Appendix B

WSA for Water Supply Option B
(Onsite Groundwater)

Water Supply Assessment
Middle Green Valley Project

Solano County, California

Prepared for:
Solano County

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May, 2013

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Table of Contents

List of Tables

List of Figures

Appendix

Executive Summary

The purpose of this Water Supply Assessment (WSA; prepared in accordance with Senate Bill 610 enacted in 2001) is to determine the sufficiency of groundwater as a supply resource for the planned 'Middle Green Valley Project' (Project) during normal, dry, and multiple-dry years. Solano County is the Lead Agency for the Project and has identified a second option for water supply that utilizes local groundwater for domestic potable water, which this WSA addresses. This WSA evaluates the water needs of the Project until the year 2035 in relation to existing and future water demands and supply within the Middle Green Valley Specific Plan Area (Plan Area) and adjacent portions of Green Valley within a study area previously addressed by the U.S. Geological Survey (USGS) (Thomasson et al., 1960)[1] (**Figure ES-1**). When referenced in this document, 'Thomasson study area (north/south)' refers to portions of Green Valley addressed by Thomasson (1960), excluding those areas also within the Plan Area. Although the proposed Project-related development will be limited to the Plan Area, the available water sources for the Project, particularly groundwater sources, extend beyond the Plan Area boundary. Water sources available throughout Green Valley will include the contiguous Suisun-Fairfield groundwater basin and various water systems' infrastructure. This WSA includes detailed information on historical and projected groundwater requirements in the Plan Area and Thomasson study area (north/south)[2] and will be included in the environmental documents prepared for the Project pursuant to the California Environmental Quality Act (CEQA).

Key components and findings of the WSA include:

- The Plan Area covers 1,917 acres, with current land uses consisting primarily of irrigated agriculture (280 acres); non-irrigated agriculture and fallowed lands (425 acres); and native vegetation, rangeland, and isolated residential and semi-agricultural areas (1,212 acres). Existing residential development in the Plan Area includes approximately 55 existing residences mostly distributed amongst agricultural parcels.
- The proposed Project includes land conservation and development components with 1,490 acres designated as permanent open lands (including approximately 440 acres for working agriculture) and 415 acres designated for the development of up to 500 new residential units (400 primary, 100 secondary) in four neighborhoods including fewer than 20 acres of community facilities and agriculture-related commercial facilities.

[1] Thomasson, H.G., Olmsted, F.H., and E.F. LeRoux. 1960. Geology, Water Resources and Usable Ground-Water Storage Capacity of Part of Solano County, California, U.S. Geological Survey Water Supply Paper 1464.

[2] In this WSA, the phrase "Thomasson study area (north/south)" is used to refer to those portions of Green Valley that were studied by Thomasson (1960) and are also outside the Plan Area. On **Figure ES-1**, those are the two areas delineated in blue and located directly north and south of the Plan Area. The total area studied by Thomasson in the Green Valley area was about 2,400 acres, 900 acres of which lie within the valley floor of the Plan Area. Therefore, the area referred to as the "Thomasson study area (north/south)" in this document corresponds to the balance, which totals about 1,500 acres. Where the intent is to refer to the entire 2,400 acre portion of Green Valley studied by Thomasson, an attempt has been made to consistently refer to that as the "USGS study area."

- Project Option B, addressed by this WSA, proposes to meet the Project-related water demands with a combination of treated groundwater for all new potable water demand (186 acre-feet/year (afy)), recycled water for landscaping demand (54 acre-feet/year), and a combination of surface water and groundwater to meet agricultural demands (510 to 560 acre-feet/year).
- Groundwater levels in Green Valley have been generally stable since the earliest records collected in 1918. Although groundwater level records do show some variation in levels from year to year, these changes appear to result from variations in water year type rather than excess pumping, even when groundwater use was estimated at three times the current estimate for Green Valley. Current groundwater levels throughout the Plan Area are reflective of a full basin with groundwater levels ranging from 1 to 30 feet below ground surface in the Plan Area.
- When accounting for the continuation of current groundwater use for irrigation and rural residential needs and previous groundwater supply documented by the USGS (Thomasson et al., 1960), Green Valley's groundwater resources have a surplus of at least 744 acre-feet/year with which to meet the planned 186 acre-feet/year Project demand for potable water.
- The Solano Irrigation District (SID) supplies the Plan Area with surface water from Lake Berryessa, through the Solano Project, to meet the majority of current agricultural demands and is expected to continue such deliveries in the future. The Solano Project has maintained an overall average reliability of 99% for deliveries from Lake Berryessa to purveyors including SID since Solano Project deliveries began in 1959, through 2007 (average of 100% reliability during normal years, 99% reliability during dry years, and 99% reliability during multiple-dry years) (Okita, 2010; SID, 2006).
- Groundwater resources in Green Valley, as documented by the USGS (Thomasson et al., 1960) appear sufficient to replace 75% of annual surface water deliveries by SID within the Plan Area and adjacent portions of Green Valley should curtailment become necessary due to a multi-year drought. Any increased groundwater pumping required to meet non-Project demands due to an SID curtailment would not affect the ability of Project wells to meet potable water demands as described in the Specific Plan Water Supply Option B.
- A site-specific aquifer evaluation, including test hole and test well drilling, is recommended to optimize the productivity of the proposed Project supply wells while limiting any potential impacts to existing wells.

Middle Green Valley Project

The Middle Green Valley Project (Project) includes several components, including a proposed neighborhood framework, associated land use designations, building types standards, financial and infrastructure implementation provisions, community design themes, landscape standards, open land requirements, etc., as outlined in the Middle Green Valley Specific Plan (Solano County, 2010). The Project proposes a combination of land conservation and development provisions designed to create a limited number of new residential units. The maximum number of new primary residential units is set at 400, and up to 100 new secondary residential units would also be allowed, in compact cluster development patterns surrounded by an interconnected network of agricultural and natural open lands

served by a system of rural streets, bikeways, and pedestrian pathways and trails. A major portion (1,490 acres, or 78 percent) of the Plan Area is designated as permanent open land, of which approximately 440 acres would be used for working agriculture. The remaining portion of the Plan Area (approximately 415 acres, or 22 percent) is designated for development using a four-neighborhood approach.

Water Options – Option B Groundwater

The Specific Plan offers two options for providing water and wastewater services. This WSA is only concerned with addressing the components of the second option, Option B, of the Specific Plan. Option B utilizes local groundwater for domestic supply in the Plan Area. SID water would continue to be used for agricultural and domestic irrigation purposes. The Project water would be treated to California Code of Regulations Title 22 Standards prior to being pumped to onsite storage facilities. The proposed onsite groundwater system configuration consists of at least three groundwater wells at a sustained flow of potentially 100 gallons per minute (gpm) each, approximately 4.5 miles of pipelines, and 500,000 gallons of storage in two water storage tanks. The proposed wells and distribution system are proposed to provide the estimated total annual water requirement for the potable domestic supply of 186 acre-feet per year.

Under Option B, groundwater is proposed to be the sole source of potable drinking water to the residents and businesses in the Plan Area. The approximately 55 existing residential housing units in the Plan Area would continue to receive water from private, onsite groundwater wells.

The Project anticipates the establishment of a County Service Area (CSA) to provide the financial and management structure for the Plan Area's water system. The proposed CSA would be responsible for providing the level of treatment necessary to meet safe drinking water standards for residential domestic use. The County will require a monitoring and reporting program to establish baseline groundwater conditions prior to development in order to ensure that the Project has no adverse effects on existing private wells. The County will also require a Water Master Plan to demonstrate that wells, pumping, storage, and distribution components meet County and State requirements.

Hydrogeology of the Groundwater Basin

This WSA includes a description of the subsurface conditions within Green Valley, as well as the Suisun-Fairfield Valley Groundwater Basin, the local groundwater basin in which the Project is located. The major water-producing units in the Plan Area are the Sonoma Volcanics and overlying Alluvial Deposits. Wells have typically been completed largely in the alluvium, but some wells extend into the Sonoma Volcanics. Well completion records in Green Valley indicate that wells are completed in the deeper volcanics, the shallow alluvium, or a combination of both. Well completion records in Green Valley also indicate variability in well depths and well yields. Wells in the valley floor range in depth from 30 feet to nearly 300 feet with yields between 12 and 350 gallons per minute, and have an average capacity of 160 gallons per minute. Wells completed outside the valley floor, in the adjacent foothills, are typically only screened in the Sonoma Volcanics aquifer unit and generally yield less than 100 gallons per minute.

The three (or more) proposed deep wells planned to be constructed to serve the Plan Area would likely be completed at least partially in the Sonoma Volcanics. Groundwater in the Plan Area and to the south in Green Valley flows to the south and southeast following the trend of the valley.

Groundwater levels in Green Valley, in the vicinity of the Plan Area, are relatively shallow (ranging from depths of less than one foot to 70 feet below the ground surface between 1918 and 2012). Seasonal fluctuations of between ten and twenty feet between fall and spring measurements are common (**Figure ES-2**). Groundwater levels have historically been very stable with some response to climatic variability, but levels consistently exhibit full recovery from dry periods. Historical groundwater conditions for 1950 were compared to recent groundwater levels where available in the vicinity of the Project, and current groundwater conditions are found to be comparable to historical conditions. Little variation in water source availability is anticipated between normal to dry years. Groundwater levels have remained stable throughout dry periods where records are available, including multiple-dry years.

Groundwater quality data in Green Valley are limited to eleven wells with publicly available data (from the California Department of Public Health, the California Department of Water Resources, and the USGS) and a few privately owned wells with water quality data requested for this WSA (SID, Green Valley Country Club (GVCC), and private landowners). To update the groundwater quality data for this WSA, water quality samples were obtained from two private wells to supplement the other available data (public and private). The groundwater quality in the Plan Area is generally good, with some instances of iron and manganese concentrations exceeding secondary drinking water standards. Water treatment may be required if similar conditions are encountered at the proposed Project well sites.

Past and Current Water Requirements and Supply

Historical pumping in Green Valley was estimated by the USGS for the years between 1941 and 1951, and ranged between 100 and 1,400 acre-feet per year for irrigation purposes (Thomasson et al., 1960). An extrapolation of maximum groundwater pumping rates in the Plan Area during this period yields approximately 525 acre-feet per year extracted in the Plan Area. Thomasson also estimated the storage capacity in Green Valley for the depth range of 10 to 200 feet below ground surface as shown in the table below (1960).

Table ES-1 Estimated Total Groundwater Storage Capacity in Green Valley (within 10 to 200 feet below ground surface) (Thomasson et al., 1960)

	Depth (feet below ground surface)	Specific Yield (%)	Storage Capacity (acre-feet)
	10-50	12	12,000
	50-100	10	12,000
	100-200	9	22,000
TOTAL	10-200	10	46,000

For the depths of 10 to 200 feet below ground surface, the estimated groundwater storage capacity in the entire Green Valley is 46,000 acre-feet.

To determine the current water requirements and supply in the Plan Area and Thomasson study area (north/south), an analysis involving land use was performed for this WSA using Department of Water Resources (DWR) land use surveys of Solano County for 1994 and 2003, high resolution aerial photography from 2010, Landsat 5 satellite imagery (USGS Earth Resources Observation and Science Center, accessed 2012) and calculated Normalized Vegetative Difference Index (NDVI) coverages, and the Draft Environmental Impact Report for Middle Green Valley (SCDRM, 2010). Agricultural crop type and distribution were evaluated in the Plan Area. It was determined that, over the last 20 years, land use along the central and lowest part of the Plan Area (along Green Valley Creek and Green Valley Road) has been predominantly agricultural. Along the eastern and western sides of the Plan Area, at the higher elevations, land use is less developed and mostly native vegetation and open rangeland. Some isolated residential and semi-agricultural areas exist as individual ranches or in clusters along Green Valley Road. Dense urban areas do not occur within the Plan Area, but such areas have expanded outside of and along the northern and southern boundaries of the Plan Area.

Agricultural land use was divided into irrigated and non-irrigated categories to determine the current water requirements or water demand. Current residential and commercial water demand was determined based on the number of developed parcels and, in the predominately agricultural Plan Area, estimated residences. Water supply in the Plan Area for agricultural and residential purposes is provided through deliveries from SID and from pumped groundwater. Water supply in the Thomasson study area (north/south) is provided by deliveries from SID, City of Vallejo, and City of Fairfield along with pumped groundwater. Groundwater use was calculated for this WSA as the difference between estimated demand and the known supply of water from other sources. SID provided partial delivery records for fifteen years (1998 – 2012). The City of Fairfield provided delivery records for three years (2010-2012). The City of Vallejo provided an average annual water delivery amount. The current water requirements and supply are summarized in the table below (**Table ES-2**).

Table ES-2 Middle Green Valley Plan Area and Thomasson Study Area (North/South)
Current Estimated Water Requirements and Sources (acre-feet/year)[1]

Land Use	Acres[2]	Applied Water Rate (afy/acre)	Water Requirement (afy)	Water Source (acre-feet/year)			
				Surface Water		Groundwater	TOTAL
				SID	Vallejo and Fairfield		
Middle Green Valley Plan Area							
Existing Residential/Ag Residential/Commercial[3]			**110**	**20**		**90**	**110**
Irrigated Agriculture							
Vineyard within SID area	126	0.4[4]	50[5]	50[6]			50
Vineyard outside SID area	90	0.6-1.1[7]	50-100			50-100	50-100
Pasture and Other within SID area	64	1.4[8]	90[9]	90			90
Irrigated Agriculture Subtotal			**190-240**	**140**		**50-100**	**190-240**
MGV Plan Area Subtotal			**300-350**	**160**		**140-190**	**300-350**
Thomasson Study Area (North/South)							
Existing Residential/Ag Residential/Commercial (incl. Golf Course)			1,630-1,700[10]	390-460[11]	970[12]	270[13]	1,630-1,700
Irrigated Agriculture			30-50	20-40[14]		10[15]	30-50[16]
Thomasson Study Area (North/South) Subtotal			**1,660-1,750**	**410-500**	**970**	**280**	**1,660-1,750**
Combined MGV Plan Area and Thomasson Study Area (North/South)			**1,960-2,100**	**570-660**	**970**	**420-470**	**1,960-2,100**

1 Water requirement and water source values are rounded to the nearest ten acre-feet per year.

2 Figures in this column are based on land use determinations made for this WSA as described in **Section 4.1.2.1**, see also **Figure 2-2** (SID area), **Figure 4-2** (2011 land use), **Table 4-4** (2011 agricultural land use).

3 Regarding figures in this row, SID data shows that in the Plan Area SID delivered 20 acre-feet for residential use in 2011 to 11 parcels. That averages to a little less than 2 acre-feet per year per parcel, which was conservatively rounded to an estimated 2 acer-feet per year per parcel, as discussed in **Sections 4.1.2.2** and **4.1.2.5**.

4 This figure was estimated as 50 ÷ 126 = 0.4, as discussed in **Section 4.1.2.5**.

5 Figure is reported SID data for 2011, as discussed in **Section 4.1.2.2**.

6 Figure is reported SID data for 2011, as discussed in **Section 4.1.2.2**.

[7] This figure was estimated based on the estimated applied water demand for vineyards in the SID service area with allowances for differences in depth to groundwater and soil moisture or unknown local practices, as discussed in **Section 4.1.2.5**.

[8] This figure was estimated as 90 ÷ 64 = 1.4, as discussed in **Section 4.1.2.5**.

[9] Figure is reported SID data for 2011, as discussed in **Section 4.1.2.2**.

[10] Total water requirement for existing residential and commercial parcels in the Thomasson study area (north/south), includes the GVCC (See **Sections 4.1.2.2** and **4.1.2.5**)

[11] The range of annual SID deliveries to the GVCC from 2004 to 2010 (150 acre-feet to 221 acre-feet) plus SID Landscaping deliveries in the Thomasson study area (north/south) in 2011, as discussed in **Section 4.1.2.2**.

[12] The sum of 2011 deliveries from each City, 213 acre-feet and 749 acre-feet, as discussed in **Section 4.1.2.3**.

[13] The sum of groundwater pumpage required to meet water demands not accounted for by deliveries from surface water sources, as discussed in **Section 4.1.2.5**.

[14] The known deliveries by SID in 2011 for all agricultural land uses in the Thomasson study area (north/south) plus the range of known annual SID deliveries for an unreported agricultural parcel (5.5 acre-feet to 26.6 acre-feet), as discussed in **Section 4.1.2.2**.

[15] The sum of groundwater pumpage required to meet water demands not accounted for by deliveries from surface water sources, as discussed in **Section 4.1.2.5**.

[16] The sum of current estimated irrigated agriculture water requirements based on 2011 land use classifications, estimates of crop water demand, and known deliveries by SID, as discussed in **Sections 4.1.2.2 and 4.1.2.5.**

Future Water Requirements

Projected water demands for the Plan Area include two main components: domestic and agricultural water requirements which total between 860 to 910 acre-feet per year (**Table ES-3**). Each of these components encompasses some existing domestic and agricultural water utilization in addition to the planned water utilization for the Project. The Project demands are based on information developed for the Middle Green Valley Specific Plan (2010). Existing demand totals 300 to 350 acre-feet per year based on existing residential and current agricultural water uses. Future demand at full build-out is 560 acre-feet per year, based on 240 acre-feet for the Project (domestic and landscaping), and the remaining demand based on the assumption that all remaining land in the category of Agricultural Preserve not currently in production is put into production and requires 2 acre-feet per year per acre. The agricultural component of the projected water demands is 190 to 240 acre-feet per year for existing current land use, and 320 acre-feet per year for possible future water demand. There are approximately 160 acres of land designated as Agricultural Preserve by the Plan that are not currently in production. Existing and Project water requirements are summarized in **Table ES-3**.

