Appendix L:
Utilities Supporting Information

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L.1 - Water Supply Assessment

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FINAL REPORT

Water Supply Assessment The Ranch Project

PREPARED FOR

City of Antioch

APRIL 2019

WEST YOST ASSOCIATES

FINAL REPORT | APRIL 2019

Water Supply Assessment for The Ranch Project

Prepared for

City of Antioch

Project No. 855-60-18-02

April 17, 2019

Project Manager: James P. Connell, PE — Date

April 17, 2019

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Table of Contents

List of Appendices

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

Richland Communities, Inc., a developer, is planning to construct a primarily residential development, called The Ranch (Project), on property within the City of Antioch (City) limits. A Project Environmental Impact Report (EIR) is being prepared. The purpose of this Water Supply Assessment (WSA) is to support the EIR for the proposed Project.

The legal requirement for a WSA and the project background are discussed below.

1.1 Legal Requirement for a Water Supply Assessment

California Senate Bill 610 (SB 610) was approved by Governor Davis on October 9, 2001, and made effective on January 1, 2002. SB 610 amended California state law to improve the link between information on water supply availability and certain land use decisions made by cities and counties. Specifically, certain sections of the California Water Code were amended to require coordination between land use lead agencies, and public water purveyors. The purpose of this coordination is to ensure that prudent water supply planning has been conducted, and that planned water supplies are adequate to meet existing demands, anticipated demands from approved projects and tentative maps, and the demands of proposed projects.

The amended Water Code sections 10910 through 10915 (inclusive) require land use lead agencies to: (1) identify any public water purveyor that may supply water for a proposed development project; and (2) request from the identified purveyor a WSA. The purpose of a WSA is to demonstrate the sufficiency of the purveyor's water supplies to satisfy the water demands of a proposed development project, while still meeting the water purveyor's existing and planned future uses. Water Code sections 10910 through 10915 delineate the specific information that must be included in a WSA.

The purpose of this WSA is to perform the evaluation required by Water Code sections 10910 through 10915 in connection with the Project. It is not to reserve water, or to function as a "will serve" letter or any other form of commitment to supply water (see Water Code section 10914). The provision of water service will continue to be undertaken in a manner consistent with applicable City policies and procedures and consistent with existing law.

1.2 Background

The proposed Project is located inside the City limits within the Sand Creek Focus Area. The Sand Creek Focus Area contains parcels designated by the Antioch General Plan for open space, residential, business park, commercial, and mixed-use development. The Project is within the City water service area and the Contra Costa Water District (CCWD) water service area.

The proposed Project site consists of 551.5 acres of primarily undeveloped land. Currently, the site includes a cattle-grazing operation, a single-family residence, and various barns and outbuildings located on the eastern portion of the site. Historical uses of the site include grazing and limited natural gas exploration.

Sand Creek, a tributary of Marsh Creek, flows west to east through the proposed project site. The topography of the site is varied, ranging from relatively level areas in the eastern and central portions of the site, gently-sloping hills immediately north and south of Sand Creek, and moderate to steep slopes in the western portion of the site. A large stockpile of soil and large boulders is situated on the northern portion of the proposed project site, near the terminus of Dallas Ranch Road.

The Project Vicinity is shown on Figure 1-1.

This WSA has been prepared on behalf of the City as a part of the Project application process and the preparation of the Project EIR.

1.3 Water Supply Assessment Preparation, Format and Organization

This WSA for the Project has been prepared by West Yost Associates, as requested by the City.

The format of this WSA is intended to follow Water Code sections 10910 through 10915 to clearly delineate compliance with the specific requirements for a WSA. The WSA includes the following sections:

- Chapter 1: Introduction
- Chapter 2: Description of Project
- Chapter 3: Required Determinations
- Chapter 4: City of Antioch Water Service Area
- Chapter 5: City of Antioch Water Demands
- Chapter 6: City of Antioch Water Supplies
- Chapter 7: Determination of Water Supply Sufficiency
- Chapter 8: Water Supply Assessment Approval Process
- Chapter 9: References

