.
2	Potentially acquire easement through 038-050-004. May be able to avoid property if able to move into the existing Sharon Boulevard right-of-way
3	Convert existing 40 foot sewer easement for existing 24-inch sanitary sewer main to a 60 foot public utility easement with the proposed 24-inch transmission main 10 feet from the 24-inch sanitary sewer main. Potentially have to acquire easement from APN 038-050-006 (NW of Ellis and Krohn Street.) if proposed public utility easement overlaps property boundary.
4	Avoid existing underground cable and existing high voltage line guy wires during construction
5	Remove portion of existing sidewalk of overpass and open cut section of embankment to construct 24-inch transmission main into south side of Ellis St. paralleling existing 24-inch sanitary sewer.
6	Bore and jack 36-inch steel casing beneath Ellis Street. Bridge crossing Madera Irrigation District Lateral 24.2 Canal. Steel casing will be approximately 10 feet below bridge foundation and 150 feet long.

1.7 Tank Location Evaluation

Carollo evaluated the eight potential tank site locations shown on Figure 5. The eight sites were grouped into four groups and evaluated using the following criteria:

- Need for additional supporting utilities.
- Site access.
- Environmental conditions.
- Availability of the land.

QK found that none of the proposed sites present a high risk to sensitive biological resources. Electrical utilities are available along Ellis Street and will require additional routing by PG&E once a site is selected. It was assumed that this effort will equally impact each site. Each site is accessible via existing road right of way and will require a driveway developed for City staff access.

The vicinity of storm drain facilities and offsite water and transmission main to supply the tank from Well 38 varies across the different site groups. It was assumed that the storm drain facilities will be connecting to planned facilities outlined in the City of Madera Storm Drain Master Plan. Figure 5 shows the tank site groups and Table 11 lists the groups, sites included, and description of the group. These sites were grouped based on relatively similar costs to connect to the transmission main and storm drain facilities in Ellis Street and the required work to make improvements to the site.

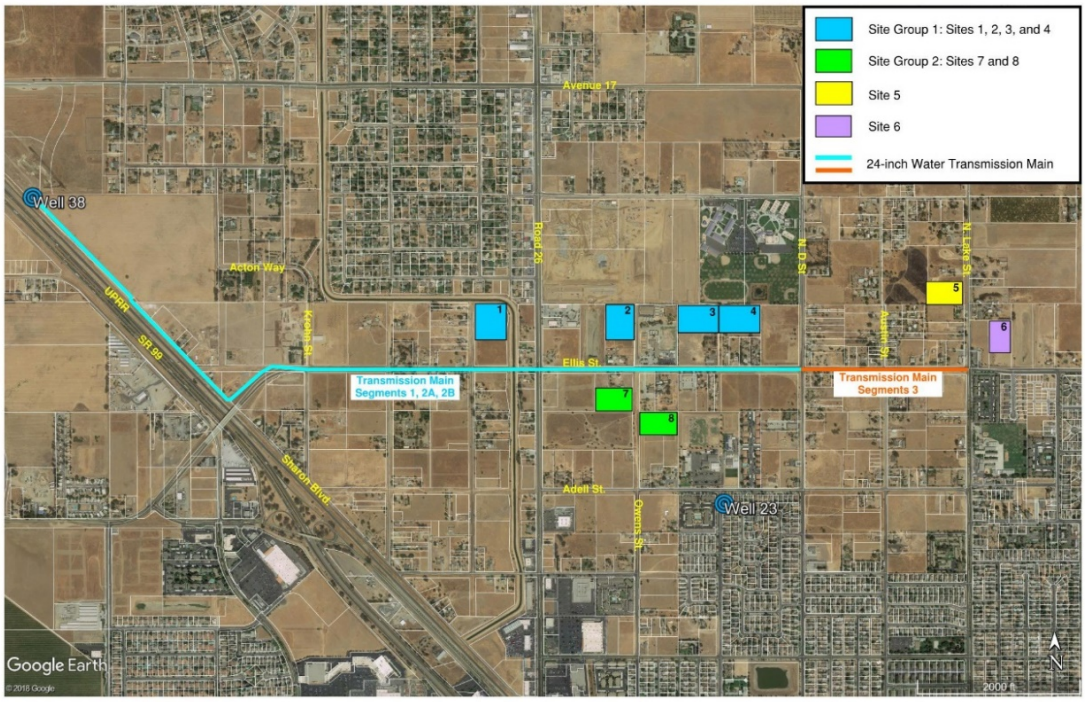


Figure 5 Tank Site Group Locations

Table 11 Tank Site Group Descriptions

Site Group	Sites Included	Site Group Description
Site Group 1	1, 2, 3 and 4	• All four sites require approximately 500 LF of offsite piping to connect to the proposed 24- inch transmission main. • All four sites require the same driveway development • All four sites requires approximately 500 LF of Storm Drain facilities to connect to the City's Planned Storm Drain system
Site Group 2	7 and 8	• Both sites need approximately 600 LF of offsite piping to connect to the proposed 24- inch transmission main • Both sites require the same drive development. • Both sites requires approximately 600 LF of offsite storm drain facilities to connect to the City's Planned Storm Drain system
Site Group 3	5	• Need approximately 800 LF of offsite piping and the Segment 3 24-inch transmission main to connect to segments 1, 2A and 2B. • Site 5 can be directly accessed from N. Lake Street and require minimal driveway development. • Site 5 requires approximately 75 LF of offsite storm drain facilities to connect to the City's Planned Storm Drain system
Site Group 4	6	• Need approximately 350 LF of offsite piping and the Segment 3 24-inch transmission main to connect to segments 1, 2A and 2B. • Site 6 requires driveway development off of Ellis Street. • Site 6 requires approximately 25 linear feet of storm drain facilities to connect to the City's Planned Storm Drain system.

1.8 Tank Site Configuration

Figure 6 shows a conceptual tank site configuration for the 2.5-MG and 3.25-MG tank options, and both include accommodations for a similar size concrete tank to be constructed in the future. Figure 7 shows the 5-MG tank configuration and does not include a future tank. The following are key points of the layout:

- Tank will be approximately 35 feet tall and buried 5 feet, so 30 feet of tank will be visible.
- Larger volume is provided by increasing the tank footprint.
- The perimeter of the site will have a 20-foot landscaping buffer for visual screening.
- Sites range from approximately 2.2 to 2.4 acres.
- Site includes electrical and chemical building, pump station, generator/transformer, yard piping, and parking areas all on site.
- Offsite storm drainage will connect to the planned City Storm Drain facilities.

