Appendix G:

Wastewater Facilities Review for Cordoba Center Project

Wastewater Facilities Review

For

Cordoba Center Project

Santa Clara County, California

Prepared For
Ascent Environmental, Inc.
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Sacramento, CA 95814

Project #1700037

Prepared By

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November 2017

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INTRODUCTION

This report presents a review of plans for onsite wastewater treatment and disposal facilities for the proposed Cordoba Center project in Santa Clara County. The proposed project would be located on an approximately 15.8-acre site fronting Monterey Road between the City of Morgan Hill and community of San Martin (**Figure 1**). This review has been prepared under a sub-contracting agreement with Ascent Environmental, Inc., to provide technical analysis and recommendations for consideration in the environmental impact review of the project. The specific focus of the review was evaluation of the feasibility of proposed wastewater facilities in terms of applicable standards of practice, regulatory compliance, and potential impacts to public health and water quality.

The Cordoba Center project is proposed to provide an Islamic worship and cultural center for Muslim residents in the southern portion of the Santa Clara Valley. Proposed project facilities would include a mosque, multi-use community building, cemetery, an area for youth summer camps, caretaker's residence and additional supporting and ancillary structures.

The property abuts a regional sewer line owned and operated by the South County Regional Wastewater Authority that serves the cities of Gilroy and Morgan Hill. However, sewer service is not available to the property, since the site does not lie within the Sphere of Influence of either of the two cities. Therefore, development of the site will require self-contained onsite wastewater treatment and disposal facilities. Permitting of the wastewater facilities will be through Santa Clara County Department of Environmental Health (DEH).

Wastewater facilities for the project are presented in plans prepared by Steven R. Hartsell, R.E.H.S. (Pacifica, California), dated November 30, 2015. Briefly, the wastewater facilities proposed for the project include two systems:

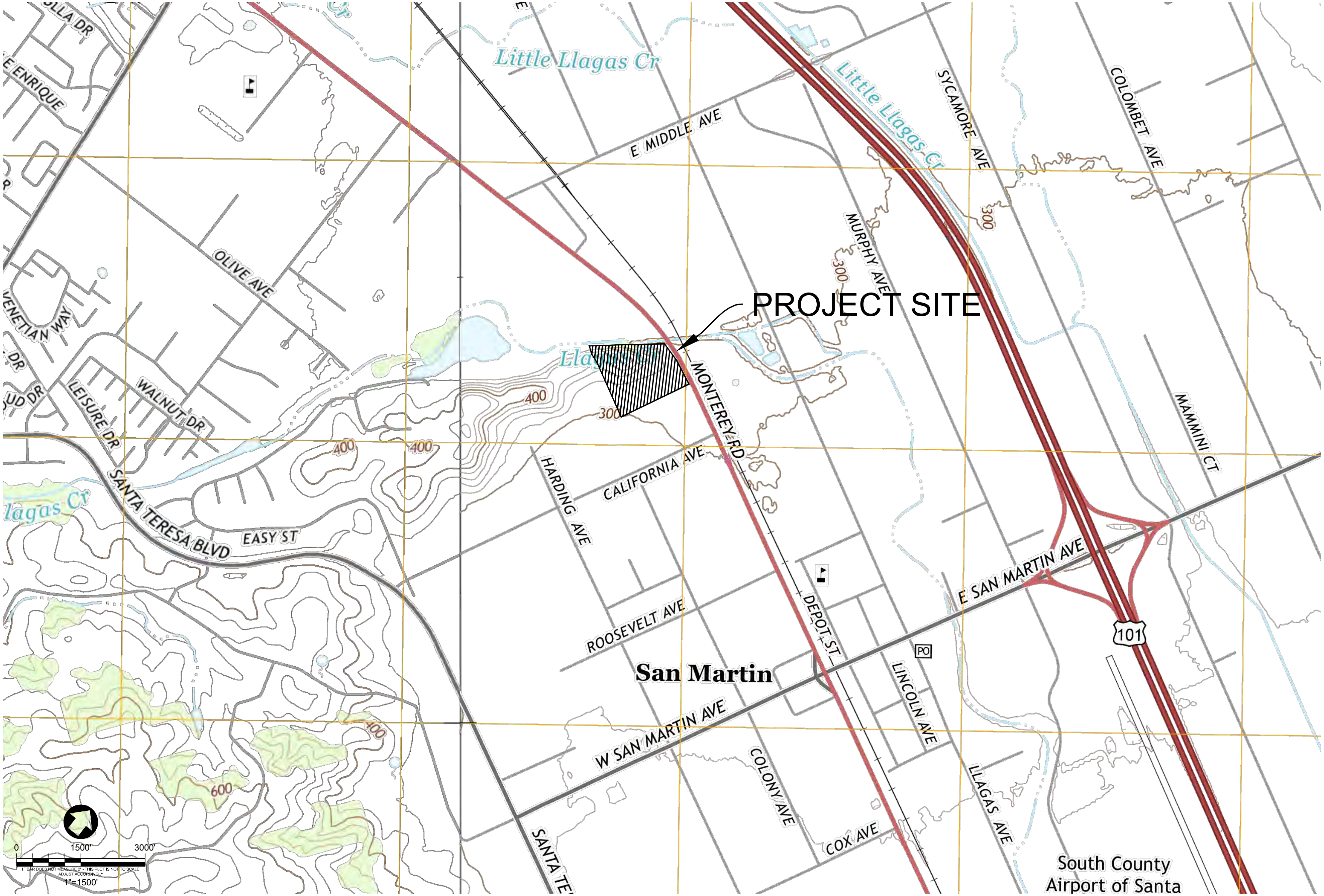
(1) 450 gallons per day (gpd) system for the caretaker's residence; and
(2) 6,000 gpd system for all other wastewater flows from project buildings and activities.

Both systems would utilize septic tanks followed by supplemental/secondary treatment units (Multi-Flo"), followed by disposal to separate subsurface drip dispersal fields located near the center of the property, on the hillside immediately north and upslope of the community building and sports-courts/playground area (**Figure 2**).

Work performed for this review included:

- **Site Inspection.** Site inspection, test borings and observation of soils and groundwater conditions on April 25, 2017.

- **Background Information and Data**. Compilation and review of relevant background information and supporting data regarding soil, geology, groundwater, hydrology, water quality and land and water use activities encompassing the project site and vicinity. This included information from DEH, Santa Clara Valley Water District and Central Coast RWQCB, as well as investigations of the project site and vicinity by various consultants.



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PROJECT SITE
CORDOBA CENTER

SAN MARTIN, CALIFORNIA

FIGURE

1

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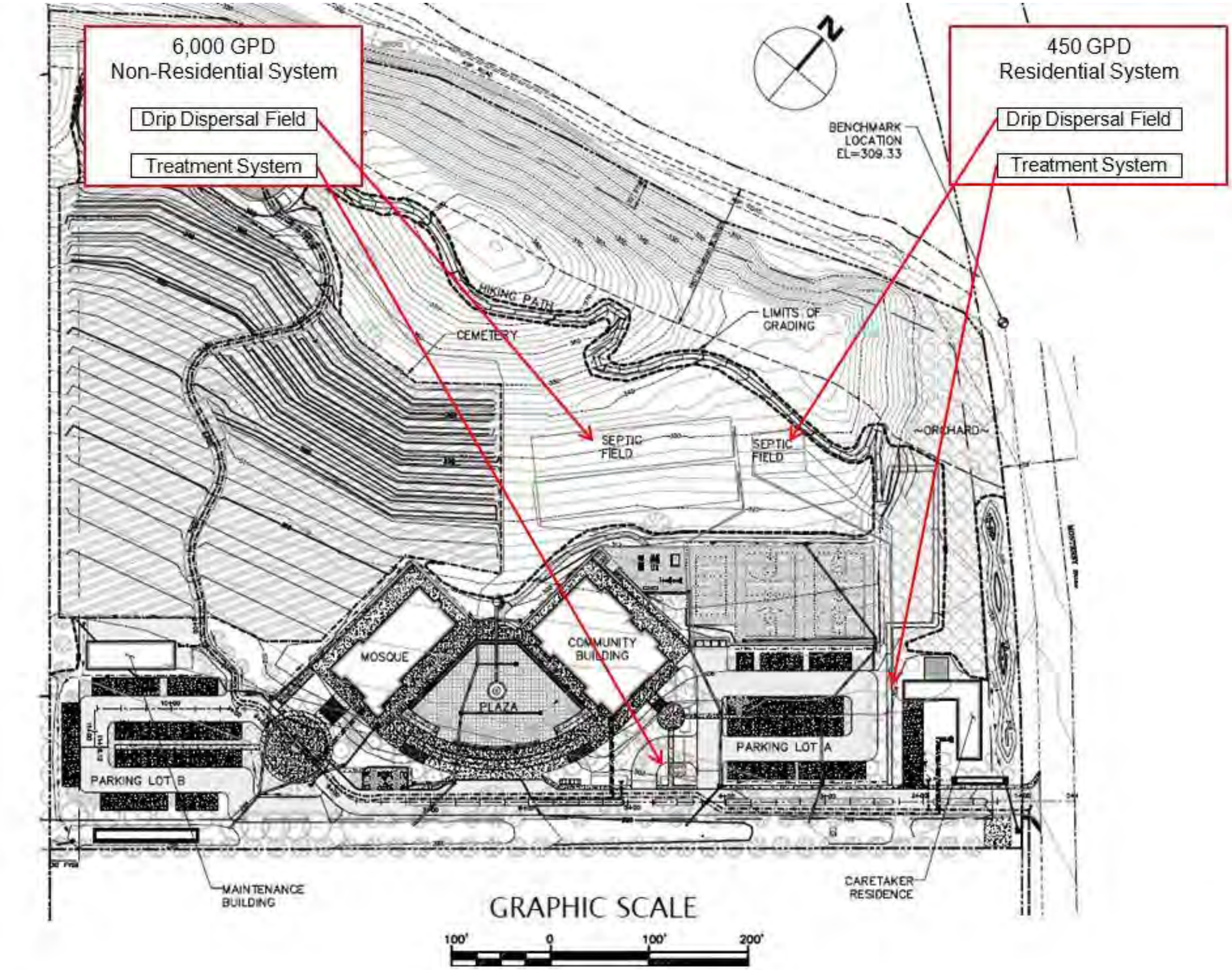

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PROPOSED WASTEWATER FACILITIES

FIGURE 2

- **Wastewater System Plans.** Review and evaluation of the feasibility and regulatory compliance of proposed wastewater system plans, including plan layout and detail drawings, material/equipment specifications, and supporting design analysis and calculations.

- **Cumulative Impact Analysis.** Analysis of cumulative impacts of the proposed wastewater facilities per DEH requirements and guidelines, relative to potential groundwater mounding (water table) effects, and long-term nitrate and salt loading effects on water quality.

PROJECT SITE CONDITIONS

Geography and Land Uses

The project site encompasses a rural undeveloped property of approximately 15.8 acres. The site ranges from elevation 300 feet above mean sea level (amsl) on the southern side, up to 386 feet amsl at peak of the ridgeline on the northern side. The project site is predominantly grassland that has been used in the past for agricultural purposes, including orchard and other crops. The site is bordered on the east by Monterey Road, on the north by Llagas Creek and associated open space, and on the south and west by rural residential properties.

The project area is semi-arid, characterized by mild winters and hot, dry summers. The average rainfall is approximately 21 inches per year, with the majority of rainfall occurring from November through April. Average monthly precipitation and evapotranspiration totals for the San Martin area are given in **Table 1.**

Table 1.
Average Precipitation and Evapotranspiration for Project Area

Month	Average Precipitation[1] (inches)	Reference Evapotranspiration[2] (inches)
Jan	4.47	1.24
Feb	3.84	1.68
Mar	3.32	3.41
Apr	1.43	4.80
May	0.37	6.20
Jun	0.12	6.90
Jul	0.05	7.44
Aug	0.06	6.51
Sep	0.37	5.10
Oct	0.84	3.41
Nov	2.48	1.80
Dec	3.50	0.93
Total	**20.85**	**49.42**

[1]Santa Clara Valley Water District, precipitation data for Coyote Reservoir
[2] Zone 8, Inland SF Bay Area, DWR/CIMIS, 1999

Geology

The project site is located within hillside terrain along the northeast flank of the Santa Cruz Mountain Range. The northern portion of the property is characterized by an east-west trending bedrock ridge, which slopes steeply down to Llagas Creek on the north side. The south side of the ridge, where project development is proposed, consists of a gently-inclined hillslope and level alluvial terrain.

The bedrock ridge is underlain by Franciscan Greenstone, with colluvium on the southerly flanks, and Older Alluvium on the level alluvial terrace forming the eastern and southern sides of the property (Connelly, 2007). **Figure 3** provides a site geology map and location of geotechnical exploratory test pits and boreholes provided by Milstone Geotechnical (2017).

Surface Waters and Drainage

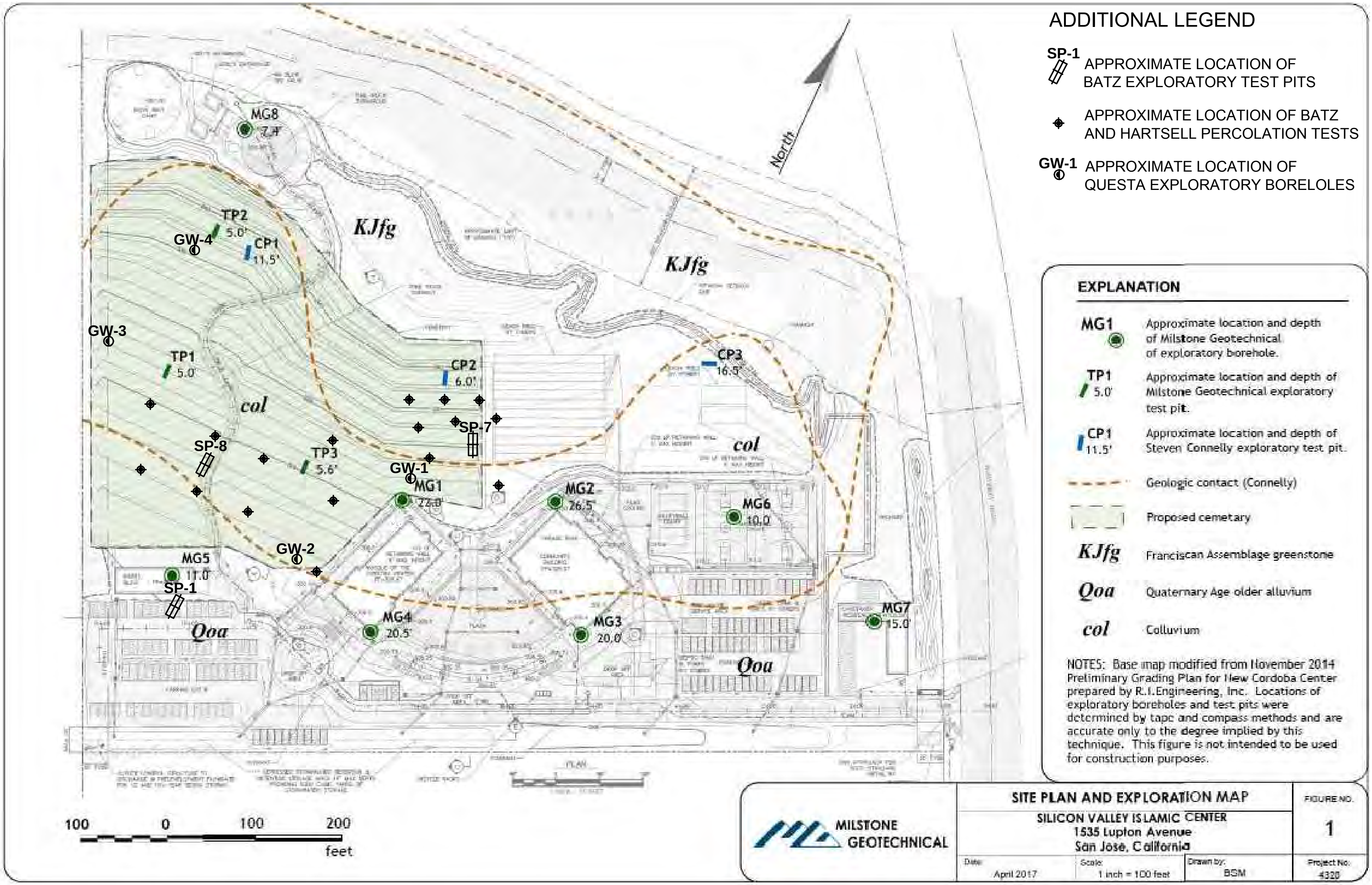
The project site lies within the watershed of Llagas Creek, which borders the northern side of the property. There are no streams or other watercourses on the property. Rainfall not absorbed into the soils flows generally as sheet-flow to the south-southwest, away from the northern property boundary and Llagas Creek. Although Llagas Creek is located on the parcel immediately north of the site, due to the presence of the bedrock ridge and topography, the site is not located in a flood hazard zone.

Groundwater

The project site lies on the western edge of the Llagas Subbasin of the Gilroy-Hollister Valley Groundwater Basin (**Figure 4**). Ground water in this Subbasin occurs generally under unconfined conditions, with some zones of confinement. For characterization and reporting purpose, the SCVWD divides the Subbasin vertically into "Shallow" and "Principal" aquifers. The Shallow Aquifer includes all basin fill materials to a depth of 150 feet below ground surface and the Deep Aquifer consists of all materials at greater depth to the base of the aquifer[1]. Groundwater flow is generally from north to south in the project vicinity. The groundwater is used extensively for domestic, agricultural and industrial water uses, providing 95% of the water supply for the cities of Gilroy and Morgan Hill, unincorporated community of San Martin and other rural residential and uses in the area.

Groundwater on the project site occurs in the older alluvium and in fractured bedrock in some areas. There is an existing (inactive) well in the southeast corner of the project site completed in the older alluvium that is planned to be refurbished and put into use to irrigate project site landscaping. In a 2007 groundwater assessment using monitoring well data from the vicinity, depth to groundwater was estimated to range from 17 to 25 feet below ground surface (bgs) in areas under consideration for septic systems (Geoconsultants, Inc. 2007). Actual measured depths to groundwater within the project site obtained during various exploratory testing are listed in **Table 2.**

[1] SCVWD, 2014.



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Drawn: MF			
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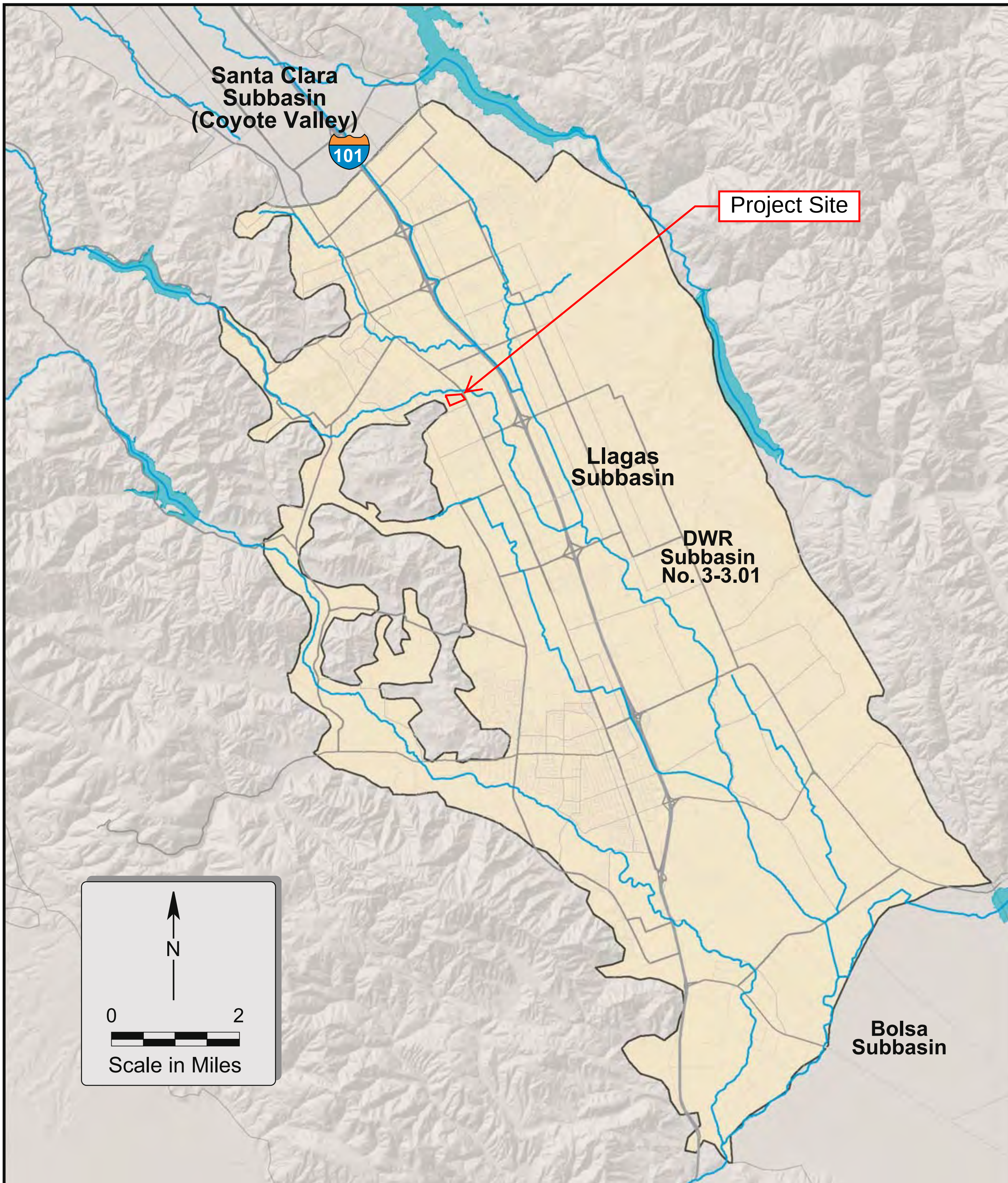

LEGEND

(swatch)	DWR-Designated Llagas Subbasin
DWR	California Department of Water Resources

July 2017	Figure 4 Llagas Groundwater Subbasin
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Source: Final Salt and Nutrient Management Plan (SCVWD, 2014)

Table 2.
Depth to Groundwater Measurements within Project Site
(feet, below ground surface)

Date	Location and Approximate Surface Elevation	Proposed Project Facilities	Source	Depth to Groundwater (feet, bgs)
6/15/2006	Southwest, elev. 298'	Maintenance Bldg	Batz, test pit SP-1	15.5'
6/15/2006	Center, elev.304'	Community Plaza	Batz, test pit SP-2	15.0'
4/25/2017	Southeast, elev.304'	Existing Well	Questa, water well reading	23.2'
4/25/2017	Center, elev. 316'	Cemetery	Questa, test borehole GW-1	24.7'
4/25/2017	West, elev.302'	Cemetery	Questa, test borehole GW-2	25.8'
4/25/2017	West, elev. 316'	Cemetery	Questa, test borehole GW-3	18.0'
4/25/2017	Center, elev. 328'	Drip dispersal field	Questa, test borehole A-1	Dry to 8'
4/25/2017	Center, elev. 314'	Play area	Questa, test borehole A-2	Dry to 8'

As an additional point of reference, wet weather groundwater readings taken at four monitoring well locations on the east side of the neighboring vacant property (Patel) south of the site during February-March of 2000 and February-March of 2016, found the highest water table conditions at 14.4 to 16.2 feet bgs, with one well dry to 20.5 feet.

Soils

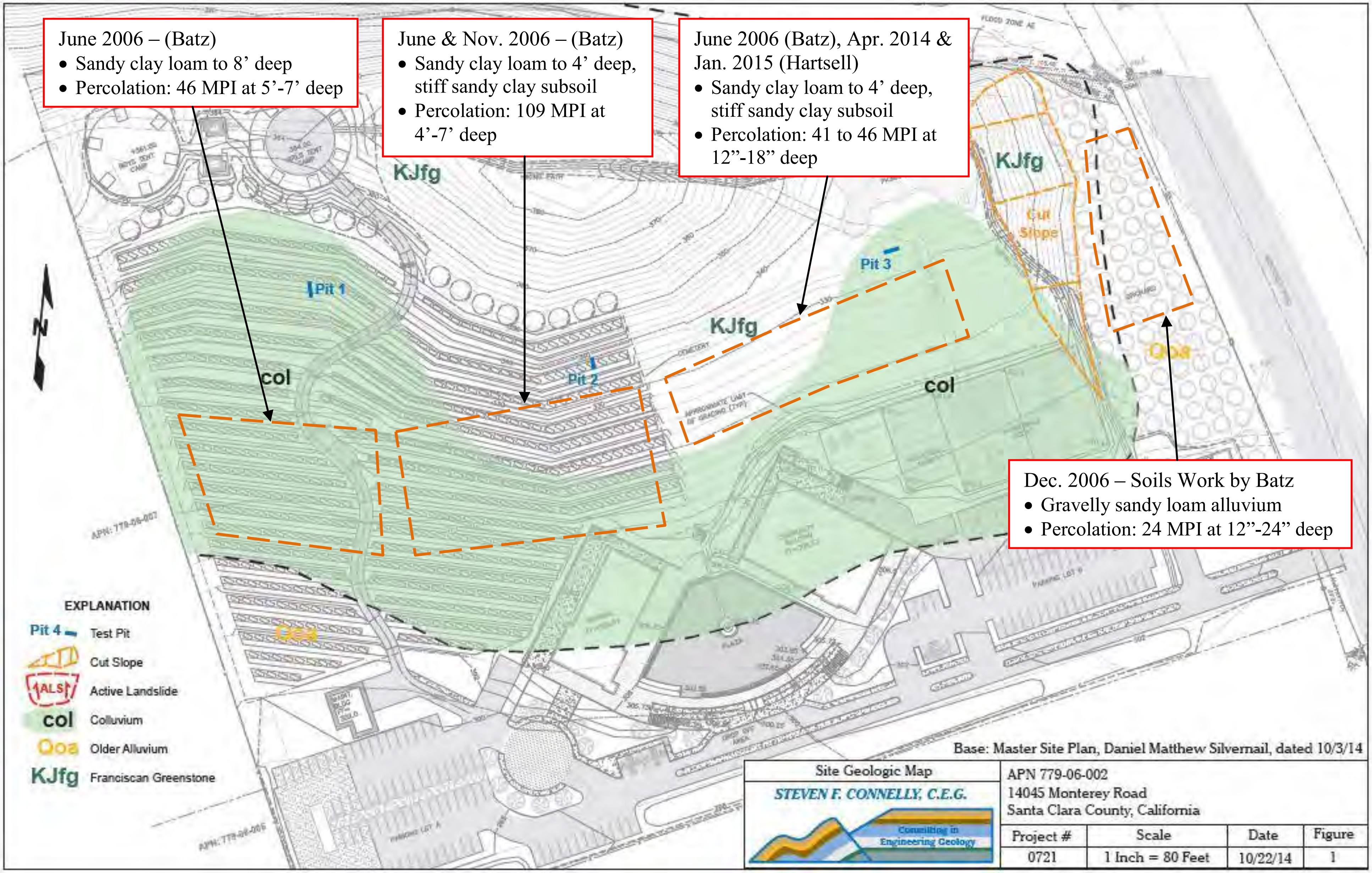
The Soil Survey of Eastern Santa Clara Area (1974) shows the following soils occurring on the property:

- Keefers clay loam overlies the bedrock on the lower portions of the south-facing slope of the bedrock ridge. These are deep well drained soils, with moderate permeability, underlain by slowly permeable gravelly clays. These soils coincide with areas planned for the cemetery and wastewater drip dispersal fields.

- Pleasanton gravelly loam occurs in areas coinciding with the older alluvial fan deposits in the center and southern portions of the site. These soils consist of well drained loams underlain by gravelly sedimentary alluvium. These soils coincide with locations planned for many of the project buildings, parking and activity areas.

- Cortina very gravelly loam, fine sandy loam and sandy loam are found on the eastern portions of the site. These are deep well drained soils with good permeability. These soils coincide with the area of the proposed orchard.

Between 2006 and 2015, various soil investigations and numerous percolation tests were conducted in several different areas of the property for evaluation of suitability and design for onsite wastewater treatment and disposal options. The initial work in 2006 was done by Batz Environmental Consulting, and the most recent work in 2014-2015 was done by S.R. Hartsell, REHS. The location and results of soil profile test pits are compiled and included as part of the proposed wastewater disposal system plans (Hartsell, 2016) and are provided in **Appendix A** for reference. Using the site geology map prepared by Connelly (2007), **Figure 5** displays and summarizes the general location



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SEPTIC SYSTEM SOILS WORK

FIGURE 5

and findings in different areas of the site, including typical soil conditions and average percolation test results at the different locations and depths examined. In general, the soil and percolation testing show conditions consistent with soil survey findings: (1) sandy clay loamy soils with moderate to slow percolation rates (41 to 109 mpi) on the south-facing hillslopes in the center of the site, with the effective depth of suitable soil affected by the presence of stiff sandy clay subsoils in some areas; and (2) gravelly and sandy loam soils with moderate to fast percolation rates in the alluvial area along the eastern side of the side.

REGULATORY REQUIREMENTS

Porter-Cologne Water Quality Control Act of 1969

The Porter-Cologne Water Quality Control Act (Porter-Cologne) established the State Water Resources Control Board (State Water Board) and divided the state into nine (9) regional basins, each with a regional water quality control board (RWQCB). Santa Clara County falls within the jurisdiction of the San Francisco Bay and Central Coast Regional Water Boards. The project site lies within the jurisdiction of the Central Coast Regional Water Quality Control Board (Region 3). The State Water Board is the primary state agency responsible for protecting the quality of the state's surface and groundwater resources, although most of the day-to-day implementation authority is delegated to the various RWQCBs. Porter-Cologne provides for development and periodic review of water quality control plans (basin plans), which designate beneficial uses and establish water quality objectives (standards) for surface waters and ground waters. Basin plans also include programs to achieve and maintain water quality objectives and provide the technical basis for establishment of waste discharge permit conditions and enforcement actions related to wastewater treatment facilities and a host of other activities that may affect water quality.

State Policy for Onsite Wastewater Treatment Systems

In 2000 the State legislature passed Assembly Bill 885 (AB 885) directing the State Water Board to develop statewide requirements for onsite wastewater treatment systems (OWTS), known commonly as septic systems. The new statewide requirements were adopted into the "Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems", dated June 19, 2012, and referred to as the "OWTS Policy". The Policy took effect in the spring of 2013. The Policy establishes a statewide, risk-based tiered approach for the management, installation and performance of OWTS. The Policy applies to all OWTS having design flows of 10,000 gpd or less, and is incorporated into all RWQCB Basin Plans. Among other things, it permits and, to a large degree, encourages counties and other local agency to regulate OWTS within their jurisdiction through the development of a Local Agency Management Program (LAMP), including standards, criteria and practices suited to local conditions.

Santa Clara County Local Agency Management Program (LAMP)

In 2013 Santa Clara County revised local codes and practices for OWTS, bringing County requirements up to date with industry standards and incorporating flexibility for application of newer "alternative" wastewater treatment and dispersal methods. The revised codes and practices were incorporated in a LAMP, prepared in accordance with the requirements of the State Water Board's OWTS Policy. The LAMP was approved by the San Francisco Bay Regional Water Board (lead RWQCB for this action), in December 2104. The LAMP applies to all OWTS within Santa Clara County having wastewater design flows of up to 10,000 gpd, with the exception of those located on State and Federally-owned lands. Any OWTS with a design flow exceeding 10,000 gpd would be regulated by the respective California Regional Water Quality Control Board.

Under the LAMP, authority for regulation of onsite wastewater systems, including projects such as Cordoba Center, lies with the Santa Clara County Department of Environmental Health (DEH). County requirements for onsite wastewater systems are contained in Division B11 of the County Code, and in an accompanying *Onsite Systems Manual*, which provides policies, procedures and technical details related to permitting, design, construction and operation of onsite wastewater systems. Key regulatory requirements for onsite wastewater systems are summarized below.

Wastewater System Size. County Code applies to systems with design wastewater flows of up to 10,000 gallons per day (gpd). Systems with flows greater than 10,000 gpd must obtain approval from the applicable Regional Water Quality Control Board (RWQCB), which is the Central Coast Region in this case. The RWQCB also is notified and provided information for any onsite wastewater system with flows of 2,500 gpd or greater for review and comment. Additionally, any system with flows over 2,500 gpd requires the issuance of a renewable operating permit.

Treatment. Treatment of sewage prior to subsurface disposal must, at a minimum, include primary treatment (i.e., sedimentation) as provided by a septic tank. Additional or "supplemental" treatment, such as sand filtration or a proprietary treatment system (e.g., aerobic treatment unit or filtration system), can be provided to overcome certain soils constraints, space limitations, steep slopes, shallow groundwater conditions, or effluent quality requirements. Supplemental treatment systems are required to meet basic secondary effluent standards for reduction of biochemical oxygen demand (BOD) and total suspended solids (TSS). As applicable, additional requirements for nitrogen removal may be incorporated or assigned to mitigate potential effects on groundwater resources for projects involving high density of OWTS or larger flow systems.

Effluent Dispersal. The conventional method for effluent dispersal is a gravity-fed, gravel-filled disposal (leaching) trench, 18 to 36 inches wide and up to 8-feet deep. County code also allows for the use of several types of "alternative" dispersal system designs to overcome particular site constraints, in particular shallow soils and/or high groundwater conditions. The alternative dispersal system options include: shallow pressure-distribution trenches; mound systems; at-grade systems; pressure-dosed sand-filled trenches, and subsurface drip dispersal systems

Soil Depth. Conventional disposal trenches require a minimum of five (5) feet of soil below the trench bottom. For alternative systems, the minimum soil depth may be reduced to two (2) feet or three (3) feet, depending on the type of alternative design. For example, shallow pressure distribution trench systems require a minimum soil depth of three feet below trench bottom; mounds and subsurface drip dispersal systems require a minimum of two feet of soil depth below the field.

Soil Percolation. Soil percolation must be within the range of 1 to 120 minutes per inch (MPI) for conventional and alternative systems. The percolation rate is used for sizing the dispersal system and also affects the groundwater separation requirement (below).

Groundwater Separation. For conventional systems, the minimum depth to groundwater (below trench bottom) ranges from five (5) feet to 20 feet, depending on the percolation rate as indicated below. Soils with faster percolation rates require greater groundwater separation due to the potential for less absorption and treatment of effluent by the soil.

Percolation Rate, MPI	Depth to Groundwater, ft
1-5	20
6-30	8
31-120	5

For alternative systems, minimum depth to groundwater may be reduced from the above requirements applicable to conventional systems, and varies according to the particular type of alternative system and percolation rate. For example, a shallow pressure distribution trench system in soils with a percolation rate of 6-120 MPI requires a minimum groundwater separation of three (3) feet below trench bottom. With the addition of supplemental treatment, the minimum separation distance can be reduced to two (2) feet, which also applies for mounds and subsurface drip dispersal systems.

Ground Slope. Maximum ground slope in the disposal area for conventional disposal trenches is 30 percent. For slopes between 30 and 40 percent the use of a shallow pressure distribution trench system or subsurface drip dispersal is required. Slopes over 40 percent require the use of a subsurface drip dispersal system.

Setbacks. Minimum horizontal setbacks between septic tank and leachfield systems and various physical site features are listed in Code Section B11-67; some of the key requirements include:

Site Feature	Minimum Setback (ft)
Well (private, individual)	100
Public water well	150
Watercourse	100
Reservoir	200
Drainage channel, swale	50
Cuts or steep embankments	4 x height (min. 25’ up to 100’)
Property lines	10

Dual Leachfield Systems. The County requires the installation of dual disposal fields, each 100 percent of total required size, so that effluent can be alternated from one to another. This is for periodic resting and as a back-up in the event of failure, repair or maintenance needs.

Cumulative Impact Considerations. In addition to the above specifications, large flow onsite wastewater systems require evaluation of groundwater mounding hydraulics (i.e., water table rise), nitrate loading or other possible cumulative effects. Per County policy, the types of systems falling in this category are community-type systems serving several dwellings, commercial establishments or an entire community where the wastewater design flow exceeds 1,500 gpd, or where the system is located on a small parcel (< 1 acre). This is part of the design analysis, and is done to assure that the site conditions (e.g., soil depth, groundwater depth, and percolation) are adequate for the proposed wastewater application rate. This analysis may dictate certain adjustment in the layout, sizing or wastewater flow to ensure that the soils are not overloaded with wastewater, and to prevent area-wide water quality impacts extending beyond the property.

General Use of Dispersal Areas. Activities and construction in the disposal field area must be limited to those that will not interfere with the operation or maintenance of the subsurface trenches or piping. Roads, paved surfaces, buildings and fills of more than 12 inches deep may not be constructed over disposal fields since they may cause unnecessary soil compaction and restrict maintenance access to the system. Use of disposal field areas for playgrounds, parks, gardens, landscaping and open space is allowed, as these uses do not generally pose problems for subsurface drainfield operation.

PROJECT FACILITIES AND WASTEWATER FLOWS

Project Activities and Buildings

Project activities that will generate wastewater flows include: (a) prayer activities - daily, weekly, funeral and twice-a-year prayer services; (b) banquets, community dinners, community picnics, weddings, meetings, special events; (c) summer youth camping; (d) site maintenance staff and office; and (e) caretaker's family residence. The buildings and facilities accommodating these activities include:

- **Mosque**. The proposed mosque structure would have a prayer hall designed for up to 300 people, and would include restrooms, observation/babysitting area, and office for the Iman. The building would be used for daily prayers, Friday and Ramadan religious services, weddings and funerals.

- **Community Building (Assembly Hall).** The proposed community building would be a two-story multi-use building that would include an event hall, kitchen, classrooms, conference room, office, and restrooms. The community building would accommodate any events that include food, including potlucks, formal dinners, wedding receptions, and other community-gathering activities. Meetings and youth Sunday school would also occur in this building.

- **Youth Summer Camp.** A 0.38-acre section of the ridgeline above the cemetery would be used for a summer youth camp (up to nine, one-week camps per summer). Permanent structures would include two bathhouses and wooden tent platforms. Separate bathhouses (girls and boys) would provide shower and toilet facilities.

- **Maintenance Building.** A maintenance building, serving the entire site, would be used for storage of equipment, maintenance vehicles, and office space and restroom for maintenance personnel.

- **Caretaker's Dwelling.** A 3-bedroom caretaker's residence (single-family home) would be located near the site entrance off Monterey Road.

Estimated Wastewater Flows

Wastewater flows at the Cordoba Center will fluctuate from day-to-day and also seasonally, between summer camping periods and the rest of the year. **Tables 3, 4** and **5** provide a summary of estimated peak daily flow for each day of the week, including camping and non-camping seasons and for four special events during the year in non-camping periods. The estimated wastewater flows are based on maximum occupancy/attendance for different activities and buildings as provided by the project applicant using applicable unit wastewater flows (e.g., gpd per person), based on guidelines contained in the Santa Clara County DEH *Onsite Systems Manual*. Key assumptions that form the basis of the peak daily wastewater flow estimates include the following:

- Day visitors and parishioners, varies daily from 212 to 362 per day: 15 gpd per person
- Special events, (4) Fridays/year, non-camping periods, 500 people: 15 gpd per person
- Onsite staff, varies from 2 to 5 per day: 15 gpd per person
- Camping, up to 48 youth and 4 adults for week-long camp: 35 gpd per person
- Caretaker's residence, 3-bedroom single-family home: 450 gpd

Table 6 summarizes the peak day and peak week flow estimates for the non-residential facilities for different times of the year and special event weeks, which form the basis of design for the onsite wastewater treatment and disposal facilities.

Average daily flows, which also affect wastewater facilities design and operation, would be expected to be on the order of about 50 to 75 percent of the peak daily and peak weekly flow estimates, due to the combination of occupancy and unit wastewater generation rates normally being less than the assumed maximum design values.

The maximum daily wastewater flow of 450 gpd for a 3-bedroom residence would be the basis of design for the Caretaker's wastewater system per County design standards. Similar to the non-residential system, average daily wastewater flow for this residential system would normally be no more than about 50 to75 percent of the design flow.