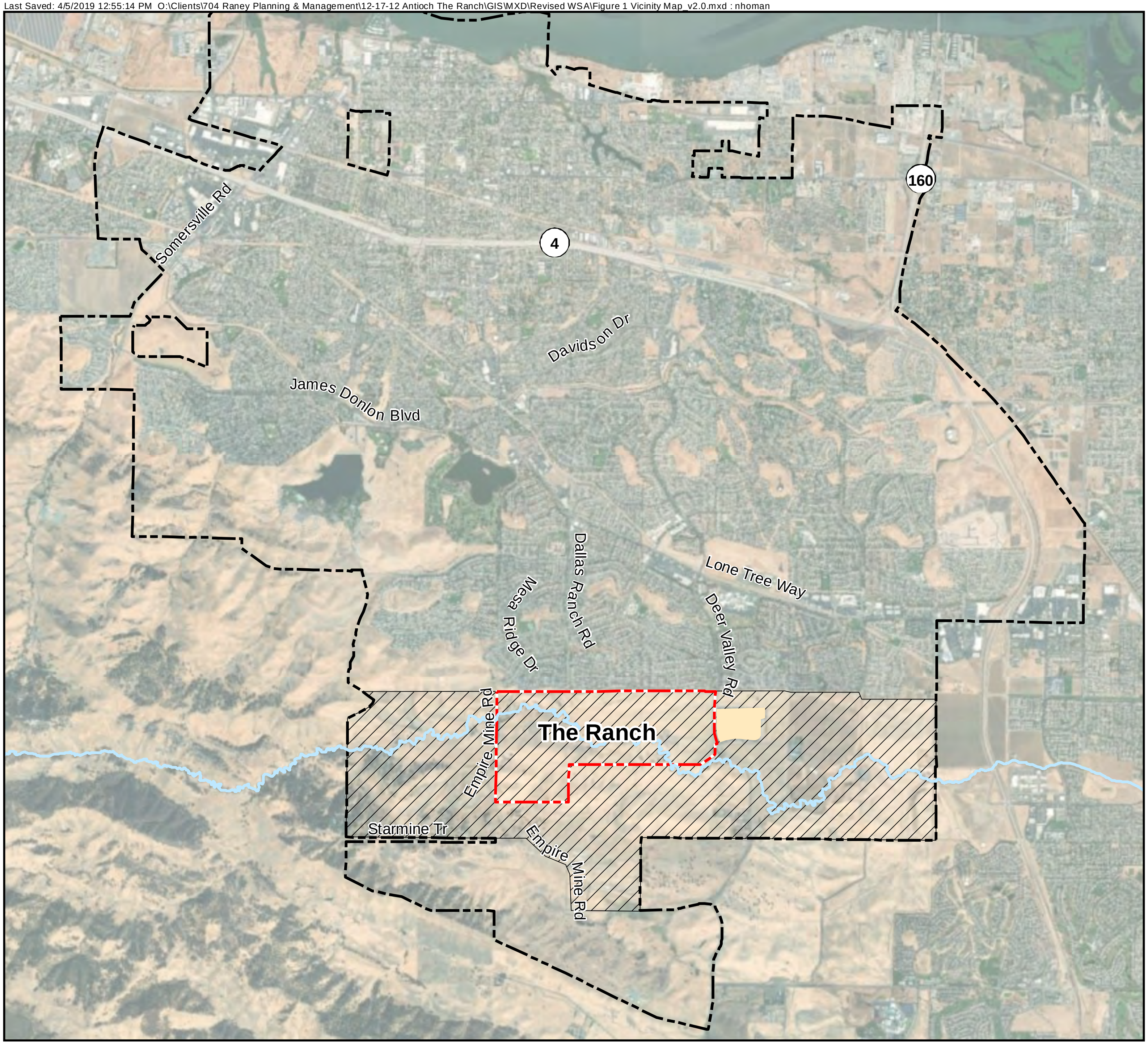
Relevant citations of Water Code sections 10910 through 10915 are included throughout this WSA in *italics* to demonstrate compliance with the specific requirements of SB 610.

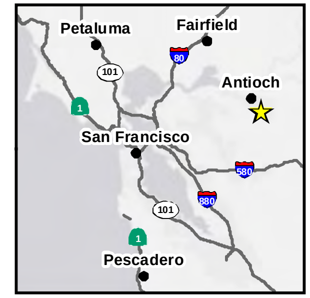
1.4 Acronyms and Abbreviations Used in this Water Supply Assessment

The following acronyms and abbreviations have been used throughout this WSA.

