TECHNICAL MEMORANDUM

TO: San Pasqual Valley Groundwater Sustainability Agency

PREPARED BY: Paula Silva/Jacobs, Nate Brown/Jacobs, Craig Cooledge/Jacobs, Jenny Callan/Jacobs, Sally Johnson/W&C, Martha De Maria y Campos/W&C

REVIEWED BY: Sally Johnson/W&C, Mark Elliott/Jacobs

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RE: Project Management Action (PMA) No. 7: Initial Surface Water Recharge Evaluation, Task 3: Water Sources for Potential Recharge Projects

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ACRONYMS & ABBREVIATIONS

AF	Acre-foot	hp	horsepower
AFY	Acre-feet per year	M&I	Municipal and industrial
Basin	San Pasqual Valley Groundwater Basin	MGD	Million gallons per day
cfs	Cubic feet per second	NAD83	North American Datum of 1983
City	City of San Diego	NAVD88	North American Vertical Datum of 1998
County	County of San Diego	PMA	Project and Management Action
CWA	San Diego County Water Authority	psi	Pounds per square inch
DDWD	Division of Drinking Water	Ramona MWD	Ramona Municipal Water District
DSOD	Division of Safety of Dams	SPV	San Pasqual Valley
DWR	Department of Water Resources	SPV GSP Model	SPV GSP Integrated Groundwater/Surface Water Flow Model
GDE	Groundwater Dependent Ecosystem	USGS	United States Geological Survey
gpm	Gallons per minute	WY	Water Year
GSA	Groundwater Sustainability Agency	WYT	Water Year Type
GSP	Groundwater Sustainability Plan		

1. INTRODUCTION

The San Pasqual Valley Groundwater Sustainability Agency (GSA) – comprised of the City of San Diego (City) and the County of San Diego (County) – approved and submitted to the California Department of Water Resources (DWR) the San Pasqual Valley Groundwater Sustainability Plan (GSP) in January 2022 (City and County, 2021). The GSP provides guidance and quantifiable metrics to ensure the continued sustainable management of groundwater resources within the San Pasqual Valley Groundwater Basin (Basin) over the 20-year GSP implementation period (**Figure 1-1**). To accomplish this, the GSP includes a hydrogeological conceptual model, monitoring requirements, sustainability criteria, and several projects and management actions. The projects and management actions (PMAs) included in the GSP are intended to create opportunities for sustainable groundwater management in the Basin that respond to changing conditions and help prevent undesirable results. The Basin is currently sustainably managed, so no additional PMAs are needed to achieve sustainability. However, implementing PMAs could improve resilience against challenging future hydrologic conditions, such as extended droughts.

This technical memorandum is the third of several that focuses on PMA No. 7, which aims to complete an Initial Surface Water Recharge Evaluation. The first technical memorandum describes the evaluation criteria by which the best surface water recharge strategies for the Basin will be determined (City, 2022a). The second technical memorandum describes the approach and results of a streambed investigation along Santa Ysabel Creek in the eastern San Pasqual Valley (SPV) and provides recommendations for updating the SPV GSP Integrated Groundwater/Surface Water Flow Model (SPV GSP Model) (City, 2022b).

This third technical memorandum includes the assessment of potential water sources that could be used for surface water recharge projects within the SPV Groundwater Basin (Basin). The recharge projects (or strategies) will be evaluated further in a future technical memorandum. In this technical memorandum, potential recharge locations and water sources to be used for recharge strategies are presented. Potential recharge areas have not been vetted by stakeholders or permitting agencies, so they should be viewed as conceptual for this stage of study. The potential source water analysis in this technical memorandum includes the following:

- **Streamflows:** The magnitude and frequency of streamflows in the eastern portion of the Basin are analyzed to assess the availability of this source of water for enhanced surface water recharge opportunities.
- **Sutherland Reservoir releases:** The existing infrastructure, agreements, and operations of Sutherland Reservoir are analyzed to provide context for the potential availability of stored water for controlled reservoir releases. The magnitude and frequency of inflows to the reservoir are analyzed to assess potential additional releases to be used to increase the Santa Ysabel Creek streamflow entering the Basin.
- **Untreated water from Ramona Municipal Water District (Ramona MWD):** The existing infrastructure, agreements with San Diego County Water Authority (CWA), and operations are reviewed to identify potential delivery quantities and conveyance needs for direct deliveries to Basin farmers and/or to designated Basin recharge locations.

Other potential sources of water for enhanced recharge in the Basin, such as recycled water, are not included in this study and not discussed in this technical memorandum.

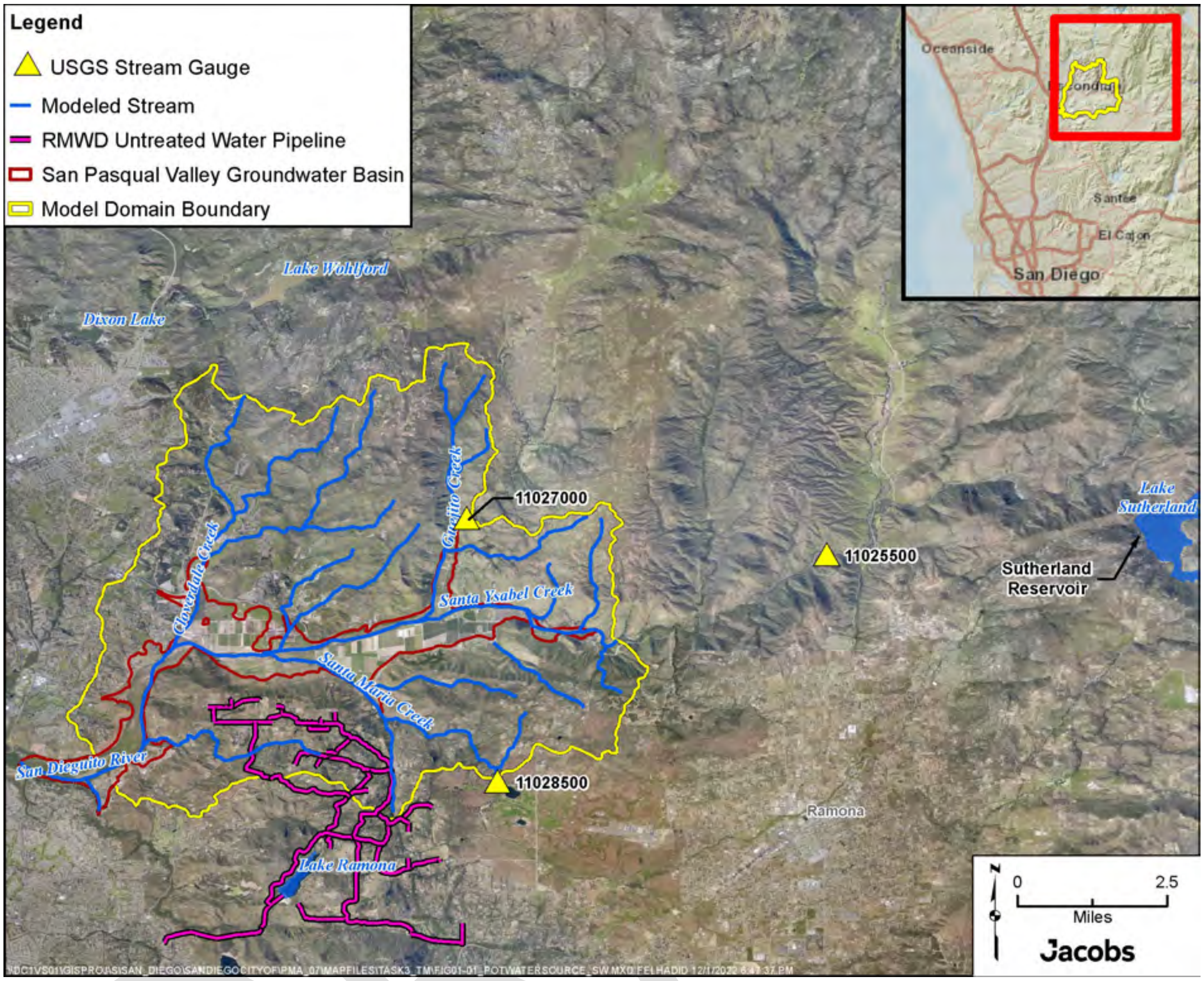

Figure 1-1. Regional Location Map

The GSA will use the Initial Surface Water Recharge Evaluation to help quantify potential benefits to the Basin and assess the feasibility of implementation of potential recharge projects. Ultimately, completing this Initial Surface Water Recharge Evaluation is estimated to take two years, and the resulting information will be provided in a Preliminary Feasibility Study. The Preliminary Feasibility Study will summarize the Initial Surface Water Recharge Evaluation technical memoranda developed during this process, and will include the following sections:

- Evaluation Criteria and Ranking Process (Task 1)
- Streambed Investigation (Task 2)
- Water Sources for Recharge (Task 3)
- Potential Recharge Strategies (Task 4)
- Modeling Approach and Results (Task 5)
- Potential Benefits to Groundwater Dependent Ecosystems (GDEs) (Task 6)

The following section provides a summary of potential source water quantities and describes conceptual-level recharge strategies.

2. HYPOTHETICAL SOURCE WATER QUANTITIES AND CONCEPTUAL RECHARGE STRATEGIES

Details around specific scenarios for additional water quantities and recharge strategies will be presented in the Task 4 technical memorandum, which will be completed in 2023. As previously mentioned, this technical memorandum includes an initial assessment to estimate hypothetical source water quantities and conceptual recharge strategies. In this section, a summary of preliminary results is presented to help frame the subsequent discussion of a more detailed analysis of the water sources in Sections 3 through 5. The conceptual-level strategies being considered (in no particular order) are listed here:

- Enhanced recharge via Santa Ysabel Creek and Santa Maria Creek
- Enhanced recharge via infiltration basins
- Enhanced recharge via injection wells
- In-lieu recharge via storing untreated water from Ramona MWD in storage ponds and growers in the Basin using this water to offset groundwater use for irrigation

Establishing these conceptual-level recharge strategies helps establish links between different recharge sources and recharge strategies. Ultimately, representatives from the City, the County, CWA, Ramona MWD, key local growers, and stakeholders will be convened in 2023 to gain consensus on recharge strategies and locations presented in this technical memorandum. Therefore, information presented in this technical memorandum should be viewed as a starting point for Task 4, recharge strategy development.

2.1 Hypothetical Quantities of Source Water for Recharge Strategies

Estimated monthly volumes of source water for recharge strategies are presented by source in **Figure 2-1.** These volumes provide an initial sense of the seasonal and multi-year availability of water supply that hypothetically could have been available during WYs 2005 through 2019 under the following operational conditions:

- If the excess streamflow passing by Ysabel Creek Road could have been retained and recharged east of Ysabel Creek Road,
- If surface water from Sutherland Reservoir could have been periodically released by the City to Santa Ysabel Creek, resulting in increased Santa Ysabel Creek flows to the Basin, while maintaining existing operations,
- If Ramona MWD could have delivered untreated water supply to the Basin during the summer using available system delivery capacity.

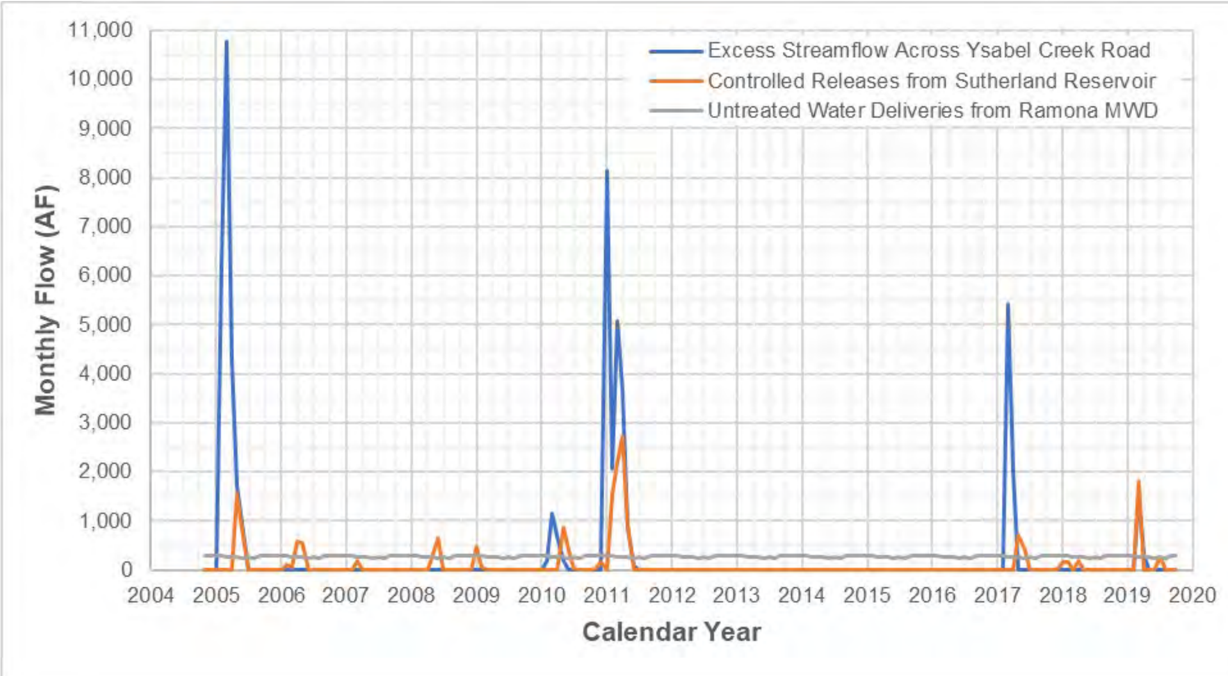

Figure 2-1. Hypothetical Monthly Quantities of Source Water for Enhanced Recharge Strategies

One of the primary sources of groundwater recharge in the Basin occurs through leakage of surface water along Santa Ysabel Creek in the eastern portion of the Basin. Because there were no stream gauges in the Basin during the 15-year historical period shown in **Figure 2-1**, estimates of streamflow from a preliminary version of SPV GSP Model v2.0 were used in this analysis. The version of the SPV GSP Model used during development of the GSP (City and County, 2021) will hereafter be referred to as SPV GSP Model v1.0, whereas the version that will be updated to support decisions associated with PMA No. 7 will be referred to as SPV GSP Model v2.0. Simulated streamflow information presented in this section and the following sections is based on a preliminary (non-calibrated) version of SPV GSP Model v2.0. Therefore, simulated streamflow information presented herein is subject to change as the model refinement and recalibration process continues to improve upon SPV GSP Model v1.0. The preliminary streamflow characteristics presented in this technical memorandum provide a reasonable starting point for bounding potential surface water recharge quantities that could be used to enhance groundwater recharge in the eastern SPV.

The permeable streambed of Santa Ysabel Creek naturally allows full infiltration of streamflow entering the Basin most of the time, leaving miles of a dry gap between the streamflow front and Ysabel Creek Road. Therefore, years when more frequent and larger streamflow events occur are the most likely years with periods of full transmission of streamflow in Santa Ysabel Creek through the eastern portion of the Basin. Thus, quantifying the frequency and magnitude of excess streamflow that crosses Ysabel Creek Road is a good step toward quantifying potential recharge opportunities with that excess water. As shown in **Figure 2-1**, the estimated monthly volume of excess streamflow across Santa Ysabel Road during the 15-year historical period ranged from 0 to nearly 11,000 acre-feet (AF), according to the preliminary version of SPV GSP Model v2.0. Section 3 provides additional details on the streamflow characteristics along various segments of Santa Ysabel Creek.

Given the limited streamflow entering the Basin in Santa Ysabel Creek, controlled releases from Sutherland Reservoir are being considered as a strategy to increase streamflows in the creek. Based on an initial assessment of historical data, some water from Sutherland Reservoir could be available for other uses, mostly during the January through May period, while maintaining the reservoir's existing operations, which include water releases to the San Vicente reservoir. Controlled releases are a more feasible way to provide additional flow to the creek than uncontrolled releases (spills) because the reservoir rarely reaches maximum storage capacity that would trigger such uncontrolled releases. Since the reservoir began operating in 1954, the estimated frequency of annual spills exceeding 5,000 AF has been less than 6 percent of the time. Because natural runoff is the only substantial inflow to the reservoir, water availability is sensitive to hydrology, and would most likely not be available during drought years as shown in **Figure 2-1** for years 2012 through 2016. Conveyance losses and operational feasibility are other key considerations that will be further evaluated using the CWASim tool to simulate operation scenarios as part of the future Task 4 technical memorandum that will further develop recharge strategies. Section 4 provides a detailed analysis of the Sutherland Reservoir water balance as well as a description of existing infrastructure, operation, and agreements.

