Recycled Water Modeling Study

Prepared for the

Rancho Murieta Community Services District

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Prepared by

AECOM

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Acronyms and Abbreviations

ACP	asbestos cement pipe
AF	acre-feet
AFY	acre-feet per year
District	Rancho Murieta Community Services District
ft	foot or feet
gpm	gallons per minute
LF	linear feet
MAWA	maximum applied water allowance
MG	million gallons
MGD	million gallons per day
psi	pounds per square inch
RMCC	Rancho Murieta Country Club
RMCSD	Rancho Murieta Community Services District
WWRP	Wastewater Reclamation Plant

1.0 INTRODUCTION

This technical memorandum (TM) summarizes the hydraulic modeling work performed to evaluate the existing and proposed recycled water conveyance systems for the Rancho Murieta Community Services District (RMCSD). Currently, the recycled water conveyance system serves two golf courses and Van Vleck Ranch. This system is described in Section 2.1. Future residential developments are proposed in two phases, which will include expansions of the recycled water conveyance system and additional recycled water demands. The proposed improvements on transmission mains are described in Section 2.2.

In 2013 and 2014, the District conducted a feasibility study of the proposed recycled water system in support of a Title XVI grant application. The study determined the demand and supply of recycled water for existing and planned irrigation users.

The goals of this hydraulic modeling study are the following:

- Revise the proposed irrigation water users based on updated development plans.
- Evaluate the hydraulic performance of the existing and proposed recycled water systems
- Determine hydraulic constraints of the existing recycled water system
- Recommend changes, if necessary, to the proposed hydraulic improvements described in the 2014 Title XVI Recycled Water Feasibility Study (2014 Title XVI Study)
- Update cost estimates to reflect changes to the proposed improvements

This TM is organized as follows:

- Section 2.0 – Descriptions of the existing and proposed recycled water conveyance systems
- Section 3.0 – Summary of model development
- Section 4.0 – Summary of hydraulic analysis
- Section 5.0 – Cost estimates
- Section 6.0 – Study conclusions and recommendations

2.0 EXISTING AND PROPOSED RECYCLED WATER CONVEYANCE SYSTEMS

This section describes the existing and proposed recycled water transmission and distribution systems.

2.1 Existing Transmission and Distribution Systems

Existing recycled water uses are the two golf courses and the Van Vleck Ranch. The transmission system used to convey recycled water to serve these existing uses is shown in Figure 1.

2.1.1 North and South Golf Courses

The recycled water transmission and distribution systems associated with the two golf courses were installed in 1983. Since that time, recycled water has been successfully used in accordance with Title 22 and other regulatory requirements to meet golf course irrigation demands. Tertiary treated recycled water is pumped from the 1.8 MG Equalization Basin located at the Wastewater Reclamation Plant (WWRP) to Bass Lake by the Recycled Water Pump Station. Recycled water is conveyed through a 12-inch asbestos cement pipe (ACP) from the WWRP, across Highway 16, over the foot bridge (Yellow Bridge), to the 10th hole of the North Golf Course. From this point, the pipeline is reduced to an 8-inch ACP and runs east along the golf course fairways to Bass Lake.

Tertiary treated recycled water is also conveyed from the WWRP to Lake 16 of the South Golf Course by gravity through another 12-inch ACP pipeline. Lakes 16 and 17 of the South Golf Course are interconnected by a culvert. From these lakes, recycled water is pumped to Lakes 10 and 11. The pipeline from Lake 17 to Lake 11 also runs along the golf course fairways and is 8-inch ACP. The pressure rating for all ACP pipelines is 150 psi.

Irrigation pump stations are located adjacent to both Bass Lake and Lake 11. These stations continuously pump the recycled water from the lakes and pressurize the golf course irrigation systems. Multiple pumps are used to meet varying demands, and fertilizer injections systems are also present. The piping material for the irrigation systems is PVC and varies in size from 2- to 6-inch in diameter. The main irrigation distribution pipelines run along the golf course fairways with branches for the sprinkler heads. Irrigation valves are located throughout the golf courses to control the operation of the sprinkler heads. Most valves in the fairways control 3 to 4 sprinklers, while each sprinkler on the greens is generally controlled by individual control valves.