ABAG	Association of Bay Area Governments
AFY	Acre-Feet Per Year
Canal	Contra Costa Canal
CCWD	Contra Costa Water District
CEQA	California Environmental Quality Act
City	City of Antioch
CVP	Central Valley Project
DD	Delta Diablo Sanitation District
DU	Dwelling Unit
EIR	Environmental Impact Report
gpcd	Gallons Per Capita Per Day
gpd	Gallons Per Day
MG	Million Gallons
MGY	Million Gallons Per Year
mg/L	Milligrams Per Liter
Project	The Ranch
SB X7-7	Senate Bill X7-7
SB 610	California State Senate Bill 610 of 2001
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
WSA	Water Supply Assessment

Last Saved: 4/5/2019 12:55:14 PM O:\Clients\704 Raney Planning & Management\12-17-12 Antioch The Ranch\GIS\MXD\Revised WSA\Figure 1 Vicinity Map_v2.0.mxd : nhoman





N

0 2,500 5,000

Scale in Feet

Symbology

- City of Antioch
- Sand Creek Focus Area
- Project Boundary
- Kaiser Permanente Antioch Medical Center
- Sand Creek

Figure 1-1

Project Vicinity

City of Antioch
Water Supply Assessment
The Ranch

2.0 DESCRIPTION OF PROJECT

A description of the Project, including Project Location and Proposed Land Usages and Acreages, is provided below.

2.1 Project Location

The Project site is located in Contra Costa County, in the City of Antioch, north of the portion of Empire Mine Road located between Starmine Trail and Deer Valley Road, east of the portion of Empire Mine Road located between Mesa Ridge Drive and Starmine Trail, south of a residential area, west of Deer Valley Road. The Project area, located on the south side of the City, is within the City's limit and General Plan area. In the General Plan, the Project site is located within the Sand Creek Focus Area, and includes land uses such as Golf Course community/Senior Housing/Open Space, Hillside and Estate Residential, and Public/Quasi Public.

The Project area is surrounded by a variety of existing land uses as follows:

- **North**: The boundary on the north of the Project site is primarily occupied by a single-family medium-low density residential subdivision.
- **East**: The Project site is bordered on the east by Deer Valley Road and the Kaiser Permanente Antioch Medical Center.
- **South**: The Project site is bordered on the south by undeveloped land (planned for future residential development).
- **West**: The Project site is bordered on the west by undeveloped land (planned for future residential development).

The Project location is presented on Figure 1-1.

2.2 Proposed Land Uses and Acreages

Proposed land use for the Project includes residential development, a "Village Center" area, a site reserved for a future fire station, several parks, and open space. Proposed land use for the Project is shown in Figure 2-1.

The proposed Project would provide a mix of single-family and active adult residential neighborhood types organized into two distinct development areas to the north and south of the Sand Creek corridor. The northern development area would consist primarily of low-density single-family residential lots, with some medium-density single-family lots located near the Village Center. The southern development area would consist primarily of active adult residential lots. A total of 1,177 residential dwelling units are planned.

The Village Center would provide goods and services to residents of the development area neighborhoods, as well as to the existing Kaiser Permanente Antioch Medical Center. The Village Center would accommodate up to 54,000 square feet of neighborhood commercial, office, and retail space. The fire station would not be constructed as part of the Project, but would be constructed later in coordination with the Contra Costa Fire Protection District. The planned parks include several large neighborhood parks as well as numerous pocket parks that would generally be smaller than one acre. The open space includes hills, ridgelines, and a trail system along Sand Creek and throughout the Project site. The proposed Project's land uses are presented in Table 2-1.