The third water source analyzed is untreated water deliveries from Ramona MWD. This source is less subject to availability changes due to local climate because it is untreated water imported through the CWA's system. This water was formerly used for local irrigation by Ramona MWD customers and delivered to Ramona MWD's flow control facility RAM1 at the westerly boundary with the City of Poway. The Ramona MWD's untreated water demands have decreased from approximately 5,000 AFY to current demands of approximately 300 AFY to 400 AFY (Ramona MWD, 2022b). CWA's untreated supplies are a mix of water from the Colorado River Aqueduct and the State Water Project. **Figure 2-1** shows a hypothetical monthly delivery provided by Ramona MWD corresponding to an annual total delivery up to 3,350 AFY. Ramona MWD staff estimated 3,350 AFY could be delivered at two different locations from its untreated water system's Robb Zone using 80 percent of its conveyance capacity and assuming existing demand is within the 2019-2021 average. An alternative delivery point could be available for 850 AFY from its Snow Zone, assuming the same conveyance capacity of 80 percent and average future local demand. A monthly volume of approximately 280 AF could be delivered continuously throughout the year. One advantage of this water source is that some untreated water could be available during dry years, and only require minor modifications to the existing untreated water system infrastructure to deliver this additional water supply to the Basin. Discussions with CWA and Ramona MWD, including discussion around capacity and potential other constraints to receiving untreated water, will continue in future planning and design phases of the project. Operation of the First Aqueduct, through which untreated imported water is conveyed to Ramona MWD by CWA, would need to be aligned with and incorporate Ramona MWD's re-established new untreated water demand. It is possible that restrictions on water deliveries could be applied during droughts, given that this is not a municipal or industrial water use, the possibility of which will need to be considered in the future. Section 5 provides a description of existing Ramona MWD's water supply sources and operations.

2.2 Criteria for Selecting Surface Water Recharge Locations

The eastern portion of the Basin is the most suitable area for implementing enhanced surface water recharge strategies and was considered when evaluating these potential water sources. The focus on enhanced recharge strategies in the eastern portion of the Basin is consistent with past studies in the area (e.g., CDM, 2010; CH2M, 2016). Conceptual recharge locations have been identified based on the following criteria:

- Focus on the eastern portion of the Basin, where the deeper water table could accommodate additional recharge from enhanced recharge strategies.

- Prioritize recharge locations on City-owned parcels to avoid the need for land purchase or new easements.
- Prioritize enhancing retention of water supply within the eastern portion of the Basin. Therefore, improving outflows to Lake Hodges is not a priority for this study.
- Minimize distances between sources of recharge water and points of delivery to minimize lengths and cost of conveyance infrastructure.
- Prioritize recharge areas near existing roadways to facilitate routine maintenance.
- Prioritize recharge locations near representative monitoring wells that are used for ongoing GSP compliance to track effects of recharge on groundwater levels and quality.
- Minimize disturbance of existing active agricultural lands (e.g., orchards).

Figure 2-2 shows generalized areas that meet these criteria to varying degrees and **Table 2-1** describes these areas. Potential recharge areas have not been vetted by stakeholders or permitting agencies, so they should be viewed as conceptual for this stage of study.

The following sections summarize the estimated quantities of streamflow, controlled releases from Sutherland Reservoir, and Ramona MWD's untreated water system. These estimates represent quantities of source water that, hypothetically under certain assumptions, could have potentially been used for enhanced recharge strategies over a 15-year historical period including water years (WYs) 2005 through 2019.

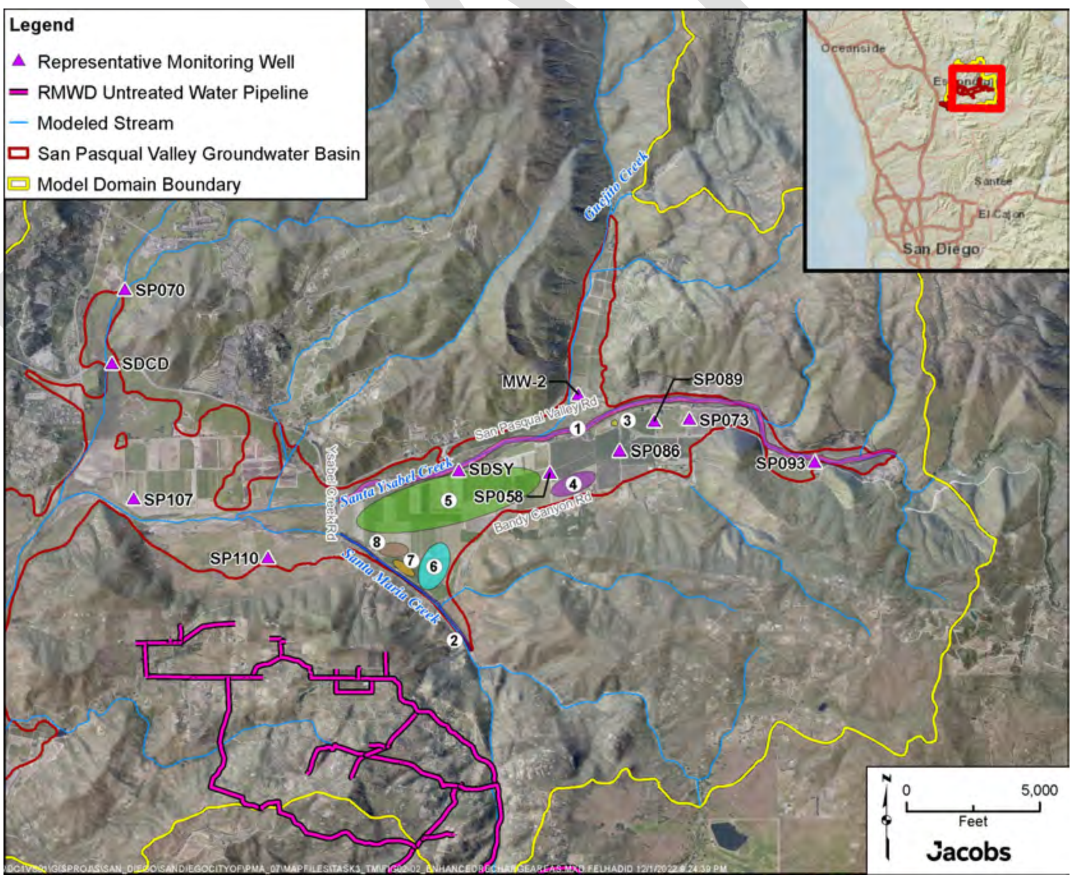

Figure 2-2. Six Hypothetical Areas for Enhanced Recharge Strategies

Table 2-1. *Summary of Initial Recharge Area Identification*

Area No.	Description and Initial Thoughts on Suitability for Enhanced Recharge Strategies
1	• Miles of permeable streambed along Santa Ysabel Creek east of Ysabel Creek Rd • Ideal for enhanced recharge strategies of excess streamflows via streambed infiltration • Excess streamflow would generally have better water quality than imported water sources
2	• More than a mile of streambed along Santa Maria Creek east of Ysabel Creek Rd • Good for enhanced recharge strategies via streambed infiltration
3	• In City-owned parcel near mouth of Rockwood Canyon along San Pasqual Valley Rd and Bandy Canyon Rd • Adjacent to San Pasqual Valley Staging Area • Located close to Santa Ysabel Creek; potentially short pipeline from creek as an occasional water source for recharge • Longer pipeline routes would be required from the untreated water distribution system • Limited space for recharge infrastructure; may be more suitable for injection strategies
4	• In City-owned parcel southwest of Area No. 3 along Bandy Canyon Rd • Area already cleared with sod crop; looks favorable for recharge infrastructure • Located between two representative monitoring wells for water levels • Longer pipeline routes would be required from the untreated water distribution system • Good for enhanced recharge strategies via infiltration basins and/or injection wells
5	• In large City-owned parcel west of Area No. 4 • Large areas of parcel are already cleared with sod and forage crops; looks favorable for recharge infrastructure • Santa Maria and Santa Ysabel Creeks both flow adjacent to area; potentially short pipeline from these creeks as an occasional water source for recharge • Shorter pipeline route from the untreated water distribution system • Some portions of area might be suitable for storage ponds and in-lieu recharge strategies • Reasonably good for enhanced recharge strategies via infiltration basins and/or injection wells, but some portions of area would likely be too far west to provide much additional supply benefits to eastern portion of the Basin
6	• In City-owned parcel south of Area No. 5 along Bandy Canyon Rd near mouth of Bandy Canyon • Shorter pipeline route from the untreated water distribution system • Some portions of parcel might be suitable for storage ponds and in-lieu recharge strategies • Possibly adequate for enhanced recharge strategies via infiltration basins and/or injection wells, but some portions of parcel may be too far south and west to provide much additional supply benefits to eastern portion of the Basin
7	• In City-owned parcel west of Area No. 6 along Bandy Canyon Rd next to Santa Maria Creek • Shorter pipeline route from the untreated water distribution system • Some portions of parcel might be suitable for storage ponds and in-lieu recharge strategies • Area is not ideal for enhanced recharge strategies via infiltration basins or injection wells • Some portions of parcel may be too far south and west to provide much additional supply benefits to eastern portion of the Basin
8	• In City-owned parcel between Area Nos. 5 and 7 along Bandy Canyon Rd • Shorter pipeline route from the untreated water distribution system • Some portions of parcel might be suitable for storage ponds and in-lieu recharge strategies • Area is not ideal for enhanced recharge strategies via infiltration basins or injection wells • Some portions of parcel may be too far south and west to provide much additional supply benefits to eastern portion of the Basin

*See **Figure 2-2** for locations of these areas.*

3. HISTORICAL STREAMFLOW

One of the primary sources of groundwater recharge in the Basin occurs through leakage of surface water along Santa Ysabel Creek in the eastern portion of the Basin. To develop and implement surface water recharge projects within the Basin, it is important to understand the availability of naturally occurring streamflow and the groundwater/surface-water interactions that can occur throughout the Basin.

The Basin lies within the San Dieguito Drainage Basin, which is comprised of SPV and several canyons – most notably are Rockwood Canyon, Bandy Canyon, and Cloverdale Canyon. Within the Basin, the San Dieguito River is formed at the confluence of Santa Ysabel Creek and Santa Maria Creek and flows into Hodges Reservoir downgradient from the southwest boundary of the Basin (**Figure 1-1**). The eastern end of the Basin is generally a groundwater recharge area, where the aquifer receives water primarily from streambed infiltration of Santa Ysabel, Guejito, and Santa Maria Creeks. The western end of the Basin is generally a groundwater discharge area, where some groundwater discharges to the San Dieguito River or is consumed by vegetation. Groundwater that does not discharge to the river or is not consumed by vegetation leaves the Basin as subsurface outflow and flows toward Hodges Reservoir.

Upgradient from the San Dieguito River confluence, there are three U.S. Geological Survey (USGS) stream gauges along Santa Ysabel Creek (USGS 11025500), Guejito Creek (USGS 11027000), and Santa Maria Creek (USGS 11028500) with daily historical streamflow measurements. These stream gauges are all located upstream of the Basin (**Figure 1-1**). These stream gauge data were utilized in the development of SPV GSP Model v1.0 covering a 15-year historical period from water years (WYs) 2005 through 2019 (that is, October 2004 through September 2019) (City and County, 2021). No stream gauges existed within the Basin during this 15-year period.

Figure 3-1 presents annual volumes of streamflow measured at the Santa Ysabel Creek, Guejito Creek, and Santa Maria Creek gauges during the 15-year historical period. Water Year Types (WYTs)[1] established during the development of the GSP are also shown in **Figure 3-1** to provide context for the hydrology observed throughout the historical period. In general, Santa Ysabel Creek provides the largest source of streamflow to the eastern portion of the Basin, followed by Santa Maria Creek, and then Guejito Creek. As shown in **Figure 3-1**, these streams are ephemeral and typically only flow after precipitation events with sufficient intensity and duration. Therefore, without substantial precipitation events, the eastern portion of the Basin typically has dry streambeds.

[1] W = wet, AN = above normal, N = normal, D = dry, and C = critically dry.

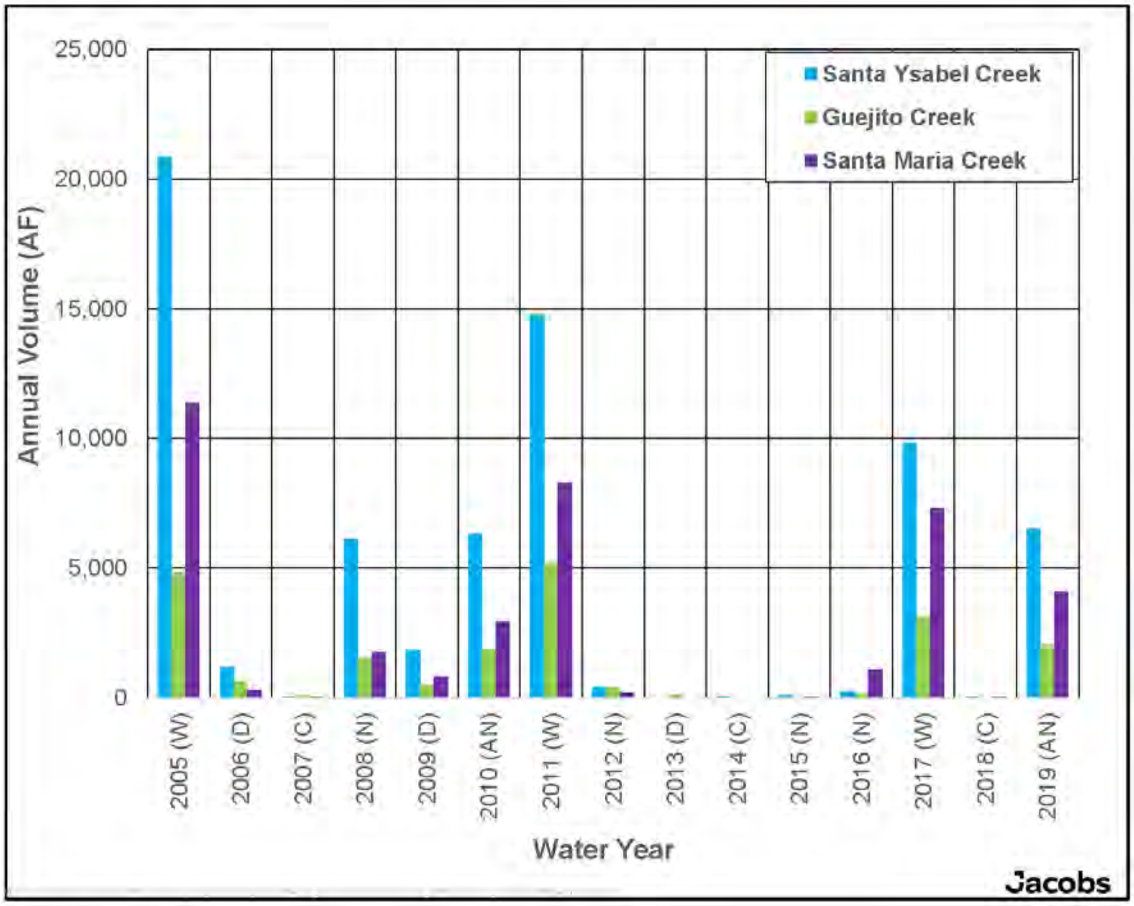

Figure 3-1. Annual Streamflow Volumes at Santa Ysabel, Guejito, and Santa Maria Creeks' Gauges

The permeable streambed of Santa Ysabel Creek naturally allows full infiltration of streamflow entering the Basin most of the time. Therefore, years when more frequent and larger streamflow events occur are the most likely years with periods of full transmission of streamflow in Santa Ysabel Creek through the eastern portion of the Basin. It is difficult to quantify the amount of excess streamflow (that is, streamflow leaving the eastern portion of the Basin) that would be available for recharge projects without a stream gauge within the eastern Basin. Given these complexities and the lack of measured streamflow data in this portion of the Basin, the best available tool to help quantify potential volumes of streamflow available for recharge projects is the SPV GSP Model. To better understand these groundwater/surface-water conditions, "virtual" stream gauges were incorporated into the modeling process and used to extract simulated streamflow data from a preliminary version of SPV GSP Model v2.0. This preliminary version of SPV GSP Model v2.0 is undergoing updates and recalibration with improved representation of stream channel conditions. Although this model update is not complete, it provides a reasonable starting point for estimates of streamflow at key locations where physical stream gauges are not present. **Figure 3-2** presents the locations of these virtual stream gauges. Virtual stream gauges were incorporated into the first five river miles of Santa Ysabel Creek, based on estimated distances from the intersection of Santa Ysabel Creek and the eastern SPV GSP Model boundary.