Table 3. Maximum Use and Wastewater Flows – Summer Camp Season (9 weeks/yr)

User Activity	Occupancy / Unit Flow, gpd	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Weekly Ave
Day Visitors & Parishioners	People	212	212	212	212	300	212	362	
	Flow, @ 15 pd	**3,180**	**3,180**	**3,180**	**3,180**	**4,500**	**3,180**	**5,460**	
Staff	People	5	5	5	5	2	2	2	
	Flow, @ 15 gpd	**75**	**75**	**75**	**75**	**30**	**30**	**30**	
Summer Camp	People	52	52	52	52	52	52	52	
	Flow, @ 35 gpd	**1,820**	**1,820**	**1,820**	**1,820**	**1,820**	**1,820**	**1,820**	
Non-res Total	Daily Flow, gpd	**5,075**	**5,075**	**5,075**	**5,075**	**6,350**	**5,030**	**7,310**	**5,570**
Caretaker Res.	Flow, gpd	**450**	**450**	**450**	**450**	**450**	**450**	**450**	**450**
Combined Total	Flow, gpd	**5,525**	**5,525**	**5,525**	**5,525**	**6,800**	**5,480**	**7,760**	**6,020**

Table 4. Maximum Use and Wastewater Flows – Non-Camp Season (39 weeks/yr)

User Activity	Occupancy / Unit Flow, gpd	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Weekly Ave
Day Visitors & Parishioners	People	212	212	212	212	300	212	362	
	Flow, @ 15 pd	**3,180**	**3,180**	**3,180**	**3,180**	**4,500**	**3,180**	**5,460**	
Staff	People	5	5	5	5	2	2	2	
	Flow, @ 15 gpd	**75**	**75**	**75**	**75**	**30**	**30**	**30**	
Summer Camp	People	-	-	-	-	-	-	-	
	Flow, @ 35 gpd	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Non-res. Total	Daily Flow, gpd	**3,255**	**3,255**	**3,255**	**3,255**	**4,530**	**3,210**	**5,490**	**3,750**
Caretaker Res.	Flow, gpd	**450**	**450**	**450**	**450**	**450**	**450**	**450**	**450**
Combined Total	Flow, gpd	**3,705**	**3,705**	**3,705**	**3,705**	**4,980**	**3,660**	**5,940**	**4,200**

Table 5. Maximum Use and Wastewater Flows – Special Event Weeks (4 weeks/yr)

User Activity	Occupancy / Unit Flow, gpd	Mon	Tues	Wed	Thur	Fri	Sat	Sun	Weekly Ave
Day Visitors & Parishioners	People	212	212	212	212	500	212	362	
	Flow, @ 15 pd	**3,180**	**3,180**	**3,180**	**3,180**	**7,500**	**3,180**	**5,460**	
Staff	People	5	5	5	5	2	2	2	
	Flow, @ 15 gpd	**75**	**75**	**75**	**75**	**30**	**30**	**30**	
Summer Camp	People	-	-	-	-	-	-	-	
	Flow, @ 35 gpd	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Non-res. Total	Daily Flow, gpd	**3,255**	**3,255**	**3,255**	**3,255**	**7,530**	**3,210**	**5,490**	**4,179**
Caretaker Res.	Flow, gpd	**450**	**450**	**450**	**450**	**450**	**450**	**450**	**450**
Combined Total	Flow, gpd	**3,705**	**3,705**	**3,705**	**3,705**	**7,980**	**3,660**	**5,940**	**4,629**

Table 6. Summary of Estimated Non-Residential Wastewater Flows for Maximum Occupancy and Activities

	Summer Camp Season (9 wks/yr)	Non-Camping Season (39 wks/yr)	Special Event Weeks (4 wks/Yr)
Peak Day Flow, gpd	7,310 (Sunday)	5,490 (Sunday)	7,530 (Friday)
Peak Week Flow, average gpd	5,570	3,750	4,179

PROPOSED WASTEWATER FACILITIES

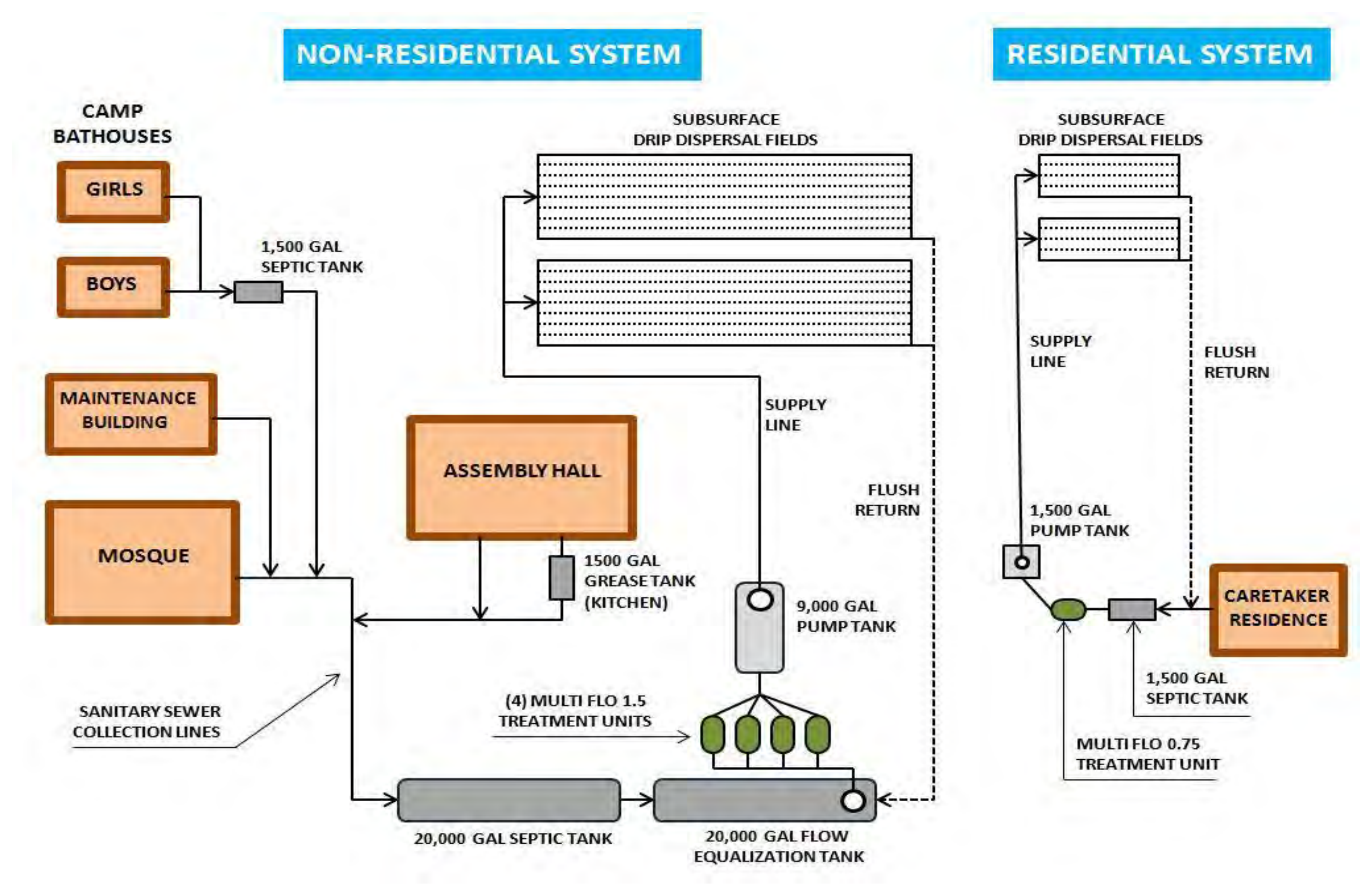
The project is proposed to be served by two independent onsite wastewater treatment systems, one for the caretaker's single family residence and a larger system that would accommodate all of the non-residential facilities and activities of the project. The proposed wastewater facilities plan (shown earlier in **Figure 2**) is diagrammed schematically in **Figure 6** and described below. Detailed plan layout drawings of the proposed wastewater facilities are provided in **Appendix A**.

Caretaker's Residence. The 3-bedroom caretaker's residence would be served by an individual system consisting of the following:

- Design flow of 450 gpd, maximum daily flow
- 1,500-gallon septic tank
- Supplemental/secondary treatment unit (NSF 40), Multi-Flo Model 0.75
- 1,500-gallon pump chamber
- Subsurface drip dispersal field located on the hillslope northwest of the residence, including two side-by-side 100-percent capacity drip fields, each providing 1,125 square feet of infiltration area.

Non-residential System. A larger flow system would serve the remainder of the site, including the mosque, community building, maintenance facility, and campground bathhouses. This system would consist of the following:

- Design flow – single day peak of 7,530 gpd
- Design flow – weekly peak flow of 6,000 gpd
- Sanitary sewer collection system from all buildings leading to treatment area, located between the eastern parking lot, the community building, and the access road.
- 1,500-gallon septic tank at camp bathhouses, followed by a 4-inch effluent line connecting to the main sanitary sewer system near the mosque.
- 20,000-gallon septic tank, sized for >2 times the peak daily flow
- 20,000-gallon flow equalization tank, which will even out daily fluctuations in flow during the week, metering up to 6,000 gpd of flow to the secondary treatment system.



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PROPOSED WASTEWATER FACILITIES SCHEMATIC
CORDOBA CENTER

FIGURE 6

- Supplemental/secondary treatment system (NSF 40) consisting of (4) Multi-Flo, Model 1.5 units in parallel.
- 9,000-gallon pump chamber with duplex pump system for dosing effluent to the dispersal field.
- Subsurface drip dispersal field located on the hillslope directly north of the community building and play courts, including two side-by-side 100-percent capacity drip fields, each 50-ft wide by 200-ft long, with 10,000 square feet of infiltration area.

FEASIBILITY AND REGULATORY COMPLIANCE

Soil and Site Suitability

While conditions vary across the site, soil profile evaluations and percolation testing have demonstrated the property has suitable conditions for onsite wastewater disposal in accordance with Santa Clara County requirements. The area selected for the wastewater disposal fields has minimum soil depth (2 feet below dripline) and percolation rates (41 to 46 mpi) suitable for use of shallow drip dispersal, which is the dispersal method proposed. Ground slopes averaging 15% are satisfactory for the proposed dispersal method.

With respect to horizontal setbacks distances, the proposed wastewater facilities comply with all minimum required setbacks from wells, streams, and other water features as well as other site and landscape features with two exceptions, both related to setback distance between the dispersal fields and cut slopes. The proposed residential wastewater dispersal system is located too close to a large existing cut slope on the eastern side of the property. The proposed non-residential dispersal field is located too close to a proposed cut slope adjacent to the pathway along the north side of the play area and sports courts. These two setback issues are addressed below under the discussion of the dispersal field and under Cumulative Impact Analysis.

Primary Treatment (Septic Tanks) and Flow Equalization

The proposed septic tank sizing (1,500 gallons) for the Caretaker's residence meets the minimum requirement in the *Onsite Systems Manual* for residential systems. The 20,000-gallon septic tank for the non-residential system exceeds the minimum County requirement of two times the peak daily wastewater flow (7,530 gpd x 2 = 15,060 gallons) for large flow systems.

The inclusion of a flow equalization tank to even out the fluctuations in daily flows (after the septic tank) is consistent with provisions in the *Onsite Systems Manual*. Based on the wastewater flow estimates presented in **Tables 3**, **4** and **5**, the proposed sizing (20,000 gallons) is adequate to ensure daily wastewater flows delivered to the secondary treatment unit and dispersal field will remain below the selected system design flow of 6,000 gpd, for peak activity periods. Our analysis shows average daily flow during peak week activities (summer camping season) to be 5,570 gpd (**Tables 3** and **6**).

Secondary (Supplemental) Treatment

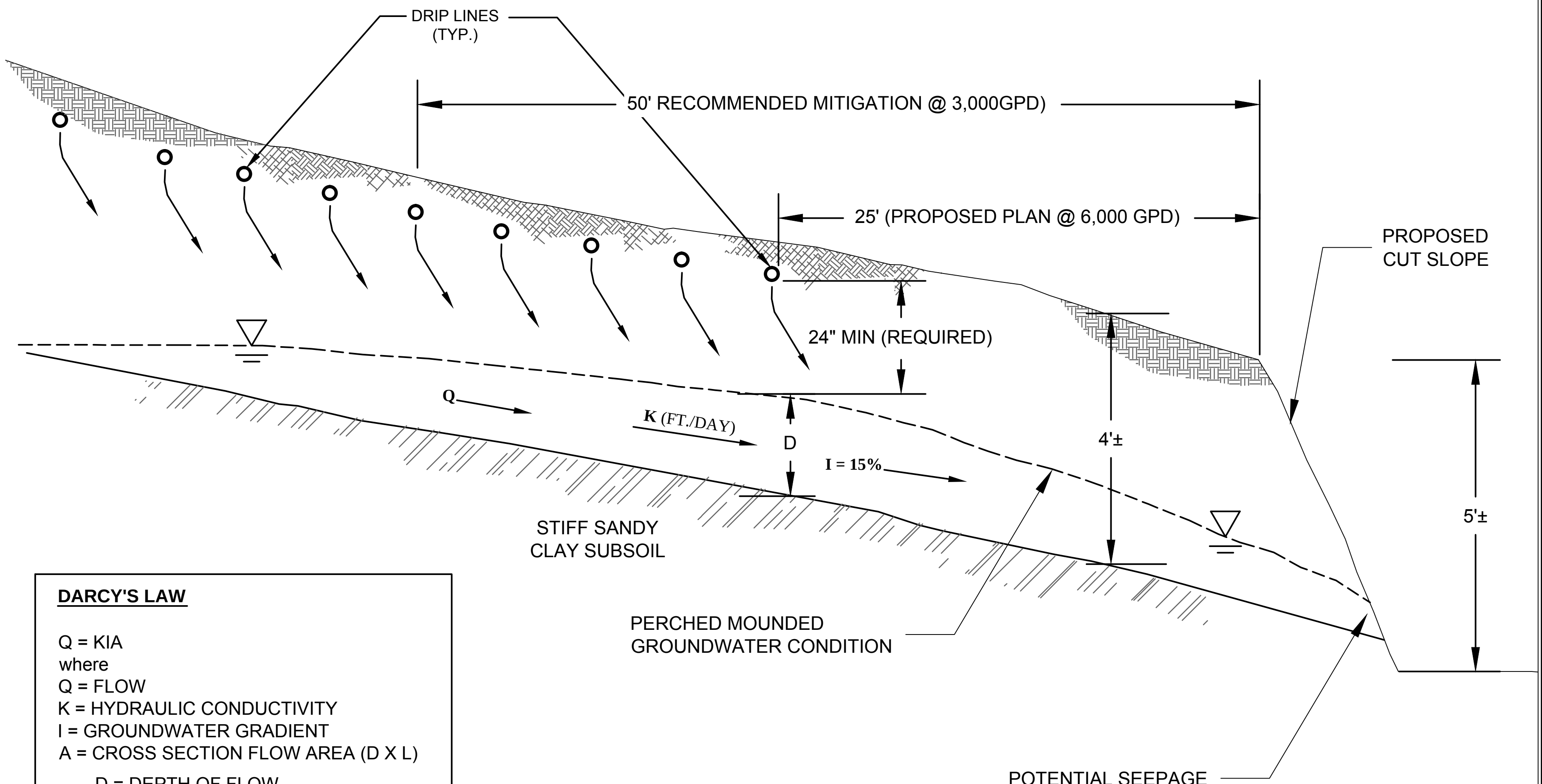
The supplemental/secondary treatment systems proposed for both the Caretaker residence and the non-residential systems are required, at a minimum, for any system utilizing drip dispersal methods. The particular system proposed, Multi-Flo, has proper NSF 40 certification (as required by the *Onsite Systems Manual*) for production of secondary quality wastewater effluent.

The Multi-Flo system has good reported performance in meeting secondary treatment standards. However, it does not have design features or demonstrated capability for significant nitrogen removal (Multi-Flo Design Manual, 2003). As addressed below under Cumulative Impacts Analysis, the wastewater treatment system will need to incorporate nitrogen removal features in order to meet a minimum effluent nitrogen limit (average monthly concentration) of 20 mg-N/L or less. Treatment system options are available that can achieve nitrogen removal to this levels; however, the Multi-Flo system as proposed is not among the options. Consequently, the proposed wastewater facilities plan will have to be modified to include a supplemental treatment system capable of meeting a 20 mg/L (average) nitrogen effluent performance limit as well as meeting basic NSF 40 secondary treatment requirements. Wastewater effluent monitoring requirements should be established by the DEH as conditions of the operating permit for the project to provide on-going assurance that the system performs as required.

Wastewater Disposal Systems

The wastewater disposal systems proposed for the Caretaker residential system and the non-residential system both employ the use of subsurface drip dispersal methods, which is suitable for the soil conditions and percolation test findings in the selected areas. However, the proposed design does not consider two important factors: (1) the overall hydraulic loading in a relative small, concentrated area underlain by "stiff sandy clay" subsoils at a shallow depth (4 feet); and (2) positioning of the wastewater disposal field immediately upslope (10 to 25 feet) from a proposed graded cut slope (5-feet high) on the north side of the playground and and recreation areas. These factors pose the risk of an unacceptable level of saturation (groundwater "mounding") beneath the drip fields and strong possibility of lateral seepage of inadequately treated effluent at the proposed cut slope downhill. These issues are illustrated in **Figure 7**.

Groundwater Mounding. Per requirements and guidelines contained in the *Onsite Systems Manual*, a minimum vertical separation distance of 24 inches to the "mounded" water table condition must be maintained below the dispersal point for large-flow wastewater systems (>1,500 gpd) under design flow conditions. Although there has been no shallow winter water table condition documented in the proposed drip dispersal field areas due to normal rainfall conditions, the stiff sandy clay subsoils at a depth of 4 feet pose a significant restriction to vertical water movement and the strong likelihood of the creation of "perched" groundwater in response to the proposed wastewater discharge of up to 6,000 gpd. The proposed plans do not include any analysis addressing this issue. Per the information and calculations presented in the Cumulative Impact Analysis section of this report (and **Appendix B**), we have determined that the issue of soil saturation in the proposed drip field area can be mitigated to an acceptable level by lengthening the wastewater disposal area to a cross-slope distance of approximately 250 to 300 feet (currently 200 feet proposed) and reducing the overall design hydraulic loading to 3,000 gpd; i.e., 50% reduction compared to the proposed design. To do this and still provide capacity for the projected wastewater flows will require the



DARCY'S LAW

Q = KIA
where
Q = FLOW
K = HYDRAULIC CONDUCTIVITY
I = GROUNDWATER GRADIENT
A = CROSS SECTION FLOW AREA (D X L)

D = DEPTH OF FLOW
L = CROSS-SLOPE LENGTH

Date:	7/12/2017
Drawn:	MF
Appr'd:	NH
Dwg. No:	1700037_FIGURE_7

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GROUNDWATER MOUNDING SCHEMATIC

FIGURE
7

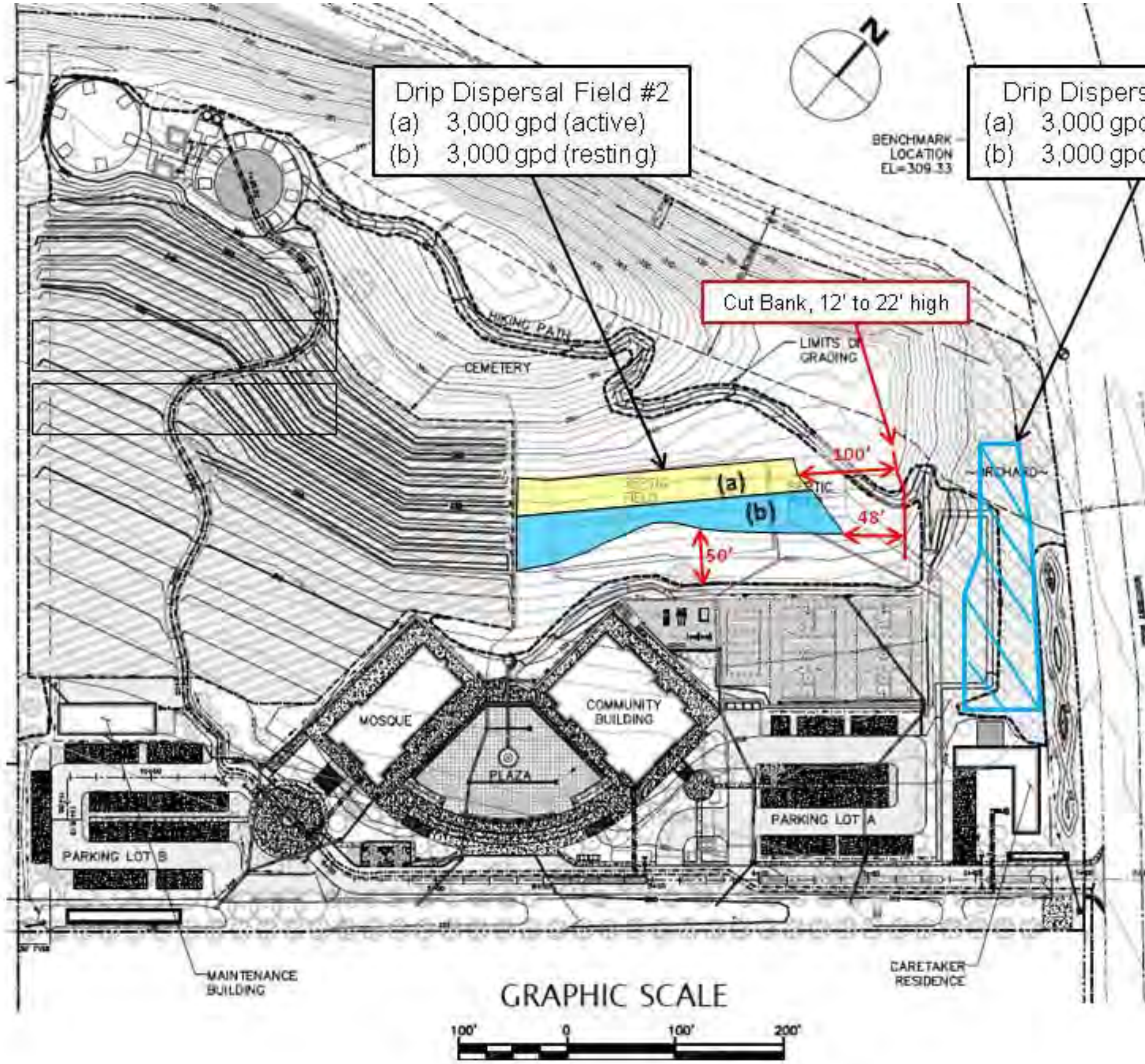
development of another wastewater disposal field area with capacity for 50% of the design wastewater flow. The orchard area on the east side of the project site has sufficient area and suitable soil conditions to provide this additional alternate area for wastewater disposal.

Cut Slope Setback. Per County regulations, the required horizontal setback distance between a dispersal field and cut slope or embankment is equal to four (4) times the height (h) of the cut slope (i.e., "4xh") measured from the top of the slope. The proposed wastewater plans are in conflict with this requirement as follows:

- **Residential System.** About half of the proposed residential wastewater dispersal field is situated within the required horizontal setback distance to the exiting cut slope located to the east, toward Monterey Road. Based on the varied height of the cut, the required setback distance (4xh) would be about 60 to 100 feet. As diagrammed in the applicant's septic system plan, the proposed dispersal field maintains a setback of about 50 to 60 feet from the cut slope. Therefore, reconfiguration of the residential wastewater dispersal field is required to comply with County requirements. There appears to be sufficient available area to allow this adjustment to be made.

- **Non-residential System.** The horizontal distance between the non-residential dispersal field and the proposed cut slope adjacent to the pathway along the north side of the play area and sports courts does not meet the necessary setback requirements. As illustrated in **Figure 7**, with the expected development of perched lateral groundwater flow conditions beneath the proposed drip dispersal field, there is a strong likelihood of downslope seepage ("breakout") of wastewater effluent at the proposed cut slope above the playground and recreation area. County requirements for setbacks to cut slopes specify a minimum distance of 25 feet and four (4) times the height (h) of the cut, whichever is greater. The *Onsite Systems Manual* also includes requirements and guidelines for geotechnical assessment of wastewater disposal systems that call-out the need to assess and establish appropriate setbacks from cut slopes based on site specific soils, geology and drainage conditions. Based on observed soil conditions (stiff sandy clay at 4-ft depth), the potential for creation of lateral perched groundwater flow conditions, and proposed grading plans, in our opinion a minimum horizontal setback distance of 50 feet should be maintained between the non-residential drip dispersal fields and the proposed cut slope in question. A 50-foot setback would be equivalent to the required setback from a drainage ditch.

Mitigated Wastewater Disposal Plan. Compliance with the above recommendations for reduced hydraulic loading in the proposed dripfield area and increased horizontal setback to the cut slopes can be accomplished by: (a) eliminating the lower non-residential drip dispersal field shown on the proposed project wastewater plan; (b) reconfiguring the area for the residential drip dispersal field to maintain 60 to 100-ft setback from the easterly cut slope (see **Figure 8**); (c) confining drip dispersal to the area higher up on the hillside in areas of less than 20% slope and within the area already percolation-tested; (d) extending the non-residential drip field a greater distance laterally across the slope (250 to 300 feet); and (e) developing an additional alternate drip dispersal field in the orchard area on the east side of property with capacity for 50 percent of the design wastewater flow.



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ALTERNATIVE – MITIGATED WASTEWATER DISPOSAL PLAN

FIGURE 8

The above mitigated plan is illustrated in **Figure 8**. Under this mitigated approach, the hillside drip field and the recommended orchard drip field would be operated in tandem, each receiving 50% of the daily wastewater flow. Individually, each field would have a primary (active) and secondary (resting) drip dispersal system installed to meet minimum requirements for a dual, 200% capacity dispersal system. Combining the flow from the Caretaker's residence into the non-residential system to have a single system is recommended for operational efficiency, but would not be essential. Drip field design for the hillside area should be based on an application rate of 0.4 gpd/ft^2, applicable to soils with percolation rates averaging 46 to 60 MPI, which has been demonstrated for this area. For a design flow of 3,000 gpd (50% of total flow) this would require two fields of 7,500 ft^2 each. The two hillside drip dispersal fields ("a" and "b") diagrammed in **Figure 8** have areas of about 9,000 ft^2 and 10,000 ft^2, respectively.

The development and operation of the alternate drip dispersal field in the eastern side of the site would not conflict with the proposed reestablishment of an orchard in this area. Sub-surface drip dispersal lines are manufactured with root-inhibiting materials and commonly installed and used for turf, landscaping and crop irrigation. The layout and design of the driplines would need to be developed in coordination with the orchard planting and operation plans. Soil percolation in the orchard area is adequately demonstrated by prior testing in 2006 and the nature of the alluvial soil conditions; however, additional percolation testing may be required in this area for drip field sizing, depending on the selected layout.

CUMULATIVE IMPACT ANALYSIS

Groundwater Mounding

Hillside Drip Dispersal Field. Groundwater mounding, i.e., water table rise, will occur to some degree under any large sub-surface disposal field. The amount of water table rise is governed primarily by the wastewater loading rate, the hydraulic conductivity (i.e., permeability) of the sub-surface materials and the slope or gradient of the water table. Analysis of groundwater mounding potential for the proposed drip dispersal field (non-residential system) was analyzed here through the application of Darcy's Law. This is the most appropriate analysis for hillside situations where there is an underlying restrictive layer, which is apparent at this site from soil profile observations. Analysis was completed for two cases: (1) the drip dispersal field as proposed; and (2) the alternative mitigated wastewater dispersal plan per recommendations above, including 50% reduced wastewater flow and lengthening the cross-slope distance of the hillside drip field. The calculations and supporting assumptions are provided in **Appendix B.** The results are summarized **Table 7**, showing results for peak day design flow (up to 6,000 gpd) and peak weekly flows for summer camping and non-camping seasons, per wastewater flow estimates in **Table 6**. As indicated in the far right-hand, the minimum required net vertical separation distance of 24 inches would be met under the mitigated plan, but not for the proposed plan.

Table 7.
Estimated Groundwater Mounding and Net Water Table Separation
Hillside Drip Dispersal Field – Proposed and Mitigated Plan

Wastewater Discharge Scenario	Wastewater Flow (gpd)	Cross-Slope Drip Field Length, (feet)	Estimated Groundwater Rise (inches)	Net Vertical Water Table Separation below Drip Lines* (inches)
Proposed Wastewater Disposal Plan				
Peak Day	6,000	200	32	8
Peak Week, Camp Season	5,570	200	30	10
Peak Week, Non-camping Season	3,750	200	20	20
Mitigated Wastewater Disposal Plan				
Peak Day	3,000	275	11	28
Peak Week, Camp Season	2,785	275	10	29
Peak Week, Non-camping Season	1,875	275	7	33

* Based on 48-inch depth to restrictive clay subsoils and placement of driplines at 8 inches below grade.

Recommended Orchard Area Drip Dispersal Field. Groundwater mounding effects will be much less in the recommended drip field in the orchard area due to the much more permeable sandy and gravelly alluvial soils and deeper depth to groundwater (15 feet or more). **Appendix B** includes calculations and assumptions for analysis of groundwater mounding effects utilizing the methodology presented in the publication "Ground-Water Mounding Due to On-Site Sewage Disposal" (Finnemore and Hantzsche, 1983) a copy of which is also included in **Appendix B** for reference. The methodology is applicable for the case of wastewater discharge over a relatively flat water table, which best represents the situation in the orchard area. Based on dripfield dimensions of approximately 300-feet long by 75-feet wide, the results of the analysis indicate a projected water table rise of less than 0.5 feet under peak day and peak week wastewater flows. This would be insignificant based on the estimated water table depth of 15-feet or more in this area.

Nitrate Loading

Nitrate loading from onsite wastewater treatment and disposal systems can potentially degrade groundwater supplies and contribute to nutrient enrichment of surface water bodies. Where sewage disposal is concentrated, e.g., in clustered or large-flow leachfield areas such as planned for the proposed project, localized nitrate impacts on groundwater are more likely than for dispersed rural residential systems and require additional analysis. In Santa Clara County, such analysis is required by County Code (Section B11-74), with guidelines and criteria contained in Part 2 of the *Onsite Systems Manual*.

The Central Coast Regional Water Board has established a groundwater-nitrogen concentration objective of 5 mg-N/L for the Llagas Groundwater Subbasin (Water Quality Control Plan for the Central Coast Region, Basin Plan, 2011). The drinking water standard for nitrate is 10 mg-N/L. The *Final Salt and Nutrient Management Plan (SNMP) for the Llagas Groundwater Subbasin* (SCVWD, 2014) presents extensive analysis of groundwater nitrate concentrations, sources, fate and transport of nitrogen in the project area. A principal purpose of the SNMP is to estimate the assimilative capacity of the groundwater basin relative to nitrate and salt (TDS) concentrations, to guide management activities for various activities that affect groundwater quality. With respect to nitrate concentrations, the assimilative capacity is defined as the difference between the Median Water Quality Baseline (MWQB) determined to be 5 mg-N/L and the Maximum Contaminant Level (MCL), which is the drinking water standard of 10 mg-N/L. The MWQB is based on preserving existing groundwater quality or attainable levels believed to be achievable through control of point sources of nitrogen.

The proposed wastewater treatment and disposal facilities for the project are a controllable point source of nitrate-nitrogen. To determine an appropriate level of effluent nitrogen concentration for the system a nitrate loading analysis was conducted, including assumptions and comparison of different treatment levels along with pertinent hydrological and soil conditions of the project site that influence the resultant effects on groundwater quality from percolating wastewater.

Methodology. The nitrate loading analysis was completed using an annual chemical-water balance analysis. Analyses were completed for two cases: (1) the proposed wastewater disposal plan as presented by the applicant's consultant (Hartsell); and (2) the revised or mitigated wastewater disposal plan as recommended from our review. The methodology is described in the publication "Predicting Groundwater Nitrate-Nitrogen Impacts" (Hantzsche and Finnemore, Groundwater, Vol. 30, No. 4, July-August 1992). According to this methodology, the long-term concentration of nitrate as nitrogen (NO_3-N or nitrate-nitrogen) in the upper saturated groundwater zone can be closely approximated by the quality of percolating recharge waters. Considering the contributions from subsurface disposal of treated wastewater and natural sources picked up by rainfall leaching of soil and vegetation, the average concentration of nitrate-nitrogen in recharge water, n_r, is estimated using the following equation:

$$n_r = \frac{Wn_w(1-d) + Rn_b}{(W+R)}$$

Where:

n_r = resultant average concentration of NO_3-N in recharge water, mg-N/L

W = average annual volume of wastewater entering the soil, acre-ft/yr (AFY)

n_w = total nitrogen concentration of wastewater effluent, mg-N/L

d = fraction of NO_3-N lost due to denitrification and/or plant uptake in the soil

R = average annual volume of rainfall recharge from areas of the project site encompassing the dispersal field(s), AFY

n_b = background NO_3-N concentration of rainfall recharge at the water table resulting from atmospheric sources of nitrogen and percolation of rainwater through native soils, mg-N/L

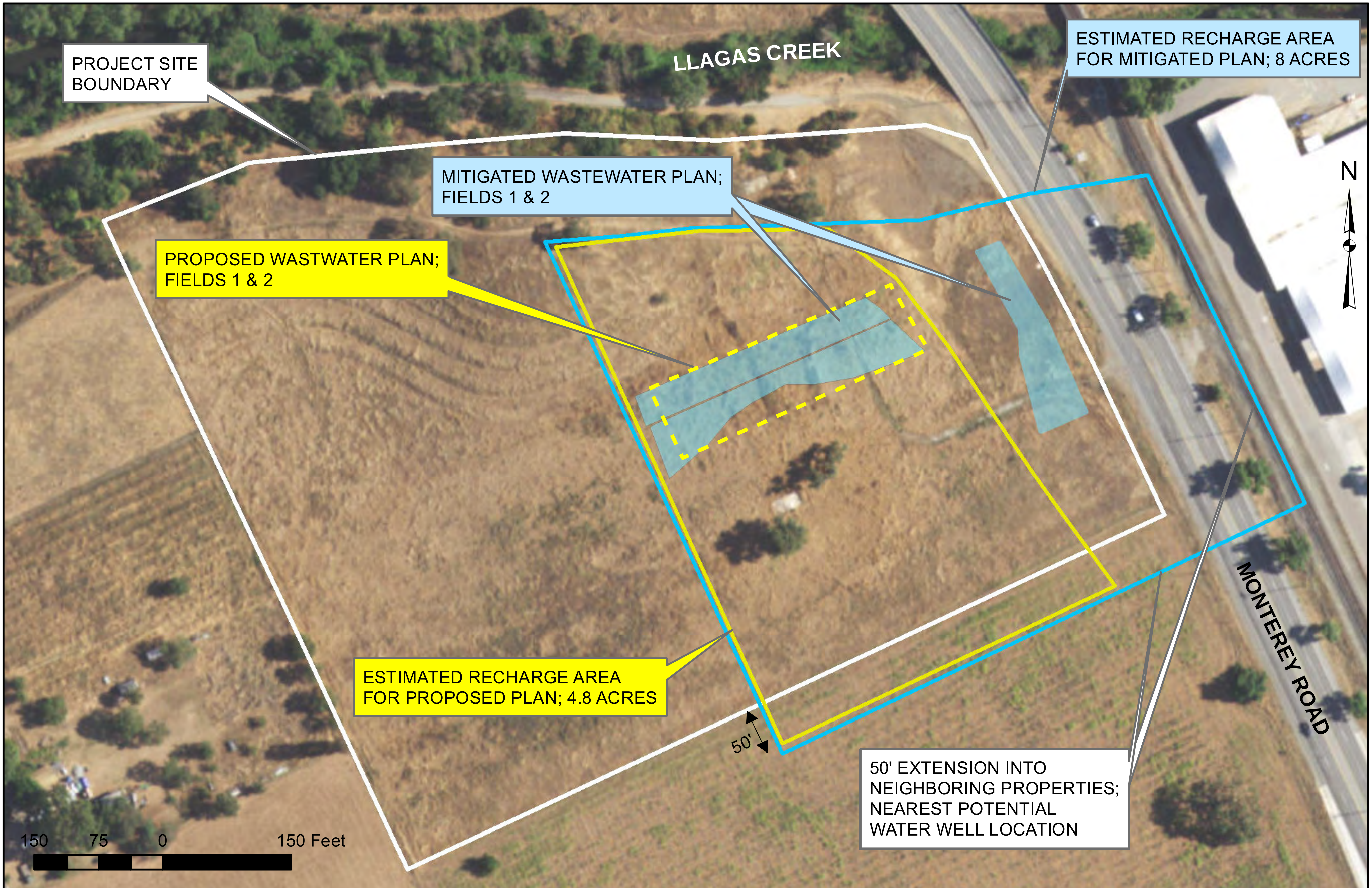
Data and Assumptions. Per the equation presented above, resultant nitrate-nitrogen concentration in the percolating water is estimated to be the weighted average or combined concentration due to wastewater loading and recharge of percolating rainfall ("deep percolation") contributed from the portion of the project site encompassing the wastewater disposal area(s). The following summarize the various assumptions.

- **Recharge Area.** Estimated recharge area differs for the proposed plan and mitigated plan based on the locations of the dispersal fields within the site, as depicted in **Figure 9:** (1) proposed plan – 4.8 acres; (2) mitigated plan - 8 acres. Per guidelines contained in the *Onsite Systems Manual*, the recharge area extends off-site to the nearest point of existing or potential water well(s), which is estimated to be a minimum of 50 feet into the neighboring properties to the east and south of the site.

- **Wastewater Volume.** The nitrate loading analysis was completed for an average annual wastewater discharge volume at of 3.7 acre-ft per year, based on an average daily flow of 3,300 gpd (75% of maximum occupancy flow conditions).

- **Wastewater Effluent Nitrogen Concentration.** Calculations were made for several different assumed effluent total nitrogen concentrations, 10, 15, 20 and 30 mg-N/L, in order to evaluate an appropriate limit for the treatment system design. This approach was taken since the applicant's wastewater system plan alludes to provision of denitrification, but does not include a proposed performance standard for nitrogen effluent concentration. Additionally, the proposed supplemental treatment system (Multi-Flo) is not certified or rated for nitrogen removal; it's capability for nitrogen removal is uncertain.

- **Soil Denitrification and Plant Uptake.** Total nitrogen removal in the soil due to denitrification is estimated to be 15 percent of the total nitrogen in the percolating wastewater effluent in well drained soils, such as the alluvial soils on the eastern portions of the site. This value is in agreement with estimates provided in the Final SNMP (SCVD, 2014). Higher values up to 25 percent would be reasonable for the heavier-textured loamy and sandy clay colluvial soils in the hillside drip field area proposed by the applicant. Additionally, since shallow drip dispersal methods will be used for effluent disposal, nitrogen removal via plant uptake will also occur, at least during the growing season. Studies of subsurface drip dispersal have documented total rates of nitrogen removal in subsurface drip dispersal systems of 30 to 70 percent of applied nitrogen (Beggs, 2011), including the effects of plant uptake as well as denitrification processes. Our analysis included calculations for 15-, 20-, 25- and 30-percent soil nitrogen removal to account for a reasonable but conservative (safe) range, taking into account effects of both soil denitrification and plant uptake.



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GROUNDWATER RECHARGE AREAS FOR NITRATE AND SALT LOADING ANALYSIS

FIGURE 9

- **Rainfall Recharge (Deep Percolation).** Rainfall recharge, also termed "deep percolation", is the portion of the seasonal rainfall that does not leave the site as runoff or through plant uptake or evaporation from land surface ("evapotranspiration"). The estimated rainfall recharge varies for different parts of the site according to the landscape surface conditions, slope and soils. Rainfall recharge was estimated using a monthly water balance analysis, which is presented along with supporting assumptions in **Appendix C**. From the analysis, the estimated rainfall recharge values for the project site were: (a) 5.79 inches per year (0.48 acre-ft per acre) for the hillside drip dispersal recharge area; and (b) 8.16 inches per year (0.68 acre-ft per acre) for the orchard drip field recharge area. Combining these recharge rates with the respective recharge areas resulted in estimated annual rainfall recharge volumes of: (1) 2.30 acre-ft per year for the proposed plan (4.8-acre recharge area); and (2) 4.48 acre-ft per year for the mitigated plan (8-acre recharge area).

- **Background Nitrate Concentration**. Estimated background nitrate concentration associated with percolating rainwater recharge was assumed to be 0.5 mg-N/L as there are no other sources of nitrogen additions/discharges within the identified recharge zones. (Note that the nitrogen loading effects from the proposed cemetery, which are addressed in a separate report by Questa, will occur on the western side of the project site and not within the identified recharge area encompassing the wastewater facilities.)

Results. Table 8 presents the estimated resultant nitrate-nitrogen concentration of percolating water for the proposed and mitigated plans for a range of wastewater effluent concentration limits and soil denitrification/plant uptake assumptions. Calculation spreadsheets are provided in **Appendix C.**

Table 8.
Estimated Localized Groundwater Nitrate-Nitrogen Concentration Impacts
Proposed and Mitigated Wastewater Disposal Plan[1] (mg-N/L)

Effluent Nitrogen[2] (mg-N/L)	Proposed Wastewater Disposal Plan — Nitrogen Removal via Soil Denitrification/Plant Uptake				Mitigated Wastewater Disposal Plan — Nitrogen Removal via Soil Denitrification/Plant Uptake			
	15%	20%	25%	30%	15%	20%	25%	30%
10	5.43	5.12	4.81	4.50	4.12	3.89	3.66	3.44
15	8.05	7.58	7.12	6.66	6.04	5.70	5.36	5.02
20	10.66	10.05	9.43	8.82	7.96	7.51	7.06	6.60
30	15.90	14.98	14.05	13.13	11.80	11.12	10.45	9.77

[1] At nearest potential neighboring water well location
[2] Assumed performance standard for supplemental treatment unit (monthly average)

Under Santa Clara County cumulative impact guidelines for nitrate loading analysis, an evaluation-compliance criterion of 7.5 mg-N/L or less is specified in areas served by individual water wells, determined at the point of an existing or potential future well; for areas not served by individual wells the evaluation criterion is 10 mg-N/L. Since there are no existing or proposed individual wells on the neighboring properties bordering the south[2] and east sides of the site, a 10 mg-N/L evaluation criterion may be justified. However, since individual water wells are common in the general project

2. Development on the 14-acre parcel to the south will obtain water service from West San Martin Water Works.

area, especially west and southwest of the project, a 7.5 mg-N/L evaluation criterion was judged to be appropriate for our analysis. Using the 7.5 mg-N/L criterion, **Table 8** (highlighted values) indicates the need for effluent nitrogen limits of: (1) 15 mg-N/L for the project's proposed wastewater disposal plan; and (2) 20 mg-N/L for the mitigated wastewater disposal plan.

The mitigated wastewater disposal plan including a 20 mg-N/L effluent nitrogen limit is recommended. This effluent limit is achievable with available practicable technology, but it is not assured with the Multi-Flo wastewater system currently proposed. Modifications to the proposed wastewater treatment system will be required. Wastewater effluent monitoring requirements should be established by the DEH as conditions of the operating permit for the project to provide on-going assurance that the system performs as required.

Three additional points should be noted:

(1) The proposed project includes a 3.5-acre cemetery on the western side of the site that also represents a significant source of nitrogen addition to the soils and groundwater. However, since the contributing recharge areas and groundwater flow directions for the cemetery and wastewater system do not overlap, their immediate down-gradient groundwater impacts were analyzed separately. Analysis of water quality impacts from the cemetery are covered in a separate report by Questa, also prepared under a sub-contracting agreement with Ascent Environmental, Inc., to provide technical analysis and recommendations for consideration in the environmental impact review of the project. The analysis addresses the estimated nitrate loading effects specifically from the cemetery on adjacent down-gradient properties. It also includes analysis of the extended cumulative effects on a broader local groundwater area, including the combined contributions from the proposed Cordoba cemetery and wastewater system, the proposed Patel RV Park, and existing septic systems serving the 14 nearby rural residences located west and southwest of the project site.

(2) In regard to the 14-acre vacant property to the south: (a) the ambient shallow groundwater nitrate-nitrogen concentration was determined to be 4.0 mg-N/L from water quality sampling in March 2016 (Questa Engineering, 2016); and (b) the proposed development on the property (Patel RV Park) includes the use of a wastewater treatment system (13,000 gpd flow) designed to meet a 10 mg-N/L effluent concentration (average) and use of sub-surface drip dispersal on the eastern side of the property for effluent disposal. The proposed wastewater system for the Cordoba Center, including the above analysis of nitrate loading and recommended effluent limitations, do not conflict with the plans and analysis for the neighboring project. Additionally, the combined effects of the wastewater systems for both the proposed Cordoba Center and Patel RV Park projects are addressed in the extended cumulative nitrate loading analysis contained in the cemetery water quality study noted in (1) above.

(3) The existing agricultural well on the southerly boundary of the project site lies within the projected wastewater recharge area and flow direction. Although currently inactive, if the well is refurbished and put into service for irrigation of site landscaping, this would have a beneficial effect in intercepting groundwater flow and associated nitrate, and returning the

nitrate to the landscaping for uptake by vegetation. This could provide an additional reduction in expected groundwater nitrate loadings generated by project. For example, if the well were to be operated at a rate of 1,500 gpd (average one gallon per minute) during the dry season (April through October), this diversion of water and onsite reuse would reduce the nitrate-nitrogen leaving the site by about 10 percent of the projected mass loadings estimated in the nitrate loading analysis above. An average irrigation volume of 1,500 gpd would roughly match the dry season water demands (26 inches) for approximately 20,000 square feet of vegetated landscaping.

Salt Loading

With the exception of distilled water, all water contains dissolved solids, which include various salts and other minerals such as calcium, chloride, magnesium, potassium, and sodium. Domestic wastes can increase the concentration of total dissolved solids (TDS) in the wastewater (as compared with the water supply) by about 200 mg/L, or greater where water softener brine is added (Crites and Tchobanoglous, 1998). Dissolved solids are not removed to any appreciable degree through onsite treatment systems (septic tanks or supplement treatment systems) or by passage through the soil. Therefore, the project's use of an onsite wastewater system would contribute to some incremental increase in the TDS levels in the groundwater beneath and down-gradient of the wastewater dispersal fields.

To estimate the cumulative effect of TDS loading on local groundwater quality from the proposed wastewater facilities, an annual loading analysis was completed similar to the previously described nitrate-nitrogen loading analysis. Analysis was done for two cases: (1) the proposed wastewater disposal plan as proposed by the applicant; and (2) the revised or mitigated wastewater disposal plan as recommended from our review. The methodology, assumptions and results are presented below.