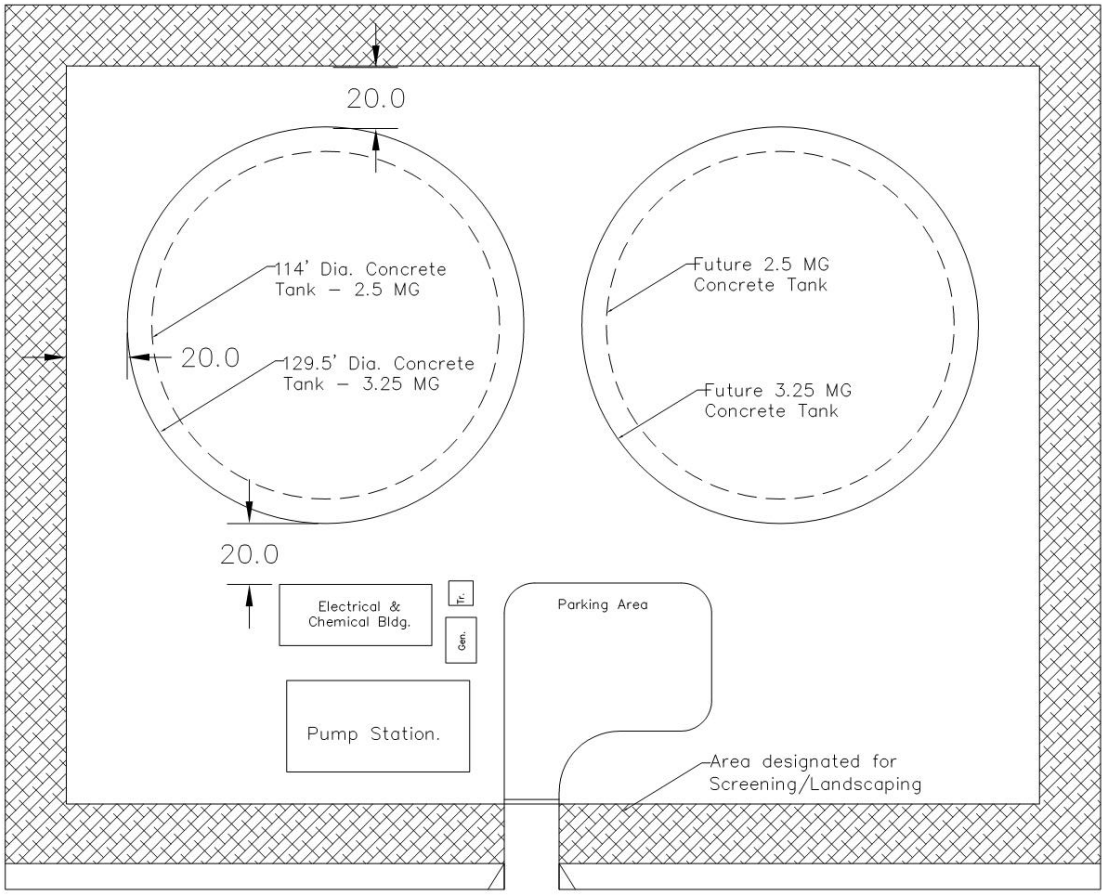


Figure 6 Typical Site Configuration for 2.5 or 3.25-MG Concrete Tank

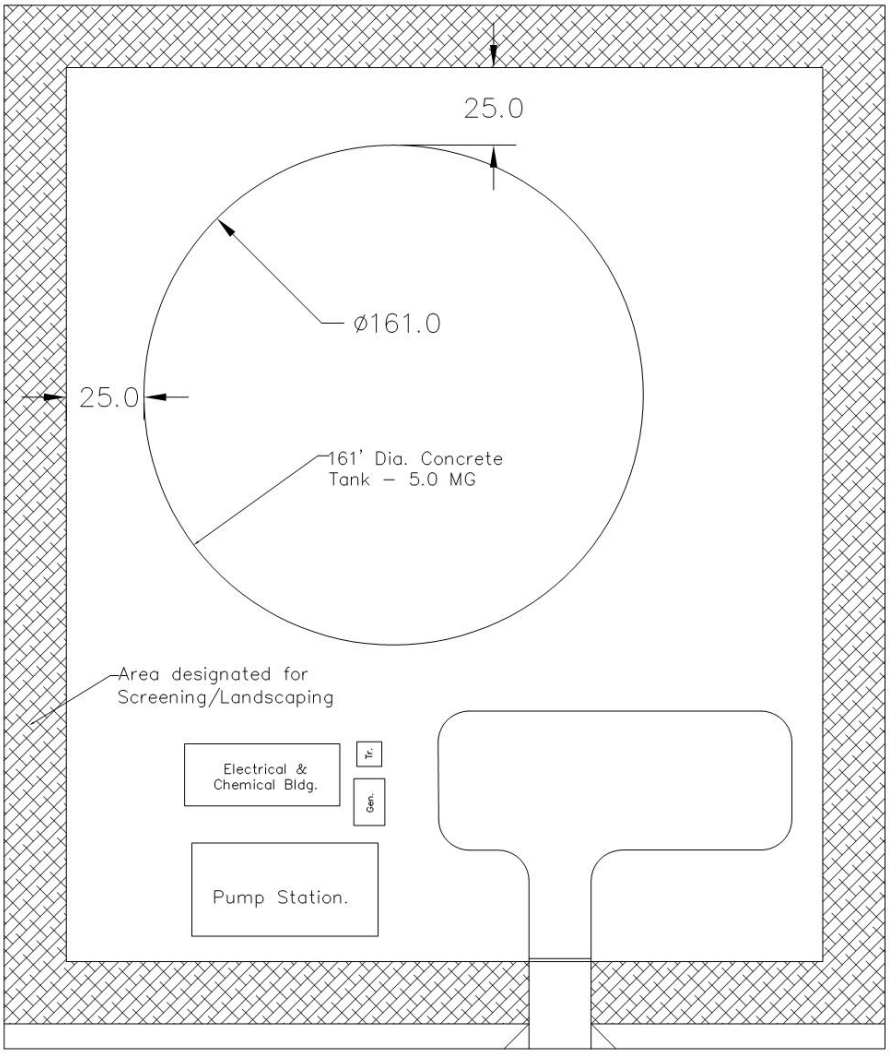


Figure 7 Typical Site Configuration for 5-MG Concrete Tank

1.9 Budgetary Cost Estimate

The budgetary cost estimate has been split into on-site costs and off-site costs. On-site costs include the tank, yard piping, booster pump station, electrical building, screening, and fence and offsite costs include the connection to the transmission main, the transmission main needed to operate the tank, driveway access, and utilities. As discussed in the previous section, the four site groups are defined based on the different offsite costs associated with each group, therefore a budgetary estimate for the three tank sizes options, 2.5, 3.25, and 5 MG, was developed for each site group. The following assumptions were used in developing the budgetary cost estimate.

- Offsite storm drain will connect to City of Madera's planned storm drain facilities.
- Bore and Jack beneath Madera Irrigation District Lateral 24.2 Canal is a 36-inch steel casing.
- Land cost is not included.
- Total project construction contingency, 20 percent of total direct costs.

- Engineering design, 10 percent of total direct costs.
- Administrative and legal, 5 percent of total direct costs.
- Construction management, 10 percent of total direct costs.

Tables 12, 13 and 14 list the total onsite costs and the total project costs for a 2.5, 3.25, and 5-MG concrete tank, respectively. The costs provided are subject to change once a site selection has been finalized.

Table 12 2.5-MG Concrete Tank Project Budgetary Cost Estimate

Tank Site Groups	Group 1	Group 2	Group 3	Group 4
Sites Included	**1, 2, 3, & 4**	**7 & 8**	**5**	**6**
Pipe Segments Included	**1, 2A, 2B**	**1, 2A, 2B**	**1, 2A, 2B, 3**	**1, 2A, 2B, 3**
Tank and Onsite Improvements	$9,435,000	$9,435,000	$9,435,000	$9,435,000
Access Driveway	$50,000	$60,000	$7,500	$30,000
Offsite Storm Drain	$150,000	$180,000	$22,500	$7,500
Transmission Main	$2,064,500	$2,064,500	$2,474,500	$2,474,500
Tank/Transmission Main Connection	$100,000	$120,000	$180,000	$60,000
Bore and Jack Beneath Canal	$470,000	$470,000	$470,000	$470,000
Construction Cost Subtotal	**$12,269,500**	**$12,329,500**	**$12,589,500**	**$12,477,000**
Construction Contingency	20 percent			
Construction Contingency	$2,454,000	$2,466,000	$2,518,000	$2,496,000
Total Construction Cost	**$14,723,500**	**$14,795,500**	**$15,107,500**	**$14,973,000**
Engineering	10 percent of construction total			
Administrative and Legal	5 percent of construction total			
Construction Management	10 percent of construction total			
Project Markup Subtotal	**$3,681,000**	**$3,699,000**	**$3,777,000**	**$3,744,000**
Total Project Cost	**$18,405,000**	**$18,495,000**	**$18,885,000**	**$18,717,000**

Table 13 3.25 MG Concrete Tank Project Budgetary Cost Estimate

Tank Site Groups	Group 1	Group 2	Group 3	Group 4
Sites Included	**1, 2, 3, & 4**	**7 & 8**	**5**	**6**
Pipe Segments Included	**1, 2A, 2B**	**1, 2A, 2B**	**1, 2A, 2B, 3**	**1, 2A, 2B, 3**
Tank and Onsite Improvements	$10,463,000	$10,463,000	$10,463,000	$10,463,000
Access Driveway	$50,000	$60,000	$7,500	$30,000
Offsite Storm Drain	$150,000	$180,000	$22,500	$7,500
Transmission Main	$2,064,500	$2,064,500	$2,474,500	$2,474,500
Tank/Transmission Main Connection	$100,000	$120,000	$180,000	$60,000
Bore and Jack Beneath Canal	$470,000	$470,000	$470,000	$470,000
Construction Cost Subtotal	**$13,297,500**	**$13,357,500**	**$13,617,500**	**$13,505,000**
Construction Contingency	20 percent			
Construction Contingency	$2,660,000	$2,672,000	$2,724,000	$2,701,000
Total Construction Cost	**$15,957,500**	**$16,029,500**	**$16,341,500**	**$16,206,000**
Engineering	10 percent of construction total			
Administrative and Legal	5 percent of construction total			
Construction Management	10 percent of construction total			
Project Markup Subtotal	**$3,990,000**	**$4,008,000**	**$4,086,000**	**$4,052,000**
Total Project Cost	**$19,948,000**	**$20,038,000**	**$20,428,000**	**$20,258,000**

Table 14 5 MG Concrete Tank Budgetary Cost Estimate

Tank Site Groups	Group 1	Group 2	Group 3	Group 4
Sites Included	**1, 2, 3, & 4**	**7 & 8**	**5**	**6**
Pipe Segments Included	**1, 2A, 2B**	**1, 2A, 2B**	**1, 2A, 2B, 3**	**1, 2A, 2B, 3**
Tank and Onsite Improvements	$12,503,000	$12,503,000	$12,503,000	$12,503,000
Access Driveway	$50,000	$60,000	$7,500	$30,000
Offsite Storm Drain	$150,000	$180,000	$22,500	$7,500
Transmission Main	$2,064,500	$2,064,500	$2,474,500	$2,474,500
Offsite Piping Cost	$100,000	$120,000	$180,000	$60,000
Bore and Jack Beneath Canal	$470,000	$470,000	$470,000	$470,000
Construction Cost Subtotal	**$15,337,500**	**$15,397,500**	**$15,657,500**	**$15,545,000**
Construction Contingency	20 percent			

Table 14 5 MG Concrete Tank Budgetary Cost Estimate (continued)

Tank Site Groups	Group 1	Group 2	Group 3	Group 4
Construction Contingency	$3,068,000	$3,080,000	$3,132,000	$3,109,000
Total Construction Cost	**$18,405,500**	**$18,477,500**	**$18,789,500**	**$18,654,000**
Engineering	10 percent of construction total			
Administrative and Legal	5 percent of construction total			
Construction Management	10 percent of construction total			
Project Markup Subtotal	**$4,602,000**	**$4,620,000**	**$4,698,000**	**$4,664,000**
Total Project Cost	**$23,008,000**	**$23,098,000**	**$23,488,000**	**$23,318,000**

1.10 Construction Phasing Options

The demand analysis presented three different water storage options.

- Constructing a single 2.5-MG tank at this time and a second 2.5-MG tank in 2030.
- Constructing a single 3.25-MG tank at this time and an additional tank in the future.
- Constructing a single 5.0-MG tank.

Using the tank site capital costs presented in Tables 12, 13, and 14, the total cost of tank ownership for each option, including financing costs, is presented in Table 15 for comparison purposes.

Hydraulic modeling scenarios show that the system currently cannot fully utilize more than 2.0 MG of operational storage without additional supply and growth in demand. If operations are not changed during low demand periods or if demand growth does not occur, the tank will have a low water turnover rate which may lead to water quality issues that could include excessive water age and disinfection residual loss.

Table 15 Total Financed Cost of Each Tank Size

	2.5 MG Concrete Tank	2.5 MG Concrete Tank (Future)	3.25 MG Concrete Tank	5 MG Concrete Tank
Tank Site Capital	$9,435,000	$6,447,000	$10,463,000	$12,503,000
Years Financed	2020-2050	2030 - 2060	2020-2050	2020-2050
Total Financed	$18,413,000	$12,582,000	$20,419,000	$24,400,000

Notes:
(1) A 5 percent interest rate is used as the typical bond finance rate.
(2) A 2.56 percent rate is used to project present worth.

1.11 Conclusions and Recommendations

Based on the results of the analyses described in this technical memorandum, Carollo recommends that the City move forward with the design and construction of a 2.5-MG prestressed concrete tank and associated transmission main. Constructing a 2.5-MG tank will allow the City to achieve its goals of improving system reliability in the short- and medium-term to serve existing users at the lowest capital cost. A 2.5-MG tank will meet system storage requirements and will also include a 20 percent volume buffer for drought resilience and future growth in demand in the short- and medium-term.

Appendix A

DEMAND ANALYSIS

CITY OF MADERA

TECHNICAL MEMORANDUM

NORTHEAST TANK DESIGN SUPPORT

Preliminary

April 2019

AKEL
ENGINEERING GROUP, INC.

AKEL
ENGINEERING GROUP, INC.

April 18, 2019

City of Madera
205 W. Fourth Street
Madera, CA 93637

Attention: Mrs. Ellen Bitter, P.E.
Project Manager

Subject: Technical Memorandum – Northeast Tank Design Support

Dear Ellen:

We are pleased to submit this letter report documenting the hydraulic analysis results and evaluation of tank and booster station sizing options for the Northeast Madera Tank Facility (NE Tank). This analysis evaluates the tank and booster station sizing options, as well as the potential for phasing the tank construction based on system capacity and demand needs. The evaluation is intended to aid City staff in the design and decision making process for the construction of the NE Tank.

1.0 BACKGROUND AND PURPOSE

The City of Madera completed their Water System Master Plan in September 2014 (2014 WSMP), and which planned for the phased and orderly growth of the water infrastructure to meet the development needs of the 2009 General Plan. This Master Plan evaluated the need for improvements to service growth and specifically, supply requirements due to adverse water quality conditions in parts of the City. Two alternatives were evaluated within the 2014 WSMP:

- **Alternative 1:** Continue to place wells where development occurs, and treat the wells that have adverse water quality conditions.
- **Alternative 2:** Construct two new tanks on the east side of the system, and utilize booster stations to meet the demands of a new east pressure zone. This alternative was selected as the “Preferred” alternative for servicing future development.

Subsequent to the 2014 WSMP, California experienced the worst drought in its modern history. The City of Madera was impacted significantly, with multiple well failures over the course of the drought. As such, the City has begun the process of designing the first tank site, and evaluating phasing options.

Akel Engineering Group (AEG) entered into a contract with the City of Madera to complete a hydraulic model evaluation of the tank and associated booster pump station, and to provide design support services for the sizing of each. This letter report documents the results of the evaluation.