Table 2-1. Proposed Land Uses for The Ranch

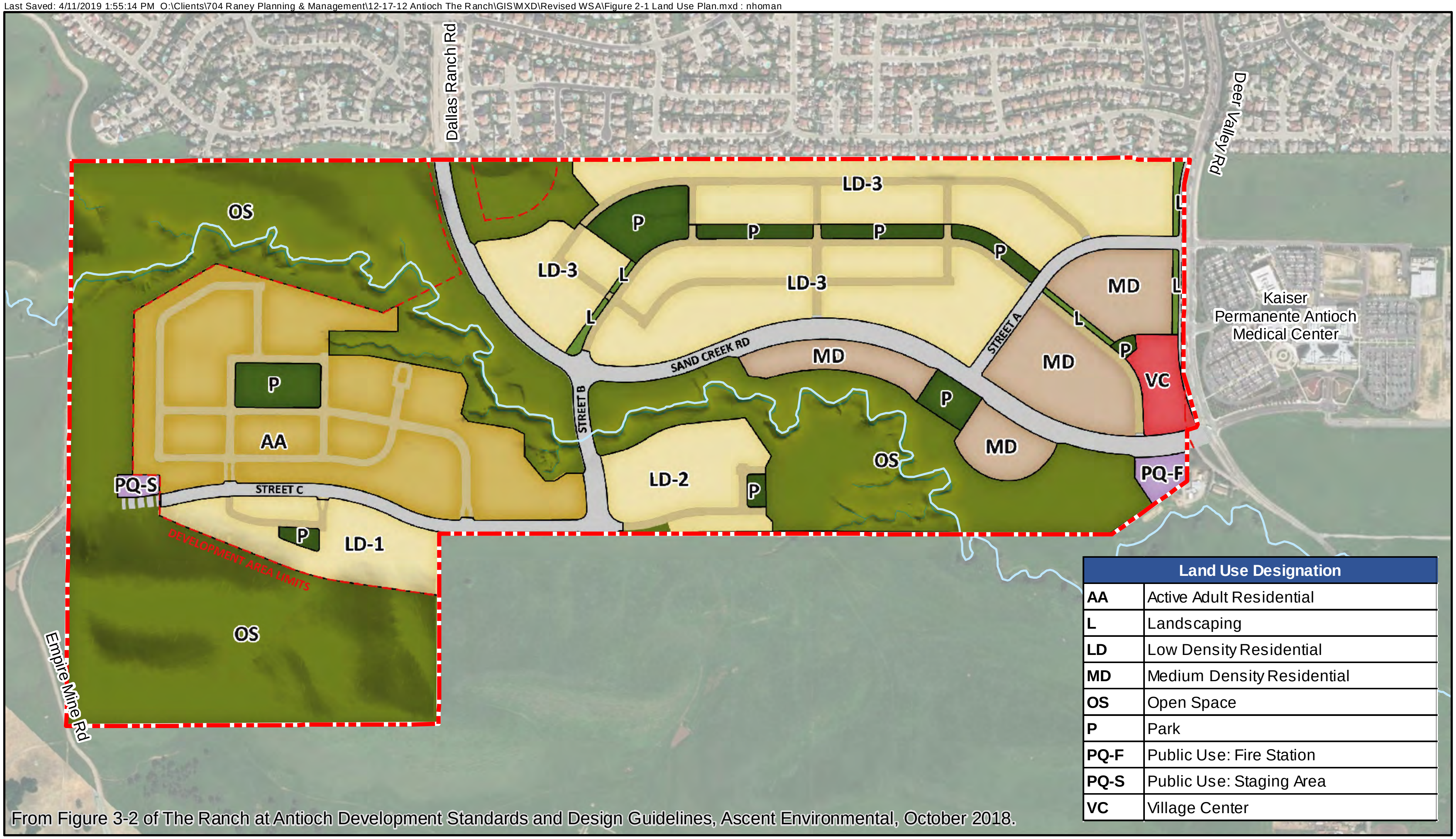
Proposed Land Use and Landscape Planting[(a)]	Land Area, acres
Single-Family Residential, Low Density	140.5
Single-Family Residential, Medium Density	38.0
Active Adult	75.0
Village Center	5.0
Fire Station	2.0
Parks	20.0
Landscape	2.5
Open Space	229.5
Major Roadways	38.0
Staging Area	1.0
Total	**551.5**

(a) Land use data based on The Ranch at Antioch Development Standards and Design Guidelines, Ascent Environmental, October 2018.

The current General Plan land use designation for the Project parcels within the Sand Creek Focus Area indicates Golf Course community/Senior Housing/Open Space, Hillside and Estate Residential, and Public/Quasi Public. The proposed Project would require a General Plan Amendment to change the land use designations of the Project site to Low Density Residential, Medium Low Density Residential, Mixed Use, Public/Quasi Public Space, Open Space, and Senior Housing.

