APPENDIX A

Santa Clarita Valley Water Agency Water Operations Model

General Methodology

An analytic spreadsheet model developed for CLWA by MBK Engineers and updated by Geosyntec Consultants for SCV Water was used in this analysis to update SCV Water's Reliability Plan. The model performs annual water operations for the SCV Water service area over a specified study period, using demands as they are projected to increase over the study period and, to reflect the uncertainty in the hydrology over the study period, using supplies that would be available under multiple hydrologic sequences. For each hydrologic sequence, the model steps through each year of the study period, comparing annual supplies to demands and operating SCV Water storage programs as needed, adding to storage in years when supplies exceed demand and withdrawing from storage when demand exceeds supplies. Results from the multiple hydrologic sequences are then compiled and summarized to provide a statistical assessment of the reliability of SCV Water's supplies and storage programs to meet its projected demands over the study period.

Hydrologic Variability

Of the many factors affecting this reliability assessment, the factor with the greatest degree of variability and with the largest impact on supplies (and to a lesser degree, demands) is hydrology. Hydrology in northern California significantly affects the availability of SWP supplies; local hydrology affects the availability of Alluvial groundwater supplies (as well as demands); and dry-year reductions in SWP supplies affect the need for additional Saugus groundwater pumping.

The SWP supply data used in this analysis is based on the results of SWP modeling studies conducted by DWR using CalSim, a computer model that simulates monthly operations of the SWP and CVP systems. Among other model inputs, CalSim uses hydrologic inflows to the model based on 82 years of historical monthly inflows from 1922 through 2003, adjusted to reflect current levels of development in the supply source areas. All of the CalSim studies used in this analysis also reflect changes to temperature and precipitation centered around 2035 (2020 to 2049) and a 45-cm sea level rise.

CalSim studies are essentially a "snapshot-in-time" type of analysis. That type of study uses a fixed set of facilities, operating requirements/constraints, and water demands, operated over a number of years using historical hydrology. The resulting supply deliveries from a CalSim study provide an indication of the potential supply reliability of the SWP system, as that system is assumed to exist and be operated at a given point in time. However, for this Reliability Plan analysis, what is desired is potential supplies over a study period (i.e., the 40-year period from 2021 through 2060) with conditions such as demands, supplies, and storage programs changing over the study period.

To reflect the potential variability in hydrology over the study period, for this analysis, a number of hydrologic sequences are used, based on the same historical hydrologic period used in the

CalSim studies. Based upon the 82 years of hydrologic record used in CalSim, a series of 82 hydrologic "traces" is used. Each trace consists of 30 years of sequential hydrology, with the beginning year of each trace lagging the beginning year of the previous trace by one year. For example, the first trace begins with 1922 hydrology assumed for year 2021, 1923 hydrology for 2022, etc., through 1961 hydrology for 2060. The hydrology is shifted by one year for the second trace, beginning with 1923 hydrology for 2021, 1924 hydrology for 2022, etc., through 1962 hydrology for 2060. This one-year shift continues until the end of the hydrologic period (2003) is reached, where the data begins "wrapping" back to 1922 hydrology. The end result of this process is 82 traces of hydrology.

Each hydrologic trace is used to analyze SCV Water's supply and demand performance over the study period – in other words, if that sequence of hydrology were to occur again, how adequate would the supplies associated with that hydrology and the storage programs in place be in meeting demands over the study period? Study period results from each of the 82 hydrologic traces are then compiled and summarized and are used to provide a statistical assessment of the reliability of SCV Water's supplies and storage programs to meet its projected demands over the study period.

SCV Water – Water Operations

Demand and Supplies

As mentioned above, the SCV Water model performs annual water operations for the SCV Water service area over a specified study period, using demands as they are projected to increase over the study period and using supplies that would be available under the multiple hydrologic traces described above. For each hydrologic trace analyzed, the model steps through each year of the study period, comparing annual supplies to demands. Input to the model allows demands and supplies to change during the study period, so specific input data for these parameters is entered for each year during the study period.