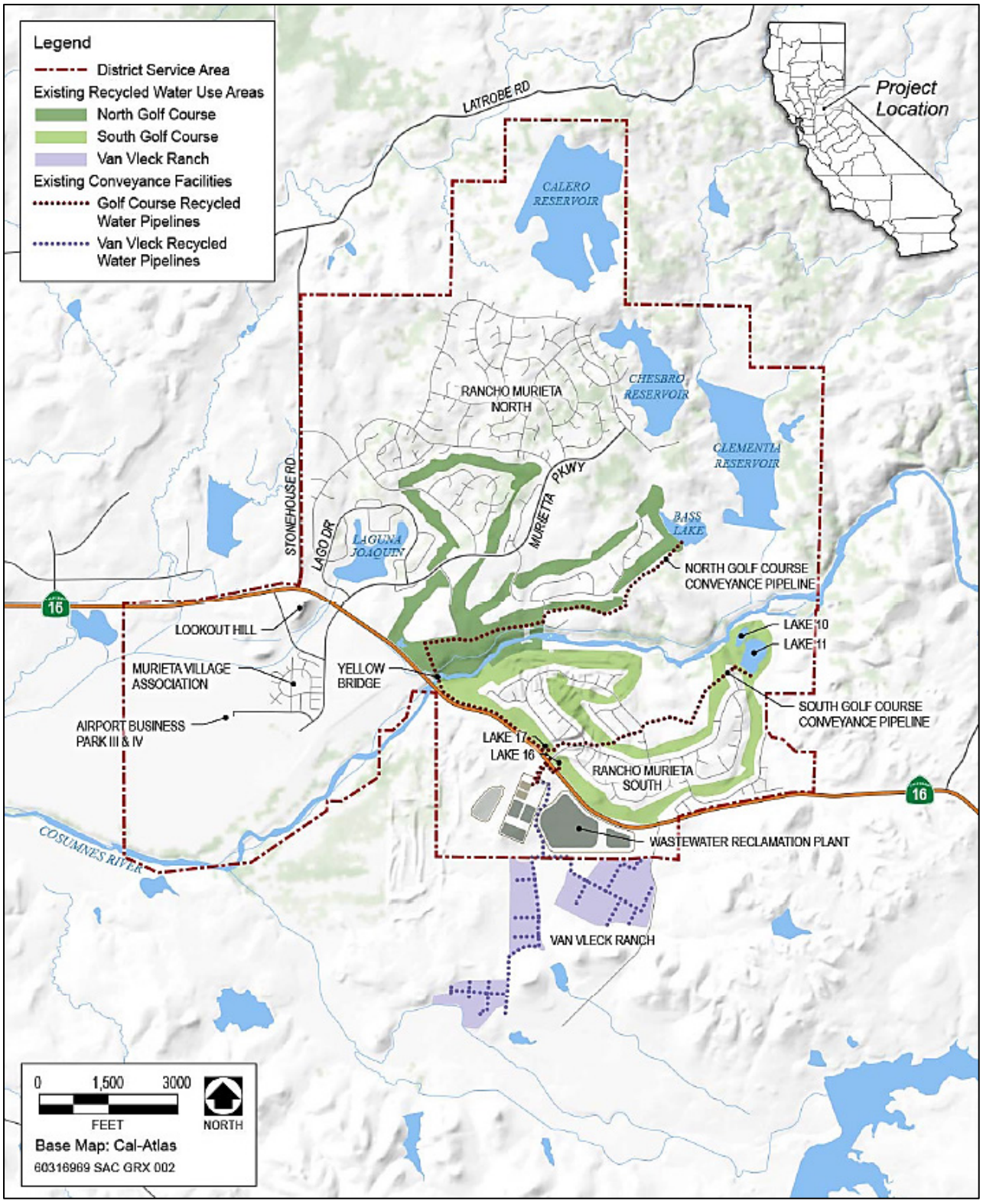


Figure 1. Existing Recycled Water Conveyance System

2.1.2 Van Vleck Ranch

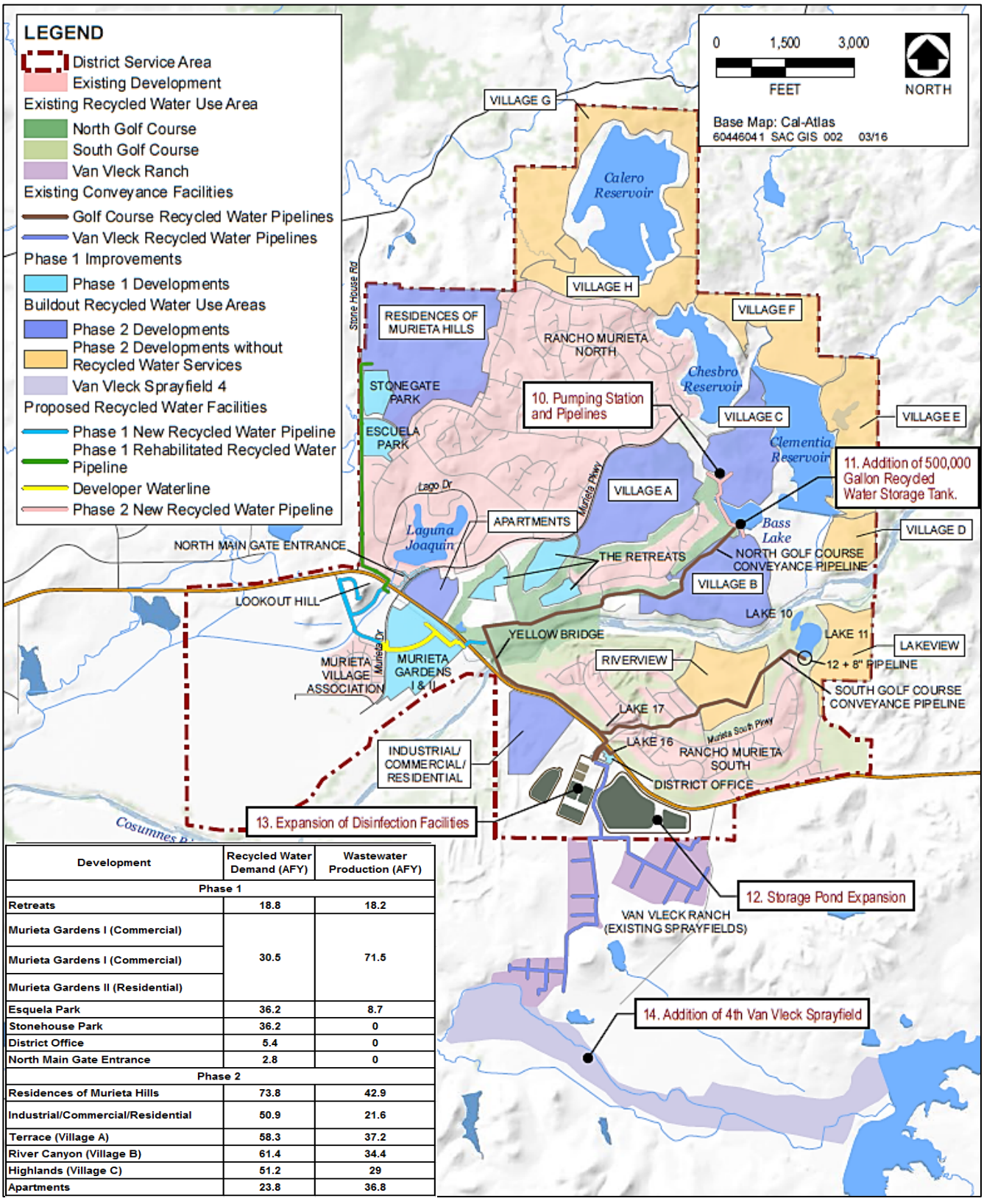
It is understood that during wet weather, recycled water in excess of irrigation demands is pumped from the existing North Golf Course Pump Station to Van Vleck Ranch. Recycled water is transmitted to Van Vleck Ranch through approximately 1,800 linear feet of aboveground 12- and 8-inch Certa-Lok™ PVC irrigation pipe. This line is used to convey recycled water to the Van Vleck Ranch boundary. About 4,050 linear feet (LF) of aboveground 8-, 6-, 4-, and 3-inch Certa-Lok™ PVC irrigation pipe is used to convey recycled water to three spray irrigation systems. The 12- and 8-inch PVC pipeline was installed in 2007 and is owned and operated by the District, and has the words “RECYCLED WATER/RECLAIMED WATER” stenciled on top. One of the three existing pumps within the Recycled Water Pump Station is used to convey recycled water through the transmission pipeline to three spray fields. There are no potable water or sewer pipelines along the transmission or distribution pipeline alignment.

The distribution system consists of approximately 29 strings of K-line irrigation systems, which are in turn composed of movable sprinklers and 40 mm piping. Each movable sprinkler is housed within a plastic pod. The connecting piping is flexible and the entire string of sprinklers can be moved from spray field to spray field. It should be noted that since the current residential area and golf courses provide enough capacity for treated effluent disposal, the Van Vleck Ranch is considered part of the effluent management system with additional spray field and therefore is not modeled in this study.

2.2 Proposed Transmission Improvements

The planned improvements for expanding the District recycled water program are shown in Figure 2. These improvements were revised from projects defined by the 2014 Title XVI study based on input received from the District. Individual improvements would be time-phased into two phases to correspond with development. The following two improvement phases have been established for the addition of recycled water facilities:

- Phase 1 System Improvements: 2020 – 2025
- Phase 2 System Improvements: 2020 – 2035



Development	Recycled Water Demand (AFY)	Wastewater Production (AFY)
Phase 1		
Retreats	18.8	18.2
Murieta Gardens I (Commercial)	30.5	71.5
Murieta Gardens I (Commercial)		
Murieta Gardens II (Residential)		
Esquela Park	36.2	8.7
Stonehouse Park	36.2	0
District Office	5.4	0
North Main Gate Entrance	2.8	0
Phase 2		
Residences of Murieta Hills	73.8	42.9
Industrial/Commercial/Residential	50.9	21.6
Terrace (Village A)	58.3	37.2
River Canyon (Village B)	61.4	34.4
Highlands (Village C)	51.2	29
Apartments	23.8	36.8

Figure 2. Proposed Recycled Water Transmission and Distribution System Improvements

Planned new recycle water services and associated pumping and storage facilities by phase are as follows:

Phase 1	Phase 2
Murieta Gardens	Industrial, Commercial, Residential
Residences of Murieta Hills	Apartments
Retreats	River Canyon (Village B)
Escuela	Terrace and Highlands (Village A and C)
Stonehouse Park	Bass Lake Storage Tank and Pump Station
North Main Gate Entrance	
District Office Front Yard	
North Golf Course Pump Station	
Lookout Hill Storage Tank and Pump Station	

2.2.1 Phase 1 Improvements

Recycled water is pumped from the WWRP to either the North Golf Course or Van Vleck Ranch. This pumping station is referred to as the North Golf Course Pump Station in this report. The role of the North Golf Course Pump Station is proposed to be expanded to also supply recycled water to future recycled water users in the north area of Rancho Murieta. In accordance with the 2014 Title XVI Study, this pump station is proposed to (1) separate the functions of this station so that one pumping system serves the North Recycled Water Transmission Main and one pumping system serves the Van Vleck Ranch; and (2) increase the pumping capacity to the North Recycled Water Transmission Main to approximately 2,110 gpm. Note that the 2,110 gpm flow rate is based on the capacity maximum velocity of 6 feet per second through the existing 12-inch recycled water pipeline serving the North Golf Course, assuming 6 fps maximum pipe velocity.