Although the Project is not specifically identified in the City's 2015 UWMP, the Sand Creek Focus Area is included. Proposed land uses, although somewhat different from those designated in the General Plan, are generally consistent with the existing designations. The Project is expected to have water demands comparable to those of a project which developed the land in accordance with the existing General Plan land use designations.

Last Saved: 4/11/2019 1:55:14 PM O:\Clients\704 Raney Planning & Management\12-17-12 Antioch The Ranch\GIS\MXD\Revised WSA\Figure 2-1 Land Use Plan.mxd : nhoman



Land Use Designation	
AA	Active Adult Residential
L	Landscaping
LD	Low Density Residential
MD	Medium Density Residential
OS	Open Space
P	Park
PQ-F	Public Use: Fire Station
PQ-S	Public Use: Staging Area
VC	Village Center

From Figure 3-2 of The Ranch at Antioch Development Standards and Design Guidelines, Ascent Environmental, October 2018.

Symbology

Project Boundary

Sand Creek

0 500 1,000

Scale in Feet

Figure 2-1

Proposed Land Use

City of Antioch
Water Supply Assessment
The Ranch

3.0 REQUIRED DETERMINATIONS

This Chapter describes the required determinations for a WSA.

3.1 Does SB 610 apply to the Project?

10910(a) Any city or county that determines that a project, as defined in Section 10912, is subject to the California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code) under Section 21080 of the Public Resources Code shall comply with this part.

10912(a) "Project" means any of the following:

(1) A proposed residential development of more than 500 dwelling units.

(2) A proposed shopping center or business establishment employing more than 1,000 persons or having more than 500,000 square feet of floor space.

(3) A proposed commercial office building employing more than 1,000 persons or having more than 250,000 square feet of floor space.

(4) A proposed hotel or motel, or both, having more than 500 rooms.

(5) A proposed industrial, manufacturing, or processing plant, or industrial park planned to house more than 1,000 persons, occupying more than 40 acres of land, or having more than 650,000 square feet of floor area.

(6) A mixed-use project that includes one or more of the projects specified in this subdivision.

(7) A project that would demand an amount of water equivalent to, or greater than, the amount of water required by a 500-dwelling unit project.

Based on the following facts, SB 610 does apply to the Project.

- The City has determined that the Project is subject to the California Environmental Quality Act (CEQA) and that an EIR is required.
- The Project includes both a residential development and a "Village Center" designated for commercial, office, and retail space, and therefore is a mixed-use project. The residential development portion of the Project includes 1,177 residential dwelling units and therefore meets the definition of a "Project" as specified in Water Code section 10912(a) paragraph (1) as defined for proposed residential developments. The Project, with the proposed "Village Center", also meets the definition of a "Project" as specified in Water Code section 10912(a) paragraph (6) as defined for mixed-use projects.

Therefore, according to Water Code section 10910(a), a WSA is required for the Project.

3.2 Who is the Identified Public Water System?

10910(b) The city or county, at the time that it determines whether an environmental impact report, a negative declaration, or a mitigated negative declaration is required for any project subject to the California Environmental Quality Act pursuant to Section 21080.1 of the Public Resources Code, shall identify any water system that is, or may become as a result of supplying water to the project identified pursuant to this subdivision, a public water system, as defined by Section 10912, that may supply water for the project

10912(c) "Public water system" means a system for the provision of piped water to the public for human consumption that has 3,000 or more service connections…

As shown on Figure 1-1, the Project is currently located inside the existing City limits. The City's water system service area includes all areas within the City limits. According to the City's 2015 Urban Water Management Plan (UWMP), in 2015, the City provided approximately 4,521 million gallons (MG) of potable and raw water to over 31,798 connections. The City is by definition a public water system. Therefore, the City is the identified public water system for the Project.

3.3 Does the City have an adopted UWMP and does the UWMP include the projected water demand for the Project?

10910(c)(1) The city or county, at the time it makes the determination required under Section 21080.1 of the Public Resources Code, shall request each public water system identified pursuant to subdivision (b) to determine whether the projected water demand associated with a proposed project was included as part of the most recently adopted urban water management plan adopted pursuant to Part 2.6 (commencing with Section 10610).