Methodology. The salt loading analysis was completed using an annual chemical-water balance analysis, following the same approach as used for the nitrate-nitrogen loading analysis above. Under this approach, the long-term concentration of total dissolved solids in the upper saturated groundwater zone can be closely approximated by the quality of percolating recharge waters within the contributing recharge area on the property encompassing the wastewater disposal fields, including the combined effects from rainfall and wastewater percolation. Taking into account the contributions from the treated wastewater discharge and natural sources picked up by rainfall leaching of minerals from the soil, the average long-term concentration of TDS in recharge water ("percolate"), s_r, is estimated using the following equation:

$$s_r = \frac{W(s_s + s_w) + RS_b}{(W + R)}$$

where: s_r = resultant average concentration of TDS in recharge water leaving the property, mg/L

W = average annual volume of wastewater discharged to the soil, acre-ft/yr (AFY)

S_s = total dissolved solids concentration of water supply, mg/L

S_w = total dissolved solids addition from wastewater, mg/L

R = average annual volume of rainfall recharge from areas of the project site encompassing the disposal fields, AFY

S_b = background TDS concentration of rainfall recharge due to mineral pick-up from percolation through native soils, mg/L

Data and Assumptions. Per the equation presented above, resultant TDS concentration in the groundwater is estimated to be the weighted average or combined concentration due to wastewater loading and recharge of percolating rainfall ("deep percolation") contributed from the project site. The following summarize the various assumptions.

- **Recharge Area.** Estimated recharge area differs for the (1) proposed plan and (2) mitigated plan based on their locations within the site, as depicted in **Figure 9**: (1) proposed plan – 4.8 acres; (2) mitigated plan - 8 acres. Per guidelines contained in the *Onsite Systems Manual*, the recharge area extends off-site to the nearest point of existing or potential water well(s), which would extend a minimum of 50 feet into the neighboring properties to the east and south of the site.

- **Wastewater Volume.** The TDS loading analysis was completed for average annual wastewater discharge volume at of 3.7 acre-ft per year, based on an average daily flow of 3,300 gpd (75% of maximum occupancy flow conditions).

- **Wastewater TDS Concentrations**. Total dissolved solids concentration in wastewater effluent was assumed to be equal to the concentration in the domestic supply plus an average of 200 mg/L due to waste additions.

- **Domestic Supply.** Domestic water supply for the project will be provided by West San Martin Water Works, Inc., which has reported TDS values of 290 to 340 mg/L (2016 Consumer Confidence Report).

- **Wastewater TDS Addition**. Based on Crites and Tchobanoglous (1998) and SCVWD (2014), an average TDS addition of 200 mg/L was assumed to reflect the salt loading from residential sewage for average wastewater flow conditions.

- **Background TDS Concentration.** Estimated background TDS concentrations associated with percolating rainwater recharge was assumed to be 300 mg/L, per assumptions for "mountain front recharge" used in the "Final Salt and Nutrient Management Plan, Llagas Subbasin" (SCVWD, 2014).

- **Rainfall Recharge (Deep Percolation).** Estimated annual rainfall recharge volumes were the same as those used for the nitrate loading analysis: (1) 2.30 acre-ft per year for the proposed plan (4.8-acre recharge area); and (2) 4.48 acre-ft per year for the mitigated plan (8-acre recharge area).

Results. Table 9 summarizes the results of the analysis, along with reference groundwater TDS concentration data for comparison. Spreadsheet calculations are provided in **Appendix C**.

Table 9.
Estimated Localized Groundwater TDS Changes due to Proposed and Mitigated Wastewater Disposal Plan

Source Water TDS Concentration (mg/L)	Estimated Resultant TDS from Project Wastewater Disposal, mg/L		Reference TDS Concentrations, mg/L		
	Proposed Wastewater Disposal Plan	Mitigated Wastewater Disposal Plan	Nearest Well, South of Site	Llagas Subbasin, Northern Sallow Aquifer	Drinking Water Standard
290	417	386	350 to 400	300 to 500	500
340	448	409			

The calculations show resultant TDS concentration of affected percolating water to be in range of 386 to 448 mg/L, based on an assumed range of TDS concentration in the potable supply ranging from 290 to 340 mg/L. Based on the estimated background recharge concentration of 300 mg/L for percolating rainfall, the proposed wastewater disposal system for the proposed project would contribute to a localized incremental increase in percolate TDS concentration of about 120 to 150 mg/L for the proposed plan, and 90 to 110 mg/L for the mitigated plan. The resultant TDS concentrations of 386 to 448 mg/L are within the secondary drinking water TDS standard of 500 mg/L. The resultant TDS concentrations are also comparable with existing background TDS concentrations in the northern Shallow Aquifer of the Llagas Groundwater Subbasin, reported to be generally in the range of 300 to 500 mg/L, and 350 to 400 mg/L in the well closest to (south of) the project site (SCVWD, 2014). Based on this analysis, the salt (TDS) loading impacts of the proposed project will be localized and at levels that would not cause a significant impact to the aquifer or any existing water supply wells. By distributing the wastewater over a broader portion of the site and down-gradient areas, the mitigated wastewater disposal plan would produce lower TDS concentration changes in down-gradient areas south of the project site.

It should also be noted that, as described previously in regard to nitrate loading analysis, the salt loading effects of the proposed cemetery and the extended cumulative impacts from the Cordoba project, neighboring Patel project, and nearby rural residences are addressed in a separate water quality study of the cemetery prepared by Questa.

SUMMARY AND RECOMMENDATIONS

1. Wastewater design flows presented in the proposed wastewater plans are estimated safely based on maximum occupancy and unit wastewater flows in accordance with County requirements and guidelines. Actual flows on a weekly and monthly basis can be expected to

be in the range of 50 to 75 percent of design flows.

2. The project site has suitable soil, groundwater and other conditions for onsite wastewater disposal, and capacity for the projected wastewater flows expected by the project.

3. The proposed septic tanks (for primary treatment) and flow equalization system are appropriate and adequately sized according to County requirements and guidelines.

4. The proposed supplemental/secondary wastewater treatment system (Multi-Flo) has proper NSF 40 certification (as required by the *Onsite Systems Manual*) for production of secondary quality wastewater effluent required for use with drip dispersal; however, it does not have design features or demonstrated capability for significant nitrogen removal which will be required for the project.

5. Based on cumulative analysis of nitrate loading impacts, the wastewater treatment system should be redesigned to meet a recommended 20 mg-N/L effluent nitrogen limit (average). This effluent limit is achievable with available practicable technology, but it is not assured with the Multi-Flo wastewater system currently proposed. Wastewater effluent monitoring requirements should be established by the DEH as conditions of the operating permit for the project to provide on-going assurance that the system performs as required. At a minimum, monitoring requirements should include: (a) daily wastewater flow; and (b) monthly effluent sampling and analysis for biochemical oxygen demand (BOD) and total nitrogen (sum of total kjekdahl nitrogen and nitrate-nitrogen).

6. The proposed use of subsurface drip dispersal methods is suitable for the soil conditions and percolation test findings in the selected areas. However, the proposed design does not consider two important factors: (1) the overall hydraulic loading in a relatively small, concentrated area underlain by "stiff sandy clay" subsoils at a shallow depth (4 feet); and (2) positioning of the wastewater disposal field immediately upslope (10 to 25 feet) from a proposed graded cut slope (5-feet high) on the north side of the playground and recreation areas. These factors pose the risk of an unacceptable level of saturation (groundwater "mounding") beneath the drip fields and strong possibility of lateral seepage of inadequately treated effluent at the proposed cut slope downhill. Additionally, the proposed drip field layout for the caretaker's residence wastewater system encroaches upon the required setback to the existing graded cut slope on the east side of the property and requires reconfiguration.

7. Mitigation of the potential significant impacts of the proposed wastewater disposal plan noted in (6) above can achieved by reducing the hydraulic loading to the proposed hillside drip field and increasing lateral, down-slope setback to the proposed cut slope. This can be accomplished by: (a) eliminating the lower drip dispersal field shown on the proposed project wastewater plan; (b) confining drip dispersal to the area higher up on the slope in this area; (c) extending the drip field a greater distance laterally across the slope (250 to 300 feet); and (d) developing an additional alternate drip disposal field in the orchard area on the east side of property with capacity for 50 percent of the design wastewater flow.

8. A water-chemical mass balance analysis was completed to assess the potential long-term effect on local groundwater nitrate concentrations in the area of the wastewater disposal fields and adjacent properties. The analysis indicates nitrate concentrations of less than 7.5 mg-N/L at the nearest potential water well location (50 feet into adjoining properties) can be achieved with the incorporation of wastewater treatment facilities meeting an effluent concentration of 20 mg-N/L (average). This is consistent with the guidelines, methodology and criteria contained in the *Onsite Systems Manual.*

9. A water-chemical mass balance analysis similar the nitrate loading analysis was completed to assess the potential long-term effect on local TDS concentrations in groundwater in the area of the wastewater disposal fields and adjacent properties. The results show the TDS loading impacts will be localized, with resultant concentrations increasing by 90 to 110 mg/L for the mitigated wastewater plan recommendations. The estimated resultant concentrations of 386 to 409 mg/L are within the secondary drinking water TDS standard of 500 mg/L, and would not cause a significant impact to the aquifer or any existing water supply wells.

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Appendix A

Proposed Wastewater Facilities Plan Sheets
and
Soils Documentation

Excel spread sheet set up to show maximum daily wastewater flows and that a system set up to treat and dispose of up to 6000 gallons a day is adequate to handle them

DAY	DAY VISITORS (15 GPD)	STAFF (15 GPD)	CAMPERS (35 GPD)	GALLONS OF WASTEWATER	GALLONS PUMPED	GALLONS LEFT IN TREATMENT TANK
FRIDAY	500	2	0	7530	6000	1530
SATURDAY	212	2	48	4890	6000	420
SUNDAY	364	2	48	7170	6000	1590
MONDAY	212	5	48	4935	6000	525
TUESDAY	212	5	48	4935	6000	-540
WEDNESDAY	212	5	48	4935	6000	-1605
THURSDAY	212	5	48	4935	6000	-2670
TOTAL	1924	26	288	39330	42000	

Excerpt from County's Onsite Manual

3. Flow Equalization. Flow equalization may be used for non-residential and mixed use facilities that experience significant, regular and predictable fluctuations in wastewater flows. Examples of applicable facilities include, but are not limited to:

Churches
Schools
Special event venues

Flow equalization is the process of controlling the rate of wastewater flow through an OWTS by providing surge capacity storage and timed-dosing of the incoming flow. Installed following the septic tank, it allows peak surges in wastewater flow (e.g., from a weekend event) to be temporarily stored and metered into the treatment system and/or dispersal field at a relatively even ("average") rate over an extended number of days (e.g., during the subsequent week). This generally aids OWTS performance. Where flow equalization is proposed to be incorporated in an OWTS the following apply:

a. the septic tank capacity shall be sized based on the peak daily flow for the facility;
b. the design flow used for sizing supplemental treatment unit(s) and/or the dispersal field may be based on the equalized ("average") flow rate rather than the peak daily flow rate for the facility;
c. engineering calculations and specifications must be submitted substantiating the proposed design and operation of the flow equalization system; and
d. an operating permit (per OWTS Ordinance section B11-92) will be required.

Note:
Vehicles will not be washed on site except for golf cart type vehicles located in inside their covered storage area, there will be no significant wastewater generated by this process.

ALTERNATIVE SYSTEMS

The septic systems shown here incorporate the use of NSF 40 certified treatment units (a Multiflo) and shallow drip system dispersal of effluent to enhance the treatment of this wastewater stream and reduce any potential pollutants before they can contaminate the ground water.

The drip disposal system was designed using Geoflow (manufacturer of the the drip tubing and much of he hardware) and County criteria. Excel spreadsheets with design criteria are attached.

The treatment system is NSF 40 certified and a supplement for the owner and /County contains the operation and maintenance guidelines for it.

Since these are alternative systems in Santa Clara County, the County requires that the owner obtain an operating permit from them (has to be renewed every year and has annual fees) and hire a company to maintain the system as a condition of issuing the permit to allow its installation.

from County Onsite Manual

Dripfield Sizing

a. Minimum sizing of the dripfield area shall be equal to the design wastewater flow divided by the applicable wastewater application rate from **Table DD-1**.

b. For sizing purposes, effective ground surface area used for drip field sizing calculations shall be limited no more than 4.0 square feet per drip emitter. For example, 200 lineal feet of dripline with emitters at 2-foot spacing would provide a total of 100 emitters (200/2) and could be used for dispersal to an effective area of up to 400 ft² (100 emitters x 4 ft²/emitter). Conversely, if wastewater flow and percolation design information indicate the need for an effective area of 1,000 ft², the dripline design and layout would have to be configured to provide a minimum of 250 emitters spaced over the required 1,000 ft² dispersal area.

PAGE KEY

Attendance notes by Kim Tschantz, MSP, CEP of Cypress Environmental and Land Use Planning

Note for Friday: The 502 figure (500 a day-users + 2 staff) represents maximum attendance during special events, which will only occur 4 times/year. Two special event days will be on Friday and the other two on a weekend day. No summer camp sessions will occur during a special event day. Normally, Friday maximum attendances will be 302; or 350 if occurring during a summer camp session.

Note for Saturday: The 262 figure (212 day-users + 2 staff + 48 summer campers) represents maximum attendance on a Saturday.

Note for Sunday: The 414 figure (362 day-users + 2 staff + 48 summer campers) represents maximum attendance on a weekend when either a wedding or a funeral service is held. Sunday attendance includes Youth Sunday School which does not occur on Saturday.

Note for Monday--Thursday: This figure (217 day-users + 48 summer campers) represents maximum attendance when there could be up to 200 people attending all prayer service that day and 12 other people at a scheduled meeting in the community building and the summer youth camp is occurring and 5 weekday staff are also on the site.

PROJECT DISCUSSIONS

This plan was prepared to show where septic leach fields and septic tanks can fit and how they will be installed on this property to serve the expected volumes of wastewater. There are two classes of wastewater to be generated on this site, non-residential and residential.

The non-residential wastewater flow is composed of the flow from the campsite bathrooms, the maintenance building, the Mosque, and the Community Building. The maximum daily wastewater flow is based on the projected maximum number of users times the estimated flow from the associated activity from **Table 3-2, Wastewater Design Flow Guidelines, Multiunit and Non-residential Facilities** found in the County's **Onsite System Manual**.

1. The main buildings are expected to have water use similar to a church with a kitchen (15 gallons per day per person). The expected daily maximum attendance is discussed in the attached notes from Cypress Environmental and land Use Planning, and shown in the attached Excel Spreadsheet.
2. The Camp area has two bathrooms and will serve a total of no more than 48 people a day. The camp area bathrooms represent a possible wastewater flow of 35 gallons a day per visitor for a total of 1680 gallons.
3. The maintenance building will have two to five daily employees, who will use the restroom facilities located in this and other non-residential buildings. At 15 gallons per person per day this represents a daily wastewater flow of 30 to 75 gallons a day.

All of the non-residential flows will be treated and disposed of in the same wastewater treatment and disposal system. The total maximum daily wastewater flow that this system will need to handle is 7,530 gallons a day (see Friday use numbers on attached Excel Spreadsheet).

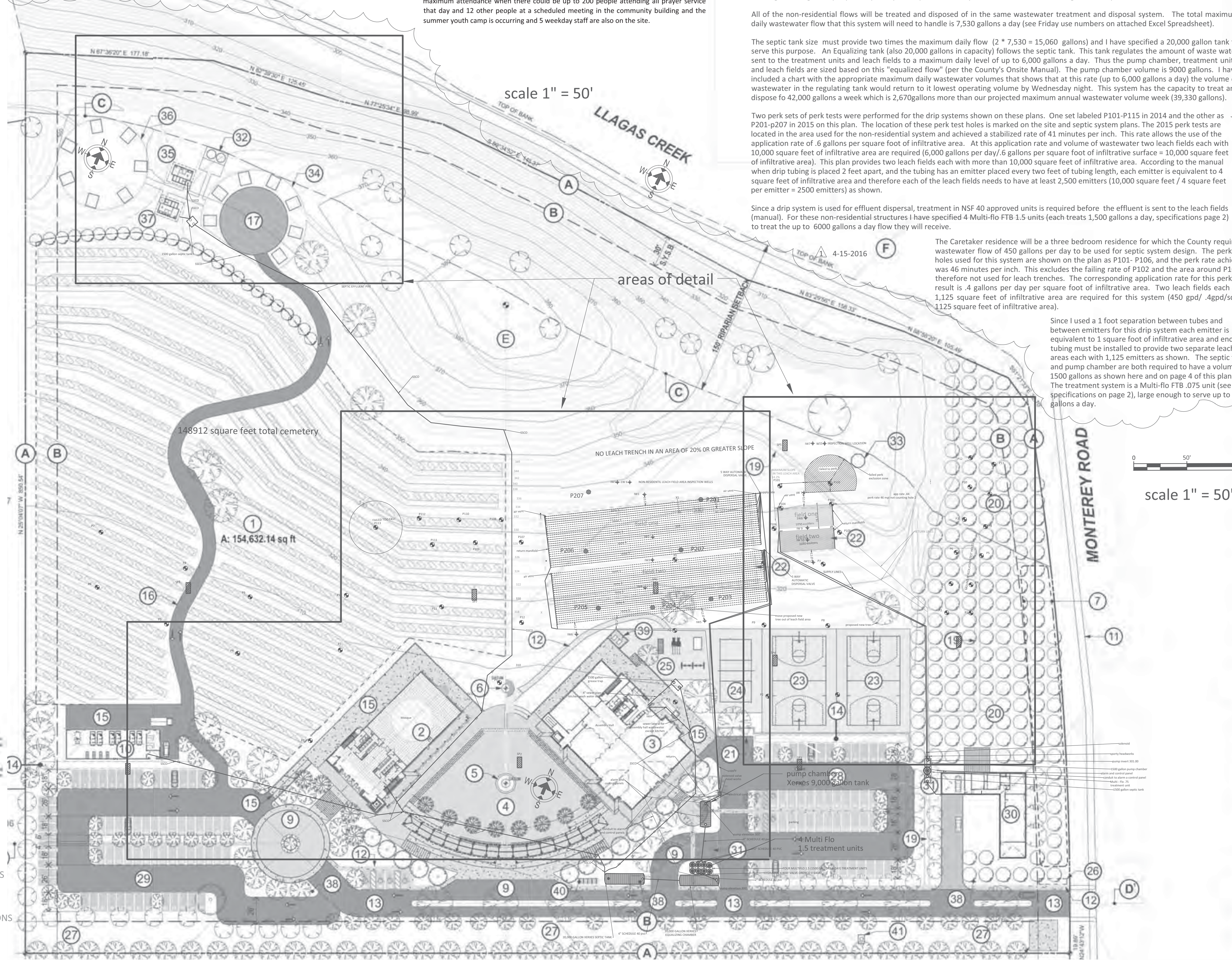
The septic tank size must provide two times the maximum daily flow (2 * 7,530 = 15,060 gallons) and I have specified a 20,000 gallon tank to serve this purpose. An Equalizing tank (also 20,000 gallons in capacity) follows the septic tank. This tank regulates the amount of waste water sent to the treatment units and leach fields to a maximum daily level of up to 6,000 gallons a day. Thus the pump chamber, treatment units, and leach fields are sized based on this "equalized flow" (per the County's Onsite Manual). The pump chamber volume is 9000 gallons. I have included a chart with the appropriate maximum daily wastewater volumes that shows that at this rate (up to 6,000 gallons a day) the volume of wastewater in the regulating tank would return to it lowest operating volume by Wednesday night. This system has the capacity to treat and dispose fo 42,000 gallons a week which is 2,670gallons more than our projected maximum annual wastewater volume week (39,330 gallons).

Two perk sets of perk tests were performed for the drip systems shown on these plans. One set labeled P101-P115 in 2014 and the other as P201-p207 in 2015 on this plan. The location of these perk test holes is marked on the site and septic system plans. The 2015 perk tests are located in the area used for the non-residential system and achieved a stabilized rate of 41 minutes per inch. This rate allows the use of the application rate of .6 gallons per square foot of infiltrative area. At this application rate and volume of wastewater two leach fields each with 10,000 square feet of infiltrative area are required (6,000 gallons per day/.6 gallons per square foot of infiltrative surface = 10,000 square feet of infiltrative area). This plan provides two leach fields each with more than 10,000 square feet of infiltrative area. According to the manual when drip tubing is placed 2 feet apart, and the tubing has an emitter placed every two feet of tubing length, each emitter is equivalent to 4 square feet of infiltrative area and therefore each of the leach fields needs to have at least 2,500 emitters (10,000 square feet / 4 square feet per emitter = 2500 emitters) as shown.

Since a drip system is used for effluent dispersal, treatment in NSF 40 approved units is required before the effluent is sent to the leach fields (manual). For these non-residential structures I have specified 4 Multi-flo FTB 1.5 units (each treats 1,500 gallons a day, specifications page 2) to treat the up to 6000 gallons a day flow they will receive.

The Caretaker residence will be a three bedroom residence for which the County requires a wastewater flow of 450 gallons per day to be used for septic system design. The perk test holes used for this system are shown on the plan as P101- P106, and the perk rate achieved was 46 minutes per inch. This excludes the failing rate of P102 and the area around P102 is therefore not used for leach trenches. The corresponding application rate for this perk test result is .4 gallons per day per square foot of infiltrative area. Two leach fields each with 1,125 square feet of infiltrative area are required for this system (450 gpd/ .4gpd/sqft = 1125 square feet of infiltrative area).

Since I used a 1 foot separation between tubes and between emitters for this drip system each emitter is equivalent to 1 square foot of infiltrative area and enough tubing must be installed to provide two separate leach areas each with 1,125 emitters as shown. The septic tank and pump chamber are both required to have a volume of 1500 gallons as shown here and on page 4 of this plan. The treatment system is a Multi-flo FTB .075 unit (see specifications on page 2), large enough to serve up to 750 gallons a day.



LEGEND

1. Cemetery
2. Mosque of The Cordoba Center
3. Community Building
4. Community Plaza
5. Fountain of the Community
6. Fountain of Memory
7. Landscape Berm
8. Utility/ service entry
9. Drop Off Area
10. Maintenance Building
11. Proposed Public Sidewalk
12. Site Accessible Path
13. Public Vehicular Access
14. Biofiltration Swale
15. Service Driveway
16. Cemetery Driveway/ Fireroad
17. Hearse/ Firetruck Turnaround
18. Path to Atherton Pond (existing)
19. Hiking Trail
20. Orchard
21. Solid Waste Service Area
22. Wastewater Treatment Area
23. Basketball Court
24. Volleyball Court
25. Playground
26. Stormwater Ret. Chamber
27. Biofiltration & Retention Swale
28. Parking Lot 'A'
29. Parking Lot 'B'
30. Caretaker Residence
31. Wastewater Processing System
32. Water Storage Tanks
33. Ramada
34. Girl's Tent Camp
35. Girl's Bathhouse
36. Boy's Tent Camp
37. Boy's Bathhouse
38. Fire Hydrant
39. HVAC Vault
40. Bicycle Racks
41. (E) abandoned/ (N) irrig well

REGULATING LINES

A. Property line
B. Setback line
C. Riparian Setback line
D. Line of the Ordinary
E. Line of Nature
F. Line of the Qibiah

site plan by Daniel Mathew Silvernail, Architect

MATERIALS KEY

- CONCRETE
- AGGREGATE BASE (AB) SURFACING
- ASPHALTIC CONCRETE
- OPEN-GRADED (PERMEABLE) ASPHALTIC CC
- TURF BLOCK

REVISIONS	
1 4-15-2016 COUNTY COMMENTS	SRH

REGISTERED ENVIRONMENTAL HEALTH SPECIALIST STEVEN R. HARTSELL # 5979 Exp. 12-31-2017 STATE OF CALIFORNIA

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SITE PLAN
SEPTIC
SYSTEM

CORDOBA CENTER
14045 MONTEREY ROAD
SAN MARTIN, CA 95046
APN 779-06-002

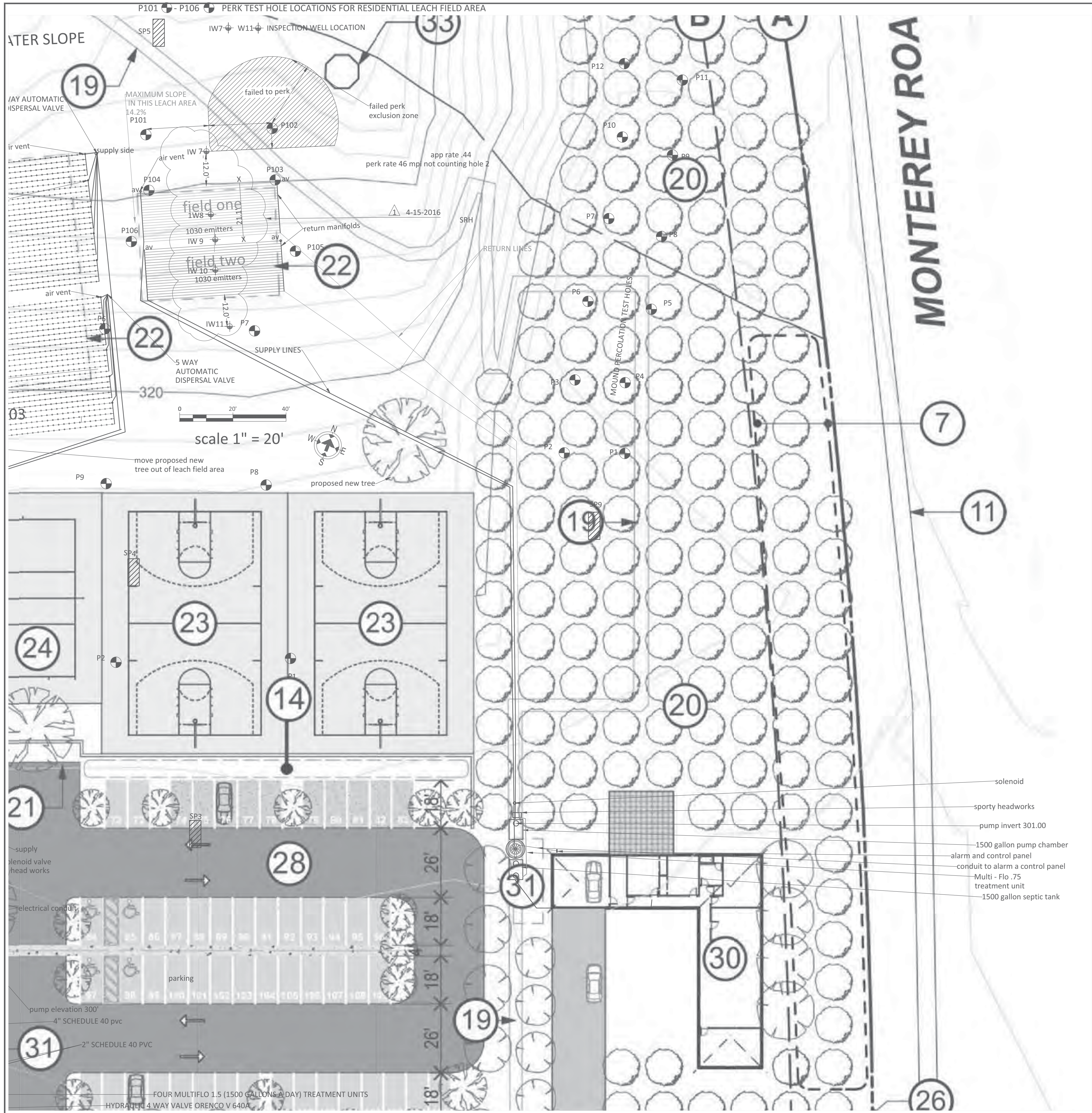
November 30, 2015

SCALE AS NOTED

BY SRH

PAGE

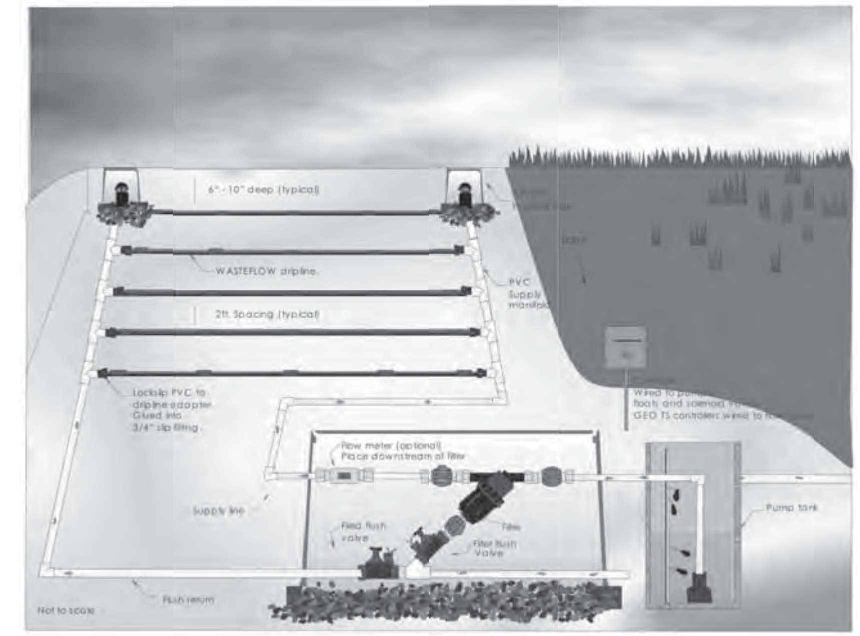
SEPTIC 1



Geoflow simplified version of drip system layout, not to scale

Diagram I: Typical Dripfield Layout

Single Family Home



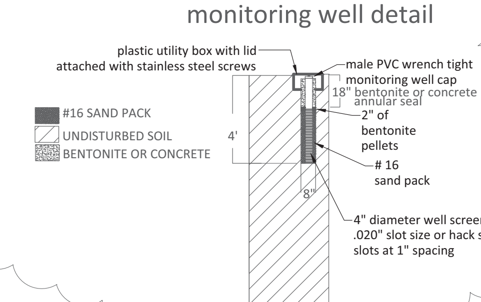
REVISIONS

1 4-15-2016

The Caretaker residence will be a three bedroom residence for which the County requires a wastewater flow of 450 gallons per day to be used for septic system design. The perk test holes used for this system are shown on the plan as P101- P106, and the perk rate achieved was 46 minutes per inch. This excludes the failing rate of P102 and the area around P102 is therefore not used for leach trenches. The corresponding application rate for this perk test result is .4 gallons per day per square foot of infiltrative area. Two leach fields each with 1,125 square feet of infiltrative area are required for this system (450 gpd/ .4gpd/sqft = 1125 square feet of infiltrative area).

Since I used a 1 foot separation between tubes and between emitters for this drip system each emitter is equivalent to 1 square foot of infiltrative area and enough tubing must be installed to provide two separate leach areas each with 1,125 emitters as shown. The septic tank and pump chamber are both required to have a volume of 1500 gallons as shown here and on page 4 of this plan. The treatment system is a Multi-flo FTB .075 unit, large enough to serve up to 750 gallons a day.

monitoring well detail



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RESIDENTIAL SEPTIC SYSTEM PLAN

CORDOBA CENTER
14045 MONTEREY ROAD
SAN MARTIN, CA 95046
APN 779-06-002

November 30, 2015

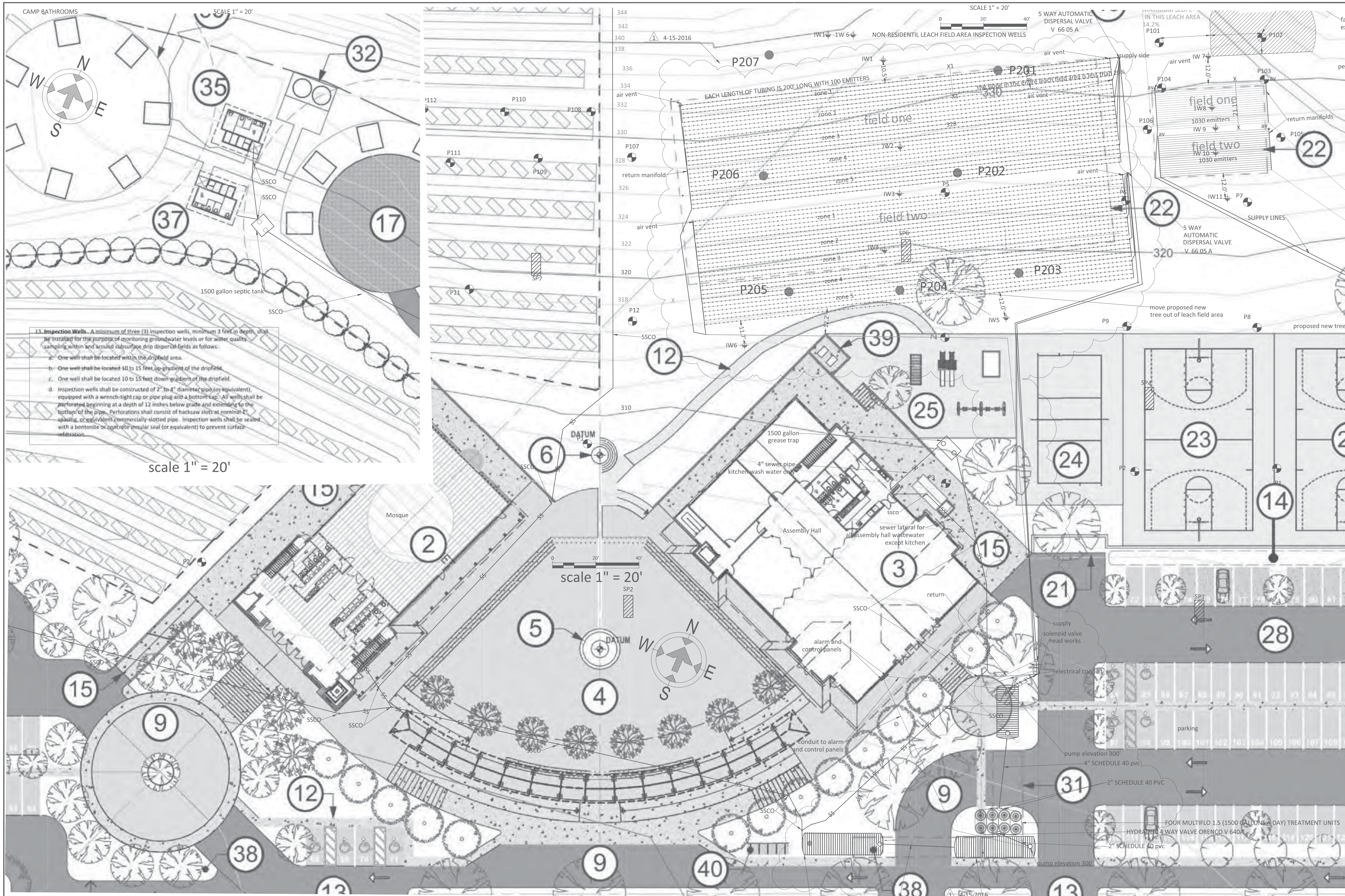
SCALE AS NOTED

BY SRH

PAGE

SEPTIC 4

P 201 - P207 PERK TEST HOLE LOCATIONS FOR NON-RESIDENTIAL LEACH FIELD AREA



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NON-RESIDENTIAL SYSTEM LAYOUT

CORDOBA CENTER
14045 MONTEREY ROAD
SAN MARTIN, CA 95046
APN 779-06-002

November 30, 2015

SCALE AS NOTED

BY SRH

PAGE

SEPTIC 6

SOIL PROFILES FROM 2008 TESTING

2015 PERK TEST RESULTS

1 4-15-2016

PERK TEST RESULTS AND APPLICATION RATES
NON-RESIDENTIAL LEACH FIELD AREA

PERK TEST RESULTS AND APPLICATION RATES
RESIDENCE LEACH FIELD AREA

Santa Clara County – Department of Environmental Health
SOIL PERCOLATION TEST RECORDED MEASUREMENTS

number 101 on site plan

number 102 on site plan

number 103 on site plan

number 104 on site plan

number 105 on site plan

number 106 on site plan

BATZ ENVIRONMENTAL CONSULTING
ONSITE WASTEWATER DESIGNS • PERCOLATION TESTS • SOIL PROFILES
MICHAEL BATZ, REHS – CONSULTANT

SOIL PROFILE INSPECTION RESULTS

HOLE # SP1 · SP2 · SP3 · SP4

COMMENTS: 1/2

106 Marcela Drive, Watsonville, CA 95076 • Office (831) 724-2223 • Fax (831) 724-2338

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ONSITE WASTEWATER DESIGNS • PERCOLATION TESTS • SOIL PROFILES
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SOIL PROFILE INSPECTION RESULTS

HOLE # SP6 · SP7 · SP8 · SP9

COMMENTS: 2/2

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Santa Clara County – Department of Environmental Health
SOIL PERCOLATION TEST RECORDED MEASUREMENTS

number 201 on site plan

number 202 on site plan

number 203 on site plan

number 204 on site plan

number 205 on site plan

number 206 on site plan

number 207 on site plan

1 4-15-2016

some of the perk tests done 2014 were subsequently designated as cemetery area

Santa Clara County – Department of Environmental Health
SOIL PERCOLATION TEST RECORDED MEASUREMENTS

number 107 on site plan

number 108 on site plan

number 110 on site plan

number 111 on site plan

number 112 on site plan

number 114 on site plan

number 115 on site plan

1 4-15-2016

RESULTS OF RECENT PERCOLATION TESTS PERFORMED FOR CURRENT DRIP SYSTEM DESIGN

The first set of percolation test holes shown on the site plan as P101-P106 were done for the area to be used for the drip leach field area for the caretaker residence, and produced an average stabilized percolation rate fo 46 minutes per inch when calculated as directed by Santa Clara Environmental Health. The application rate allowed for this percolation rate is .4 gallons per square foot of infiltrative surface according to the County's Onsite Design Manual Table DD-1, and this rate was used to design that leach field.

The perk test performed in 2015 in the area where the leach fields that serve the non-residential portion of this project are labeled P201-P207. The location of these perk test holes is marked on the site and septic system plans. The average rate achieved in this test was 41 minutes per inch which allows the use of the application rate of .6 gallons per square foot of infiltrative area. By utilizing flow equalization the leach field will only receive 6,000 gallons a day. Therefore two leach fields each with 10,000 square feet of infiltrative area are required and shown on the plan.

source fo table is the County's Onsite Design Manual

Table DD-1. Wastewater Application Rates for Subsurface Drip Dispersal Fields

Soil Type*	Soil Percolation Rate (MPI)	Wastewater Application Rate (gpd/ft^2)
Coarse Sand	1-4	1.4
Fine Sand	5-10	1.2
Sandy Loam	11-20	1.0
Loam	21-30	0.7
Clay Loam	31-45	0.6
Silt-Clay Loam	46-60	0.4
Clay, non-swell	61-90	0.2
Clay, swell	91-120	0.1

*Soil types listed for reference information only; design shall be based on site-specific percolation data.