As shown in Figure 2, a new 12- and 10-inch recycled water transmission main is recommended in the 2014 Title XVI Study to serve Stonehouse Park and future developments in the northwest portion of Rancho Murieta. This particular transmission main will be connected to the existing 12-inch conveyance pipeline immediately north of the Yellow Bridge. Both the highway undercrossing and transmission main up to the point at which the Murieta Gardens development is served shall be a 12-inch pipeline. Beyond this point, the transmission main is reduced to a 10-inch pipeline.

A new 1,000 gpm booster pumping station at or near Lookout Hill is needed to meet the proposed peak irrigation demands to new users in the northwest corner of Rancho Murieta. Recycled water storage is also proposed at Lookout Hill to enhance system reliability.

A new recycled water pipeline will serve the Retreats developments. As shown in Figure 2, these pipelines will be connected to the existing North Golf Course conveyance pipeline. The pumping capacity at the existing North Golf Course pumping system will be increased by adding a new pumping system that would operate in parallel with the existing pump units.

Three new recycle water users were added to Phase 1 since the 2014 Title XVI Study was issued. These are Stonehouse Park, Escuela, North Gate Entrance, and the District's office.

2.2.2 Phase 2 Improvements

The Phase 2 Improvements, as defined in the 2014 Title XVI Study, consist of recycled water pipelines to serve specific developments, including the Industrial, Commercial, Residential area, Apartments. As shown in Figure 2, each pipeline would be connected to the North Golf Course Conveyance Pipeline.

Depending on seasonal demands, recycled water for residential landscape irrigation in the north and west regions could be served directly from either the WWRP, or the Lookout Hill Recycled Water Storage. During peak irrigation demands, recycle water could also be supplied from a new 500,000 gallon Bass Lake Recycled Water Tank.

3.0 HYDRAULIC MODEL DEVELOPMENT

This section describes the model development and assumptions.

3.1 Model Description

The hydraulic model is built using the Bentley WaterGEMS v8i platform, which can operate as a stand-along application or from within the ArcGIS, AutoCAD, and MicroStation environments. Selection of WaterGEMS as the model environment was largely driven by the availability of existing data in GIS formats. The model consists of all conveyance system pipes larger than 6-inch in diameter, pumps, and reservoirs for the golf course conveyance systems. Van Vleck Ranch is not included in the hydraulic model. Pipe alignments of the existing and proposed conveyance pipelines are developed from existing GIS shapefiles used in the Title 22 Engineering Report (December 2013) and the 2014 Title XVI Study (June 2014). Details of model development are described in the subsequent sections.

3.2 Data

3.2.1 Physical Data

Available data associated with describing the physical characteristics of the recycled water conveyance system are gathered from RMCSD and existing documents. Relevant data collected are summarized in Table 1.

Table 1. Summary of Model Physical Data

Item	Source
Topographic data (2-foot contours, GIS shapefile) NAVD88 Vertical Datum	Sacramento County GIS (2010)
WWRP pump curve	RMCSD O&M Manual
Existing and Proposed recycled water conveyance system alignment	Title XVI GIS, RMCSD documents, and AutoCAD drawing (1101001-Rec-Water-Tank-Exhibit-Sonehouse-Recycle-Water-Stonehouse 400 Scale.dwg) obtained from Baker-Williams Engineering Group (Mike Robertson).

3.2.2 Demand Data

Current golf course demand data are based on historical records and confirmed with Rancho Murieta Country Club (RMCC). Table 2 summarizes the historical recycled water demands for the North and South Golf Courses.

Table 2. Summary of Existing Demand Data

Golf Course	Maximum Day Demand (MGD)	Maximum Flow Rate (gpm) 8-hr irrigation period
North	1.01	2,104
South	0.92	1,917
Total	**1.93**	**4,021**

Future demands from the proposed developments are based on development estimates. Unit demands by development type are obtained using the maximum applied water allowance (MAWA) and other sources. Table 3 summarizes the unit demands used for each development type, and Table 4 summarizes the unit demand methodologies used for each development. In the cases where multiple methodologies are used, a weighted average (by number of units) of the unit demands is used to create an estimate for the total number of units in the development.

Table 3. Summary of Unit Demands by Land Use Designation

Land Use Designation	Lot Area (sf)	Roads/ ROW (%)	Lot Area (sf)	Building Coverage (sf)	Hardscape Coverage (sf)	Landscape Coverage (sf)	Irrigation Demand (AFY)[1]	References[2]
RD 1/Estates	43,560	-	-	-	-	-	0.51	Limit based on 650 gpd/day allocation minus historic indoor use of 195.2 gpd (502.2-307 gpd)
RD 3 – Low	14,520	25	10,890	3,800	2,700	4,390	0.30	Folsom Water Supply Assessment; 20% Building and 20% Hardscape Coverage; Sac County building coverage limited to 50% > 35% for Folsom - > selected by Folsom for WSA
RD 3 – High	14,520	25	10,890	2,200	2,200	6,490	0.44	Folsom Water Supply Assessment; 35% Building and 25% Hardscape Coverage; Sac County building coverage limited to 50% > 35% for Folsom
RD 5 – Low	8,700	30	6,090	2,400	1,800	1,890	0.13	Folsom Water Supply Assessment SFHD (6,000 sf lots)
RD 5 – High	8,700	30	6,090	1,500	1,800	2,790	0.19	Folsom Water Supply Assessment SFHD (6,000 sf lots)
Murieta Gardens II – Low	8,600	35	5,590	1,500	2,000	2,090	0.14	Tentative Subdivision Maps, Information from Mike Robertson (building coverage), and Opitz and Hauer, 1995
Murieta Gardens II – High	8,600	35	5,590	1,200	1,400	2,990	0.20	Tentative Subdivision Maps, Information from Mike Robertson (building coverage), and Opitz and Hauer, 1995
Triplex	-	-	-	-	-	-	0.09	Folsom Water Supply Assessment, assumed to be equal to MFLD, did not use MAWA

Notes:

[1] Obtained from MAWA, assume 100% turf irrigation

[2] MAWA used in all cases except as noted (Folsom used 85% of ET, rather than 70%)

Table 4. Summary of Demand Methodologies by Development

Development	Unit Demand Methodologies
Phase 1	
Riverview[1]	RD 5 High, RD 5 Low
Lakeview[1]	RD 5 High, RD 5 Low
Residences of Murieta Hills East	RD 1/Estates, RD 3 Low, RD 3 High
Residences of Murieta Hills West	RD 3 Low, RD 3 High
Retreats	400 gpd water allocation (50% outdoor)
Murieta Gardens I (Commercial)	2.93 ft/yr (1 acre park)
Murieta Gardens II (Residential)	Murieta Gardens II Low, Murieta Gardens II High
Escuela Park	RD3 Low, RD3 High, 2.93 ft/yr (4 acre park)
Phase 2	
Industrial/Commercial/Residential	RD1/Estates (conservative)
River Canyon (Village B)	RD1/Estates, 250 gpd water allocation (50% outdoor)
Highlands (Village C)	RD1/Estates, RD 3 Low, RD 3 High, 250 gpd water allocation (50% outdoor)
Terrace (Village A)	RD1/Estates, RD3 Low, RD3 High, RD 5 Low, Triplex
Apartments	250 gpd water allocation (50% outdoor)
Estates at Lake Clementia[1]	RD1/Estates, 250 gpd water allocation (50% outdoor)
Estates at Lake Chesbro[1]	RD1/Estates, RD3 Low, RD3 High, 250 gpd water allocation (50% outdoor)
Estates at Lake Calero[1]	RD1/Estates, RD3 Low, RD3 High, 250 gpd water allocation (50% outdoor)

Notes:
[1]The proposed recycled water system does not extend to these development areas.