The City's most recently adopted UWMP (the City's 2015 UWMP) was adopted by the Antioch City Council on May 24, 2016[1]. The City's 2015 UWMP included existing and projected water demands for existing and projected future land uses to be developed within the City's General Plan Sphere of Influence through 2040. The water demand projections in the City's 2015 UWMP included existing City water demands, future water demands for proposed developments within the existing City limits, and future water demands for future service areas outside the existing City limits.

Potable water demands for the proposed Project are not specifically designated in the City's 2015 UWMP, but future water demands for the planned development area within the Sand Creek Focus Area are included in the 2015 UWMP; therefore, future water demands for the Project area are accounted for in the City's 2015 UWMP.

Total water use throughout the City service area is projected in the City's 2015 UWMP to increase from 4,600 million gallons per year (MGY) in 2015 to 7,993 MGY in 2040, an increase of 3,393 MGY. The water demand projection included in the City's 2015 UWMP includes the impacts of the City's water conservation plan, and assumes compliance with the Water Conservation Act of 2009, known as SB X7-7. Projected water demand is discussed further in Chapter 5 of this WSA.

The City's 2015 UWMP showed a water supply surplus in Normal and Single Dry Years through the year 2040, but shows a supply deficit during Multiple Dry Years. Water supply reliability is discussed further in Chapter 6 of this WSA.

[1] *City of Antioch 2015 Urban Water Management Plan*, May 24, 2016, prepared by West Yost Associates.

4.0 CITY OF ANTIOCH WATER SERVICE AREA

This Chapter presents the City's Water Service Area including history and growth information for the City.

As described in the City's 2015 UWMP, the existing City water service area covers 28.8 square miles and includes the area within the City limits and some adjacent County land to the northeast and west within the City's sphere of influence. The Antioch water system serves about 31,798 connections within Contra Costa County (as of 2015). The City's service area extends from steep hilly terrain in the south and west portions of the service area to flat with a gentle slope in the northeast portion of the service area. The City's water system serves elevations from near sea level up to about 500 feet. Six primary pressure zones are currently required to distribute water.

The principal sources of raw surface water supply are the Sacramento-San Joaquin Rivers Delta and the Contra Costa Canal (Canal). Raw water from these sources can be stored in the Antioch Municipal Reservoir. Canal water, purchased from CCWD, is pumped from Victoria Canal, Rock Slough, and Old River in the western Delta and stored in the Los Vaqueros Reservoir.

For reference, background information is presented below for the City service area, including projected population and climate.

4.1 Current/Projected City Population

The City reported current and projected population in Table 3-2 of the City's 2015 UWMP. Total population for 2015 was based on State of California Department of Finance data. The population projection for 2020 through 2040 was from the Association of Bay Area Governments (ABAG) as presented in the City's 2015-2023 Housing Element. The actual City population has since surpassed the original 2015 projection. West Yost revised the population projection for 2020 through 2035 accordingly, assuming that the ABAG population projection of 124,600 for the year 2040 remains accurate and that the growth rate from 2015 through 2040 is constant. The original and revised population projections for the City from 2015 to 2040 are shown in Table 4-1.

Table 4-1. Existing and Projected Population

Year	2015	2020	2025	2030	2035	2040
Original Projection[(a)]	108,298	108,900	112,400	116,200	120,300	124,600
Revised Projection[(b)]	111,263	113,800	116,400	119,100	121,800	124,600

(a) City's 2015 UWMP, Table 3-2. Original Data Source: California Department of Finance Table E-5, downloaded May 2015 (for 2015) and City of Antioch 2015-2023 Housing Element for 2020 through 2040.

(b) Revised projection. Assumes that the ABAG population projection for 2040 is accurate and that the growth rate is constant. Original Data Source: California Department of Finance Table E-5, downloaded October 2017 (for 2015), City of Antioch 2015-2023 Housing Element for 2040, assumed constant growth rate from 2015 through 2040.

4.2 Climate

Climate and precipitation information are described in the City's 2015 UWMP. Antioch has cool and humid winters, and hot and dry summers.