MAJOR BUILDING
LEACH AREA
APPLICATION RATE

RESIDENCE
LEACH AREA
APPLICATION RATE

PERCOLATION TEST DATA FROM 2008 TESTING

BATZ ENVIRONMENTAL CONSULTING
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OWNER/APPLICANT: Sal Akhter
CONDUCTED BY: MB
CHECKED BY: AP
BEC FILE No.: 06-SCC-021
SITE LOCATION: Monterey Rd., San Martin – LOT 2
DATE: 11/08/06
APN:

Hole #	Stabilized Rate (MPI)	Adj. factor is 1.4	Adjusted Rate (MPI)	Hole Depth
P1	80		112.00	7.0'
P2	80		112.00	4.0'
P3	73.33		102.66	5.0'
P10	40		56.00	5.0'
P11	80		112.00	7.0'
P12	80		112.00	7.0'

Average (6 Tests) 108.85

Page 1 of 1

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Page 3 of 3

REVISIONS
1 4-15-2016 COUNTY COMMENTS SRH

REGISTERED ENVIRONMENTAL HEALTH SPECIALIST
STEVEN R. HARTSELL
5979
Exp. 12-31-2017
STATE OF CALIFORNIA

S.R. HARTSELL, R.E.H.S.
P.O. BOX 342
PACIFICA, CA 94044
srhartsell@gmail.com (650) 888-2419

SOIL INFORMATION
SEPTIC SYSTEM
PLAN

CORDOBA CENTER
14045 MONTEREY ROAD
SAN MARTIN, CA 95046
APN 779-06-002

November 30, 2015

SCALE AS NOTED

BY SRH

PAGE

SEPTIC 2

MOUND

BATZ ENVIRONMENTAL CONSULTING

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Mound Percolation Test Results

	A	B	C	D	E	F	G	H	I
1	OWNER/APPLICANT: Sal Akhter				BEC FILE No.:06-SCC-021				
2	CONDUCTED BY: M. Batz				SITE LOCATION: Monterey Rd., San Martin				
3	CHECKED BY: A. Peden				DATE: 12/20/06				
4					APN:				
5									
6				Stabilized					
7			Hole #	Rate (MPI)		Hole Depth			
8									
9			P1	42.67		1.0'			
10			P2	66.67		2.0'			
11			P3	21.82		1.5'			
12			P4	38.1		2.0'			
13			P5	28.89		1.5'			
14			P6	9.73		1.0'			
15			P7	5.9		1.5'			
16			P8	7.83		2.0'			
17			P9	13.36		1.0'			
18			P10	10.43		1.0'			
19			P11	26.67		1.5'			
20			P12	17.14		1.5'			
21									
22		Average (12 Tests)		24.100					
23									
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									

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Mound Percolation Test Results

OWNER/APPLICANT: Sal Akhter — BEC FILE No.:06-SCC-021

CONDUCTED BY: M. Batz — SITE LOCATION: Monterey Rd., San Martin

CHECKED BY: A. Peden — DATE: 12/20/06

APN:

HOLE #1 DIA. 12" DEPTH: 1.0' SOIL TYPE

READING	START TIME	INITIAL WATER LEVEL	READING TIME	FINAL WATER LEVEL	TIME INTERVAL	WATER DROP	PERCOLATION RATE IN/ HR	RATE MPI
1	10:10	19.125	10:40	18.250	30	0.875	1.75	34.29
2	10:40	19.250	11:10	18.500	30	0.750	1.50	40.00
3	11:10	19.500	11:40	18.750	30	0.750	1.50	40.00
4	11:40	19.500	12:10	18.875	30	0.625	1.25	48.00
5	12:10	19.625	12:40	18.875	30	0.750	1.50	40.00
6	12:40	19.625	1:10	18.875	30	0.750	1.50	40.00
							Avg. of Last 3 =	42.67

STABILIZED RATE

42.67 mpi

HOLE #2 DIA. 12" DEPTH:2.0' SOIL TYPE

READING	START TIME	INITIAL WATER LEVEL	READING TIME	FINAL WATER LEVEL	TIME INTERVAL	WATER DROP	PERCOLATION RATE IN/ HR	RATE MPI
1	10:11	19.000	10:41	18.375	30	0.625	1.25	48.00
2	10:41	19.250	11:11	18.500	30	0.750	1.50	40.00
3	11:11	19.250	11:41	18.750	30	0.500	1.00	60.00
4	11:41	19.250	12:11	18.875	30	0.375	0.75	80.00
5	12:11	19.375	12:41	18.875	30	0.500	1.00	60.00
6	12:41	19.375	1:11	18.875	30	0.500	1.00	60.00
							Avg. of Last 3 =	66.67

STABILIZED RATE

66.67 mpi

NOTES:

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Mound Percolation Test Results

	A	B	C	D	E	F	G	H	I
1	OWNER/APPLICANT: Sal Akhter					BEC FILE No.:06-SCC-021			
2	CONDUCTED BY: M. Batz					SITE LOCATION: Monterey Rd., San Martin			
3	CHECKED BY: A. Peden					DATE: 12/20/06			
4						APN:			
5									
6	HOLE #3		DIA. 12"		DEPTH: 1.5'		SOIL TYPE		
7			INITIAL					PERCOLATION	RATE
8	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
9		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
10	1	10:12	25.500	10:42	24.000	30	1.500	3.00	20.00
11	2	10:42	25.625	11:12	24.125	30	1.500	3.00	20.00
12	3	11:12	25.625	11:42	24.125	30	1.500	3.00	20.00
13	4	11:42	25.625	12:12	24.250	30	1.375	2.75	21.82
14	5	12:12	25.625	12:42	24.250	30	1.375	2.75	21.82
15	6	12:42	25.625	1:12	24.250	30	1.375	2.75	21.82
16								Avg. of Last 3 =	21.82
17									
18									
19	STABILIZED RATE								
20	21.82 mpi								
21									
22									
23	HOLE #4		DIA. 12"		DEPTH:2.0'		SOIL TYPE		
24			INITIAL					PERCOLATION	RATE
25	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
26		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
27	1	10:18	15.500	10:43	14.500	25	1.000	2.40	25.00
28	2	10:43	15.625	11:13	14.625	30	1.000	2.00	30.00
29	3	11:13	15.625	11:43	14.750	30	0.875	1.75	34.29
30	4	11:43	15.625	12:13	14.750	30	0.875	1.75	34.29
31	5	12:13	15.625	12:43	14.875	30	0.750	1.50	40.00
32	6	12:43	15.625	1:13	14.875	30	0.750	1.50	40.00
33								Avg. of Last 3 =	38.10
34									
35	STABILIZED RATE								
36	38.10 mpi								
37									
38									

NOTES:

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Mound Percolation Test Results

	A	B	C	D	E	F	G	H	I
1	OWNER/APPLICANT: Sal Akhter					BEC FILE No.:06-SCC-021			
2	CONDUCTED BY: M. Batz					SITE LOCATION: Monterey Rd., San Martin			
3	CHECKED BY: A. Peden					DATE: 12/20/06			
4						APN:			
5									
6	HOLE #5		DIA. 12"		DEPTH: 1.5'		SOIL TYPE		
7			INITIAL					PERCOLATION	RATE
8	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
9		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
10	1	10:14	18.250	10:44	17.250	30	1.000	2.00	30.00
11	2	10:44	18.250	11:14	17.250	30	1.000	2.00	30.00
12	3	11:14	18.250	11:44	17.125	30	1.125	2.25	26.67
13	4	11:44	18.250	12:14	17.125	30	1.125	2.25	26.67
14	5	12:14	18.250	12:44	17.250	30	1.000	2.00	30.00
15	6	12:44	18.250	1:14	17.250	30	1.000	2.00	30.00
16								Avg. of Last 3 =	28.89
17									
18									
19	STABILIZED RATE								
20	28.89 mpi								
21									
22									
23	HOLE #6		DIA. 12"		DEPTH:1.0'		SOIL TYPE		
24			INITIAL					PERCOLATION	RATE
25	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
26		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
27	1	10:15	17.500	10:45	13.375	30	4.125	8.25	7.27
28	2	10:45	17.500	11:15	13.875	30	3.625	7.25	8.28
29	3	11:15	17.500	11:45	14.125	30	3.375	6.75	8.89
30	4	11:45	17.500	12:15	14.375	30	3.125	6.25	9.60
31	5	12:15	17.500	12:45	14.375	30	3.125	6.25	9.60
32	6	12:45	17.500	1:15	14.500	30	3.000	6.00	10.00
33								Avg. of Last 3 =	9.73
34									
35	STABILIZED RATE								
36	9.73 mpi								
37									
38									

NOTES:

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Mound Percolation Test Results

	A	B	C	D	E	F	G	H	I
1	OWNER/APPLICANT: Sal Akhter					BEC FILE No.:06-SCC-021			
2	CONDUCTED BY: M. Batz					SITE LOCATION: Monterey Rd., San Martin			
3	CHECKED BY: A. Peden					DATE: 12/20/06			
4						APN:			
5									
6	HOLE #7		DIA. 12"		DEPTH: 1.5'		SOIL TYPE		
7			INITIAL					PERCOLATION	RATE
8	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
9		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
10	1	10:16	17.250	10:46	11.500	30	5.750	11.50	5.22
11	2	10:46	17.250	11:16	11.625	30	5.625	11.25	5.33
12	3	11:16	17.250	11:46	11.875	30	5.375	10.75	5.58
13	4	11:46	17.250	12:16	12.125	30	5.125	10.25	5.85
14	5	12:16	17.250	12:46	12.125	30	5.125	10.25	5.85
15	6	12:46	17.250	1:16	12.250	30	5.000	10.00	6.00
16								Avg. of Last 3 =	5.90
17									
18									
19	STABILIZED RATE								
20	5.90 mpi								
21									
22									
23	HOLE #8		DIA. 12"		DEPTH:2.0'		SOIL TYPE		
24			INITIAL					PERCOLATION	RATE
25	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
26		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
27	1	10:17	13.250	10:47	9.500	30	3.750	7.50	8.00
28	2	10:47	13.250	11:17	9.125	30	4.125	8.25	7.27
29	3	11:17	13.250	11:47	9.250	30	4.000	8.00	7.50
30	4	11:47	13.375	12:17	9.500	30	3.875	7.75	7.74
31	5	12:17	13.375	12:47	9.500	30	3.875	7.75	7.74
32	6	12:47	13.375	1:17	9.625	30	3.750	7.50	8.00
33								Avg. of Last 3 =	7.83
34									
35	STABILIZED RATE								
36	7.83 mpi								
37									
38									

NOTES:

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Mound Percolation Test Results

	A	B	C	D	E	F	G	H	I
1	OWNER/APPLICANT: Sal Akhter					BEC FILE No.:06-SCC-021			
2	CONDUCTED BY: M. Batz					SITE LOCATION: Monterey Rd., San Martin			
3	CHECKED BY: A. Peden					DATE: 12/20/06			
4						APN:			
5									
6	HOLE #9		DIA. 12"		DEPTH: 1.0'		SOIL TYPE		
7			INITIAL					PERCOLATION	RATE
8	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
9		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
10	1	10:18	19.000	10:48	16.125	30	2.875	5.75	10.43
11	2	10:48	19.000	11:18	16.375	30	2.625	5.25	11.43
12	3	11:18	19.000	11:48	16.625	30	2.375	4.75	12.63
13	4	11:48	19.125	12:18	16.750	30	2.375	4.75	12.63
14	5	12:18	19.125	12:48	16.875	30	2.250	4.50	13.33
15	6	12:48	19.125	1:18	17.000	30	2.125	4.25	14.12
16								Avg. of Last 3 =	13.36
17									
18									
19	STABILIZED RATE								
20	13.36 mpi								
21									
22									
23	HOLE #10		DIA. 12"		DEPTH:1.0'		SOIL TYPE		
24			INITIAL					PERCOLATION	RATE
25	READING	START	WATER	READING	FINAL WATER	TIME	WATER		
26		TIME	LEVEL	TIME	LEVEL	INTERVAL	DROP	IN/ HR	RATE MPI
27	1	10:19	13.625	10:49	9.750	30	3.875	7.75	7.74
28	2	19:49	13.625	11:19	10.125	30	3.500	7.00	8.57
29	3	11:19	13.625	11:49	10.500	30	3.125	6.25	9.60
30	4	11:49	13.625	12:19	10.750	30	2.875	5.75	10.43
31	5	12:19	13.625	12:49	10.750	30	2.875	5.75	10.43
32	6	12:49	13.625	1:19	10.750	30	2.875	5.75	10.43
33								Avg. of Last 3 =	10.43
34									
35	STABILIZED RATE								
36	10.43 mpi								
37									
38									

NOTES:

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Mound Percolation Test Results

OWNER/APPLICANT: Sal Akhter
CONDUCTED BY: M. Batz
CHECKED BY: A. Peden

BEC FILE No.:06-SCC-021
SITE LOCATION: Monterey Rd., San Martin
DATE: 12/20/06
APN:

HOLE #11 DIA. 12" DEPTH: 1.5' SOIL TYPE

READING	START TIME	INITIAL WATER LEVEL	READING TIME	FINAL WATER LEVEL	TIME INTERVAL	WATER DROP	PERCOLATION RATE IN/ HR	RATE MPI
1	10:20	19.250	10:50	17.625	30	1.625	3.25	18.46
2	10:50	19.250	11:20	17.750	30	1.500	3.00	20.00
3	11:20	19.250	11:50	18.000	30	1.250	2.50	24.00
4	11:50	19.250	12:20	18.125	30	1.125	2.25	26.67
5	12:20	19.250	12:50	18.125	30	1.125	2.25	26.67
6	12:50	19.250	1:20	18.125	30	1.125	2.25	26.67
							Avg. of Last 3 =	26.67

STABILIZED RATE
26.67 mpi

HOLE #12 DIA. 12" DEPTH:1.5' SOIL TYPE

READING	START TIME	INITIAL WATER LEVEL	READING TIME	FINAL WATER LEVEL	TIME INTERVAL	WATER DROP	PERCOLATION RATE IN/ HR	RATE MPI
1	10:21	19.000	10:51	16.750	30	2.250	4.50	13.33
2	10:51	19.000	11:21	17.000	30	2.000	4.00	15.00
3	11:21	19.125	11:51	17.250	30	1.875	3.75	16.00
4	11:51	19.125	12:21	17.375	30	1.750	3.50	17.14
5	12:21	19.125	12:51	17.375	30	1.750	3.50	17.14
6	12:51	19.125	1:21	17.375	30	1.750	3.50	17.14
							Avg. of Last 3 =	17.14

STABILIZED RATE
17.14 mpi

NOTES:

Appendix B

Groundwater Mounding Analysis

Groundwater Mounding Analysis
Cordoba Center
Hillside Drip Dispersal Field forNon-residential System

Analysis of groundwater mounding potential for the non-residential hillside drip disposal field system is analyzed here through the application of Darcy's Law (Q=KiA) as depicted in **Figure B-1**. This is the most appropriate analysis for hillside situations where there is defined restrictive layer beneath the field, which has been observed through soil profiles and test borings in this area. Analysis was completed for two cases: (1) the drip dispersal field as proposed; and (2) the alternative mitigated wastewater dispersal plan that would reduce the discharge to this field to 50% of the total wastewater flow and lengthen the cross-slope distance of the hillside drip field.

Data and Assumptions

The key data and assumptions in this analysis are as follows:

1. **Flow Rate (Q)**. Mounding analysis was conducted two cases (proposed and mitigate plans) and for three different flow conditions: (1) peak single day flow; (2) maximum weekly flow during summer camping season; and (3) maximum weekly flow during non-camping season. Flow assumptions are listed in the table below.

WW Flow Scenario	Proposed Plan Flow (gpd)	Mitigated Plan Flow (gpd)
Peak Single Day	6,000	3,000
Maximum Weekly, Camping Season	5,570	2,785
Max Weekly, Non-camping season	3,750	1,875

2. **Gradient (i)**. Grounwater gradient is estimated equal to the native ground slope in the drip field area, which averages about 15% (0.15).

3. **Hydraulic Conductivity (K)**. Horizontal hydraulic conductivity (i.e., permeability) is used in Darcy's Law for estimation of lateral hillside flow. A value of 10 ft/day was assumed for the sandy clay loam soils overlying the restrictive layer based on consideration of soil survey estimates and percolation test results:

   <u>Estimated hydraulic conductivity</u>:
   - Soil Survey: 0.12 to 1.26 ft/day;
   - Percolation testing (41 to 46 mpi): 2.6 to 2.92 ft/day
   - Average: 1.725 ft/day

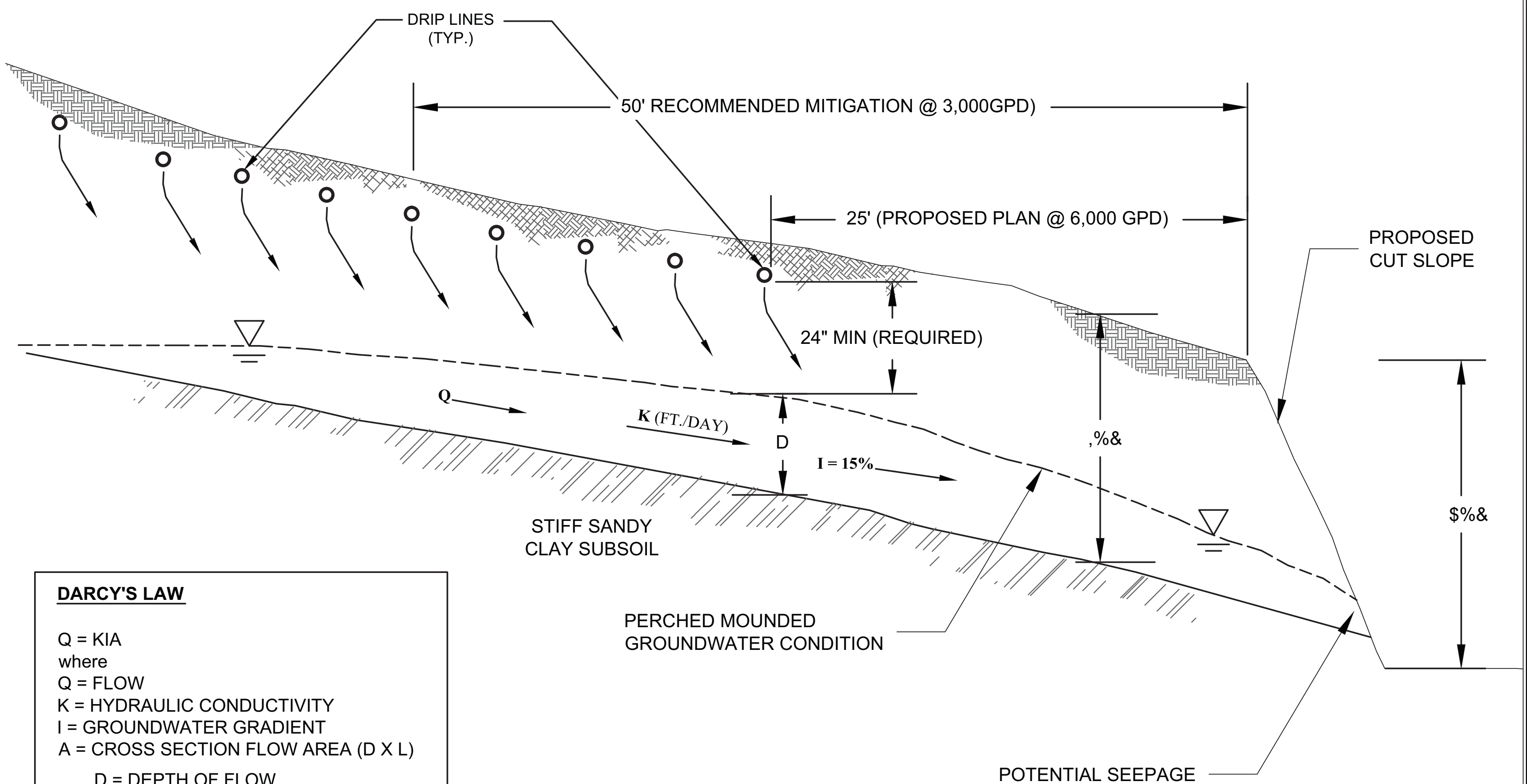
   Horizontal:vertical hydraulic conductivity ratio of 2:1 up to 10:1
   - At 2:1 ratio: (2)*(1.725) = 3.45 ft/day
   - At 10:1 ratio: (10)*(1.725) = 17.25 ft/day

- Use average value: 10 ft/day

4. **Cross-Section Area (A)**. In the Darcy equation, the cross-section area (A) for groundwater flow is equal to the depth (D) of saturation times the length (L) across the slope through which the water can be expected to travel. For this analysis, the depth of flow is calculated from the assumed/estimated values for Q, i, K and L. The calculated value for D can then be compared with the available depth of "permeable" soil below the proposed drip lines in order to determine if an adequate depth of unsaturated soil will be maintained below the trench bottom; 24 inches of unsaturated depth is required. The cross-slope length for the proposed wastewater disposal plan is 200 feet; the length for the mitigated plan is 300 feet.

Calculations

Using Darcy's Law and the above-stated data and assumptions, the calculations are provided in the attached spreadsheet table. With the dripline placed at 8 inches below grade, and a total available soil depth above the restrictive stiff sandy clay subsoil, the far right-hand column shows the resultant vertical separation distance achieved under each flow scenario for the proposed and mitigated wastewater disposal plans. The minimum required net vertical separation distance of 24 inches would be met under the mitigated plan, but not for the proposed plan.



DARCY'S LAW

Q = KIA
where
Q = FLOW
K = HYDRAULIC CONDUCTIVITY
I = GROUNDWATER GRADIENT
A = CROSS SECTION FLOW AREA (D X L)

D = DEPTH OF FLOW
L = CROSS-SLOPE LENGTH

Date:	130'3'+01
Drawn:	
Appr'd:	NH
Dwg. No:	1700037_FIGURE_7

QUESTA ENGINEERING CORP.
Civil
Environmental
& Water Resources
(510) 236-6114
FAX (510) 236-2423
BCwD>:(BCwD>:w7"74?
P.O. Box 70356 1220 Brickyard Cove Road Point Richmond, CA 94807

GROUNDWATER MOUNDING SCHEMATIC

FIGURE

B-1

Groundwater Mounding Caclulations

Cordoba Hillside Non-Residential Drip Dispersal Field

Calculated Groundwater Rise and Net Water Table Separation, per Darcy's Law Q=KiA

Waste Discharge Scenario	Q, Daily Flow		Hydraulic Conductivity, K	Groundwater Gradient, I	Cross-slope length, L	Water Table Rise, D		Net Vertical Separation Below Drip Line* (inches)
	gal/day	ft^3/day	ft/day	fraction	ft	ft	inches	
Proposed Wastewater Disposal Plan - Entire Flow up to 6,000 gpd, 200-ft cross-slope length								
Max Single Day Flow	6,000	802	10	0.15	200	2.67	32.09	8
Camp Season, 9 wks	5,570	745	10	0.15	200	2.48	29.79	10
Non-Camp Season, 39 wks	3,750	501	10	0.15	200	1.67	20.05	20
Mitigated Wastewater Disposal Plan - 50% of Flow up to 3,000 gpd, 300-ft cross-slope length								
Max Single Day Flow	3,000	401	10	0.15	300	0.89	10.70	29
Camp Season, 9 wks	2,785	372	10	0.15	300	0.83	9.93	30
Non-Camp Season, 39 wks	1,875	251	10	0.15	300	0.56	6.68	33

* Dripline placed at 8 inches deep in the soil

GROUNDWATER MOUNDING ANALYSIS
East Side Orchard Area - Drip Dispersal Field

1. **Methodology**: Per Finnemore & Hantzsche, 1983 (attached)

2. **Formula and Assumptions**:

$$Z_m = IC\left(\frac{L}{4}\right)^n\left(\frac{1}{K\bar{h}}\right)^{0.5h}\left(\frac{t}{S_y}\right)^{1-0.5n}$$

Where:

L = Length of Disposal Area = 300 *feet*

W = Width of Disposal Area = 75 *feet* (±)

I = Daily Wastewater Flow (max) @ 3,000 gallons /day, Averaged Over Disposal Area:

$$I = \left(\frac{3{,}000\ gallons/day \div 7.48\ gallons/feet^3}{300 feet \times 80\ feet}\right)$$

$$= \frac{401\ feet^3/day}{300\ feet \times 75\ \text{feet}}$$

$$= 0.018\ feet/day$$

C, n = Fitted Constants, based on L/W Ratio = C = 1.1348 and n = 1.7716

L/W = 300 *feet* ÷ 75 *feet* = 4.0
C = 1.1348
n = 1.7716

K = Hydraulic Conductivity ($feet/day$)

Percolation Test Results:

For 12 to 24 *inches (surface soils, vertical rate)*:
= 24 *minutes / inch* (±) = 2.5 *inches/hour* (±) = 5 *feet/day* (±)
Estimated horizontal rate at min 2H:1V = 10 ft per day

Per Santa Clara County Soil Survey, Cortina very gravelly loams
= 12.5 to 40 *feet/day (vertical rate)*
Estimated horizontal rate at min 2H:1V = 25 to 80 ft per day

Per Todd, for Medium Sand:
= 36 *feet/day*

Per Santa Clara Valley Water District (2014):
= 34 *feet/day* (estimated for Shallow Aquifer, north)

∴ Use 20 *feet/day*

S_y = Specific Yield of Aquifer = 0.15 (estimated for alluvium, per Todd, 1980)

h_o = Aquifer Thickness = 50 *feet*
Assume $\overline{h}$ = 50.5 *feet* (assume 1.0 *feet* rise)

t = Period of Analysis = 120 *days* (Wet Weather Season)

3. **Calculations**:

For K_H = 20 ft/day

$$Z_m = (0.018)(1.1348)\left(\frac{300}{4}\right)^{1.7716}\left(\frac{1}{(20)(50.5)}\right)^{(0.5)(1.7716)}\left(\frac{120}{0.15}\right)^{1-(0.5)(1.7716)}$$

Z_m = (0.02) (2,098) (0.0022) (2.15)

Z_m = 0.2 feet water table rise

GROUND-WATER MOUNDING DUE TO ON-SITE SEWAGE DISPOSAL

By E. John Finnemore,[1] M. ASCE and Normal N. Hantzsche[2]

ABSTRACT: Localized ground-water mounding beneath larger on-site sewage disposal fields (leach fields) may be a major problem which previously had not been adequately addressed. Existing methods to predict mounding, mainly developed for ground-water recharge spreading basins, are reviewed for applicability to sewage disposal fields. A most appropriate and accurate method is selected and considerably simplified to provide a convenient, straightforward prediction procedure for regulatory agencies and designers. The major simplification, to a single equation, is particularly accurate after longer wastewater application times, of say 10 to 20 years, when mounding is of most concern. Sensitivities of the procedure to the various simplifications, site factors, and design and management options are discussed and presented in graphical form where significant. Alternative means to reduce mounding are reviewed. Mounding problems and potential mitigation measures should be made more widely known, and long-term field verification of the theory is needed.

INTRODUCTION

For many years, on-site sewage disposal systems, particularly septic drain fields (also known as filter fields, leach fields, and soil absorption systems), have served as effective treatment devices for domestic wastewater. Dependence on these systems in the U.S.A. is growing, especially for urban fringe, rural residential, and recreational developments. This growing dependence results from present population trends away from cities, rapidly increasing costs of community sewerage, and encouragement by regulatory agencies to dispose of more wastewater to the land and less to receiving waters. Where in the past on-site systems were often considered as interim facilities until sewers could be provided, now their use is often being viewed as permanent. As a result, there are growing concerns that this may be contributing to long-term ground-water pollution.

Local health departments and water quality control authorities normally strive to protect ground-water quality by specifying a minimum vertical distance, typically from 2–5 ft (1–2 m), between disposal trenches or beds and the water table. This provides an unsaturated soil zone in which high degrees of physical, biological, and chemical treatment occur. However, under certain circumstances, particularly with larger, more

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compact, or denser disposal systems, mounding of the underlying ground water can reduce the unsaturated soil depth to the point of affecting the degree of treatment provided by the soil. Further mounding could possibly even flood the drain-field trenches/bed, producing undesirable anaerobic conditions and allowing effluent to directly enter ground water.

High water tables have been identified as a leading cause of failure of on-site disposal systems (5). However, standard design manuals for on-site disposal have not addressed ground-water mounding (4,10,16). Evaluators and designers typically apply design criteria (e.g., trench spacing, application rate) for individual residences to larger systems, and this is not always appropriate. The purposes of this paper are to provide local regulatory agencies and designers with straightforward procedures: (1) For estimating ground-water mounding and checking whether this could endanger the effectiveness of proposed disposal systems; and (2) for checking the potential effects of means to reduce mounding.

Ground-Water Mounding

Water tables may rise under disposal fields in numerous different physical situations, usually involving geological deposits of sharply contrasting permeabilities. In one of the most common of these, considered here, the disposal field drains down into, and forms a mound on, an extensive and initially near-horizontal saturated zone (Fig. 1). This frequently occurs in flatter terrain, which tends to be preferred for development.

The key need here is for a reliable yet simple method for estimating the rise of ground-water mounds caused by disposal fields and, thus, estimating the resulting reduced depth of unsaturated soil. There is very little information on this specific topic. However, some analyses of mounding developed for ground-water recharge spreading basins may be adapted for convenient application to disposal fields. Basin shapes studied include circular, square, rectangular, and long strips. For the greatest accuracy, the complete saturated-unsaturated flow system must be analyzed. However, because this requires very complex calculations,

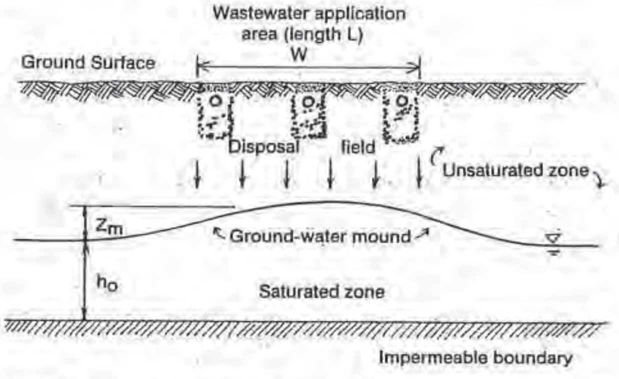

FIG. 1.—Ground-Water Mound Beneath Rectangular Disposal Field

and because the unsaturated zone is smallest under critical, high water table conditions, unsaturated flow is commonly neglected. The saturated-flow analyses appear to be limited by their use of the Dupuit-Forchheimer theory of unconfined flow, which assumes horizontal streamlines. However, comparisons with field observations under a recharge basin suggest that the Dupuit-Forchheimer assumptions are acceptable for ground-water mounds (2). Many of the saturated-flow analyses (1,11–13,15) are too complex or specialized for routine use for disposal fields. Further, some of the less complex saturated-flow analyses are unsuitable because they are limited to mound heights less than 2% of the initial depth of saturation (R. E. Glover, "Mathematical Derivations as Pertain to Groundwater Recharge," mimeo, Agricultural Research Service, U.S. Department of Agriculture, Ft. Collins, Colo., 1961). Such analyses are of little help because large, potentially critical mounds form most readily on shallow saturated zones. The method of Hantush (8) was found to be the most appropriate for the present purposes. Hantush reports his solution is applicable for mound heights, z_m, up to 50% of the initial depth of saturation, h_o, with relative errors not exceeding 6%. Rao and Sarma (15) have reported that the Hantush method reliably predicts mound growth under a strip source to heights up to at least three times the initial saturation depth, with errors less than 2%.

Fielding (6) proposed a simplified analysis of ground-water mounding under leaching beds. However, Fielding's method yields estimates of maximum ultimate mound heights generally only 20–40% of those obtained by the Hantush method for 0.5–10 yr of growth. Fielding's simplified method is therefore not recommended for this purpose. The discrepancy appears to stem from his representation of the potential gradient in the derivation of the maximum ultimate mound height.

Simplified Mounding Prediction

From the Hantush procedure (8), the expression for the maximum rise, z_m, of the water table can be rearranged into the form

$$z_m = \frac{ItS^*}{S_y} \qquad (1)$$

in which I = average recharge rate of wastewater, or the volume rate of wastewater entry into unit area of soil; t = time since the beginning of wastewater application; S_y = specific yield of aquifer, which is the volume fraction of the total aquifer which will drain freely; and S^* = a function of α and β given conveniently by Table 1 of Ref. 8. Here

$$\alpha = \frac{L}{4}\sqrt{\frac{S_y}{K\bar{h}t}} \qquad (2a)$$

$$\beta = \frac{W}{L}\alpha \qquad (2b)$$

in which L and W = respectively, the length and width of the disposal field (wastewater application area; $L \geq W$); K = horizontal hydraulic conductivity of the aquifer; and

TABLE 1.—Values of Constants Fitted to Longtime Expression, $S^* = C\alpha^n$, for Various Length-to-Width Ratios[a]

Length to width ratio, L/W (1)	Value of Fitted Constant: C (2)	Value of Fitted Constant: n (3)
1	3.4179	1.7193
2	2.0748	1.7552
4	1.1348	1.7716
8	0.5922	1.7793

[a]For $\alpha \leq 0.04$.

$$\bar{h} = h_o + \frac{z_m}{2} \quad \text{(3)}$$

For longer times, t, on the order of years, which are of particular concern with disposal fields, the magnitudes of α and β become very small. In the region close to the origin, where α and β are not greater than 0.04, the tabular function for S^* can be closely fitted by an expression of the form $S^* = C\alpha^n$ for various length-to-width ratios. Resulting values of the constants C and n are given in Table 1. This expression enables Eqs. 1 and 2a to be combined, leading to the equation for longtime mound height

$$z_m = IC\left(\frac{L}{4}\right)^n \left(\frac{1}{K\bar{h}}\right)^{0.5n} \left(\frac{t}{S_y}\right)^{1-0.5n} \quad \text{(4)}$$

which is accurate provided $t > t_{\lim} = 40L^2S_y/(Kh_o)$.

It is evident from the preceding that to compute the maximum water table rise, z_m, it must first be estimated for use in Eq. 3. Although the calculations do not seem to be very sensitive to initial estimates, they may be repeated once or twice to eliminate small inaccuracies.

Equation 4 and Table 1 together reveal that at large times, t, the mound growth is closely proportional to time raised to the one-eighth power. Under these conditions, the mound grows by only 9% when the time is doubled. Furthermore, this unending growth results from the Hantush assumption of an infinite aquifer. Because real aquifers usually have outflows at some limits, the mound growth will also be limited and estimates given by the preceding equations will be safe, upper bounds.

Influence of Site Factors

Man has little control over the magnitudes of a number of the variables involved in the prediction procedure just considered. Three of these, i.e., K, t, and h_o, have been found to have major impacts on mound growth. Examples of these impacts, for typical ranges of values of the variables, are given here to characterize them and to help regulators and designers identify situations of potential concern. The examples were

chosen to help identify those combinations of conditions which result in mound heights in the 2–3 ft (1 m) range, which border on unacceptability where unsaturated soil depths are minimal. The examples in this section are based on a wastewater discharge of 2,500 gal/day or 334 cu ft/day (9.46 m^3/day), applied to a 100 ft (30 m) square disposal field. Because discharge and field size may more easily be controlled by designers, their effects on mounding are reviewed later under Design and Management Options.

Rates of mound growth are compared in Figs. 2–3 for various aquifer conductivities. Also, the accurate Hantush procedure is compared with the longtime Eq. 4, shown dashed. After a relatively short period of early rapid rise, the curves settle down to their gradual longtime rise (Fig. 2). At very short times, the curves for the Hantush procedure are asymptotic to the maximum possible rise curve (for no lateral flow) which has the equation $z_m/t = I/S_y$. At short times, the longtime Eq. 4 gives rather high but conservative predictions of rise. As t increases and approaches $t_{\lim}$, Eq. 4 approaches the accurate Hantush solution (Figs. 2–3). We should note that the hydraulic conductivities cited in Figs. 2–3 are in the horizontal direction, which for many soils may be significantly larger than the vertical conductivities.

The strong influence of the depth, h_o, of the saturated zone on mound growth is apparent in Fig. 4. Shallow saturated zones are clearly the most hazardous. Also, this figure indicates that, during seasonal declines of the water table, mound growth rates must increase.

The effect of specific yield over a typical range of, say, 0.10–0.25 was found to be very minor in comparison with the effects of K, t, and h_o.

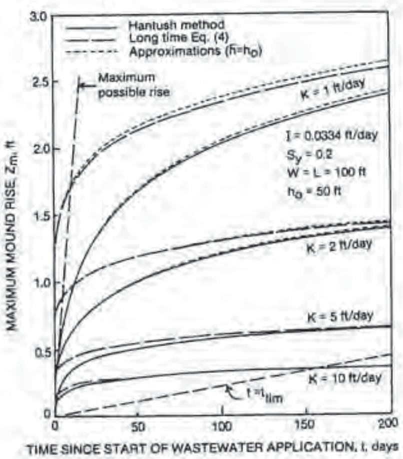

FIG. 2.—Mound Growth at Short Wastewater Application Times (1 ft = 0.305 m)

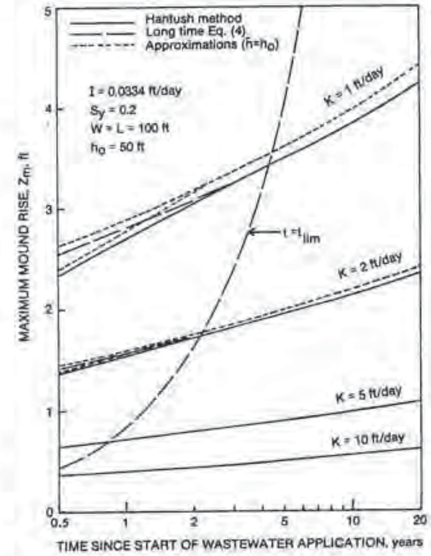

FIG. 3.—Mound Growths at Long Wastewater Application Times (1 ft = 0.305 m)

Design and Management Options

For a given average wastewater flow rate, there are three options which a designer may consider as possible ways of reducing mounding: (1) Increasing the size (area) of the disposal field; (2) elongating the shape of the area covered by the field; and (3) operating the field intermittently.

Effects of increasing the plan area of the disposal field, for a constant wastewater loading rate, are shown in Fig. 5. As can be seen, mound height reductions are greater for lower hydraulic conductivities. Also, with successive increases in field size, relative reductions in mounding decrease.

Effects of elongating the shape of the constant area covered by the disposal field are shown in Fig. 6. Over the practical range of length-to-width ratios of 1–10, say, the mound height reduction due to elongation is more significant with low hydraulic conductivities.

The third possible means to reduce mounding might be to operate the disposal field intermittently so that the mound has an opportunity to dissipate between wastewater applications. Presuming long-term wastewater storage to be impractical, and presuming the wastewater application rate per unit area to be limited, this would require alternating use of duplicate fields, thus doubling the total disposal area. Hantush (8) provides a procedure for computing the decay of the mound after the wastewater application is stopped. As an example, the results of operating a certain field for 180 days and then allowing it to recover for 180 days are presented in Fig. 7. At the end of the rest period the mound height is still 14% of its peak value, and we can closely estimate the consequences of subsequent application and resting periods (shown

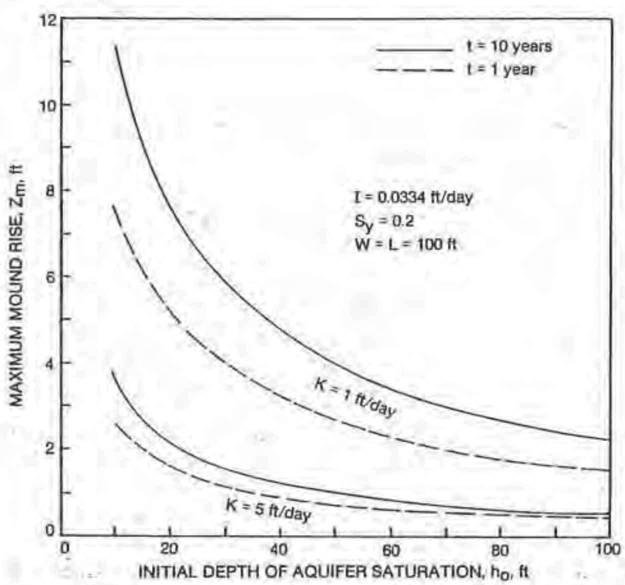

FIG. 4.—Influence of Ground Water Depth on Mound Growth (1 ft = 0.305 m)

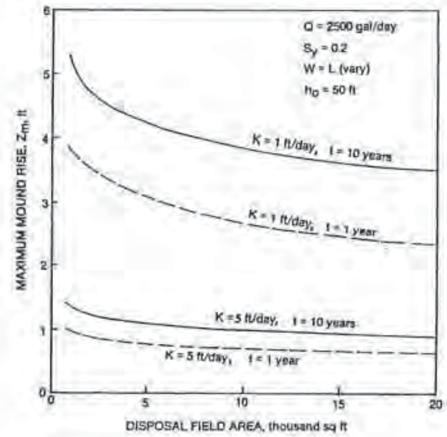

FIG. 5.—Influence of Disposal Field Size on Mound Growth (1,000 gal/day = 3.79 m³/day; 1 ft = 0.305 m; 1 sq ft = 0.0929 m²)

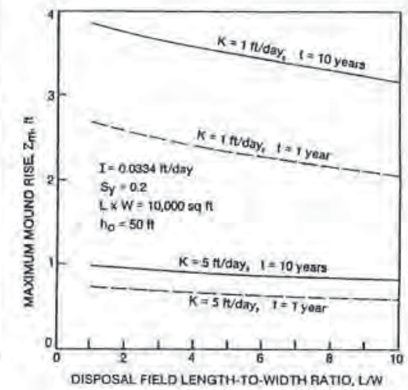

FIG. 6.—Influence of Disposal Field Shape on Mound Growth (1 ft = 0.305 m; 1 sq ft = 0.0929 m²)

dashed). These consequences involve large fluctuations in the mound height. If, on the other hand, the total flow were applied continuously to the total available disposal area, this would correspond to half the application rate per unit area and would result in the lower, continuous growth curve shown in Fig. 7. Although intermittent operation of disposal fields is sometimes used to reduce soil clogging, the near-double mound heights resulting from the alternating operation are clearly no advantage over a continuous operation where water table levels are critical.

Depending on site and design features, a fourth option, reducing infiltration from precipitation and irrigation over the field area, may be possible. Where high winter ground-water levels are critical, landscaping, covering with less permeable soils, and drainage may be used to locally reduce deep percolation from non-wastewater sources. This reduction can then help to offset the wastewater application.

Determination of Aquifer Properties

The preceding methods of analysis require knowledge of three fundamental aquifer characteristics at the site: (1) The natural depth of saturation, h_o; (2) the horizontal hydraulic conductivity of the aquifer, K; and (3) the specific yield of the aquifer.

The natural depth, h_o, of the saturated zone actually varies with the seasons. Its upper limit may be determined from records or observations of the fluctuating water table at nearby locations, but it must be remembered that site development may strongly affect these. Its lower limit, the impermeable boundary, may be identified from drilling records and core sampling or by geophysical methods such as well logs, electric logs, or seismic sounding.

The hydraulic conductivity, K, of the aquifer should be determined by

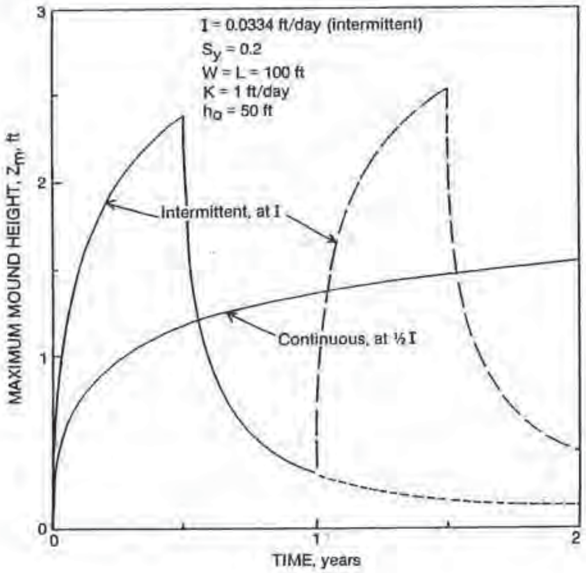

FIG. 7.—Mound Growth Under Intermittent and Continuous Operation (1 ft = 0.305 m)

a method which is, as far as possible, broadly representative of the zone to be affected by the ground-water mound. As in the mound, flow in the test should be predominantly horizontal. This is best achieved by standard well pumping tests, slug tests, or bail tests (7,9). Measurements of K at points may be made by permeameter tests or by piezometer techniques. Such point determinations are of questionable value for representing a larger aquifer, but they may help identify layers with different K values within the aquifer.

Failing this, many published soils surveys include estimated K values. Interpretation would be required as to whether the K of the surface soils differs from that at the mound level. In addition, the Soil Conservation Service has prepared rating curves relating vertical hydraulic conductivity to soil type (A. J. Erikson, "Soil Permeability Classes Related to Texture," unpublished working document, Soil Conservation Service, U.S. Department of Agriculture, Utah, 1973). Horizontal conductivities are typically significantly larger than vertical conductivities; low values of horizontal conductivity will result in conservative mounding estimates on the high or "safe" side.

The specific yield, S_y, of the aquifer is also obtained by some conductivity tests, such as the Theis pumping test (7). It must be less than the total porosity of the aquifer, and can be estimated as the difference between the volumetric water contents above and below a falling water table. These water contents may be measured by gamma ray and neutron probe techniques. In the absence of these, many published soil surveys include estimates of specific yield.

Historical observations of nearby mounding, if sufficiently detailed,

may possibly be used to identify some aquifer constants by back-calculation or curve matching. The previous analysis of the influence of site factors indicated that mounding calculations are less sensitive to errors in S_y than they are to errors in h_o or K.

Before attempting any field measurements, the considerable literature on aquifer test methods should be consulted (3,7,9). Furthermore, users of these procedures should compare the cost of obtaining site-specific data on aquifer properties with the cost of a more conservative design. For, where additional space is not expensive, the total project cost might be less if based upon worst-case assumptions of aquifer properties.

Practical Applications

Firstly, we should note that with the smallest common disposal fields, for individual homes with typical maximum wastewater loads of about 250 gal/day (33 cu ft/day; 0.946 m^3/day) and with typical disposal field areas of about 600 sq ft (55 m^2), the Hantush method predicts 10-yr mound heights of only 1–13 in. (2–33 cm) for common field conditions. Thus, ground-water mounding under disposal fields of individual homes is very unlikely to be of concern.

For larger disposal fields, when identifying the wasteload application rate to be used in the procedures recommended here, it is important to use the average flow rate because mounding is a longtime cumulative effect. This rate will be lower than that used in the design of the disposal field, because the field must be designed to accommodate transient, maximum flows. If the system is expected to receive extended peak wastewater loadings at rates significantly above average, coinciding with the water table at its seasonal high, then their effects on mounding should be evaluated by a procedure similar to that used for the intermittent operation considered earlier.

Accurate solutions at "smaller" times require the use of Eqs. 1–3 with an intermediate table look-up. Table interpolation can be aided by preparing curves of the S^*-α relationship for perhaps a few different length-to-width ratios. Interpolations are most critical where values are the smallest (relative errors are largest), and where curvature in the relationship is the greatest. These factors combine near the origin, corresponding to longtimes, and, in such circumstances, the fitted S^*-α expression (Table 1) and Eq. 4 are recommended. Equation 4 facilitates developing ratios for estimating time variations. At smaller times, the error caused by using Eq. 4 increases, as indicated in Fig. 2. However, this error is on the safe side, for if Eq. 4 is used at smaller times it leads to overestimates of mounding.

Because the Hantush method predicts that mounds will continue to rise indefinitely, albeit slowly, a particular time needs to be chosen for design. A period of 10 yr is suggested, based partly on past service-life experience with disposal fields. Even if the field should serve for 40 yr, which would be a rare occurrence, the mound would rise by no more than another 20%.