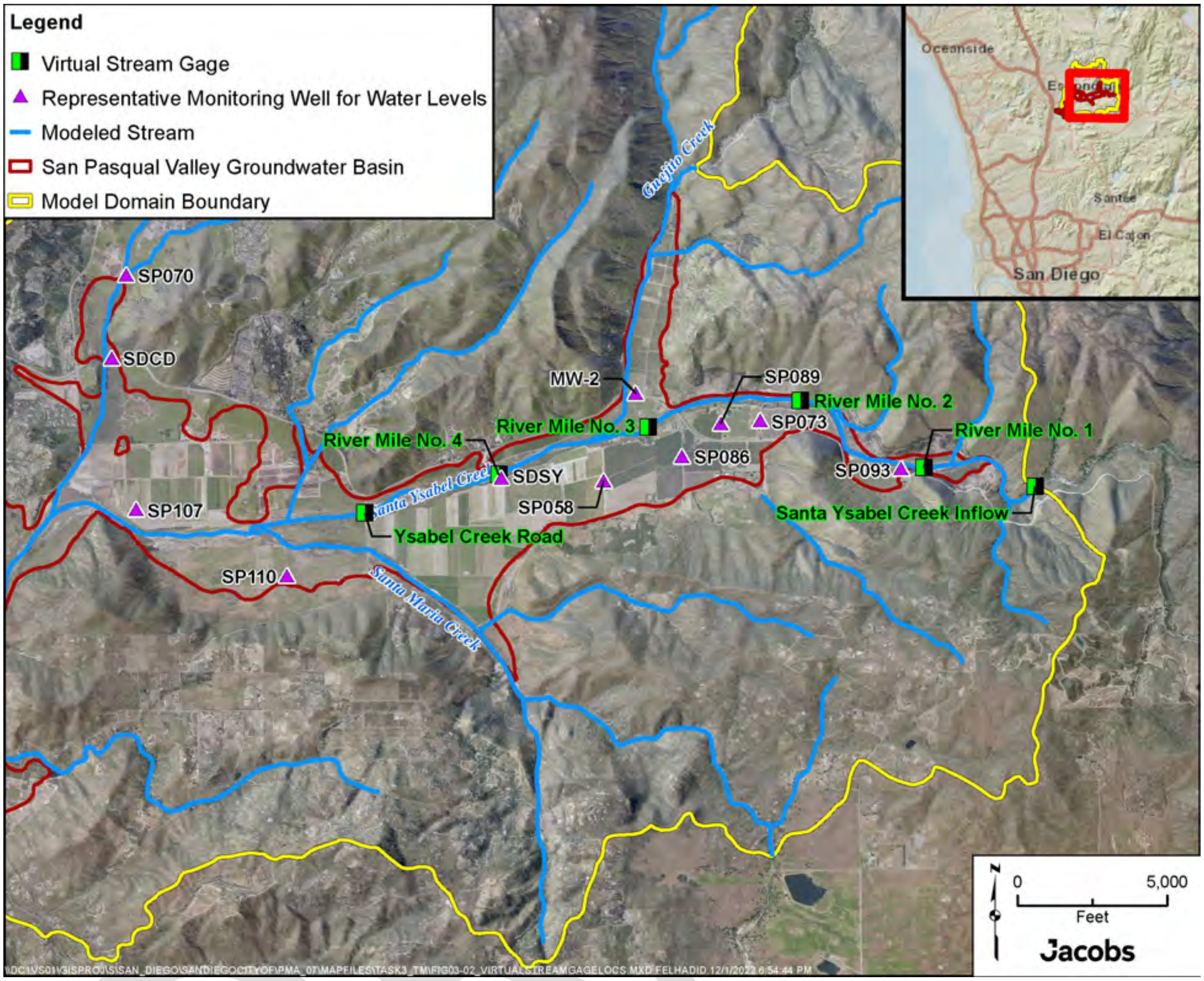

Figure 3-2. Virtual Stream Gauge Locations

Table 3-1 summarizes annual volumes of streamflow for each virtual streamflow gauge for the 15-year historical period. According to the preliminary version of the SPV GSP Model v2.0, there are 5 years out of the 15-year historical period when streamflow entering the eastern portion of the Basin flowed beyond the most downstream virtual streamflow gauge, which coincides with Ysabel Creek Road. Ysabel Creek Road was selected as the downstream virtual stream gauge location in Santa Ysabel Creek as a convenient geographic reference point for discussion and because it is west of any likely surface water recharge projects that may be developed in the Basin. In general, Santa Ysabel Creek streamflow volumes decrease from east to west across the eastern portion of the Basin, except between River Mile Nos. 3 and 4 because of streamflow additions from Guejito Creek at its confluence with Santa Ysabel Creek.

Table 3-1. ***Modeled Annual Streamflow Volumes at Virtual Stream Gauges***

Water Year[a]	Santa Ysabel Creek Inflow	River Mile No. 1	River Mile No. 2	River Mile No. 3	River Mile No. 4	Ysabel Creek Road
2005 (W)	24,062	24,135	23,181	20,340	24,526	23,826
2006 (D)	1,276	548	0	0	0	0
2007 (C)	29	0	0	0	0	0
2008 (N)	6,416	5,847	3,976	867	51	0
2009 (D)	1,982	1,492	397	0	0	0
2010 (AN)	6,625	6,494	5,674	2,785	3,059	2,230
2011 (W)	17,116	18,013	17,550	15,195	20,566	19,903
2012 (N)	487	0	0	0	0	0
2013 (D)	18	0	0	0	0	0
2014 (C)	67	0	0	0	0	0
2015 (N)	105	0	0	0	0	0
2016 (N)	301	0	0	0	0	0
2017 (W)	12,264	12,275	11,045	6,823	7,817	7,446
2018 (C)	548	491	0	0	0	0
2019 (AN)	7,073	6,742	5,358	2,345	2,463	1,816

[a] Water year types are shown in parentheses and defined as follows: W=wet, AN=above normal, N=normal, D=dry, and C=critically dry.

Values are expressed in units of annual acre-feet.

Not all water years with similar annual streamflow result in the same groundwater/surface-water characteristics. For example, there are two years, WYs 2008 and 2010, during which a similar volume of streamflow occurred at the Santa Ysabel Creek inflow gauge (6,416 AF and 6,625 AF, respectively). However, the excess streamflow passing beyond Ysabel Creek Road in the preliminary version of SPV GSP Model v2.0 was significantly different (0 AF and 2,230 AF, respectively). The two years leading up to WY 2008 were dry and critically dry, which likely resulted in groundwater-level declines in the eastern portion of the Basin in WY 2008, allowing for greater infiltration of streamflow in WY 2008 as compared to WY 2010. This means that streamflow in WY 2008 infiltrated before reaching Ysabel Creek Road, whereas in WY 2010, streamflow would have reached at least Ysabel Creek Road, despite both water years having similar volumes of water entering the Basin. A similar comparison can be made between WYs 2011 and 2017, both of which were wet WYs that followed very different sequences of hydrology in preceding years. As a result, the excess streamflow at Ysabel Creek Road was also significantly different between these two years (19,903 in WY 2011 and 7,446 in WY 2017).

Table 3-2. Modeled Monthly Streamflow Volumes in Santa Ysabel Creek at Ysabel Creek Road

Month	2005 (W)[a]	2010 (AN)[a]	2011 (W)[a]	2017 (W)[a]	2019(AN)[a]	Average
Oct	0	0	0	0	0	0
Nov	0	0	0	0	0	0
Dec	0	0	8,133	0	0	1,627
Jan	6,231	179	2,077	0	0	1,697
Feb	10,782	1,169	5,088	5,415	1,492	4,789
Mar	4,308	685	3,663	2,031	314	2,200
Apr	1,743	195	868	0	10	563
May	759	2	74	0	0	167
Jun	2	0	0	0	0	0
Jul	0	0	0	0	0	0
Aug	0	0	0	0	0	0
Sep	0	0	0	0	0	0
Annual	23,826	2,230	19,903	7,446	1,816	11,044

[a] Water year types are shown in parentheses and defined as follows: W=wet and AN=above normal.

Values are expressed in units of monthly acre-feet.

Although annual streamflow volumes are helpful in conceptualizing potential volumes of water available for surface water recharge projects, it is also important to consider the seasonal timing of streamflow. **Table 3-2** presents simulated monthly streamflow volumes at Ysabel Creek Road for the five above-normal and wet years of the historical period when streamflow is modeled to have occurred at this location (**Figure 2-1**). Based on the preliminary version of the SPV GSP Model v2.0, excess streamflow through the eastern portion of the Basin occurred between December and May with peak streamflow volumes occurring in the month of February on average. Aside from the timing and magnitude of streamflow volume, it is important to consider stream depths during these events to ensure that the enhanced recharge strategies could access and utilize excess streamflow along Santa Ysabel Creek.

Figure 3-3 presents a series of figures that show the percentage of days during the historical 15-year period where streamflow depths exceed depth thresholds of 0.5, 1, 2, and 4 feet along Santa Ysabel Creek, as simulated in the preliminary version of SPV GSP Model v2.0. The purpose of these graphics is to illustrate the infrequent nature of streamflows of different depths in the eastern portion of the Basin during the historical period. The cooler and warmer colors along the modeled streams indicate a larger and smaller percent of the 15-year historical period when the streamflow depth was at least 0.5, 1, 2, and 4 feet. **Figure 3-3** shows that the occurrence of deeper stream depths from WYs 2005 through 2019 was more prevalent at the eastern end of the Basin, according to the preliminary version of SPV GSP Model v2.0. These graphics further highlight the infrequent nature of large streamflow events providing full transmission of streamflow between Ysabel Creek Road and the east end of the Basin. The frequency of streamflow depth and the timing of surface water volumes will be further evaluated under Task 4 of PMA No. 7 during the development of recharge strategies to assess whether these strategies could take full advantage of the intermittent excess streamflow events that occur in the eastern portion of the Basin.

The availability of surface water during the historical 15-year period that hypothetically could have been utilized as a source for surface water recharge projects was intermittent and only available during certain above normal and wet years when the preceding hydrology was favorable (**Figure 2-1** and **Table 3-1** and **Table 3-2**). Streamflow entering the eastern portion of the Basin during most years already replenishes the aquifer through infiltration of the streambed. Thus, the recharge strategies devised under Task 4 of PMA No. 7 will focus on the times when streamflow would otherwise leave the eastern portion of the Basin. The development of these strategies will need to take advantage of locations along Santa Ysabel Creek where adequate streamflow volumes and depths occur to ensure any infrastructure put into place could access and convey the excess streamflow to recharge locations.

The SPV GSP Model v2.0 will be utilized as the primary tool for characterizing the availability of streamflow along Santa Ysabel Creek. As calibration of the SPV GSP Model v2.0 is finalized, refinements of the streamflow volumes presented herein will be refined to better reflect hydrologic conditions in the Basin.

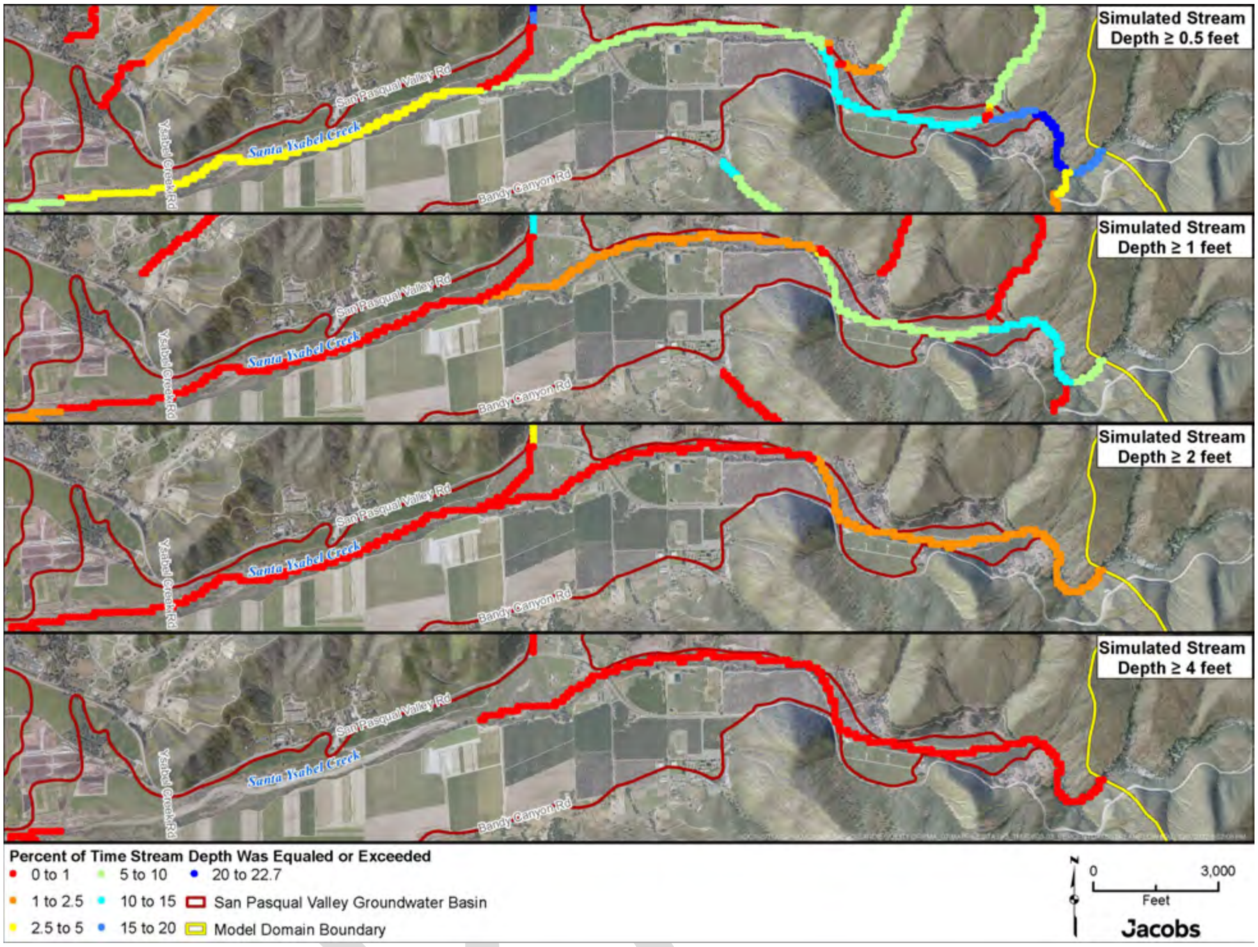

Figure 3-3. Percent of Days Streamflow Occurred During the 15-year Historical Period

4. SUTHERLAND RESERVOIR

Sutherland Reservoir is owned and operated by the City and is under the regulatory jurisdiction of the DWR, Division of Safety of Dams (DSOD) and SWRCB, Division of Drinking Water (DDW). This reservoir is located approximately nine miles northeast of the town of Ramona on Santa Ysabel Creek, a tributary system to the San Vicente Reservoir and a tributary stream to the Hodges Reservoir (City, 2020). Sutherland Reservoir is open to the public for recreational use, but functions primarily as a water impoundment.

In this section, the natural runoff stored in Sutherland Reservoir is assessed as a potential source for recharge projects in the Basin. In addition, the Sutherland Reservoir's existing infrastructure, agreements, and operations are analyzed to provide context for the potential availability of stored water to be released to augment streamflow in Santa Ysabel Creek entering the Basin. The magnitude and frequency of this additional source of water to the Basin are analyzed to assess its potential for use in enhance surface water recharge strategies. However, the actual future water availability from Sutherland Reservoir, in addition to hydrology variability affected by climate change, could be subject to future unknown regulation and restrictions. Recharge strategies will be explored as part of the next technical memorandum documenting Task 4, Potential Recharge Strategies.