Table 5 summarizes the comparisons of the demand estimates based on the number of units from the 2014 Title XVI Study and more recent estimates, as provided in Appendix A. Based on discussions with RMCSD, it is determined that using recycled water for Riverview and Lakeview from the south golf course conveyance system would be low on priority. Therefore, all subsequent analyses assume no irrigation demands from Riverview and Lakeview. Overall, recycled water demands increased from approximately 370 to 380 AFY for the developments served by the North Golf Course conveyance system. Using these annual average demands, the irrigation demands are estimated assuming an 8 or 9 hour irrigation period for the maximum day demand, as shown in Table 6.

Table 5. Comparison of Demand Estimates

Development	# Units		Recycled Water Demand (AFY)		Wastewater Production (AFY)	
	Title XVI	Recent Estimates	Title XVI	Recent Estimates	Title XVI	Recent Estimates
Phase 1						
Retreats	84	84	18.8	18.8	18.2	18.2
Murieta Gardens I (Commercial)	50	19.2 (hotel, shops, restaurants)	8.5	30.5	10.8	71.5
Murieta Gardens I (Commercial)	1 acre park	1 acre park	2.8		0.0	
Murieta Gardens II (Residential)	99	78	16.8		21.4	
Escuela Park	40	40	14.8	36.2	8.7	8.7
Stonehouse Park	4 acre park	4 acre park	14.4	36.2	0.0	0.0
District Office	-	-	-	5.4	-	0.0
North Main Gate Entrance	-	-	-	2.8	-	0.0
Phase 1 Totals	**471**	**644**	**1001.1**	**129.9**	**59.1**	**98.4**
Phase 2						
Residences of Murieta Hills		198	73.8	73.8	42.9	42.9
Industrial/Commercial/Residential	100	100	50.9	50.9	21.6	21.6
Terrace (Village A)	177	172	60.0	58.3	38.3	37.2
River Canyon (Village B)	120	159	46.4	61.4	26.0	34.4
Highlands (Village C)	110	134	42.0	51.2	23.8	29.0
Apartments	170	170	23.8	23.8	36.8	36.8
Phase 2 Totals	**875**	**925**	**296.9**	**299**	**189.4**	**201.9**
Not Served by Recycled Water						
Riverview	140	140	22.4	22.4	30.3	30.3
Lakeview	99	99	15.8	15.8	21.4	21.4
Estates at Lake Clementia	94	84	35.5	31.7	20.3	18.2
Estates at Lake Chesbro	78	88	26.0	29.4	16.9	19.0
Estates at Lake Calero	139	139	52.1	52.1	30.1	30.1
Not Served Totals	**550**	**550**	**151.8**	**151.4**	**119**	**119**

Table 6. Future Daily Irrigation Demands and Peak Hour Demands

Proposed Development	Irrigation Volume (gallons per day)	Irrigation Demand (gpm) – 8-hour Irrigation Period	Irrigation Demand (gpm) – 9-hour Irrigation Period
North Main Gate Entrance	17,760	37	33
District Office	9,120	19	17
Retreats	63,360	132	117
Murieta Gardens	101,280	211	188
Escuela Park	120,480	251	223
Stonehouse Park	120,480	251	223
Terrace (Village A)	188,160	392	348
River Canyon (Village B)	214,080	446	396
Highlands (Village C)	165,120	344	306
Apartments	80,160	167	148
Residences of Murieta Hills	248,640	518	460
Industrial/Commercial/Residential	171,360	357	317
Subtotal	**1,500,000**	**3,125**	**2,778**
Existing Golf Course North	1,010,000	2,104	1,870
Existing Golf Course South	920,000	1,916	1,704
Total	**3,430,000**	**7,145**	**6,352**

From Table 6, it can be seen that the total irrigation volume exceeds the planned maximum daily capacity of the WWRP (3.0 MGD). The deficit is assumed to be supplemented with potable water by adding it to the storage equalization basin at the WWRP. This ensures that the maximum water produced at the WWRP and the proposed storage tanks will satisfy the irrigation demands.

3.3 Assumptions

Based on the data available for model development, some assumptions are made to develop the model. Assumptions regarding system characteristics and model boundary conditions are summarized in Table 7.

Table 7. Model Assumptions

Component	Assumption
Model node elevations	3 feet below contour elevation (NAVD88)
Initial pipe roughness (Hazen-Williams C-factor)	120 for existing pipe (ACP) 130 for new pipe (DIP or PVC)
Demand node locations	Existing demands are placed immediately upstream of Bass Lake and Lake 11. Demands for the proposed developments are placed at single nodes at the furthest downstream location of the development site.
Model simulation	Model is simulated using steady-state analysis
Recycled water production	Maximum production of 3.0 MGD (2,083 gpm over 24 hours)
Lake and tank Refill	Refill of the tanks and lakes continue outside of the irrigation period (either 8 or 9 hour irrigation period)

3.4 Calibration

In the absence of downstream flow and pressure data for the North and South Golf Course recycled water conveyance systems, the model is calibrated to the extent possible using the discharge flow and pressure from the WWRP pumps, as shown in Table 8. It should be noted that these data are relevant only to the North Golf Course conveyance system.

Table 8. Model Pump Calibration Data

Operation	Flow (gpm)	Discharge Pressure (psi)
2 – 100 hp pumps	1,383	126
Pump 2 – 100hp	1,114	95
Pump 3 – 100 hp	1,068	88

Table 9 summarizes the pump calibration results. The relative speed factors for the pumps are adjusted such that the flow and discharge pressures match the observed values for the various operating scenarios. Because it is anticipated that both pumps will be operational during maximum day demand conditions, the adjusted relative speed factors for the operating condition where both pumps are running are used for the future modeling scenarios.

Table 9. Pump Calibration Results

Operation	Pump 2 – Relative Speed Factor	Pump 3 – Relative Speed Factor
2 – 100 hp pumps	0.92	0.915
Pump 2 – 100 hp	0.958	N/A
Pump 3 – 100 hp	N/A	0.92

4.0 HYDRAULIC ANALYSIS

4.1 Planning Criteria

Planning criteria based on the standards set forth in the Recycled Water Standards (2013) and general system preferences are used to determine appropriate improvements to the recycled water conveyance system. Table 10 lists selected design standards that are relevant to modeling the conveyance system. Demand locations are defined as connection points between the distribution mains and smaller diameter lines with spray heads attached. Depending on the locations of the proposed storage tanks, pressure control valves may need to be installed to reduce the water pressure to appropriate level.

Table 10. Selected Planning Criteria

System Attribute	Criteria
Pipe velocity	Max. 7 ft/s
Pressures at demand locations	Min. 40 psi
System pressures	Min. 10 psi
Pipe Material	PVC or Ductile Iron

For modeling purposes, several constraints are used to determine the hydraulic capacity of the system. These constraints include the following:

- A maximum 3.0 MGD production from the WWRP (equates to 2,083 gpm)
- Irrigation periods of 8 or 9 hours. Golf course and residential irrigation demands are active only for a specified irrigation period. For the golf courses, the irrigation flow rate based on the historical demand will be greater than the rate recycled water can be delivered to refill Bass Lake or Pond 10/11 during the irrigation period. This will result in drawdown of the lake/ponds until they are refilled after the irrigation period.
- Complete refill of the lake/pond and tank volumes. Refilling of these storage sources are assumed to occur both during irrigation (if possible) and outside of the irrigation period.
- 50 percent operating volumes in the proposed storage tanks (Lookout Hill and Bass Lake) used as recycled water sources to supplement WWRP recycled water production.