2.0 PLANNING ASSUMPTIONS

Several meetings were conducted with City staff to outline the growth planning assumptions for the City of Madera, and to identify a near-term planning phase for the tank implementation. City staff generally consider the initial phase of the tank site to be a ten-year project, with growth being reassessed as development conditions change. In an effort to identify the areas of potential growth within the 10-year planning horizon, AEG met with City planning and engineering staff to identify broad areas of planned development.

2.1 Land Use Planning

The land use planning evaluation that was included as part of this analysis was based on the General Plan land use, and areas specifically identified by City staff as having the potential to develop within the next 10 years. Seven specific areas were identified by staff for development in the 10 year horizon, and as shown on **Figure 1**. Each area was labeled for reference purposes and the buildout population of the area was documented based on the General Plan land use densities.

2.2 Population Planning

In order to adequately plan the 10 year growth period, current City-wide population growth projections were evaluated for the purposes of accurately projecting the demand needs of the future population. With respect to population planning, several recent planning documents were evaluated as shown on **Figure 2** and included in the following:

- **2014 Water System Master Plan (2014 WSMP):** This estimating methodology assumed 3.5% compounding annual growth with a baseline year of 2010. This methodology resulted in an approximate population of 220,000 people by the year 2047.
- **2015 Urban Water Management Plan (2015 UWMP):** The methodology revised the 2014 WSMP projections, and utilized a 2.0% compounding annual growth rate, with a baseline year of 2015. This methodology resulted in an approximate population of 120,000 people by the year 2047.
- **Vision 2025 General Plan EIR:** This document provided a single population estimate for 2030, and which was estimated at approximately 180,000 people.

Based on feedback from City staff, the 2014 WSMP was considered overly conservative, while the 2015 UWMP may not have adequately projected the potential growth potential within the City. Thus, a combination of the two methodologies was assumed in an effort to provide a more realistic planning projection. Accordingly, 2018 through 2032 population growth was estimated at 2.0% compounding annual, and 3.5% thereafter.

The planning areas are shown on **Figure 1** and described as follows:

- **Area 1:** This area is located in the northeastern-most portion of the planning area, and also at a distinctly higher ground elevation. Due to the ground elevation, service of this area would require a new pressure zone. This may be accomplished by isolating the new tank and providing pressure relief valves into the City, or a new separate pump specifically for service of this area. The buildout population is expected at approximately 16,800 residents, with a 10-year development population of 5,800.
- **Area 2:** This area is expected to develop in the near-term due to the addition of the new high school, and was thus included in the analysis. The buildout population is expected at approximately 6,400 residents, with a 10-year development population of 2,200.
- **Area 3:** This area has seen new development recently, and that development is expected to continue in the coming years. The buildout population is expected at approximately 3,700 residents, with a 10-year development population of 1,300.
- **Area 4:** This area has seen new development recently, and that development is expected to continue in the coming years. The buildout population is expected at approximately 10,900 residents, with a 10-year development population of 3,700.
- **Area 5:** This area is expected to begin development in the next 10 years, and master planned communities are currently being explored in this location. The buildout population is expected at approximately 10,900 residents, with a 10-year development population of 3,700.
- **Area 6:** This area is develop related to the community college plans. The buildout population is expected at approximately 6,500 residents, with a 10-year development population of 2,200.
- **Area 7:** This area is located adjacent to existing development and has been projected as a point of development in the near term planning horizon. The buildout population is expected at approximately 4,400 residents, with a 10-year development population of 1,500.

3.0 WATER SYSTEM DEMANDS

The evaluation study water demands were based on the 2014 WSMP methodology and the revised population planning assumptions discussed in a previous section. As part of this evaluation, recent production trends were evaluated to determine overall water use within the City.

The 2014 WSMP based the per capita consumption factors on the 2010 UWMP factor of 190 gallons per day per capita. The City, concurrent with the Master Plan, completed a full-scale metering program of the City water customers. As such, production has been consistently dropping (**Figure 3**). Accordingly, the gallons per day per capita values are decreasing with time as well, and as of 2017, had fallen to 124 gallons per day per capita (**Figure 4**).

Due to the extreme drought from 2012 to 2017 and the uncertain nature of water demands rebounding during periods of wetter weather, staff chose to rely on a conservative factor of 155 gallons per day per capita for planning the water system. Thus, this analysis relies on the updated planning and population assumptions documented in Section 2 of this report, and the 155 gallons per day per capita use factor. Based on these assumptions, the 2047 water demand is estimated at 22.7 million gallons per day (mgd) during average day demand conditions. This is approximately half of the 2014 WSMP estimate of 41.7 mgd (**Figure 5**).

4.0 NORTHEAST TANK SIZING ANALYSIS

The revised demands and 10-year development areas were used as the basis of sizing the northeast tank. A matrix was developed as part of the evaluation process, and is documented on **Table 1**.

4.1 Evaluation Summary

The tank sizing analysis included 15 modeling scenarios that focused on the following:

- **Planning Year.** The hydraulic modeling scenarios evaluated 2022 demands for the tank initial operations, as well as 2032 demands for the extended viability of tank operations.
- **Well Supply.** Supply scenarios, including well outages, were evaluated to determine the impact on the water systems ability to replenish the tank.
- **Northeast Tank Facility.** The scenarios evaluated whether the tank was online, the size of the tank, and the booster station size that discharged the tank volume to the system.
- **Transmission Main Segments.** Several core transmission main segments were evaluated for their need to meet system criteria, as well as their ability to convey the tank discharge to the system. These segments are also required to replenish the tank from the existing well supply.
- **Analysis Results.** The analysis results are based on the parameters set forth in the categories listed above. The results document the daily tank depletion and replenishment, the loss of volume if applicable, the site pressure setting, and pressures for various locations. Finally, the results qualify whether the scenario is capable of meeting the system performance and criteria, and whether the scenario is operationally sustainable.

4.2 Evaluation Results

The hydraulic evaluation considered varying alternatives for tank sizing, pump station sizing, and transmission main segmenting. The transmission main segments, tank and pump location, and the existing system are documented on **Figure 6** for ease of reference. The following sections discusses the needs for each category.

4.2.1 Storage Tank Sizing

The storage tank location was based on preliminary land availability and hydraulic significance. The design team will provide a more detailed evaluation of the locations, and based on other factors. Preliminary sites were identified by the design team, and are documented in **Appendix A**. This evaluation coincides more closely with locations 3 and 4 of the appendix.

The evaluation results indicate that two tank sizes are feasible for current operations and for operations within the 10 year planning horizon. The sizes were determined through an iterative process that involved evaluating the ability to deplete and replenish the storage reservoir within the maximum day, as well as the need to service future growth in the eastern portion of the City. These sizes are documented as follows:

- **2.5 Million Gallon (MG) Storage Reservoir:** This size meets maximum day demand requirements, as well as providing good turnover during maximum day conditions.
- **3.25 MG Storage Reservoir:** This size meets maximum day demand requirements, as well as providing additional volume during drought periods to relieve supply wells. However, this tank size may require additional operational efforts to utilize the full volume.

4.2.2 Pump Station Sizing

The analysis indicated that there are limitations within the existing system that do not allow for extended high volume pumping. The addition of transmission main segments allow for volumes up to 5,000 gpm, without adverse velocity impacts on the existing distribution system. Thus, this analysis assumed 5,000 gpm pumping for each scenario that included the storage reservoir.

4.2.3 Transmission Mains

The analysis evaluated the potential impacts of five segments, and which were also identified in the 2014 WSMP. It should be noted that the diameter and location of the transmission mains were updated to accommodate the change in location of the tank. The water main descriptions are shown in **Figure 6** and as follows:

- **Segment 1:** This 24-inch segment is adjacent to the tank and connects the 14-inch water main in D Street to the 12-inch water main in Country Club Drive, along Ellis Street.
- **Segment 2A:** This 24-inch segment connects to the 12-inch water main in Country Club Drive and proceeds west along Ellis Street to Sharon Boulevard.
- **Segment 2B:** This 24-inch segment connects Segment 2A to Well 38 along Sharon Boulevard.
- **Segment 3:** This 24-inch segment connects the 14-inch water main in D Street to the 12-inch water main in Ellis Street, along Ellis Street.

- **Segment 4:** This 12-inch segment connects to Segment 2A and jogs across State Route 99 via the Ellis Street overcrossing, and connecting to the existing 12-inch pipeline in Kennedy Street. The segment begins again as a 12-inch at Foxglove Way, and continues south along Granada Drive and connects to the existing 12-inch just north of Cleveland Avenue. This segment also includes the construction of Well 37.

- **Segment 5:** This 12-inch segment connects to the existing 12-inch on A Street, and continues along Road 28 and Tozer Street and connects to the existing 12-inch in Clinton Street.

Based on the hydraulic analysis results, and the ability of the tank to fill and deplete, Segments 1, 2A, 2B, and 3 are critical to the operational sustainability of the Northeast Tank facility. **Figure 7** documents the pressures in the event of a fire at Pershing Elementary School. As shown, the pressures are capable of meeting fire flow requirements with Segments 1, 2A, and 2B. However, **Figure 8** documents the tanks percent full during the same fire. As shown on the lower portion of the graphic, the tank fully depletes during the fire. Thus, Segment 3 is also recommended. It should be noted that this is also affected by the criticality of Well 23, which is the primary source of supply in the northeastern portion of the City.

5.0 CONCLUSIONS

The land use and population planning estimates results in approximately 21,200 new residents within the City of Madera by the year 2032 (**Figure 1**). Based on the increase in population and associated water demand, the City is proactively planning a critical piece of infrastructure related northeast side of town, and which has historically had lower pressures due to ground elevation. Additionally, the failure of wells in this location, and poor water quality, has necessitated the construction of the Northeast Tank Facility, and which was documented in the 2014 WSMP.

The analysis results were documented on **Table 1** and indicate that a 2.5 MG tank, with a 5,000 gpm booster station are sufficient to meet the water demand needs of the northeast area for the next 10 years. It should be noted that, in order to adequately convey water to and from the tank, and meeting fire flow requirements, transmission main segments 1, 2A, 2B, and 3 are recommended (**Figure 6**).