4.1 Definitions

There are several technical terms associated with reservoir operations that are normally indicated as inflows to the reservoir and outflows from the reservoir. The following terms are used in this section:

- Inflows to the reservoir: water flowing into the reservoir to be stored. Inflows into the reservoir are defined based on the source from which they originate.
    - Runoff: draining of water flowing across the surface of an area. For each reservoir there is a specific drainage area that provides runoff that enters the reservoir as streamflow. Runoff is that part of the precipitation, snow melt, or irrigation water that appears in surface streams, rivers, drains, or sewers.
    - Rain on surface: the precipitation that falls directly onto the body of water (area) of the reservoir. This inflow volume is calculated as the precipitation depth times the water surface area, which varies depending on the storage level in the reservoir.
    - Other inflows: other reservoir inflows could come as imported water delivered through piped connections and as subsurface inflow from surrounding water-bearing zones.
- Outflows from the reservoir: stored water in the reservoir can leave the reservoir as a controlled release or uncontrolled release.
    - Controlled releases: also known as withdrawals, corresponds to stored water releases that require operation of outlet structures for routine maintenance and for compliance with dam safety. There are different purposes of controlled releases such as delivering water to downstream users to meet demands, transfer water to another reservoir, to allow empty space in reservoir in preparation of a flood event (flood releases or emergency operations).
    - Uncontrolled releases: these correspond to stored water that leaves the reservoir either through the spill crest, because the maximum storage capacity has been reached or due to leakages and other reservoir losses. Spillways typically represent structures at the top of the dam that allow water to go over the top of the dam in an uncontrolled manner releasing surplus flood water to ensure dam safety. The spill crest is the highest elevation of the floor of the spillway.

4.2 Historical Water Balance

Sutherland Reservoir captures runoff from the surrounding 53-square-mile drainage area, which is part of the San Dieguito Drainage Basin. Runoff and rain on the reservoir's surface are the only inflows to the reservoir. There are no additional inflows in the form of deliveries or piped connections into the reservoir and it is assumed that subsurface inflows to the reservoir are negligible. **Figure 4-1** presents Sutherland Reservoir's estimated annual runoff from the surrounding drainage area and the precipitation on the reservoir's surface. WYTs[1] established during the development of the GSP are shown to provide context for the hydrology observed during the 15-year historical period. Because there are no streamflow gauges upstream of the reservoir, the runoff is estimated by conducting a monthly water balance with information provided by the City comprising (City, 2022c) a monthly time series of inflows to Sutherland Reservoir and

[1] W = wet, AN = above normal, N = normal, D = dry, and C = critically dry.

outflows from the reservoir (see definitions in Section 4.1). The City Public Utilities Department produces this monthly time series with information from the National Oceanic and Atmospheric Association, and San Diego Geographical Information System.

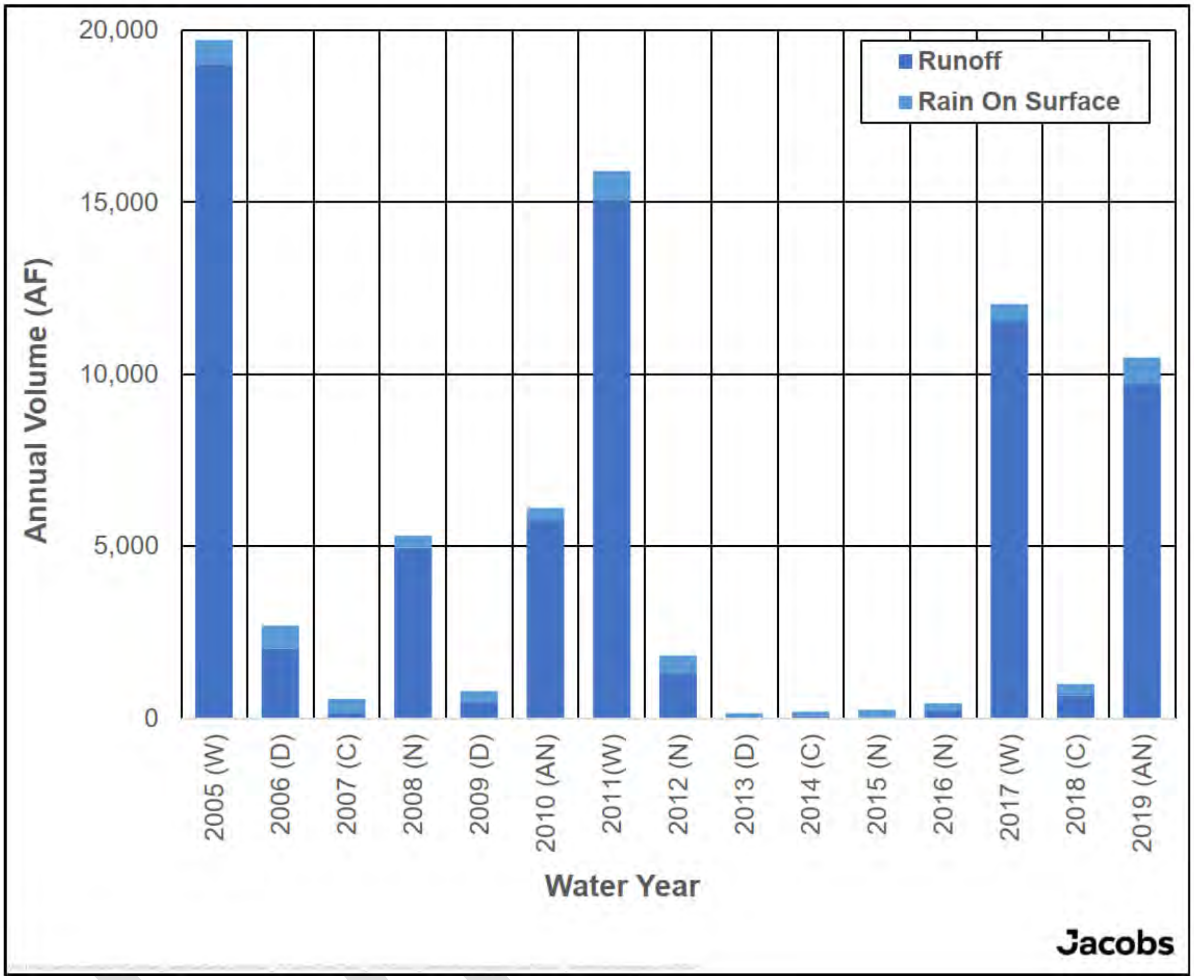

Figure 4-1. Estimated Annual Inflows to Sutherland Reservoir

Figure 4-2 presents the average annual inflows and outflows of Sutherland Reservoir during the 15-year historical period (WYs 2005 through 2019) that were used for the water balance (City, 2022c). The annual average inflow to the reservoir during this period was 5,166 AF, with a maximum annual inflow of 19,714 AF and a minimum annual inflow of 153 AF, showing significant variability (see **Figure 4-1**). The reservoir typically loses more than 4 feet of water every year due to evaporation (1,127 AFY), which represents approximately 22 percent of the average annual inflows. The remaining stored water was mostly transferred to San Vicente Reservoir (3,546 AFY). Other outflows were minor volumes: spills did not occur during this period and deliveries to Ramona only occurred during WYs 2005 through 2007 of around 500 AFY. More details on the existing operations are provided in the section below.

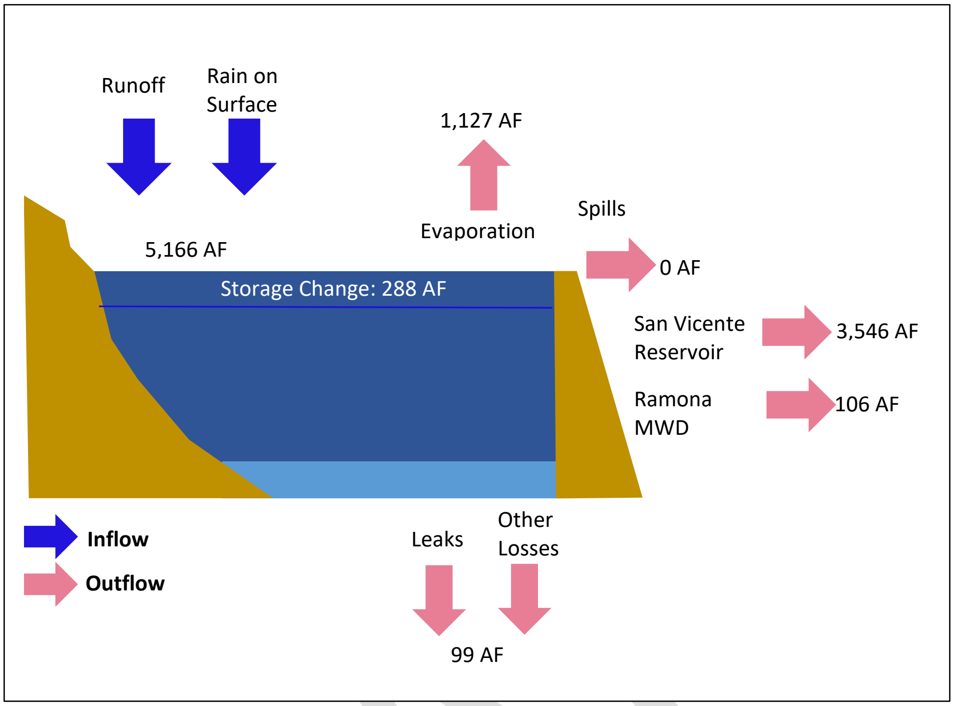

Figure 4-2. Sutherland Reservoir Average Annual Inflows and Outflows for Water Years 2005 through 2019

4.3 Existing Infrastructure, Operation and Agreements

In the following paragraphs, the key infrastructure, operations, and agreements are reviewed to understand limitations and existing operation conditions related to water spills (excess water above maximum capacity flowing to the Santa Ysabel Creek) and operational releases (water transfers downstream for other purposes).

4.3.1 Historical Reservoir Details and Spills

Sutherland Reservoir has a maximum storage capacity of 29,345 AF according to the latest bathymetry survey (City, 2021). When full, the water surface area is 557 acres at elevation 2,057 feet above the National Geodetic Vertical Datum of 1929 (NGVD29). The surface area versus volume curve is provided in **Attachment A**. Once the water level reaches this maximum elevation, water starts flowing through the spillway crest up to a maximum spill of 41,220 cubic feet per second (cfs) (City, 2022b).

During WYs 2005 through 2019 there were no recorded spills. In order to estimate the spill frequency outside of this 15-year historical period, the records between 1954 and 2021 were reviewed. During this longer-term period, spills occurred only during seven WYs: 1978, 1979, 1980, 1983, 1984, 1993, and 1995. The estimated frequency of annual spills exceeding 5,000 AF between 1954 and 2021 was less than 6 percent (see **Figure 4-3**).

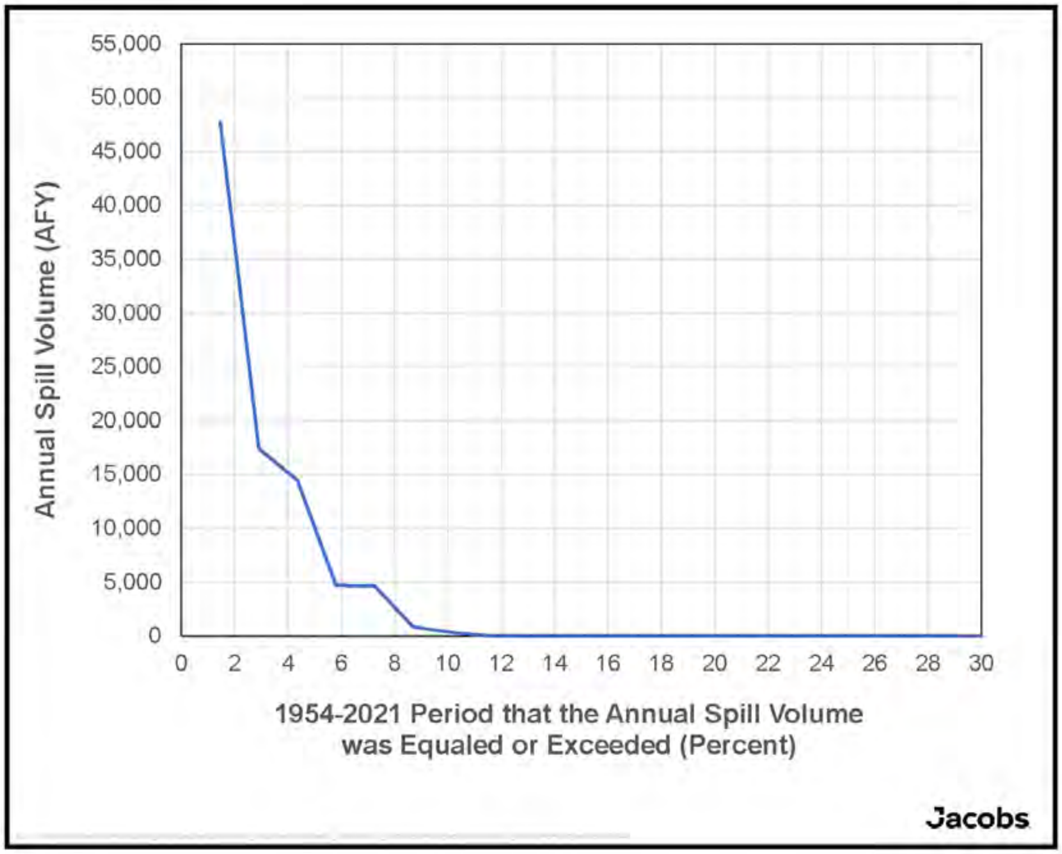

Figure 4-3. Historical Frequency of Sutherland Reservoir Spills

4.3.2 Reservoir Operational Releases

The Sutherland Dam outlet structure includes two 36-inch outlet pipes and a 30-inch gate valve which discharges to the 36-inch Sutherland Pipeline. One outlet pipe belongs to the City (west intake) and the other to Ramona MWD (east intake), though both are operated by the City. The east intake has a 24-inch bypass pipeline that can be used to control releases to Santa Ysabel Creek and has served as the main emergency valve. This intake is currently not functioning, and an interim plan is in place to use a combination of blow-offs along the west intake for emergency releases. If additional controlled releases are to be implemented, the same approach would need to be used to release flows to Santa Ysabel Creek. Currently, controlled releases to the Santa Ysabel creek are not taking place. The City is under no obligation per any agreements to release water to Santa Ysabel Creek.

Water released from the Sutherland Reservoir travels through the Sutherland-San Vicente mortar-coated steel mostly a 36-inch diameter pipeline for approximately 12 miles (see **Figure 4-4**). The pipeline runs southwest from Sutherland Reservoir through the town of Ramona and has a connection to Ramona MWD's Bargar WTP (currently out of commission and no longer used). The release capacity varies depending on the reservoir elevation and the valve operations, under the most current operation, the releases could reach up to 160 cfs as estimated for Alternative D in the 2020 Sutherland Outlet Works Status and Drawdown Alternatives (City of San Diego, 2020). Below are the descriptions of the current operation and agreements for these two controlled releases: to Ramona MWD and to San Vicente Reservoir.