The need for an accurate estimate of z_m in Eq. 3 to enable calculation of z_m makes repetitious calculations necessary when accuracy is desired. Equation 4 and the curves of Figs. 2–6 help provide the needed first estimates, and so help reduce repetition. However, repetition may be avoided altogether by taking $\bar{h} = h_o$, which yields the approximate solutions shown by the dotted curves in Figs. 2–3. Errors resulting from this approximation are found in the examples considered here to be generally less than 3%, which is very minor by comparison with the errors possible in the site parameters, K and h_o. Furthermore, these approximation errors are on the high and therefore "safe" side. This labor-saving approximation, therefore, appears appropriate unless z_m/h_o is large or unless accurate site parameter values are available and high computational accuracy is required.

Users of Figs. 2–6 should remain aware that the apparent accuracy of the curves could be misleading. The accuracy of the results obtained from them depends entirely on the accuracy of the input data, most importantly the site parameters, K and h_o.

The potential benefits of increasing the size of the disposal field and elongating its shape, indicated in Figs. 5–6, must be compared with land and construction costs and restrictions of the site. Where water table levels are critical, designs involving intermittent operation of the disposal field appear to be at a strong disadvantage.

The mounding equations assume that without any wastewater recharge the saturated depth of the aquifer, h_o, remains constant. Because this depth varies with the seasons, the mean normal saturated depth should be used to compute the mound height, z_m, and this should be added to the highest natural winter water table to determine the highest, worst case mound height. This procedure should be followed even if the aquifer depletes annually. During drought periods, when h_o, is below normal, Eq. 4 indicates that the mound will grow faster than normal.

Wastewater fed to disposal fields by gravity may not be uniformly distributed, particularly in larger fields. This could result in greater mounding in localized areas. Such problems can be prevented by providing a dosing or pressure distribution system (4,10,14).

Users of these procedures should remember that this paper considers only one aspect of development. The ground-water level changes due to mounding are *additional* to those caused by other factors such as changed land use, increased surface imperviousness, and water importation or export.

Summary and Conclusions

This study has identified convenient methods for estimating and mitigating the cumulative hydraulic impacts of wastewater disposal fields on the ground water beneath them. These methods are presented in a manner useful to practicing engineers. They have recently been adopted for use by the North Coast Regional Water Quality Control Board of California.

There are too major findings concerning the ground-water hydraulics. First, except possibly in extreme cases, significant ground-water mounding is not likely to result from on-site wastewater applications at typical individual residences. Second, localized mounding of ground water beneath large, common disposal systems maybe a major concern which

heretofore has not been adequately addressed in the siting and design of such systems.

Two major means are available to reduce ground-water mounding. The most effective approach is to increase the size of the disposal field, thereby reducing the wastewater application rate per unit area. The second method is to elongate the disposal field; however, this is not always very effective.

Users of these methods should be well aware of their limitations. First, they are largely theoretical and presently in need of verification for the variety of conditions considered, so that they should be used with judgment by experienced engineers. Second, they are limited to the case of a single permeable layer with a horizontal, impermeable boundary below. Modifications should be possible to account for permeability variations due to layering and for leakage through the lower boundary.

The following recommendations are made:

1. To perform intensive, long-term monitoring of selected large common disposal systems to verify in the field the predictive theory of ground-water mounding for different combinations of site factors and design and management options.
2. That local regulatory agencies require mounding analyses to be conducted for average wastewater disposal rates equivalent to two or more individual residences.
3. That local regulatory agencies should make widely known the potential problems with, and estimation techniques and mitigation measures for, ground-water mounding under disposal fields.

Acknowledgments

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Appendix II.—Notation

The following symbols are used in this paper:

C = fitted constant;
h_o = initial depth of aquifer saturation;
h = representative, average depth of aquifer saturation within ground-water mound;
I = wastewater average recharge rate (volume rate of entry into unit area of soil);
K = horizontal hydraulic conductivity of aquifer;
L = length of disposal field;
n = fitted constant;
Q = volume rate of wastewater application (ILW);
S_y = specific yield of aquifer;
S^* = $\int_0^1 \text{erf}\,(\alpha/\sqrt{\tau})\,\text{erf}\,(\beta/\sqrt{\tau})\,d\tau$, given by Table 1 of Ref. 8;
t = time since beginning of wastewater application;
W = width of disposal field ($W \leq L$);
z_m = maximum height of ground-water mound, above h_o;
α = variable defined by Eq. 2a;
β = variable defined by Eq. 2b; and
τ = dummy variable.

Appendix C

Nitrate and Salt Loading Calculations

Wastewater Nitrogen Loading Analysis - Calculations for Cordoba Site Wastewater Discharge

Nitrogen Mass Loading

Total effluent nitrogen concentration: Calculate for **10, 15, 20 & 30 mg-N/L**

Average annual loading: Ave annual flow*Total N

Assumed nitrogen assimilation by adsorption and denitrifiation: **15% to 30%**

Site Characteristics & Assumptions

Rainfall-Recharge Area: **Proposed Plan: 4.8 acres; Mitigated Plan: 4.8 acres plus additional 3.2 acres = 8 acres**

Estimated annual groundwater recharge amount: 4.8 ac Hillside area: 5.79 inches 0.48 ft), per detailed water balance for developed conditions

3.2 ac Orchard area: 8.16 inches (0.68 ft), per Santa Clara County LAMP

Wastewater Discharge Volume: 75% of ave max weekly wastewater flow for combined discharge from residential & non-residential systems:

Residence:	3 at 75 gpd per bedroom (Onsite Manual):		225	
Non-residential:	9 wks at 5,570 (max weekly)	50,130		
	39 wks at 3,750 (max weekly)	146,250		
	4 wks at 4,179 (max weekly)	16,716		
	Sub-total	213,096		
	Weighted Ave:	4,098		
	of Weighted Annual Max:		3,074	
	Total		**3,299**	**Use 3,300 gpd**

Water Quality Criteria/Limits

Groundwater nitrate-N water quality baseline objective: 5.0 mg-N/L (Basin Plan)

Groundwater nitrate-N drinking water standard: 10 mg-N/L; and OWTS Manual for public water supply areas

Groundwater nitrate-N water quality objective: 7.5 mg-N/L (OWTS Manual for areas with individual wells)

Use 7.5 mg-N/L at point of compliance: nearest potential off-site water well location

Table C-1. Proposed Project Nitrate-N Loading Calculations

Wastewater				Average Rainfall Recharge (4.8 ac area)					Resultant	7.5 mg-N/L Compliance
Flow		Effluent Total N_w	Denit.	Central Hillside Area 4.8 acres		Orchard Area (N/A)		Background Nitrogen, N_B	Resultant GW Nitrogen, N_C	
gpd	ac-ft/yr	mg-N/L	(fraction)	feet	ac-ft			mg-N/L	mg-N/L	
3,300	3.70	10	0.15	0.48	2.30			0.5	5.43	Compliant
3,300	3.70	10	0.20	0.48	2.30			0.5	5.12	
3,300	3.70	10	0.25	0.48	2.30			0.5	4.81	
3,300	3.70	10	0.30	0.48	2.30			0.5	4.50	
3,300	3.70	15	0.15	0.48	2.30			0.5	8.05	Non-compliant
3,300	3.70	15	0.20	0.48	2.30			0.5	7.58	Compliant
3,300	3.70	15	0.25	0.48	2.30			0.5	7.12	
3,300	3.70	15	0.30	0.48	2.30			0.5	6.66	
3,300	3.70	20	0.15	0.48	2.30			0.5	10.66	Non-compliant
3,300	3.70	20	0.20	0.48	2.30			0.5	10.05	
3,300	3.70	20	0.25	0.48	2.30			0.5	9.43	
3,300	3.70	20	0.30	0.48	2.30			0.5	8.82	
3,300	3.70	30	0.15	0.48	2.30			0.5	15.90	
3,300	3.70	30	0.20	0.48	2.30			0.5	14.98	
3,300	3.70	30	0.25	0.48	2.30			0.5	14.05	
3,300	3.70	30	0.30	0.48	2.30			0.5	13.13	

Table C-2. Mitigated Project Nitrate-N Loading Calculations

Wastewater				Rainfall Recharge (4.8 ac + 32. ac = 8 ac total)					Resultant	7.5 mg-N/L Compliance
Flow		Effluent Total N_w	Denit.	Average Annual Recharge						
				Central Hillside Area 4.8 acres		Orchard Area 3.2 acres		Background Nitrogen, N_B	Resultant GW Nitrogen, N_C	
gpd	ac-ft/yr	mg-N/L	(fraction)	feet	ac-ft	feet	ac-ft	mg-N/L	mg-N/L	
3,300	3.70	10	0.15	0.48	2.30	0.68	2.18	0.5	4.12	Compliant
3,300	3.70	10	0.20	0.48	2.30	0.68	2.18	0.5	3.89	
3,300	3.70	10	0.25	0.48	2.30	0.68	2.18	0.5	3.66	
3,300	3.70	10	0.30	0.48	2.30	0.68	2.18	0.5	3.44	
3,300	3.70	15	0.15	0.48	2.30	0.68	2.18	0.5	6.04	
3,300	3.70	15	0.20	0.48	2.30	0.68	2.18	0.5	5.70	
3,300	3.70	15	0.25	0.48	2.30	0.68	2.18	0.5	5.36	
3,300	3.70	15	0.30	0.48	2.30	0.68	2.18	0.5	5.02	
3,300	3.70	20	0.15	0.48	2.30	0.68	2.18	0.5	7.96	Non-compliant
3,300	3.70	20	0.20	0.48	2.30	0.68	2.18	0.5	7.51	Compliant
3,300	3.70	20	0.25	0.48	2.30	0.68	2.18	0.5	7.06	
3,300	3.70	20	0.30	0.48	2.30	0.68	2.18	0.5	6.60	
3,300	3.70	30	0.15	0.48	2.30	0.68	2.18	0.5	11.80	Non-compliant
3,300	3.70	30	0.20	0.48	2.30	0.68	2.18	0.5	11.12	
3,300	3.70	30	0.25	0.48	2.30	0.68	2.18	0.5	10.45	
3,300	3.70	30	0.30	0.48	2.30	0.68	2.18	0.5	9.77	

Table C-3. Cordoba Center Project
Estimated TDS Concentration of Water/Wastewater Percolate @ Nearest Potenial Off-site Water Well Location (South and East)

Project Scenario	Water Supply, TDS Concentration (mg/L)	Recharge Area (ac)		Wastewater Discharge Volumes (W)			Rainfall Recharge (R)				Total Recharge	Mass Salt Loadings			Resultant
		Hillside Area	Orchard Area	Discharge Volume (gpd)	Discharge Volume (Mgal/yr)	Discharge Volume (ac-ft/yr)	Hillside (ft/yr)	Hillside (ac-ft/yr)	Orchard (ft/yr)	Orchard (ac-ft/yr)	Total Recharge Volume (ac-ft/yr)	Wastewater Mass TDS	Background Mass TDS Loadings	Total Mass TDS Loadings	Resultant Percolate TDS Concentration (mg/L)
Case 1 Propsed Plan	290	4.8		3,300	1.20	3.70	0.48	2.30			6.00	1,811	691	2,503	417
	340	4.8		3,300	1.20	3.70	0.48	2.30			6.00	1,996	691	2,687	448
Case 2 Mitigated Plan	290	4.8	3.2	3,300	1.20	3.70	0.48	2.30	0.68	2.18	8.18	1,811	1,344	3,155	386
	340	4.8	3.2	3,300	1.20	3.70	0.48	2.30	0.68	2.18	8.18	1,996	1,344	3,340	409

<u>Calculation Notes:</u>

Residence: 3 bedrooms at 75 gpd per bedroom = 225 gpd

Non-residential: 75% of weighted average peak weekly flows for: (a) 9-wks camp season; (b) 39 wks non-camp season; and (c) 4 wks special events:

= 0.75*[(5,570*9)+(3,750*39)+(4,179*4)]/52 wks = 3,076

Total = 225 + 3076 = 3,299 gpd, use 3,300 gpd

Wastewater Mass TDS = W*(290 to 340 mg/L source water + 200 mg/L wastewater addition)

Background Mass TDS = R*300 mg/L (moutain front recharge, SCVWD 2014)

Resultant TDS, mg/L = Total Mass TDS/Total Rechage Vol

Water Balance Analysis - Applicable to Cordoba Site. East Side/Orchard Area Per Santa Clara County LAMP							
Month	Ave Precip. (in/month)	Average Runoff Rate (%)	Available Precip. (in/month)	Reference ETo (in/month)	Adjusted ET (in/month)	Net Rainfall Recharge (in/month)	
Jan	4.47	0.20	3.58	1.24	0.87	2.71	
Feb	3.84	0.20	3.07	1.68	1.18	1.90	
Mar	3.32	0.15	2.82	3.41	2.39	0.44	
Apr	1.43	0.10	1.29	4.80	3.36	0.00	
May	0.37	0.00	0.37	6.20	4.34	0.00	
Jun	0.12	0.00	0.12	6.90	4.83	0.00	
Jul	0.05	0.00	0.05	7.44	5.21	0.00	
Aug	0.06	0.00	0.06	6.51	4.56	0.00	
Sep	0.37	0.00	0.37	5.10	3.57	0.00	
Oct	0.84	0.00	0.84	3.41	2.39	0.00	
Nov	2.48	0.10	2.23	1.80	1.26	0.97	
Dec	3.50	0.20	2.80	0.93	0.65	2.15	
Total	**20.85**		**17.60**	**49.42**	**34.59**	**8.16**	**inches/yr**
						0.68	**ac-ft/ac-yr**
						0.39	**fraction of annual precip**

Notes:

1. Ave monthly precip, Coyote Reservoir, SCVD
2. Ave monthly runoff volumes estimated by USDA-NRCS Curve Number Method; Cortina gravelly loam, Hyd Soil Group A
3. "Available Precip" equal to ave monthly precip minus estimated runoff volume; no carryover soil moisture; water holding capacity <0.05
4. Reference ETo from DWR/CIMIS for Zone 8, Inland SF Bay Area; 0.7 Landscape Coeff multiplier

Water Balance Analysis - Applicable to Central Hillside Drip Field Area Adjusted for Hyd Soil Group C, Impervious Surface Area, Soil Moisture Carryover (50%/month)								
Month	Ave Precip. (in/month)	Average Runoff Rate (%)	Available Precip. (in/month)	Reference ETo (in/month)	Adjusted ET (in/month)	Net Rainfall Recharge (in/month)	Adjusted for 50% Soil Moisture Carryover to next month	
Jan	4.47	0.30	4.27	1.24	0.87	3.40	1.70	
Feb	3.84	0.30	4.39	1.68	1.18	3.21	1.61	
Mar	3.32	0.25	4.10	3.41	2.39	1.71	0.85	
Apr	1.43	0.10	2.14	4.80	3.36	0.00	0.00	
May	0.37	0.00	0.37	6.20	4.34	0.00	0.00	
Jun	0.12	0.00	0.12	6.90	4.83	0.00	0.00	
Jul	0.05	0.00	0.05	7.44	5.21	0.00	0.00	
Aug	0.06	0.00	0.06	6.51	4.56	0.00	0.00	
Sep	0.37	0.00	0.37	5.10	3.57	0.00	0.00	
Oct	0.84	0.00	0.84	3.41	2.39	0.00	0.00	
Nov	2.48	0.10	2.23	1.80	1.26	0.97	0.49	
Dec	3.50	0.30	2.94	0.93	0.65	2.29	1.14	
Total	**20.85**		**21.88**	**49.42**	**34.59**	**11.58**	**5.79**	inches/yr
							0.48	ac-ft/ac-yr
							0.28	fraction of annual precip

Notes:

1. Ave monthly precip, Coyote Reservoir, SCVD
2. Ave monthly runoff volumes estimated by USDA-NRCS Curve Number Method; Keefers clay loam, Hyd Soil Group C; adjusted for project impervious surface
3 "Available Precip" = ave monthly precip minus est runoff volume, plus 50% carryover soil moisture from prior month; water holding capacity 0.20
4. Reference ETo obtained from DWR/CIMIS for Zone 8, Inland SF Bay Area; 0.7 Landscape Coefficient multiplier

Water Balance Analysis - Applicable to Cordoba Site West Side/Cemetery Area Adjusted for Hyd Soil Group C, Impervious Surface Area, Soil Moisture Carryover (50%/month)								
Month	Ave Precip. (in/month)	Average Runoff Rate* (%)	Available Precip. (in/month)	Reference ETo (in/month)	Adjusted ET (in/month)	Net Rainfall Recharge (in/month)	Adjusted for 50% Soil Moisture Carryover to next month	
Jan	4.47	0.25	4.58	1.24	0.87	3.71	1.86	
Feb	3.84	0.25	4.74	1.68	1.18	3.56	1.78	
Mar	3.32	0.20	4.44	3.41	2.39	2.05	1.02	
Apr	1.43	0.10	2.31	4.80	3.36	0.00	0.00	
May	0.37	0.00	0.37	6.20	4.34	0.00	0.00	
Jun	0.12	0.00	0.12	6.90	4.83	0.00	0.00	
Jul	0.05	0.00	0.05	7.44	5.21	0.00	0.00	
Aug	0.06	0.00	0.06	6.51	4.56	0.00	0.00	
Sep	0.37	0.00	0.37	5.10	3.57	0.00	0.00	
Oct	0.84	0.00	0.84	3.41	2.39	0.00	0.00	
Nov	2.48	0.10	2.23	1.80	1.26	0.97	0.49	
Dec	3.50	0.25	3.11	0.93	0.65	2.46	1.23	
Total	**20.85**		**23.22**	**49.42**	**34.59**	**12.76**	**6.38**	inches/yr
							0.53	ac-ft/ac-yr
							0.31	fraction of annual precip

Notes:

1. Ave monthly precip, Coyote Reservoir, SCVD
2. Ave monthly runoff volumes estimated by USDA-NRCS Curve Number Method; Keefers clay loam, Hyd Soil Group C; adjusted for project impervious surface
3 "Available Precip" = ave monthly precip minus est runoff volume, plus 50% carryover soil moisture from prior month; water holding capacity 0.20
4. Reference ETo obtained from DWR/CIMIS for Zone 8, Inland SF Bay Area; 0.7 Landscape Coefficient multiplier

Cemetery Water Quality Impact Review

For

Cordoba Center Project

Santa Clara County, California

Prepared For
Ascent Environmental, Inc.
455 Capitol Mall, Suite 300
Sacramento, CA 95814

Project #1700037

Prepared By

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REGISTERED PROFESSIONAL ENGINEER
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Norman N. Hantzsche, P.E.
November 2017

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FIGURES

INTRODUCTION

This report presents a review of plans for the establishment of an Islamic cemetery as a component of the proposed Cordoba Center project in Santa Clara County. The proposed project would be located on an approximately 15.8-acre site fronting Monterey Road between the City of Morgan Hill and the community of San Martin (**Figure 1**). This review has been prepared under a sub-contracting agreement with Ascent Environmental, Inc., to provide technical analysis and recommendations for consideration in the environmental impact review of the project. The specific focus of the review was evaluation of the potential impacts to public health and groundwater quality from the cemetery.

The proposed Cordoba Center project would provide an Islamic worship and cultural center for Muslim residents in the southern portion of the Santa Clara Valley. In addition to the cemetery, the proposed project facilities would include a mosque, multi-use community building, an area for youth summer camps, caretaker's residence and additional supporting and ancillary structures. The cemetery would be located on 3.5 acres on the western side of the site. The cemetery area would be terraced to provide a level surface for the graves and adjoining gravel pedestrian paths and would be landscaped to resemble native grassland (**Figure 2**).

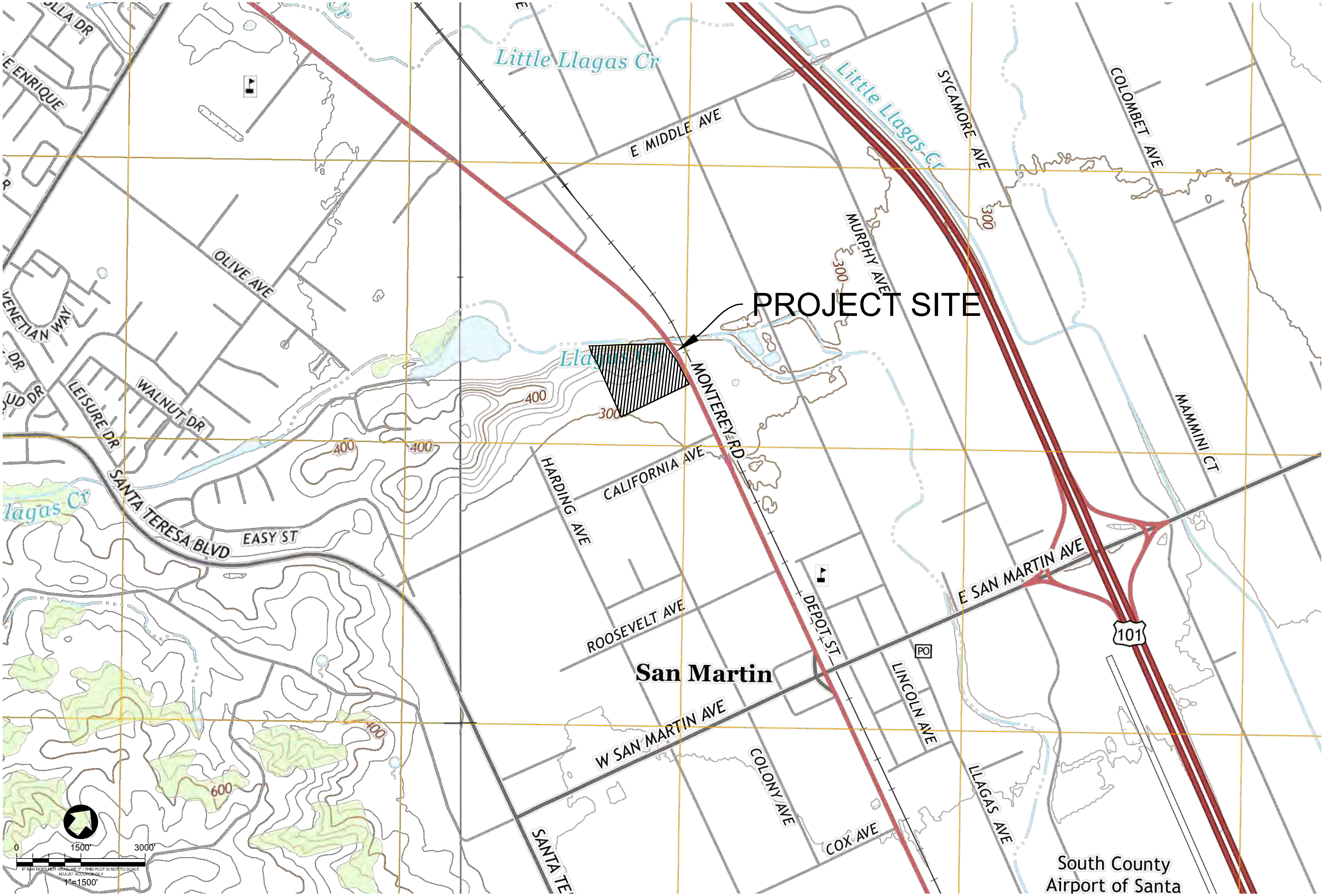
Work performed for this review included:

- **Site Inspection:** Site inspection, test borings and observation of soils and groundwater conditions within the proposed cemetery area on April 25, 2017.

- **Background Information and Data:** Compilation and review of relevant background information and supporting data regarding soil, geology, groundwater, hydrology, water quality and land and water use activities encompassing the project site and vicinity. This included information from Santa Clara County Department of Environmental Health (DEH), Santa Clara Valley Water District (SCVWD) and Central Coast Regional Water Quality Control Board (RWQCB), as well as investigations of the project site and vicinity by various consultants.

- **Cemetery Research:** Research and review of pertinent studies and scientific publications regarding cemeteries, including documented and/or potential impacts on public health, groundwater quality and other environmental concerns and recommended guidelines and practices to avoid or minimize impacts.

- **Review and Water Quality Impact Analysis:** (1) review and evaluation of the plans for the proposed cemetery relative to project site soil and groundwater conditions and conformance to recommended siting and operational guidelines; and (2) analysis and estimation of potential impacts on groundwater quality within and near the project site due to pathogens, nitrate, and mineral salt (TDS) additions from the planned cemetery burial practices.



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Drawn: MF
Appr'd: NH
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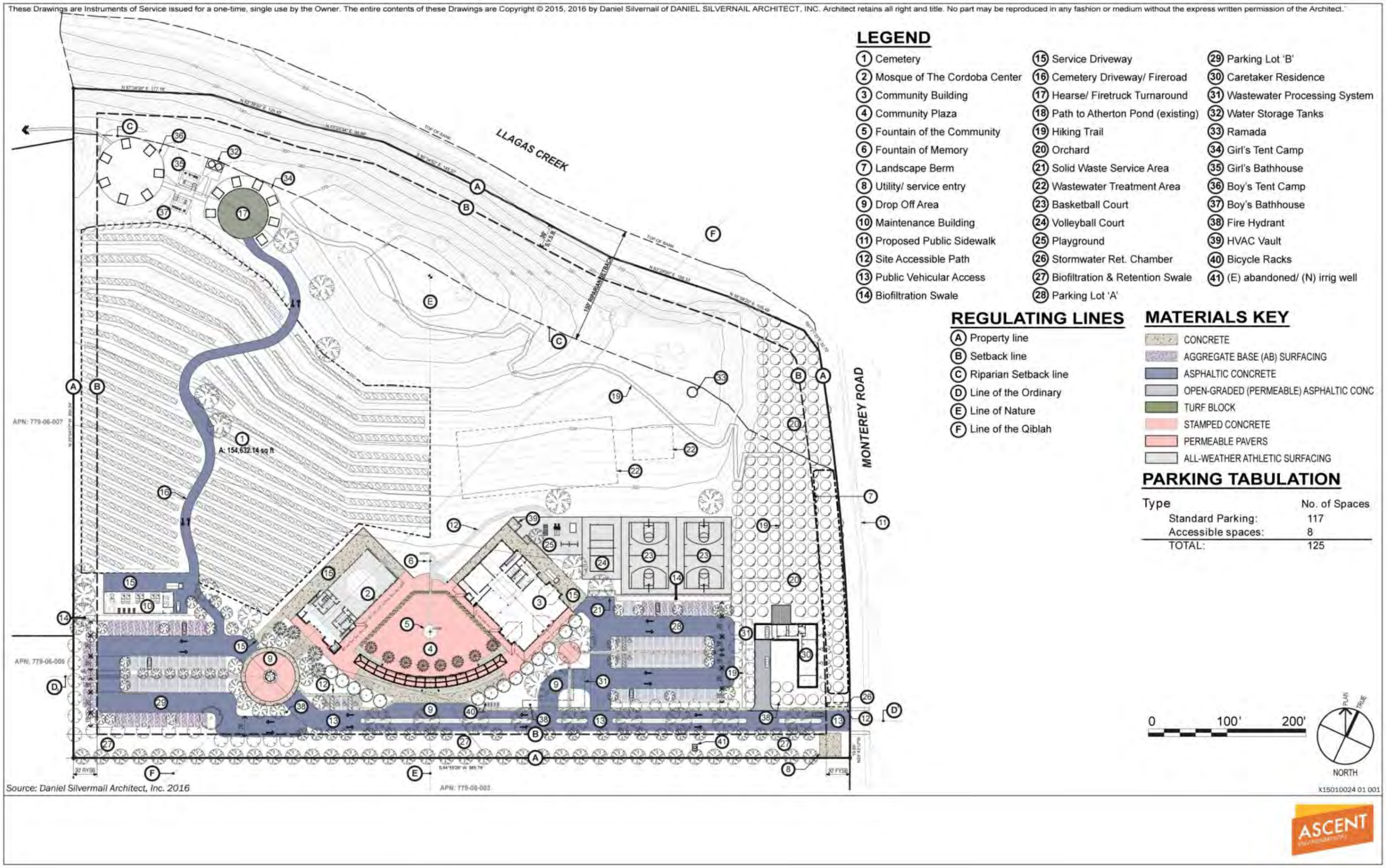
PROJECT SITE
CORDOBA CENTER

SAN MARTIN, CALIFORNIA

FIGURE
1



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PROJECT NO.:	1700037
DRAWN:	DD
APPROVED:	NH

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PROJECT SITE PLAN

FIGURE 2

PROJECT SITE CONDITIONS

Geography and Land Uses

The project site encompasses a rural undeveloped property of approximately 15.8 acres. The site ranges from elevation 300 feet above mean sea level (amsl) on the southern side, up to about 385 feet amsl at the ridgeline on the northern side. The project site is predominantly grassland that has been used in the past for agricultural purposes, including orchard and other crops. The site is bordered on the east by Monterey Road, on the north by Llagas Creek and associated open space, and on the south and west by rural residential properties.

The project area is semi-arid, characterized by mild winters and hot, dry summers. Average rainfall is approximately 21 inches per year, with about 90 percent occurring from November through April.

Surface Waters and Drainage

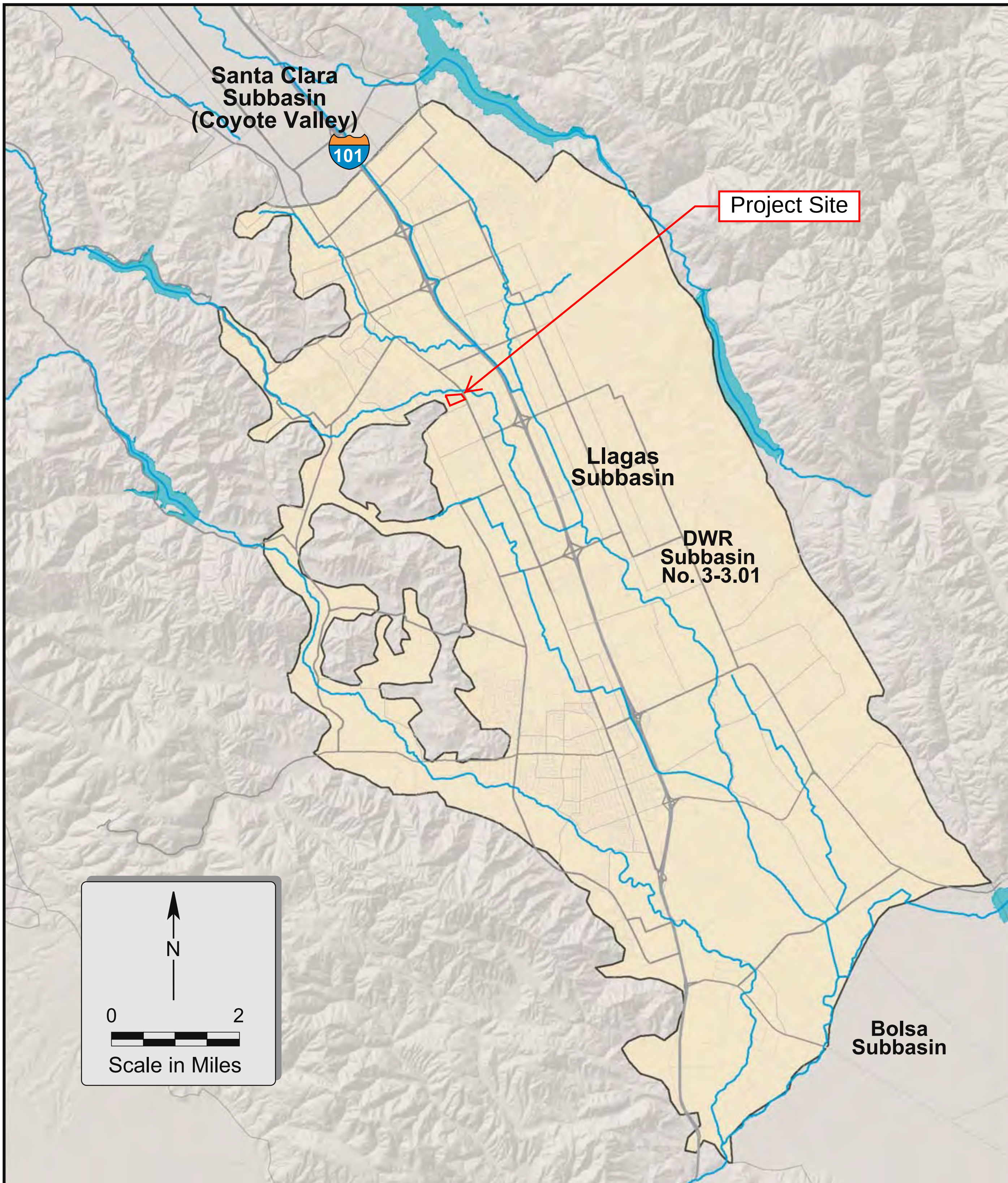
The project site lies within the watershed of Llagas Creek, which borders the northern side of the property; however, there are no streams or other watercourses on the property. Rainfall not absorbed into the soils flows generally as sheet-flow to the south-southwest, away from the northern property boundary and Llagas Creek.

Groundwater

Regional. The project site lies on the western edge of the Llagas Subbasin of the Gilroy-Hollister Valley Groundwater Basin (**Figure 3**). Ground water in this subbasin occurs generally under unconfined conditions, with some zones of confinement. For characterization and reporting purposes, the SCVWD divides the Subbasin vertically into "Shallow" and "Principal" aquifers. The Shallow Aquifer includes all basin fill materials to a depth of 150 below ground surface and the Deep Aquifer consists of all materials at greater depth to the base of the aquifer (SCVWD, 2014). The groundwater is used extensively for domestic, agricultural and industrial water uses, providing 95 percent of the water supply for the cities of Gilroy and Morgan Hill, unincorporated community of San Martin and other rural residential and uses in the area.

Local. Locally to the south and west of the project site, groundwater occurs in materials mapped as older alluvium, consisting of unconsolidated clay, silt, and sand formed as floodplain deposits. The alluvium extends into the southern and eastern edges of the project site, thinning-out at the base of the Franciscan bedrock and colluvial slopes which underlie most of the site.

Groundwater levels vary seasonally and from year-to-year depending on precipitation patterns, with typical water table depths in the range of about 15 to 30+ feet below ground surface (bgs). Information from the SCVWD Annual Groundwater Report for calendar year 2015 indicate groundwater flow in this part of the Llagas Subbasin to be generally in a southerly direction, with an average gradient of about 0.4 percent (see groundwater maps, **Appendix A**).



LEGEND

	DWR-Designated Llagas Subbasin
DWR	California Department of Water Resources

July 2017

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Figure 3
Llagas Groundwater
Subbasin

Source: Final Salt and Nutrient Management Plan (SCVWD, 2014)

Groundwater quality in the project area (Shallow and Principal Aquifers) is considered good to excellent for domestic uses. With few exceptions, SCVWD well water monitoring data show nitrate and total dissolved solids (TDS) concentrations compliant with drinking water standards and evidence of either stable conditions or a decreasing trend in nitrate and TDS levels over the past 15 years of monitoring. **Appendix A** provides several graphics from the 2015 Annual Groundwater Report depicting groundwater quality findings. SCVWD data show one well, about 3,000 feet west of the project site, with reported nitrate concentrations in excess of the drinking water Maximum Contaminant Level (MCL) of 10 mg-N/L. SCVWD monitoring data over the past 18 years for 26 wells within 1/2 mile of the project site indicate nitrate-nitrogen concentrations ranging from 0.29 to 20.9 mg-N/L, with an average concentration of 7.1 mg-N/L.

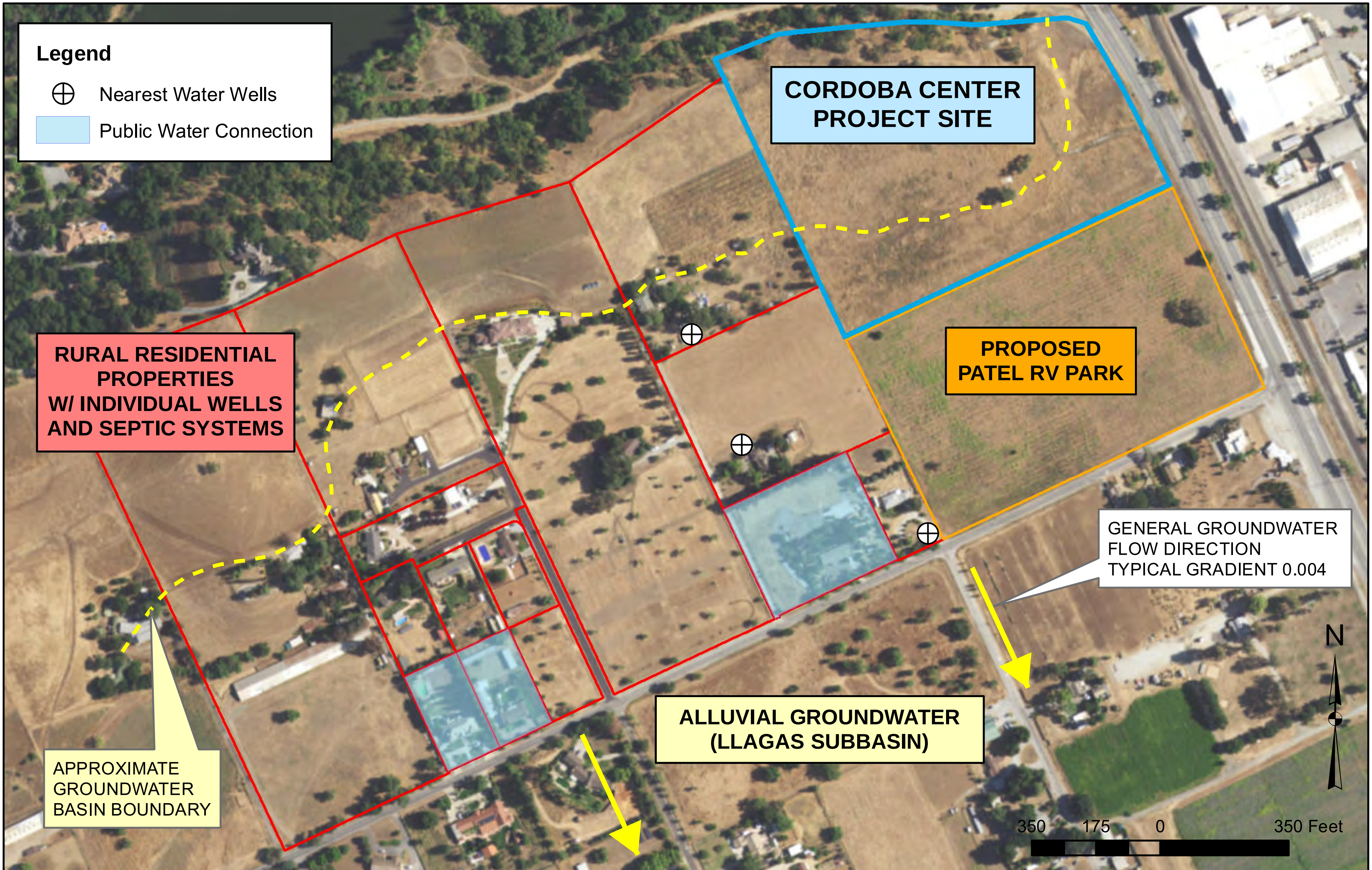
Most of the neighboring rural residential properties rely on groundwater for individual well water supplies. A few properties obtain water service from West San Martin Water Works, Inc. (WSMWW), which is the main water supplier for the western portions of San Martin (west of Monterey Road). Water service for the Cordoba Center project is planned to be supplied by WSMWW as is proposed development on the 14-acre vacant property bordering the south side of the project site, where an RV park is planned (Patel RV Park). **Figure 4** shows the relationship of the project site to the local groundwater basin, neighboring properties, and the estimated location of the nearest existing water wells, which range from about 300 to 600 feet from the southwestern boundary of the project site. Areas north of the alluvial groundwater basin are underlain by colluvium and bedrock containing typically minimal and discontinuous groundwater resources.

Project Site. Groundwater on the project site occurs in the older alluvium along the southern and eastern sides of the property and in fractured bedrock in some places. In a 2007 groundwater assessment using monitoring well data from the vicinity, depth to groundwater was estimated to range from 17 to 25 feet bgs on the project site (Geoconsultants, 2007). In connection with the current review of the proposed Cordoba Center project, on April 25, 2017 Questa completed several exploratory boreholes for direct observation of groundwater levels on the site, focusing particularly on the proposed cemetery area. The results are presented in **Table 1**, including the location of the groundwater measurements, geologic materials where water was encountered, depth to water, and water table elevation in feet amsl.

Table 1. Onsite Groundwater Measurements, April 2017

Designation	Location[1]	Soil-Geologic Materials[2]	Ground Surface Elevation (feet, amsl)	Depth to Groundwater (feet, bgs)	Water Table Elevation (feet, amsl)
GW-1	Cemetery – mid	Franciscan Bedrock	316	24.7	291.3
GW-2	Cemetery - lower	Franciscan Bedrock	302	25.8	276.2
GW-3	Cemetery – mid	Franciscan Bedrock	316	18.0	298.0
GW-4	Cemetery - upper	Colluvium	338	Dry to 15.0' Boring Depth	N/A
A-1	Wastewater disposal field	Colluvium	328	Dry to 8.0' Boring Depth	N/A
A-2	Play area	Colluvium	314	Dry to 8.0' Boring Depth	N/A
Existing Inactive Well	Southeast corner	Older Alluvium	304	23.2	280.8

[1]According to project site plan;
[2] Materials where water observation made



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PROJECT AREA CONDITIONS

FIGURE 4

Also included in **Table 1** is the water level reading taken at an existing (inactive) irrigation well in the southeast corner of the project site that is planned to be refurbished and put into use to irrigate project site landscaping. Borehole locations and approximate groundwater contours (per April 2017 data) are shown on **Figure 5;** borehole logs are provided in **Appendix B**.

Geology and Soils

The project site is located within hilly terrain along the northeast flank of the Santa Cruz Mountain Range. The northern portion of the property is characterized by an east-west trending bedrock ridge, which slopes steeply down to Llagas Creek on the north side. The south side of the ridge consists of a gently-inclined hillslope and level alluvial terrain (**Figure 5**).

The bedrock ridge is underlain by Franciscan Greenstone, with colluvium on the southerly flanks, and older alluvium on the level alluvial terrace forming the eastern and southern sides of the property (Connelly, 2007). The proposed cemetery will be primarily within the colluvium hillslopes, overlapping small areas mapped as alluvium in southwest corner and Franciscan Greenstone in the northeast corner.

The Soil Survey of Eastern Santa Clara Area (1974) shows the following soils occurring on the property:

- Keefers clay loam overlies the bedrock on the lower portions of the south-facing slope of the bedrock ridge. These are deep well drained soils, with moderate permeability, underlain by slowly permeable gravelly clays. These soils coincide with areas planned for the cemetery.