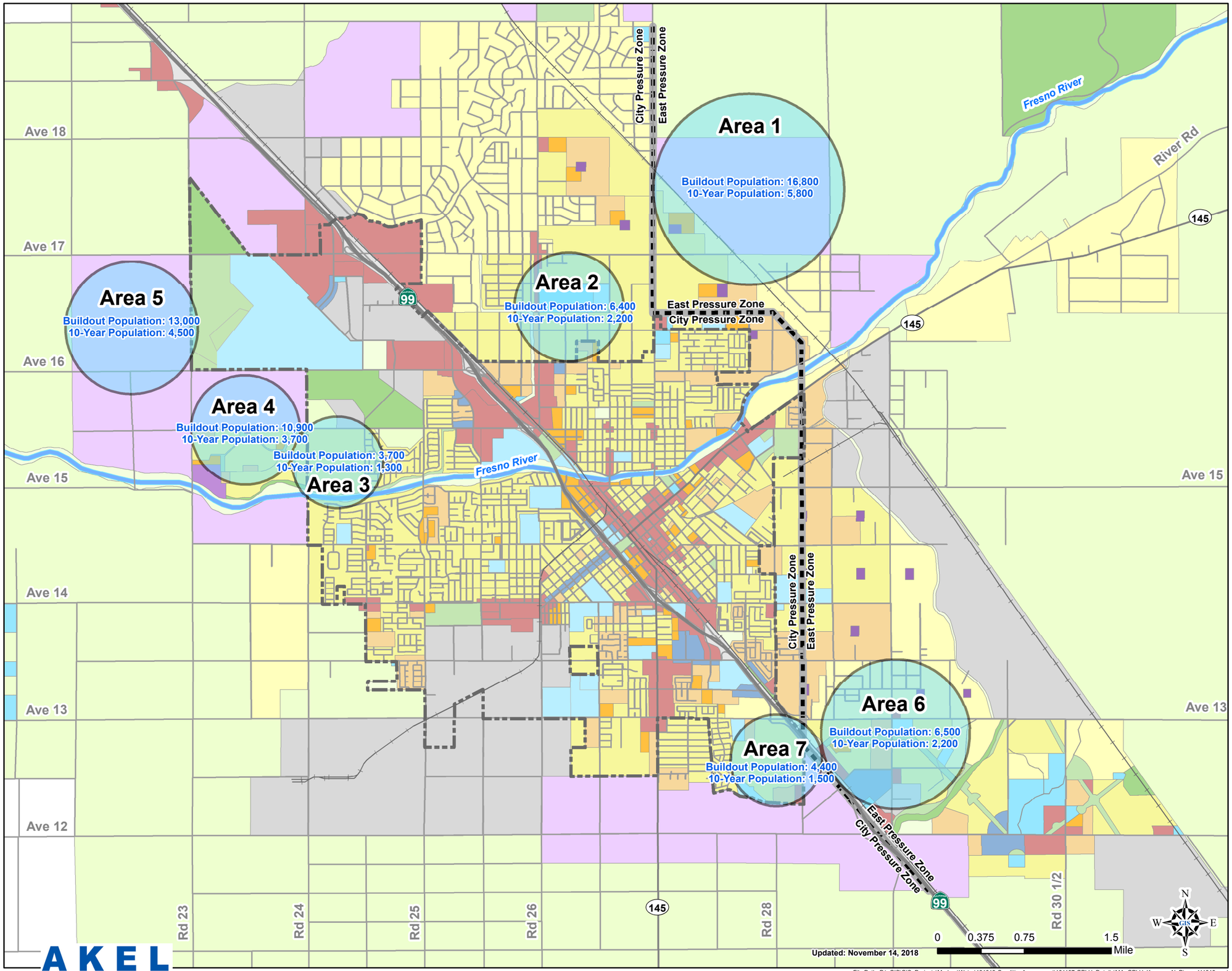
It was a pleasure working with you; Keith Helmuth, City Engineer; and other City staff on this project.

Sincerely,

AKEL ENGINEERING GROUP, INC.

Tony Akel, P.E.
Principal

FIGURES



Legend

- Streets
- Highways
- Railroads
- City Limits
- Pressure Zone Boundary
- Fresno River

General Plan Land Use

- C - Commercial
- O - Office
- I - Industrial
- VLD - Very Low Density Residential
- LD - Low Density Residential
- MD - Medium Density Residential
- HD - High Density Residential
- NMU - Neighborhood Mixed Use
- VMU - Village Mixed Use
- VR - Village Reserve
- OS - Open Space
- RC - Resource Conservation/Agriculture
- P&SP - Other Public and Semi-Public Uses

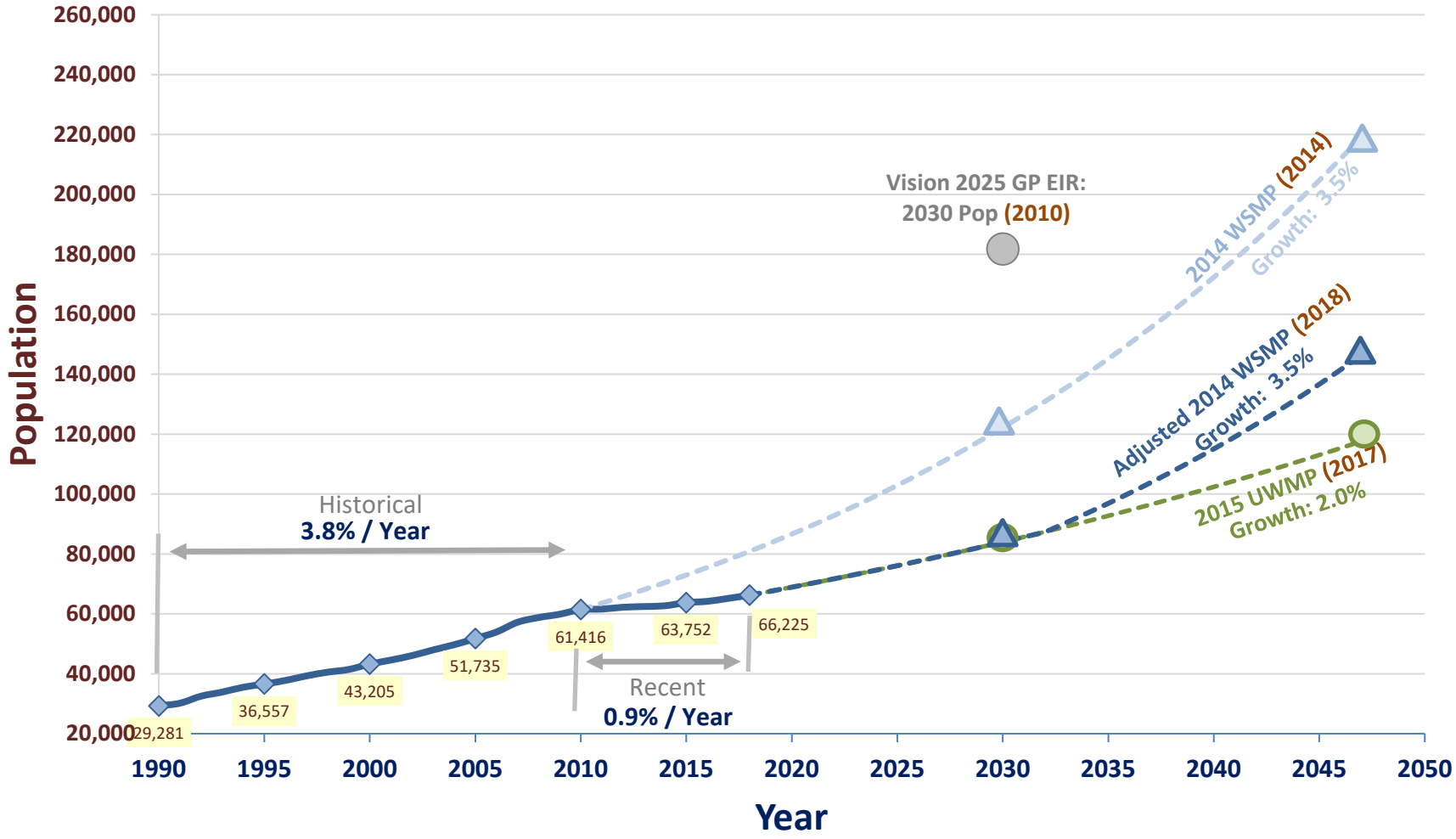
Note: 10-Year Planning Areas as identified by City Planning Staff on 11/6/2018

PRELIMINARY

Figure 1
10-Year Planning Areas

Northeast Tank Design Support
City of Madera

AKEL
ENGINEERING GROUP, INC.



LEGEND

- Historical Population
- Growth - 2015 WSMP
- 2015 UWMP
- Adjusted WSMP

PRELIMINARY

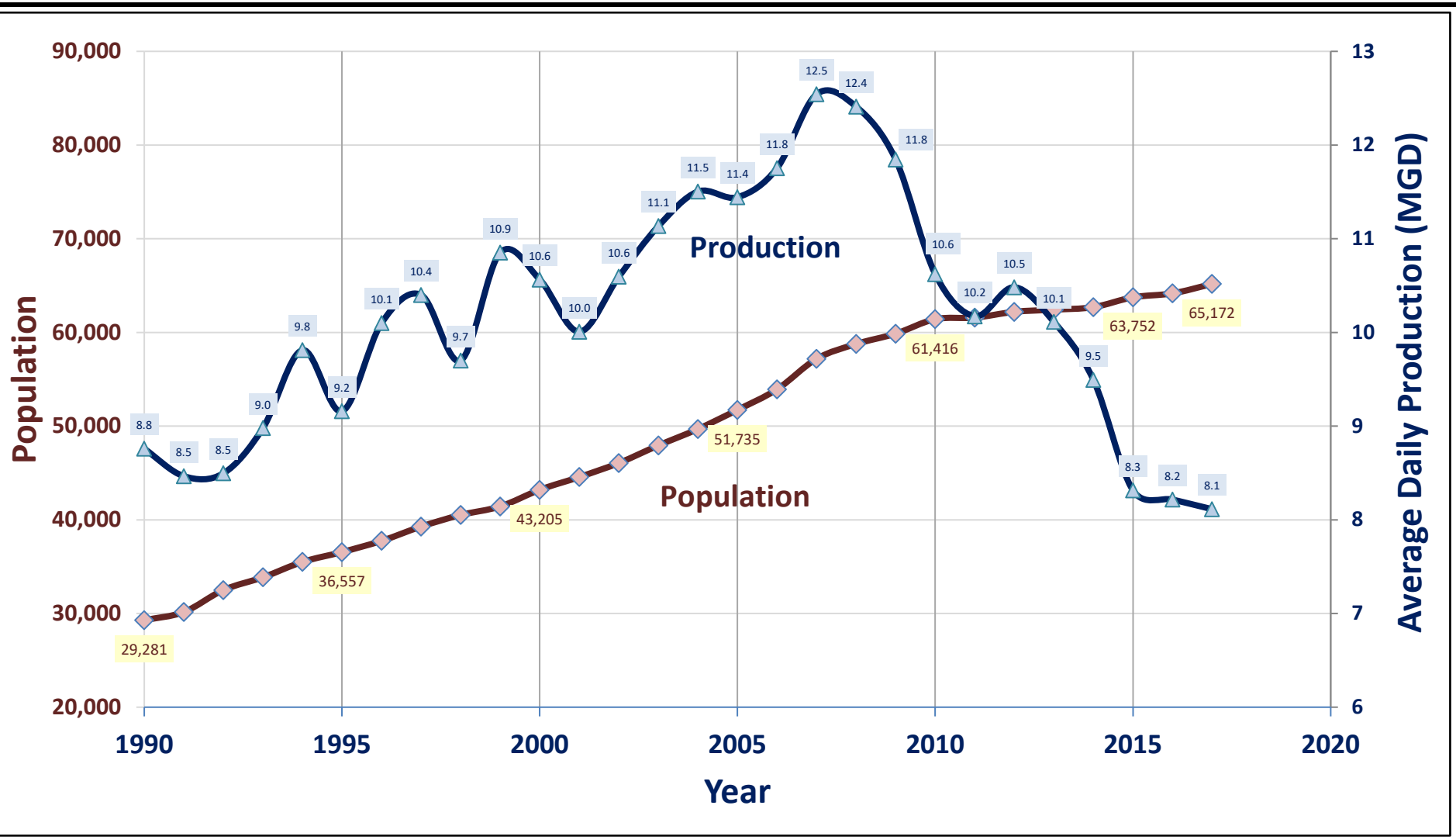
Notes:

1. Percentages shown are compounding.
2. Vision 2025 GP EIR per General Plan Update Draft EIR Table 4.3-1.
3. Estimated Vision 2025 GP population per Future Land Use, GP densities, and 3.2 people per dwelling unit.