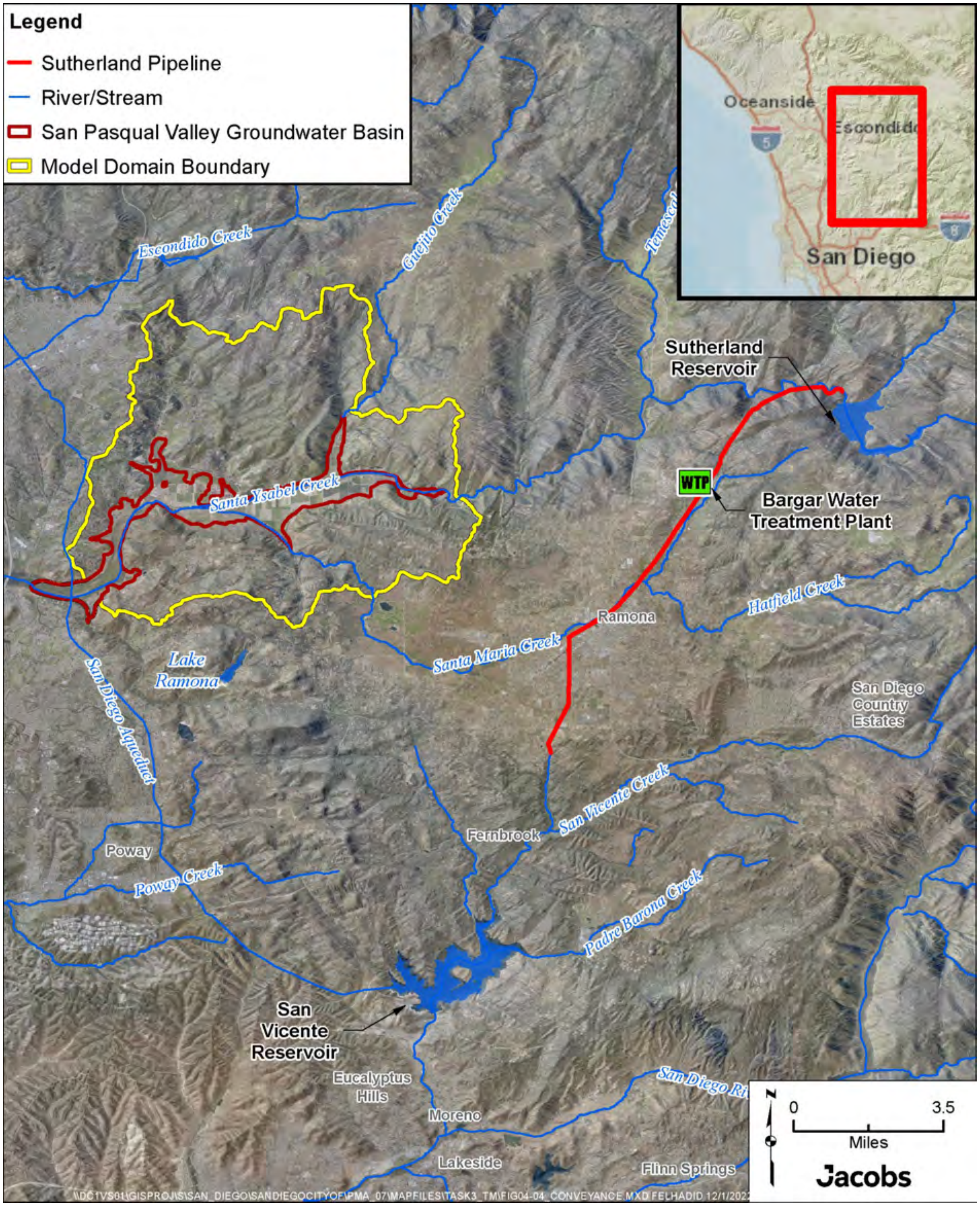

Figure 4-4. Conveyance Associated with Sutherland and San Vicente Reservoirs

The controlled releases to Ramona MWD are based on an agreement between Ramona MWD and the City signed on July 17, 2000 (Ramona MWD and City, 2000). This agreement is called the *Water Exchange and Transportation Agreement, and Water Exchange and Facility Utilization Agreement* and allows Ramona MWD to reserve or purchase stored water from Sutherland Reservoir available above the stage gauge of 65 feet (that is, above the minimum storage requirement of 112 AF). This volume was initially capped to 2,500 AF and then increased to 10,000 AF in an amendment (Ramona MWD and City, 2010) on August 27, 2010. The water to be delivered is subject to the City's approval on May 1st of each year. The delivered water plus Ramona MWD's share of evaporation, seepage and spill losses, is exchanged for delivery of an equal amount of Ramona MWD untreated water purchased from and delivered by CWA to the City at San Vicente Reservoir. Historic reservoir records and letters between the City and Ramona MWD indicate that only during year 2006, untreated water from Sutherland Reservoir was delivered to the Bargar WTP. As previously mentioned, the Barger WTP has been off-line since 2007 (CWA, 2021b). As seen in **Figure 4-5**, annual releases to Ramona MWD of approximately 500 AFY only took place during three years (WYs 2005 through 2007).

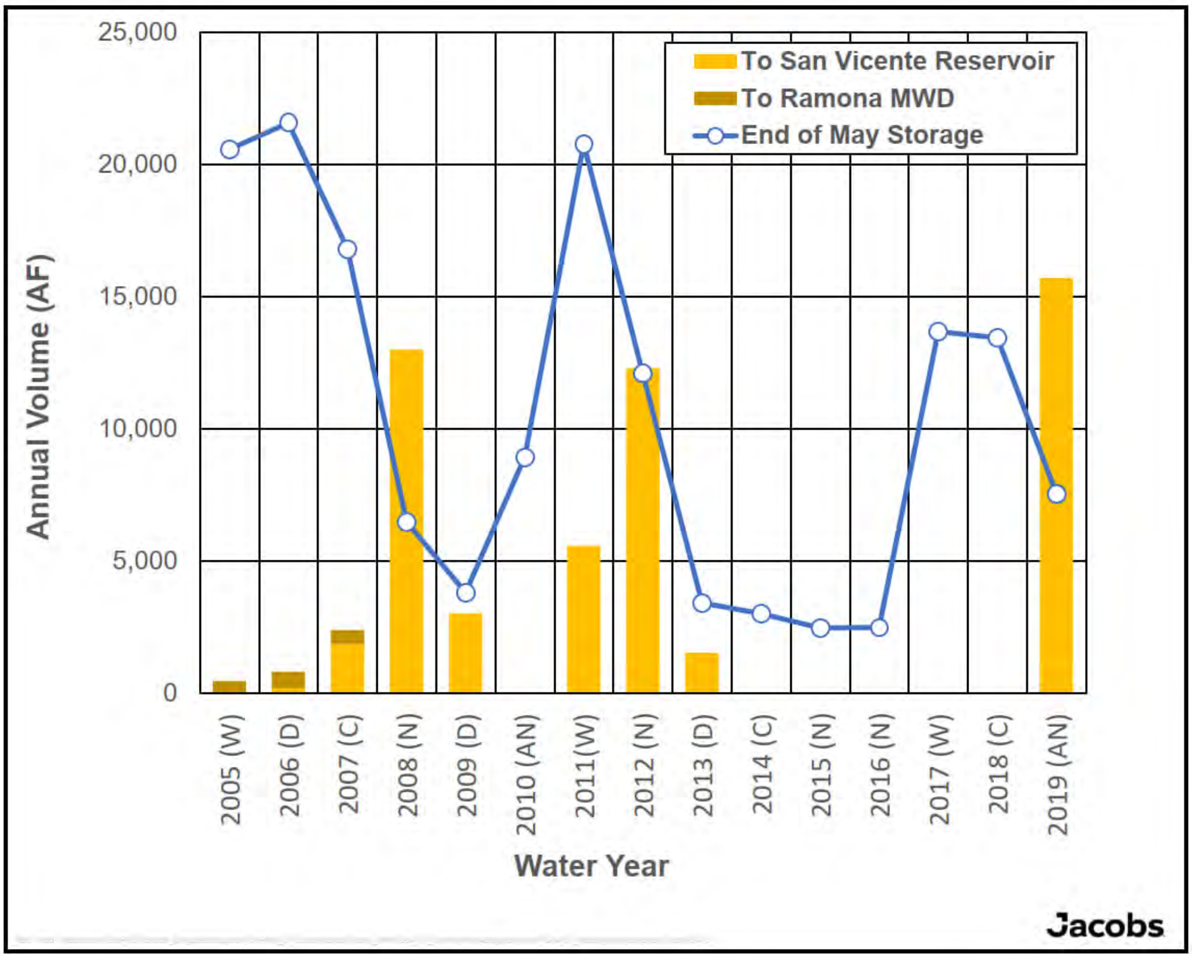

Figure 4-5. Historical Annual Releases from Sutherland Reservoir

The controlled releases to San Vicente Reservoir are based on water availability in Sutherland Reservoir, space available in San Vicente Reservoir to receive this water, and flow operation criteria. These controlled releases represent the majority of the reservoir's outflow; close to 70 percent of the water captured in

Sutherland Reservoir was ultimately transferred to San Vicente Reservoir during WYs 2005 through 2019, then to Alvarado WTP for treatment and delivery to City customers. The Sutherland-San Vicente Pipeline reduces its diameter to 27-inches and discharges into a San Vicente Creek tributary approximately two miles north of the San Vicente Reservoir. Based on the historical annual releases shown in **Figure 4-5**, there are no established volume and frequency releases to San Vicente Reservoir. In addition, the available yield and storage levels are not the only operation criteria. During WY 2010 and the period of WYs 2014 through 2018 there were no withdrawals from the reservoir. Annual releases to San Vicente above 10,000 AF only took place during three years (WYs 2008, 2012, and 2019). The controlled releases to San Vicente include operation criteria to minimize streambed erosion in San Vicente Creek, protect endangered species, and maximize conveyance efficiency. These operational criteria to determine the controlled release flows include the following:

- Release flow magnitude is determined based on Sutherland Reservoir storage level (that is, a higher storage level allows greater flow rate during releases). The range of flows can be between 50 and 95 cfs.
- Timing of releases follow these criteria:
  - February to April: minimize withdrawals during bass spawning season
  - March to September: during Arroyo Toad breeding season, the flow rates must be less than 10 million gallons per day (MGD)
  - March to April: maximize releases when the Santa Ysabel Creek streambed is saturated after the rainy season to reduce stream losses. The assumed stream conveyance loss between Sutherland and San Vicente reservoir is 22 percent (City, 2022d).
- Controlled releases only take place if there is available storage capacity in San Vicente Reservoir unless the releases bypass the reservoir and go directly to Alvarado WTP. San Vicente Reservoir is used to store water from other sources. Space to store water coming from Sutherland Reservoir needs to be available before starting the controlled releases. For instance, San Vicente Reservoir needs to have around 30 percent of available storage capacity before it can accept additional water from Sutherland Reservoir. This is below 200,000 AF of stored water with the possibility to store approximately another 70,000 AF until reaching its maximum capacity. Other criteria for evaluating the feasibility of the City to make releases from Sutherland or keep the water in the reservoir includes the need to use other local surface water resources like El Capitan reservoir.

Figure 4-5 shows the historical controlled releases to San Vicente Reservoir. During WY 2010 and the period of WY 2014 to WY 2018 there were no withdrawals from the reservoir even though stored water was available suggesting the above-mentioned operational criteria were implemented. Annual releases to San Vicente above 10,000 AF only took place during three years (WYs 2008, 2012, and 2019).

Figure 4-6 illustrates stored water at Sutherland Reservoir fluctuated between 7 to 70 percent of its full capacity and below the spillway level. The stored water volume did not decrease below 7 percent (around 2,000 AF) of its full capacity. The monthly releases from Sutherland Reservoir are below 4,000 AF and larger flow releases mostly took place from January through May.

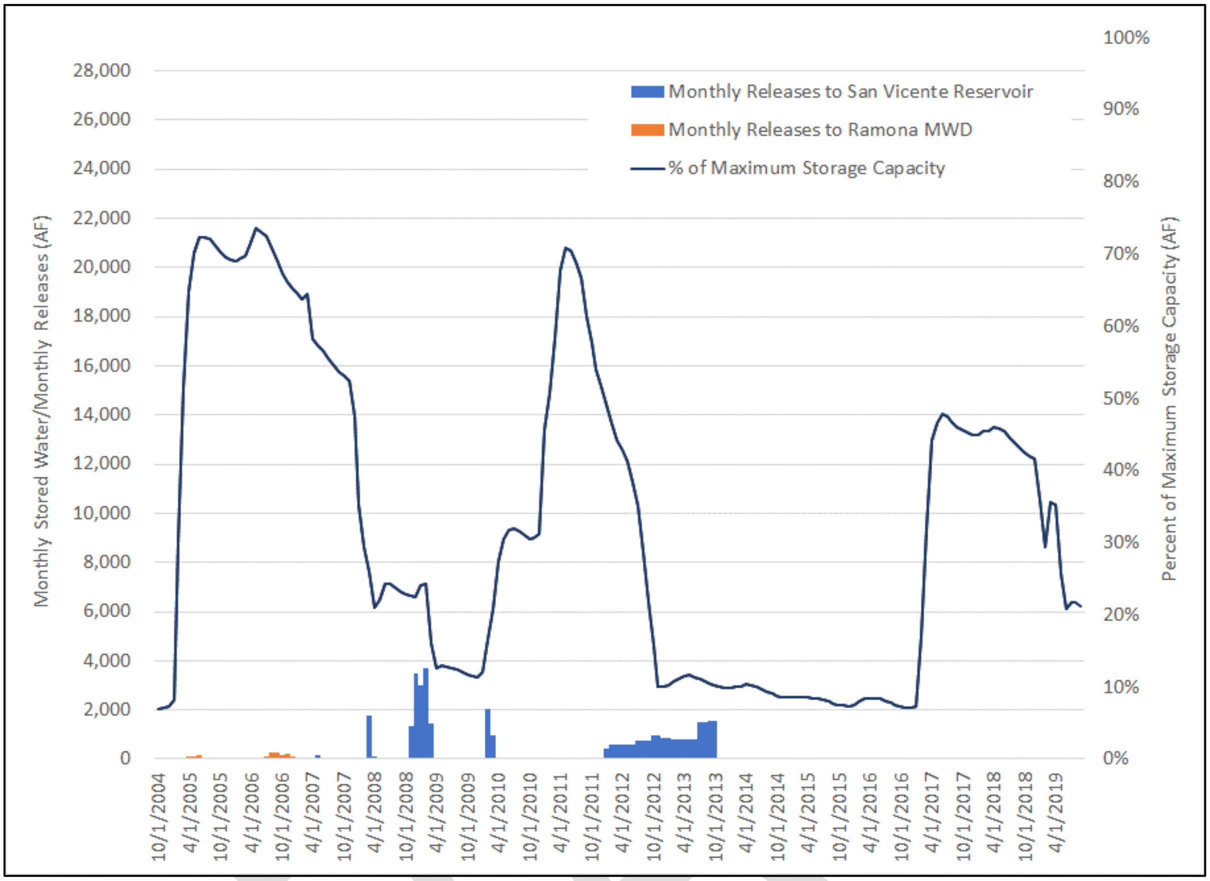

Figure 4-6. Historical Monthly Sutherland Reservoir Storage Volume and Releases

4.4 Considerations for Reservoir Releases to Santa Ysabel Creek

The availability of Sutherland Reservoir's stored water during the historical 15-year period that hypothetically could have been utilized as a source for releases to Santa Ysabel Creek is limited because most of the available runoff (around 70 percent) was transferred to the San Vicente reservoir and there were no spills. The feasibility of additional releases would depend on reservoir operational changes to increase releases during certain years preceding above normal and wet years when the stored water level is above normal operational levels. Sutherland Reservoir normal operating levels are less than 40 percent of maximum capacity (City, 2020). An initial estimate of range of this potential available water in historical years is presented in **Table 4-1**.

The recharge strategies that will be developed in future technical memorandum #4 for PMA No. 7 that include controlled releases from Sutherland Reservoir will focus on hypothetical operational changes to increase reservoir releases without dropping the storage level below normal operations or reducing releases to San Vicente and Ramona MWD below historic volumes. The outlet release capacity at the corresponding storage level would need to be taken into consideration to determine the release rate. For these initial hypothetical releases, it was assumed the releases would take place through the opening of the 20-inch blow-off near the dam and discharge into Santa Ysabel Creek with an average capacity of 74 cfs. Also, it was assumed the storage volume after the additional controlled releases would be at a minimum of 5,000 AF. The development of more refined operation scenarios will need to take advantage of optimization strategies as well as conveyance efficiency. Currently, 22 percent of the released volume to San Vicente reservoir is conveyance loss; mostly in the last 2-mile segment that is directly discharged into the San Vicente Creek prior to entering the San Vicente Reservoir (City, 2022). Similarly, the additional releases would be discharged into the Santa Ysabel creek with similar low efficiency challenges given direct discharges into the creek streambed. There are approximately 8 river miles of Santa Ysabel Creek between Sutherland Reservoir and the Basin boundary.

The CWASim model will be utilized as the primary tool for developing a set of operational scenarios to assess the potential daily magnitude of additional releases and the impact on storage levels. The output of these scenarios will be daily timeseries that will be processed to account for conveyance losses and represent additional stream inflows to the Basin via Santa Ysabel Creek to be used in SPV GSP Model v2.0.