Table ES-3 Summary of Projected Middle Green Valley Plan Area Water Demands

DEMAND	Acres	Existing Acre-feet/year	Future Acre-feet/year
Residential			
Existing Residential/Ag Residential (includes 10 Agriculture-Residential and the 25-50 Rural Farm units)	215	110	
MGV Plan Domestic	(refer to Table 5-1)		186
MGV Plan Landscaping (non-potable; application of recycled water)	(a)		54
Agricultural			
Agriculture (Current; see Table 4-6)	280	190-240	
Agriculture (Agricultural Preserve remaining lands not currently active agriculture)	160		320
Subtotals:		***300-350***	***560***
Total Projected Demand		**860-910**	

a) For example, recycled water application on rural residential housing for landscaping purposes

Groundwater Supply Sufficiency

Land within the Plan Area will rely on both groundwater and surface water. Surface water will be provided by SID, mostly for agricultural uses, while Option B of the Project proposes to use domestic water originating from local groundwater sources in the form of three (or more) supply wells. There is also a component of existing agricultural and residential demand that will continue to be supplied by local private groundwater wells. In summary, the entire groundwater demand of 326 to 376 acre-feet per year in the Plan Area (at build out) includes:

- 90 acre-feet per year for existing private/residential supplied by private wells (**Table ES-2**),
- 50 to 100 acre-feet per year for agriculture on lands situated outside SID's service area supplied by private wells (**Table ES-2**), and
- 186 acre-feet per year for Plan potable water domestic use supplied by three (or more) Project wells (**Table ES-3**).

Groundwater pumping amounts are not documented in Green Valley, except for a historical period between 1941 and 1951, as estimated by the USGS (Thomasson et al., 1960). The maximum amount of groundwater pumping during the period of record was 1,400 acre-feet per year in 1949 (Thomasson et

al., 1960). The USGS Green Valley study area covered approximately 2,400 acres (Thomasson et al., 1960), 900 acres of which lie within the valley floor of the Plan Area (**Figure ES-1**). Applying the amount of pumping over the entire USGS Green Valley study area translates to a groundwater extraction rate of 0.58 acre-feet per year per acre. Applying the 0.58 acre-feet per year per acre maximum groundwater extraction rate on record, a maximum of approximately 525 acre-feet per year of groundwater may have been pumped in this historical period in the Plan Area. For the purposes of this WSA, it is estimated that 525 acre-feet per year of groundwater would be available to the Plan Area without depleting the groundwater aquifer. An agricultural demand of about 525 acre-feet per year was historically met by groundwater with no adverse effects, i.e., groundwater levels remained stable from spring to spring. Historical groundwater conditions for 1950 were compared to recent groundwater levels where available in the vicinity of the Project. Current groundwater conditions are found to be comparable to historical conditions. Groundwater levels have remained stable throughout dry periods where records are available.

Agricultural water deliveries are sufficient within the SID service area, with allotments available to agricultural customers within the SID service area. Available SID delivery records specific to the Green Valley area indicate that deliveries have been unaffected by dry periods (**Figure 2-3**). Historical records of Solano Project surface water deliveries to purveyors including SID indicate an overall average reliability of 99%, since deliveries began in 1959 through 2007 (average of 100% reliability during normal years, 99% reliability during dry years, and 99% reliability during multiple-dry years) (Okita, 2010; SID, 2006). Therefore, the SID deliveries portion of water supply to the Plan Area is not expected to change between normal, single-dry, and multiple-dry water year types. To the extent that SID agricultural surface water deliveries remain reliable, agriculture in the Plan Area would not need to look to utilize groundwater to meet irrigation water demands.

Normal, Single-Dry and Multiple-Dry Water Years

The Project will achieve full build out conditions within the first five years, so there is no change in water demand between the years 2015, 2020, 2025, 2030, and 2035 (**Table ES-4**). The nature of the Project is such that the water demand is unaffected by climatic variability. This means that there is no difference in water demand for the Project between a normal water year, a single-dry year, or multiple-dry year types (**Table ES-5**). The water supply does not change on a yearly basis, so there is no difference between the water supply in the years 2015, 2020, 2025, 2030, and 2035. Historical records indicate that the availability of groundwater is unaffected by water year type (i.e., in some years climatic variability causes some changes in groundwater levels, but spring to spring water levels recover, as indicated in historical water level records). Available SID delivery records specific to the Green Valley area indicate that deliveries have been unaffected by dry periods and are indicative of varying crop patterns.

Table ES-4 Comparison of Future Groundwater Demand and Supply for the Middle Green Valley Plan Area

	Groundwater Demand and Supply (acre-feet)				
	2015	2020	2025	2030	2035
Projected Groundwater Demand[1]	326-376	326-376	326-376	326-376	326-376
Projected Groundwater Supply[2]	525+	525+	525+	525+	525+
Projected Surplus	**149-199+**	**149-199+**	**149-199+**	**149-199+**	**149-199+**

[1] Assumes full Project build out by 2015

[2] Groundwater supply based on estimated historical pumping amounts with no recorded adverse effects, discussed in **Section 4.1.1.**

Table ES-5 Comparison of Future Groundwater Supply Sufficiency for the Middle Green Valley Plan Area

	Groundwater Demand and Supply (acre-feet)				
	Normal	Single-Dry	Multiple-Dry Year		
			1	2	3
Projected Groundwater Demand	326-376	326-376	326-376	326-376	326-376
Projected Groundwater Supply	525+	525+	525+	525+	525+
Projected Surplus	**149-199+**	**149-199+**	**149-199+**	**149-199+**	**149-199+**

As mentioned above, historical records of Solano Project surface water deliveries indicate an overall average reliability of 99% for all water years types (Okita, 2010). Therefore, it is reasonable to assume that the SID deliveries to the Plan Area and Thomasson study area (north/south) are not expected to change between normal, dry, and multiple-dry water year types. The estimated surplus of water resources in the Plan Area and adjacent Thomasson study area (north/south), including the surface water component, is between 1,544 and 1,684 acre-feet per year (**Table ES-6, Figure ES-3**).

Table ES-6 Summary of Annual Middle Green Valley Plan Area and Thomasson Study Area (North/South) Projected Water Supplies, Water Demands, and Overall Supply Sufficiency through 2035 for Normal, Single-Dry, and Multiple-Dry Years

AVAILABLE WATER SUPPLIES	Middle Green Valley Plan Area		Thomasson Study Area (North/South)		Totals
	Surface Water (acre-feet)	Groundwater (acre-feet)	Surface Water (acre-feet)	Groundwater (acre-feet)	All Sources (acre-feet)
Groundwater[1]	NA[2]	525+	NA	875+	1,400+
Solano Irrigation District[3]	1,000+	0	680+	0	1,680+
City of Vallejo[4]	0	0	210+	0	210+
City of Fairfield[5]	0	0	860+	0	860+
Project Recycled Water[6]	NA	NA	NA	NA	NA
Total Projected Supply	**1,000+**	**525+**	**1,750+**	**875+**	**4,150+**
PROJECTED WATER DEMAND	**Middle Green Valley Plan Area**		**Thomasson Study Area (North/South)**		**Totals**
	Surface Water (acre-feet)	Groundwater (acre-feet)	Surface Water (acre-feet)	Groundwater (acre-feet)	All Sources (acre-feet)
Existing Residential/Ag Residential/Commercial	20[7]	90[7]	1,360-1,430[12]	270[12]	1,740-1,810
MGV Plan Domestic (potable)	0	186[8]	NA	NA	186
MGV Plan Landscaping (non-potable)[9]	NA	NA	NA	NA	NA
Agriculture (current)	140[10]	50-100[10]	20-40[13]	10[14]	220-290
Agriculture (expanded)	320[11]	0	0	0	320
Total Estimated Demand	**480**	**326-376**	**1,380-1,470**	**280**	**2,466-2,606**
Projected Surplus	**520+**	**149-199+**	**280-370+**	**595+**	**1,544-1,684+**

[1] Groundwater supply based on estimated historical pumping amounts with no recorded adverse effects, discussed in **Section 4.1.1.**

[2] Not Applicable

[3] SID deliveries are based on current, historic, and potential amounts within the SID service area, further discussed in **Section 4.1.2.2**

[4] City of Vallejo deliveries are based on reported deliveries, as further discussed in **Section 4.1.2.4**.

[5] City of Fairfield deliveries are based on reported deliveries, as further discussed in **Section 4.1.2.3**.

[6] Recycled water is planned to be used for domestic landscape irrigation, further discussed in **Section 5.3**.

[7] Estimated based on 55 existing residences and a use of 2 afy per parcel, further discussed in **Section 4.1.2**.

[8] Planned domestic demand, as discussed in **Section 5.2**.
[9] Recycled water is planned to be used for domestic landscape irrigation, further discussed in **Sections 2.4.3 and 5.3**.
[10] Current agricultural demand is estimated for the year 2011 based on analysis of land use in **Section 4.1.2**.
[11] Expanded agricultural demand represents land not currently in active production (160 acres) and a representative conservative crop use of 2 afy per acre, further discussed in **Section 5.2**.
[12] Estimated based on known current surface water deliveries and calculated groundwater pumpage in the Thomasson study area (north/south) discussed in **Sections 4.1.2**.
[13] As discussed in **Section 4.1.2.5** and accompanying **Table 4-6**.
[14] As discussed in **Section 4.1.2.5** and accompanying **Table 4-6**.

Recommendations

This water supply sufficiency assessment focuses on the current and historical groundwater resources in the Plan Area. In order to develop the resource for the Project, a few recommendations should be considered. These recommendations are mainly concerned with gaining site-specific aquifer data by initiating a test hole and test well drilling program to aid in siting the supply wells in the optimum locations at target depth intervals and analyzing for potential impacts:

1) Placement of public supply wells should be in the main valley floor and not in the adjacent hills in order to utilize the deeper aquifer unit and avoid increased depths to water.
2) Spacing of wells should accommodate any potential well interference either with each other (other Plan wells) or nearby private wells (agricultural or domestic).
3) Monitoring wells are recommended to be completed at a minimum in the shallow alluvial aquifer as well as below in the Sonoma Volcanics (these monitoring wells would be paired with the public supply wells).
4) A review of existing well completion reports nearest the test well sites should occur to confirm the aquifer unit already in use and help identify the deeper aquifer materials to be developed for public supply in order to minimize the potential for drawdown effects on nearby wells.
5) Analyses to be performed should include aquifer testing and monitoring that would confirm drawdown at a level that is not of concern in nearby wells or surface water features.

Due to the limited availability of site-specific information regarding aquifer parameters and well capacities, a test hole and test well drilling program is recommended to aid in the siting and design of wells for the community water supply system. The siting, or location, of the test wells will ensure that adverse effects due to mutual well interference do not occur on existing private wells. Construction of Project potable supply wells in deeper aquifer materials (below existing wells) is suggested such that they are protective of shallow-completed private domestic wells and therefore also of any surface water bodies nearby. Aquifer testing and analysis is also recommended to gain site-specific knowledge of the subsurface and should be performed to confirm that drawdown associated with the Project will not affect nearby wells.

1.0 Introduction

1.1 Purpose

Cities and counties with large development projects are required by Senate Bill 610 (SB 610, which amended Part 2.10, Division 6 of the California Water Code in 2001) to prepare a Water Supply Assessment (WSA). This WSA describes the projected water demands resulting from the proposed Middle Green Valley Project (Project) located in Solano County, California (**Figure 1-1**) and the availability of water to supply those demands during normal, single-dry, and multiple-dry years. Solano County is the Lead Agency for the Project and has identified a second option for water supply that uses local groundwater for domestic potable water, which this WSA addresses. This WSA evaluates the water needs of the Project until the year 2035 in relation to existing and future water demands and supply within the Middle Green Valley Plan Area (Plan Area) and adjacent portions of Green Valley to the north and south of the Plan Area within the Thomasson (1960) study area (Thomasson study area (north/south)).

Although the proposed Project-related development will be limited to the Plan Area, the available water sources for the Project, particularly groundwater sources, extend beyond the Plan Area boundary. Sources available throughout Green Valley will include the contiguous Suisun-Fairfield groundwater basin and various water systems' infrastructure. The U.S. Geological Survey (USGS) study by Thomasson (1960)[3] referenced throughout this WSA provides the most thorough and foundational characterization of the geology and hydrogeology of Green Valley, as confirmed by the Consolidated Final Program Environmental Impact Report for the Central Valley Flood Protection Plan (DWR, 2012). In addition to reviewing previous studies of geology and hydrogeology in the Suisun-Fairfield area of Solano County, which includes Green Valley, Thomasson (1960) conducted detailed geologic mapping and groundwater assessments based on data collected through a canvass of well construction, groundwater level, and groundwater quality data from existing wells in Green Valley and throughout Solano and Yolo Counties. Furthermore, Thomasson (1960) described the groundwater resources in Green Valley as distinct from other portions of the Suisun-Fairfield area due to the physical structure of Green Valley, an alluvial valley bounded to the north, east, and west by outcropped bedrock (see **Section 3.2**).

Detailed information on current, historical, and projected groundwater requirements in the Plan Area and the Thomasson study area (north/south) are summarized in this WSA. This WSA will be included in the environmental documents prepared for the Project pursuant to the California Environmental Quality Act (CEQA).

1.2 Report Organization

This report is structured to facilitate the presentation of information required by the Water Code including the analyses necessary to evaluate the sufficiency of the water supply to meet projected future demands.

[3] Thomasson, H.G., Olmsted, F.H., and E.F. LeRoux. 1960. Geology, Water Resources and Usable Ground-Water Storage Capacity of Part of Solano County, California, U.S. Geological Survey Water Supply Paper 1464.

Chapter 1 provides an overview of the legal requirements for the WSA and describes the Middle Green Valley Project. It provides definitions of key terms and describes water resource management plans in nearby areas.

Chapter 2 describes the current and future Middle Green Valley Plan Area and includes a summary of projected population growth, climate, and existing and planned sources of water supply.

Chapter 3 describes the hydrogeology of the groundwater basin, including its geology and well and aquifer characteristics.

Chapter 4 describes regional and local groundwater conditions. Historical and current pumpage in the Plan Area and adjacent, contiguous portions of Green Valley are analyzed along with groundwater level and quality data.

Chapter 5 describes current and future water demands based on the Middle Green Valley Project.

Chapter 6 provides an overview of the overall supply sufficiency by comparing projected groundwater demands in the Plan Area and Green Valley to available supplies. This chapter includes a discussion of the permits and financing necessary to make the water supply available to planned new development.

1.3 Proposed Middle Green Valley Project

The Project proposes to establish a land use and circulation layout utilizing development clustering, a transfer of development rights (TDR) program, and use of conservation easements, to benefit, and to limit the effects of residential development on the rural character of the valley, and on the valley's viewsheds, wildlife habitat, wildlife movement corridors, and agricultural activities. The Project includes several components, including a proposed neighborhood framework, associated land use designations, building types standards, financial and infrastructure implementation provisions, community design themes, landscape standards, open land requirements, etc., as outlined in the Middle Green Valley Specific Plan (Solano County, 2010). The Project proposes a combination of land conservation and development provisions designed to create a limited number of new residential units. The maximum number of new primary residential units is set at 400, and up to 100 new secondary residential units would also be allowed, in compact cluster development patterns surrounded by an interconnected network of agricultural and natural open lands served by a system of rural streets, bikeways, and pedestrian pathways and trails (**Figure 1-2**).

A major portion (1,490 acres, or 78 percent) of the Plan Area is designated as permanent open land, of which approximately 440 acres would be used for working agriculture. The remaining portion of the Plan Area (approximately 415 acres, or 22 percent) is designated for development using a four-neighborhood approach. The four neighborhoods are proposed to include: the Green Valley Road Corridor, Elkhorn Neighborhood, Three Creeks Neighborhood, and Nightingale Neighborhood.

Within the four neighborhoods, the following components are proposed:

- Development of up to 400 primary residential units, with up to 100 new secondary residential units, on approximately 337 acres.

- Up to 18 acres of community/public service uses, including a potential non-denominational chapel (up to 200 seats), farm stand (up to 3,000 square feet), community recreation center (up to 8,000 square feet), neighborhood school (up to 100 students)[4], and a land conservancy office (up to 3,000 square feet).
- Up to approximately 50,000 square feet of agricultural commodity processing and commercial nurseries (for wineries, olive oil production, etc.), up to 10,000 square feet of agricultural tourism retail, and a possible inn of up to 25 rooms.
- Up to 10,000 square feet of neighborhood-service office and retail commercial floor space.
- Approximately 60 acres of existing and proposed rural roads and other infrastructure.

The Specific Plan offers two options for providing water and wastewater services. This WSA is only concerned with addressing the components of the second option, Option B, of the Specific Plan. Option B utilizes local groundwater for domestic supply in the Plan Area. Groundwater use would be solely for domestic purposes, and Solano County Irrigation District (SID) water would continue to be used for agricultural and domestic irrigation purposes. Water treatment is anticipated to consist of mixed media filtration and disinfection unless measured chemical constituents indicate further treatment. The proposed onsite groundwater system configuration consists of at least three groundwater wells at a sustained flow of potentially 100 gpm each, approximately 4.5 miles of pipelines, and 500,000 gallons of storage in two water storage tanks preferably located at elevation. The proposed wells and distribution system would provide the estimated total annual water requirement for the potable domestic supply of 186 acre-feet per year.

Wastewater from the Plan Area would be collected and treated locally using a Membrane Bioreactor (MBR) package wastewater treatment plant. All tertiary treated water would be reused for agricultural and domestic irrigation purposes in conjunction with SID water but using separate delivery systems. Infrastructure for wastewater would include approximately 5.7 miles of pipeline, two pump stations, and the MBR tertiary treatment unit.