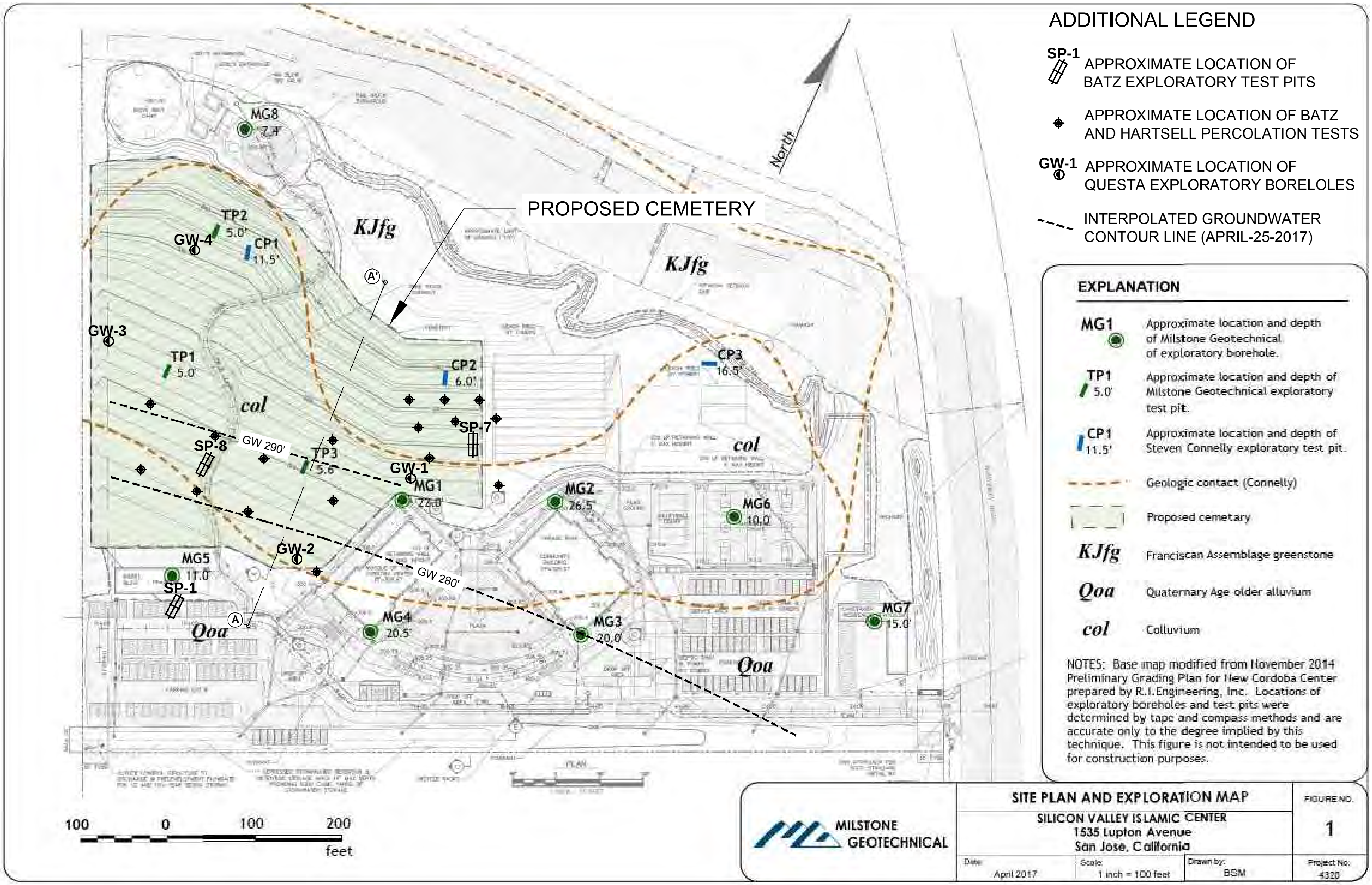
- Pleasanton gravelly loam occurs in areas coinciding with the older alluvial fan deposits in the center and southern portions of the site. These soils consist of well drained loams underlain by gravelly sedimentary alluvium. These soils coincide with locations planned for many of the project buildings, parking and activity areas.

- Cortina very gravelly loam, fine sandy loam and sandy loam are found on the eastern portions of the site. These are deep well drained soils with good permeability. These soils coincide with the area of the proposed orchard.

Between 2006 and 2017, numerous soil test pits, exploratory boreholes and percolation tests were conducted in different areas of the property in connection the development of plans for the project. **Figure 5** identifies the test locations in and around the proposed cemetery area; observations and findings are summarized in **Table 2**.

Figure 6 presents a south-north cross-section ($A\text{-}A^1$) roughly through the middle of the cemetery area, developed from the proposed grading plan and various test pit and borehole observations. The conditions in the proposed cemetery can be summarized as follows:

- Ground slope: average of 15%, ranging from 7% in the lower portions to 25% at the upper edge of the cemetery;



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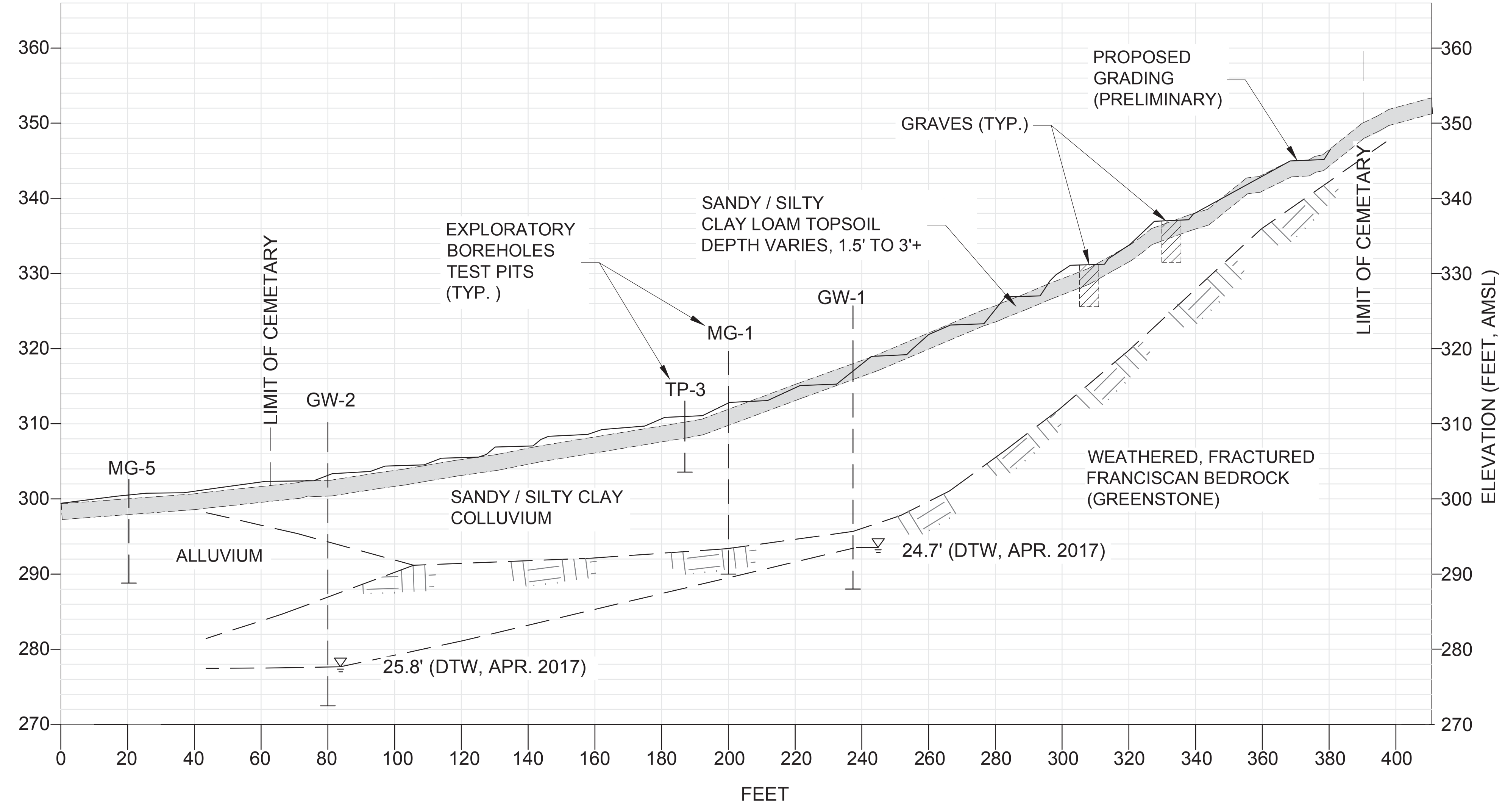
GEOLOGIC MAP AND TEST LOCATIONS

FIGURE

5



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SOIL - GEOLOGIC CROSS-SECTION THOROUGH CEMETERY

FIGURE
6

- Topsoil: sandy-silty clay loam, typically up to about 3-feet deep;
- Subsoil: sandy-silty clay and clayey sand, moderately to very stiff, some gravels, transitioning to weathered rock;
- Bedrock: weathered-fractured Franciscan bedrock (Greenstone) encountered at typical depths of 11 to 23 bgs, shallower near the upper (northern) limits of the cemetery;
- Percolation: moderate to slow percolation rates at depths of 3 to 7 feet;
- Groundwater: groundwater at depths of 18 to 25 feet bgs, occurring within fractured bedrock.

PROJECT CEMETERY PLANS

The project proposes an Islamic cemetery to be located within a 3.5-acre area on the western side of the site. The cemetery area would be terraced to provide a level surface for the graves and adjoining gravel pedestrian paths and would be landscaped to resemble native grassland. Each grave would be 5 to 6 feet below ground and marked by a flat marker. Graves would be oriented generally east-west along the line of Qiblah to face Mecca. A paved driveway (2-way traffic) would wind north-south through the cemetery, from the Maintenance area to the Camping area. No buildings would be sited in this area. **Figure 7** shows the proposed layout of the cemetery consistent with the preliminary grading plan, including terraces, grave sites and driveway.

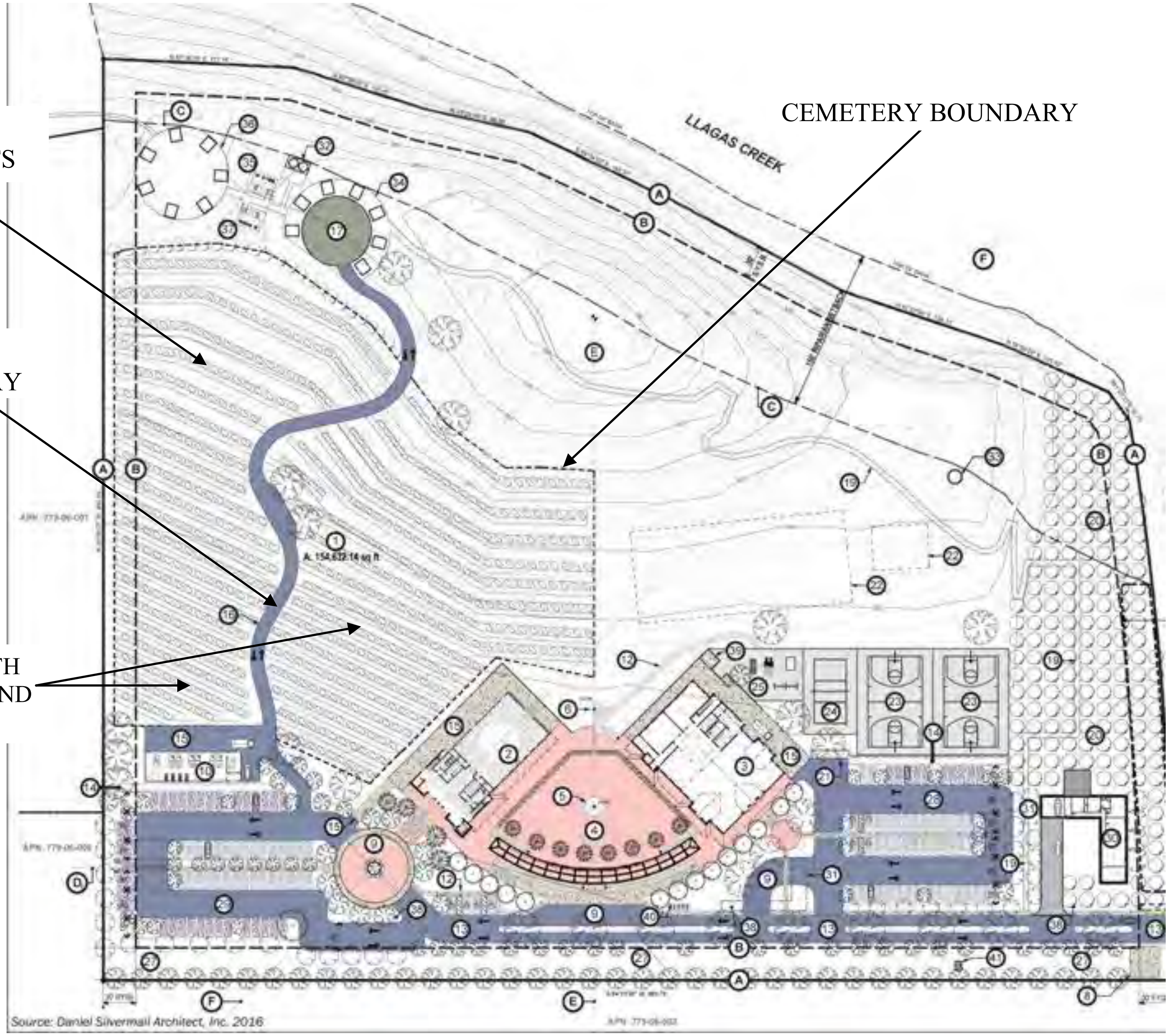
The cemetery would be owned and operated by the project applicant, Silicon Valley Islamic Center (SVIC). Muslim burial rites require that the deceased's body is returned to earth as soon as practically possible, in its natural form, untreated and unembellished, and allowed to completely and naturally biodegrade. Typical procedures followed in Islamic burials include the following:

- the body of the deceased is transported to a state-certified morgue, prepared and ritually washed for burial, and shrouded only in white, untreated cloth;

- the body is placed in a simple cardboard coffin and transported to the mosque for funeral services, followed by transport to the cemetery;

- at the burial site, the shrouded body is removed from the coffin and placed directly on dirt in the grave, which is backfilled with dirt and leveled to grade.

Burials in the cemetery would occur within the same area in a given year or group of years. SVIC plans to develop the cemetery in four or more phases with the first phase occurring at the north end of the cemetery and moving down the slope in sequential phases in successive years. This will allow successive phases of the cemetery to be developed without disturbing the area of existing grave sites. Burials would occur within each phase-area before the next phase-area is developed. The preliminary plan provided in **Figure 7** shows a conceptual layout of burial plots. The applicant has indicated that a more precise cemetery layout drawing will be provided as part of construction documents for the project, which could change the orientation and total number of burial plots that could be accommodated in the cemetery. **Figure 6** (earlier) shows a south-north cross-section through the center of the cemetery, showing the conceptual grading plan and the relationship of proposed graves to the underlying soils, geology and groundwater conditions.



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PRELIMINARY CEMETERY PLAN

FIGURE 7

WATER QUALITY REGULATORY REQUIREMENTS, ISSUES AND GUIDELINES

Regulatory Requirements

State and Regional Water Boards. In California, and the U.S. in general, there are no established water quality requirements specific to cemeteries. While the State Water Board and Regional Water Boards have authority over virtually all matters that may affect water quality, these agencies have not developed requirements, policies or permitting procedures for the development or operation of cemeteries.

The Regional Water Board's involvement in the review of water quality issues for cemeteries is normally on a case-by-case basis, often as a commenting agency during the environmental review for new facilities. Grading activities and stormwater runoff associated with the development of the cemetery site, landscaping and drainage facilities are commonly addressed during this process. Although there are no examples to point to where this has been done, the Regional Water Boards have the authority to require technical studies, monitoring and potentially waste discharge permits for cemeteries in cases where it is determined that a cemetery poses a threat to water quality.

The underlying basis and framework for Regional Water Board water quality management activities is provided through the development of Water Quality Control Plans ("Basin Plans"), which, among other things, designate beneficial uses and establish water quality objectives (standards) for surface waters and ground waters in their jurisdiction. For the Llagas Groundwater Sub-basin, the water quality objective for nitrate is 10 mg-N/L, the maximum contaminant level (MCL) for drinking water. The Central Coast Regional Water Board has also established 5 mg-N/L as the median water quality baseline objective (MWQB), which is the target level believed to be attainable through preservation of existing conditions and management of controllable sources of nitrogen. The difference between the MWQB objective and the MCL is considered the assimilative capacity of the groundwater basin (SCVWD, 2014).

Santa Clara County. Santa Clara County DEH does not have any public health or water quality requirements, policies, or authority for review and permitting of cemeteries. However, DEH administers the County's Local Agency Management Program for onsite wastewater treatment systems, which addresses subsurface dispersal of wastewater contaminants with similar soil suitability and groundwater protection issues as those posed by the leaching effects from cemeteries. Siting requirements for conventional onsite wastewater dispersal systems (leachfields) are particularly relevant as a point of reference in considering the potential effects and acceptable conditions for cemeteries, including the following:

- **Soil Depth.** Conventional disposal trenches require a minimum of five (5) feet of soil below the trench bottom.
- **Groundwater Separation**. Minimum depth to groundwater (below trench bottom) ranges from five (5) feet to 20 feet, depending on the percolation rate.
- **Setbacks**. Minimum horizontal setbacks between septic tank and leachfield systems and

various physical site features include some of the following key requirements:

Site Feature	Minimum Setback (ft)
Well (private, individual)	100
Public water well	150
Watercourse	100
Reservoir	200
Drainage channel, swale	50
Cuts or steep embankments	4 x height (min 25' up to 100')
Property lines	10

- **Cumulative Impact Considerations**. In addition to the above specifications, evaluation of nitrate loading or other possible long-term cumulative effects on water quality is required for larger systems and other cases, notably in the San Martin area.

Groundwater Quality Issues

General. Concerns regarding potential cemetery impacts on groundwater quality are generally considered to be those from the leaching of:

a) decomposition compounds and materials from buried human remains, including bacteria, viruses, organic substances, mineral salts and other inorganic elements;

b) embalming fluids such as formaldehyde, methanol and a myriad of other organic ingredients;

c) various chemicals and substances from decay of man-made artifacts and materials buried with the body including caskets, vaults, and ornamentation; and

d) excess fertilizers and pesticides applied for maintenance of lawns and other landscaping.

The proposed cemetery at Cordoba Center will consist of natural burials, without the use of embalming fluids or caskets and their potential leaching effects. Additionally, landscaping is planned to consist of native grassland vegetation rather than maintained lawns, eliminating the need for pesticide and fertilizers common at many cemeteries. Accordingly, the issues of potential groundwater concern for the proposed cemetery will be those associated with the leaching of products of decomposition from the buried human remains.

Decomposition Products. The basic elements and decomposition products from buried human remains are similar to materials found in domestic sewage, and many constituents are identical to those present in the natural environment. The impact on groundwater is not due to any specific toxicity they possess, but rather due to the potential for increasing the concentration of naturally occurring organic or inorganic substances to levels that would render the groundwater unfit for potable supplies or other uses (WHO, 1998).

The human body is composed of approximately 64 percent water, 20 percent protein, 10 percent fat, 1 percent carbohydrates and 5 percent minerals. Decomposition involves various chemical and biological transformations affected by the condition of the cadaver and microbial activity in the grave, which is influenced by environmental factors such as temperature, precipitation, depth of burial, soil characteristics and oxygenation. The typical period for full decomposition at normal burial depths in well drained soils is estimated to be about 10 years. Decomposition in waterlogged or poorly drained soils may require up to 20 years or more (Rodrigues, 2003; Fineza, 2014).

The primary end products of decomposition available for dispersal and leaching in the soil environment are inorganic compounds such as water, carbon dioxide and methane (gas), ammonia and ammonia compounds, nitrogen, phosphoric acid and hydrogen sulfide, as well as various inert substances (Fineza, 2014).

A wide variety of microorganisms are involved in the decomposition process and also available for leaching from grave sites. Human remains and decomposition products contain large numbers and types of bacteria, pathogenic and others, as well as viruses. These include typical microorganisms known to be responsible for waterborne diseases, such as streptococci, bacillus, and entero-bacteria such as Salmonella (Fineza, 2014).

The primary elemental substances found in the human body are listed in given in **Table 3**, along with the approximate weight (in grams) for a typical male (70 kg), female and average of the two. The values shown in the table represent the theoretical mass added to the soil from each grave site, and potentially available for leaching into the soil and groundwater (WHO, 1998).

Table 3. Elemental Composition of Human Body (grams)

Element	Male[1]	Female[2]	Average
Carbon	16,000	11,200	13,600
Nitrogen	1,800	1,260	1,530
Calcium	1,100	770	935
Phosphorous	500	350	425
Sulfur	140	98	119
Potassium	140	98	119
Sodium	100	70	85
Chlorine	95	67	81
Magnesium	19	13	16
Iron	4	3	3.5

[1] Based on 70 kg adult male
[2] Approximately 70 percent of values for male

Water Quality Investigations and Siting Guidelines - International

Although the issue of cemetery impacts on groundwater quality has not received much attention in the U.S., over the past 20 years there have been several studies and regulatory efforts in other part of the world (e.g., Australia, Brazil, Canada, Portugal, South Africa, UK) to evaluate effects at specific sites and establish improved guidelines and practices for siting new cemeteries.

Examples of some of the study findings include:

- Studies in Australia examined groundwater conditions near recent interments, showing an increase in electrical conductivity (salinity) close to recent graves, and elevated concentrations of chloride, nitrate, nitrite, ammonium, orthophosphate, iron, sodium, potassium, and magnesium ions beneath the cemetery. The studies found that salinity and chloride concentrations rapidly diminished with distance from graves (Dent, 1998).

- In Canada, nitrate concentrations exceeding the drinking water criterion (10 mg-N/L) were detected at one cemetery monitoring well location in southern Ontario in an investigation performed in the early 1990s. The study did not investigate the possible influence of other off-site sources of nitrate, limiting the conclusions that could be drawn. Nevertheless, the study concluded that the nitrogen load from large numbers of graves represented the greatest long-term environmental concern from cemeteries (Formanek, 1997).

- Other studies in Brazil and Portugal found indications of probable groundwater impacts from cemeteries due to unfavorable soil and hydrogeologic conditions (coarse soils, shallow groundwater). For example, in the Brazil study groundwater was observed as high as 2 feet below ground surface, putting graves in direct contact with groundwater during certain times of the year. Also, the study did not confirm the cemetery as the definitive source of bacteria because of the presence of other sources of contaminants in the study area, particularly septic systems. The Portugal study did not identify the soil and groundwater conditions in the cemetery, but also had inconclusive findings due to the presence and suspected interference from septic systems in the area. Elevated water quality parameters found in these studies included electrical conductivity, ammonium, nitrate, calcium, chemical oxygen demand, total coliform and fecal indicator bacteria (Fineza, 2014; Rodrigues, 2003).

In general, these studies and other work concluded a clear need to conduct site specific soil, geologic and hydrogeologic characterization investigations prior to the siting of new cemeteries to avoid potential water quality and public health impacts.

In 1998 the World Health Organization (WHO) produced a "state of knowledge" brief regarding water pollution from cemeteries and the mechanisms to ameliorate the pollution potential. Presented in the conclusions of the brief are a list of conditions suggested as possible guidelines for siting and design of cemeteries based on unpublished draft guidelines from the UK Environment Agency available at the time. In more recent years, England, Scotland and Ireland converted the unpublished 1998 criteria into formal guidelines for new cemeteries in these countries (NIEA, 2009; SEPA, 2015; UK, 2017). **Table 4** lists the criteria contained in the WHO brief alongside comparable criteria adopted by Santa Clara County for siting of standard leachfield systems, which are being applied in this study as a basis of evaluating the proposed Cordoba Center cemetery. Highlighting (shading) is used in the table to indicate the more stringent (protective) requirement for each item. As indicated, Santa Clara County leachfield siting requirements are more protective for all items except horizontal setback to drinking water wells. Santa Clara standards put greater emphasis on soil conditions and vertical groundwater separation as the key factors for contaminant attenuation, and are a reflection of criteria developed from many years of research and application throughout California and the U.S.

Consideration of cumulative wastewater constituent loading, which is extremely important in regard to groundwater nitrate impacts, is also addressed in Santa Clara County requirements. In contrast, cumulative loading issues are not recognized in the 1998 WHO criteria, but may be considered to be covered indirectly through their recommended greater setback distance from drinking water wells. On balance, Santa Clara County requirements for leachfields are shown to be comparable and generally more protective of water quality than the WHO criteria, and suitable for use in our evaluation.

Table 4
Comparison of 1998 WHO Cemetery Guidelines and Santa Clara County Leachfield Siting Requirements

Item	WHO Guidelines for Cemeteries[1]	Standard Leachfield Requirements Santa Clara County OWTS Ordinance & Manual
Soil and groundwater Investigation	Recommended; No procedures identified	Required; including soil profiles, percolation testing, & groundwater level determinations
Vertical separation to groundwater	3.3 feet (1 meter)	5 to 20 feet, depending on percolation rate
Vertical separation to bedrock	3.3 feet (1 meter)	5 feet
Setback to drinking water wells and springs	820 feet (250 meters)	100 feet (individual well) 150 feet (public well)
Setback to other wells, springs and watercourses	98 feet (30 meters)	100 feet
Setback to field drains	33 feet (10 meters)	50 feet
Locating in rapidly permeable soils (coarse sand)	See footnote[2]	Prohibited by percolation requirements
Locating in flood-prone areas	Not addressed	Prohibited within 10-yr floodplain
Cumulative wastewater constituent loading	Not addressed	Required for large flow systems, including nitrate and salt loading analysis

[1] Presented as "…draft conditions that could be used to site and deign a future well managed cemetery…" based on unpublished information from UK Environment Agency, 1998.
[2] Distance to drinking water wells may need to be increased in areas of rapid groundwater velocity

Factors and Recommended Siting Conditions for Cemeteries

Based on literature cited in this review along with knowledge from the onsite wastewater field regarding the behavior and attenuation of bacteria, viruses and other contaminants in soils and groundwater, the following are identified as key guidelines and criteria to prevent adverse effects on groundwater quality from cemeteries.

- **Soil conditions**. Deep, well drained, medium to fine textured soils are preferred to facilitate decomposition processes and promote the adsorption, filtration and long travel times for water and contaminant movement. Soil should be permeable enough to allow the entrance of air, so that decomposition can occur. Porous soil types such as sand or gravel should be avoided, as should burials directly in fractured rock.

- **Vertical separation to groundwater.** An unsaturated soil zone of at least 3 to 5 feet beneath the graves is necessary for maximum attenuation of bacteria and viruses and other decomposition processes. Water movement and contaminant transport in the unsaturated (vadose) zone is slow compared to the saturated zone, providing greater residence time for effective removal of microbial contaminants.

- **Horizontal setbacks from wells and watercourses**. Minimum horizontal setback distances of 100 feet or more should be maintained from wells and watercourses as a safeguard against contaminant entry into an active water supply or seepage into surface water body.

- **Horizontal setbacks from drains and cut slopes.** Graves should be setback from site drainage facilities (surface or sub-surface) and from cut slopes/embankments to minimize the potential for lateral seepage flow to "breakout" at the surface. Appropriate setback distances are site-specific, and should be determined based on factors such as soil conditions, rainfall and percolation conditions, ground slope, grading, and burial depths.

- **Landscape position.** Locating cemeteries on upland landscapes in areas of gently to moderately sloping terrain is preferred. Lowland areas and depressions should be avoided to minimize the potential for inundation from rising water tables and/or flooding.

Physiographic settings characterized by high rainfall, thin soils, coarse sand/gravelly alluvium, or fractured rock, represent the greatest risk of groundwater contamination due to insufficient soil contact area and retention time for bacteria, viruses and other end products in the vadose zone.

WATER QUALITY IMPACT ANALYSIS

Cemetery Site Suitability

Figure 8 provides a schematic cross-section of the proposed cemetery plan, depicting the planned grading of terrace rows and typical grave excavations in relation to the existing soil, geologic materials and groundwater observations from subsurface investigations. Based on results of numerous soil test pits, exploratory borings and percolation tests, the area proposed for the cemetery has conditions considered favorable for protection of groundwater against the leaching effects from decomposition products, as indicated by the following:

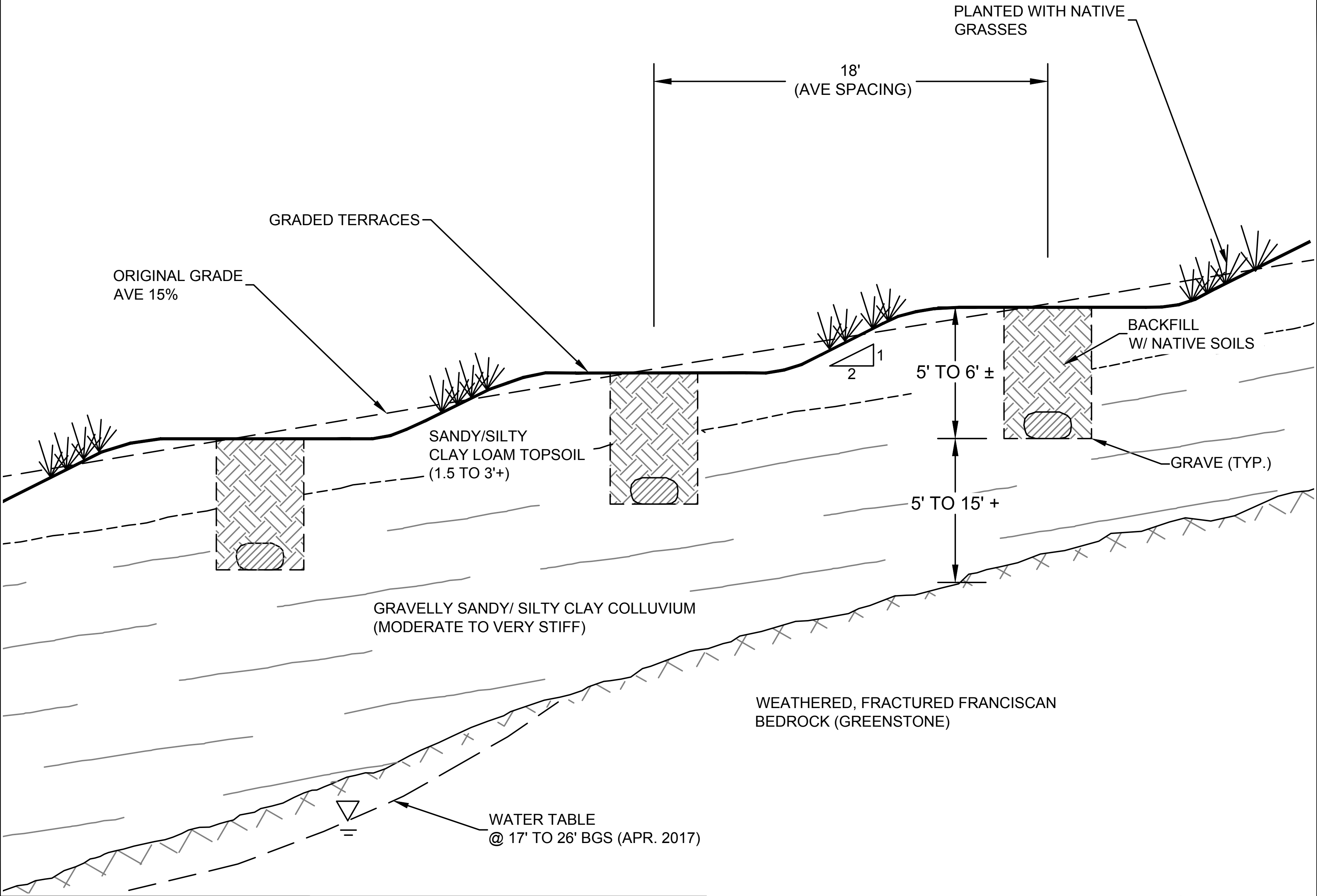
(a) well-drained loamy surface soils and underlying fine-textured clayey sub-soils;

(b) vertical separation distance of 5 to 15+ feet to groundwater beneath the proposed graves;

(c) gentle to moderate hillside landscape position of about 7 to 25 percent, averaging 15 percent;

There are no existing or proposed drainage channels within the cemetery area. The preliminary plan for grading of burial terraces indicates relatively small height of cut and fill slopes, with low probability of creating avenues for surface breakout of lateral seepage flow.

Regarding proximity to water wells, the nearest existing domestic water supply well is located approximately 350 feet west of the southwest corner of the proposed cemetery, which, in combination with the deep, fine textured soil conditions and vertical separation to groundwater, is a sufficiently safe horizontal setback distance to ensure against water quality contamination from the proposed cemetery.



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CEMETERY PLAN CROSS-SECTION

FIGURE

8

The one aspect of the proposed cemetery site that differs from general guidance is the presence of heavy, stiff clay sub-soils in some areas. The clayey texture and low permeability is advantageous from the standpoint of restricting the sub-surface migration of contaminants. However, clayey soils also restrict aeration and drainage and contribute to slower decomposition rates (Formanek, 1998). This would not present any significant impacts to water quality, but it could affect the excavation methods and backfill materials used for grave sites in certain parts of the cemetery.

Bacteria and Viruses

Each grave will introduce vast numbers and types of bacteria, pathogenic and others, as well as viruses. These include typical microorganisms known to be responsible for waterborne diseases, such as streptococci, bacillus, entero-bacteria such as Salmonella (Fineza, 2014).

Many of these microorganisms usually die-off or disintegrate, in place, within a few days or weeks, although some pathogens can be retained for longer periods, e.g., months. They can also be picked-up by percolating rainfall and transported into the surrounding soils where they are subject to attenuation by the following mechanisms:

- **microbial predation –** consumption by other soil microbes;
- **filtration** – physical trapping between soil particles;
- **adsorption** - attachment to the surfaces of soil particles;
- **die-off** - degradation or inactivation due to the inability of the pathogen to sustain itself in the soil environment.

Key factors affecting the above processes include the depth, texture, and structure of the soil, and other physicochemical properties such as moisture, temperature, oxygen and pH. Finer textured soils (e.g., silts and clays) provide the best conditions for attenuation of bacteria and viruses due to greater soil surface area, torturous flow paths, small pore size openings, moisture retention, and long retention times.

It is well known from studies and experience with OWTS that soils have a tremendous capacity to remove bacteria and viruses from percolating wastewater. The retention and die-off of most, if not all, pathogenic bacteria and viruses occur within a few feet in medium to fine textured soils for standard leachfield systems (Anderson et al, 1994; Washington State DOH, 1990), and provide the basis for establishment of the standard 5-foot soil depth and groundwater separation criteria for septic tank-leachfield systems (Santa Clara County 2014). Viruses can also be retained and eliminated within a few feet, depending on the soil conditions; but it is generally accepted that they can persist longer and travel farther in the soil than bacteria (Anderson et al, 1991; Ayres Associates, 1993). Water movement and contaminant transport in the unsaturated (vadose) zone is slow compared to the saturated zone, providing greater residence time for effective removal of microbial contaminants. Additionally, most of the research studies of OWTS pathogen removal have focused on sandy soil types; and the results of these studies have formed the basis for the soil depth criteria for OWTS. Consequently, the soil depth criteria are oriented toward the "worst case" conditions (sandy, permeable soils), and there is a built-in safety factor, with respect to pathogen removal, for finer textured soils with higher silt and clay fractions.

The same principles and criteria adopted for OWTS are relevant to gauging the leaching effects from buried human remains in a cemetery. An additional measure of safety is provided by the fact that leaching and transport of microbes from graves is driven only by seasonal rainfall percolation, and not by a steady flow of percolating wastewater which is the case for leachfield systems. Based on soil and groundwater conditions (5 to greater than 15-foot unsaturated zone) and proposed cemetery burial plans, pathogenic bacteria and viruses associated with decomposing bodies would not pose a threat of impact to groundwater, because they would be effectively attenuated and removed during passage through the deep fine-textured native soils that separate the graves from the groundwater.

Nitrogen Loading Analysis –Cemetery Recharge Area

Nitrogen is one of the key elements of the human body and is an important water quality impact consideration for the proposed cemetery. Nitrogen comprises roughly 3 percent of the human body (by weight), occurring in many organic molecules, including amino acids that make up proteins and nucleic acids that make up DNA. Under aerobic conditions, organic forms of nitrogen convert eventually to the nitrate form, which is soluble and mobile, and can be transported readily through the soil to the groundwater. Nitrate accumulation in groundwater is a critical concern in the San Martin area, due to the substantial reliance on groundwater for water supplies and the history of impacts and continuing vulnerability of groundwater quality due to leaching of nitrogen from agricultural and landscape fertilizers, septic systems, municipal wastewater systems, animal wastes and other man-made and natural sources (SCVWD, 2014).

Approach and Methodology. A water-chemical mass balance analysis was completed to assess the potential contribution of nitrogen from the proposed cemetery to the subsurface environment and the resulting long-term effect on local groundwater quality. The approach was similar to the analysis conducted for the project wastewater facilities (Questa, July 2017), and follows principles and guidelines in the Santa Clara County *Onsite Systems Manual* pertaining to evaluation of cumulative water quality impacts from onsite wastewater disposal. The underlying rationale and methodology is described in the publication "Predicting Groundwater Nitrate-Nitrogen Impacts" (Hantzsche and Finnemore, Groundwater, Vol. 30, No. 4, July-August 1992). According to this methodology, the long-term concentration of nitrate (NO_3) in the upper groundwater zone can be closely approximated by the quality of percolating recharge waters, including the integrated effects of rainfall, wastewater and other discharges, as applicable, and associated nitrogen available for leaching.

For the cemetery analysis, the mass balance approach was modified to account for key differences between wastewater disposal operations and cemeteries, which include the following:

- A cemetery is more comparable to a landfill, involving the one-time introduction of a discrete amount of nitrogen with each burial plot, with burials occurring regularly, year-after-year over an extended period of time.

- Leaching of nitrogen from each grave site is driven only by seasonal rainfall percolation, without any assist from a regular supply of percolating wastewater or other applied water flow.

- Leaching of nitrogen from each grave site will occur over a finite amount of time related closely to the time required for decomposition of the interred body, which is typically on the order of about 10 years.

Based on the above considerations, the analysis was approached as follows:

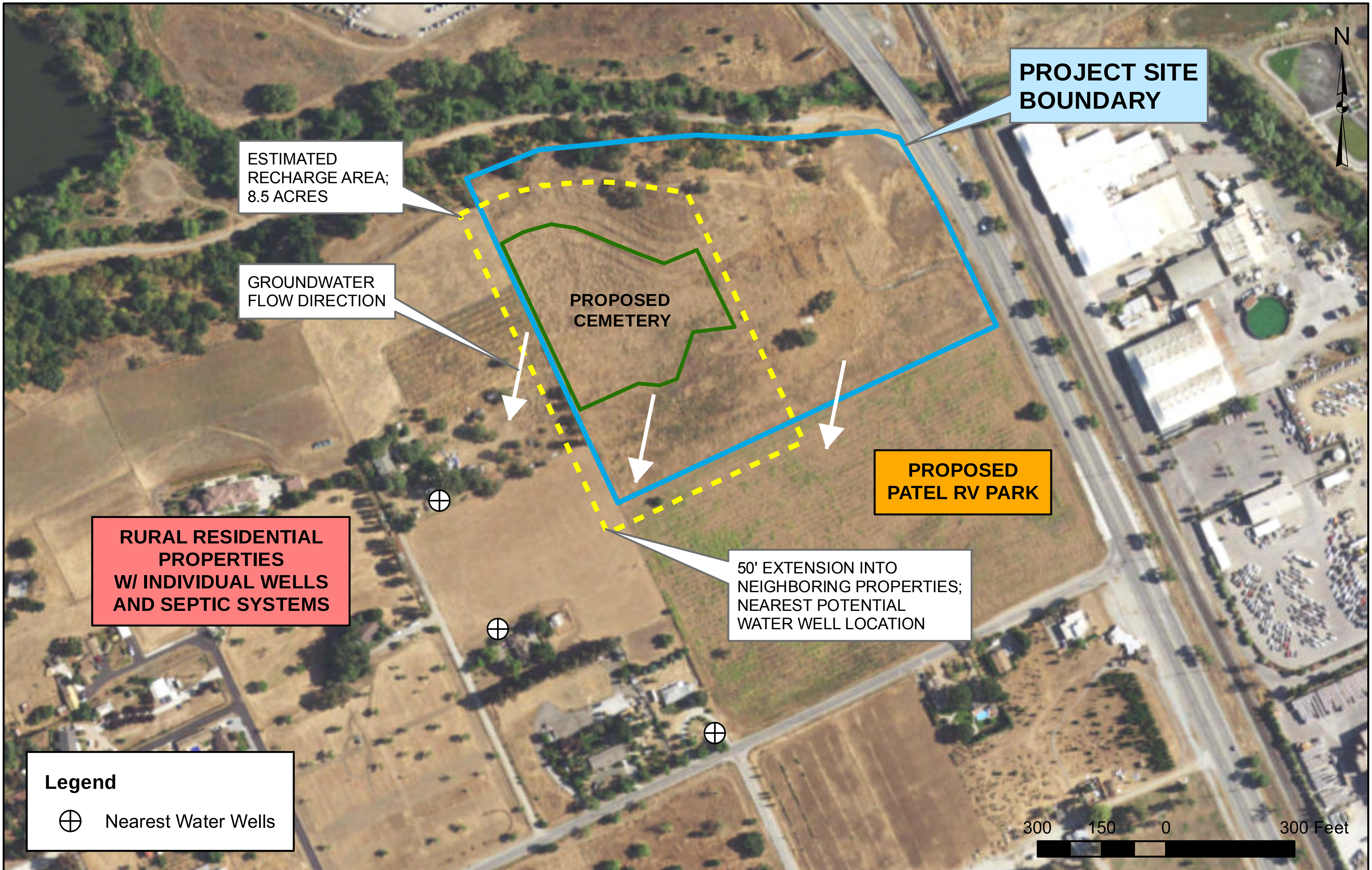
1. An annual chemical-water balance was constructed from Year 1 through Year 10 of cemetery operation, using average annual rainfall-recharge for each year and varying the nitrogen load according to the assumed number of burials per year, and the accumulated total each successive year. The maximum impact to groundwater was estimated as the resultant concentration reached in Year 10, representing the contribution from ten years of burials. The assumption is that after ten years time, the effects from Year 1 would have dissipated, replaced by the newly introduced loading from Year 11 burials, and so on. Ten years was selected to match the estimated time for release of all nitrogen from a buried decomposing corpse, and the release of nitrogen was assumed to be evenly distributed over the ten years ($1/10^{th}$ per year). Selection of a shorter or longer time period for full decomposition and nitrogen release would change the time to reach maximum impact, but it would not change the magnitude of the impact. For example, if full decomposition extends over 20 years, the annual loading would be $1/20^{th}$ per year but the total and maximum impact would be the same.

2. The estimated recharge area was determined topographically to include the portions of the project site encompassing the proposed cemetery and extending off-site to the nearest point of existing or potential water well(s), which was taken to be is a minimum of 50 feet into the neighboring properties to the west and south of the site (see **Figure 9**). This is in accordance with guidelines in the *Onsite Systems Manual*. The nearest existing well is approximately 300 feet west of the southwest corner of the property. Note also, that the recharge area abuts, but does not overlap the recharge area assumed for the separate analysis of the wastewater system nitrate and salt loading impacts (Questa, 2017).

3. The annual nitrogen available for leaching from each grave site was assumed to be $1/10^{th}$ the total nitrogen load per body, using an average total nitrogen of 1,530 g per body, based on an average between typical male and female body composition, giving an average loading rate of 153 g/year per grave.

4. Estimated background nitrate-nitrogen concentration associated with percolating rainwater recharge was assumed to be 0.5 mg-N/L as there are no other significant sources of nitrogen additions/discharges within the identified recharge zone.

5. Calculations were made for different assumed annual number of burials (20, 30, 40, 50, 60, 80 & 100 per year) to assess impacts according to varied levels of cemetery operations.