October 25, 2018

Figure 2
Historical and Projected Population
Northeast Tank
City of Madera

AKEL ENGINEERING GROUP, INC.



LEGEND

Population

Average Daily Production (MGD)

PRELIMINARY

October 25, 2018

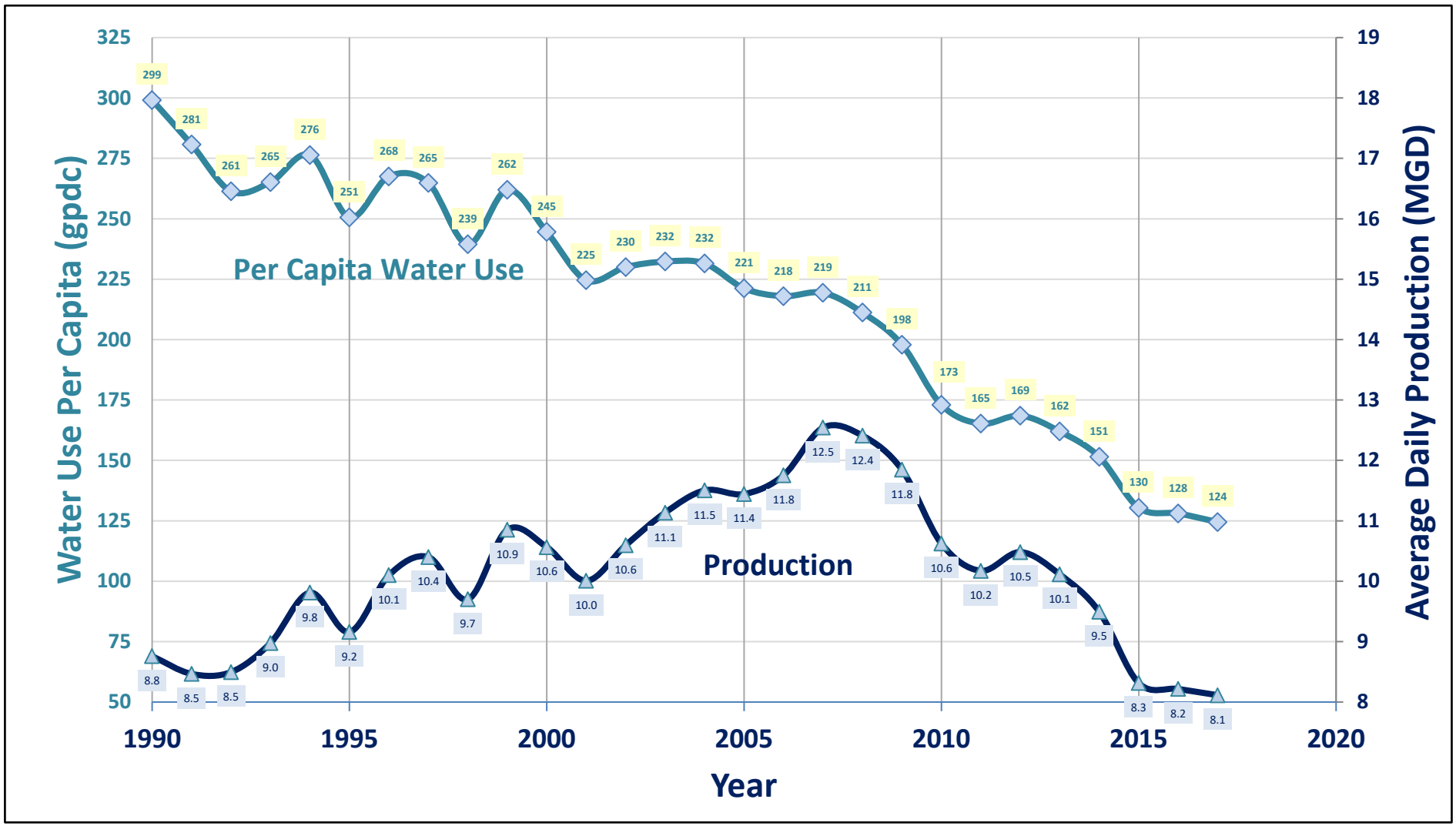
Figure 3

Historical Population vs. Average Daily Production

Northeast Tank

City of Madera

AKEL ENGINEERING GROUP, INC.



LEGEND

Per Capita Consumption (gpdc)

Average Daily Production (MGD)

PRELIMINARY

October 25, 2018

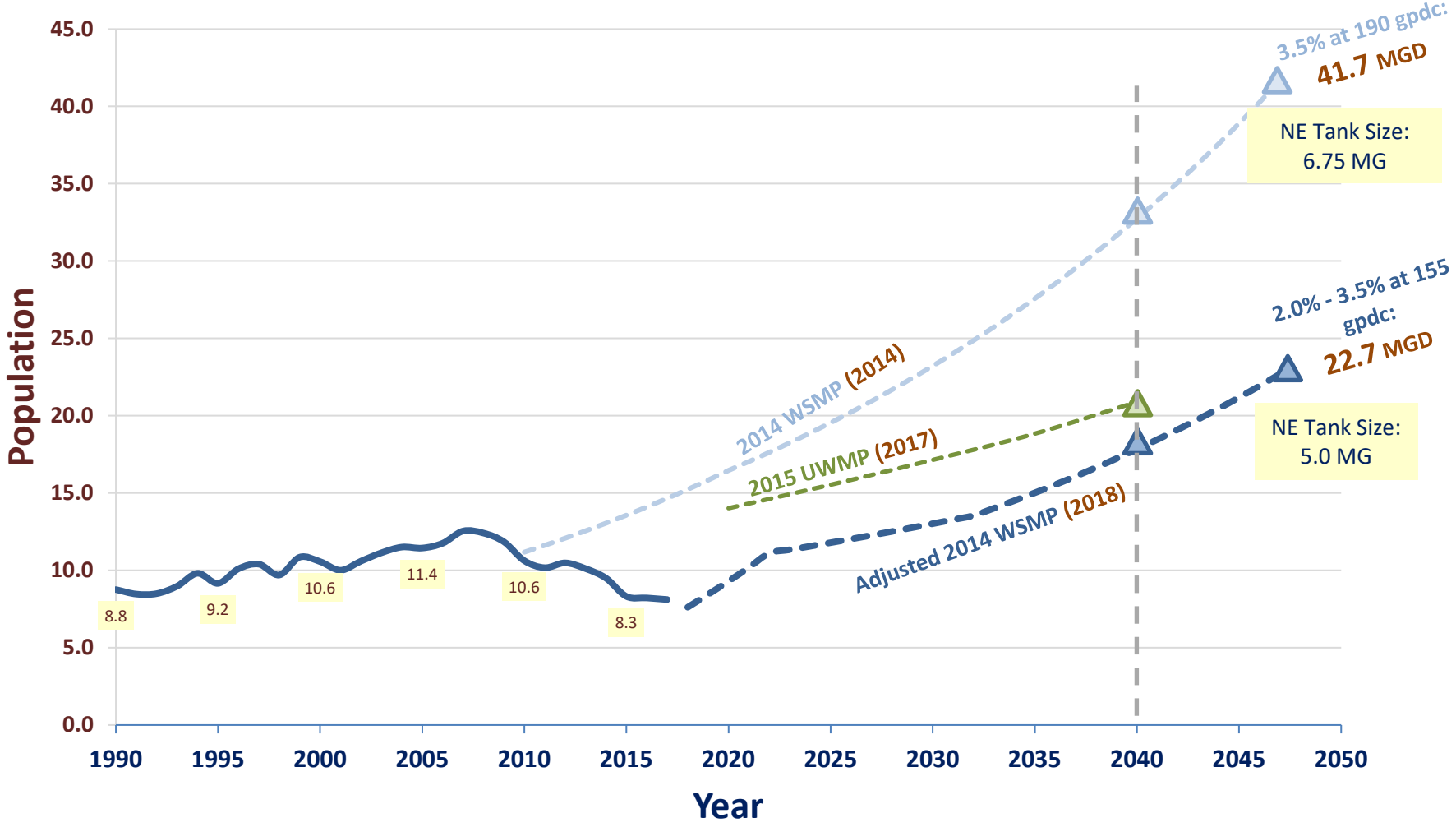
Figure 4

Water Use Per Capita vs. Average Daily Production

Northeast Tank

City of Madera

AKEL ENGINEERING GROUP, INC.



LEGEND

- Historical Production
- Growth - 2014 WSMP
- 2015 UWMP
- Adjusted WSMP

PRELIMINARY

Notes:

1. Percentages shown are compounding.
2. Vision 2025 GP EIR per General Plan Update Draft EIR Table 4.3-1.
3. Estimated Vision 2025 GP population per Future Land Use, GP densities, and 3.2 people per dwelling unit.
4. 2018 Projection assumes 2.0% growth through 2032 and 3.5% thereafter.

October 25, 2018

AKEL ENGINEERING GROUP, INC

Figure 5
Demand Projections
Northeast Tank
City of Madera

Legend

- North East Tank
- Well 37
- Lift Station

Proposed Infrastructure

- Segment 1
- Segment 2A
- Segment 2B
- Segment 3
- Segment 4
- Segment 5

Existing System

- 1 MG Tank
- Wells
- Well not in Use

Pipes

- 6" or Less
- 8"
- 10" or Greater
- City Limits
- Railroads
- Streets

PRELIMINARY

Figure 6
Infrastructure Alternatives

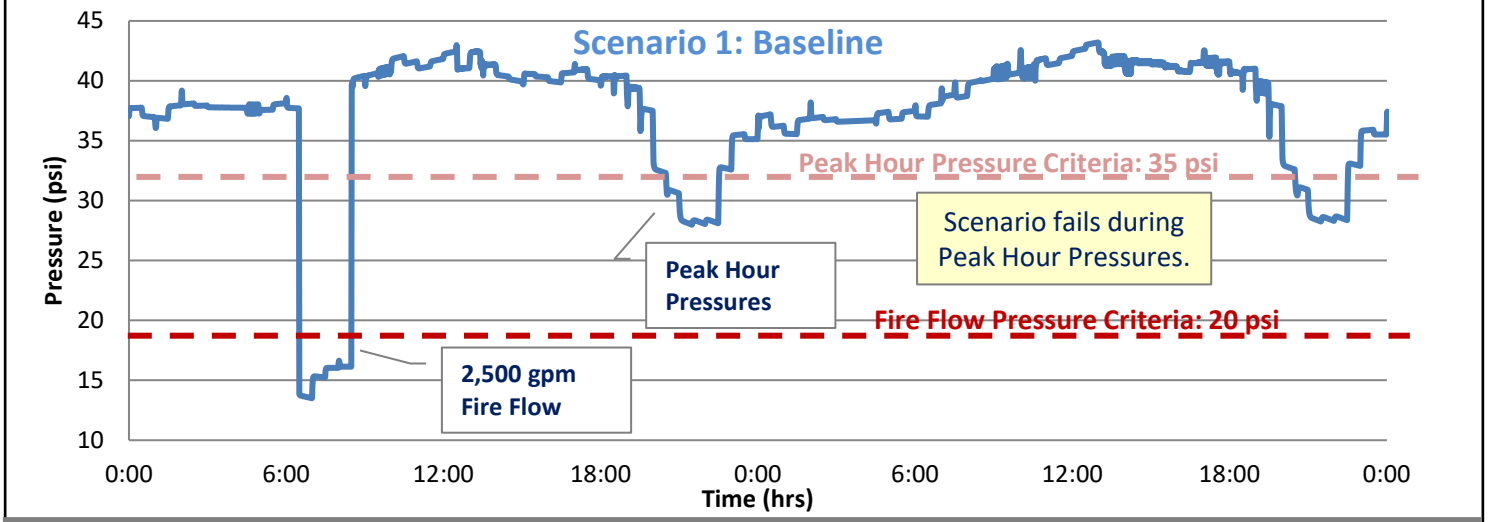
Northeast Tank Design Support
City of Madera