The annual supplies included in the model to meet demands in the SCV Water service area are: groundwater (both Alluvial and Saugus); recycled water; SWP water; and Buena Vista-Rosedale water. The availability of some of these supplies is projected to increase over the study period (i.e., recycled water and municipal groundwater use), while other supplies are either constant each year (Buena Vista-Rosedale water) or are assumed to be independent of year during the study period (i.e., SWP water). Data input to the model is for normal-year conditions over the study period.

In addition to changes over time, some supplies are also affected by hydrology (i.e., groundwater and SWP water). Hydrologic effects are incorporated into the model through use of the 82 hydrologic traces described above. In the case of groundwater, for example, when a dry year occurs in the local watershed in a particular hydrologic trace, Alluvial pumping is assumed to decrease from normal-year pumping amounts. In contrast, Saugus pumping does not necessarily increase at the same time, because its pumping is tied to hydrology in northern California and the availability of SWP supplies. SWP supplies are taken directly from CalSim model results for each year in the hydrologic trace.

Similarly, demands in the SCV Water service area are assumed to increase over the study period, and projected normal-year demands are input to the model. Demands are also affected by local weather, with lower or higher than normal demands occurring when local conditions are either wet or dry, respectively. As with supplies, the hydrologic effects on demands are incorporated into the model through use of the 82 hydrologic traces. When a dry year occurs in a particular hydrologic trace, demand is increased from normal-year amounts, and in a wet year is reduced.

The demand and supply parameters included in the SCV Water model and whether they are assumed to change over time or be affected by hydrology are summarized in Table A-1.

Storage Programs

As mentioned previously, the annual water operations included in SCV Water's model also include operation of its storage programs. For each hydrologic trace analyzed, the model steps through each year of the study period, comparing annual supplies to demands and operating SCV Water storage programs as needed over the study period, adding to storage in years when supplies exceed demand and withdrawing from that storage when demand exceeds supplies. The model keeps track throughout the study period of the amount of water stored within each program, beginning with a starting storage amount, and then adding to and subtracting from storage as it operates the programs over the study period. Input to the SCV Water model includes storage and capacity data for each storage program, including: beginning (2021) storage; total storage capacity; capacity for annual additions to storage ("put" capacity); and capacity of annual withdrawals ("take" capacity). The capacities are entered for each year during the study period, and so can easily reflect planned changes to programs, such as a planned increase in take capacity, or a program that begins or ends at some point during the study period.

The storage programs included in the SCV Water model include: SWP flexible storage; SWP carryover in San Luis Reservoir; Rosedale-Rio Bravo Banking Program, Semitropic Banking Program, and Semitropic – Newhall Land Banking Program; potential participation Antelope Valley East Kern Banking Program; and potential participation in Aquaterra Banking Program. Exchanges, which are essentially a form of storage program, include Antelope Valley East Kern Exchange and United Water Conservation District Exchange. In addition to these programs, the model also includes dry year supplies available for purchase under the Yuba Accord and Nickel water and potential participation in Sites Reservoir. In addition to these identified programs, the model includes placeholders for new banking programs and for new exchanges.

The priorities for use of these programs in any year when there is a surplus or shortfall in supplies is identified in Table A-2. In a year when total annual supplies exceed demand, the model adds the surplus supply to these storage programs, within the capacity constraints identified in model input. The model starts with the first program listed in Table A-2 under Supply Surplus and adds the surplus (up to that program's put capacity) to storage in that program (up to the program's total storage capacity). Any remaining surplus supply is added to the second program, and so on, until all the supply is stored or there are no more programs in which to store it. Conversely, in a year when total annual supplies are less than demand, the model withdraws the shortfall from available storage programs. The model starts with the first program listed in Table A-2 under Supply

Shortfall and withdraws the shortfall (up to that program's take capacity) from any available storage in that program. Any remaining shortfall is withdrawn from the second program, and so on, until the shortfall is eliminated or there are no more programs to draw from. Any remaining annual supply surplus or shortfall is tracked in the model and totaled over the study period, and those totals are then used to assess system performance and reliability.