4.2 Existing Conditions

The existing recycled water conveyance system is evaluated under assumed existing conditions. Figure 3 shows the hydraulic model of the existing system with existing golf course irrigation demands placed on the red nodes, as labelled. Due to the lack of information on the Lake 17 pump, assumptions are made regarding Lake 17 pump operations. Calibrated pump curves for existing pumps are used to characterize the pumps at the WWRP. Table 11 summarizes the model results for the existing systems. The flow rates observed from the model

assumes that there is at least 10 psi of pressure in the conveyance system during those particular flow rates. This ensures that there is sufficient pressure for the water to move through the system to the receiving lakes.

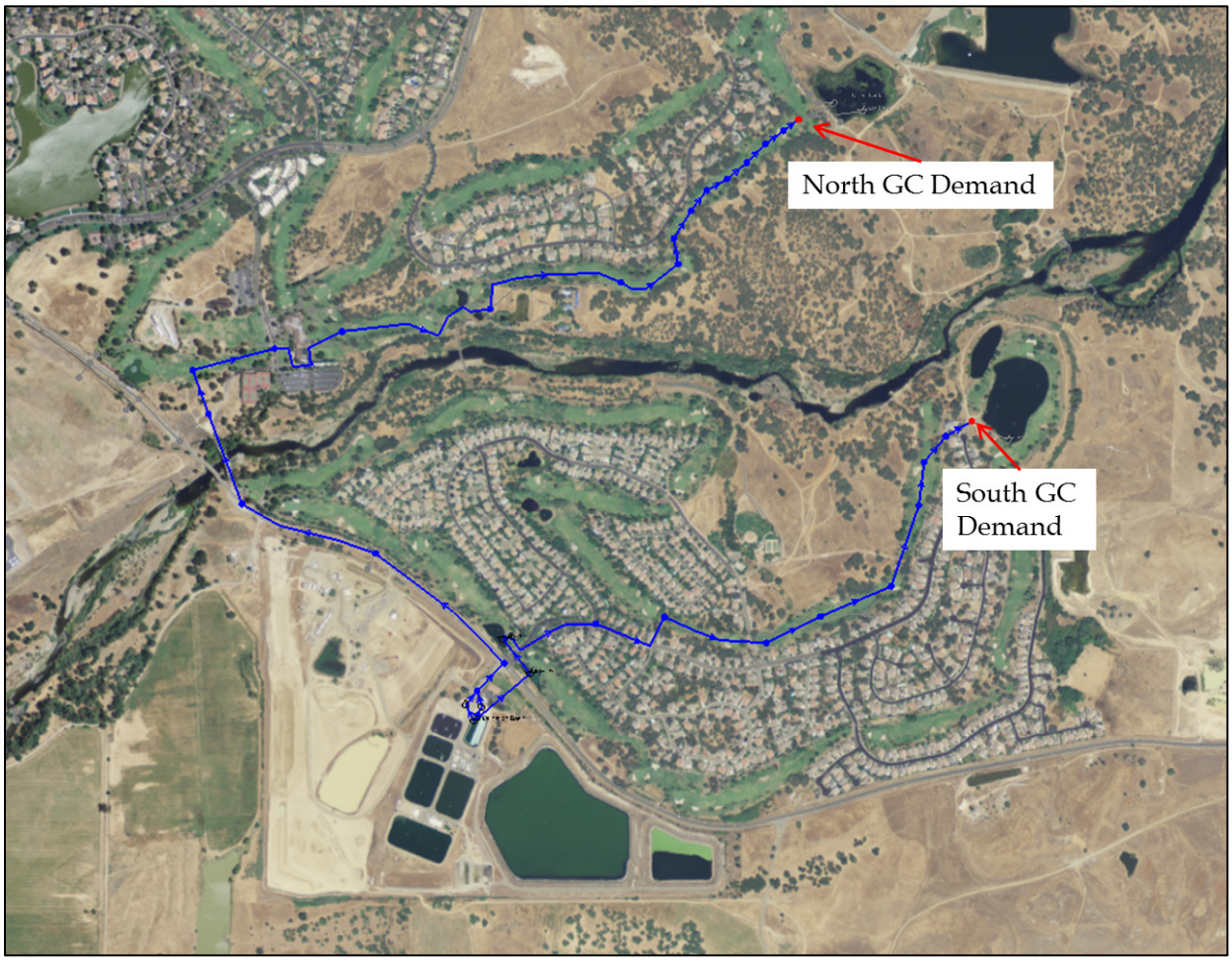


Figure 3. Hydraulic Model of Existing System

Table 11. Existing System Model Results

Golf Course	Pump Operations	Total Flow (gpm)	Observations
North	Existing pump curves	1,225	• System pressures > 10 psi • Max. flow velocity: 7.8 ft/s
South	Assumed pump operation (1,000<gpm at 100 ft.)	639	• System pressures > 10 psi • Max. flow velocity 4.1 ft/s

4.3 Future Developments

Plans for future land development projects, as described in Section 2.2, are included in the hydraulic model to evaluate the effects of additional demands on the system. Figure 4 shows a map of the modeled distribution system with labels identifying the existing and proposed recycled water users.

Two demand scenarios (8 or 9 hour irrigation period) were evaluated using the full model. The results are summarized in Table 12.

Table 12. Residential Irrigation Demand Sets

		Irrigation Maximum Flow Rate	
Proposed Development	**Phase**	**8-hour Irrigation Period (gpm)**	**9-hour Irrigation Period (gpm)**
North Main Gate Entrance	1	37	33
District Office	1	19	17
Retreats	1	132	117
Murieta Gardens	1	211	188
Escuela Park	1	94	84
Stonehouse Park	1	251	222
River Canyon (Village B)	2	167	148
Highlands (Village C)	2	129	115
Terrace (Village A)	2	147	131
Apartments	2	167	148
Residences of Murieta Hills	2	518	461
Industrial/Commercial/Residential	2	357	317
	Total	**2,229**	**1,981**