Table 4-1. Estimated Historical Range of Water Resources Hypothetically Available from Sutherland Reservoir to Santa Ysabel Creek

Month	2005 (W)[a]	2006 (D)[a]	2007 (C)[a]	2008 (N)[a]	2009 (D)[a]	2010 (AN)[a]	2011 (W)[a]	2012 (C)[a]	2013 (C)[a]	2014 (C)[a]	2015 (C)[a]	2016 (C)[a]	2017 (W)[a]	2018 (C)[a]	2019 (AN)[a]
Oct	0	0	0	0	0	0	42	0	0	0	0	0	0	0	0
Nov	0	0	0	0	0	0	169	0	0	0	0	0	0	0	0
Dec	0	0	0	0	474	0	0	0	0	0	0	0	0	176	0
Jan	0	112	0	0	61	0	1,549	0	0	0	0	0	0	176	0
Feb	0	67	195	0	0	0	2,201	0	0	0	0	0	0	0	1,817
Mar	0	571	0	0	0	0	2,735	0	0	0	0	0	0	195	0
Apr	1,561	557	0	315	0	865	910	0	0	0	0	0	706	0	0
May	666	0	0	673	0	410	0	0	0	0	0	0	415	0	0
Jun	0	0	0	0	0	43	0	0	0	0	0	0	0	0	279
Jul	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aug	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sep	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual	2,227	1,308	195	989	535	1,318	7,606	0	0	0	0	0	1,121	547	2,097

[a] Water year types are shown in parentheses and defined as follows: W=wet and AN=above normal, N=normal, D=dry, and C=critically dry. Values are expressed in units of monthly acre-feet.

5. RAMONA MUNICIPAL WATER DISTRICT

In this section, Ramona MWD's existing infrastructure, agreements with CWA, and operations are reviewed to identify potential delivery quantities and conveyance facilities needed for direct deliveries to Basin growers and/or to designated Basin recharge locations.

5.1 Existing Water District Sources and Operations

Ramona MWD provides water for urban and agricultural users servicing an area of 45,796 acres (72 square miles) (Ramona MWD, 2022). Of the service areas, Ramona MWD provides water to approximately 10,000 water meter connections on 7,000 urban parcels and 3,000 rural parcels. Ramona MWD purchases treated and untreated water from the CWA, which delivers water at three wholesale connections, two treated and one untreated. As previously mentioned, the Ramona MWD's Bargar WTP has been out of commission since 2007 and Ramona MWD is 100% reliant on CWA treated water deliveries for municipal and industrial (M&I) uses (Ramona MWD, 2022). The intakes with the CWA's and pump stations owned by Ramona MWD include:

- Intake RAM1 is for the delivery of untreated water with a capacity of 18.5 cfs. This connection can bring water to Lake Ramona using the Poway Pump Station (27-inch pipeline and 3 pumps, 13.36 cfs capacity flow). There is also the Lake Ramona pump station (4 pumps, 23.4 cfs) downstream the Ramona Lake connecting with Ramona MWD's untreated water system. See **Figure 5-2**.

- Intake RAM3 is for the delivery of treated water with a capacity of 32 cfs. This is the main CWA's delivery point currently used. A 30-inch diameter pipeline connecting to the Poway Forebay, where it is then pumped into the system via the Poway Treated Water Pump Station.

- Intake RAM2 is for the delivery of treated water from the Poway Treatment Plant in the neighboring City of Poway with a capacity of 10 cfs. This connection is only used during shutdowns from the Water Authority facilities to Connection 3.

Over the past 5 years (2018-2022), the total untreated water purchased from CWA for use throughout Ramona MWD has fluctuated resulting in an average of 405 AFY, and generally decreased over time.

Ramona MWD has access to two reservoirs (Sutherland Reservoir and Lake Ramona) (Ramona MWD, 2022). As previously mentioned, Sutherland Reservoir is owned and operated by the City. Although Ramona MWD has access to Sutherland Reservoir, it no longer has a surface water treatment plant and therefore cannot use water from Sutherland Reservoir. Lake Ramona is owned by Ramona MWD and is filled with untreated water from the CWA. There is essentially no runoff to the Lake. Lake Ramona has a capacity of 12,000 AF (CWA, 2021a) and its purpose is to supply untreated irrigation water to Ramona MWD's agricultural customers.

The GSA is considering using Ramona MWD's untreated water system to purchase additional supply from the CWA and deliver it to the Basin. CWA's untreated water supplies come from the Colorado River Aqueduct and the State Water Project, and is delivered to Ramona MWD's system via the San Diego Aqueduct. This untreated water can be a mix of the two sources, blended at the aqueduct, or one or the other, depending on supply availability and operational decisions. Lake Skinner, owned by Metropolitan Water District of Southern California, is the primary storage for the San Diego Aqueduct. Untreated water from Lake Skinner flows directly into Pipelines 3 and 5 (Second Aqueduct). Untreated water from the Second

Aqueduct is delivered through the Crossover Pipeline to the First Aqueduct to serve Escondido, Helix, Poway, Ramona, San Diego, and Vista. Ramona MWD has access to the First Aqueduct untreated water deliveries at the RAM1 flow control facility with a capacity of 18.5 cfs. From this CWA's delivery point, untreated water is pumped to Lake Ramona through the Poway Pump Station (2 pumps on duty and 1 pump on stand-by with a capacity of 13.36 cfs) and then from Lake Ramona to untreated water system through the Lake Ramona pump station (3 pumps on duty and 1 pump on stand-by with a capacity of 23.4 cfs) (see **Figure 5-1**).

Ramona MWD is planning to decommission the untreated water system as the agricultural demand has decreased to the point that it is no longer affordable to operate and maintain a dual water system. The Robb and Snow untreated water zones may be kept active because there are high-volume agricultural customers served from these zones. During the last three years (2019-2022), the average demand in these zones has been approximately 372 AFY. An initial assessment was conducted by Ramona MWD to estimate annual flows that could potentially be available to the Basin and indicated that 3,350 AFY from the Robb Zone or 850 AFY from the Snow Zone would be available from these areas of their untreated water system. During winter months, when there is less irrigation demand, there could be more flow available for delivery to the Basin compared to summer (July – October) when agricultural irrigation demands are higher. A monthly average of approximately 280 AF could be delivered constantly throughout the year with a maximum of 304 AF during March. Ramona MWD staff estimated an annual volume of 3,350 AFY could be delivered from its untreated water system's Robb Zone or 850 AFY from its Snow Zone using 80 percent of its conveyance capacity and assuming future untreated system local demand (2019-2021 average) continues to be delivered.

Minor modification would be required to the existing untreated water system infrastructure to deliver this additional source water to the Basin. A pressure-reducing station would need to be installed between the Woodson Untreated Zone and the Robb Untreated Zone along Highland Valley Road to feed the identified delivery points. Depending on the delivery volume and the need for interrupted deliveries, the untreated water could be stored in Lake Ramona, bypass the lake and pumped to the Kennedy tanks, or bypass the lake and pump directly to the Robb and/or Snow Untreated Zones for delivery. See **Figure 5-2**.

Ramona MWD would have to coordinate with CWA on the availability, timing, and delivery of additional imported untreated water for recharge to the Basin. Ramona MWD already coordinates on a daily basis with CWA to request flow changes for its treated and untreated water systems. Ramona MWD and the CWA have signed agreements to purchase and deliver untreated water for storage in Lake Ramona in such amounts that are practical, according to the parties' delivery and storage desires and capabilities. A 10,000 AF maximum stored volume at any one time and any one year was established. The CWA has not recently used Lake Ramona to store water.

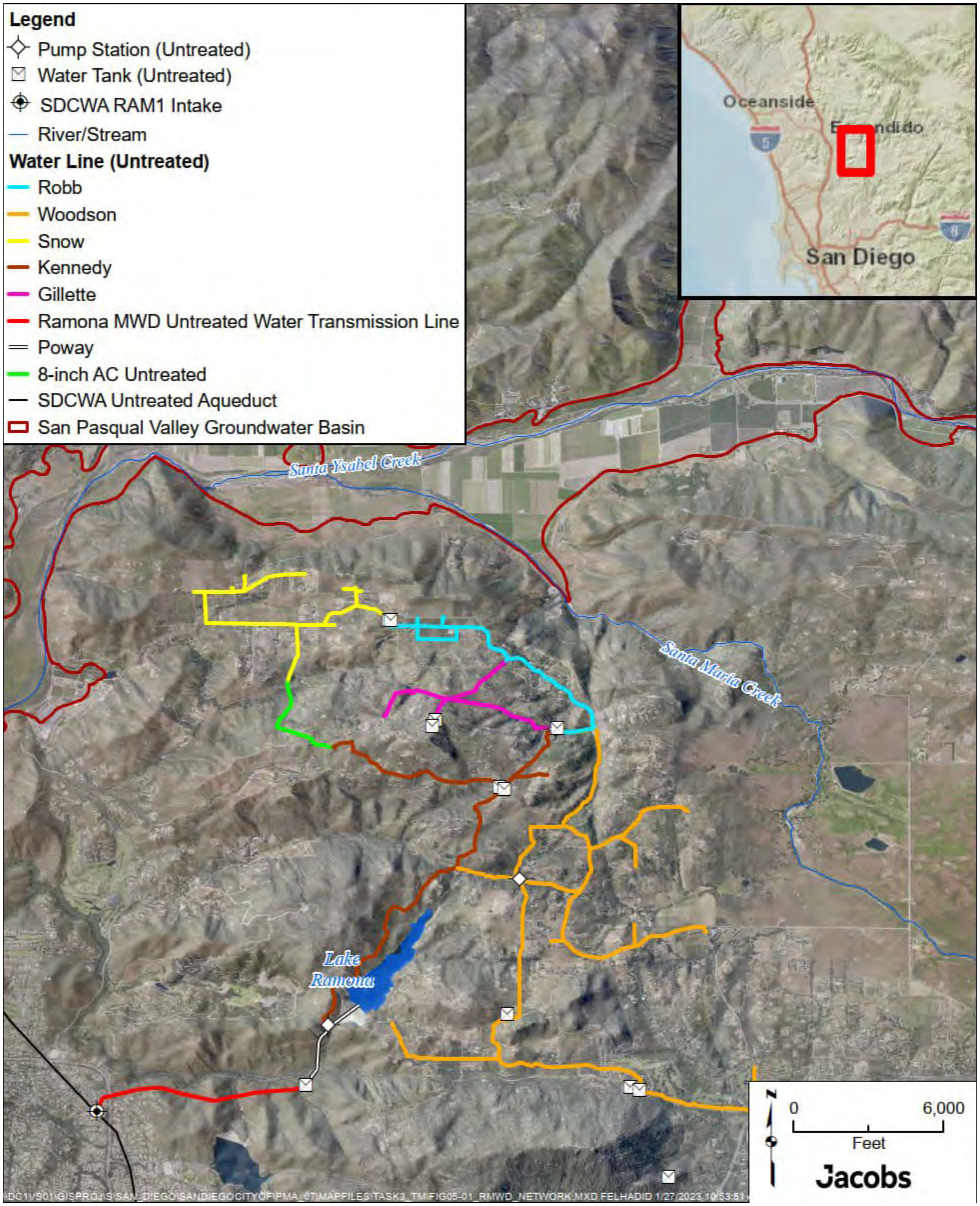

Figure 5-1. Ramona Municipal Water District's Untreated Water Network

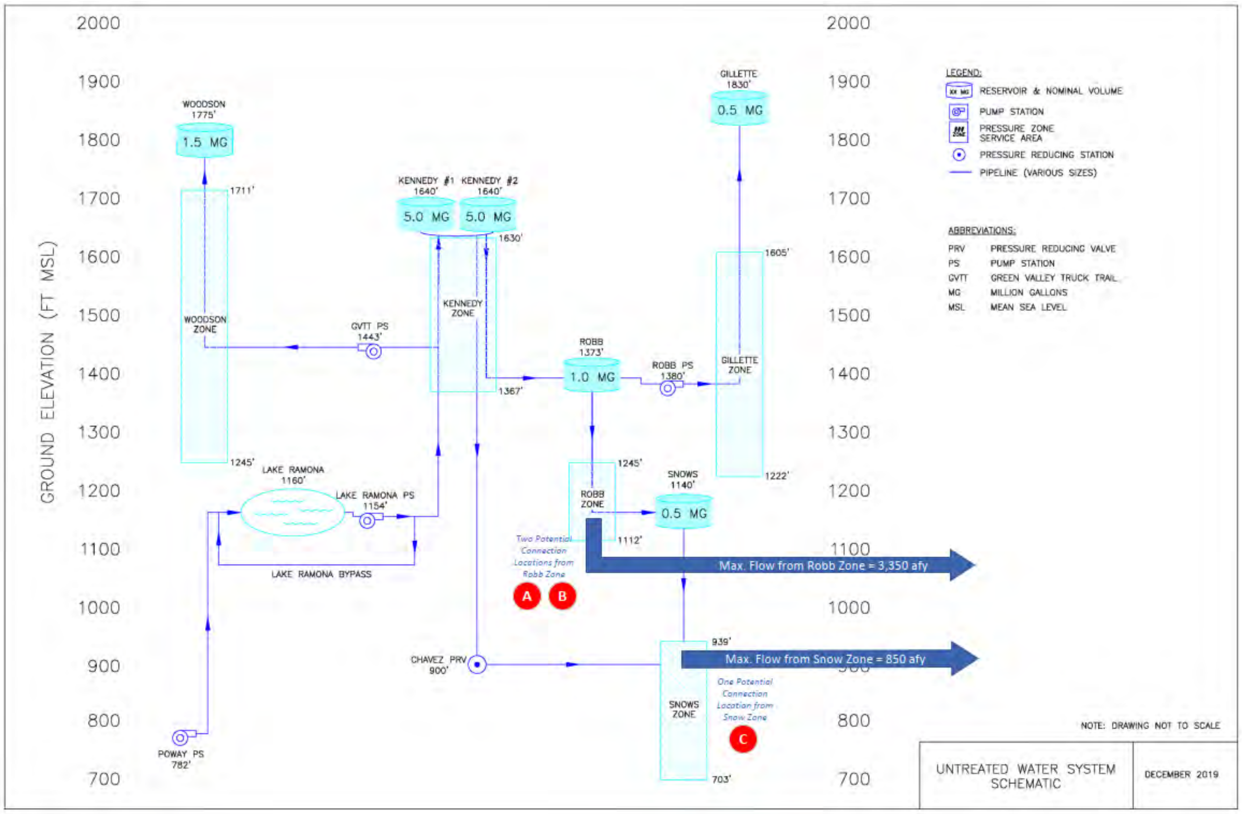

Figure 5-2. Ramona Municipal Water District's Untreated Water Network: Operation Zones

5.2 Potential Delivery Alternatives and Conveyance Requirements for Untreated Water

The volume of water available from Ramona MWD could be used in two ways that would benefit the Basin. The first is in-lieu recharge, using direct delivery to local growers to offset pumping demands, and would potentially require construction of conveyance pipelines from Ramona MWD's untreated water system to local growers' irrigation systems. The second approach is direct recharge, which would require construction of conveyance system from Ramona MWD's untreated water system to a recharge facility – either a groundwater recharge basin and/or injection wells. The need of water treatment prior to being used for basin recharge needs further evaluation, an initial water quality review is presented in Section 5.3. In the following subsections, the potential delivery alternatives and conveyance requirements are discussed.

5.2.1 Delivery to Local Growers

In-lieu recharge would involve direct delivery of untreated water to storage facilities such as ponds or tanks that would then be connected to existing local irrigation systems to help offset groundwater pumping. For this approach, water would be delivered directly to one or more growers within the areas identified for direct recharge (see Section 5.2.2). These growers are located near the diversion points from Ramona MWD and are within the portion of the Basin most suited to enhanced recharge. The imported irrigation water from Ramona MWD that is not consumed by plants or lost to evaporation would serve as an additional source of groundwater recharge. This approach would require voluntary participation by growers, need to be economically feasible, and result in a reliable water supply alternative to groundwater pumping.

The untreated water would be a reliable source of supplemental water and would help reduce the need for future conservation measures or restrictions. However, the price of untreated water from Ramona MWD would need to be determined to assess whether use of the untreated water system would represent a feasible cost-benefit alternative to growers and the Basin as a whole.

If this in-lieu recharge strategy is determined to be feasible, the location of pipeline alignments, potential growers to receive direct deliveries, location of storage facilities, and cost sharing/funding options would be developed in a future memorandum. In addition, existing programs currently being used in the region to deliver water to growers, such as the Permanent Special Agricultural Water Rate Program would be considered.

5.2.2 Delivery to Recharge Locations

Hypothetical potential recharge areas were identified in the Basin based on criteria identified in Section 2.2, and are shown in **Figure 2-2**. Ramona MWD identified three potential diversion points to its untreated water system, two in the Robb Zone and one in the Snow Zone. In this section, the required water delivery infrastructure is discussed for each of these potential diversion points.