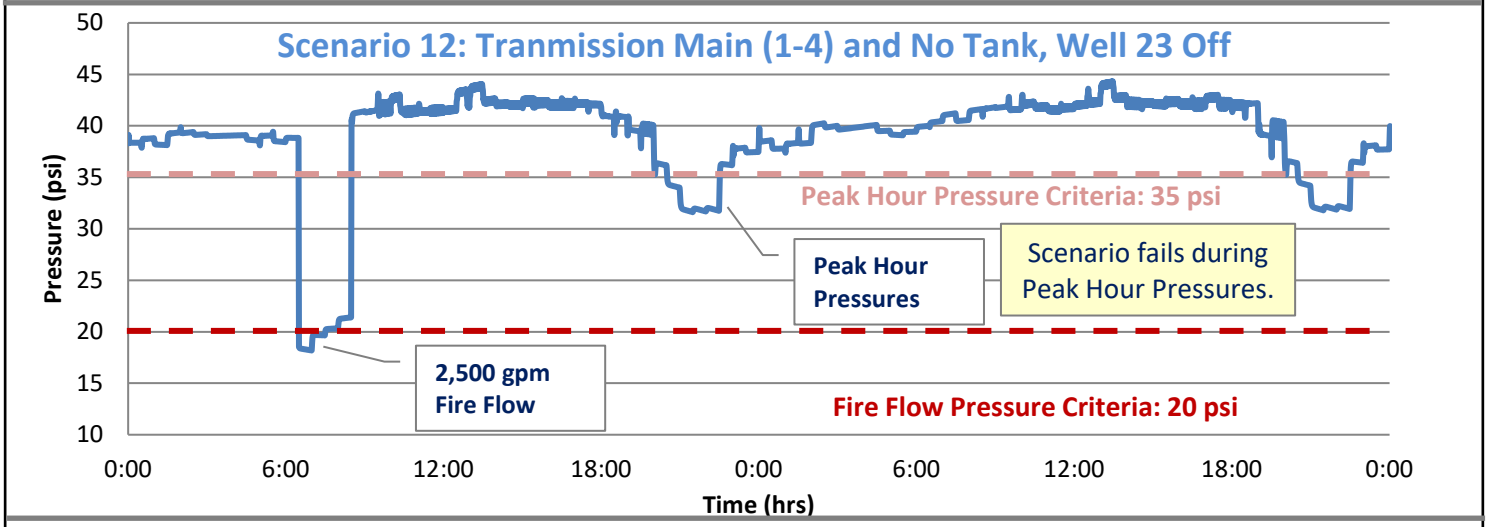
Updated: April 18, 2019

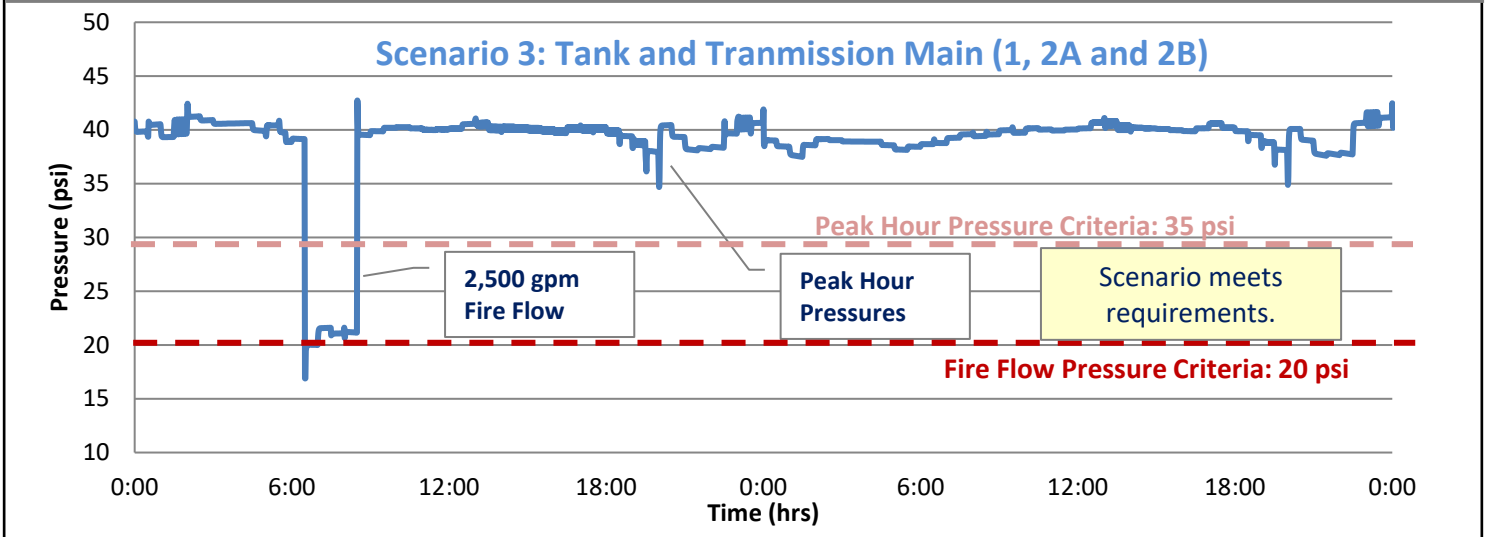
0 0.25 0.5 1 Mile

File Path: P:\xGIS\GIS_Projects\Madera\Water\161019-ConditionAssessment\MA_InfrastructureAlts_041819.mxd

AKEL ENGINEERING GROUP, INC.







NOTES:

PRELIMINARY

1. Pressures shown at the John J. Pershing Elementary School during Maximum Day Demands.

December 31, 2018

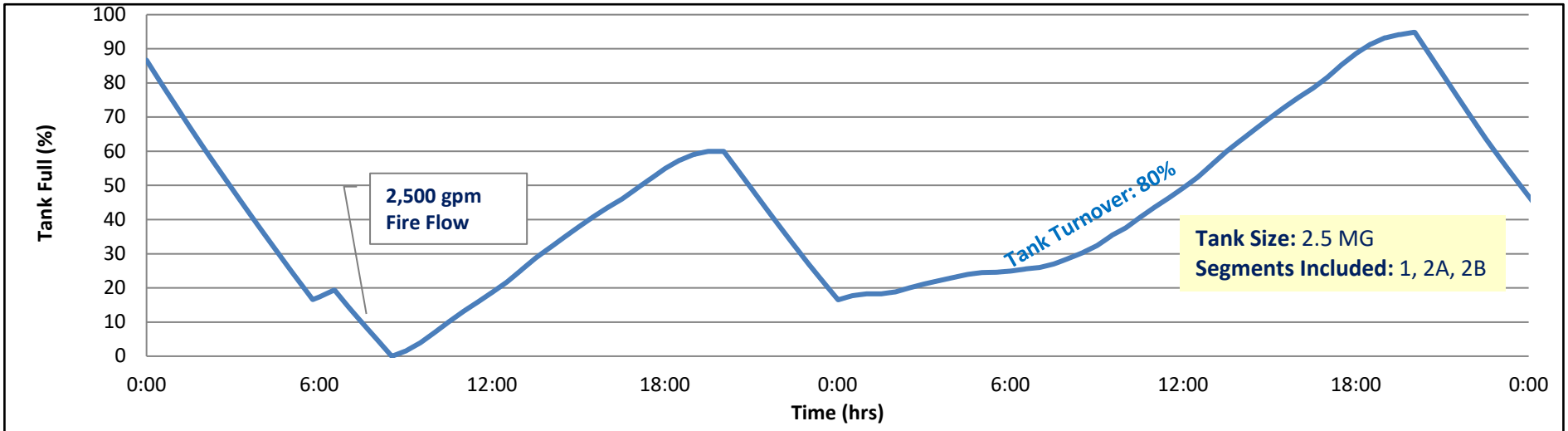
Figure 7

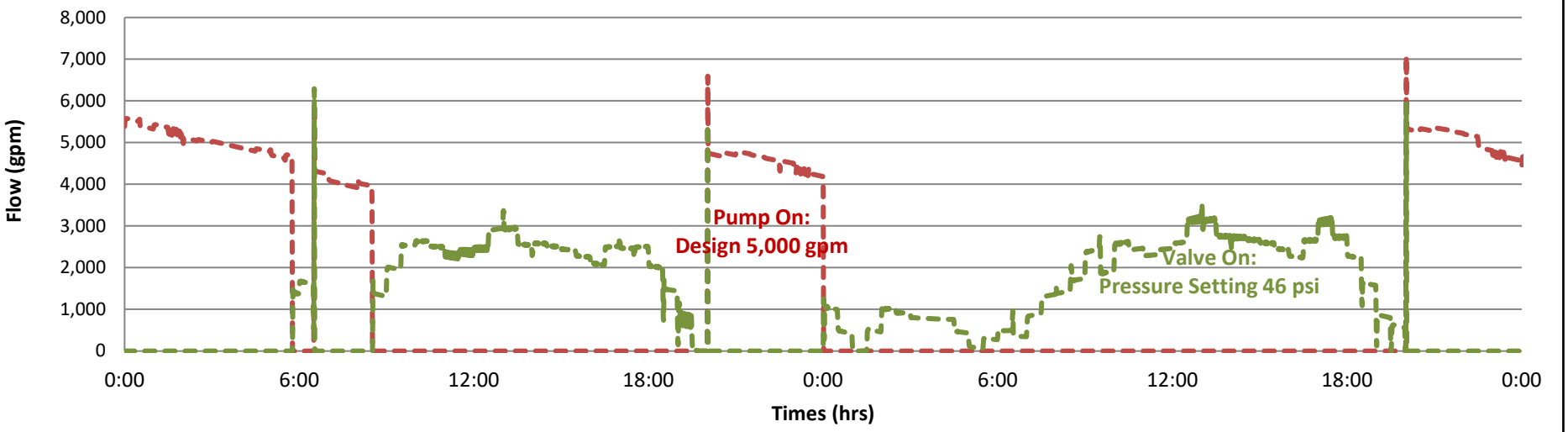
Tank Justification

NE Tank Design Support

City of Madera

AKEL ENGINEERING GROUP, INC.





LEGEND

- Tank % Full
- Pump Station Flows
- Fill Valve Flows

NOTES:

1. 2022 Maximum Day Demand conditions.
2. Segments 1, 2A and 2B are active.