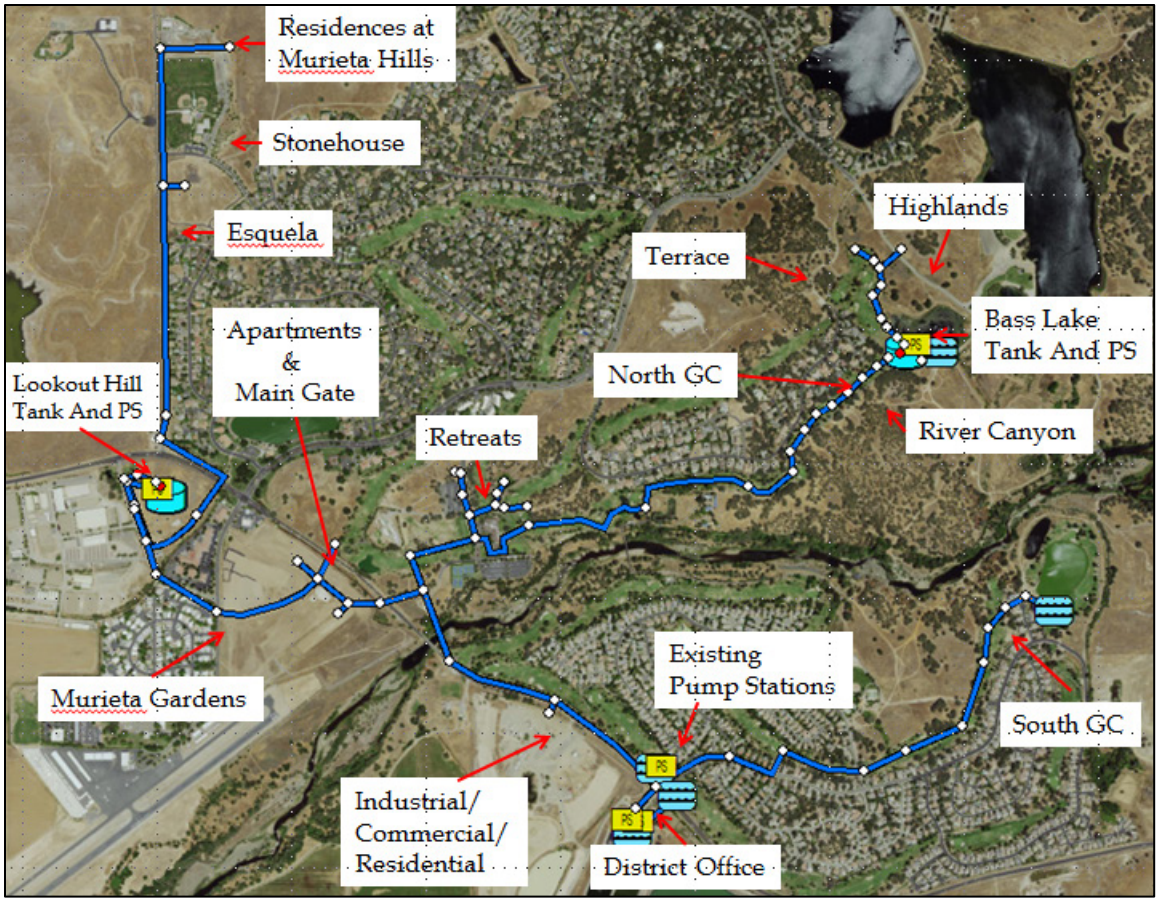


Figure 4. Hydraulic Model of System at Build-out

Table 13 summarizes the model results under the two demand scenarios. Results indicate that the planning criteria are met, with marginal improvement in pipe velocities and maximum pipe pressure when using a 9 hour irrigation period compared to an 8 hour period.

Table 13. Proposed Developments Model Results

Irrigation Period (hours)	Max. Pipe Velocity (ft/s)	Demand Node Pressures (psi)	Max. Pipe Pressure (psi)
8	5.3	> 40	93
9	4.9	> 40	95

The GIS information used to map the proposed recycle water system improvements resulted in refinements to the length of pipes used in the model. The hydraulic network model allowed some minor adjustments to pipe diameters. A comparison of proposed facilities between the 2014 Title XVI Study and the hydraulic network model are summarized in Table 14.

Table 14. Comparison of Recycle Water System Component Quantities between 2014 Title XVI Study (Before) and Network Model (After)

Improvement/Development	Components	Before	After
Phase 1			
Murieta Gardens	6-inch pipe 12-inch pipe	220 LF 1,010 LF	306 LF 3,500 LF
Residence of Murieta Hills	10-inch pipe	10,630 LF	5,700 LF
Retreats	6-inch pipe	1,725 LF	1,746 LF
Escuela Park	6-inch pipe	260 LF	200 LF
Stonehouse Park	4-inch pipe	0*	200 LF
North Main Gate Entrance	4-inch pipe	0*	200 LF
District Office	2-inch pipe	0*	200 LF
North Golf Course Pump Station	Increase existing pumping capacity	Add 1,050 gpm pumping system to operate in parallel with existing	Add a new 2,110 gpm pumping system to operate independently
Lookout Hill Storage Tanks and Pump Station	200,000 gallon Storage Tank	2 tanks with 1,000 gpm booster pump	1 tank with 1,000 gpm booster pump
Phase 2			
Industrial, Commercial, Residential	6-inch pipe	190 LF	150 LF
Apartments	6-inch pipe	110 LF	100 LF
River Canyon (Village B)	8-inch pipe	440 LF	260 LF
Terrace and Highlands (Village A and C)	6-inch pipe 8-inch pipe	850 LF 1,170 LF	650 LF 1,270 LF
Bass Lake Tank and Booster Pump Station	500,000 gallon Storage Tank	1 tank at Bass Lake with 1,040 gpm booster pump	1 tank at Bass Lake with 1,000 gpm booster pump

* New recycle water users identified after the 2014 Title XVI Study

The hydraulic network model was able to better define the storage and pumping requirements needed to support the proposed recycle water network expansion. Most notable is that the storage volume needed at Lookout Hill can be reduced from 400,000 gallons (one new 200,000 gallon tank and refurbish the existing 200,000 gallon tank) to 200,000 gallons (one new 200,000 gallon tank and demolish the existing tank).

The new 200,000 gallon storage tank proposed at Lookout Hill will enhance system reliability; however, storage at Lookout Hill is not needed to meet peak demands in future developments in northwest Rancho Murieta. There is sufficient storage at the WWRP to equalize the diurnal pattern of recycled water flows over a 24-hour period with the recycled water demand over an 8-hour period. Storage on Lookout Hill will enhance system reliability by providing a volume roughly equal to one-day of irrigation demand that can be used in the event of planned or unexpected outages or emergency conditions that would otherwise limit the ability to deliver recycled water to the future developments in the northwest portion of Rancho Murieta.

It is understood that the District is interested in rehabilitating the existing 200,000 gallon water storage tank at Lookout Hill and re-purpose it for recycled water storage. Likewise, an existing

force main connecting from Lookout Hill to Residents of Murieta Hills is no longer in service and offers the potential to be repurposed for recycled water use.

Refurbishing steel tanks and re-purposing existing pipelines offer potential cost savings; however, for the purpose of this report, it is assumed that all facilities will be provided as new installations. Evaluating the condition of existing facilities for refurbishing or re-purposing is beyond the scope of this study. Assuming costs for new facilities represents a more conservative approach to budget planning.

The pumping system to serve the North Golf Course and proposed new recycled water users in northwest Rancho Murieta is recommended to be completely replaced with a new pumping system capable of delivering 2,110 gpm. This contrasts with the 2014 Title XVI Study for the North Golf Course pumping system which was to increase the existing capacity to 2,110 gpm by adding new pumping equipment in parallel with the existing pumping system. The recommended plan is to provide a new pumping system to serve the North Golf Course and new users in northwest Rancho Murieta. The existing pumping system can continue to be used and, with relatively simple piping changes, can become dedicated to only sending recycled water to Van Vleck Ranch. The combination of a new pumping system along with a modified existing pumping system will meet an objective of the 2014 Title XVI Study to separate the functions of the existing pumping station.

5.0 COST ESTIMATES

Planning-level estimates are developed for the proposed developments and then compared with the costs assuming the quantities from the 2014 Title XVI Study. Costs for the 2014 Title XVI Study are revised based on the quantities presented in the 2014 Title XVI Study and the unit prices developed for the purpose of this modeling study.

Pricing is based on several assumptions as follows:

1. For the purpose of this study, the installed costs for pipeline and other facilities are assumed based on the following unit costs:

Component	Unit Cost ($)	Units
2-inch dia pipe	30	per linear foot
4-inch dia pipe	43	per linear foot
6-inch dia pipe	75	per linear foot
8-inch dia pipe	107	per linear foot
10-inch dia pipe	135	per linear foot
12-inch dia pipe	170	per linear foot
Road Undercrossing	125,000	lump sum for each
Storage Tanks	2.20	per gallon
Pre-Fab Building	150	per square foot
Pumping Station	720	per gpm pumped for reclaimed water reuse

2. Unit costs for each component include all materials and labor for all work normally associated with the item including pipe, valves and all appurtenances, concrete, trenching, backfill and surface restoration, tanks, electrical, I&C, and disposal of waste materials including AC pipe.
3. Additional costs are applied to installed costs to develop a total probable construction cost:

Probable Construction Cost Assumptions	
Contingency (Construction)	25%
Contractor General Conditions	10%
Contractor Overhead and Profit	15%
Escalation to Mid-Point of Construction	4.5%

4. Total budget for planning purposes must include administrative, engineering, and construction management costs. Assumptions for these costs are applied as follows:

Implementation Cost Assumptions	
Administration Fees	5.0%
Regulatory (CEQA) Compliance	2.5%
Engineering and Construction Management	17.5%
Contingency (Implementation Soft Costs)	5.0%

Estimated probable construction costs are presented in Table 15. Costs include a comparison between the Estimated Probable Construction Costs before and after this 2016 Network Modeling Study. For the purpose of comparison, quantities of various components from the 2014 Title XVI Study were applied to the pricing assumptions developed for this study to produce estimated costs for the 2014 Title XVI Study.