Assumptions Used in this Reliability Plan

For this Reliability Plan update, the study period analyzed is 2021 through 2060 (ten years after year of development buildout in the service area assumed in the 2020 UWMP). Six scenarios were evaluated, each run twice: 1) using demand with active conservation; and 2) using demand without active conservation. The scenarios are described generally as follows:

- **Base Scenario:** Represents those elements of the SCV Water portfolio that currently exist. As the analysis moves through the study period restoration of well capacity temporarily taken out for water quality concerns takes place consistent with 2020 UWMP Tables 4-8B, 4-8C, 4-9B and 4-9C well case containing the existing and restored groundwater supplies. Imported supplies include SWP supplies based on 2040 climate conditions pursuant to DWR's CALSIM modeling for the 2019 Delivery Capability Report, the firm Buena Vista Rosedale Transfer, and if necessary, in dry years, SWP Flexible Storage, Nickel Water, Yuba Accord water. The Base case also includes the existing banking programs, specifically existing Rosedale Banking supplies at the existing 10,000 AFY of recovery, SCV Water Semitropic and access to the Newhall Land and Farming withdrawal capacity, that are drawn on during years when the other previously mentioned supplies are insufficient to meet demands.
- **Scenario 1:** Represents the supplies used in the 2020 UWMP's reliability analysis. It builds on the Base scenarios by adding additional Saugus Formation pumping capacity for use in dry periods and developing an additional 10,000 AFY of extraction capacity under the existing water banking agreement with Rosedale Rio-Bravo Water Storage District.
- **Scenario 2:** Similar to Scenario 1, but the dry supply from Saugus Formation wells 5 through 8 is replaced with participation in the AVEK's High Desert Water Bank.
- **Scenario 3:** Similarly replaces Saugus Formation wells 5 through 8 with participation in the Sites Reservoir.
- **Scenario 4:** Assumes all of the new Saugus Formation wells 3 through 8 are not constructed and replaced with a combination of Sites Reservoir and the AVEK High Desert Water Bank.
- **Scenario 5:** Like Scenario 4 assume no new Saugus Formation Wells and also eliminates the new recovery capacity from the Rosedale banking program. It replaces these with the AVEK High Desert Bank and Sites Reservoir, as well as the participation in the McMullin Aquaterra Water Bank.

See Table A-3 for more detail on specific assumptions included in each scenario.

Approach Used in this Reliability Plan

The approach used in this Reliability Plan is similar to the 2017 update of the Reliability Plan. This approach retains the exact same wet and dry periods that occurred during the 82-year period of hydrologic record, with the effect of those periods on SWP deliveries taken directly from CalSim model runs. It is not reliant on how well a regression analysis reflects hydrologic wet or dry periods and their effects on SWP deliveries. In this Reliability Plan update, six different scenarios are analyzed, each of which is based on a different CalSim model run. Under the previous approach, this would have required a separate regression analysis for each scenario.

Since the first Reliability Plan was prepared in 2003 (for foremerly CLWA), the length of the hydrologic record used in CalSim has increased from 73 years to 82 years of hydrologic record. Under the approach used in this Reliability Plan update, the longer the hydrologic record used in CalSim, the more sequences of hydrology can be developed and used for analysis of SCV Water system operations. The use of the 82 hydrologic sequences developed is considered to be adequate to assess system performance and reliability for the purposes of this Reliability Plan update.

Furthermore, the SCV Water model actually operates SCV Water's storage programs over the study period. This allows an assessment not only of whether there is adequate take capacity to meet demands in supply-limited years, but whether there is adequate supply and put capacity in years of excess to store those supplies for eventual dry-year withdrawals.