5.2.2.1 Delivery from Robb Zone

The first diversion point in the Robb Zone was located along Highland Valley Road, approximately 500 feet west of Starvation Mountain Road (see **Figure 5-3)**. The second diversion point in the Robb Zone was also located along Highland Valley Road, approximately 800 feet north of Highland Trails Drive. Both diversion points would allow for delivery of up to 3,350 AFY untreated water to SPV as discussed in Section 5.1. The second diversion point in the Robb Zone was determined to be less desirable for potential recharge due to the longer pipelines that would be required to reach the recharge areas compared to the other Robb Zone diversion point. Therefore, this diversion point is not explored further in this technical memorandum.

From the Robb Zone preferred diversion point approximately 500 feet west of Starvation Mountain Road, the starting elevation is 757 feet, with the recharge areas having elevations of between 354 feet to 407 feet, which would allow water flow by gravity to aquifer recharge areas. It is estimated that no pumps would be required for conveyance and delivery based on preliminary assumptions to estimate the need for pumping, including calculated frictional head loss, an assumed delivery pressure of 10 pounds per square inch (psi) for the recharge basins. A 12-inch pipe would be sufficient to accommodate the flows to deliver the full volume of water per year of 3,350 AFY (that is, an average of about 3 million gallons per day [mgd] or about 4.62 cubic feet per second [cfs]). Maximum available flow from Ramona MWD at this diversion point is 6.6 cfs, based on seasonal demands and availability. Twelve-inch pipes with a maximum flow rate of 6.6 cfs results in flow velocity of 8.4 feet per second, within the City of San Diego’s design standards for maximum velocity of 15 feet per second, and a head loss of 18.9 feet per 1,000 feet of pipe. However, should the City determine a lower velocity and/or head loss is preferred, a larger diameter pipeline could be considered.

From this Robb Zone diversion point, potential pipeline alignments were identified that considered the minimum pipeline lengths needed to reach the distal portions of the recharge areas while still being able to utilize existing rights-of-way and minimizing creek crossings. These considerations were selected to reduce potential permitting needs, reduce impacts to growers, and potentially reduce costs. For Recharge Areas 1 and 2, which are instream recharge locations along Santa Ysabel Creek and Santa Maria Creek, respectively, the conveyance pipeline alignment also sought to be sufficiently upstream to allow for recharge of the full volume within the identified area, without creating excessive pipeline needs. Discharge points to Recharge Area 1 and Recharge Area 2 may shift during refinement of the alignments to best maximize recharge in these areas should additional analysis find that the preliminary locations would not allow for maximum recharge. For Recharge Area 1, the potential pipeline alignment to Santa Ysabel Creek would discharge at San Pasqual Valley Road, rather than at the easternmost portion of the creek identified, which would have required a substantial increase in pipeline length. For Santa Maria Creek, the potential pipeline would discharge near the Bandy Canyon Road creek crossing, to avoid the need to cross into private property upstream of this crossing.

The hypothetical pipelines to each of the eight recharge areas are shown in **Figure 5-1**. As seen in the figure, the pipelines would travel northeast from the diversion point to a private road at Bandy Canyon Ranch, where it turns northwest to Bandy Canyon Road. To reach Recharge Areas 7 and 8, the pipeline would follow Bandy Canyon Road until it turns north on Ysabel Creek Road, and back east to cross Santa Maria Creek and reach the two recharge areas. As noted, Recharge Area 2, Santa Maria Creek, would be reached at the point where Bandy Canyon Road crosses the creek, and represents the shortest of the hypothetical alignments. For Recharge Areas 1, 3, 4, 5, and 6, the hypothetical pipeline would cross Santa Maria Creek and continue east and northeast along Bandy Canyon Road, with a turnoff along a private road to reach Recharge Area 6, approximately 0.6 miles east of the creek crossing. Recharge Area 5 would be reached via a private road across from the intersection of Bandy Canyon Road and Burkhard Hill Road. Another 0.25 miles east along Bandy Canyon Road would be a turnout to reach Recharge Area 4, whereas Recharge Areas 1 and 3 would be reached by continuing to follow Bandy Canyon Road to where it crosses Santa Ysabel Creek.

These hypothetical pipelines would be refined based on further exploration of viable recharge locations within each recharge area, as well as potential access or permitting considerations that may arise. Additionally, pipes may need to be resized to accommodate pressure and flow requirements, or other design needs that might arise. As the potential recharge projects are refined, other infrastructure needs, such as a pump station or treatment facility should injection wells be used for recharge, would also be incorporated.

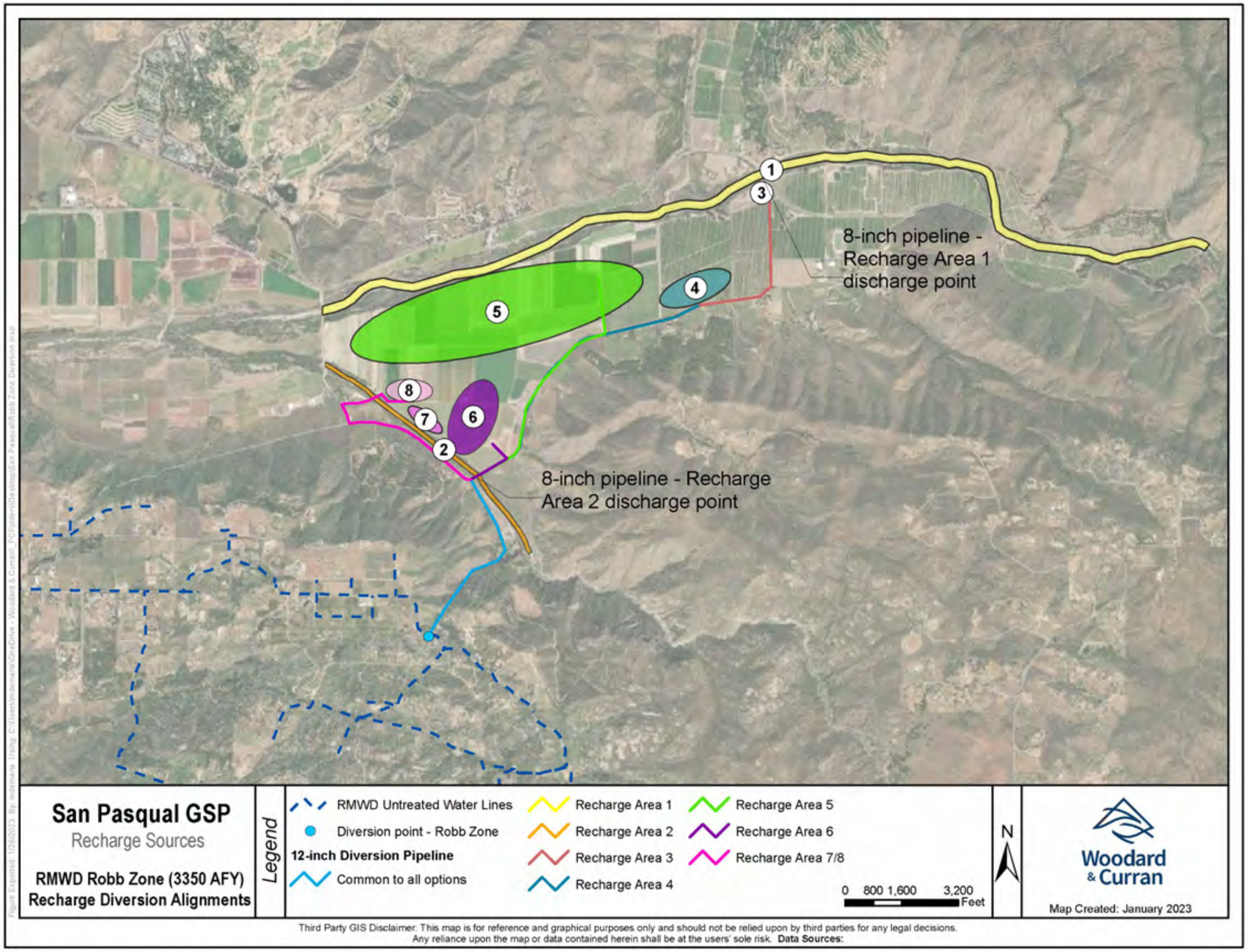

Figure 5-3: Hypothetical Pipelines from Robb Zone Diversion Point

5.2.2.2 Delivery from Snow Zone

The Snow Zone diversion point would be located approximately 200 feet north of the intersection of Bandy Canyon Road and Sky High Road, where Bandy Canyon Road turns northeast. From this diversion point, up to 850 AFY would be available for recharge. This diversion point has an elevation of 1,180 feet, and would deliver to the same potential recharge areas as above, which have elevations of between 354 and 407 feet. Similar to the hypothetical alignments from the Robb Zone, the Snow Zone alignments would be able to use gravity and would not require pumps to convey untreated water to the recharge areas. The smaller volume of available water would result in an average of 0.76 mgd of flows, or 1.17 cfs, with maximum flow rate of 2.3 cfs based on seasonal demand and availability. Supplies from this diversion point would only require 8-inch diameter pipes. At maximum flow, this would result in a head loss of 19.4 feet per 1,000 feet, and a velocity of 6.6 feet per second.

Using the same considerations for hypothetical alignments as the Robb Zone pipelines (that is, fewer creek crossings, less pipeline length, and using rights-of-way where possible), the Snow Zone pipelines are shown in **Figure 5-2**. As shown in **Figure 5-2**, this diversion point would have the pipelines follow Bandy Canyon Road from the diversion point to Ysabel Creek Road, where it would then follow the same alignments as described for the Robb Zone diversion point's pipelines to reach each of the recharge areas. As with the alignments described for the Robb Zone diversion alignments, these hypothetical alignments would be refined based on final recharge location and method and to accommodate final pressure and flow needs. Should injection wells be selected as the preferred recharge method, a pump station would be incorporated, with details explored in a future technical memorandum.

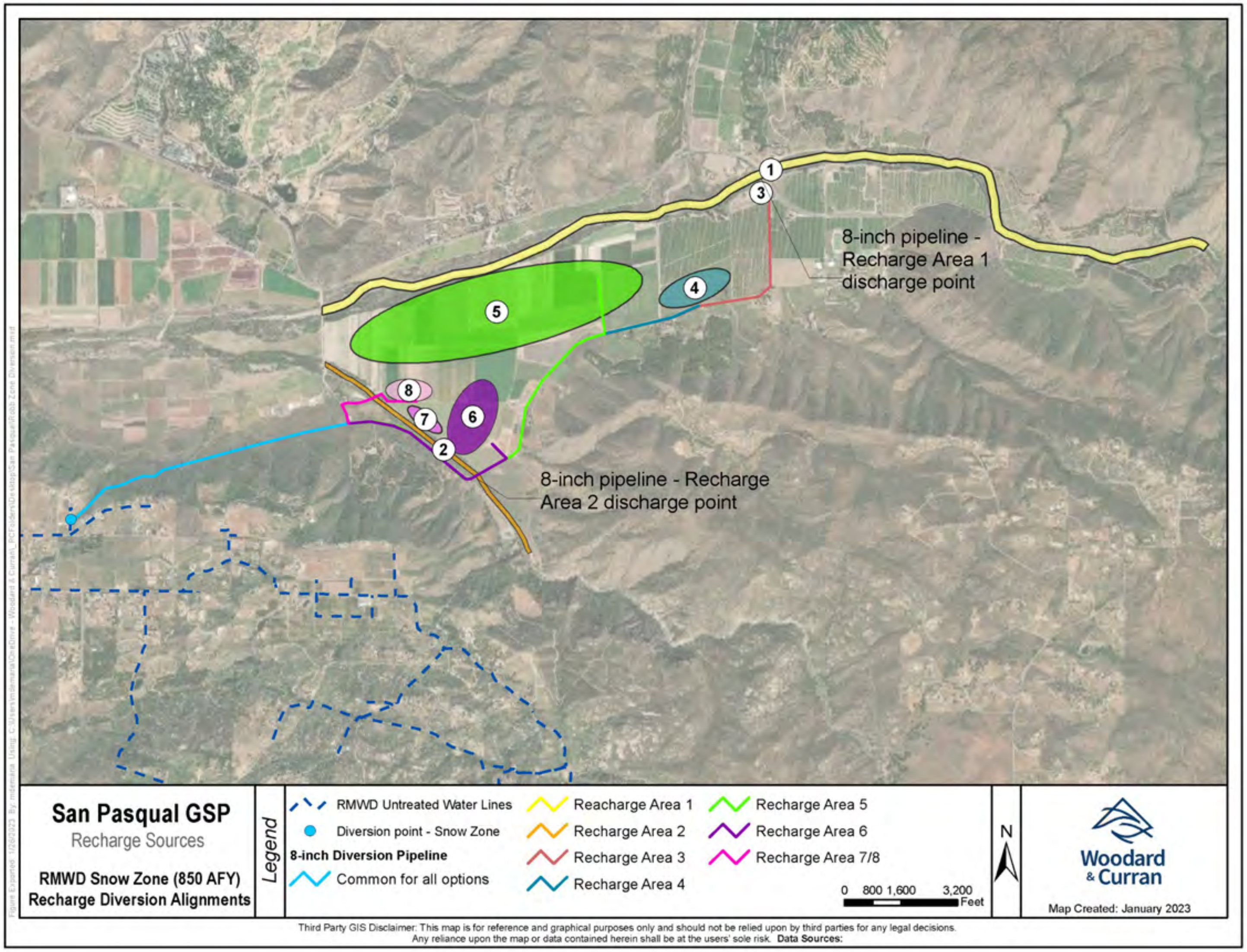

Figure 5-4: Hypothetical Pipelines from Snow Zone Diversion Point

5.3 Water Quality Review Relative to San Pasqual Academy's Existing Wells

The scope of work for this task requires a comparison of water quality of Ramona MWD's untreated water system with groundwater quality near the San Pasqual Academy to identify whether there is a need for further impact assessment of San Pasqual Academy water sources. San Pasqual Academy is located at 17701 San Pasqual Valley Road in the eastern portion of the Basin. (**Figure 5-5**). This facility is located outside the City-owned and -leased areas of the Basin, residing in the jurisdiction of San Diego County.

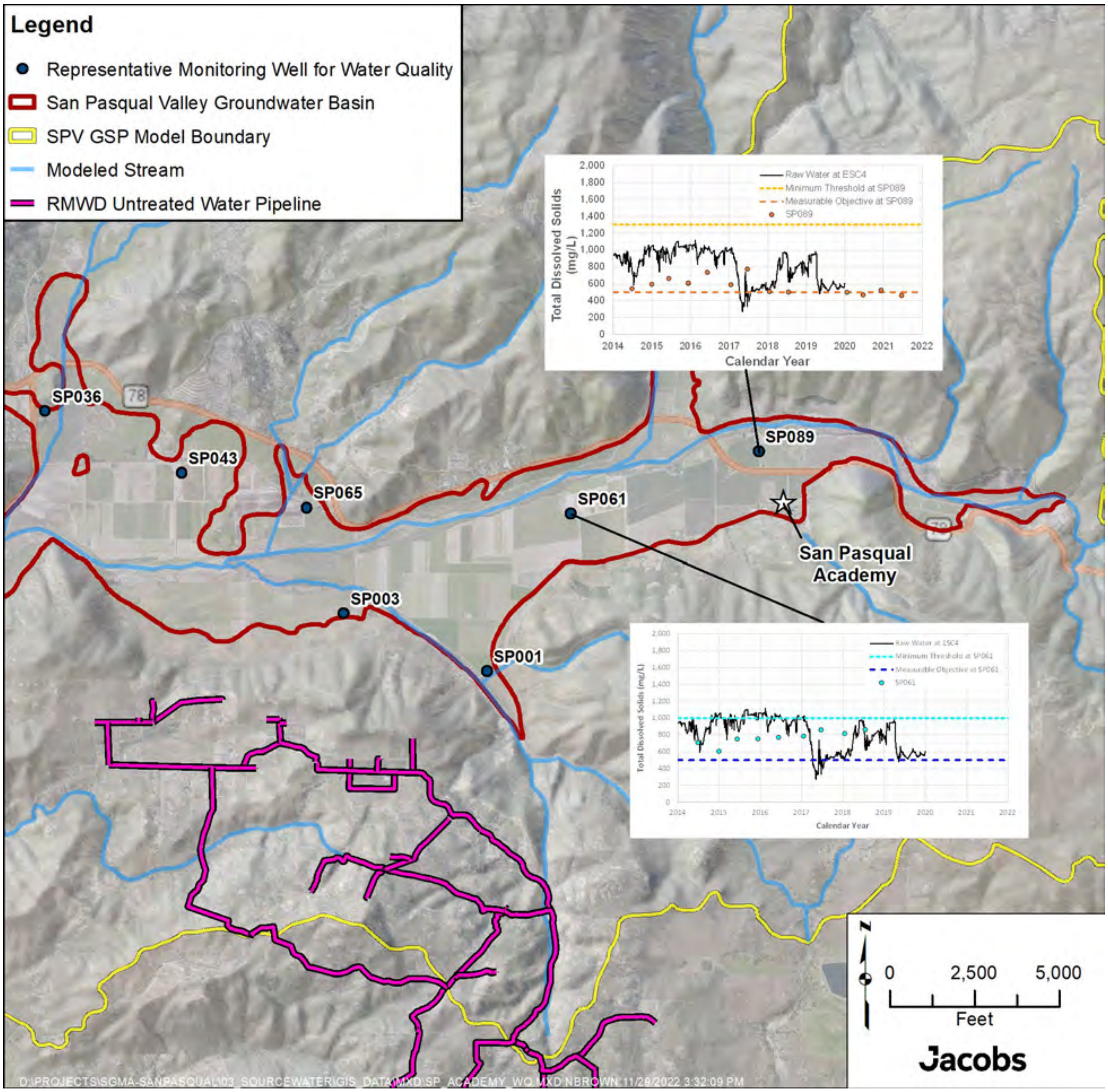

Figure 5-5. Comparison of TDS Concentrations Near San Pasqual Academy

The water quality comparison described herein focuses on total dissolved solids (TDS), because TDS is the only water quality parameter routinely monitored for the untreated water system (Personal Communication, 2022). If alternatives that include importation of water from the untreated water system are retained for further analysis after the Preliminary Feasibility Study, it may be necessary to perform additional sampling and expand the list of analytes. Expanding the list of analytes would be done to facilitate a more comprehensive assessment of how groundwater quality near San Pasqual Academy could potentially evolve in response to enhanced recharge activities in the eastern portion of the Basin. Further, water quality in the untreated water system is sensitive to the percentage that comes from the State Water Project (SWP) versus the Colorado River Aqueduct and this percentage varies from year to year. Generally, the greater the percentage of SWP water in the untreated water system, the lower the TDS concentrations.