The Specific Plan proposes the formation of a County Services Area (CSA) to maintain and operate water, sewer, storm drainage, recycled water, and parks and recreation services.

1.4 Scope of Analysis

This WSA includes a review of groundwater resources as well as existing and future planned development within the Plan Area to the year 2035. Adjacent portions of Green Valley within the study area addressed by the USGS as part of a previous report on the hydrogeology and groundwater resources of Solano County (Thomasson et al., 1960) are also considered in this WSA. Historical, current, and projected water demands have been estimated for the Plan Area and adjacent Thomasson (1960) study area. When referenced in this document, "Thomasson study area (north/south)" refers to

[4] An earlier draft of the Specific Plan described the school as being for up to 300 students. The Plan was then changed to reflect a maximum of 100 students. (Middle Green Valley Draft Final Specific Plan (2010), Table 3-4, and pp. 3-12, 3-61.) The estimate of water demand has continued to use the 300-student figure. (Middle Green Valley Draft Final Specific Plan (2010) Table 4-3; see also, below, Table 5-1.)

portions of Green Valley addressed by Thomasson (1960), excluding those areas also within the Plan Area. The WSA is based upon and intended to fulfill the requirements of SB 610 as described below.

1.5 SB 610 Requirements for Groundwater Sources

SB 610 became effective on January 1, 2002 with the intent to strengthen the process by which local agencies determine the adequacy and sufficiency of current and future water supplies to meet current and future demands. SB 610 amended the California Public Resources Code to incorporate Water Code findings within the CEQA process for certain types of projects. SB 610 amended the Water Code to expand the types of information included in Urban Water Management Plans (UWMP) from Water Code Section 10620 *et seq.* and to amend Water Code Part 2.10 Water Supply Planning to Support Existing and Planned Future Uses (Section 10910 *et seq*.). The latter Part 2.10 describes the roles and responsibilities of the Lead Agency under CEQA and the public water system (water supplier) with respect to comparing current and future water supplies with current and projected future water demands. A project requiring a WSA, as defined in SB 610, includes 1) a proposed residential development having more than 500 dwelling units; 2) a proposed shopping center or business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space; 3) a proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space; 4) a proposed hotel or motel, or both, having more than 500 rooms; 5) a proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area; 6) a mixed-use development that includes one or more of the uses described above; 7) a development that would demand an amount of water equivalent to or greater than the amount of water required by a 500-dwelling-unit project; and 8) for Lead Agencies with under 5,000 water service connections, any new development that will increase the number of water service connections in the service area by ten percent or more.

If the water supplier has already completed an UWMP, it must identify whether the new demands are included in the UWMP. If the UWMP includes the demands, it may be incorporated by reference. In this case, it is anticipated that the water supplier will be a CSA supported by a Community Services District (CSD), which have not yet been formed, and there is no UWMP; therefore, Water Code Section 10910 requires the preparation of a WSA. To comply with the SB 610 requirements, this WSA includes the following information:

- A description of the water service area including climate, current and projected population, and other demographic factors that affect water management planning. Demographic data are presented in five-year increments for the period 2015 to 2035.
- A description and quantification of the existing and planned water source (groundwater).
- A description of the water source availability during normal, single-dry, and multiple-dry water year types.
- A description of current and projected water demands among all user classes in the future public water system service area in five-year increments.

- A discussion of the total projected water supplies determined to be available to the Middle Green Valley water system during normal, single-dry, and multiple-dry water years for a 20-year horizon that will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses.

WSA requirements are specified when groundwater is identified as a source. For the Plan Area, groundwater is planned to serve as the sole source of potable drinking water, and delivered surface water will provide agricultural and landscaping water demands. Due to the inclusion of groundwater as a source of water, the WSA must include the following additional information:

- A review of any information contained in an UWMP relevant to the identified water supply for the proposed project. Due to the fact that Middle Green Valley does not have an UWMP, a guidance document prepared by the California Department of Water Resources (DWR) suggests that the WSA include discussion of any existing groundwater management plan and how it would affect the water supplier's use of the basin (DWR, 2003b).
- A description of any groundwater basin from which the proposed project would be supplied with groundwater, including information obtained from the most current DWR bulletin that characterizes the condition of the groundwater basin (i.e., whether DWR has identified the basin as overdrafted, or projected that the basin will become overdrafted if present management conditions continue, and what measures are being taken to prevent overdraft conditions from occurring). As suggested in the DWR guidance document relating to the implementation of SB 610, if the basin has not been (or recently been) evaluated by DWR, data that indicate historical and recent groundwater level trends should be evaluated.
- A detailed description and analysis of the amount and location of groundwater pumped by the public water system for the past five years from any groundwater basin from which the proposed project will be supplied.
- A detailed description and analysis of the amount and location of groundwater that is projected to be pumped (for at least a twenty-year horizon) by the public water system from any basin from which the proposed project will be supplied.
- An analysis of the sufficiency of the groundwater that will be supplied from the basin or basins to meet the projected water demand of the proposed project.

1.6 Definition of Terms

1.6.1 Sufficiency

Water Code Section 10910(f)(5) requires inclusion of "an analysis of the sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project."

Water Code Section 10910(c)(3) states:

> "If … the public water system has no urban water management plan, the water supply assessment for the project shall include a discussion with regard to whether the public water

> system's total projected water supplies available during normal, single dry, and multiple dry water years during a 20-year projection will meet the projected water demand associated with the proposed project, in addition to the public water system's existing and planned future uses, including agricultural and manufacturing uses."

The Water Code Sections (Water Code 10910 *et seq*.) above are understood to mean that the analysis of the sufficiency of groundwater from the basin applies to the availability of water supplies to meet the projected water demands during normal, dry, and multiple-dry years within a 20-year projection. The area from which groundwater will be withdrawn to meet the projected demands for the project and other public, agricultural, and industrial uses is the Middle Green Valley Plan Area that overlies a portion of the Suisun-Fairfield Valley Groundwater Basin of the San Francisco Bay Hydrologic Region. The Plan Area along with the adjacent portions of Green Valley previously studied by Thomasson (1960) is the area used for the analysis of supply sufficiency. The Court of Appeal has held that a WSA need not analyze groundwater pumping by all users in an entire basin, and SB 610 does not specify a particular methodology for sufficiency analysis and in that respect affords substantial discretion in determining how to measure water sufficiency (O.W.L. Foundation v. City of Rohnert Park (2008) 168 Cal. App. 4th 568, 574).

This WSA considers conditions within both the Plan Area and the Green Valley portion of the groundwater basin as part of this analysis. The U.S. Geological Survey (USGS) study by Thomasson (1960) referenced throughout this WSA provides the most thorough and foundational characterization of the geology and hydrogeology of Green Valley, as confirmed by the Consolidated Final Program Environmental Impact Report for the Central Valley Flood Protection Plan (DWR, 2012). In addition to reviewing previous studies of geology and hydrogeology in the Suisun-Fairfield area of Solano County, which includes Green Valley, Thomasson (1960) conducted detailed geologic mapping and groundwater assessments based on data collected through a canvass of well construction, groundwater level, and groundwater quality data from existing wells in Green Valley and throughout Solano and Yolo Counties. Furthermore, Thomasson (1960) described the groundwater resources in Green Valley as distinct from other portions of the Suisun-Fairfield area due to the physical structure of Green Valley, an alluvial valley bounded to the north, east, and west by outcropped bedrock (see **Section 3.2**).

1.6.2 Overdraft

The SB 610 requirements discussed above include evaluation of the condition of the groundwater basin, including whether DWR has identified the basin to be in overdraft or projected to become overdrafted. The word "overdraft" is defined by DWR as follows (DWR, 2003a):

> "[T]he condition of a groundwater basin or subbasin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which the water supply conditions approximate average conditions (DWR, 1998)."

Bulletin 118 also reports that "overdraft can be characterized by groundwater levels that decline over a period of years and never fully recover, even in wet years. If overdraft is determined and continues for a number of years, "significant adverse impacts may occur, including increased extraction costs, costs of

well deepening or replacement, land subsidence, water quality degradation, and environmental impacts" (DWR, 2003a).

An independent analysis of historical groundwater level and pumpage data is included in Chapter 4.

1.7 Water Management Plans

This section includes a review of available Urban Water Management Plans that are in the vicinity of the Middle Green Valley Project area and how they pertain to groundwater resources in the area. Also included in this section are summaries of four Groundwater Management Plans in Solano County, though only one (Solano Irrigation District) covers groundwater in the vicinity of the Project area.

Solano County Water Agency, 2010 Solano County Water Agency Urban Water Management Plan – Final Draft

The Solano County Water Agency (SCWA) service area includes all of Solano County, with a population of 413,300 in 2010. Solano County covers 829 square miles of land and 78 square miles of water. The population is projected to grow from 413,300 in 2010 to 454,000 in 2030 (SCWA, 2010). SCWA serves as a water wholesaler for the Solano Project and the State Water Project (SWP). The Solano Project is a federal project with the U.S. Bureau of Reclamation that stores water in Lake Berryessa for delivery to users throughout the region. The Solano Project utilizes three major facilities to deliver this water to contracted municipal and agricultural users: Monticello Dam, the Putah Diversion Dam, and Putah South Canal. The contracted water supply (plus operational losses) for the Solano Project total 207,350 acre-feet per year. The SWP provides water to SCWA through a contract with DWR, using the North Bay Aqueduct, delivering untreated municipal water. SCWA has contracted for an ultimate allocation of 47,756 acre-feet of water per year from the SWP and provides water to the Cities of Benicia, Vacaville, Fairfield, Vallejo, Suisun City, Rio Vista, and Dixon (Suisun City, Rio Vista, and Dixon currently do not have facilities to receive their water). SCWA does not provide groundwater supplies, nor does it provide any other water supplies beyond the two wholesale sources.

The SCWA UWMP contains an appendix that is the first phase of an Integrated Regional Water Management Plan for the Solano Agencies. This appendix contains existing SCWA program descriptions and individual member agency water supplies and current demands. The following paragraphs are derived from this part of the SCWA UWMP.

Prior to the development of the Solano Project, groundwater was extensively used in Solano County both for municipal and agricultural supplies. The Solano Project helped alleviate historically declining groundwater levels in some agricultural areas, resulting in rebounding water levels. The Cities of Dixon and Rio Vista are served exclusively with groundwater and the City of Vacaville utilizes groundwater for one third of its municipal supply. SID has its own wells to supplement their surface water supply from the Solano Project. Growers outside of districts that provide surface water rely entirely on groundwater unless they have an individual right to a surface water supply. Most rural residential landowners have individual shallow groundwater wells that serve their domestic needs. There are also some small rural residential water systems that distribute groundwater to their customers. Groundwater use values were provided between 1999 and 2002 for the Cities of Dixon, Rio Vista, Vacaville, and SID (**Table 1-1**)

Table 1-1 Groundwater Use Values (acre-feet per year) for Dixon, Rio Vista, Vacaville, and SID (SCWA, 2010)

Entity	1999	2000	2001	2002
Dixon	3,429	3,450	3,469	3,545
Rio Vista	1,565	1,550	1,725	1,799
Vacaville	4,096	5,141	6,211	6,638
SID	4,820	5,959	5,300	6,853

The City of Dixon receives groundwater supplies from the California Water Service Company (8 wells averaging 500 to 600 feet below the ground surface distributed around Dixon) and the Dixon-Solano Municipal Water Service (4 wells between 800 to 1,500 feet below the ground surface). The City of Rio Vista relies on six wells, four of which are active, ranging in depth between 500 and 1,000 feet below ground surface. The City of Vacaville relies on 10 deep aquifer wells located mostly in the Elmira well field that supplement their surface water deliveries. SID has a network of 29 wells between 400 and 1,000 feet below ground surface that are used conjunctively with surface water supplies.

City of Fairfield, CA 2010 Urban Water Management Plan

The City of Fairfield's water service area population was 102,090 in 2010 over approximately 22 square miles east and south of Green Valley (Fairfield, 2011). The water system's treatment, storage, and distribution system consists of 2 treatment plants, 11 reservoirs and approximately 378 miles of distribution lines, delivering an average of 21 million gallons per day. The City has approximately 76 million gallons of treated water storage capacity. The City's UWMP projects that the service area population will increase from 102,090 in 2010 to 147,970 in 2035. Water demand, or actual water delivery amount, was 5,759 million gallons per year in 2010 and forecast to increase to 12,369 million gallons per year by 2035. The majority of water users fit in the single family, multi-family, industrial, or landscaping categories. The primary water sources for the City are the Solano Project, the SWP, and "settlement water" derived from the yield of the SWP when the Sacramento-San Joaquin Delta experiences flows obtained through negotiations with DWR in 2003. Groundwater is not used as a supply source due to brackish conditions from tidal inflows, making it unsuitable for irrigation or drinking water use without prohibitively expensive treatment. The City does not anticipate using groundwater in the future.

City of Vallejo, 2005 Urban Water Management Plan

The City of Vallejo is an urban water supplier providing water for municipal purposes to approximately 37,800 connections, serving a population of approximately 116,670 people within the City's boundaries and unincorporated areas of Solano and Napa Counties, based on the 2000 census (City of Vallejo, 2006). The City of Vallejo's water service area is characterized by a mixture of residential and commercial land use. Since the 1950's the City has sold raw water to and operated a treatment plant on behalf of Travis Air Force Base and is considered a wholesaler of water to the base. The City of Vallejo's population is projected to reach 198,000 in the year 2025. Water demands estimated for the Vallejo

Water Systems include allocations for the City of Vallejo, the Vallejo Lakes System, and wholesale customers (including Travis Air Force Base, City of Benicia, and City of American Canyon). Total deliveries are projected to grow from 28,790 acre-feet per year in 2000 to 35,610 acre-feet per year in 2025. The City relies on five sources of surface water: Solano Project Water, SWP water, Vallejo Permit Water, Lakes Frey and Madigan, and Lake Curry. These five sources are projected to supply an entitlement totaling 47,150 acre-feet per year in 2010 and beyond.

Groundwater is not produced by the City of Vallejo Water Systems nor is its production planned for the future. The City of Vallejo 2005 UWMP briefly references the existence of an available freshwater aquifer in the Napa-Sonoma Valley Groundwater Basin but does not provide any assessment or characterization of that or any groundwater resource as a potential source for the Vallejo Water Systems.

Suisun Solano Water Authority Urban Water Management Plan, 2011

The Suisun Solano Water Authority (SSWA) is comprised of two entities: Suisun City and Solano Irrigation District, serving water to 29,868 people in 2010 (SSWA, 2011). In 2010 it served a service area population of 29,800 plus a population of 68 in the residential area of Mankas Corner, for a total service area population of 29,868 (SSWA, 2011). The primary land uses in the 4.0 square mile area of Suisun City are residential and commercial. The population in Suisun City is projected to grow from 29,800 in 2010 to 35,000 in 2035, and no growth is projected for Mankas Corner beyond the current population of 68. SSWA has two sources of water: the U.S. Bureau of Reclamation Federal Solano Project and DWR's SWP. SSWA currently has a water treatment facility that receives surface water from the Solano Project and following treatment delivers it to the service area. As of the 2011 UWMP, the SSWA did not have the ability to utilize their SWP entitlement due to lack of connection to their water treatment plant, but the SSWA may develop such capability in the future. Suisun City has an annual entitlement of 1,600 acre-feet from the Solano Project and a growing annual entitlement from the SWP of a maximum of 1,300 acre-feet in the year 2015. SID has entitlements and agreements for 141,000 acre-feet per year of agricultural and domestic water through the Solano Project, but it serves many areas in Solano County besides Suisun City, including three other cities, Maine Prairie Water District, and SID customers. The total water supply deliveries of the Solano Project to SSWA (includes Suisun City and SID-Suisun) in 2010 was 4,114 acre-feet, with a projected planned annual water supply of 6,000 acre-feet by the year 2035. As of 2011, groundwater was not used by SSWA. SSWA delivered groundwater produced by one well owned by Suisun City until 2001. This well, located in Suisun Valley near Mankas Corner, had a production capacity of 275 gpm (or 443 acre-feet per year) and delivered between 9 and 161 acre-feet per year of water to SSWA customers in the Suisun Valley through the Suisun Valley Pipeline between 1994 and 2001. The well was taken out of service due to a number of reasons, including the installation of the Benton Court and Suisun Valley Pumping Plants in 2000-2001, leaky and deteriorating pipeline connecting the well to the system, and relatively high iron and manganese concentrations, and it is no longer connected to the SSWA system. Since 2001, SSWA has not used groundwater in its system.

Solano Irrigation District Groundwater Management Plan, 2006

SID's Groundwater Management Plan (GWMP) was prepared in accordance with California Water Code (CWC) Section 10750 *et seq.* and was adopted on January 16, 2006. The goal of the GWMP is to help maintain a long-term, sustainable, reliable supply of high quality groundwater which will benefit the water supplies for all parties within the service area.

SID contracts surface water supplies from the Solano Project, and SID owns approximately 40 wells throughout the District (not all in the Solano Subbasin). SID is a major user of groundwater from the Solano Subbasin extracting approximately 10,000 acre-feet per year, about 6% of the overall SID water supply. SID uses groundwater for both agricultural and municipal purposes. Implementation measures in the GWMP consist mostly of monitoring groundwater levels, managing groundwater extraction and monitoring water quality. SID has performed monitoring as described in the GWMP. SID continues to participate with other agencies (through the Solano Water Authority and SCWA groundwater activities) overlying the groundwater basin to collectively monitor and report groundwater levels and coordinate groundwater basin management.