TABLE A-1
SCV WATER – WATER OPERATIONS MODEL:
VARIABILITY IN DEMAND AND SUPPLIES

Parameter	STUDY PERIOD VARIATIONS		HYDROLOGIC VARIATIONS	
	Change over Study Period?	Reason for Change	Variation due to Hydrology?	Reason for Variation
DEMANDS				
Demands	Yes	Increases due to population growth	Yes	Higher outdoor use in locally dry years, and lower use in wet years
SUPPLIES				
Alluvial pumping	Yes	Increases due to conversion of agricultural pumping to M&I use	Yes	Reduced availability in locally dry years
Saugus pumping	Yes	Increased capacity due to restored, replacement, and planned wells	Yes	Increased usage in years that are dry in northern California
Recycled water	Yes	Increases resulting from planned distribution system and use	No	
SWP Table A	No		Yes	Northern California hydrology effects on supply availability and Delta requirements
Sites Reservoir	No		Yes	Northern California hydrology effects on supply availability and Delta requirements
Buena Vista-Rosedale	No		No	
Nickel water – Newhall Land	No		No	

TABLE A-2
SCV WATER – WATER OPERATIONS MODEL:
STORAGE PROGRAM USE PRIORITIES

SUPPLY SURPLUS	SUPPLY SHORTFALL
Priorities for Additions to Storage In year when Supplies exceed Demand	**Priorities for Withdrawals from Storage In year when Supplies less than Demand**
1. SWP flexible storage	1. Yuba Accord (dry-year water purchase)
2. SWP carryover in San Luis Reservoir	2. SWP carryover in San Luis Reservoir
3. Rosedale-Rio Bravo Banking Program	3. Antelope Valley East Kern Exchange
4. Antelope Valley East Kern Banking Program	4. United Water Conservation District Exchange
5. AquaTerra Banking Program	5. New exchange(s)
6. Semitropic Banking Program	6. Semitropic Banking Program surcharge(1)
7. Semitropic – Newhall Land Banking Program	7. Semitropic Banking Program
8. New banking program(s)	8. Antelope Valley East Kern Banking Program
9. New exchange(s)	9. Aquaterra Banking Program
	10. Rosedale-Rio Bravo Banking Program
	11. SWP flexible storage
	12. Nickel Water
	13. Semitropic – Newhall Land Banking Program
	14. New banking program(s)

Note:

(1) Semitropic Banking Program surcharge is the remaining balance of water SCV Water stored in 2002 and 2004 under a temporary storage agreement with Semitropic. In 2015, SCV Water entered into a long-term banking program with Semitropic (labeled here as "Semitropic Banking Program"), with specified storage, put, and take capacities. The balance of the previously stored water was transferred into the Semitropic Banking Program and is in addition to the water that may be stored under that new program (thus the label here as "surcharge"). This water is still available for withdrawal by SCV Water but uses Semitropic Banking Program withdrawal capacity. Further, there can be no additions to the amount "surcharged" in the Semitropic Banking Program.

TABLE A-3
SCV WATER - WATER OPERATIONS MODEL: RELIABILITY PLAN SCENARIO ASSUMPTIONS

	BASE SCENARIO	SCENARIO 1 (~2020 UWMP)	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Study Period	2021 - 2060	same as Base	same as Base	same as Base	Same as Base	Same as Base
HYDROLOGY						
Hydrologic period included	1922 - 2003	same as Base	same as Base	same as Base	Same as Base	Same as Base
Climate change	• SWP hydrology: Includes effects of 2035 emission level and 45 cm sea level rise • Local hydrology: None	same as Base	same as Base	Same as Base	Same as Base	Same as Base
DEMANDS						
Demand w/ plumbing code savings	• Increases from 72,063 AFY in 2021 to 115,083 AFY by 2050 • Normal demands are adjusted for weather by a multiplier ranging from 0.93 to 1.06[1]	same as Base	same as Base	same as Base	Same as Base	Same as Base
Demand w/ active conservation	• Increases from 69,831 AFY in 2021 to 101,030 AFY by 2050 *[UWMP Table 2-13]*[2] • Normal demands are adjusted for weather by a multiplier ranging from 0.93 to 1.06 [1]	same as Base	same as Base	same as Base	Same as Base	Same as Base