Monthly climate data are provided in Table 4-2. The data in Table 4-2 were presented in the City's 2015 UWMP Table 3-1 and were obtained from the Western Regional Climate Center for Antioch, California and the California Irrigation Management Information Service for Station #47: Brentwood.

Antioch's monthly average of maximum daily temperature ranges from 54 to 91 degrees Fahrenheit, while the monthly average of minimum daily temperature ranges from 37 to 58 degrees Fahrenheit. The historical annual average precipitation is approximately 14 inches. The rainy season typically begins in November and ends in March. Average monthly precipitation during the winter months is about 2 to 3 inches, but records show that the monthly precipitation has been as high as 8 inches and as low as 0 inches. Low humidity usually occurs in the summer months, from May to September. The high temperature and low humidity that usually occur in the summer months result in high water demands. Landscape irrigation, including lawn watering, in the summer is a major contributor to the higher summer water demands.

Table 4-2. City of Antioch Average Monthly Climate Data

Month	Standard Monthly Average Evapotranspiration, inches(a)	Average Total Rainfall, inches(b)	Average Temperature, F°(b)	
			Max	Min
January	1.17	2.78	54.0	37.1
February	1.98	2.43	60.3	41.0
March	3.74	2.00	65.5	43.4
April	5.47	0.90	71.6	46.4
May	7.14	0.36	78.6	51.4
June	7.97	0.90	86.1	56.3
July	8.22	0.02	91.1	57.6
August	7.39	0.04	89.9	56.9
September	5.57	0.18	86.3	55.3
October	3.77	0.64	77.4	50.3
November	1.89	1.58	64.4	43.1
December	1.12	2.20	54.9	37.4
Total/Average	55.43	14.03	73.3	48.0

(a) From City's 2015 UWMP, Table 3-1. Original Data Source: California Irrigation Management Information System (CIMIS) data for Station #47: Brentwood (downloaded January 5, 2015).

(b) From City's 2015 UWMP, Table 3-1. Original Data Source: Western Regional Climate Center data for Antioch, California (period of record: March 1, 1955 to December 31, 2014).

5.0 CITY OF ANTIOCH WATER DEMANDS

> *10910(c)(2) If the projected water demand associated with the proposed project was accounted for in the most recently adopted urban water management plan, the public water system may incorporate the requested information from the urban water management plan in preparing the elements of the assessment required to comply with subdivisions (d), (e), (f), and (g).*

The projected water demand for the proposed Project and the City are discussed below.

5.1 Projected Water Demand for the Project

The projected water demand for the proposed Project is based on water demand factors for single-family and active adult residences that were calculated from projections in the City's 2015 UWMP, Tables 3-2 and 4-3, and an estimate of the required irrigation demand based on the City's Water Efficient Landscape Ordinance. Single-family dwelling unit (DU) potable water demand was projected to be 350 gallons per day per dwelling unit (gpd/DU) from 2020 through 2040. These factors will assist the City in complying with the provisions of Senate Bill X7-7 (SB X7-7), which establishes target per capita water demands to be met by the year 2020.

The projected water demand for the proposed Project is shown in Table 5-1. Detailed calculations are included in Appendix A.

Table 5-1. Projected Potable Water Demand for The Ranch[a]

Component	Projected Annual Potable Water Demand, MGY
The Ranch	166.6
Unaccounted-for Water[b]	9.7
Total Water Demand	**176.3**

(a) See Attachment A for detailed water demand projections.
(b) Based on 5.5 percent of total water production (see City's 2015 UWMP, Table 4-3).

As indicated in Table 5-1, the total projected annual water demand for the proposed Project is approximately 176.3 MGY, assuming an unaccounted-for water value of 5.5 percent of total water produced.

The average number of people per DU in Single-Family Residential households is assumed to be 3.0[2]. The average number of people per DU in active adult households is assumed to be 2.0. Using these assumptions, the proposed Project would provide housing for up to approximately 3,109 people.

[2] *City of Antioch 2015 Urban Water Management Plan*, Section 3.4, May 24, 2016, prepared by West Yost Associates.