The GWMP presents the following Best Management Objectives:

1. Monitor and manage groundwater levels that will result in a net benefit to groundwater users throughout the District.
2. Strive to maintain a reliable and consistent groundwater quality for the beneficial use of groundwater users in the District.
3. Strive to minimize the risk of future significant impacts from land surface subsidence.
4. Facilitate conjunctive use operations which will encourage the optimum beneficial use of water resources within the District.

Reclamation District No. 2068 Groundwater Management Plan, 2005

RD 2068's GWMP was prepared in accordance with CWC Section 10750 *et seq*. and was adopted on December 8, 2005. The goals of the GWMP are to 1) state RD 2068's overall groundwater management goal; 2) put forth preliminary basin management objectives applicable to the RD 2068 service area; 3) provide a mechanism for the continued collection of baseline groundwater and aquifer information; and 4) establish preliminary management actions, including provisions for updating the plan as conditions change and new information becomes available.

Since RD 2068 is not currently a groundwater user, implementation measures in the GWMP consist mostly of monitoring regional groundwater levels, water quality, and subsidence. RD 2068 has performed monitoring as described in the GWMP. The GWMP recommended completion of a conjunctive use study. RD 2068 completed the conjunctive use study and has published the report "Reclamation District 2068 Conjunctive Use Feasibility Study" dated January 31, 2006. RD 2068 received funding through a later grant application for a test conjunctive use well. RD 2068 continues to participate with other agencies (through the Solano Water Authority and SCWA groundwater activities) overlying the groundwater basin to collectively monitor and report groundwater levels and coordinate groundwater basin management.

The GWMP presents the following Best Management Objectives:

1. Maintain groundwater elevations that result in a net benefit to basin groundwater users.
2. Protect and maintain groundwater quality within the RD 2068 service area for the benefit of basin groundwater users.
3. Minimize the risk of future significant impact due to inelastic land subsidence.
4. Plan and implement a conjunctive use program that minimizes short-term decreases in groundwater elevations, maintains groundwater elevations at acceptable levels over the long term, and minimizes water quality impacts resulting from the use of groundwater to meet some of the demands previously met by surface water.

City of Vacaville Groundwater Management Plan, 2011

The City of Vacaville's original GWMP was adopted on February 28, 1995. The City of Vacaville updated its GWMP in February 2011 to meet SB 1938 CWC requirements. The goals of the GWMP are to maintain a high quality, reliable, and sustainable water supply, continue to manage groundwater conjunctively with surface water resources, and support basin management objectives directed towards sustainability of groundwater supplies within the basin and subbasin. Groundwater management involves the ongoing performance of coordinated actions related to groundwater withdrawal, replenishment, and protection to achieve long-term sustainability of the resource without detrimental effects on other resources.

Vacaville is a major user of groundwater from the Solano Subbasin extracting approximately 6,700 acre-feet per year, about 20% of the overall City water supply. Implementation measures in the GWMP consist mostly of monitoring groundwater levels, managing groundwater extraction and monitoring water quality. Vacaville has performed monitoring as described in the GWMP. Vacaville continues to participate with other agencies (through the Solano Water Authority and SCWA groundwater activities) overlying the groundwater basin to collectively monitor and report groundwater levels and coordinate groundwater basin management.

The GWMP presents the following Best Management Objectives:

1. Assessment of groundwater basin conditions
2. Avoidance of progressive groundwater level declines
3. Preservation of groundwater quality
4. Increased conjunctive use of surface water and groundwater resources

Maine Prairie Water District Groundwater Management Plan, 1997

MPWD has an approved GWMP (in accordance with the CWC prior to 2003 amendments). The GWMP was adopted on January 21, 1997. MPWD does not pump groundwater, so they have not updated their GWMP to SB 1938 standards. The goal of the GWMP is to work cooperatively with landowners within the District to most efficiently manage and monitor the groundwater resources within the District.

MPWD is not currently a groundwater user, and implementation measures in the GWMP consist mostly of monitoring regional groundwater levels, water quality, and subsidence. MPWD has performed monitoring as described in the GWMP. MPWD continues to participate with other agencies (through the Solano Water Authority and SCWA groundwater activities) overlying the groundwater basin to collectively monitor and report groundwater levels and coordinate groundwater basin management.

The GWMP presents the following Best Management Objectives:

1. Conduct monitoring of four key wells to evaluate local groundwater conditions.
2. Review DWR groundwater quality monitoring for the area.
3. Acknowledges that groundwater levels benefit from abundant surface water supplies.
4. Accepts state standards for well construction, abandonment, and destruction.

2.0 Middle Green Valley Plan Area

The Middle Green Valley Plan Area is located in the western portion of Solano County in Green Valley. Green Valley is a north-northwest to south-southeast valley situated between the Coast Range Mountains west and north of Fairfield and Suisun City, north of the intersection of Interstate 80 and Interstate 680, as depicted in **Figure 1-1**. Green Valley is located approximately 35 miles east of San Francisco and approximately 40 miles west of Sacramento. The Plan Area is centrally located in Green Valley, located south of Rockville Road and north of Reservoir Lane and covering approximately 3 square miles (or 1,905 acres).

2.1 Plan Area Characteristics

The existing Plan Area covers just over 1,900 acres of land north and west of the Fairfield City limits, along Green Valley Road, and at the eastern edge of the western hills of the Coast Ranges. The Plan Area consists of a valley floor, with two drainage corridors (Green Valley Creek and Hennessey Creek), surrounded by foothills, including steep slope areas and oak woodland native vegetation. The Plan Area includes grazing lands in the hills, a mixture of cultivated and cultivable agricultural land on the valley floor, over 200 acres of vineyard, and a number of existing building and infrastructure elements, including approximately 55 rural residential units, a 10,000 square foot winery, three livestock feed barns, numerous additional agricultural barns, sheds and other accessory structures, approximately 20 miles of fencing, approximately 6 miles of overhead power and communications lines, three stock ponds, and a Solano County Water Agency operated reservoir. To the north and south of the Plan Area, existing suburban residential developments exist in the unincorporated upper Green Valley to the north and incorporated City of Fairfield immediately to the south and southeast.

The proposed Plan Area establishes a different land use layout, with a combination of land conservation and development. Approximately 1,490 acres of the proposed Plan Area are designated as permanent open land, of which approximately 440 acres would be preserved as working agriculture. The remainder of the planning area is designated for development, establishing four neighborhoods with rural roads, residential building types, and community buildings, with a maximum of 400 new primary residential units and up to 100 new secondary residential units.

2.2 Current and Projected Plan Area Population

Current and/or projected populations are given for areas covering portions or all of the Plan Area. The Green Valley CDP (Census Designated Place), which covers approximately 8.3 square miles of Solano County, and only the northeastern portion of the Plan Area, had a population of 1,859 in 2000 and 1,625 in 2010 (U.S. Census Bureau, accessed 2012). Solano County, however, had a population of 394,542 in 2000 and increased to 413,344 by 2010 (U.S. Census Bureau, accessed 2012). The portion of Solano County that is unincorporated had a total population of 23,500 in 2010 (SCDRM, 2010, from *ABAG, Projections and Priorities 2009, August 2009*). The projected population for 2030 for the unincorporated portion of Solano County is 25,800, and for the entire Solano County is 495,800 (SCDRM, 2010, from *ABAG, Projections and Priorities 2009, August 2009*).

The existing Plan Area contains approximately 55 single-family houses and ancillary agricultural structures. The houses are located in small subdivisions and on larger agricultural parcels on both the east and west sides of Green Valley Road. Assuming a total of 55 single-family houses and 2.93 persons per household (the average household size in unincorporated Solano County between 2005 and 2010), the existing population in the Plan Area is approximately 150 people. The new housing units for the proposed Plan (400 new primary and 100 new secondary housing units) will accommodate an increase of approximately 1,485 residents (based on an estimated average of 2.97 people per household for unincorporated Solano County in 2030), making the total proposed population of the Plan Area approximately 1,635 at build-out (SCDRM, 2010).

2.3 Climate and Precipitation

The climate of Middle Green Valley is classified as Mediterranean, or dry-summer subtropical, characterized by warm summers with some morning overcast and cool winters in which temperatures seldom drop much below freezing. Most of the rain falls in the winter months and ordinarily little or none falls during the summer growing season (Thomasson et al., 1960). Between 1994 and 2010 in nearby Suisun Valley, temperatures ranged from an average low of 38°F and an average high of 57°F in December to an average high 85°F and an average low of 58°F in August, while the average annual reference evapotranspiration[5] was approximately 50.5 inches/year with the most reference evapotranspiration occurring in July and the least in January (California Irrigation Management Information Station Suisun Valley #123 from UCIPM, accessed 2012; and DWR CIMIS, accessed 2012). The annual average precipitation as measured in nearby Fairfield between 1951 and 2011 is approximately 22.7 inches (Fairfield Station #42934 NCDC, accessed 2012), with most precipitation falling as rain between November and March. **Figure 2-1** shows the average monthly temperature and precipitation data at the two stations mentioned above.

2.4 Existing and Planned Water Sources

This section contains a description of the existing and planned water supply, storage, and conveyance facilities in the current and future Plan Area. Currently, the Plan Area has two sources of water supply: on-site groundwater and SID agricultural irrigation water.

2.4.1 Groundwater

Although a final determination has not been made concerning the future source of water supply for the Plan Area, this WSA considers groundwater to be the proposed sole source of potable drinking water to the new residents and businesses in the Plan Area. The approximately 55 existing residential housing units in the Plan Area receive water from private, onsite groundwater wells. The central part of the Plan Area lies above the Suisun-Fairfield Valley Groundwater Basin. Groundwater level data from the Plan Area indicate levels have been stable and groundwater supplies have been sufficient to meet demands.

[5] Evapotranspiration represents how much water is lost to the atmosphere through evaporation (from soil and plant surfaces) and transpiration (via plant tissues). Estimates of evapotranspiration are useful for agricultural irrigation purposes including system design, irrigation scheduling, water transfers, planning, and other water issues. Reference evapotranspiration, or ETo refers to measured evapotranspiration from a standardized grass surface (DWR CIMIS, 2009: http://wwwcimis.water.ca.gov/cimis/infoEtoOverview.jsp).

The Suisun-Fairfield Valley Groundwater Basin covers approximately 133,600 acres and contains wells with a maximum well yield of 500 gpm with an average well yield of 200 gpm (DWR, 2003a). A more detailed description of the local well yield and aquifer properties of the Green Valley and Suisun-Fairfield Valley Groundwater Basin are included in Chapter 3.

The option considered in this WSA to meet project domestic water demands in the Plan Area involves onsite groundwater. The project proposes to receive its primary potable water supply from a series of three or more onsite deep wells. The water would be treated by small treatment facilities at each well to provide filtration and disinfection to current California Code of Regulations (CCR) Title 22 Waterworks standards and California Department of Public Health (CDPH) regulatory oversight prior to being pumped to an onsite storage facility. The project also proposes the establishment of a CSA to provide the financial and management structure for the Plan Area's water system. The proposed CSA would be responsible for providing the level of treatment necessary to meet safe drinking water standards for residential domestic use. The County will require completion of a detailed hydrological study and approval of a Water Master Plan that demonstrates proposed well locations and the capability of the well system to deliver sustained supply rates that meet County and State standards. The Water Master Plan will include engineering specifications regarding well locations and depths; water pumping, filtration and disinfection specifications; and water storage and distribution facilities and sizing. The detailed hydrological study would include a monitoring and reporting program that would monitor the aquifer's response to the new wells for a period prior to project construction and would continue beyond system installation for a jurisdictional-specified minimum period.

2.4.2 Surface Water

SID has jurisdiction over the central part of the Plan Area (**Figure 2-2**) and provides irrigation water to agricultural operations within their service area. SID receives its water from the Solano Project, which delivers surface water from Lake Berryessa through various features, including the Putah Diversion Dam, the Putah South Canal (PSC) and small terminal reservoir, and associated waterways, laterals, and drainage works. The PSC and Lake Berryessa are operated by SID under a contract with the U.S. Bureau of Reclamation.

SID's Cereda pumping plant is located within the Plan Area on Green Valley Road in the vicinity of Jeni Lane. The plant, built around 1964, facilitates delivery of raw water through a pipeline in Green Valley Road to SID's Green Valley unlined in-ground reservoir located opposite Country Club Drive, approximately one-half mile north of the northern boundary of the Plan Area. The unlined reservoir has a capacity of approximately 3 acre-feet. The pump station and reservoir provide service to Green Valley in what are referred to as "upper" and "lower" pressure zones. SID delivers water for agricultural use to many but not all landowners in Green Valley within their service area through a distribution system.

2.4.3 Recycled Water

Wastewater generated from the approximately 400 new homes in the Plan Area is planned to include a recycling effort that would "resupply" about 54 acre-feet per year (Middle Green Valley Draft Final Specific Plan, 2010). The remainder of the wastewater generated (81 acre-feet per year) would be treated onsite to California Title 22 Standards. This latter amount is planned to be used for irrigation on

the surrounding agricultural lands or returned to a municipal sewer system such as the Fairfield Suisun Sewer District (depending on the time of year).

This section deals only with the 54 acre-feet per year of recycled water currently planned to resupply the project. This recycled water must meet stringent regulatory requirements monitored by the CDPH and treated to the California Title 22 Standards for tertiary (advanced) treatment of water (Middle Green Valley Draft Final Specific Plan, 2010). It must also meet regional and local standards. Wastewater is treated to these rigid standards to ensure that public health and environmental quality are protected.

3.0 Hydrogeology of the Groundwater Basin

3.1 Groundwater Basin Description

Green Valley is a roughly north-south trending valley that is approximately three miles long and one mile in width at its widest point near Cordelia. The valley is bounded on the west and east by the low hills of Vaca Mountains. South of the valley are the marshes of San Pablo Bay and Suisun Bay. The intermittent Green Valley Creek roughly bisects the valley as it flows toward Cordelia from the north end of the valley.

Green Valley is located on the western edge of the Suisun-Fairfield Valley Groundwater Basin (Basin 2.3) (**Figure 3-1**) of the San Francisco Bay Hydrologic Region as defined in DWR's Bulletin 118 (DWR, 2003a). The elevation of the valley floor ranges from approximately 162 feet above mean sea level (msl) near the intersection of Green Valley Road and Twin Creeks Boulevard to an elevation of 22 feet above msl where Mangels Boulevard crosses Green Valley Creek. The valley encompasses roughly 2,400 acres of the 133,600 acres of the Suisun-Fairfield Valley Groundwater Basin.

3.2 Geology of the Green Valley within the Suisun-Fairfield Valley Groundwater Basin

The hills of the Vaca Mountains that bound Green Valley are composed mainly of Eocene rocks of marine and fluvial origin and the Pliocene Sonoma Volcanics which include ash flow tuffs and andesitic and basaltic flows. The volcanics that form the hills on the east side of the valley continue under the relatively thin valley alluvium to form the base of the valley. The hills that make up the western side of the valley are composed of the sandstones of the Markley Formation that are covered by recent (Holocene, Pleistocene) landslide deposits. The valley alluvium is comprised of Holocene fan deposits of clay, silt, sand, and gravels originating from the surrounding hills. Recent deposits of silt, sand, and gravel have been deposited immediately adjacent to Green Valley Creek. The principal geologic units of the Green Valley area are shown on **Figure 3-2** and summarized below.

Markley Formation: The Markley Formation is composed of Eocene age arkosic sandstone of marine and fluvial depositional origin. Massive to well-bedded, the formation is typified as gray to yellow brown with abundant muscovite. The rocks of the Markley formation make up hills on the west side of the valley and continue below the western edge of Green Valley, dipping approximately 15°E. The Markley Formation is generally not targeted for water supply due to poor water quality and low yields.

Sonoma Volcanics: The Pliocene Sonoma Volcanics include ash flow tuffs and andesitic and basaltic flows. Thomasson (1960) mapped the hills that surround the valley floor collectively as the Sonoma Volcanics. In 1998, the California Division of Mines and Geology published a geologic map of the Cordelia quadrangle that mapped the Sonoma Volcanics in greater detail, differentiating tuff, andesites, and basalt flows that form the eastern hills of the valley (Bezore et al., 1998). The Sonoma Volcanics collectively lie unconformably atop the older Markley Formation.

Quaternary Landslide Deposits: The hills on the west side of the valley composed of Markley Formation rocks are covered by numerous recent and Pleistocene landslides; the toes of the landslides define the extent of the valley floor on the west side.

Alluvial Fan Deposits: The floor of Green Valley is coved by a layer of alluvium composed of clay, silt, sand, and gravel from fans originating in the surrounding hills. Based on drilling logs, the depth of the alluvium is believed to be approximately 150 feet.

Stream Channel Deposits: Recent stream channel and over bank deposits consist of silt, sand, and gravel deposited immediately adjacent to the banks of Green Valley Creek.

3.3 Well Yields and Aquifer Characteristics

This section discusses well yields and aquifer characteristics for the aquifer system in the Green Valley area. The aquifer characteristics discussed below (e.g., specific capacity, transmissivity, and storage coefficient) refer to the ability of aquifers to transmit and store groundwater. Calculations based on data from long-term, constant rate pumping tests are the preferred method of estimating aquifer characteristics. However, in the absence of such data, as is the case in Green Valley, aquifer characteristics were estimated using well completion reports, which sometimes report information that can be used to estimate aquifer characteristics, and data from previous studies.

The Sonoma Volcanics and the valley alluvium are the principal formations targeted for domestic and agricultural groundwater supply needs in the valley and the surrounding hills. Wells on the periphery of the valley and in the surrounding hills target the volcanic rocks almost exclusively. Wells constructed in the valley may target the deeper volcanics, the shallow alluvium, or a combination of both.