Table 15. Summary of Estimated Probable Construction Costs Before and After this Study

Proposed Infrastructure	Before [1]	After [2]	Difference [3]
Phase 1			
Murieta Gardens	517,534	1,227,655	710,122
Residences of Murieta Hills	2,371,286	1,271,527	-1,099,759
Retreats	213,780	216,383	2,603
Escuela Park	32,222	28,504	-3,718
Stonehouse Park	0	14,211	14,211
North Gate Entrance	0	14,211	14,211
District Office	0	9,914	9,914
North Golf Course Pump Station	1,249,219	2,510,336	1,261,116
Lookout Hill Storage and Pump Station	2,201,831	1,978,756	-223,075
Subtotal Phase 1	**$ 6,585,872**	**$ 7,271,497**	**$ 685,625**
Phase 2			
Industrial, Commercial, Residential	230,098	225,140	-4,957
Apartments	220,183	218,944	-1,239
River Canyon	77,795	45,970	-31,825
Terrace and Highlands	312,206	305,100	-7,105
Bass Lake Tank and Booster Pump Station	3,116,934	3,069,345	-47,589
Subtotal Phase 2	**$ 3,957,215**	**$ 3,864,499**	**$ ($92,716)**
Total Phases 1 and 2	**$ 10,543,087**	**$ 11,135,995**	**$ 592,908**

[1] Before: Estimated Probable Construction Cost based on Quantities from 2014 Study and 2016 Prices

[2] After: Estimated Probable Construction Cost based on Quantities from 2016 Study and 2016 Prices

[3] Difference = After – Before

As a result of this modeling study, quantities and sizing of system components identified in the previous 2014 Title XVI Study were adjusted. The sum of the total probable costs to construct Phases 1 and 2 is $11,135,995 which represents an increase of approximately $600,000 (rounded-up) as compared to the estimated construction cost presented in the 2014 Title XVI Study.

The increase in estimated cost can be attributed primarily to the additional cost to replace the existing North Golf Course Pump Station with a new, stand-alone, 2,110 gpm pumping system that can be operated independently leaving the existing pumping system to be dedicated to pumping only to Van Vleck Ranch. To a lesser degree, additional costs were added for extending service to three new recycled water users that were not included in the 2014 Title XVI Study.

Facilities needed to serve the northwest area of Rancho Murieta consist of the facilities needed to serve Murieta Gardens and Residences of Murieta Hills combined. Although the cost estimated for Murieta Gardens increased, the decrease in cost estimated for Residences of Murieta Hills more than offsets the additional cost for Murieta Gardens. As a whole, the sum of the costs for Murieta Gardens and Residences of Murieta Hills combined, which represents the cost to serve areas in northwest Rancho Murieta, decreased as an outcome of the modeling study.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on modeling results, the following conclusions and recommendations are made:

- The proposed maximum capacity of the WWRP (3.0 MGD) is insufficient to provide the full residential irrigation demands. This modeling study assumes that potable water will be supplemented at the WWRP. Capacity of the WWRP should be increased from 2.3 MGD to 3.0 MGD prior to using recycled water for residential irrigation.
- It is recommended that Riverview and Lakeview should not be prioritized for irrigation using recycled water. This modeling study assumes no residential irrigation demand from the Riverview and Lakeview development.
- Active demand management may be necessary to ensure sufficient water is available for irrigation and potable water supplementation. It is assumed that residential and golf course irrigation can occur over an 8 or 9 hour irrigation period, with refilling of Bass Lake, Lakes 10/11, and the proposed storage tank during the remaining 14 or 15 hours in a day.
- There does not appear to be any significant advantage of using a 9 hour irrigation period as opposed to an 8 hour irrigation period.
- The proposed system, as originally described in the 2014 Title XVI Study and adjusted based on the findings from this hydraulic network modeling study, has sufficient capacity to meet the proposed residential irrigation demands while meeting the specified planning criteria.

7.0 REFERENCES

Rancho Murieta Community Services District. 2013. *Recycled Water Standards*.

AECOM. June 2014. *Title XVI Recycled Water Feasibility Study*. Submitted to Rancho Murieta Community Services District.

Hydroscience Engineers. 2013. *Title 22 Engineering Report – Temporary Sprayfields*.

Rancho Murieta Community Services District. (no date). *Rancho Murieta Wastewater Reclamation Plant Operation and Maintenance Manual*.

APPENDIX A

Development Phase List

Updated Phasing Plan

Demands			8-hr	sum	9-hr	sum
Phase 1	North Main Gate Entrance	17,760	37		33	
	District Office	9,120	19		17	
	Retreats	63,360	132		117	
	Murieta Gardens	101,280	211		188	
	Stonehouse Park	120,480	251		223	
	Escuela Park	120,480	251	901	223	801
	North Golf Course		2103		1869	
	South Golf Course		1915	4018	1703	3572
	Phase 1 Demand		**4,919**		**4,373**	
	Capacity		6,246		5,552	
Phase 2						
	Village A	214,080	446		396	
	Village C	165,120	344		306	
	Village B	188,160	392		348	
	Apartments	80,160	167		148	
	Residences of Murieta Hills	248,640	518		460	
	Industrial/Commercial/Residential	171,360	357		317	
	Phase 2 Subtotal		**2,224**		**1,975**	
	Phase 1 and 2 Total		7,143		6,348	
	Capacity		6,246		5,552	
	Difference (Supplemental Potable Water), gpm		897		796	
	Difference (Supplemental Potable Water), gallons		430,685		429,725	

RW Production Sources			
WWRP gpm	2082	2082	
Potable Water Supplementation	896	796	
Subtotal	2978	2878	
Reduced GC Demand (assumed)	1000	1000	
	941	494	
	451,885	267,025	Phase 1
	3,165	2,469	Phase 2
	1,519,405	1,185,355	

Original Phasing Plan

Development Phase	Development	Development State	Contact and Phone Number	Other Questions
1	Riverview	Entitled	Les Hock, 916-801-9500	149 Lots Total
1	Lakeview	Entitled	Gary Parker, R & B 916-364-5474	99 Lots Total
1	Residence – East	Entitled	Les Hock, 916-801-9500	99 Lots Total - 95 RD 3 los 4 RD 1lots
1	Residence – West	Entitled	JDI, Rob Weil	99 RD3 Lots
1	Retreats	Entitled	Bill Cummings, 916-984-7025	84 Lots – 4,900 sf with additional 700 sf landscape area, plus Streetscape and open space.
1	Murieta Gardens I (commercial)	Entitled	Mike Robertson (916) 331-4336 x 14 or John Sullivan, 916-807-4360	Commercial landscaping and a 1 ac park. plus Streetscape
1	Murieta Gardens II (residential)	Entitled	Mike Robertson (916) 331-4336 ext 14 or John Sullivan, 916-807-4360	78 Lots Total, Rd 5 at 5,200 sf min lots, Potential irrigation to detention basin/passive use area. streetscape
2	Airport Business Park		Live Oak Properties, DP&A Ph 916.504-2882	4.2 ac, 50,000 +/- sf M-1 or M-2 warehouse/office/storage
2	Lookout Hill	Pending	John Sullivan, 916-807-4360	Restaurant, 4 +/- acre mixed use, open space
2	Industrial/Commercial/ Residential 39	Pending	John Sullivan, 916-807-4360	Warehouse 400,000 sf; light industrial
2	Village A (River Canyon)	Pending	John Sullivan, 916-807-4360	159 Lots/units total
2	Village B (Highlands)	Pending	John Sullivan, 916-807-4360	134 Lots/units total
2	Village C (Terrace)	Pending	John Sullivan, 916-807-4360	172 Lots/units total
2	Village D (Granlee)	Pending	John Sullivan, 916-807-4360	58 Lots/units total
2	Village E (The Village at Lake Jean)	Pending	John Sullivan, 916-807-4360	115 Lots/units total
2	Village F (Chesbro Square)	Pending	John Sullivan, 916-807-4360	104 Lots/units Total
2	Village G (Calero East)	Pending	John Sullivan, 916-807-4360	20 Lots/units total
2	Village G (Calero West)	Pending	John Sullivan, 916-807-4360	130 Lots/units total
2	Village G (Calero North)	Pending	John Sullivan, 916-807-4360	30 Lots/units total
2	Apartment 17		Bill Cummings, 916-984-7025 or Frank Stathos	17 acres, potential 170 apt unit
2	Escuela	Pending	AKT, Brian Vail	4 ac Park plus 13 ac of RD-3
2	Potential Future Development, Park Property	Pending	Rancho Murieta Association	28 Lots/units total