PRELIMINARY

December 31, 2018

Figure 8

Tank Operations

(Minimum Req. New Facilities)

Northeast Tank Design Support

City of Madera

AKEL ENGINEERING GROUP, INC.

TABLES

Table 1 Modeled Scenarios and Analysis Results Summary

Northeast Tank Design Support
City of Madera

PRELIMINARY

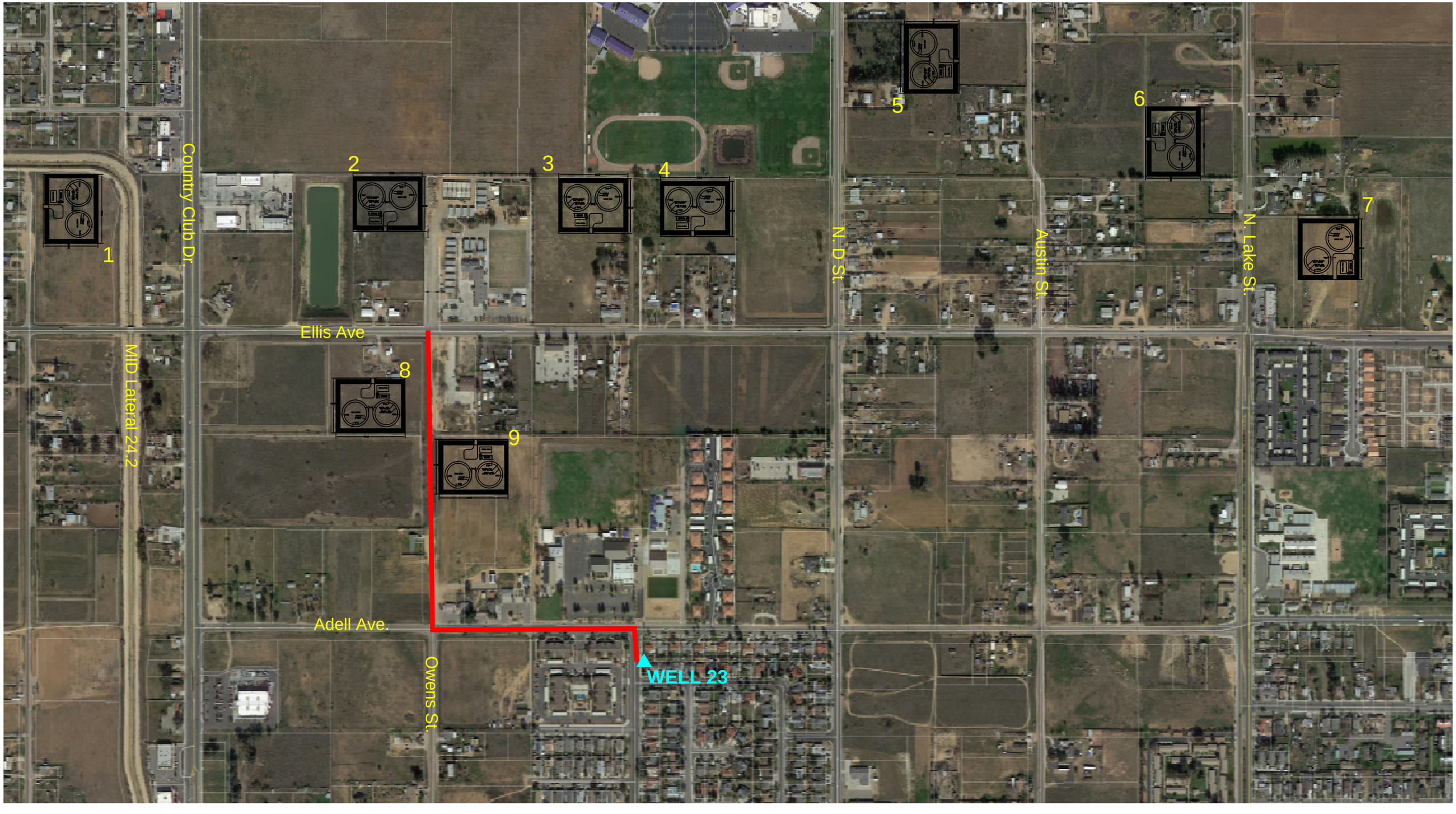
Scenario No.	Planning Year		Demands			Well Supply				NE Tank Facility					New Transmission Segments						Analysis Results								Analysis Comments	
	2022	2032	Demand Condition	Drought Planning	Projected Demand	Total Supply Production	Firm Supply Production	NE Well 23 Off	Required Additional Wells	New NE Tank Online	New NE Tank Capacity			New NE Booster Station Capacity	Segment 1	Segment 2A	Segment 2B	Segment 3	Segment 4 + Well 37	Segment 5	Tank Depletion	Tank Replenishment	Daily Volume Loss	Minimum Tank Site Pressure	NE Peak Hour Pressure	NE Maximum Pressure	Fire Flow Pressure @ 2,500 gpm[5]	Meets Criteria	Operational Sustainability	Figure
											2.5	3.25	5.0											Criteria 35	Criteria 80	Criteria 20			
1	2	3	4	5	(gpm) 6	(gpm) 7	(gpm) 8	9	10	11	(MG) 13	(MG) 14	(MG) 15	(gpm) 16	17	18	19	20	21	22	(%) 23	(%) 24	(MG) 25	(psi) 26	(psi) 27	(psi) 28	(psi) 30	31	32	33
A. Improvements without Tank																														
1	2022		MDD		15,430	22,810	21,070							n/a											29	44	14	No	No	6
2	2022		MDD		15,430	22,810	21,660	OFF						n/a	Seg 1	Seg 2A	Seg 2B	Seg 3	Seg 4						33	45	19	No	No	6
3	2022		MDD		15,430	22,810	21,070							n/a	Seg 1	Seg 2A	Seg 2B	Seg 3	Seg 4						36	46	20			
B. New Tank (Site 3 or 4[6])																														
4	2022		MDD		15,430	22,810	21,070			Tank	2.5			5,000	Seg 1	Seg 2A	Seg 2B				80%	80%		46	39	45	21			6,7
5	2022		MDD		15,430	22,810	21,070			Tank	2.5			5,000	Seg 1	Seg 2A	Seg 2B	Seg 3			80%	80%		46	39	45	23			
6	2022		MDD		15,430	22,810	21,660	OFF		Tank	2.5			5,000	Seg 1	Seg 2A	Seg 2B				80%	67%	0.3	46	38	45	21		No	
7	2022		MDD		15,430	22,810	21,660	OFF		Tank	2.5			5,000	Seg 1	Seg 2A	Seg 2B	Seg 3			80%	80%		46	39	46	22			
8	2022		MDD		15,430	22,810	21,660	OFF		Tank	2.5			5,000	Seg 1	Seg 2A	Seg 2B	Seg 3	Seg 4		80%	80%		46	39	45	25			
9	2022		MDD		15,430	22,810	21,070			Tank		3.25		5,000	Seg 1						55%	20%	1.1	46	31	43	n/a	No	No	
10	2022		MDD		15,430	22,810	21,070			Tank		3.25		5,000	Seg 1	Seg 2A	Seg 2B				63%	63%		46	39	44	n/a			
11	2022		MDD		15,430	22,810	21,070			Tank		3.25		5,000	Seg 1	Seg 2A	Seg 2B	Seg 3			63%	63%		46	39	46	n/a			
12	2022		MDD		15,430	22,810	21,070			Tank		3.25		5,000	Seg 1	Seg 2A	Seg 2B	Seg 3	Seg 4		63%	63%		46	39	47	n/a			
13	2022		MDD		15,430	22,810	21,070			Tank		3.25		5,000	Seg 1	Seg 2A		Seg 3	Seg 4		63%	49%	0.4	46	38	46	n/a		No	
14	2022		MDD		15,430	22,810	21,660	OFF		Tank		3.25		5,000	Seg 1	Seg 2A	Seg 2B	Seg 3			63%	40%	0.7	46	37	46	n/a		No	
15		2032	MDD		20,000	22,810	21,070		3	Tank		3.25		5,000	Seg 1	Seg 2A	Seg 2B	Seg 3	Seg 4	Seg 5	63%	63%		46	39	46	n/a			

Notes:

1. Demands are based on 155 gpcd.
2. Total well capacity. Scenario 8 assumes Well Number 23 is offline to document worst case standby requirement.
3. Segmenting is intended to match the Infrastructure Alternatives mapping.
4. North east pressure is assumed at Ellis Street and Chapin Street.
5. Fire flows: General northeast neighborhood - 1,500 gpm fire. Pershing Elementary - 2,500 gpm fire. Fire occurs during maximum day demands, while the tank is filling.
6. Site locations based on map provided by Carollo Engineers 12/20/2018.
7. Drought planning scenarios assume the following: No demand adjustments and supplies are reduced by 12%.

12/27/2018

APPENDIX


1
2
3
4
5
6
7
8
9
Country Club Dr.
N. D St.
Austin St.
N. Lake St.
Ellis Ave
MID Lateral 24.2
Adell Ave.
Owens St.
WELL 23

Appendix B

TRANSMISSION MAIN ROUTING ANALYSIS

601 Pollasky Avenue, Suite 301 | Clovis, CA 93612

February 20, 2019

Paul Amico
Project Manager
Carollo Engineers, Inc.
710 W Pinedale Ave
Fresno CA 93711

Subject: Updated Madera Water Tank and Pipeline Project: Route Analysis

Dear Paul:

The purpose of this letter is to provide an updated summary of the findings from the preliminary research of the possible routes for the large-diameter water transmission line along Ellis Avenue to Well 38. The Alternative Routes Exhibit attached shows three possible routes for the line to get from Ellis Avenue to Well 38. Noteworthy differences between these three routes are summarized below in order to help facilitate the decision-making process in choosing a route. The updates reference easement acquisition information for Route #3 as well as dry utility information received subsequent to the initial route analysis provided via letter dated February 7, 2019. All other items remain unchanged and remain intact in this letter.

The research efforts included a desktop analysis of biological considerations, request of existing utility information from several companies in the area, coordination with the County of Madera and Madera Valley Water in search of existing sewer and water lines, and research of existing Right of Ways and easements for the various routes.

The biological analysis did not result in any route or tank site having a higher risk than another as far as causing impacts to sensitive biological resources. It was concluded that there is a low risk that areas along the routes would support sensitive natural communities, special-status plant species, or most special-status wildlife species that occur in the region. However, an on-site survey may reveal specific areas where impacts would be more likely to occur. None of the potential tank sites were included in the Cortese list for UGST and other hazards and are all in an area of minimal flood hazard.

The dry utility research showed that AT&T and Comcast facilities in the project area are primarily overhead, but buried cable and conduit does exist. These underground utilities are mainly outside of the roadway except for where they cross streets. Level 3 fiber services also exist in the area, once again, mainly outside of the roadway, but its location should be positively identified in the design stage as these are fiber optic lines that provide services to businesses, agencies, and citizens, where interruption would be costly and disruptive to the community. PG&E plats were received after the initial route analysis letter and show that PG&E has underground gas and electrical throughout the area. The utility crossings are shallow compared to the proposed water pipeline and do not pose significant conflicts for

this alignment analysis. See attached Underground Facilities Summary Exhibit for an overview of the project area.