3.3.1 Well Yields

Based on a review of drillers' logs filed by drilling contractors with the California Department of Water Resources, approximately eighty supply wells have been constructed in the Green Valley area, which includes the main valley floor and adjacent foothills. The wells range from 30 to 560 feet in depth and yield between 5 and 350 gallons per minute. Nearly half of the wells were constructed on the valley floor. In the Plan Area, well yields (where known) range between about 90 to 300 gpm for wells completed to depths ranging from about 130 to 205 feet deep. The majority of the wells constructed in the valley floor were for irrigation, although some serve to meet both domestic and irrigation needs. The wells constructed in the hills that surround the valley are typically utilized for domestic supply only.

In the Green Valley area, yields from wells completed[6] exclusively within the Sonoma Volcanics are generally less than those completed only within the alluvium. However, due to thickness of the Sonoma Volcanics formation, significant well yields of over several hundred gallons per minute can be realized in deep wells constructed with long intake screens. Wells constructed in the Sonoma Volcanics on the

[6] Completed means screened in and/or constructed so as to extract groundwater from a certain part of the subsurface aquifer system.

valley floor range in depth from 30 feet to nearly 300 feet (in one or both formations) with yields for these wells ranging from 12 to 350 gallons per minute, with an average of 160 gallons per minute. Wells completed outside the valley floor are typically only screened within the Sonoma Volcanics and generally yield less than 100 gallons per minute.

3.3.2 Specific Capacity

Specific capacity (gpm/ft) is the ratio of well yield (gpm) to drawdown[7] (ft) and provides a measure of productivity for both the aquifer and the well. Specific capacity is calculated as Q/s, where Q is the yield of the well in gpm and s is the drawdown in feet. This specific capacity value indicates how much water can be pumped for every foot of drawdown in the well. Ideally, measurements of static water level, pumping water level, and discharge rate are collected from pump tests after a well has been fully developed and used to calculate its specific capacity. Specific capacities can be calculated from estimates of discharge rates and drawdown during test pumping conducted following well construction. However, specific capacities calculated from airlifting[8] operations are typically not as reliable due to estimation errors and because wells are not yet fully developed.

Drillers' logs for 17 Green Valley wells included information on discharge rate and drawdown from which specific capacities were calculated. Specific capacities in the 17 wells ranged from 0.08 gpm/ft to 6 gpm/ft, with an average of 0.1 gpm/ft. This information was sufficient to develop an understanding of the relatively low specific capacity and corresponding low transmissivity for the formations from which groundwater has been typically produced in Green Valley. Although the average specific capacity of Green Valley wells is relatively low, deep wells with deep pump settings can meet domestic water needs for the Project.

3.3.3 Transmissivity

The ability of an aquifer to transmit water is measured by the transmissivity, which can be defined as the permeability of the formation times the saturated thickness. In the absence of aquifer test data, transmissivity can be estimated from specific capacity using an empirical equation for a confined[9] aquifer: $T = Q/s * 2000$, where T is the transmissivity in gallons per day per foot (gpd/ft) and Q/s is the specific capacity in gpm/ft. Using calculated specific capacities from the 17 drillers' logs that contained discharge and drawdown information, estimated transmissivities in Green Valley ranged from 160 gpd/ft to 12,000 gpd/ft. The average transmissivity for the 17 wells is 200 gpd/ft.

3.3.4 Storage Coefficient

The storage coefficient is the volume of water an aquifer releases from groundwater storage per unit change in head per unit area (Driscoll, 1995). In an unconfined aquifer system, as may be the case in

[7] Drawdown refers to the lowering of water levels in response to pumping.

[8] Airlifting is a common method of estimating a newly drilled well's productivity. However, the procedure is performed by forcing compressed air into the well rather than by using a pump, often performed before well construction is complete. Due to many unknown variables, the discharge rate can only be estimated and may not provide an accurate reflection of aquifer characteristics.

[9] The relatively low specific capacity values for the Sonoma Volcanics suggest the empirical equation for confined conditions is more appropriate than the equation for unconfined conditions.

Green Valley for the upper part of the aquifer system, the amount of water that can be released from or added to storage per unit surface area and per unit change in hydraulic head is called the specific yield. In a confined aquifer, the water derived from storage associated with a decline in head comes from the expansion of water molecules themselves and the compression of the aquifer matrix materials.

Thomasson (1960) reported the specific yield of the Sonoma Volcanics to be approximately 0.25% based on data from well 5N/2W-30B1. This value is consistent with average values reported in the literature for consolidated or fractured rock. Thomasson (1960) indicates relatively higher values may be present in the volcanics in the northern part of the valley, but the tight character (low permeability) of underlying older rocks in the southern part may limit their utility for water supply. Based on eight wells that are completed almost exclusively within the alluvium, Thomasson reported an average specific yield of about 10%. This value is consistent with average values for similar material. However, neither Thomasson (1960) nor subsequent investigators have reported storage coefficients for an explicitly confined alluvial system within the Plan Area. This information is recommended to be developed as part of the testing program (Chapter 6).

3.3.5 Summary

Groundwater has been historically utilized for domestic and agricultural purposes in the Middle Green Valley Plan Area. Wells have typically been completed largely in the alluvium, but some wells extend into the Sonoma Volcanics. Well yields (where known) range between about 90 to 300 gpm for wells completed to depths ranging from about 130 to 205 feet deep. Wells completed outside the valley floor are typically only screened within the volcanics and generally yield less than 100 gallons per minute. The three (or more) deep wells planned to be constructed to serve the Middle Green Valley Plan Area would likely be completed at least partially in the Sonoma Volcanics. Based on information reported by Thomasson (1960), well yields for wells constructed in the Sonoma Volcanics in the northern part of the valley may differ from well yields for those in the southern part of the valley, with yields in the northern part being somewhat greater.

4.0 Groundwater Conditions

4.1 Groundwater Pumpage

This chapter discusses the historical and current groundwater pumpage, as estimated from a 1960 water supply paper from the USGS (Thomasson et al., 1960) and an analysis of more current land use.

4.1.1 Historical Pumpage

A table of estimated historical pumpage of groundwater for irrigation between 1941 and 1951 in Green Valley is shown below in **Table 4-1.**

Table 4-1 Estimated Pumpage of Groundwater for Irrigation, 1941-1951 (Thomasson et al., 1960)

Year	Green Valley Pumpage (acre-feet)	Sacramento Valley Water Year Type (from CA DWR Bulletin 120)
1941	*100*	Wet
1942	*100*	Wet
1943	*200*	Wet
1944	*200*	Dry
1945	**300**	Below Normal
1946	**500**	Below Normal
1947	**800**	Dry
1948	**900**	Below Normal
1949	**1,400**	Dry
1950	*1,300*	Below Normal
1951	*900*	Above Normal

[1] Extrapolated where italic, by Thomason (1960); based on estimated pumpage for the entire Suisun-Fairfield USGS study area, which includes Green Valley, as discussed in **Section 4.1.1**.
[2] Sacramento Valley Water Year designations, originally published in inter-annual updates to CA DWR Bulletin 120, are summarized by DWR according to the final determination for each year at **http://cdec.water.ca.gov/cgi-progs/iodir_ss/wsihist** (accessed 3/18/2013).

The development of groundwater for human use had little effect on water levels in Green Valley at the rates listed above. The wide variety in yearly pumpage is explained partly by variation in rainfall and partly by an increase in development of the resource. Water levels in Green Valley indicate that groundwater pumpage did not reduce the volume of water in storage appreciably between 1919 and 1952 (see additional discussion in section 4.2). Water levels were more influenced by climatic variability (heavy precipitation in the winters leading to replenishment where little extraction was derived from storage) (Thomasson et al., 1960). The maximum annual amount of groundwater extraction during the period between 1941 and 1951 was 1,400 acre-feet (in 1949). Over the approximately 2,400 acre USGS study area in Green Valley, this translates to an approximate maximum groundwater extraction rate of

0.58 acre-feet per year per acre. The portion of the Plan Area that is covered by the USGS Green Valley study area consists of the valley floor, and is approximately 900 acres. Applying the 0.58 acre-feet per year per acre maximum groundwater extraction rate on record, a maximum of approximately 525 acre-feet per year of groundwater may have been pumped in this historical period in the Plan Area.

Thomasson also estimated the storage capacity in Green Valley (1960). The total groundwater storage capacity was estimated for the depth range 10 to 200 feet below ground surface in the 2,400 acres that make up the USGS study area of Green Valley. The storage estimate is based on the physical character of deposits as interpreted from 16 well logs. The estimated total groundwater storage capacity in Green Valley between 10 to 200 feet below ground surface is shown below in **Table 4-2**. The alluvium in Green Valley is underlain by the Sonoma Volcanics throughout all but the southwestern part where the volcanics may be missing in places and the alluvium may rest directly on rocks of Eocene age. As such, Thomasson (1960) assumed that the northern part of the valley underlain by volcanics could be utilized, but the tight character, or more consolidated nature, of underlying older rocks in the southern part would limit their utility. Thomasson (1960) hypothesized that a lowering of water levels by 100 feet beneath 1,000 acres in the northern part of Green Valley would result in a yield of approximately 10,000 acre-feet of water, although this volume is greater than the usable storage capacity. Based on hydrographs of water levels from five wells in various parts of Green Valley, Thomasson (1960) offered an estimate of net groundwater pumping in the Green Valley of 1,000 acre-feet per year in the late 1950s, where net groundwater pumping refers to the difference between total groundwater extraction and excess irrigation that infiltrates below the crop root zone and assumed to return to the aquifer system. Thomasson (1960) further explains that the high spring groundwater levels in all of the wells with records indicate little or no depletion of storage at this rate of net groundwater pumping.

Table 4-2 Estimated Total Groundwater Storage Capacity in Green Valley (within 10 to 200 feet below ground surface) (Thomasson et al., 1960)

	Depth (feet below ground surface)	Specific Yield (%)	Storage Capacity (acre-feet)
	10-50	12	12,000
	50-100	10	12,000
	100-200	9	22,000
TOTAL	10-200	10	46,000

4.1.2 Current Pumpage

This section discusses current water requirements, water supply, and pumpage based on analysis of land use in the Plan Area and surrounding Thomasson study area (north/south) for 2003 and 2011. Current water requirements within the Plan Area are based on data from 2011 because SID surface water delivery data are available for that period and agricultural crop types and acreages from 2011 are most relevant to current practices. Total current estimated water requirements and supply are shown in **Table 4-6**.

4.1.2.1 Land Use Analysis

DWR appraises statewide water demands by performing land use surveys by county or other study area on a rotating basis. DWR's North Central Region Office surveys its counties every seven to ten years, depending upon the changes in land use for that county. DWR land use surveys of Solano County were available for 1994 and 2003 (DWR, 2000; DWR, 2011) and evaluated in the determination of crop type and crop distribution within the Plan Area. While the 1994 survey is not presented specifically here, it was considered along with the 2003 survey in order to discuss the long-term trends in land use within the Plan Area. Over the last 20 years, land use along the central and lowest part of the Plan Area (along Green Valley Creek and Green Valley Road) has been predominantly agricultural. Along the eastern and western sides of the Plan Area, at the higher elevations, land use is less developed and mostly native vegetation and open rangeland. Some isolated residential and semi-agricultural areas exist as individual ranches or in clusters along Green Valley Road.

Dense urban areas do not occur within the Plan Area, but such areas are present and have expanded outside of and along the northern and southern Plan Area boundaries. The Thomasson study area (north) contains urban land uses, primarily residential and a golf course classified as urban landscaping. There is also a minor proportion of agricultural land use in the Thomasson study area (north); typically these are small orchards or vineyards sharing a parcel with a residence not larger than 13 acres. The Thomasson study area (south) is also composed predominantly of urban land uses. The area is almost entirely within the City of Fairfield and consists of residential and commercial developments, with the latter sited along Interstates 80 and 680, which cross the Thomasson study area (south)in a generally southwest to northeast alignment.

Agricultural Land Use

The 2003 DWR land use survey reported crops grown in the Plan Area as similar to 1994 that include vineyards, irrigated pasture, grains, truck crops[10], field crops[11], and deciduous crops as shown in **Figure 4-1** and tabulated in **Table 4-3**. Agricultural land use totaled 588 acres in the Plan Area; the remaining 1,329 acres were native vegetation, rangeland, or residential. Agricultural land use in the surrounding Thomasson study area (north/south) was considerably less, totaling 79 acres. The remaining 1,781 acres were accounted for as native vegetation, rangeland, residential, or commercial land uses.

Agricultural land use in 2011 was estimated from multiple sources including: high resolution aerial photography from 2010, Landsat 5 satellite imagery (USGS EROS, accessed 2012) and calculated Normalized Vegetative Difference Index (NDVI) coverages, and the map in Figure 2.4 of the EIR – Existing Buildings and Infrastructure within the Specific Plan Area. When available, monthly satellite images were reviewed through the year for interpretation of the presence or absence of agricultural activities

[10] Truck crops refer to the "Truck, Nursery, and Berry Crops" designation applied by DWR for agricultural land uses characterized by annual vegetable and fruit crops (e.g., asparagus, melons, cabbage, etc.), also including perennial bush berries (e.g. blackberries, raspberries, etc.) and plant nurseries (DWR, 1999).

[11] Field crops refer to the "Field Crops" designation applied by DWR for agricultural land uses characterized by annual fiber and oil commodity crops (e.g., cotton, flax, castor beans, etc.), also including sugar beets and corn (field and sweet) while excluding grain, hay, and rice crops (DWR, 1999).

(USGS EROS, accessed 2012). Imagery from 2005, 2007, 2009, 2010 and 2011 was also reviewed to consider the transition over time between 2003 and 2011 (USGS EROS, accessed 2012). The mapped distribution is shown in **Figure 4-2** and tabulated in **Table 4-4**.

Table 4-3 Middle Green Valley Plan Area and Thomasson Study Area (North/South)

2003 Agricultural Land Use

Land Use	Middle Green Valley Plan Area Acres	Thomasson Study Area (North/South) Acres
Irrigated Agriculture		
Vineyard	263	6
Pasture	60	44
Orchard	8	22
Truck/Field	161	4
Subtotal	492	75
Non-irrigated Agriculture		
Grain/Cover Crop	96	0
Fallow	0	4
Subtotal	96	4
TOTAL	**588**	**79**

Table 4-4 Middle Green Valley Plan Area and Thomasson Study Area (North/South)

2011 Agricultural Land Use

Land Use	Middle Green Valley Plan Area Acres	Thomasson Study Area (North/South) Acres
Irrigated Agriculture		
Vineyard	216	8
Pasture	55	0
Orchard	8	10
Truck/Field	1	0
Subtotal	280	18
Non-irrigated Agriculture		
Grain/Cover Crop	357	0
Fallow	68	14
Subtotal	425	14
TOTAL	**705**	**32**

In 2011, the Plan Area remained predominantly agricultural in active land use; however, there has been a significant shift since 2003 from irrigated crop types to non-irrigated types. The 2011 crop types included vineyards, irrigated pasture, grains, deciduous crops, and minor truck/field crops for a total of 705 acres. The remaining 1,212 acres were native vegetation, rangeland, or residential. Since 2003, within the Plan Area, the trend in agricultural land use has been toward a small decrease in vineyard acreage, almost complete elimination of truck and field crops, and most of the (prime) farmland being planted in winter/early spring grain crops that typically do not require irrigation.

Outside of the Plan Area agricultural land uses also decreased between 2003 and 2011. In the Thomasson study area (south), 44 acres of contiguous pasture mapped in 2003 immediately south of the Plan Area were entirely converted to urban residential parcels by 2011. Elsewhere in the Thomasson study area (south) 4 acres of truck/field crops were converted to urban land use by 2011. In the Thomasson study area (north), agricultural land uses increased somewhat from 18 acres of orchards and vineyards on 14 parcels to 28 acres of orchards and vineyards on 13 parcels.

Residential and Commercial Land Use

In 2003, DWR identified 110 acres of urban (residential), semi-agricultural (farmstead), and urban industrial (winery) area within the Plan Area. Through the review of high resolution imagery captured in 2010 and the EIR (SCDRM, 2010; Figure 2.4), the extent and distribution of residential area are believed to be unchanged in the Plan Area since 2003. This area equates to approximately 55 individual dwellings/private residences (SCDRM, 2010). Most of these residences are in two clusters on the east side of Green Valley Road with the remainder situated throughout the Plan Area on larger parcels.

Residential and commercial land uses expanded in extent between 2003 and 2011 in the Thomasson study area (south) and remained relatively consistent in the Thomasson study area (north). As described above, 44 acres of pasture immediately south of the Plan Area were converted to residential parcels, averaging 0.5 acres per parcel. Other portions of southern Green Valley experienced continued development of residential and commercial parcels, typically from areas previously mapped as native vegetation or urban (vacant). Such conversions affected 184 parcels covering 62 acres. In the Thomasson study area (north), 8 acres were observed to convert from an urban designation, as mapped by DWR, to native vegetation in 2011. However, any decrease in urban land use extent is likely due to the more detailed effort of the 2011 land use mapping. The 2011 land use analysis conducted for this WSA is based on land use determinations given to individual parcels. Land use units mapped by DWR in 2003 are not limited by individual parcels. As a result, the 2003 urban land use units include areas such as roads and undeveloped parcels of varying sizes that are not distinguishable from adjacent land uses as they are in the 2011 land use analysis.

The residential acreage distribution is shown on **Figures 4-1 and 4-2**.