	BASE SCENARIO	SCENARIO 1 (~2020 UWMP)	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
SUPPLIES						
Groundwater[3][4][5]						
Alluvium	• Normal year pumping increases from 15,714 AFY in 2021 to 30,797 AFY by 2035, based on existing wells and planned conversion of agricultural pumping *[UWMP Table 4-7]* • Compared with normal-year pumping, total aquifer pumping is reduced to 13,338 AFY in 2021 and 26,071 AFY by 2035 during locally dry years, per the basin yield analysis[6]	same as Base	same as Base	same as Base	same as Base	same as Base
Saugus	Existing Saugus assuming that Saugus well 201 is returned to service in 2022 and Saugus well 205 is returned to service in 2024. • Normal year pumping decreases from between 13,490 AFY in 2021 to 9,900 AFY by 2035. • Dry year pumping increases from 14,980 AFY in 2021 to 20,810 AFY by 2030, per the basin yield analysis	Same as Base plus additional Saugus wells 3-8 that would provide: • Normal year pumping of 13,490 AFY in 2021 and 10,400 AFY by 2035. • Dry year pumping increase to 14,980 AFY in 2021 and 33,800 AFY by 2030. [7]	same as Base plus additional Saugus wells 3 & 4, providing: • Normal year pumping of 13,490 AFY in 2021 and 10,140 AFY by 2035. • Dry year pumping of 14,980 AFY in 2021 increasing to 26,060 AFY by 2035. [7]	same as Scenario 2	same as Scenario 2	same as Base
Recycled Water						

	BASE SCENARIO	SCENARIO 1 (~2020 UWMP)	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Recycled water	Increases from 860 AFY in 2021 to max of 8,960 AFY by 2050 *[UWMP Table 2-4.2]*(8)	same as Base	same as Base	same as Base	same as Base	same as Base
Imported Supply						
SWP Table A	• From CalSim run ELT under future conditions with: o updated climate change data o new endangered species interim take permit o new coordinated agreement with CVP • Deliveries to SCV Water average 51,158 AFY, ranging from 8,298 AFY to 95,200 AFY, depending on hydrologic year *[2019 DCR Technical Addendum]*(9)	same as Base	same as Base	same as Base	same as Base	same as Base
SWP carryover	none	none	none	none	none	none
SWP flexible storage	Max capacity: • 2017-25: 6,060 AF2026-50: • 4,684 AF(10) *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base
Buena Vista - Rosedale	11,000 AFY every year *[UWMP p. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base
Nickel water	• 1,607 AFY every year *[UWMP pp. 4-2]* • Available 2022-50(11)	same as Base	same as Base	same as Base	same as Base	same as Base
Yuba Accord	• 1,000 AFY available for purchase during dry periods • Available 2021-25(12) *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base

	BASE SCENARIO	SCENARIO 1 (~2020 UWMP)	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Banking/Exchange Programs						
Semitropic Bank surcharge	• Max capacities: o Storage: 35,970 AF o Put: 0 AFY o Take: 5,000 AFY(13) (14) • Available through 2045 *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base
Semitropic Bank	• Max capacities: o Storage: 15,000 AF o Put: 5,000 AFY o Take: 5,000 AFY(13) (14) • Available through 2045 *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base
Semitropic – Newhall Land Bank	Max capacities: • Storage: 55,000 AF • Put: 4,950 AFY • Take: 4,950 AFY(14) *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base
Rosedale Bank	Max capacities: • Storage: 100 TAF • Put: 20 TAFY • Take: o 2021-50: 10,000 AFY *[UWMP pp. 4-2]*	same as Base, except: • Take: o 2021-29: 10,000 AFY o 2030-50: 20,000 AFY(15)	same as Scenario 1	same as Scenario 1	same as Scenario 1	same as Base
New Bank	none	none	none	none	none	none
Antelope Valley East Kern Exchange	• Max capacities: o Storage: 2,250 AF o Put: 0 AFY o Take: 2,250 AFY when SWP Table A Allocation > 30% • Available through 2030(16) *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base

	BASE SCENARIO	SCENARIO 1 (~2020 UWMP)	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
United Water Conservation District Exchange	• Max capacities: o Storage: 500 AF o Put: 0 AFY o Take: 500 AFY when SWP Table A Allocation > 30% • Available through 2030[16] *[UWMP pp. 4-2]*	same as Base	same as Base	same as Base	same as Base	same as Base
Antelope Valley East Kern Bank	none	none	Max capacities: • Storage: 70,000 AF • Put: 20,000 AFY • Take: 20,000 AFY Available beginning in 2023	none	same as Scenario 2	same as Scenario 2
Aquaterra Bank	none	none	none	none	none	Max capacities: • Storage: 70,000 AF • Put: 20,000 AFY • Take: 20,000 AFY Available beginning in 2023