Route #1: This pipeline route goes from Well 38 north to Avenue 17, then east on Avenue 17 to Road 26, then south on Road 26 to Ellis Avenue, then east on Ellis Avenue

- **Right of Way**: Avenue 17 and Road 26 are fully constructed streets with curb and gutter and at least 80 feet of Right of Way. Both streets have two lanes each way with a turn lane down the middle. There looks to be at least a plan to acquire Right of Way from the dead end of Sharon north to Avenue 17.
- **Existing Water Line**: Madera Valley Water has an existing 12" water line near the south curb in Avenue 17 from just east of the canal past Road 26. This line continues north crossing Avenue 17 at Hill Drive and just east of the canal.
- **Canal Crossing**: The proposed pipeline would have to cross the existing MID Canal on Avenue 17 where there is an existing culvert supporting a fully built out road with curb and gutter. Whether local agencies would require the pipe be attached to the culvert, bored under the culvert, or the culvert can to be open cut to lay the pipe is unknown at this time.

Route #2: This route goes southeast from Well 38 along Sharon Blvd, then heads east at a point south of Acton Way to Krohn Street, then south on Krohn Street to Ellis Avenue, then east on Ellis Avenue.

- **Right of Way**: Ellis Avenue and Krohn Street have at least 80 feet of Right of Way. Ellis Avenue has one lane in each direction with shoulders and Krohn Street is dirt for approximately 750 feet north of Ellis and becomes a roughly paved road with minimal striping as it turns along action way. There is no Right of Way heading west from the bend at Action Way and Arnold Way to Sharon Blvd. There is an easement for other purposes along this leg, but an additional easement would be necessary to construct the proposed pipeline. Sharon Blvd has at least 60 feet of Right of Way.
- **Canal Crossing**: The proposed pipeline would have to cross the existing MID Canal on Ellis Avenue where there is an existing culvert supporting a paved road with shoulders. Whether local agencies would require the pipe be attached to the culvert, bored under the culvert, or the culvert can to be open cut to lay the pipe is unknown at this time.

Route #3: This route heads southeast from Well 38 along Sharon Blvd all the way to Ellis Avenue, then northeast along the new overpass and then east along Ellis Avenue.

- **Right of Way**: Ellis Avenue has at least 80 feet of Right of Way from CA 99 to Road 27 and Sharon Blvd has at least 60 feet of Right of Way. There is an existing sewer easement along the overpass which would need to be widened at least 10 feet to ensure a 10-foot separation between the existing sewer pipe and proposed water line. Easement acquisition would be necessary over parcels 038-050-001, 002, 003, 004, 007, 008, and possible 006.
- **New Construction**: The proposed pipeline would have to pass through a portion of the newly constructed overpass on Ellis Street just west of Krohn Street.

- **Canal Crossing:** As in Route #2, the proposed pipeline would have to cross the existing MID Canal on Ellis Avenue. Whether local agencies would require the pipe be attached to the culvert, bored under the culvert, or the culvert can to be open cut to lay the pipe is unknown at this time.

Sincerely,

Trisha Barlow

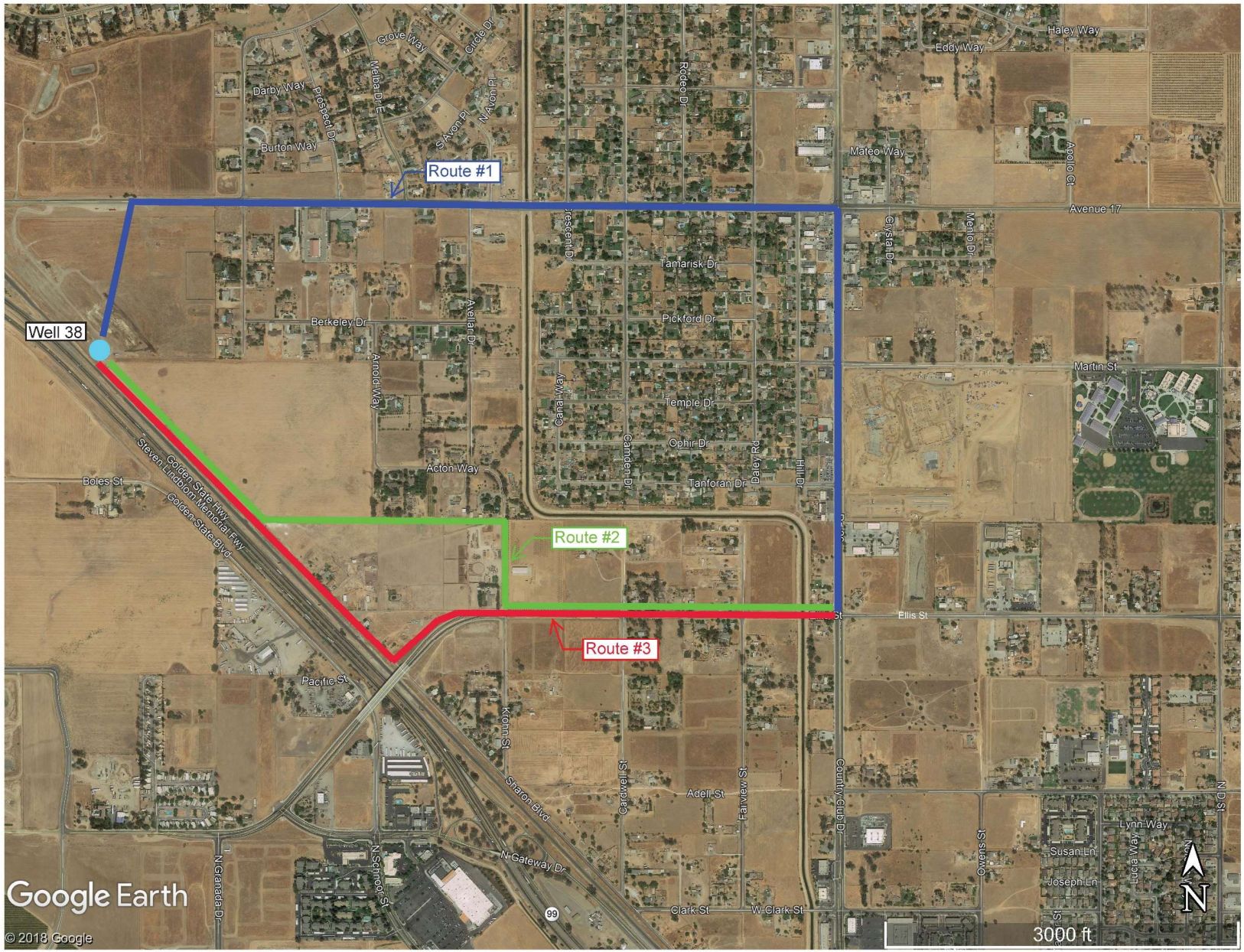
Trisha Barlow, PE
Associate Engineer

Enclosures: Alternative Routes Exhibit, Underground Facilities Summary Exhibit

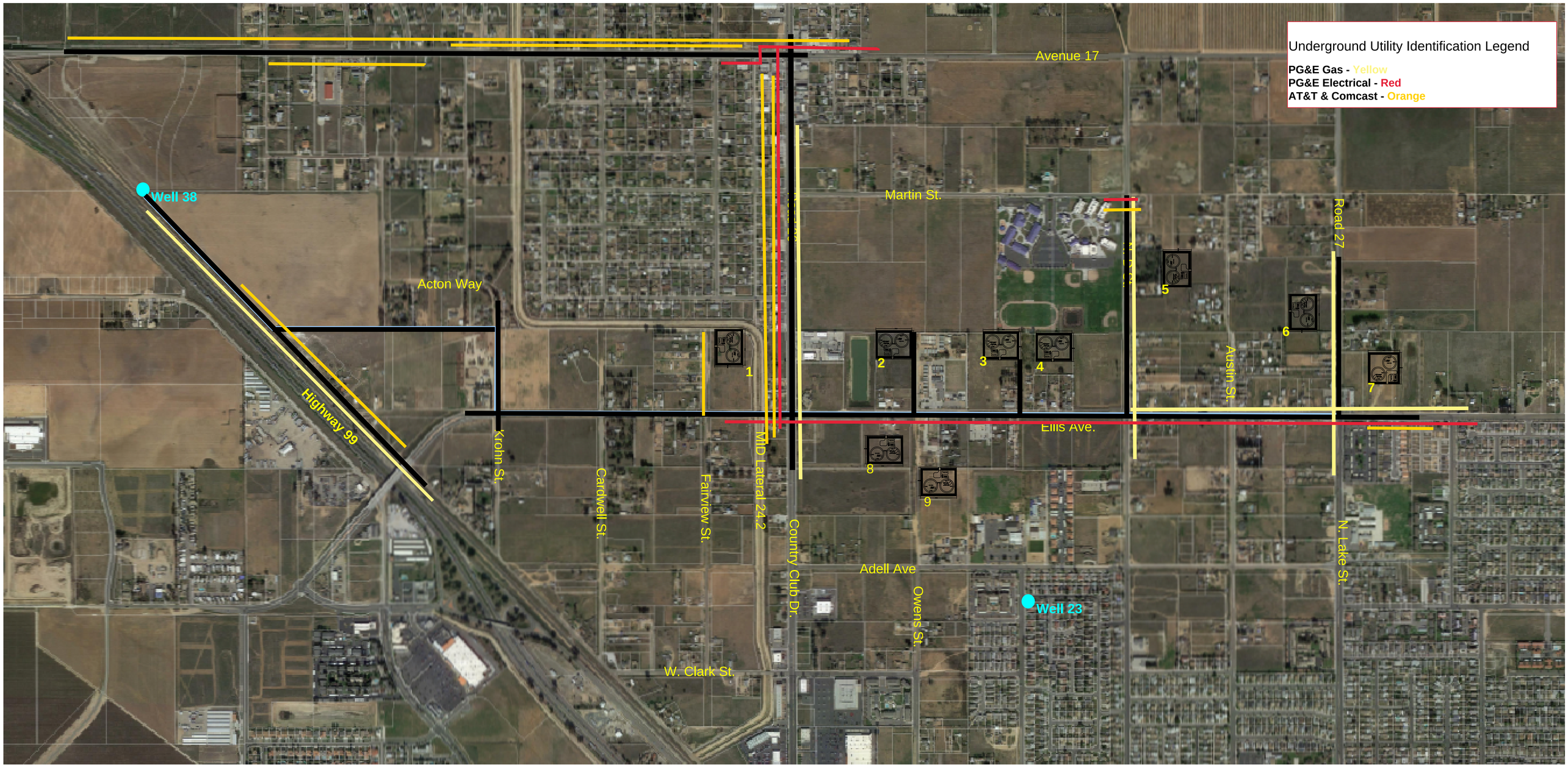
cc: Amber Adams, QK; Anthony Cemo, Carollo

180483/ 1.4 /1

TB/AA



Alternative Routes Exhibit
Madera Tank and Pipeline Project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PG&E Gas - Yellow
PG&E Electrical - Red
AT&T & Comcast - Orange
Avenue 17
Martin St.
Well 38
Acton Way
Highway 99
Krohn St.
Cardwell St.
Fairview St.
MID Lateral 24.2
Country Club Dr.
Owens St.
Austin St.
Road 27
N. Lake St.
Ellis Ave.
Adell Ave
W. Clark St.
Well 23
1
2
3
4
5
6
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8
9