4.1.2.2 Solano Irrigation District Deliveries

Deliveries of surface water by SID to the Middle Green Valley area began in the mid-1960s (personal communication, Paul Fuchslin[12], June 22, 2012). Currently, SID delivers non-potable water to 18 agricultural and 11 residential (classified by SID as Municipal and Industrial (M&I)) turnouts within the Plan Area through a piped distribution system to a service area shown on **Figure 2-2**. Within the Plan Area, SID water is available to those parcels within the service area boundary as shown. Parcels receiving water from SID within the last nine years are shown **on Figure 2-2**. SID water deliveries are summarized in **Tables 4-5a and 4-5b,** which show the recent total deliveries to these agricultural, Municipal and Industrial (M&I), and landscaping customers. SID also provided landscaping water delivery data for 1998 through 2003; although not shown here those data were used to calculate the applicable water supply from SID. For the purposes of this WSA, water deliveries classified by SID as M&I or landscaping are considered to have been applied to meet existing residential, agricultural residential or commercial land use demands.

Table 4-5a Recent Solano Irrigation District Deliveries to the Middle Green Valley Plan Area

Year	Agriculture (acre-feet)	M&I (acre-feet)
2004	574	18
2005	Not Available	11
2006	451	23
2007	398	31
2008	223	21
2009	162	21
2010	154	17
2011	140	19
2012	Not Available	Not Available

Farmers in SID's service area may order water by several methods, communicating with SID's watertenders and its operations department. If agricultural demand increases to historically high levels, SID has the ability to require farmers to submit orders by use of specified forms. SID would deliver the requested amount of water barring any water shortages. In the case of shortages, SID would allocate and provide to customers the water that was available (SID, 1980). SID's surface water deliveries provided through the Solano Project have been 99% reliable between 1959 and 2007 (average of 100% reliability during normal years, 99% reliability during dry years, and 99% reliability during multiple-dry years) (Okita, 2010).[13]

[12] Paul Fuchslin, P.E., Director of Engineering, Solano Irrigation District

[13] When used in this WSA, reliability refers to the percent of full, requested water allocation delivered in a given year.

Table 4-5b Recent Water Deliveries to the Thomasson Study Area (North/South)

	Solano Irrigation District		City of Fairfield	City of Vallejo
Year	Agriculture (acre-feet)	Landscaping (acre-feet)	Residential/Commercial (acre-feet)	Residential/Commercial (acre-feet)
2004	14	544	Not Available	213[1]
2005	16-37[2]	373	Not Available	
2006	27	493	Not Available	
2007	26	523	Not Available	
2008	17	572	Not Available	
2009	37	556	Not Available	
2010	24	437	821	
2011	21-42[2]	389-460[3]	749	
2012	25-46[2]	477-548[3]	861	

[1]Data for the City of Vallejo Lakes Water System was provided as an average rate of 481 gpd/unit/year. That rate was distributed among the residential parcels within the Thomasson study area (north) to determine average annual water deliveries by the City of Vallejo.

[2] Agricultural water deliveries provided by SID for 2005, 2011, and 2012 were missing values for one parcel. The ranges shown represent the sum of known deliveries for that year to other parcels and the range of annual water deliveries for the unreported parcel between 2006 and 2010 (5.5 acre-feet to 26.6 acre-feet).

[3] SID Landscaping water delivery records for 2011 and 2012 do not include delivery totals for the GVCC. The ranges shown for those years include the known Landscaping deliveries to other parcels and the range of annual water deliveries to the GVCC from 2004 through 2010. (150 acre-feet to 221 acre-feet).

Agricultural Deliveries

Recent annual deliveries of agricultural water by SID within the Plan Area are summarized in **Table 4-5a** and shown in **Figure 2-3**. Within the Plan Area, data are not available for 2005, 2012, or for water years prior to 2004. Annual deliveries were historically higher as more land was irrigated with crop types that had higher water demands (e.g., truck crops) than crops presently grown (e.g., vineyards). All customers within the SID boundary are entitled to apply for an allotment of water deliveries prior to March 1 each year (SID, 1980). In 2008 the range of applied water rates in Solano County was between 1.24 acre-feet per year per acre and 4.50 acre-feet per year per acre (personal communication, Paul Fuchslin 9/13/12). Recent trends toward lower demands for SID agricultural water have been the result of two primary factors. There are currently fewer acres in production than historically, and there has been a gradual conversion to crops with a lower water requirement (i.e., vineyards or grains).

Of the 280 acres of irrigated crops in the Plan Area in 2011, 190 acres were within the SID service area. The predominant irrigated crops in the SID service area in 2011 were vineyards and pasture with a few acres of orchard and truck crops. Total surface water deliveries for agriculture by SID within the Plan Area were 140 acre-feet (**Table 4-5a**), with vineyard (126 acres) receiving 50 acre-feet and pasture and other irrigated crops (64 acres) receiving 90 acre-feet. Well completion reports provided by DWR for

Green Valley do not show any irrigation wells located within the SID service area portion of the Plan Area, including all irrigated lands west of Green Valley Road in the Plan Area. Furthermore, shallow depths to groundwater observed in the Plan Area (see **Section 4.2**) suggest that deep rooted, perennial crops, including grapes, may have met some of their moisture requirement through access to groundwater. The estimated average applied water rates in the SID service area, therefore, were 0.4 acre-feet per year for vineyards and 1.4 acre-feet per year for pasture and other irrigated crops (**Table 4-6**).

SID has also delivered agricultural water to nine parcels in the Thomasson study area (north), summarized in **Table 4-5b** and shown in **Figure 2-3**. These deliveries were made to parcels with small vineyards and orchards, covering fewer than 14 acres. Four of the vineyards, covering 3.4 acres, were planted between 2003 and 2011. Despite this small expansion, agricultural water deliveries to the Thomasson study area (north/south) have remained generally constant relative to the decline in deliveries seen in agricultural water deliveries to the Plan Area for the period of record. The available SID water supply for these parcels in the Thomasson study area (north) is taken to be the sum of known deliveries to eight of the parcels in 2011 and the 2006 to 2010 range of annual water deliveries for one unreported parcel.

Residential, Agricultural Residential, and Commercial Deliveries

Monthly records of deliveries to 11 residential (M&I) customers in the Plan Area were available from 2004 to 2011, and those data were summarized to present the annual deliveries in **Table 4-5a** and **Figure 2-3**. Over the eight-year period from 2004 through 2011, water deliveries ranged from a low of 11 acre-feet in 2005 to a high of 31 acre-feet in 2007, averaging 1.8 acre-feet per year per residential customer. This year-to-year fluctuation is likely related to dry-year versus wet-year demand, where a dry year (such as 2007) leads to an increase in demand for residential landscaping needs, and a wet year leads to a corresponding decrease in demand.

Prior to 1999, residential customers of SID were able to meet all their water demand by keeping a point-of-entry system that would treat the water to then-potable conditions. However, under current CDPH Title 22 water requirements this method of treatment for a public water supply is no longer permitted. The 11 current residential (M&I) customers in the Plan Area that continue to receive SID surface water into their homes also use bottled water for potable uses.

In 2011 SID delivered 19 acre-feet to 11 residences in the Plan area. This figure was rounded to 20 acre-feet for the estimate of current water requirements presented in Table 4-6. The balance of current water requirements for existing residences in the Plan Area was attributed to groundwater pumping (see **Section 4.1.2.5**).

Outside of the Plan Area, SID delivers landscaping water to 254 parcels in the Thomasson study area (north), which received 239 acre-feet of water in 2011. The majority of these parcels are mapped as urban residential land uses. These landscaping deliveries have been comparable in magnitude to the deliveries of agricultural water within the Plan Area, except that the landscaping water deliveries have shown a more consistent demand from year to year (**Table 4-5b**). The Green Valley Country Club

(GVCC), which irrigates an 18-hole golf course in the Thomasson study area (north), is the largest single recipient of SID landscaping water. The water requirement for the GVCC included in **Table 4-6** is the range of water deliveries reported by SID for the seven years between 2004 and 2010 for which data are available, 150 acre-feet per year to 221 acre-feet per year. Annual SID deliveries to the GVCC used for this WSA include only the proportion of the total annual deliveries that correspond to the proportion of the total GVCC acreage that lies within the Thomasson study area (north) boundary (103 acres of 140 total GVCC acres).

4.1.2.3 City of Fairfield Deliveries

The City of Fairfield provides potable water to urban customers in the Thomasson study area (south) and is the only public source of potable water within the city limits (personal communication, George Hicks[14] 12/26/12). Water delivery data for 2010 to 2012, supplied by the City of Fairfield, are summarized in **Table 4-5b**. The data show variations ranging from 10% to 15% over those years, with 749 acre-feet delivered in 2011. These variations appear largely attributable to changes in water year type; aerial imagery from 2010 and 2012 show no detectable changes in the extent of development over those years.

4.1.2.4 City of Vallejo Deliveries

The City of Vallejo provides potable water to the Thomasson study area (north) through the Lakes Water System. The City delivers an average of 481 gallons per day per unit in the Green Valley Area (personal communication, Eric Jansen[15] 02/04/2013). For purposes of this WSA, as shown in **Table 4-5b,** this average delivery amount was applied to all 429 parcels in the Thomasson study area (north). Thus, the total estimated water supply provided by the City of Vallejo to the Thomasson study area (north) in 2011 was 213 acre-feet.

4.1.2.5 Groundwater Use Estimates for Middle Green Valley Plan Area and Thomasson Study Area(North/South)

Total current estimated water requirements and supply are shown in **Table 4-6**. Most agricultural water requirements within the Plan Area are met by surface water delivered by SID, and the remaining balance is supplied by local groundwater pumping. Given the costs associated with groundwater pumping and well maintenance, any parcel receiving surface water deliveries is assumed to not also be using groundwater except where surface water deliveries are low enough to suggest that some additional supply is necessary, as in the Thomasson study area (north) where 100 parcels receive only surface water from the City of Vallejo.

Metered surface water has been delivered by SID to the parcels shown in **Figure 2-2** and described above. Groundwater pumping data are not available since private wells are neither metered nor indirectly measured. As a result, groundwater pumping is estimated for this WSA from land use based calculations of total water demand. In general, the method applied for this WSA involves quantifying land use, computing applied water requirements for each use, and summing total water requirements

[14] George Hicks, Director of Public Works, City of Fairfield
[15] Eric Jansen, P.E., Senior Civil Engineer, City of Vallejo

for the aggregate of various uses in the Plan Area. In areas where groundwater pumping is known or anticipated to occur, total water requirements not met by the sum of other sources is deduced to be supplied by groundwater.

Ideally, this method of estimating groundwater pumping is most accurate when several parameters are known (i.e., crop types and acreages, rate of applied water, and surface water delivery amounts). Applied water rates vary depending on the individual crop water requirement (kc), reference evapotranspiration (ETo), precipitation and irrigation methods, and also the local conditions such as soil, slope, and depth to groundwater. For 2003, when a formal land use survey was last performed by DWR and significantly more acres were under irrigated cultivation, most land use parameters are available except for surface water delivery amounts. Groundwater pumping could not be estimated for this 2003 period without the surface water component, however.

The estimate of current groundwater pumping within the Plan Area is based on data from 2011 because SID surface water delivery data are available for that period and agricultural crop types and acreages from 2011 are most relevant to current practices. For this WSA, current rates of applied water are estimated based on published estimates for the Northern San Francisco Bay region (DWR, 1975) with modifications made where data regarding available water sources and information on local practices indicate a substantial variation from published values. Estimated rates were generally lower than typical applied water rates found in other areas, but the estimated rates were considered appropriate for this analysis because they were derived from Green Valley data.

As described above, the majority of the agriculture in the Plan Area in 2011 was grain/cover crops and fallow acreage that infrared satellite imagery and SID delivery records indicate did not receive irrigation. On the east side of Green Valley Road, outside of the SID service area, 90 acres of vineyards did not receive surface water and are irrigated with groundwater from wells on individual properties. In the absence of surface water delivery data, an applied water rate for these vineyards was estimated based on a modification of the rate applicable to the SID service area. The estimated applied water rate was conservatively estimated to be higher in this portion of the Plan Area due to somewhat greater depths to groundwater in this area that would likely exceed the reach of grapevine roots. An approximation for the local applied water rate for vineyards within the Plan Area is between 0.6 and 1.1 acre-feet per year per acre, which indicates that between 50 and 100 acre-feet of groundwater were pumped in 2011 to meet that demand.

Residential demand in the Plan Area was met in 2011 deliveries of surface water to 11 parcels within the SID service area and pumping from individual domestic wells outside of the service area. Total Plan Area residential demand was estimated to be about 110 acre-feet per year[16]. In 2011, SID delivered 19 acre-feet, rounded to 20 acre-feet for **Table 4-6**, for residential use and the remaining approximately 90 acre-feet were estimated to have been met by groundwater pumping. Current water requirements in the

[16] Total residential demand is estimated to be approximately 2 acre-feet per year per parcel for indoor and outdoor uses. This estimate is conservatively developed from deliveries by SID to residential parcels in SID's service area in the Plan Area between 2004 and 2011, which averaged 1.8 acre-feet per year per residence.

Plan Area come from both agricultural and residential land uses, and it is estimated to be between 300 and 350 acre-feet per year. Part of this demand was met by deliveries from SID (160 acre-feet), and the remaining demand was met by groundwater (140 to 190 acre-feet). Total current estimated water requirements and supply are shown in **Table 4-6**.

Outside of the Plan Area, land use and documented surface water supplies indicate that groundwater in the Thomasson study area (north/south) is predominately used to meet residential demands, with some smaller portion used to irrigate small orchards and vineyards. Annual groundwater use for irrigation in the Thomasson study area (north/south) was estimated using applied water rates of 2.1 acre-feet per acre for orchards (DWR, 1975) and 0.6 acre-feet per acre to 1.1 acre-feet per acre for vineyards (the estimated applied water rates for Plan Area vineyards not receiving SID water). Total current groundwater pumpage for agricultural land uses in the Thomasson study area (north/south) is estimated to be of 10 acre-feet per year for two small orchards and two small vineyards not receiving surface water.

Groundwater pumping for residential use in the Thomasson study area (north/south) was calculated based on the same conservative demand estimate of 2 acre-feet per year per residence/residential parcel applied within the Plan Area (see **Table 4-6**). The estimated demand was applied to 100 parcels north of the Plan Area where only the City of Vallejo provides potable water at a rate of 0.5 acre-feet per year per unit. Groundwater was allocated accordingly and totaled 150 acre-feet per year for 100 residences/residential parcels. The GVCC is not included in this groundwater use calculation since recorded water deliveries provided by SID appear sufficient to meet the anticipated irrigation demand. Of the three wells on golf course property only one currently has a pump installed. That well is maintained as a "backup" supply for non-potable irrigation water (personal communication, Ray Story[17], May 23, 2012).

South of the Plan Area potable water supplied by the City of Fairfield was determined to be sufficient for all parcels receiving water from the City. However, 61 developed parcels in the vicinity of Cordelia Road have no record of water supplied by the City of Fairfield between 2010 and 2012. Groundwater is estimated to meet the complete estimated demand of 2 acre-feet per year for these parcels resulting in 122 acre-feet per year pumped from groundwater.

The portion of total current estimated water requirements supplied by groundwater within the Plan Area is 140 to 190 acre-feet per year (**Table 4-6**). This is well below the estimated maximum historical pumping rate of 525 acre-feet per year for the Plan Area, as described in **Section 4.1.1,** which was not observed to appreciably reduce the amount of groundwater in storage. Total current estimated water requirements supplied by groundwater within the Plan Area and Thomasson study area (north/south) is 420 to 470 acre-feet per year (**Table 4-6**). This too is well below the 1,400 acre-feet per year maximum pumping rate for Green Valley estimated by Thomasson (1960).

[17] Ray Story, Golf Course Superintendent, Green Valley Country Club

Table 4-6 Middle Green Valley Plan Area and Thomasson Study Area (North/South)
Current Estimated Water Requirements and Sources (acre-feet/year)[1]

Land Use	Acres[2]	Applied Water Rate (afy/acre)	Water Requirement (afy)	Water Source (acre-feet/year)			
				Surface Water		Groundwater	TOTAL
				SID	Vallejo and Fairfield		
Middle Green Valley Plan Area							
Existing Residential/Ag Residential/Commercial[3]			**110**	**20**		**90**	**110**
Irrigated Agriculture							
Vineyard within SID area	126	0.4[4]	50[5]	50[6]			50
Vineyard outside SID area	90	0.6-1.1[7]	50-100			50-100	50-100
Pasture and Other within SID area	64	1.4[8]	90[9]	90			90
Irrigated Agriculture Subtotal			**190-240**	**140**		**50-100**	**190-240**
MGV Plan Area Subtotal			**300-350**	**160**		**140-190**	**300-350**
Thomasson Study Area (North/South)							
Existing Residential/Ag Residential/Commercial (incl. Golf Course)			1,630-1,700[10]	390-460[11]	970[12]	270[13]	1,630-1,700
Irrigated Agriculture			30-50	20-40[14]		10[15]	30-50[16]
Thomasson Study Area (North/South) Subtotal			**1,660-1,750**	**410-500**	**970**	**280**	**1,660-1,750**
Combined MGV Plan Area and Thomasson Study Area (North/South)			**1,960-2,100**	**570-660**	**970**	**420-470**	**1,960-2,100**

1 Water requirement and water source values are rounded to the nearest ten acre-feet per year.

2 Figures in this column are based on land use determinations made for this WSA as described in **Section 4.1.2.1**, see also **Figure 2-2** (SID area), **Figure 4-2** (2011 land use), **Table 4-4** (2011 agricultural land use).