	BASE SCENARIO	SCENARIO 1 (~2020 UWMP)	SCENARIO 2	SCENARIO 3	SCENARIO 4	SCENARIO 5
Sites Reservoir	None	None	None	Alt 3 used available beginning in 2030, with long-term average of 2.8 TAF/year and dry and critically dry years average of 7.1 TAF/year. Dry year deliveries range between 0.1-16.3 TAF/year	Same as Scenario 3	Same as Scenario 3

<u>Notes</u>:

(1) "Wet" and "dry" years for demand impact determination are based on local precipitation and temperature for water years from 1928 through 2003, with the demand multiplier ranging between 0.93 and 1.06.

(2) Normal demands for 2021 through 2060 based on demands from *SCV Demand Study Update, Final Technical Memorandum #2 (Maddaus Water Management, March 2021).*

(3) Existing groundwater supplies represent the quantity of groundwater available to be pumped with existing wells. Schedule for recovered well capacity based on Groundwater Treatment Implementation Plan Technical Memorandum, Kennedy Jenks 2021 Appendix C, and reflected in Tables 2-4 A and 2-5 A. Overall pumping remains within the groundwater basin yields per the 2020 SCV-GSA Draft Water Budget Development Tech Memo (GSI 2020) and the updated Basin Yield Analysis(LSC & GSI 2009).

(4) Future and Recovered groundwater supplies include recovered impacted wells and new groundwater well capacity that may be required by SCV Water's production objectives in the Alluvial Aquifer and the Saugus Formation. When combined with existing Agency and non-Agency groundwater supplies, total groundwater production remains within the sustainable ranges identified in Tables 4-10 and 4-11 of the 2020 UWMP and is within the groundwater basin yields per the 2020 SCV-GSA Draft Water Budget Development Tech Memo(GSI 2020) and the updated Basin Yield Analysis(LSC & GSI 2009).

(5) Reduction in existing supply reflects pumping being shifted from existing wells to well capacity recovered after installation of PFAS treatment.

(6) Future Category includes all wells restored from PFAS and Perchlorate water quality issues, and other future alluvial wells including those associated with development under the Newhall Ranch Specific Plan.

(7) Future and Recovered Saugus wells include perchlorate-impacted Well 205, two replacement wells (Saugus 3 & 4), and up to four new wells (Saugus 5-8) planned to provide additional dry-year supply. New dry-year wells would not typically be operated during average/normal years.

(8) Existing recycled Water is based on current average annual use.

(9) SWP supplies are based on average deliveries from DWR's 2019 DCR (58% - 52% at buildout due to climate change). 2019 DCR assumptions include: updated climate change data (based on 2035 emissions and 45 cm sea level rise), a new endangered species interim take permit and a new coordinated operating agreement with the CVP.

(10) Includes both SCV Water and Ventura County entities flexible storage accounts through 2025 and only SCV Water portion beyond 2025.

(11) Existing Newhall Land supply committed under approved Newhall Ranch Specific Plan. Assumed to be transferred to SCV Water during Newhall Ranch development, and available for annual purchase prior to that.

(12) Supply shown is amount available in dry periods, after delivery losses. This supply would typically be used only during dry years and is available through 2025.

(13) Banking programs labeled here as “Semitropic Bank surcharge” and “Semitropic Bank” share the same 5,000 AFY take capacity, so withdrawals from both programs combined cannot exceed 5,000 AF in a given year.

(14) Existing Newhall Land supply. Assumed to be transferred to SCV Water during Newhall Ranch development, with firm withdrawal capacity made available to SCV Water prior to that.

(15) Firm withdrawal capacity under existing Rosedale Rio-Bravo Banking Program to be expanded by 10,000 AFY by 2030 (for a combined total of 20,000 AFY).

(16) Supplies shown are totals recoverable under the exchange and would typically be recovered only during dry years.