Figure 5-5 shows TDS concentrations since 2014 for the untreated water system at the Escondido 4 (ESC4) monitoring location along with groundwater TDS concentrations at SP061 and SP089. These two monitoring wells (SP061 and SP089) are designated in the GSP as representative monitoring wells for water quality and are the most proximal representative monitoring wells to San Pasqual Academy (City and County, 2021). The TDS concentrations for the untreated water system and these two representative monitoring wells are presented along with two concentration thresholds established in the GSP: minimum threshold and measurable objective. A minimum threshold is defined in the SGMA regulations as a numeric value for each sustainability indicator used to define undesirable results. In this case, the TDS minimum threshold has been set at the historical high measured concentration for the representative monitoring well, or 1,000 milligrams per liter (mg/L), whichever is greater in concentration (City and County, 2021). A measurable objective is defined in the SGMA regulations as the specific, quantifiable goals for the maintenance or improvement of specified groundwater conditions that have been included in an adopted GSP to achieve a basin's sustainability goal. A measurable objective is used to help guide the GSA as it continues sustainable groundwater management over a GSP's planning and implementation horizon. In this case, the TDS measurable objective is 1,000 mg/L for representative monitoring wells that have historical TDS concentrations greater than 1,000 mg/L and 500 mg/L for representative monitoring wells that have historical TDS concentrations generally less than 1,000 mg/L (City and County, 2021). Therefore, because historical TDS concentrations at SP061 and SP089 have been less than 1,000 mg/L, the TDS measurable objective for these representative monitoring wells is set at 500 mg/L.

As shown in **Figure 5-5**, TDS concentrations of the untreated water system at ESC4 since 2014 have generally been greater than groundwater TDS concentrations at SP061 and SP089 and periodically greater than the minimum threshold of 1,000 mg/L at SP061. The latest available TDS concentrations of the untreated water system at ESC4 provided by CWA are from December 2019 and they are lower than the minimum thresholds and just above the measurable objective of 500 mg/L (City and County, 2021). Recent groundwater TDS concentrations at SP061 and SP089 have also been around the measurable objective of 500 mg/L. Therefore, more recent TDS concentrations in the untreated water system at ESC4 have been similar to groundwater TDS concentrations at SP061 and SP089. More recent TDS concentrations in the untreated water system would be needed to compare them with the groundwater TDS concentrations that have occurred since 2019. If 2019 TDS concentrations in the untreated water system are indicative of future TDS concentrations, then water quality impacts from the recharge project associated with deliveries from Ramona MWD in the areas near SP061 and SP089 should not result in triggering minimum thresholds, but they could prevent groundwater TDS concentrations from achieving measurable objectives at these two representative monitoring wells.

5.4 Considerations for Ramona MWD deliveries

The untreated water system conveyance capacity and the existing customers' demands are the main characteristics that would need to be considered when developing the delivery schedule for Ramona MWD's untreated water system. If the CWA's flow control facility is operated 75 percent of the time, it would be able to deliver approximately 10,000 AFY, which is the maximum storage capacity suggested in the agreements for storing CWA's untreated water. However, the existing agricultural customers' demands and the system conveyance capacity will determine the ability to deliver this annual volume. In addition, the CWA would need to confirm its untreated water availability and conveyance capacity.

Ramona MWD staff indicated that 3,350 AFY could be delivered from the Robb Zone or 850 AFY from the Snow zone. Depending on whether the Robb or Snow Zone location is chosen, a monthly volume of up to approximately 300 or 95 AF, respectively could be delivered throughout the year to the SPV Basin on an annual basis provided there has not been much fluctuation driven by hydrology and provided that CWA would agree to meet this additional demand.

One of the advantages of this water source is that untreated water could be available during dry years and minor modification would be required to the existing untreated water system infrastructure to deliver this additional water source to the Basin.

Discussions with CWA, based on capacity and potential other constraints to receiving untreated water, should continue in future planning and design phases of the project. First Aqueduct operation would need to be aligned and incorporate Ramona MWD's newly re-established untreated water demand into its operations. Also, restrictions on water deliveries might need to be applied during drought conditions because this is not an M&I water use.

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ATTACHMENT A: SUTHERLAND

A.1 Sutherland design capacities

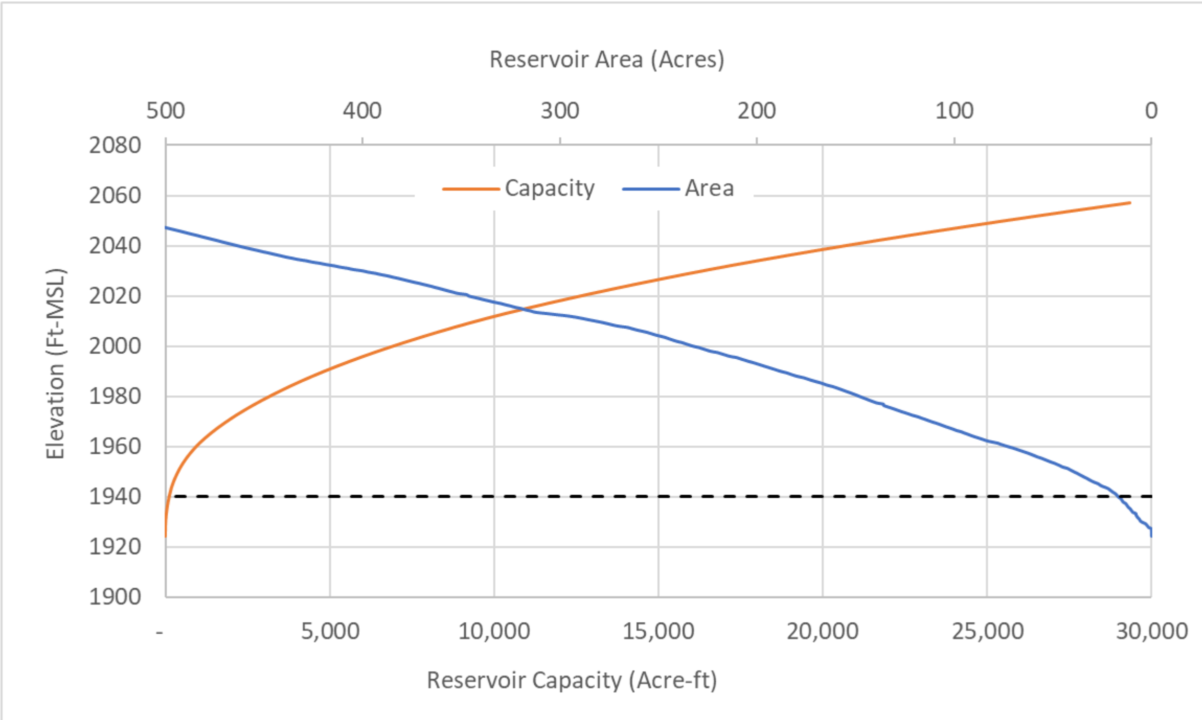
Design Element	Capacity/Length	Source
Capacity	29,345 AF	Sutherland Information Request
Spillway Crest Elevation	2,057 ft	Sutherland Information Request
Spillway Capacity	41,214 cf	Sutherland Information Request
Dead Pool	112 acre-feet	Sutherland Information Request
Maximum Release to San Vicente Reservoir through Sutherland Pipeline without blow-offs	95 cfs	Sutherland Information Request
Maximum Release to Santa Ysabel Creek through Sutherland Pipeline with blow-offs	110 cfs	Sutherland Information Request
San Vicente Pipeline	11-miles	City of San Diego, UWMP 2020
San Vicente Pumping Facilities	300 MGD	City of San Diego, UWMP 2020

A.2 Sutherland operational rules

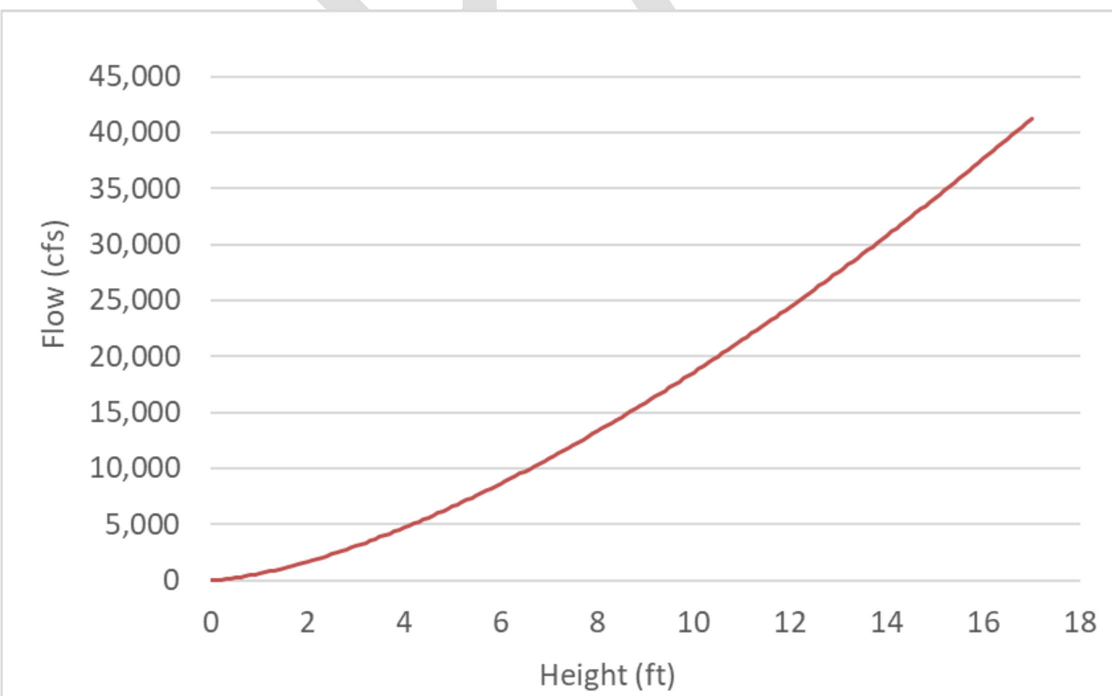
Operation Rules	Source
February to April: minimize withdrawals during bass spawning season	City of San Diego, 2022. Sutherland Information Request
March to April: maximize releases when the Santa Ysabel Creek streambed is saturated after the rainy season to reduce stream losses. The assumed stream conveyance loss between Sutherland and San Vicente reservoir is 22 percent	City of San Diego, 2022. Sutherland Information Request
San Vicente Reservoir needs to have around 30 percent of available storage capacity. This is below 200,000 AF of stored water with the possibility to store approximately another 70,000 AF until reaching its maximum capacity.	City of San Diego, 2022. Sutherland Information Request
March to September: during Arroyo Toad breeding season, the flow rates must be less than 10 million gallons per day (MGD)	City of San Diego, 2022. Sutherland Information Request

Releases flow rates: Based on Sutherland stored volume		City of San Diego, 2022. Sutherland Information Request
Sutherland stored volume	Release flow	
0-2,000 AF	55 cfs	
2,000-5,000 AF	67 cfs	
5,000-20,000 AF	90 fs	

A.3 Area vs Capacity Curve



A.4 Spill Crest Capacity



A.5 Agreements Summary

August 27, 2010. Ramona Amendment 1

- An amendment to the Water Exchange Agreement to increase the water exchange cap from the existing 2,500 Acre Feet ("AF") to a total of 10,000 AF, including all reserved water and owned water. Such cap raise will allow Ramona MWD to hold more water in Sutherland Reservoir, when available.

March 17, 2008. Subject: Water Available in Sutherland Reservoir

- In 2008, the current water level at Sutherland Reservoir was 81 feet with a storage of 5,500 acre feet. The City is currently drafting water from Sutherland and expects to be at approximately 5,200 AF by March 21, 2008. This represents about 2,500 AF above gauge 65 feet and available to Ramona MWD. The intent of the letter is to discuss the existing agreement for any Reserved Water should be drafted from the reservoir within the same year that is requested. Therefore, if RWMD does not have an operating plan to draft Reserved Water within the same year, the City recommends Ramona MWD purchase the required water as owned Water.

April 10, 2006. Subject: Water Exchange Report

- Letter in response to the requesting reservation of 2,500 acre feet of water in Sutherland Reservoir. States that Sutherland's reservoir water level is at gauge 128.7 feet with 21,368.8 AF of storage. This amounts to about 18,717 AF above gauge 65. Therefore, the City authorizes the reservation of2,500 AF for Ramona MWD in Sutherland Reservoir, beginning May I, 2006.

July 17, 2000. Agreement for Water Exchange and Transportation between the City of San Diego and the Ramona Municipal Water District.

- The reserved water will be transported by the city from Sutherland Reservoir through the Sutherland Reservoir/San Vicente Pipeline. The water delivered is subject to city approval on May 1st. The delivered water plus Ramona MWD's share of evaporation, seepage and spill losses, shall be exchanged for delivery of an equal amount of Ramona MWD untreated water purchased from and delivered by CWA to CITY at any other CITY facility.
- Owned Water shall be delivered by CITY to Ramona MWD as scheduled by Ramona MWD with 30 days written notice. Such delivery is subject to CITY approval and shall not significantly interfere, as determined by the CITY, with the CITY's ability to draft from Sutherland Reservoir.
- Term: 5 year term with 4 additional renewals

June 29, 1992. Subject: Lake Sutherland Water Exchange Agreement

- Construction: Ramona shall construct or modify to its sole expense metering and related devices;
- Water Storage and Releases: Ramona will tell the City how much water it needs before July that the city will hold in storage for Ramona for the following 12 month period. The maximum reserved in storage for Ramona shall not exceed 4,000 acre feet. If Ramona needs more than

4,000 acre feet, a written request will be needed before May 15. When the total storage in Sutherland Reservoir exceeds the requested amount, the city will decide which entity receives the water. If the city does not transfer water to the San Vicente Reservoir, Ramona is entitled to receive water from the surplus that is held in storage unless otherwise stated by the city.

- Reimbursements: commodity charge same the City pays to the CWA, operational charge 50$ per month; capital investment charge, $4 per AF
- Charges: evaporation and spillage: proportional; billing and payment, up to 1,000 AF only
- Water Quality: Ramona might elect not to use it
- Exchange of Water: Sutherland deliveries to Ramona exchanged for San Vicente deliveries to City less than 10% within 60 days after Ramona's deliveries have been completed
- Term and Termination: 20 years (2012)
- This agreement supersedes prior agreements