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CEMETERY GROUNDWATER RECHARGE AREA

FIGURE 9

6. Consistent with guidelines in the *Onsite Systems Manual*, an evaluation-compliance criterion of 7.5 mg-N/L resultant groundwater concentration was applied, since neighboring properties south and west of the proposed cemetery utilize individual water wells.

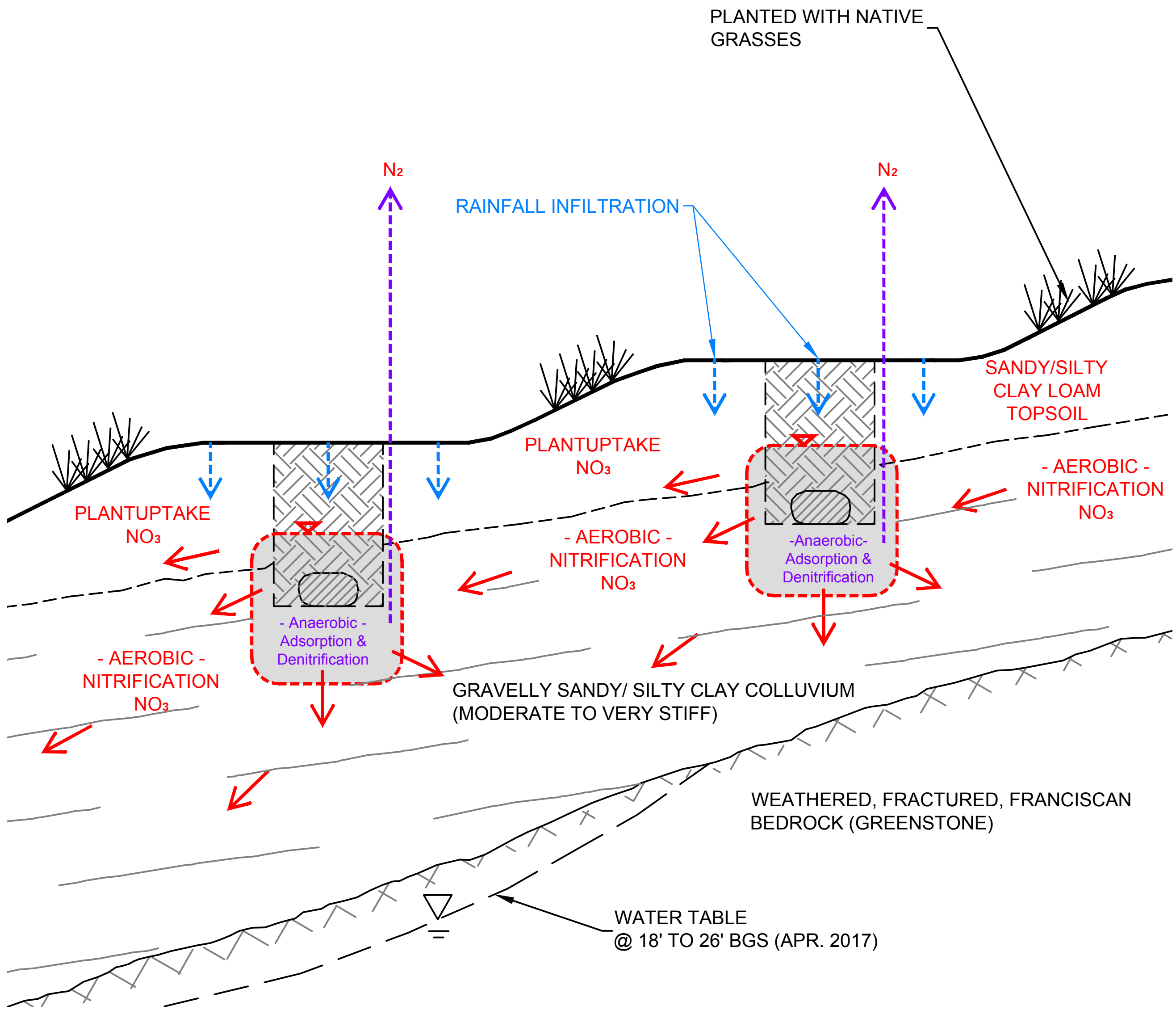
7. Nitrogen removal due to adsorption on clay soils, denitrification in anaerobic zones, and plant uptake was assumed to range from 25% to 50% of the available nitrogen, with calculations made for both values.

In regard to the last point, based solely on soil conditions (deep clay loams and clay sub-soils), a denitrification factor of 25% would be warranted if considering a wastewater percolation (leachfield) system. However, a higher value of 50% (or more) is not unreasonable for the proposed cemetery, due to the strong potential for lateral flow conditions (rather than strictly vertical percolation) caused by the stiff, slowly permeable sandy-silty clay sub-soils. As illustrated conceptually in **Figure 10**, the soil conditions and planned hillside terracing for burial plots will contribute to enhanced opportunities for nitrogen removal via plant uptake and denitrification as follows:

(1) **Plant uptake.** There will be a tendency for build-up of percolating rainwater in the grave backfill materials at certain times of the year, which will have the effect of promoting lateral seepage flow in the loamy surface soils making nitrate-nitrogen readily available for plant uptake in the root zone.

(2) **Denitrification.** Denitrification is a process that occurs under anaerobic conditions where nitrate (NO_3) is reduced by denitrifying bacteria, producing gaseous nitrogen (commonly N_2), which is lost to the atmosphere. This will be enhanced in the proposed cemetery through the establishment of alternating zones of anaerobic and aerobic conditions from one row of graves to the next downhill row. Anaerobic conditions (during decomposition) will occur within and immediately around each grave, providing a favorable environment for denitrification. Aerobic conditions, conducive to nitrification (conversion of ammonium to nitrate) will predominate in the soils between each terrace row of graves. This will facilitate pathways for some of the nitrogen leached from an uphill grave to undergo nitrification in the aerobic soil zones, followed by denitrification where lateral seepage intersects anaerobic zones around the next row of downhill graves, and so on. The planned phasing of the cemetery and sequencing of burials from uphill to downhill will support this pattern of nitrogen transformation in the soil. Additionally, the fact that percolating seepage/water movement will be seasonal and episodic in response to rainfall conditions, nitrification and denitrification processes, which tend to be sow, would be afforded relatively long timeframes to achieve maximum potential.

Calculations. The resultant nitrate-nitrogen concentration of percolating water reaching groundwater from the cemetery for a given year (1 through 10) was completed using an annual chemical-water balance analysis according to the formula and assumptions below. Calculation spreadsheets are provided in **Appendix C.**



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NITROGEN PATHWAYS IN CEMETERY SOILS

FIGURE
10

$$n_r = \frac{(Y)(X)(N_y)(1-d) + Rn_b}{(R)}$$

Where:

n_r = resultant average concentration of NO_3-N in percolating recharge water, mg-N/L

Y = year of analysis from cemetery start-up, 1 though 10

X = number of new burials each year, 20, 30, 40, 50 60, 80 & 100/yr

N_y = total annual mass nitrogen leaching from each grave site, assuming 1,530 grams total over 10-yr decomposition period; 153,000 mg/yr

d = fraction of nitrogen lost due to denitrification, plant uptake and adsorption in the soil, 0.25 to 0.50[1]

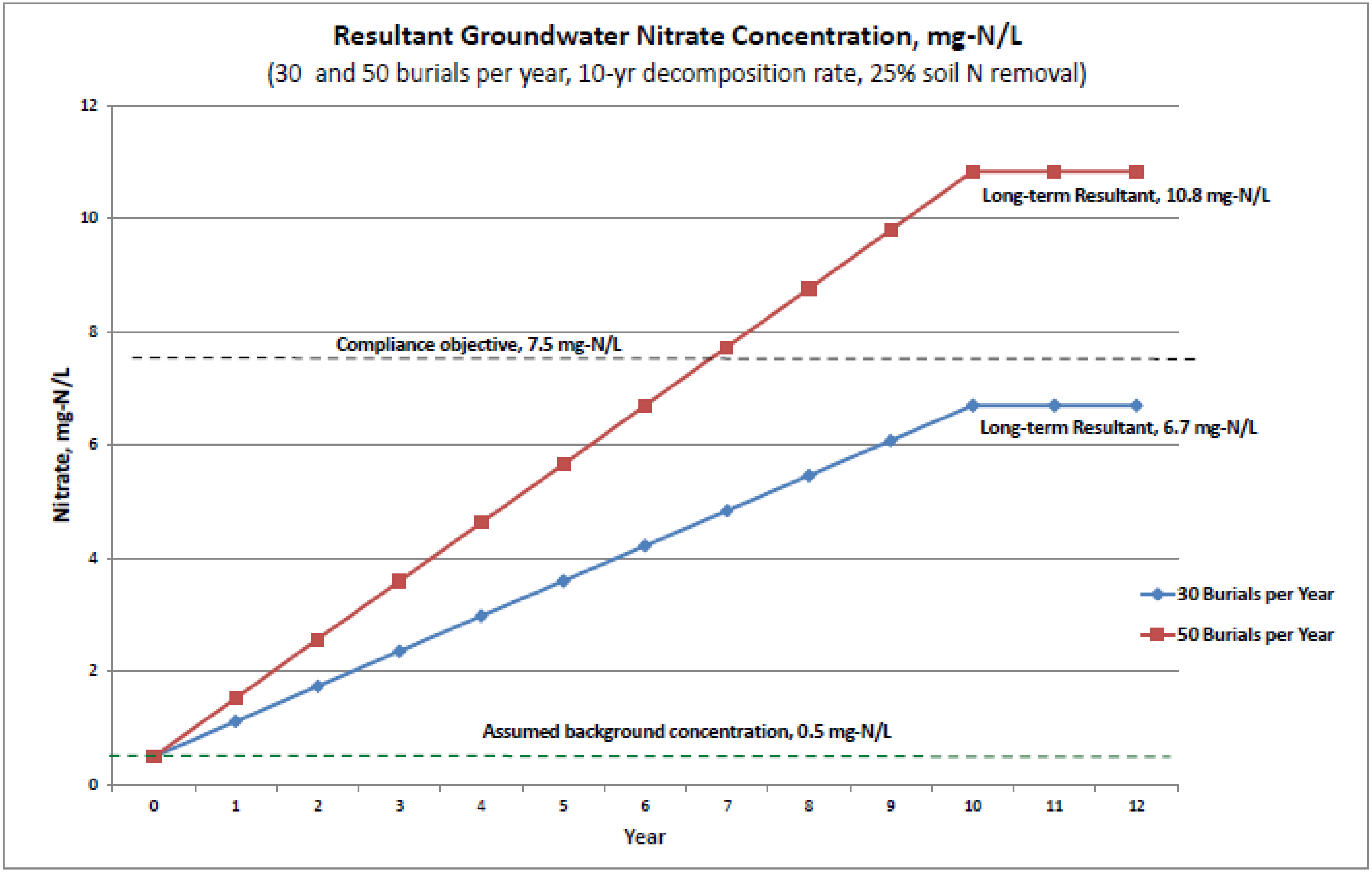
R = average annual volume of rainfall recharge from areas of the project site encompassing the cemetery and off-site to nearest potential well site; 8.5 acres at 0.53 ac-ft/yr per acre, converted to liters (based on site specific water balance analysis, **Appendix C**)

n_b = background NO_3-N concentration of percolating rainfall recharge resulting from atmospheric sources of nitrogen and pick-up from native soils and vegetation; 0.5 mg-N/L

Results. Figures 11 and **12** present graphical plots of the estimated resultant groundwater nitrate-nitrogen concentrations for Years 1 through 10 of cemetery operation for burial rates of 30 and 50 per year, at assumed soil-nitrogen removal rates of 25% and 50%, respectively. **Table 5** presents the estimated long-term resultant groundwater nitrate concentration impact for the full range of annual burial rates analyzed, at both 25% and 50% soil-nitrogen removal assumptions. The results represent the estimated maximum, long-term nitrate concentration reached in the defined recharge area (**Figure 9**) for the given factors (burial rate and nitrogen removal).

Highlighted values in **Table 3** are resultant concentrations at or below the 7.5 mg-N/L criterion for groundwater nitrate impact per guidelines for onsite wastewater systems (*Onsite Systems Manual).* The results indicate annual burial rates of 30 per year or less would be safely within the 7.5 mg-N/L criterion based on a conservative estimate of 25% soil nitrogen removal. Up to 50 burials per year may be acceptable based a higher soil nitrogen removal rate of 50%. Although the 50% nitrogen removal rate appears reasonable based on review of preliminary cemetery plans, site conditions, and

[1] For comparison, nitrogen attenuation assumptions used by the Santa Clara Valley Water District in the analysis for the Llagas Subbasin Salt and Nutrient Management Plan range from 60 percent for horse manure to 95 percent for lawn fertilizer.



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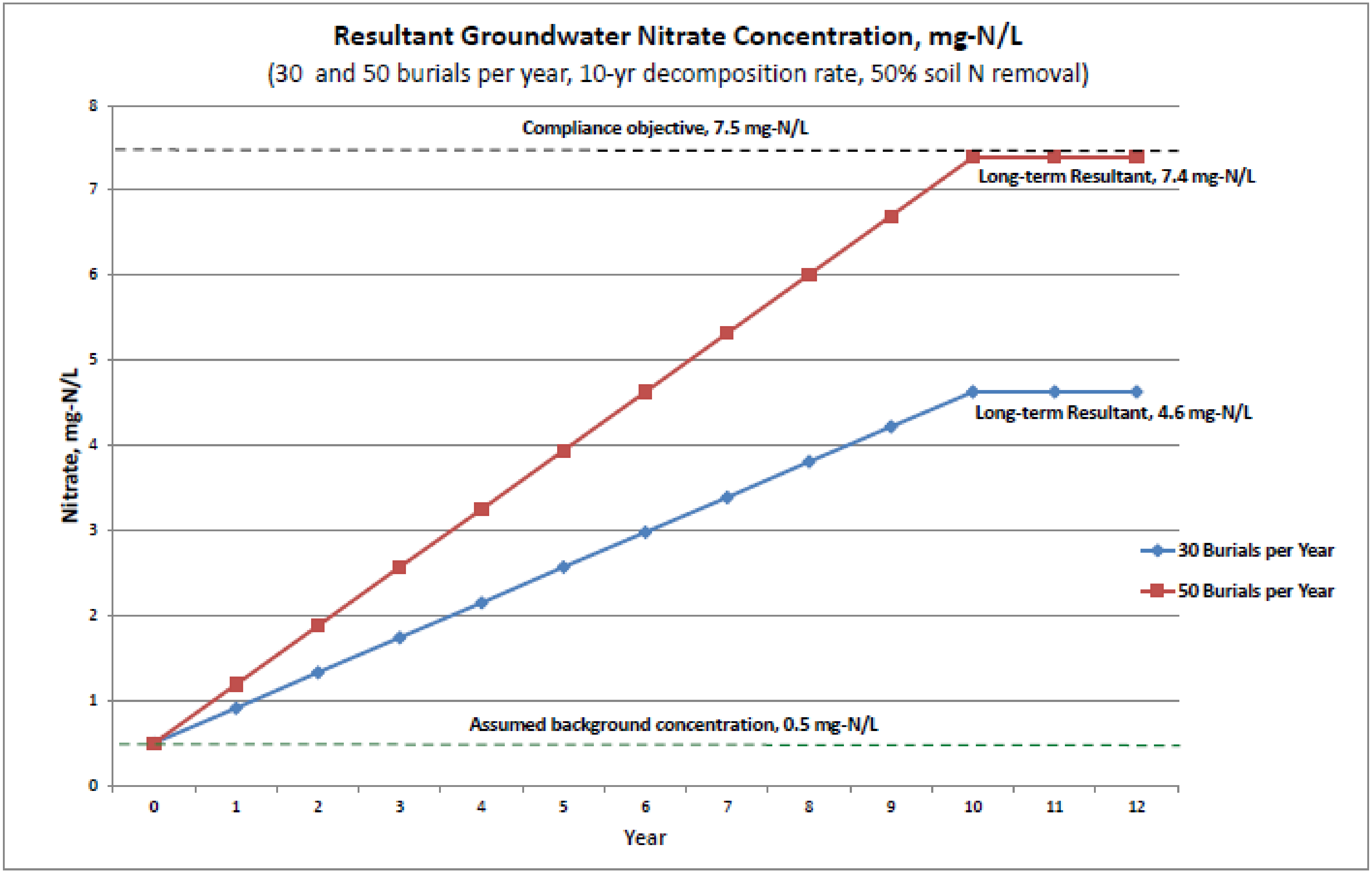
RESULTANT GROUNDWATER NITRATE CONCENTRATIONS

YEARS 1-10 @ 25% N REMOVAL

FIGURE 11



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RESULTANT GROUNDWATER NITRATE CONCENTRATIONS

YEARS 1-10 @ 50% N REMOVAL

FIGURE 12

principles of nitrogen behavior in soils, the factors and processes are complex and there is no means of validating this estimate except through implementation and monitoring over several years of cemetery operation.

Table 5
Estimated Localized Long-term Groundwater Nitrate Concentration[1]

Rate of Burial (X per year)	Resultant Nitrate Concentration, mg-N/L — Nitrogen Removal via Soil Adsorption, Denitrification and Plant Uptake	
	25%	**50%**
20	4.63	3.25
30	6.70	4.63
40	8.76	6.01
50	10.83	7.39
60	12.89	8.76
80	17.00	11.52
100	21.16	14.27

[1] At nearest potential neighboring well location (50 ft beyond property line)

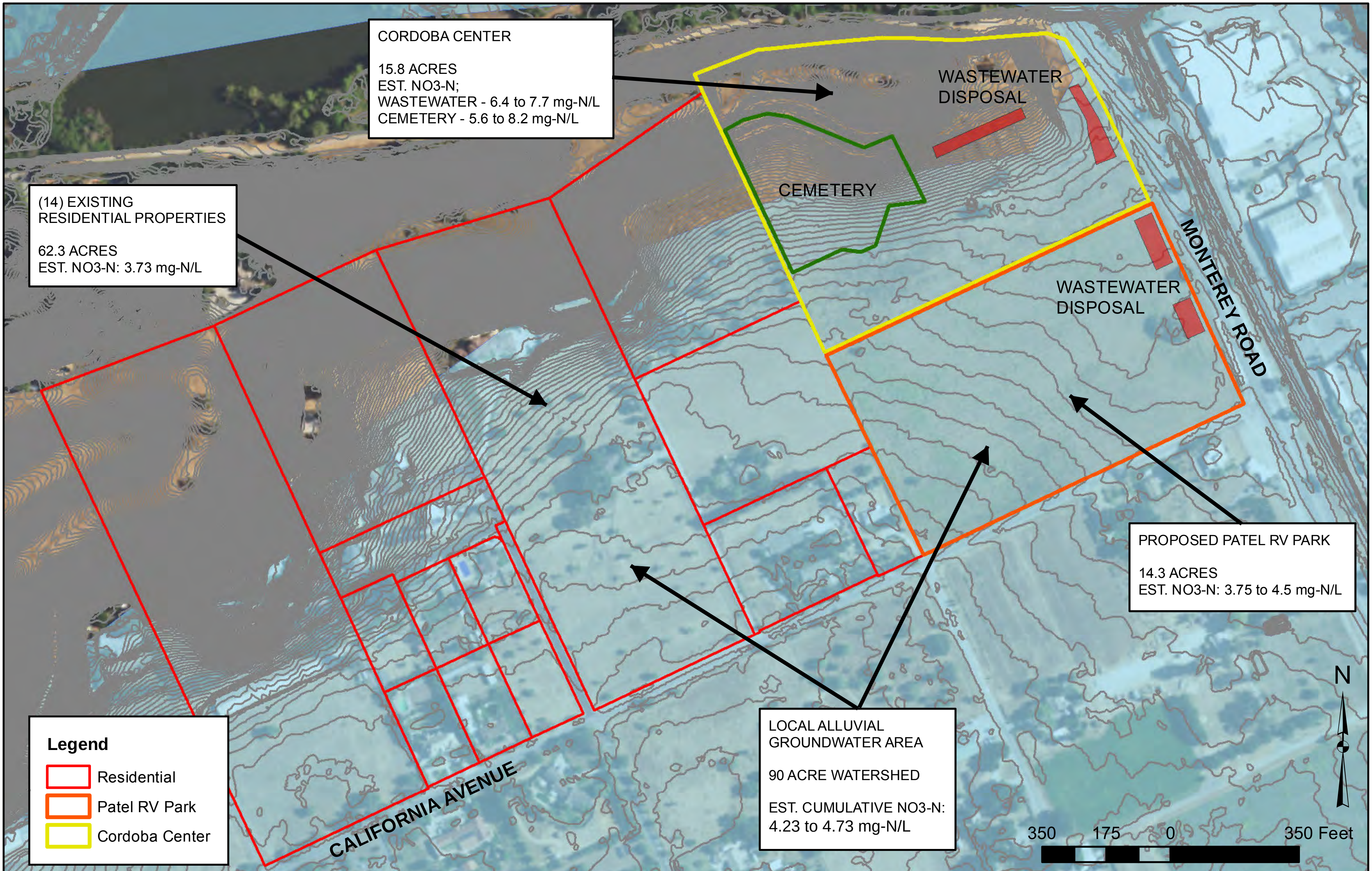
Extended Cumulative Groundwater-Nitrate Loading Effects

In addition to the localized groundwater-nitrate effects addressed above, nitrogen leached from the cemetery could have potential effects on groundwater quality extending farther south and west of the property, where there is substantial reliance on the groundwater for domestic water well supplies.

To evaluate the potential effects, an expanded cumulative mass-balance nitrate loading analysis was completed for a groundwater-recharge area of approximately 91 acres, encompassing the project site and 15 neighboring properties to the south and west. As indicated in **Figure 13**, the local area delineated for analysis includes properties in the local drainage basin north of California Avenue and up to about 3,000 feet west of Monterey Road. These properties all overlie and share a common and relatively well defined portion of the alluvial groundwater basin in this northern end of San Martin. The neighboring properties include: (a) the 14-acre property immediately south of the Cordoba Center Project proposed for development of an RV Park (Patel); and (b) 14 developed rural residential properties to the west, with lot sizes ranging from 0.9 to 16.3 acres, and averaging about 4.5 acres per parcel. All but three of the residential properties rely on individual wells for water supply; the others have water service from WSMWW.

The approach included: (1) developing an estimate of the groundwater-nitrate loading and resultant concentrations in the rural residential area due to septic system discharges; (2) utilizing the projected groundwater nitrate loading and concentration estimates for the Cordoba Center (cemetery and wastewater facilities) and similar projections for the Patel RV Park (Questa, July 2016); and (3) merging all three into a composite or cumulative estimate for the local groundwater area, assuming complete mixing of nitrogen from all sources. The results are summarized in **Table 6**; calculations are provided in **Appendix C**. Key assumptions included the following:

- **Existing Rural Residential Properties (14 total)**. Estimated nitrate loading and



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EXTENDED CUMULATIVE GROUNDWATER IMPACT AREA

FIGURE 13

groundwater concentrations were developed in accordance with guidelines and factors in the Santa Clara County LAMP and *Onsite Systems Manual,* including: (a) contributing groundwater recharge area approximated by the total property acreage (62.3 acres); (b) average annual rainfall-recharge of 8.16 inches (0.68 ac-ft/acre); (c) average wastewater flow of 225 gpd per parcel; (c) septic tank effluent nitrogen concentration of 50 mg-N/L; (d) assumed use of conventional leachfield systems; and (e) soil-denitrification rate of 15%.

- **Patel RV Park (Proposed).** Nitrate loading and resultant groundwater concentration effects were incorporated from information provided in wastewater facilities planning documents for the RV Park project (Questa Engineering, July 2016), including; (a) average wastewater flow of 8,700 gpd; (b) wastewater treatment system effluent nitrogen concentration of 10 mg-N/L; (c) subsurface drip dispersal methods; (d) soil denitrification range from low of 15% to high of 30%; and (e) estimated resultant groundwater nitrate concentration of 3.75 to 4.5 mg-N/L.

- **Cordoba Center Project**. Nitrate loading and resultant groundwater concentration effects were incorporated for both the cemetery (per analysis above) and the wastewater facilities (per separate report by Questa[2]). Adjustments were made to contributing recharge areas (and recharge volume estimates), ending at the property boundary rather than overlapping 50 feet into the adjacent parcels (potential well location).

- **Other Nitrogen Sources**. The analysis did not include the nitrogen contribution and effects from other sources that may occur in the existing rural residential development area, such as from animal wastes or landscaping/agricultural fertilizers[3].

Table 6
Estimated Cumulative Nitrate Impacts – Extended Local Groundwater Basin Area

Contributing Area	Recharge Area (acres)	Annual Recharge Volume (ac-ft/year)	Low Estimate (high soil N removal)		High Estimate (low soil N removal)	
			Annual Mass N Loading (kg/year)	Resultant Nitrate-N Concentration (mg-N/L)	Annual Mass N Loading (kg/year)	Resultant Nitrate-N Concentration (mg-N/L)
(14) Existing Residences	62.3	45.9	211	3.73	211	3.73
Proposed RV Park	14.3	19.5	90	3.75	108	4.50
Cordoba Center						
- Wastewater Facilities	7.0[1]	7.6	66	6.40	80	7.71
- Cemetery	7.1[1]	3.8	33	5.64	48	8.21
Cumulative Total/Average	**90.7**	**76.8**	**400**	**4.23[2]**	**447**	**4.73[2]**

[1] Adjusted to exclude 50-ft overlap into adjoining properties
[2] Weighted average of nitrate loading and annual recharge from all properties

The results indicate a projected resultant cumulative local groundwater nitrate concentration due to the contributions from the proposed Cordoba Center and Patel RV Park projects in the range of 4.23 to 4.73 mg-N/L. This represents an increase of about 0.5 to 1.0 mg-N/L above the estimated

[2] "Wastewater Facilities Review for Cordoba Center Project", Questa Engineering, July 2017.
[3] For example one horse generates the equivalent amount of nitrogen as a typical residential septic system, but the potential impact on groundwater depends on how the manure is managed.

concentration of 3.73 mg-N/L due to septic system contributions from the existing 14 rural residential properties in the area of analysis. About 52 to 54 percent of the increase would be attributable to the proposed Cordoba Center project, and 46 to 48 percent attributable to the proposed Patel RV Park. The resultant concentrations would be safely below the drinking water MCL of 10 mg-N/L, and also below the Median Water Quality Baseline (MWQB) value of 5 mg-N/L established by the Central Coast RWQCB for the Llagas Subbasin. The MWQB is based on preserving existing groundwater quality or attainable levels believed to be achievable through control of point sources of nitrogen. On this basis, it can be concluded that the cumulative nitrate loading effects on groundwater in the area due to contributions from the proposed Cordoba Center cemetery and wastewater facilities would be less-than-significant.

In considering this analysis and conclusions the following should be noted:

1. The estimated resultant groundwater concentrations are based on the simplifying assumption of full mixing of the recharge waters and associated nitrogen contributions from multiple sources and locations. The actual groundwater nitrate concentrations throughout the local groundwater area of study will vary above and below this average concentration, with higher concentrations expected near nitrogen sources (e.g., cemetery, wastewater disposal fields, individual septic systems or clusters of systems), and lower concentrations in groundwater areas farther from nitrogen sources.

2. Loading of nitrogen from other sources that may occur as a result of activities in the rural residential area, such as leaching from animal wastes and fertilizers, are not included in the analysis. Any effects from these other sources would be additive and would contribute to an increase in actual groundwater nitrate concentrations above the estimates provided here. Such additional nitrogen loading would not be influenced by or within the control of the proposed project.

3. Also not included in the analysis is the withdrawal of groundwater by rural residential parcels for water supply. This would generally contribute to a removal of nitrogen from the groundwater system (positive effect) as well as reduction in the volume of groundwater in the basin (negative effect). The net effect is likely to be negative (i.e., contributing to a higher nitrate concentration), but it is indeterminable without considerable additional investigation of well locations, pumping rates and water usage which are beyond the scope of this study.

Salt Loading Analysis – Cemetery Recharge Area

Mineral salts comprise about five (5) percent of the human body (by weight), which amounts to approximately 3,000 grams for an average adult. This includes measureable amounts of major minerals such as calcium, phosphorous, potassium, sulfur, sodium, magnesium and chloride, plus trace amounts of many other minerals such as iron, boron, iodine, manganese, zinc, etc. During decomposition of a buried corpse these minerals become available for leaching into the soil and potentially reaching groundwater. Most minerals are highly soluble and not removed to any appreciable degree by passage through the soil, phosphorous being an exception. Minerals that are leached will contribute eventually to an increase in the salt or total dissolved solids (TDS) concentration of groundwater.

Methodology and Analysis. To estimate the cumulative effect of TDS loading on local groundwater quality from the proposed cemetery an annual loading analysis was completed similar to the previously described nitrate loading analysis. Under this approach, the long-term concentration of TDS in the upper groundwater zone within the defined cemetery recharge area (**Figure 9**) can be approximated by the average annual volume of percolating rainfall and the normal pick-up of dissolved solids from the land surface and soils, plus the leaching of added minerals from graves.

As done for the nitrate analysis, an annual chemical-water balance was constructed from Year 1 through Year 10 of cemetery operation, using average annual rainfall-recharge for each year and varying the TDS load according to the assumed number of burials per year, and the accumulated total each successive year. The maximum impact to groundwater was estimated as the resultant concentration reached in Year 10, representing the contribution from 10 years of burials.

Calculations. The resultant TDS concentration of percolating water reaching groundwater from the cemetery for a given year (1 through 10) was completed according to the following below. Calculation spreadsheets are provided in **Appendix C.**

$$s_r = \frac{(Y)(X)(S_y) + Rs_b}{(R)}$$

Where:

s_r = resultant average concentration of TDS in percolating recharge water reaching the groundwater, mg/L

Y = year of analysis from cemetery start-up, 1 though 10

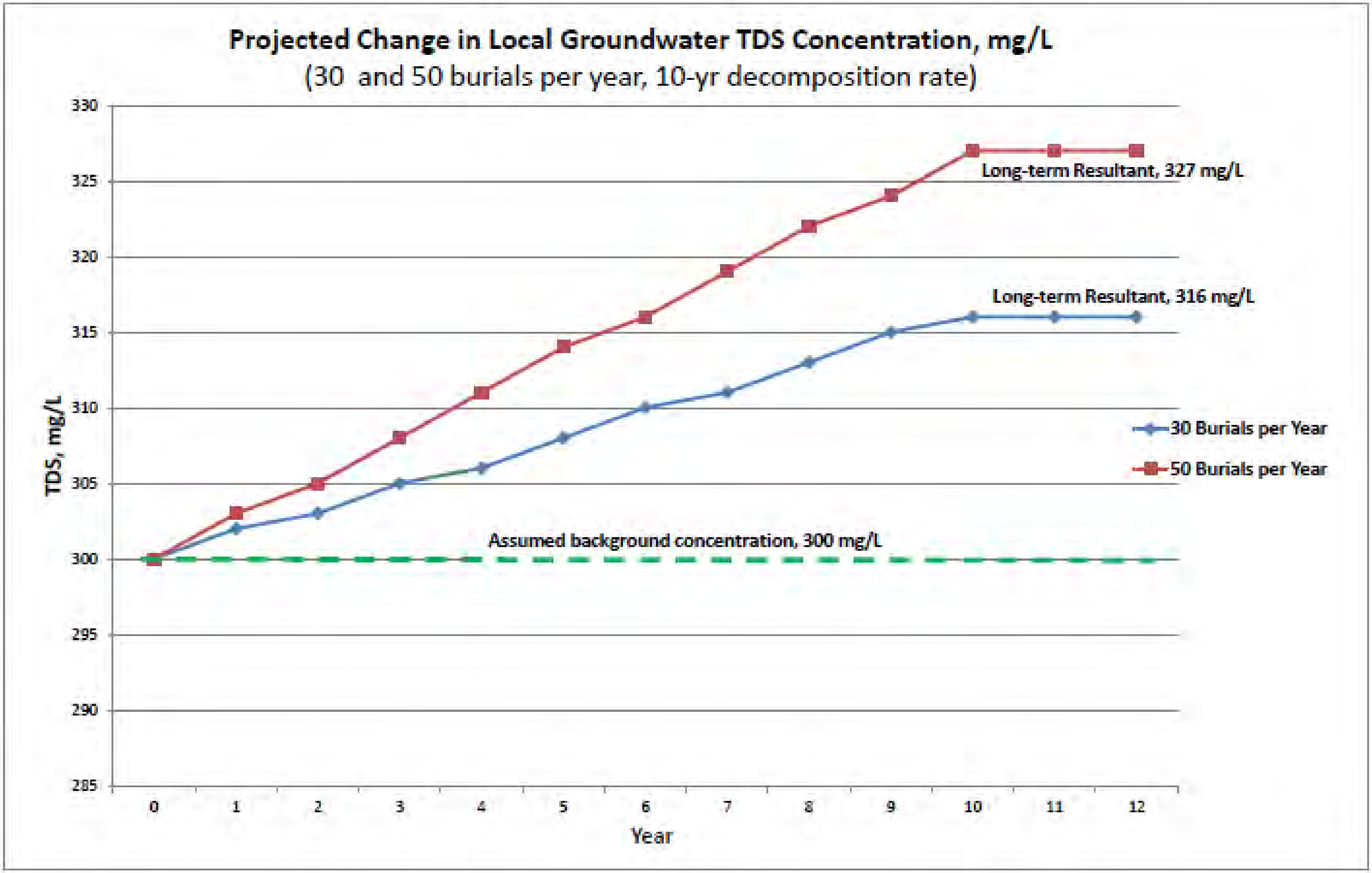
X = number of new burials each year, 20, 30, 40, 50, 60, 80 & 100/yr

N_y = total annual mass TDS leaching from individual grave sites, assuming 3,000 g total over 10-yr decomposition period; 300,000 mg/yr

R = average annual volume of rainfall recharge from areas of the project site encompassing the cemetery and off-site to nearest potential well; 8.5 acres at 0.53 ac-ft/yr per acre, converted to liters (based on site specific water balance analysis, **Appendix C**)

n_b = background TDS concentration of rainfall recharge due to mineral pick-up during percolation through native soils; 300 mg/L (SCVWD, 2014)

Results. Figure 14 presents graphical plots of the estimated resultant groundwater TDS concentrations for Years 1 through 10 of cemetery operation for burial rates of 30 and 50 per year.



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RESULTANT GROUNDWATER TDS CONCENTRATIONS

FIGURE 14

Table 7 presents the estimated long-term resultant groundwater TDS concentration impact for the full range of annual burial rates analyzed, showing estimated concentration and percent increase over background levels. The resultant values shown are the estimated maximum, long-term TDS concentration reached in the defined recharge area (**Figure 9**) for the given annual burial rates.

Table 7
Estimated Localized Groundwater TDS Concentration Impact[1]

Rate of Burial (X per year)	Resultant TDS Concentration, mg/L	Resultant TDS Percent Increase over Background[2]
20	311	4%
30	316	5%
40	322	7%
50	327	9%
60	332	11%
80	343	14%
100	354	18%

[1] At nearest potential neighboring water well location
[2] Assumes background TDS of 300 mg/L

The calculations indicate resultant TDS concentration in the affected recharge area to be in range of 308 to 327 mg/L, which would amount to an approximate increase of 3 to 14 percent over the assumed background concentration of 300 mg/L. For the burial rates of 30 and 50 per year, identified, respectively, as recommended and potentially acceptable based on nitrate loading considerations (per above), the TDS increase would be in the range of 5 to 9 percent over background. The resultant TDS concentrations are comparable to existing background TDS concentrations in the northern Shallow Aquifer of the Llagas Groundwater Subbasin, reported to be generally in the range of 300 to 500 mg/L, and 350 to 400 mg/L in the well closest to (south of) the project site (SCVWD, 2014). Based on this analysis, the salt (TDS) loading impacts of the proposed cemetery will be localized, with resultant concentrations similar to existing conditions in the area, and posing no significant impact to the aquifer or any existing water supply wells.

FINDINGS AND RECOMMENDATIONS

Findings

1. Concerns regarding potential cemetery impacts on groundwater quality are generally considered to be those from the leaching of: (a) decomposition compounds and materials from buried human remains, including bacteria, viruses, organic substances, mineral salts and other inorganic elements; (b) embalming fluids such as formaldehyde, methanol and other organic ingredients; (c) various chemicals and substances from decay of man-made artifacts and materials buried with the body including caskets, vaults, and ornamentation; and (d) excess fertilizers and pesticides applied for maintenance of lawns and other landscaping.

2. The issues of potential concern for the proposed cemetery at Cordoba Center are limited to

decomposition and leaching from the buried human remains, since the proposed project will consist of natural burials, with no use of embalming fluids or caskets, and landscaping is planned to consist of native grassland vegetation rather than maintained lawns.

3. The basic elements and decomposition products from buried remains are similar to materials found in domestic sewage, and many constituents are identical to those present in the natural environment. The impact on groundwater is not due to any specific toxicity they possess, but rather due to the potential for increasing the concentration of naturally occurring organic or inorganic substances to levels that would render the groundwater unfit for potable supplies or other uses.

4. There are no established water quality-environmental requirements for cemeteries in California, or elsewhere in the U.S. However, based on the similarity in the various constituents and their disposition in the soil for subsurface decomposition and leaching, soil and other site suitability requirements applicable to onsite wastewater disposal systems (i.e., leachfields) for protection of public health and water quality provide reasonable criteria that can also be used as a general guideline for cemeteries. This is a conservative (safe) approach, since leaching of from cemeteries is driven only by seasonal rainfall infiltration and percolation through the graves and surrounding soils, and not by a constant flow of percolating wastewater.

5. Based on results of numerous the soil test pits, exploratory borings and percolation tests, the area proposed for the cemetery has conditions considered favorable for protection of groundwater against the leaching effects from decomposition products, including: (a) deep well-drained loamy and clayey soils; (b) vertical separation of 5 to 15+ feet to groundwater beneath the graves; (c) gentle to moderate hillside landscape position; and (d) horizontal setback distances of 350+ feet to the nearest domestic water wells.

6. Based on soil conditions and proposed cemetery burial plans, pathogenic bacteria and viruses associated with decomposing bodies pose a less-than-significant threat of impact to groundwater, as they will be effectively attenuated and removed in the native soil conditions through such mechanisms as microbial predation, filtration, adsorption, and die-off.[4]

7. Potential long-term cumulative impacts on groundwater quality from the cemetery will result from the leaching of nitrogen (nitrate form) and various mineral salts, which are highly soluble and not readily retained or attenuated in the soil environment. The contribution (loading) from each grave can be estimated based on the known (average) composition of the human body; and the overall resultant effect on groundwater quality can be approximated by the number of burials over a given period of time along with information on rainfall and groundwater recharge conditions in the cemetery area.

8. A water-chemical mass balance analysis was completed to assess the potential long-term

[4] "microbial predation" refers to consumption by other soil microbes; "filtration" refers to physical trapping between soil particles; "adsorption" refers to attachment to the surfaces of soil particles; "die-off" refers to degradation or inactivation due to the inability of the pathogen to sustain itself in the soil environment.

effect on local groundwater nitrate concentrations in the area of the cemetery and adjacent properties. The analysis indicates annual burial rates of about 30 to 50 per year would produce resultant groundwater nitrate concentrations of less than 7.5 mg-N/L at the nearest potential water well location (50 feet into adjoining properties), which is consistent with the methodology and criterion applied by the County for evaluation of cumulative impacts of onsite wastewater treatment systems. The range of 30 to 50 burials per year reflects the difference in assumed nitrogen removal due to vegetative uptake, adsorption and denitrification in the cemetery soils, estimated to range from 25 to 50 percent.

9. Additional evaluation was made of the potential nitrate effects on groundwater quality extending farther south and west of the project site where there is substantial reliance on the groundwater for domestic water well supplies. This was evaluated through an expanded cumulative mass-balance nitrate loading analysis for a groundwater-recharge area of approximately 91 acres, encompassing the project site and 15 neighboring properties to the south and west. The analysis included the combined effects from both the cemetery and wastewater facilities for the project, as well as proposed development of an RV park on neighboring property to the south. The results indicate a potential increase of about 0.5 to 1.0 mg-N/L above the estimated background conditions from existing residential septic systems in the area, with resultant concentrations between about 4.23 and 4.73 mg-N/L, safely below the drinking water MCL of 10 mg-N/L. Based on this analysis the cumulative nitrate loading effects on groundwater in the area due to contributions from the proposed Cordoba Center project would be less-than-significant.

10. A water-chemical mass balance analysis similar the nitrate loading analysis was completed to assess the potential long-term effect on local TDS concentrations in groundwater in the area of the cemetery and adjacent properties. The results show the TDS loading impacts will be localized, with resultant concentrations increasing by about 4 to 18 percent over background levels (depending on annual rate of burials) but still remaining similar to existing conditions in the area, and posing no significant impact to the aquifer or any existing water supply wells.

Recommendations

The development of the cemetery should proceed in phases, with an established annual limit on the number of burials, and should be accompanied by monitoring of groundwater conditions as follows:

- The burials should be sequenced to begin in the northeastern corner of the cemetery and proceed down-hill (southerly) on the east side of the proposed driveway, maintaining maximum buffer distance between the graves and the westerly property line.

- Monitoring wells should be installed within the cemetery and along the downslope (southerly and westerly) property lines; at a minimum, monitoring shall include quarterly[5] sampling and analysis for nitrate and TDS concentrations to observe water

5 Quarterly sampling frequency based on model monitoring guidelines contained in State Water Board Order No. WQ 2014-0153-DWQ, General Waste Discharge Requirements for Small Domestic Wastewater Treatment Systems.

quality changes over time. Six (6) monitoring wells are recommended as follows: three (3) within the cemetery area; two (2) along the westerly property line; and one (1) along the southerly property line.

- Annual burial rate should be limited to 50 burials per year for the first five years of operation, subject to adjustment based on the results of groundwater monitoring.

- Groundwater monitoring data should be submitted to DEH annually for ongoing review. If at any time the groundwater nitrate concentration at monitoring wells along the westerly or southerly property lines exceed 7.5 mg-N/L, monitoring frequency should be increased to monthly sampling and nitrate analysis and continued until the concentration drops below 7.5 mg-N/L. Continued exceedance of 7.5 mg-N/L in the groundwater would be sufficient cause for the County to require reduction in the annual burial rate, or consideration of other mitigation measures proposed by the Center to achieve the same objective of <7.5 mg-N/L.

- After five (5) years, the groundwater quality data (nitrate and TDS), annual and total number of burials, recorded rainfall conditions and other factors, as appropriate should be analyzed and compared to the expected groundwater quality changes presented in the analysis in this report and used as the basis for establishing the baseline rate of annual burial (50 per year). The review and analysis should be conducted by a qualified professional with demonstrated groundwater expertise, and form the basis for either: (a) maintaining the baseline annual burial rate; or (b) adjusting the annual burial rate, either higher or lower than the adopted baseline amount. Any adjustment to the rate of burials should be reviewed and approved by DEH.