3 Regarding figures in this row, SID data shows that in the Plan Area SID delivered 20 acre-feet for residential use in 2011 to 11 parcels. That averages to a little less than 2 acre-feet per year per parcel, which was conservatively rounded to an estimated 2 acer-feet per year per parcel, as discussed in **Sections 4.1.2.2** and **4.1.2.5**.

4 This figure was estimated as 50 ÷ 126 = 0.4, as discussed in **Section 4.1.2.5**.

5 Figure is reported SID data for 2011, as discussed in **Section 4.1.2.2**.

6 Figure is reported SID data for 2011, as discussed in **Section 4.1.2.2**.

[7] This figure was estimated based on the estimated applied water demand for vineyards in the SID service area with allowances for differences in depth to groundwater and soil moisture or unknown local practices, as discussed in **Section 4.1.2.5**.

[8] This figure was estimated as 90 ÷ 64 = 1.4, as discussed in **Section 4.1.2.5**.

[9] Figure is reported SID data for 2011, as discussed in **Section 4.1.2.2**.

[10] Total water requirement for existing residential and commercial parcels in the Thomasson study area (north/south), includes the GVCC (See **Sections 4.1.2.2** and **4.1.2.5**)

[11] The range of annual SID deliveries to the GVCC from 2004 to 2010 (150 acre-feet to 221 acre-feet) plus SID Landscaping deliveries in the Thomasson study area (north/south) in 2011, as discussed in **Section 4.1.2.2**.

[12] The sum of 2011 deliveries from each City, 213 acre-feet and 749 acre-feet, as discussed in **Section 4.1.2.3**.

[13] The sum of groundwater pumpage required to meet water demands not accounted for by deliveries from surface water sources, as discussed in **Section 4.1.2.5**.

[14] The known deliveries by SID in 2011 for all agricultural land uses in the Thomasson study area (north/south) plus the range of known annual SID deliveries for an unreported agricultural parcel (5.5 acre-feet to 26.6 acre-feet), as discussed in **Section 4.1.2.2**.

[15] The sum of groundwater pumpage required to meet water demands not accounted for by deliveries from surface water sources, as discussed in **Section 4.1.2.5**.

[16] The sum of current estimated irrigated agriculture water requirements based on 2011 land use classifications, estimates of crop water demand, and known deliveries by SID, as discussed in **Sections 4.1.2.2 and 4.1.2.5.**

4.2 Groundwater Levels

4.2.1 Evaluation of Groundwater Levels in Green Valley

There are fourteen wells with groundwater level records spanning some period of time between 1918 and 2012 in the vicinity of the Plan Area and USGS study area. **Figure 4-4** shows the locations of wells with groundwater level data and representative hydrographs for each well. **Figure 4-4** shows the locations of a subset of wells with more current groundwater level data and representative depths to water relative to the land surface at each well. Eight wells are actually situated within the Plan Area, concentrated mainly in the center of the valley. One well, 04N03W01D001M (labeled 01D1 in **Figure 4-3**), has a significant period of record, spanning from 1918 to 2012. This well is located within the Plan Area, near the southern border. Depths to groundwater are relatively shallow in this well and vary from less than one foot below ground surface to 22 feet below ground surface (**Figure 4-4**). This translates to groundwater elevations between approximately 15 and 36 feet, msl. Groundwater levels in this well appear to be very stable throughout the period of record, with seasonal fluctuations of about ten feet between fall and spring measurements (**Figure 4-5**). Less than a half a mile north of the Plan Area, well 05N03W26F002M (labeled 26F2 in **Figure 4-3**) has a shorter period of record, spanning intermittently from 1918 to 1963, but also shows stable conditions. Depths to groundwater in this northern well are also relatively shallow, usually between 1 and 30 feet below ground surface when not affected by pumping. Pumping effects are seen to cause declines in the depth to groundwater measured in this well, where the levels decrease to between 40 and 70 feet below ground surface as seen in several measurements in the early 1900s. Water levels in well 26F2 between 1949 and 1963 show lesser pumping influences, with seasonal fluctuations closer to approximately 20 feet between fall and spring measurements. Other wells in the Plan Area have a much shorter period of record, all ending before 1953, and so are insufficient to determine long-term trends. Generally speaking, however, groundwater elevations are higher in the northern part of the valley, though depths to groundwater are relatively similar.

There are wells south of Green Valley with water level records that also show stable groundwater level conditions. These wells are located to the south of the Plan Area (labeled 12G1, 07D1, and 13G1 in **Figure 4-3**) and to the southeast of the Plan Area (labeled 06A1 and 05L7 in **Figure 4-3**) with measurements spanning from 1920 to 2012. These wells show very stable conditions, but some wells exhibit more effects from climatic variability (wet and dry year conditions affect levels more than seasonal fluctuations do).

4.2.2 Groundwater Elevation Contours

Historical groundwater elevation contours in Green Valley for April 1950 were created by Thomasson (1960) and recreated in **Figure 4-6**. They indicate that movement of groundwater was to the south and southeast following the trend of the valley, with a gradient of 60 feet per mile in the upper part of the valley but only about 30 feet per mile in the central part of the valley. In the southern part of the valley, the gradient further decreases to about 25 feet per mile. Groundwater discharge from Green Valley occurrs into the Suisun Marsh to the south or into the groundwater body of the broad valley area to the east (heading toward Fairfield). Groundwater levels are close to the ground surface and tend to follow the topography.

Figure 4-7 shows the April 1950 contours of equal groundwater elevation along with more recent groundwater level data at a few locations. As shown on this figure, current groundwater conditions are generally similar to those observed in 1950.

4.2.3 Summary

Groundwater levels have historically and recently been found to be stable and relatively shallow in and around the Plan Area. Groundwater moves from the northwest portion of the valley south and southeast out of the valley and east towards Suisun and Fairfield. Groundwater levels range in depth from 1 to 30 feet below ground surface when unaffected by pumping influences. In the Plan Area, seasonal fluctuations are expected to be about 10 to 20 feet from spring to fall.

4.3 Groundwater Quality

4.3.1 Public and Private Wells with Water Quality

Groundwater quality data are scarce in Green Valley. There is very little recent groundwater quality data for wells located in the Green Valley vicinity. **Figure 4-8** shows the locations of wells with water quality data in and around Green Valley. The 1960 USGS study (Thomasson et al., 1960) reported nine wells with water quality data from 1940 and 1949 in the Green Valley area, four of which are located in the Plan Area (**Figure 4-8**). Groundwater quality data were also made available from DWR for one well south of the Plan Area and south of the mouth of Green Valley (just south of Interstate 80) with records spanning from 1977 to 2006. Another well with publicly available data exists for Cresta Mesa Parque (DPH water system number 4800589). CDPH does not provide accurate location data for public supply wells, so the reported well location is within one mile of its real location and estimated to be approximately one quarter mile northeast of the northern boundary of the Plan Area, near Rockville Road.

Privately owned wells with water quality data requested for this WSA came from SID, the Green Valley Country Club, and private landowners. SID provided groundwater quality data for one well located less than one half a mile north of the Plan Area, with data from 1981 when the well was installed. Two wells from the Green Valley Country Club have water quality data from 1980 and 2002. These two wells are located over a half a mile north of the Plan Area. Another privately owned well (used for domestic and irrigation purposes) with groundwater quality data is located on the very northern portion of Green Valley, approximately 1.5 miles north of the Plan Area (labeled *TW4610GVRd* in **Figure 4-8**). This is a newly constructed well with water quality data from April, 2012.

To supplement the groundwater quality data from the sources described above, LSCE performed a round of sampling at two wells in the Green Valley area in June, 2012. These wells include Green Valley Country Club Well #3 and a private domestic well labeled *E1850CrvLn* in **Figure 4-8**. The private well is located along Cravea Lane near the northern border of the Plan Area.

4.3.2 Summary of Groundwater Quality Data

Groundwater quality in and around the Green Valley area is generally good, with some occurrences of elevated iron and manganese. The **Appendix** to this WSA contains all readily available groundwater quality data in the vicinity of the Plan Area; **Table 4-7** shows water quality results for selected

constituents. The four wells within the Plan Area are identified as such and listed first. Outside of Green Valley to the south, toward the Suisun Bay, the water quality degrades (higher concentrations of salinity and chloride are seen in wells 12G1 and 07D1), but within the Green Valley area, and particularly within the Plan Area, salinity and chloride are not an issue. Specifically, TDS and chloride results meet the recommended secondary maximum contaminant level (MCL) for these constituents of 500 mg/L and 250 mg/L respectively.

As shown in the **Appendix**, one groundwater quality result had an arsenic concentration of25 µg/L (i.e., above the MCL of 10 µg/L). This testing, conducted in 1981 at SID DW40 (Test Hole Depth 560 ft.), appears to be depth-sampling of a test hole (i.e., not sampling of a completed production well). As also shown for other depth samples collected at the same location, turbidity values were quite elevated. This indicates the elevated arsenic concentration in the sample collected from the test hole is likely due to the naturally occurring arsenic present in the suspended sediment and does not represent the dissolved arsenic concentration actually present in groundwater.

Near the Plan Area, recent Total Dissolved Solids (TDS) concentrations are relatively low and range from 140 to 240 mg/L. Near the Plan Area, nitrate (as nitrate) concentrations range from not detected to 14 mg/L. Historically and more recently, iron and manganese concentrations above secondary drinking water standards have been reported at several locations near the Plan Area. Groundwater developed to serve the Plan Area community water system may require treatment for these constituents, particularly iron and/or manganese. If warranted, treatment options for iron and manganese are available and reliable for use at the scale of potable water production described in the Specific Plan.

Table 4-7 Summary of Historical and Recent Groundwater Quality Data In and Around Middle Green Valley Plan Area

Map Label	Well Name	Date	Chloride mg/L	Elect. Conductivity umhos/cm	Iron mg/L	Manganese mg/L	Nitrate (as NO3) mg/L	Sulfate mg/L	Total Dissolved Solids mg/L
			250 secondary*	900 secondary	0.3 secondary	0.05 secondary	45 primary	250 secondary	500 secondary
HISTORICAL									
Wells in the Plan Area									
01D1	04N03W01D001M	8/25/1949	48	487	-	-	-	-	-
26Q1	05N03W26Q001M	8/25/1949	22	240	-	-	-	-	-
35A1	05N03W35A001M	8/25/1949	11	158	-	-	-	-	-
35H1	05N03W35H001M	8/25/1949	15	188	-	-	-	-	-
Wells Outside the Plan Area									
06A2	04N02W06A002M	8/25/1949	51	557	-	-	-	-	-
07D1	04N02W07D001M	8/25/1949	149	1030	-	-	-	-	-
23P1	05N03W23P001M	8/25/1949	17	236	-	-	-	-	-
26F1	05N03W26F001M	5/1/1940		-	-	-	-	-	-
26F1	05N03W26F001M	8/25/1949	12	161	-	-	-	-	-
26G2	05N03W26G002M	9/23/1949		50	-	-	-	-	-
12G1	04N03W12G001M	1977-2004	211-336	1590-2200	-	-	25.6-31	137-262	998-1490
Cresta	4800589-001	2000-2005	9	140	ND-0.2	ND	5-8.1	5.9	ND
DW40	SID Well DW40**	5/11/1981	4.9-26	150-290	0.43-5.2	0.03-0.23	<0.02-1.15	<2-8.3	130-360
GVCC2	Green Valley Country Club Well #2	1980-2002	9.4-14	200-220	0.08-0.29	<0.025-0.15	1.1	<0.5-18	194-420
CURRENT									
Wells in the Plan Area									
E1850CrvLn	Engell 1850 Cravea Lane	6/12/2012	9.7	160	<0.1	<0.010	14	5.6	180
Wells Outside the Plan Area									
12G1	04N03W12G001M	7/19/2006	210	2251	-	-	23.2	327	1330
Cresta	4800589-001	2/22/2006	13	160	-	-	ND-8.1	8.2	170
GVCC3	Green Valley Country Club Well #3	6/12/2012	11	210	11	0.37	<2.0	<0.50	140
TW4610GVRd	Tom West 4610 Green Valley Rd	4/25/2012	9.1	200	8.2	0.44	<2	4.2	240

*Water quality standards are listed for reference as *primary* Maximum Contaminant Level (MCL) or *secondary* MCLs.

**Depth specific sampling over 11 intervals and multi-hour pump test

Highlighted cells exceed Maximum Contaminant Level; *ND* indicates non-detectible concentrations with no detection limit reported

5.0 Projected Water Demands (2015-2035)

5.1 Water Demand Factors

Projected water demands for the Plan Area include two main components, including domestic and agricultural water requirements. Each of these also encompasses existing domestic and agricultural water utilization and planned water utilization for the Project. This chapter summarizes the projected demands for the Plan Area. The Project demands are based on information developed for the Middle Green Valley Specific Plan (2010).

5.2 Projected Water Demands for Domestic Use

The domestic water demand for the Project, summarized in the Middle Green Valley Specific Plan (2010), is shown below in **Table 5-1**. An estimated 186 acre-feet per year will be required to meet the Project water demands for the following: residential units (400 primary, 100 secondary units), chapel, meeting hall/farm stand, community recreation center, conservancy/post office, school, commodity processing, commercial nurseries, agricultural tourism retail, inn, winery production, neighborhood commercial. According to the Specific Plan (2010), the reduced residential unit demand contains conservation measures, including using SID water for domestic landscaping. Other water conservation measures mentioned in the Draft EIR might include utilizing water-conserving appliances and plumbing fixtures, minimizing landscape irrigation requirements with the use of native plants and efficient irrigation systems (e.g., drip, sensors, etc.).

Additionally, there are approximately 55 existing agricultural residences and/or rural farm units in the Plan Area (SCDRM, 2010) situated on a total of about 215 acres that have an estimated water demand of about 110 acre-feet per year based on a conservative use of 2 acre-feet per year per residence for indoor and outdoor uses. This estimate is conservatively developed from deliveries by SID to residences in SID's service area in the Plan Area between 2004 and 2011, which averaged 1.8 acre-feet per year per residence (see **Section 4.1.2**). Additional existing residential demand for approximately 44 agricultural residences is estimated to be met by groundwater from private, domestic wells.

The total projected demand, including existing residential/agricultural residential (110 acre-feet per year) plus the estimated demand for the Project (186 acre-feet per year), is about 296 acre-feet per year.

Table 5-1 Total Water Demand Forecast for Middle Green Valley Plan Area

	Units	Unit Demand Acre-feet	Total Demand Acre-feet
Residential (units)	400	0.34	136.0
Secondary Res. (units)	100	0.17	17.0
Chapel (seats)	200	0.09	17.2
Meeting Hall/Farm Stand (acres)	0.069	1.73	0.12
Community Rec Center (acres)	0.184	1.50	0.28
Conservancy/Post Office (acres)	0.057	1.50	0.09
School (students) [18]	300	0.02	4.95
Commodity Processing, Commercial Nurseries (acres)	1.148	1.00	1.15
Ag. Tourism Retail (acres)	0.230	1.73	0.40
Inn (rooms)	25	0.15	3.75
Winery Production (cases of wine)	100,000	0.00004	4.42
Neighborhood Commercial (acres)	0.230	1.73	0.40
Total Annual Water Requirements			**185.7**

Source: Middle Green Valley Draft Final Specific Plan, 2010 Table 4-3 and SCDRM, 2010 Table 16.1

5.3 Projected Water Demands for Other Uses

Existing and planned non potable water demands include landscaping irrigation on Plan Area acreages such as the rural residential units and other small acreages associated with Plan Area community services, existing agricultural land use (e.g., vineyards, pasture, and other crops), and other planned agricultural land use in the Plan Area which falls under the remaining acreage in the category of "Agricultural Preserve" as shown in Table 2.1 from the Final EIR (SCDRM, 2010). Plan Area landscaping or irrigation water demands would be met by use of 54 acre-feet per year of recycled water targeted to resupply the Project. The existing agricultural water demand, for about 280 acres as discussed in Chapter 4[19], ranges from about 190 to 240 acre-feet per year. This demand is met partly by SID deliveries and partly by private supply wells. The Specific Plan (2010) establishes agricultural goals and policies, which include the preservation and protection of agricultural lands. Conservatively, the additional agricultural demand that may occur within the Plan Area on Agricultural Preserve lands is about 320 acre-feet per year. This demand amount assumes that all remaining Agricultural Preserve lands not currently in active agriculture, 160 acres (i.e., Agriculture Preserve lands that are not currently actively used for agriculture; see also **Table 5.2**), will require an average applied water rate of 2 acre-feet per year per acre. Two acre-feet per year per acre is a conservative estimate of agricultural demand

[18] An earlier draft of the Specific Plan described the school as being for up to 300 students. The Plan was then changed to reflect a maximum of 100 students. (Middle Green Valley Draft Final Specific Plan (2010), Table 3-4, and pp. 3-12, 3-61.) The estimate of water demand has continued to use the 300-student figure. (Middle Green Valley Draft Final Specific Plan (2010) Table 4-3).

[19] 440 acres in the Plan Area are planned to be Agriculture Preserve (SCDRM, 2010 Table 2.1). In 2011, 280 acres of these agricultural lands were active, so the number of remaining acres not currently active within the Agriculture Preserve is 160.

based on the applied surface water rates used to estimate current water requirements in Chapter 4 combined as a weighted average based on the more irrigation-intensive crop assemblage documented by DWR in the 2003 land use survey (**Table 4-3**).