APPENDIX B

RMCSD Presentation

Rancho Murieta Community Services District

Recycled Water Conveyance System
Hydraulic Modeling Study

October 3, 2014

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Agenda

- Model Development
- Modeling Assumptions
- Demand Data and Planning Criteria
- Existing Conditions Preliminary Results
- Proposed Developments Preliminary Results

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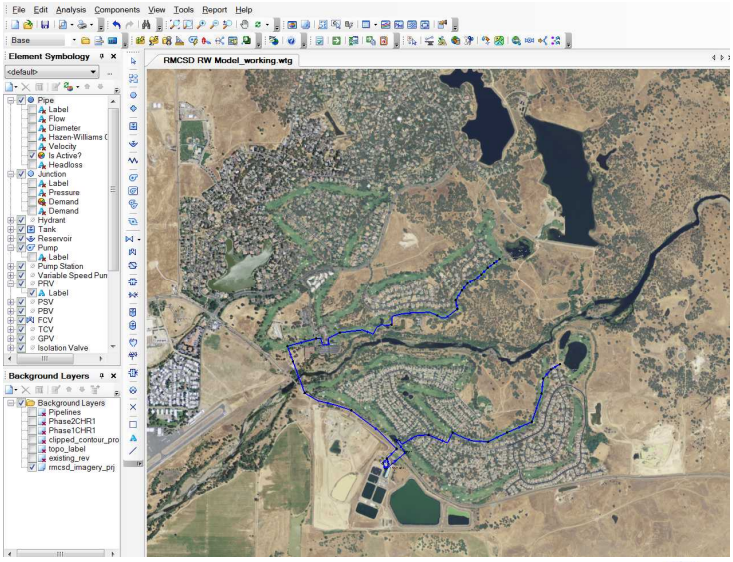
RMCSD Model Development

- Model created in WaterGEMS (Bentley)
- Includes:
  - Pipe > 6” diameter
  - Tanks
  - Reservoirs
  - Pump Stations
- Model physical data:
  - Existing GIS information
  - Existing drawings
  - Pump curves

Design Criteria

- Minimum pressure at irrigation nodes – 40 psi
- Minimum pressure in conveyance system – 10 psi
- Maximum flow velocity in conveyance system – 10 ft/s
- 50% operating volumes in proposed Bass Lake and Lookout Hill tanks

WaterGEMS Model – Existing System



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Model Assumptions

- Pipe elevations
  - Existing contour data
  - 3' pipe depth
- Pipe roughness coefficients
  - Existing pipe (ACP): 120
  - New Pipe (DIP or PVC): 130
- Demand locations
  - Single nodes
  - Furthest downstream location of development area
- Pump verification on available data

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Demand Data

– Existing System (historical demands):

Golf Course	Maximum Day Demand (MGD)	Maximum Day Demand (gpm) – 8 hour irrigation
North	1.01	2,104
South	0.92	1,917
Total	1.93	4,021

– Proposed Developments:
- Number of units
- Development type
- Adjusted for maximum day

Demand Constraints

– Maximum WWTP production (3.0 MGD or 2,083 gpm)

– Irrigation period (8 or 9 hour)

– Refill of lakes/ponds and tanks (remaining 16 or 15 hours)

– "Time Varying" Demand Set:
- Demands during irrigation period
- Demands (refill) outside of irrigation period

– Hydraulic model used to evaluate system performance for 2 demand scenarios

Existing System

- South Golf Course:
  - Unknown pump performance (assumptions made on pump capacity)
  - Flow estimated at 639 gpm
  - Dynamic pressures > 10 psi

- North Golf Course:
  - Using existing pump curves
  - Flow estimated at 1,225 gpm
  - Dynamic pressures > 10 psi

Proposed Improvements (Phase 1 and Phase 2)

- WWTP Pump Upgrades: 2,110 gpm

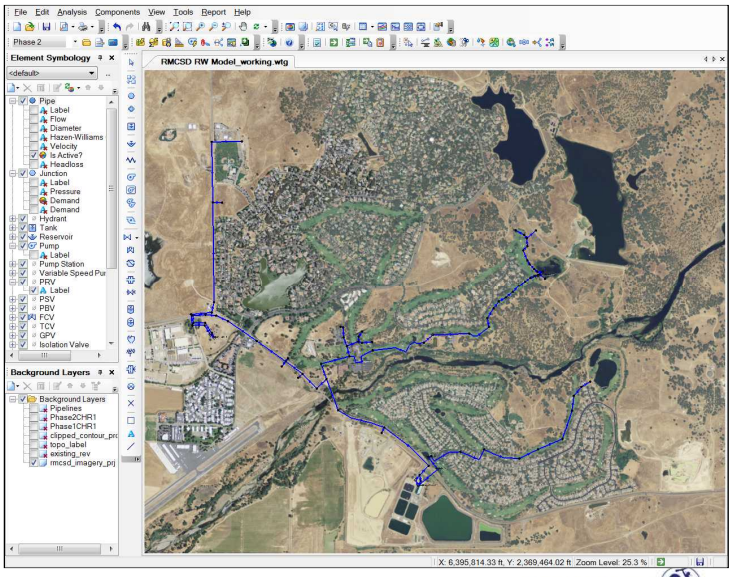
- Total Phase 1 pipe extensions:
  - ~2,000 LF of 6" pipe
  - ~10,600 LF of 10" pipe
  - ~850 LF of 12" pipe

- Total Phase 2 pipe extensions:
  - ~1,100 LF of 6" pipe
  - ~1,725 LF of 8" pipe

- 200,000 gallon storage tank and 700 gpm (65 ft.) booster pump (Lookout Hill)

- 500,000 gallon storage tank and 1,000 gpm (110 ft.) booster pump (Bass Lake)

WaterGEMS Model – Proposed System



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Proposed Demands

Proposed Development	Phase	Irrigation Demands	
		8-hour Irrigation Period (gpm)	9-hour Irrigation Period (gpm)
Residences of Murieta Hills	1	518	460
Retreats	1	132	117
Murieta Gardens	1	113	100
River Canyon	2	273	243
Highlands	2	228	203
Terrace	2	259	230
Apartments	2	167	148
Esquela	2	182	162
Industrial/Commercial/Residential	2	357	318
Total		**2,229**	**1,981**

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Proposed System Model Results

Irrigation Period	Maximum Pipe Velocity	Demand Node Pressures
8 hour	5.1 ft/s	> 40 psi
9 hour	4.9 ft/s	> 40 psi

Proposed system meets all planning criteria

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Thank You

October 3, 2014

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