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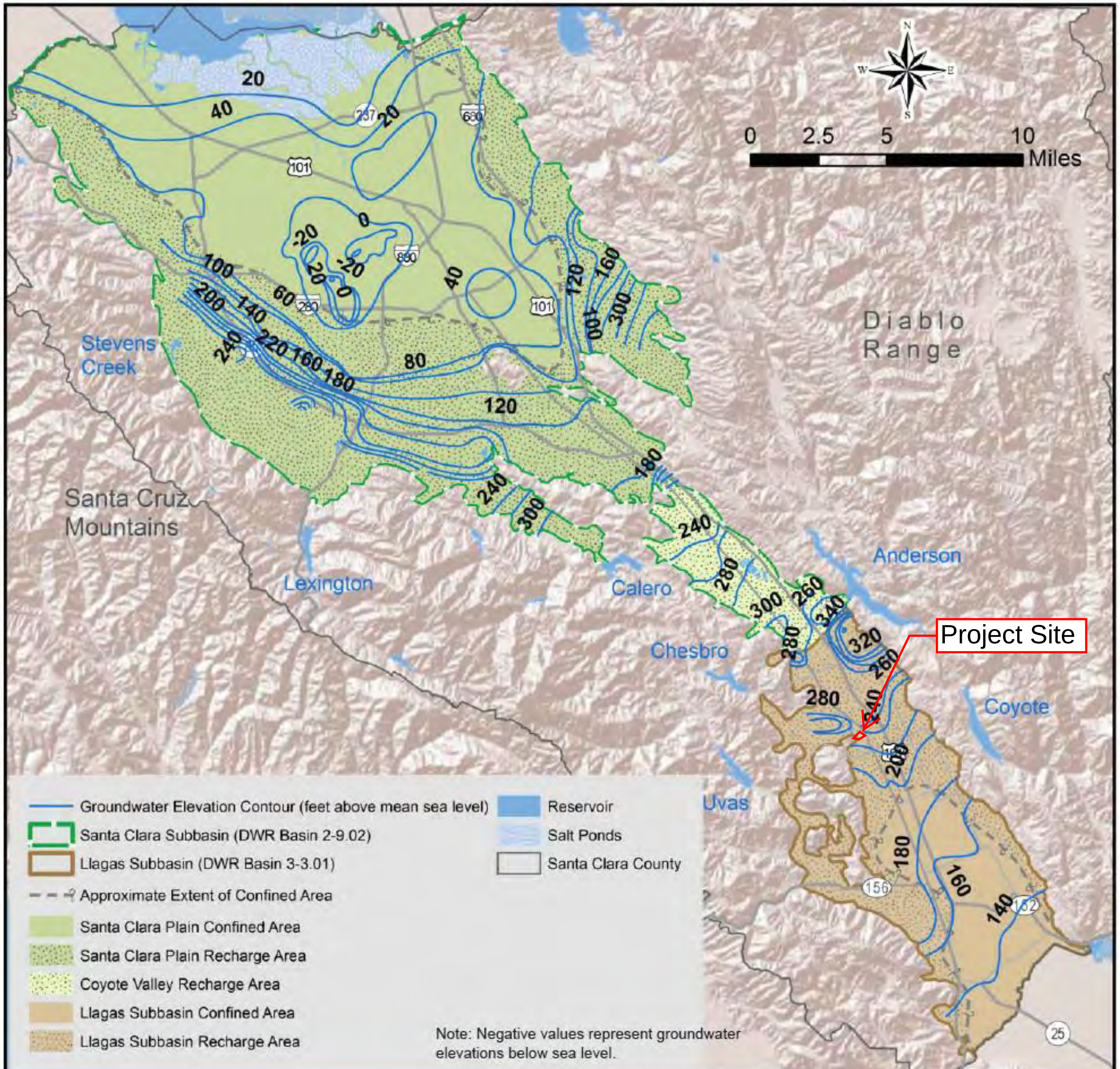
Appendix A

Groundwater Information

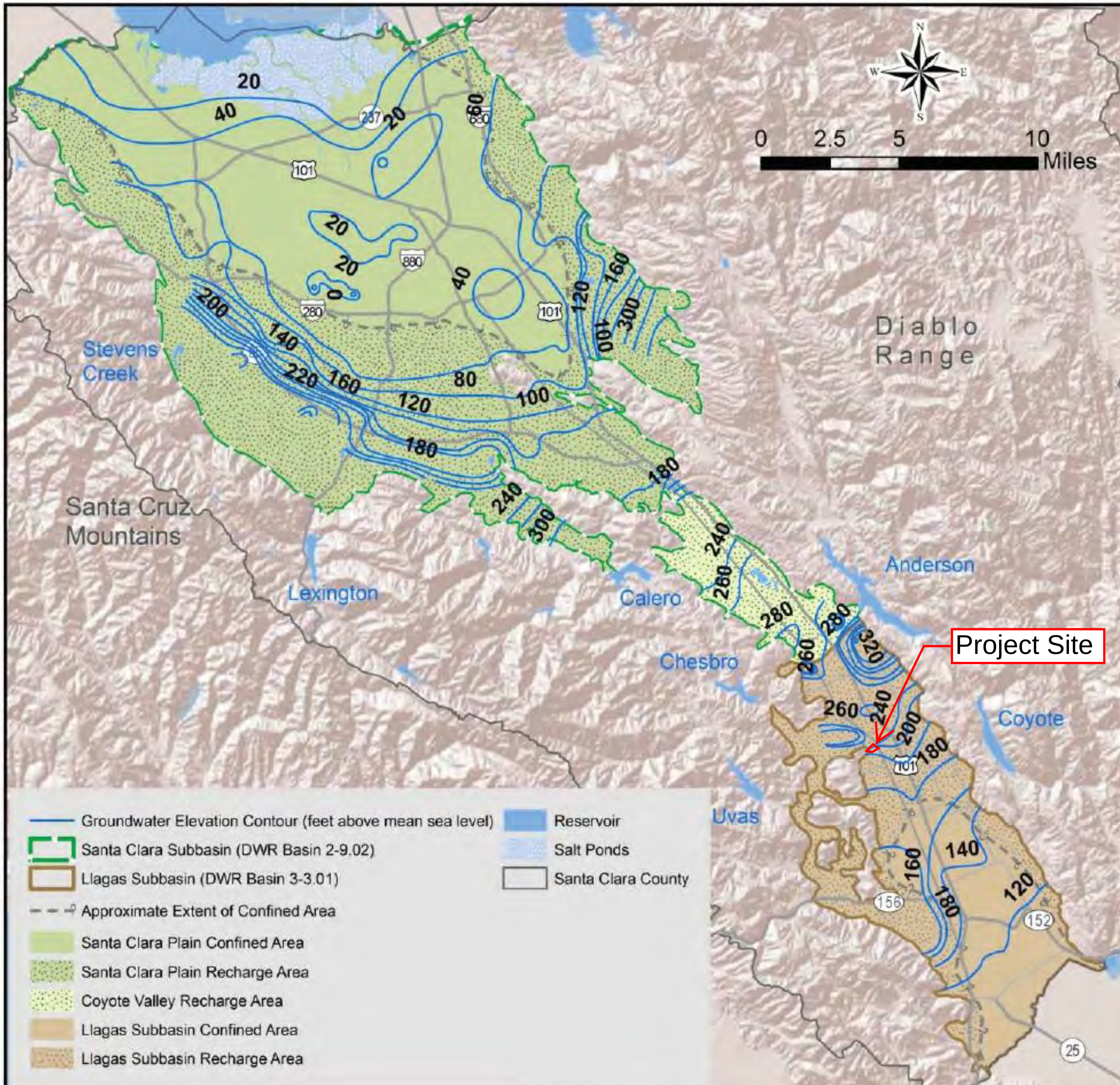
Figure 15 Spring 2015 Groundwater Elevation Contours



A1

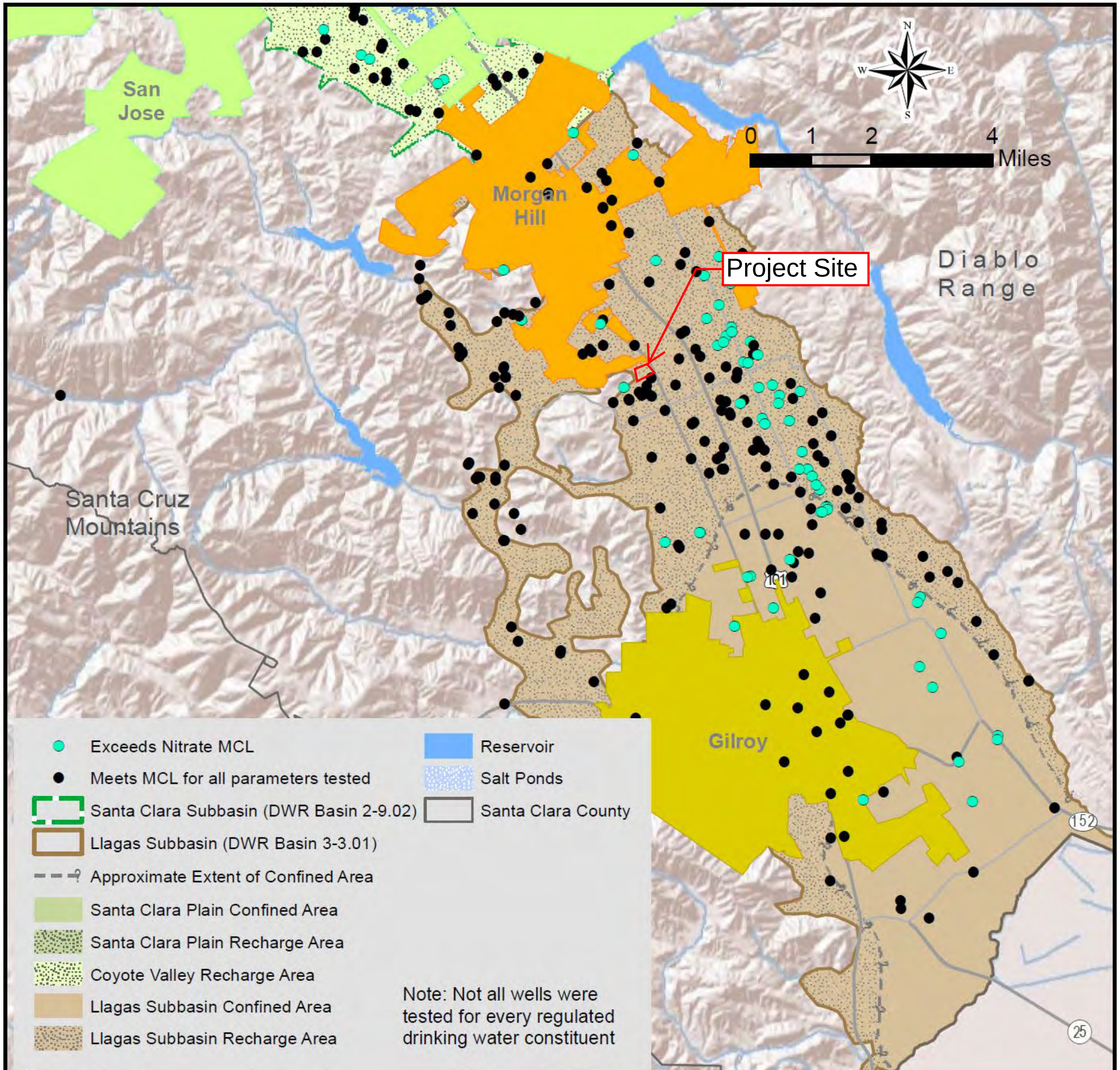
SOURCE: Santa Clara Valley Water District, Annual Groundwater Report, 2015.

Figure 16 Fall 2015 Groundwater Elevation Contours



A2

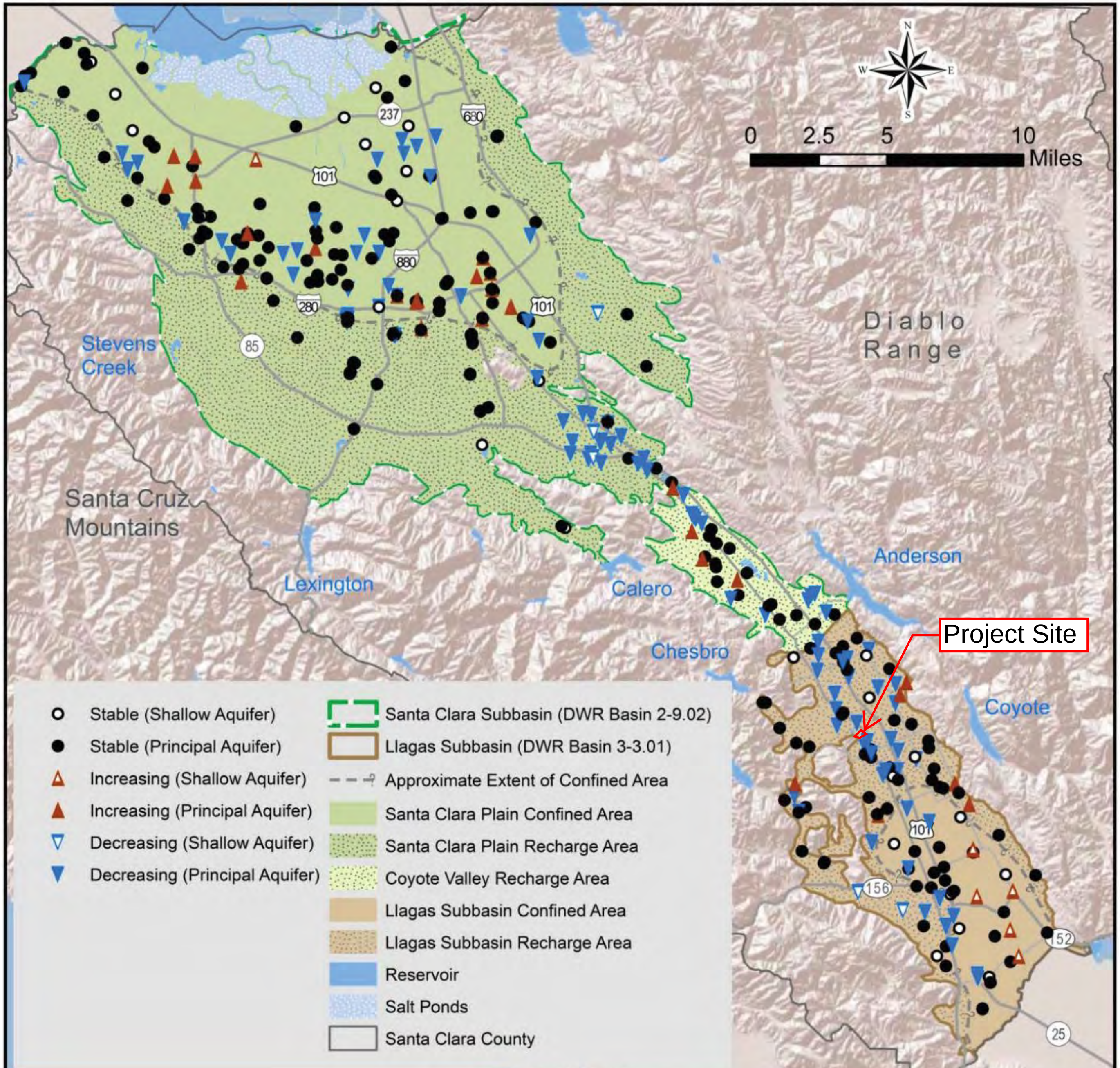
SOURCE: Santa Clara Valley Water District, Annual Groundwater Report, 2015.



A3

SOURCE: Santa Clara Valley Water District, Annual Groundwater Report, 2015.

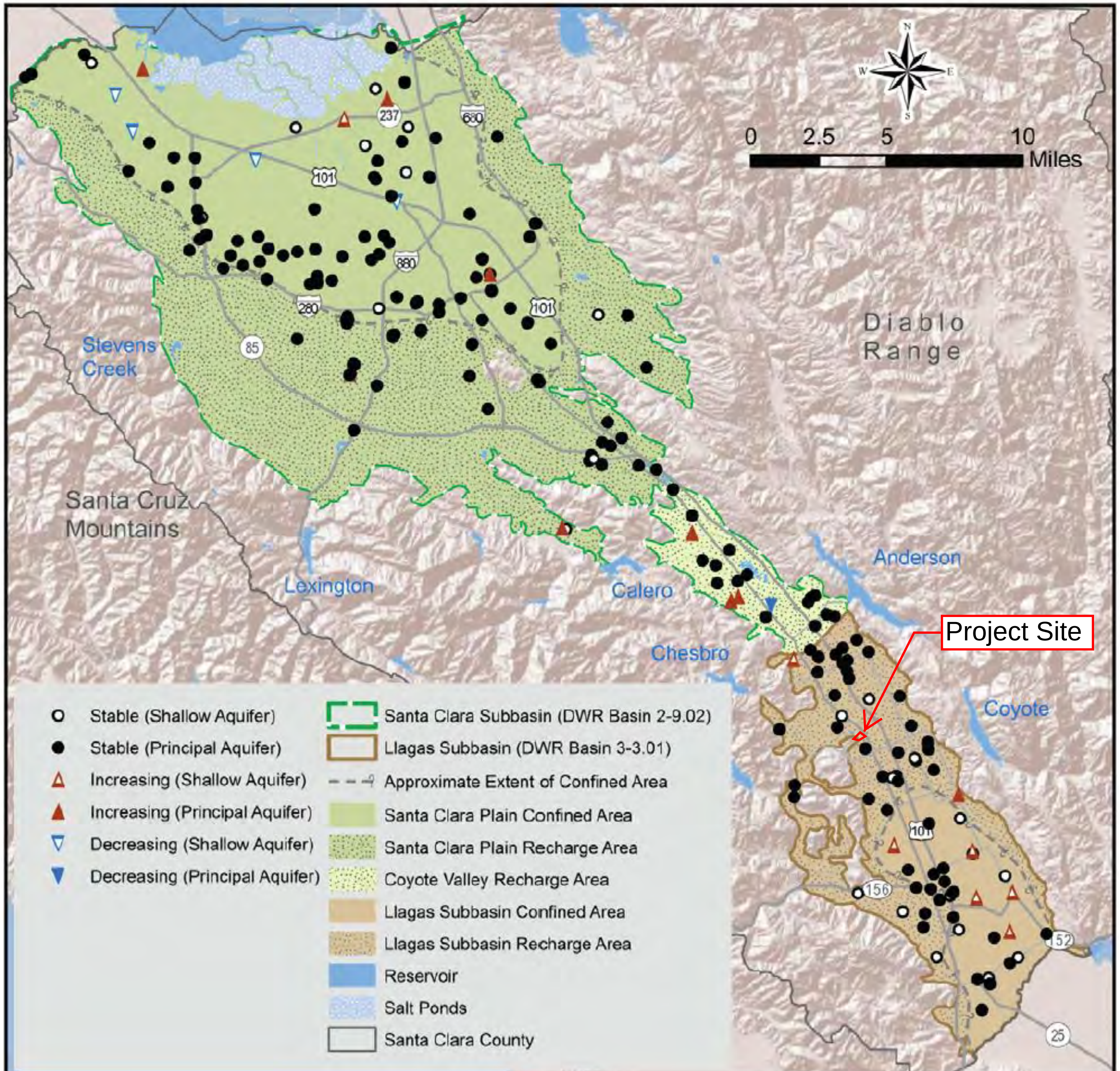
Figure 23 Nitrate Trends (2001 - 2015)



SOURCE: Santa Clara Valley Water District, Annual Groundwater Report, 2015.

A4

Figure 24 Total Dissolved Solids (TDS) Trends (2001 - 2015)



SOURCE: Santa Clara Valley Water District, Annual Groundwater Report, 2015.

A5

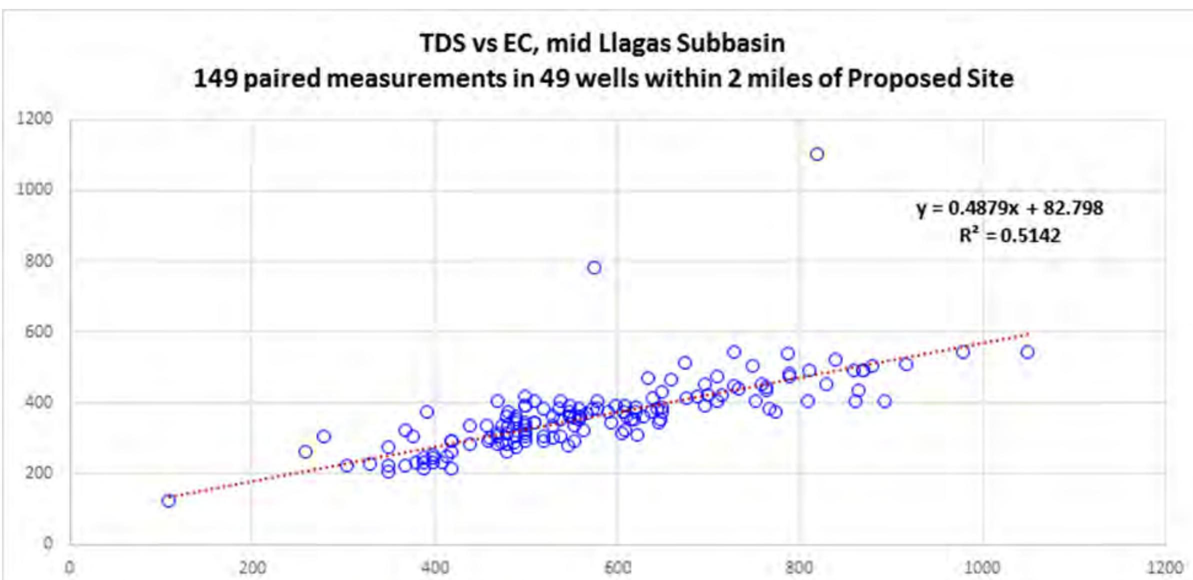
Groundwater Quality Summary for Wells Tested within approximately ½-mile of Proposed Cordoba Center Site

(Provided by Santa Clara Valley Water District, August 2017)

Analyte	Units	# of Wells	Min	Max	Median	MCL[1]	Start Date	End Date
Nitrate as N	mg/L	26	0.45	20.9	7.1	**10**	2/9/1998	10/18/2016
Total Dissolved Solids (TDS)	mg/L	1	308	380	338	*500*	2/9/1998	10/18/2016
Specific Conductance	µS/cm	11	279	642	560	*900*	10/13/2011	8/16/2016

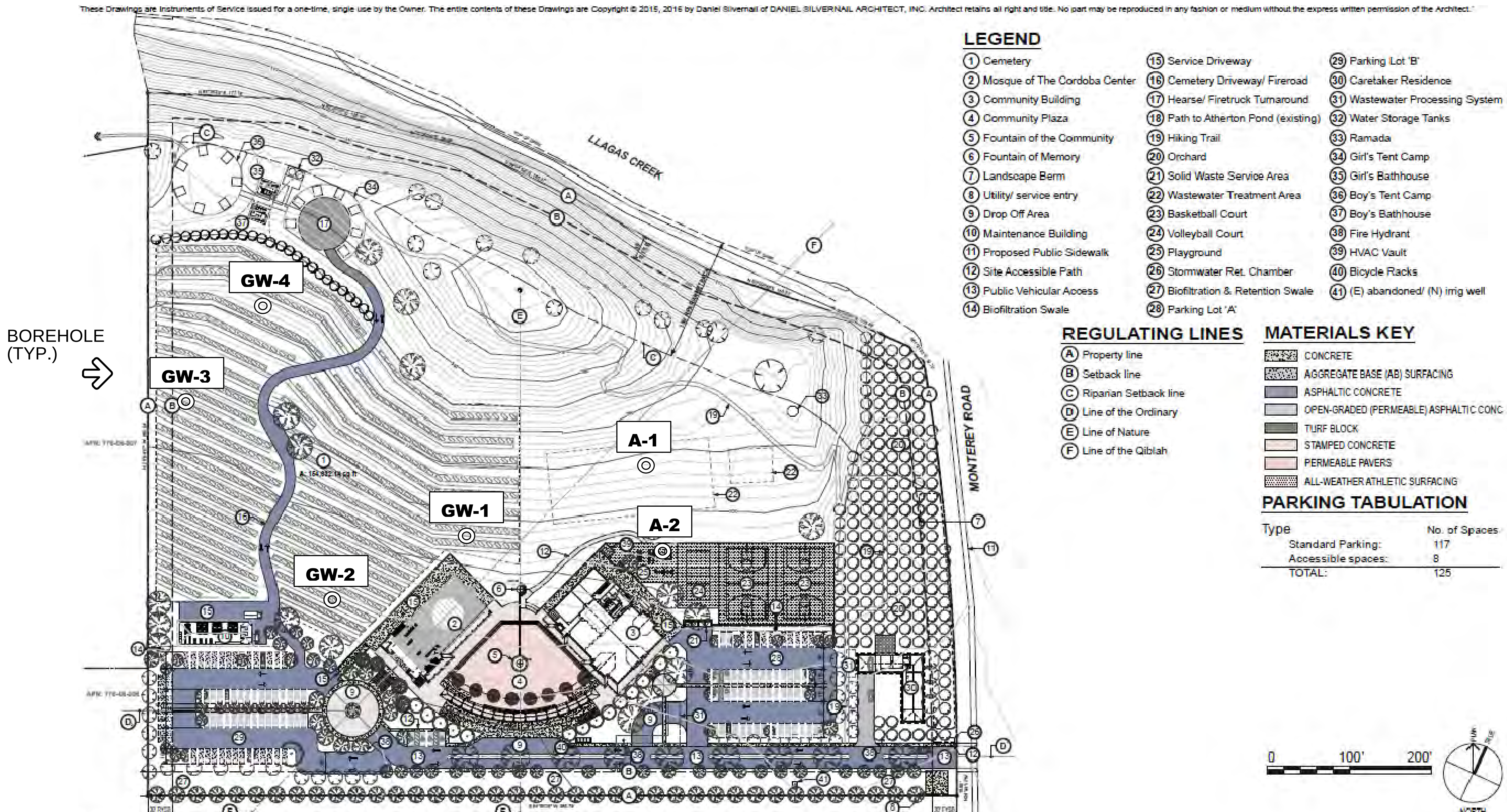
Notes:

1. MCLs for TDS and specific conductance are secondary, i.e., aesthetic based.
2. Specific conductance is loosely correlated with TDS. Only one well within area of interest has both specific conductance and TDS measurements. In a broader area two miles radius from the proposed site, there are 49 wells with 149 paired measurements of TDS and specific conductance. The linear regression equation is TDS = (0.488 x specific conductance) + 83 mg/L. This relationship could be applied to the specific conductance data above to obtain a rough estimate of TDS. Note that the R^2 value, which measures goodness of fit, is fairly low (0.51), so there is some error involved with estimating TDS from specific conductance data.



Appendix B

Soils Information



Source: Daniel Silvernail Architect, Inc. 2016

DATE:	5/17/2017
PROJECT:	Cordoba Center EIR
PROJECT NO.:	1700037
DRAWN:	MF
APPROVED:	NH

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SOIL/ GROUNDWATER BOREHOLE LOCATION MAP

APRIL 25, 2017

FIGURE

B-1

Lab Tests	Torvane, tsf	Sampler Type	% Passing #200 Sieve	Dry Density, pcf	Moisture %	Penetrometer, tsf	Blows/Foot * (Converted to SPT N-value)	Depth	Sample Location	Graphical Symbol	Groundwater Depth	USCS Symbol	Lithologic Description
								0					Topsoil: TOPSOIL
								-1					CL: REDDISH, STIFF PLASTIC CLAY
								-2					
								-3					
								-4					
								-5					
								-6					
								-7					GC: GRAVELLY, SANDY CLAY, YELLOW BROWN
								-8					
								-9					
								-10					
								-11					
								-12					
								-13					
								-14					
								-15					Chert: PIECES OF CHERT, MOSTLY ROCK IN SPOILS
								-16					
								-17					
								-18					
								-19					
								-20					SC: FINE CLAYEY SAND, SPOILS BROWN
								-21					
								-22					
								-23					Graywacke: HARDER ROCK (PER DRILLER), GREENISH MAYBE GRAYWACKE
								-24					
								-25			▼		Graywacke: HARDER ROCK, PIECE OF CHERT, GREENISH MAYBE GRAYWACKE
								-26					
								-27					
								-28					
								-29					
								-30					

*Drilling was performed by Cenozoic Exploration, License No. 682910

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LOG OF BORE HOLE GW1

14065 MONTEREY ROAD, SAN MARTIN, CA

LOGGED BY: PAUL POSPISIL, PG #7621

Figure GW1

Lab Tests	Torvane, tsf	Sampler Type	% Passing #200 Sieve	Dry Density, pcf	Moisture %	Penetrometer, tsf	Blows/Foot * (Converted to SPT N-value)	Depth	Sample Location	Graphical Symbol	Groundwater Depth	USCS Symbol	Lithologic Description
								0					CL: REDDISH LIGHT CLAY, FINE TOPSOIL, DAMP
								-1					
								-2					
								-3					
								-4					
								-5					
								-6					CH: YELLOW BROWN CLAY WITH SILTSTONE
								-7					
								-8					SM: YELLOW, FINE SANDY SILT, FRIABLE
								-9					
								-10					Sandstone: ROCK, FINE SANDSTONE
								-11					
								-12					CH: NOT PRESENT DURING DRILLING FROM 12' TO 30'
								-13					
								-14					
								-15					
								-16					
								-17					
								-18					
								-19					
								-20					
								-21					
								-22					
								-23					
								-24					
								-25					
								-26					
								-27					
								-28					
								-29					CH: CLAYEY SPOILS AT 30'
								-30					

*Drilling was performed by Cenozoic Exploration, License No. 682910

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LOG OF BORE HOLE GW2
14065 MONTEREY ROAD, SAN MARTIN, CA
LOGGED BY: PAUL POSPISIL, PG #7621

Figure GW2

Lab Tests	Torvane, tsf	Sampler Type	% Passing #200 Sieve	Dry Density, pcf	Moisture %	Penetrometer, tsf	Blows/Foot * (Converted to SPT N-value)	Depth	Sample Location	Graphical Symbol	Groundwater Depth	USCS Symbol	Lithologic Description
								0 to -3					CL: REDDISH BROWN, LIGHT CLAY/CLAY LOAM, GRAVEL TOPSOIL
								-3 to -7					CH: VERY STIFF, PALE YELLOW, PLASTIC CLAY
								-7 to -11					CL: REDDISH FRIABLE CLAY, SOME ROCK
								-11 to -15					CH: ROCKY, BROWN CLAY, MAYBE GRAYWACKE
								-15 to -20					Graywacke: ROCKY, GRAYWACKE

*Drilling was performed by Cenozoic Exploration, License No. 682910

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LOG OF BORE HOLE GW3

14065 MONTEREY ROAD, SAN MARTIN, CA

LOGGED BY: PAUL POSPISIL, PG #7621

Figure GW3

Lab Tests	Torvane, tsf	Sampler Type	% Passing #200 Sieve	Dry Density, pcf	Moisture %	Penetrometer, tsf	Blows/Foot * (Converted to SPT N-value)	Depth	Sample Location	Graphical Symbol	Groundwater Depth	USCS Symbol	Lithologic Description
								0 to -4					CL: BROWN, GRAVELLY CLAY
								-4 to -8					CL: REDDISH BROWN, GRAVELLY CLAY, FAIRLY STIFF
								-8 to -11					CH: REDDISH BROWN, PLASTIC CLAY, VERY STIFF
								-11 to -15					Chert: BEDROCK, CHERT

*Drilling was performed by Cenozoic Exploration, License No. 682910

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LOG OF BORE HOLE GW4

14065 MONTEREY ROAD, SAN MARTIN, CA

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Figure GW4

Lab Tests	Torvane, tsf	Sampler Type	% Passing #200 Sieve	Dry Density, pcf	Moisture %	Penetrometer, tsf	Blows/Foot * (Converted to SPT N-value)	Depth	Sample Location	Graphical Symbol	Groundwater Depth	USCS Symbol	Lithologic Description
								0 to -2					CL: BROWN, LIGHT CLAY, FRIABLE
								-2 to -6					CH: ORANGE PLASTIC CLAY
								-6 to -8					CH: MIXED STIFF CLAY/GRAVEL, MOSTLY STIFF CLAY

*Drilling was performed by Cenozoic Exploration, License No. 682910

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LOG OF BORE HOLE A1

14065 MONTEREY ROAD, SAN MARTIN, CA

LOGGED BY: PAUL POSPISIL, PG #7621

Figure A1

Lab Tests	Torvane, tsf	Sampler Type	% Passing #200 Sieve	Dry Density, pcf	Moisture %	Penetrometer, tsf	Blows/Foot * (Converted to SPT N-value)	Depth	Sample Location	Graphical Symbol	Groundwater Depth	USCS Symbol	Lithologic Description
								0					CL: BROWN CLAY LOAM TO LIGHT CLAY TOPSOIL
								-1					
								-2					
								-3					CL: REDDISH, FRIABLE CLAY WITH SOME GRAVEL
								-4					
								-5					CH: PALE YELLOW, PLASTIC STIFF CLAY
								-6					
								-7					CL: REDDISH BROWN, FRIABLE CLAY WITH SOME GRAVEL
								-8					

*Drilling was performed by Cenozoic Exploration, License No. 682910

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LOG OF BORE HOLE A2

14065 MONTEREY ROAD, SAN MARTIN, CA

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Figure A2

Appendix C

Nitrate and Salt Loading Calculations

Wastewater Nitrogen Loading Analysis - Calculations

Site Characteristics & Assumptions

Watershed drainage area: 8.5 acres

Estimated annual groundwater recharge amount per detailed water balance analysis:6.38 inches (0.53 ft)

Total average annual recharge volume (calcs below): 4.505 ac-ft/yr
1,467,959 gal/yr
5,556,224 ft^3/yr

Background nitrate-N concentration: assume 0.5 mg-N/L

Nitrogen Mass Loading from Cemetery

Aveage N loading from human body (male/female) = 1,530 g total, over 10 years = 153 g/yr

Average annual loading = g per burial plot * ave number of burials per year

Assumed nitrogen assimilation by plant uptake, adsorption and denitrifiation: 25 to 50%

Water Quality Criteria/Limits

Groundwater nitrate-N drinking water standard: 10 mg-N/L; and OWTS Manual for public water supply areas

Groundwater nitrate-N water quality objective: 7.5 mg-N/L (OWTS Manual for areas with individual wells)

Groundwater nitrate-N water quality bseline objective: 5.0 mg-N/L (Basin Plan)

Use 7.5 mg/L for neighboring properties without public water supply

Table C-1. Nitrate-N Mass Balance Loading Calculations - Cordoba Center Cemetery

Cemetery				**Rainfall Recharge (8.5 ac area)**			**Resultant 10-yr Cumulative at 10-yr Decomposition Rate**																		
Burials & N Load		**N Losses**	**Net N Loading**	**Ave Annual Recharge (at 0.53 ft/ft^2)**		**Background N Loading at 0.5 mg-N/L**	**Year 1** Resultant GW Nitrate	**Year 2**		**Year 3**		**Year 4**		**Year 5**		**Year 6**		**Year 7**		**Year8**		**Year 9**		**Year 10**	
Burials	N, g/yr	(fraction)	N, mg/yr	ac-ft	liters/yr	mg-N/yr	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L	Total Active Plots	mg-N/L
20	3,060	0.25	2,295,000	4.51	5,554,665	2,777,333	0.91	40	1.33	60	1.74	80	2.15	100	2.57	120	2.98	140	3.39	160	3.81	180	4.22	200	**4.63**
30	4,590	0.25	3,442,500	4.51	5,554,665	2,777,333	1.12	60	1.74	90	2.36	120	2.98	150	3.60	180	4.22	210	4.84	240	5.46	270	6.08	300	**6.70**
40	6,120	0.25	4,590,000	4.51	5,554,665	2,777,333	1.33	80	2.15	120	2.98	160	3.81	200	4.63	240	5.46	280	6.28	320	7.11	360	7.94	400	**8.76**
50	7,650	0.25	5,737,500	4.51	5,554,665	2,777,333	1.53	100	2.57	150	3.60	200	4.63	250	5.66	300	6.70	350	7.73	400	8.76	450	9.80	500	**10.83**
60	9,180	0.25	6,885,000	4.51	5,554,665	2,777,333	1.74	120	2.98	180	4.22	240	5.46	300	6.70	360	7.94	420	9.18	480	10.42	540	11.66	600	12.89
80	12,240	0.25	9,180,000	4.51	5,554,665	2,777,333	2.15	160	3.81	240	5.46	320	7.11	400	8.76	480	10.42	560	12.07	640	13.72	720	15.37	800	17.03
100	15,300	0.25	11,475,000	4.51	5,554,665	2,777,333	2.57	200	4.63	300	6.70	400	8.76	500	10.83	600	12.89	700	14.96	800	17.03	900	19.09	1000	21.16
20	3,060	0.50	1,530,000	4.51	5,554,665	2,777,333	0.78	40	1.05	60	1.33	80	1.60	100	1.88	120	2.15	140	2.43	160	2.70	180	2.98	200	**3.25**
30	4,590	0.50	2,295,000	4.51	5,554,665	2,777,333	0.91	60	1.33	90	1.74	120	2.15	150	2.57	180	2.98	210	3.39	240	3.81	270	4.22	300	**4.63**
40	6,120	0.50	3,060,000	4.51	5,554,665	2,777,333	1.05	80	1.60	120	2.15	160	2.70	200	3.25	240	3.81	280	4.36	320	4.91	360	5.46	400	**6.01**
50	7,650	0.50	3,825,000	4.51	5,554,665	2,777,333	1.19	100	1.88	150	2.57	200	3.25	250	3.94	300	4.63	350	5.32	400	6.01	450	6.70	500	**7.39**
60	9,180	0.50	4,590,000	4.51	5,554,665	2,777,333	1.33	120	2.15	180	2.98	240	3.81	300	4.63	360	5.46	420	6.28	480	7.11	540	7.94	600	**8.76**
80	12,240	0.50	6,120,000	4.51	5,554,665	2,777,333	1.60	160	2.70	240	3.81	320	4.91	400	6.01	480	7.11	560	8.21	640	9.31	720	10.42	800	11.52
100	15,300	0.50	7,650,000	4.51	5,554,665	2,777,333	1.88	200	3.25	300	4.63	400	6.01	500	7.39	600	8.76	700	10.14	800	11.52	900	12.89	1000	14.27

Salt (TDS) Loading Analysis - Calculations

Site Characteristics & Assumptions

Watershed drainage area: 8.5 acres (Point of Compliance at nearest potential well location, 50-ft off-site on adjacent parcels)
Estimated annual groundwater recharge amount per detailed water balance analysis: 6.38 inches (0.53 ft)
Total average annual recharge volume (calcs below): 4.505 ac-ft/yr
1,467,959 gal/yr
5,556,224 l/yr

Background TDS concentration: assume 300 mg/L

Mineral (TDS) Mass Loading from Cemetery

Assume 5% of human body weight is mineral. Ave wt male: 70kg, female 50 kg; Composite: 60 kg; 0.05*60 kg = 3 kg, or 3,000 g
Average annual loading @ 10-yr decomposition rate = 3,000 g/10 = 300 g/yr per burial plot * ave number of burials per year

Water Quality Criteria/Limits

Groundwater TDS drinking water standard: 500 mg/L;
Public supply: 290 to 340 mg/L for neighboring properties without public water supply (West San Martin Water Works)

Table C-2. Total Dissolved Solids (TDS) Mass Balance Loading Calculations - Cordoba Center Cemetery

Cemetery			Rainfall Recharge (8.5 ac area)			Resultant 10-yr Cumulative at 10-yr Decomposition Rate																		
Burials &TDS Load		Net TDS Loading	Average Annual Recharge		Background TDS Loading at 300 mg/L	Year 1 Resultant GW TDS	Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year8		Year 9		Year 10	
Burials	TDS g/yr	mg/yr	ac-ft	liters/yr	mg/yr	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L	Total Active Plots	mg/L
20	6,000	6,000,000	4.51	5,554,665	1,666,399,500	301	40	302	60	303	80	304	100	305	120	306	140	308	160	309	180	310	200	311
30	9,000	9,000,000	4.51	5,554,665	1,666,399,500	302	60	303	90	305	120	306	150	308	180	310	210	311	240	313	270	315	300	316
40	12,000	12,000,000	4.51	5,554,665	1,666,399,500	302	80	304	120	306	160	309	200	311	240	313	280	315	320	317	360	319	400	322
50	15,000	15,000,000	4.51	5,554,665	1,666,399,500	303	100	305	150	308	200	311	250	314	300	316	350	319	400	322	450	324	500	327
60	18,000	18,000,000	4.51	5,554,665	1,666,399,500	303	120	306	180	310	240	313	300	316	360	319	420	323	480	326	540	329	600	332
80	24,000	24,000,000	4.51	5,554,665	1,666,399,500	304	160	309	240	313	320	317	400	322	480	326	560	330	640	335	720	339	800	343
100	30,000	30,000,000	4.51	5,554,665	1,666,399,500	305	200	311	300	316	400	322	500	327	600	332	700	338	800	343	900	349	1000	354

Table C-3. Estimated Cumultative Nitrate Impacts - Extended Local Groundwater Basin Area

Resultant Groundwater Nitrate-N					Low Estimate			
Contributing Area	Recharge Area (acres)	Annual Rainfall Recharge (ac-ft)	Annual Wastewater Recharge (ac-ft)	Total Annual Recharge (ac-ft)	Annual Background N Loading (kg/yr)	Annual N Loading (kg/yr)	Total Annual N Loading (kg/yr)	Resultant Nitrate Concentration* (mg-N/L)
(14) Local Rural Residential	62.3	42.36	3.53	45.89	26.12	184.95	211	3.73
Proposed Patel RV Park	14.3	9.72	9.75	19.47	6.00	84.13	90	3.75
Cordoba Center								
Wastewater System	7.0	3.92	3.70	7.62	2.42	63.83	66	7.05
Cemetery	7.1	3.76	0	3.76	2.32	30.6	33	7.09
Total	**90.7**	**59.77**	**16.97**	**76.74**	**36.86**	**363.51**	**400**	**4.23**

* Weighted Average

Resultant Groundwater Nitrate-N					High Estimate			
Contributing Area	Recharge Area (acres)	Annual Rainfall Recharge (ac-ft)	Annual Wastewater Recharge (ac-ft)	Total Annual Recharge (ac-ft)	Annual Background N Loading (kg/yr)	Annual N Loading (kg/yr)	Total Annual N Loading (kg/yr)	Resultant Nitrate Concentration* (mg-N/L)
(14) Local Rural Residential	62.3	42.36	3.53	45.89	26.12	184.95	211	3.73
Proposed Patel RV Park	14.3	9.72	9.75	19.47	6.00	102.16	108	4.50
Cordoba Center								
Wastewater System	7.0	3.92	3.70	7.62	2.42	77.50	80	8.51
Cemetery	7.1	3.76	0	3.76	2.32	45.9	48	10.39
Total	**90.7**	**59.77**	**16.97**	**76.74**	**36.86**	**411**	**447**	**4.73**

* Weighted Average

Assumptions:

Annual rainfall-recharge: Rural Residence and Patel site: 0.68 ac-ft/ac; 0.5 mg-N/L background nitrogen loading

Annual rainfall-recharge,Cordoba site: Cemetery : 0.53 ac-ft/ac; hillside wastewater area: 0.48 ac-ft/ac; orchard area: 0.68 ac-ft/ac

Rural Residences: 225 gpd WW flow per parcel; 50 mg-N/L effluent; std leachfield; 15% denitrification

RV Park: 8,700 ave daily WW flow; 10 mg-N/L effluent; subsurface drip dispersal; denitrification: 30% **low**; 15% **high**

Cordoba Wastewater: 3,300 gpd ave WW flow; 20 mg-N/L effluent; subsurface drip dispersal; denitrification: 30% **low**; 15% **high**

Cordoba Cemetery **Low** Est: 40 burials/yr, 10-yr decay rate; 153 g/yr N release; 50% N losses to plants, adsorption and denitrification