5.4 Summary of Projected Water Demands

Total projected water demands for the existing domestic and agricultural uses and the planned Project at full build-out are shown in **Table 5-2**. These demands can also be considered as projected future demands as no further development is expected or planned within the Plan Area aside from the Middle Green Valley Project. The total projected demand ranges from 860 to 910 acre-feet per year. Separated into existing and future demands, this translates into 300 to 350 acre-feet per year of existing water demand and a conservative projection of 560 acre-feet per year in additional future water demand[20]. This demand would be met by a combination of groundwater supplies to serve the domestic needs of the planned development in the Middle Green Valley Plan Area, recycled water (54 acre-feet per year) that would meet some of the non-potable irrigation demands for landscaping in the Plan Area, and also SID water (about 634 to 680 acre-feet per year) that would be provided for irrigation on lands in the Plan Area that are also within the SID service area.

Project domestic water demands of 186 acre-feet per year will be met by groundwater. Groundwater is planned to be supplied by at least three deep wells. Historical groundwater conditions for 1950 were compared to recent groundwater levels where available in the vicinity of the Project, and current groundwater conditions are found to be comparable to historical conditions. Little variation in water source availability is anticipated between normal to dry years. Groundwater levels have remained stable throughout dry periods where records are available. For example, groundwater levels seen in well 01D1 (**Figure 4-3**) located in the southeast Plan Area, showed less than five feet of drawdown with full recovery as a result of the multiple-dry periods between 1987 to 1992.

SID deliveries count for the majority of the projected demand, as they currently provide a portion of private residential non-potable water and agricultural water in the Plan Area. The Specific Plan (2010) outlines agricultural goals and policies, which include the preservation and protection of agricultural lands. For a conservative estimate of future agricultural water demand, if all 160 acres of Agricultural Preserve went into production and used approximately 2 acre-feet per year per acre[21], the projected agricultural demand on those lands would be 320 acre-feet per year, all provided by surface water deliveries from SID. It should also be noted that SID water deliveries to the Green Valley area have been unaffected by dry periods.

[20] This estimate of future water demand is conservative, in that it assumes that all Agriculture Preserve land will be actively irrigated.

[21] This number is higher than the applied water crop demand seen in 2011 (ranged from 0.4-1.4 acre-feet per year per acre from Table 4-6) due to the possibility that future agriculture may include higher demand type crops, as seen in 2003, i.e. truck crops.

Table 5-2 Summary of Projected Water Demands for Middle Green Valley Plan Area

DEMAND	Acres	Existing Acre-feet	Future Acre-feet
Existing Residential/Ag Residential (includes 10 Agriculture-Residential and the 25-50 Rural Farm units)	215	110	
MGV Plan Domestic	(refer to Tables 5-1 and 5-2)		186
MGV Plan Landscaping (non-potable; application of recycled water)	(a)		54
Agriculture (Current; see Table 4-6)	280	190-240	
Agriculture (Agricultural Preserve remaining lands not currently active agriculture)	160		320
Subtotals:		***300-350***	***560***
Total Projected Demand		**860-910**	

a) For example, recycled water application on rural residential housing for landscaping purposes

6.0 Groundwater Supply Sufficiency

SB 610 requires that the WSA report findings relative to water supply sufficiency to meet projected water demands, in addition to existing and planned future uses, under the normal, single-dry, and multiple-dry year planning scenarios. Sufficiency is addressed in this chapter by comparing the projected water demands outlined in Chapter 5 with the available supply based on the data and analyses described in earlier chapters and summarized below.

6.1 Summary of Water Supply Availability to 2035 (Normal, Dry, and Multiple-Dry Years)

As described in earlier chapters, agricultural water is sufficient within the SID service area, with 2 acre-feet per year per acre contracts available if needed. This is more than enough to supply the agricultural demand within the SID service area. An agricultural demand of about 525 acre-feet per year in the Plan Area was historically met by groundwater with no adverse effects[22], i.e., groundwater levels remained stable and showed spring to fall recovery. Historical groundwater conditions for 1950 were compared to recent groundwater levels where available in the vicinity of the Project, and current groundwater conditions are found to be comparable to historical conditions.

Project domestic water demands of 186 acre-feet per year will be met by groundwater. Groundwater is planned to be supplied by at least three deep wells. Other non-potable demands, including those associated with existing and planned agriculture, would be met by recycled water (54 acre-feet per year) and SID water (about 634 to 680 acre-feet per year).

Little variation in water source availability is anticipated between normal, single-dry, and multiple-dry years (**Table 6-1**). Groundwater levels appear to have remained stable throughout dry periods where records are available. SID's water deliveries to the Green Valley area have been unaffected by dry periods.

6.2 Summary of Supply Sufficiency to 2035 (Normal, Dry, and Multiple-Dry Years)

For purposes of this analysis it is assumed that the Project will achieve full build out conditions within the first 5 years, so there is no change in water demand between the years 2015, 2020, 2025, 2030, and 2035 (**Table 6-2**). The nature of the Project is such that the water demand is unaffected by climatic

[22] Over the approximately 2,400 acres that the USGS study (Thomasson et al., 1960) area of Green Valley covered, the maximum annual amount of groundwater extraction during the period between 1941 and 1951 was 1,400 acre-feet (in 1949). This translates to an approximate maximum groundwater extraction rate of 0.58 acre-feet per year per acre. The portion of the Plan Area that is covered by the USGS Green Valley study area consists of the valley floor, and is approximately 900 acres. Applying the 0.58 acre-feet per year per acre maximum groundwater extraction rate on record, a maximum of approximately 525 acre-feet per year of groundwater may have been pumped in this historical period in the Plan Area. For the purposes of this WSA, it is assumed that 525 acre-feet per year of groundwater would be available to the Plan Area without depleting the groundwater aquifer.

variability. This means that there is no difference in water demand for the Project, between a normal water year, a single-dry year, or multiple-dry year types. The water supply does not change on a yearly basis, so there is no difference between the water supply in the years 2015, 2020, 2025, 2030, and 2035. Historical records indicate that the availability of groundwater is unaffected by water year type (climatic variability causes some changes in groundwater levels, but those changes are not so sizable that they would render water unavailable or prevent the use of the 525 acre-feet per year allotment estimated to be available to the Plan Area), and so would remain the same for normal water years, single-dry years, and multiple-dry years. Available SID delivery records specific to the Green Valley area indicate that deliveries appear to have been unaffected by dry periods and are indicative of varying crop patterns. Historical records of Solano Project surface water deliveries to purveyors including SID indicate an overall average reliability of 99%, since deliveries began in 1959, through 2007 (average of 100% reliability during normal years, 99% reliability during dry years, and 99% reliability during multiple dry years) (Okita, 2010; SID, 2006). Therefore, the SID deliveries portion of water supply to the Plan Area is not expected to change between normal, single-dry, and multiple-dry water year types.

Table 6-3 shows the comparison of the projected future supplies and Project demand for the Middle Green Valley Specific Plan Area for build out conditions through 2035. The "Projected Demand" is based on **Table 5-2**, and the "Projected Surplus" (Supply Less Demand) is the difference between the estimated total of all water sources (onsite groundwater development, recycled water, and the three water purveyors) and the demand. The estimated surplus shown in **Table 6-3,** for both surface water and groundwater, ranges from about 669 to 719 acre-feet per year within the Plan Area and 875 to 965 acre-feet per year in the Thomasson study area (north/south) adjacent to the Plan Area. **Figure 6-1** summarizes the projected demands and supplies through 2035.

Table 6-1 Comparison of Future Groundwater Supply Sufficiency for the Middle Green Valley Plan Area

	Groundwater Demand and Supply (acre-feet)				
	Normal	Single-Dry	Multiple-Dry Year		
			1	2	3
Projected Groundwater Demand	326-376	326-376	326-376	326-376	326-376
Projected Groundwater Supply[1]	525+	525+	525+	525+	525+
Projected Surplus	**149-199+**	**149-199+**	**149-199+**	**149-199+**	**149-199+**

[1] Groundwater supply based on estimated historical pumping amounts with no recorded adverse effects, discussed in **Section 4.1.1.**

Table 6-2 Comparison of Future Groundwater Demand and Supply for the Middle Green Valley Plan Area

	Groundwater Demand and Supply (acre-feet)				
	2015	2020	2025	2030	2035
Projected Groundwater Demand[1]	326-376	326-376	326-376	326-376	326-376
Projected Groundwater Supply[2]	525+	525+	525+	525+	525+
Projected Surplus	**149-199+**	**149-199+**	**149-199+**	**149-199+**	**149-199+**

[1] Assumes full Project build out by 2015

[2] Groundwater supply based on estimated historical pumping amounts with no recorded adverse effects, discussed in **Section 4.1.1.**

If, despite the 99% overall average supply reliability of Solano Project deliveries to SID over its first 49 years of operation, a prolonged drought were to force the curtailment of Solano Project surface water deliveries by SID to the Plan Area and Thomasson study area (north/south), groundwater resources in the Plan Area and Thomasson study area (north/south) would be sufficient to replace 76% of the SID deliveries from Lake Berryessa. Under this scenario anticipated demand for SID deliveries is expected to be 980 acre-feet per year while the anticipated available groundwater supply is at least 744 acre-feet per year.

Anticipated demand for SID deliveries is expected to be 980 acre-feet per year when accounting for full Middle Green Valley Plan implementation, including Specific Plan Option B (i.e., the estimated Project potable demand of 186 acre-feet per year are entirely met by groundwater). This estimate accounts for continued current demands for SID deliveries in the Thomasson study area (north/south) and Plan Area (660 afy, see **Table 4-6**) as well as projected expansion of SID deliveries to meet the entire anticipated demand of expanded irrigated Agricultural Preserve acreage in the Plan Area (160 acres receiving 320 afy, see **Table 6-3**). The anticipated groundwater supply available to meet unmet demands following a curtailment by SID is at least 744 afy. This estimate is based on the maximum rate of pumpage within Green Valley, derived from Thomasson (1960) (**Table 4-1**) and observed to occur without reducing groundwater levels beyond the ability of the aquifer system to recover in subsequent years (**Chapter 4.1.1**). The estimate of future available groundwater supply also accounts for existing groundwater demands within the Plan Area and Thomasson study area (north/south) (470 afy, see **Table 4-6**) as well as future demands for potable water to be developed as described in the Specific Plan under water supply Option B (186 acre-feet per year, see **Table 6-3**).

Furthermore, appropriate aquifer evaluation and system design would allow the proposed potable supply wells and associated water storage facilities to operate with sufficient flexibility to provide continuous service to the Project should drought or other unforeseen conditions force the curtailment of SID surface water deliveries to the Plan Area and Thomasson study area (north/south).

Table 6-3 Summary of Annual Middle Green Valley Plan Area and Thomasson Study Area (North/South) Projected Water Supplies, Water Demands, and Overall Supply Sufficiency through 2035 for Normal, Single-Dry, and Multiple-Dry Years

AVAILABLE WATER SUPPLIES	Middle Green Valley Plan Area		Thomasson Study Area (North/South)		Totals
	Surface Water (acre-feet)	Groundwater (acre-feet)	Surface Water (acre-feet)	Groundwater (acre-feet)	All Sources (acre-feet)
Groundwater[1]	NA[2]	525+	NA	875+	1,400+
Solano Irrigation District[3]	1,000+	0	680+	0	1,680+
City of Vallejo[4]	0	0	210+	0	210+
City of Fairfield[5]	0	0	860+	0	860+
Project Recycled Water[6]	NA	NA	NA	NA	NA
Total Projected Supply	**1,000+**	**525+**	**1,750+**	**875+**	**4,150+**
PROJECTED WATER DEMAND	**Middle Green Valley Plan Area**		**Thomasson Study Area (North/South)**		**Totals**
	Surface Water (acre-feet)	Groundwater (acre-feet)	Surface Water (acre-feet)	Groundwater (acre-feet)	All Sources (acre-feet)
Existing Residential/Ag Residential/Commercial	20[7]	90[7]	1,360-1,430[12]	270[12]	1,740-1,810
MGV Plan Domestic (potable)	0	186[8]	NA	NA	186
MGV Plan Landscaping (non-potable)[9]	NA	NA	NA	NA	NA
Agriculture (current)	140[10]	50-100[10]	20-40[13]	10[14]	220-290
Agriculture (expanded)	320[11]	0	0	0	320
Total Estimated Demand	**480**	**326-376**	**1,380-1,470**	**280**	**2,466-2,606**
Projected Surplus	**520+**	**149-199+**	**280-370+**	**595+**	**1,544-1,684+**

[1] Groundwater supply based on estimated historical pumping amounts with no recorded adverse effects, discussed in **Section 4.1.1.**

[2] Not Applicable

[3] SID deliveries are based on current, historic, and potential amounts within the SID service area, further discussed in **Section 4.1.2.2**

[4] City of Vallejo deliveries are based on reported deliveries, as further discussed in **Section 4.1.2.4**.

[5] City of Fairfield deliveries are based on reported deliveries, as further discussed in **Section 4.1.2.3**.

[6] Recycled water is planned to be used for domestic landscape irrigation, further discussed in **Section 5.3**.

[7] Estimated based on 55 existing residences and a use of 2 afy per parcel, further discussed in **Section 4.1.2**.

[8] Planned domestic demand, as discussed in **Section 5.2**.
[9] Recycled water is planned to be used for domestic landscape irrigation, further discussed in **Sections 2.4.3 and 5.3**.
[10] Current agricultural demand is estimated for the year 2011 based on analysis of land use in **Section 4.1.2**.
[11] Expanded agricultural demand represents land not currently in active production (160 acres) and a representative conservative crop use of 2 afy per acre, further discussed in **Section 5.2**.
[12] Estimated based on known current surface water deliveries and calculated groundwater pumpage in the Thomasson study area (north/south) discussed in **Sections 4.1.2**.
[13] As discussed in **Section 4.1.2.5** and accompanying **Table 4-6**.
[14] As discussed in **Section 4.1.2.5** and accompanying **Table 4-6**.

6.3 Capital Outlay Program, Permits, Regulatory Requirements, and Approvals

Middle Green Valley Draft Final Specific Plan Section 4.6, Financing Plan, describes the proposed financing mechanism that would be used by the CSA to fund the common roadway, water, sewer, storm drainage, recycled water, and other infrastructure and facilities required to serve the plan area. The section describes possible CSA establishment of a Community Facility District (CFD) which pursuant to California Assembly Bill 1600 would issue bonds with an associated special assessment charged on a fair share basis to new Plan Area residential, community services, agricultural tourism, and neighborhood commercial uses benefiting from the CFD-funded infrastructure.

The common infrastructure and facilities would be constructed incrementally as needed to serve Plan Area development. It is understood for purposes of this WSA that all facilities would be constructed within the initial 5 years of project development (i.e., full build out would occur within 5 years) (personal communication, Solano County Planning staff).

Implementation of the Middle Green Valley Specific Plan would first require Solano County Board of Supervisors certification of the Final EIR on the Specific Plan, along with (SCDRM, 2010):

- Approval of the proposed Specific Plan;
- Rezoning of the Plan Area for consistency with the Specific Plan;
- Approval of a Master Development Agreement between the County and property owners within the Plan Area. The Master Development Agreement would specify property owner obligations imposed by the County as conditions of development and would provide the property owners with certain vested development rights; and
- Board of Supervisors or landowner petition initiation of CSA formation, and ultimate CSA approval by the Board.

Subsequently, as a condition of approval for any subdivision within the Plan Area and before recordation of the first final subdivision map, the County would require approval of a Sewer Master Plan and a Drainage Master Plan. The County will also require a monitoring and reporting program to establish more detailed baseline groundwater conditions prior to development in order to ensure that the Project has no adverse effects on existing private wells. The County will also require a Water Master Plan to

demonstrate that wells, pumping, storage, and distribution components meet County and State requirements.

Implementation of Specific Plan-proposed groundwater development (Middle Green Valley Draft Specific Plan, 2010; Option B) would require regulatory oversight and issuance of a Drinking Water Program (DWP) permit from the California Department of Public Health, Division of Drinking Water and Environmental Management, and a groundwater well permit from Solano County.

The proposed establishment of a Plan Area CSA to fund and operate all Specific Plan-proposed water and wastewater system options would require Solano County LAFCO approval.

6.4 Recommendations

After investigating the sufficiency of groundwater supply in the Plan Area, listed below are recommendations for initially developing the resource for domestic supply. These recommendations are mostly associated with gaining site-specific aquifer data by initiating a test hole and test well drilling program to aid in siting the supply wells in the optimum locations at target depth intervals and analyzing potential impacts:

1) Placement of public supply wells should be in the main valley floor and not in the adjacent hills in order to utilize the deeper aquifer unit and avoid increased depths to water.
2) Spacing of wells should accommodate any potential well interference either with each other (other Plan Area wells) or nearby private wells (agricultural or domestic).
3) Monitoring wells are recommended to be completed at a minimum in the shallow alluvial aquifer as well as below in the Sonoma Volcanics and also paired with the public supply wells.
4) A review of existing well completion reports nearest the test well sites should occur to confirm the aquifer unit already in use and help identify the deeper aquifer materials to be developed for public supply in order to minimize the potential for drawdown effects on nearby wells.
5) Analyses to be performed should include aquifer testing and monitoring that would confirm drawdown at a level that is of no concern in nearby wells or surface water features.

Due to the limited availability of site-specific information regarding aquifer parameters and well capacities, a test hole and test well drilling program is recommended to aid in the siting and design of wells for the community water supply system. The siting, or location, of the test wells will ensure that adverse effects due to mutual well interference do not occur on existing private wells. Construction of Project potable supply wells in deeper aquifer materials (below existing wells) is suggested such that they are protective of shallow-completed private domestic wells and therefore also of any surface water bodies nearby. Aquifer testing and analysis is also recommended to gain site-specific knowledge of the subsurface and should be performed to confirm that drawdown associated with the Project will not affect nearby wells.

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