5.2 City Projected Water Demand for the City

The City's 2015 UWMP describes the projected City water demand through 2040. The City's metered potable water use for 2015 was 4,270 MG, which was a 22.8 percent reduction from the 2010 metered potable water use of 5,534 MG. The recent drought was the biggest factor in the decrease in water demand. Water demand decreased due to water use restrictions adopted by the City. Once these restrictions are no longer in effect, the water demand is expected to increase. The water demand projections provided in the City's 2015 UWMP were based on population and employment projections and the SB X7-7 per capita water demand targets adopted by the City.

The water use projections for 2020 through 2040 assume that the City will achieve its 2020 water use target (165 gpcd). Historical and projected water demand from 2010 through 2040 is summarized in Table 5-2.

Table 5-2. City of Antioch Historical and Projected Total Water Use, MGY[(a)]

Sectors	Actual 2010	Actual 2015	2020	2025	2030	2035	2040
Single Family Residential	3,670	2,768	4,051	4,181	4,323	4,477	4,637
Multi-Family Residential	406	405	593	612	633	655	679
Commercial	422	300	440	454	469	486	503
Industrial	240	85	125	129	133	138	143
Institutional & Governmental	0	178	260	269	278	287	298
Landscape (Potable)	610	465	681	703	727	753	780
Other	186	69	18	18	19	20	20
Total Water Deliveries	5,534	4,270	6,168	6,366	6,582	6,816	7,060
Unaccounted-for System Losses	171	222	362	374	387	400	415
Total Potable Water	5,705	4,492	6,530	6,740	6,969	7,216	7,475
Landscape (Raw)	109	29	29	29	29	29	29
Recycled Water	0	79	326	489	489	489	489
Grand Total Water Use	**5,814**	**4,600**	**6,885**	**7,258**	**7,487**	**7,734**	**7,993**

(a) Based on City's 2015 UWMP, Tables 4-1, 4-2, and 4-3.

Although the Project is not specifically identified in the City's 2015 UWMP, the Sand Creek Focus Area is included, and the City's growth projections (an additional 16,302 people from 2015 to 2040) and water demand projections (an additional 3,393 MGY from 2015 to 2040) accommodate the Project's estimated population of approximately 3,109 people and projected water demand of 176.3 MGY.

6.0 CITY OF ANTIOCH WATER SUPPLIES

10910(d)(1) The assessment required by this section shall include an identification of any existing water supply entitlements, water rights, or water service contracts relevant to the identified water supply for the proposed project, and a description of the quantities of water received in prior years by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), under the existing water supply entitlements, water rights, or water service contracts.

10910(d)(2) An identification of existing water supply entitlements, water rights, or water service contracts held by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), shall be demonstrated by providing information related to all of the following:

Written contracts or other proof of entitlement to an identified water supply.

Copies of a capital outlay program for financing the delivery of a water supply that has been adopted by the public water system.

Federal, state, and local permits for construction of necessary infrastructure associated with delivering the water supply.

Any necessary regulatory approvals that are required in order to be able to convey or deliver the water supply.

10910(e) If no water has been received in prior years by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), under the existing water supply entitlements, water rights, or water service contracts, the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), shall also include in its water supply assessment pursuant to subdivision (c), an identification of the other public water systems or water service contract-holders that receive a water supply or have existing water supply entitlements, water rights, or water service contracts, to the same source of water as the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), has identified as a source of water supply within its water supply assessments.

The Project, if approved by the City, is capable of being served by the City from the City's existing and future portfolio of water supplies. The water supply for the Project will have the same water supply reliability and water quality as the water supply available to each of the City's other existing and future water customers.

The water demands for the Project (together with existing water demands and planned future uses) are included in the City's 2015 UWMP as part of the Sand Creek Focus Area. The descriptions provided below for the City's water supplies have been taken from the City's 2015 UWMP, which was adopted by the Antioch City Council in May 2016.

6.1 Existing Potable Water Supplies

10910(f) If a water supply for a proposed project includes groundwater, the following additional information shall be included in the water supply assessment.

10910(f)(1) A review of any information contained in the urban water management plan relevant to the identified water supply for the proposed project.

10910(f)(2) A description of any groundwater basin or basins from which the proposed project will be supplied. For those basins for which a court or the board has adjudicated the rights to pump groundwater, a copy of the order or decree adopted by the court or the board and a description of the amount of groundwater the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), has the legal right to pump under the order or decree. For basins that have not been adjudicated, information as to whether the department has identified the basin or basins as overdrafted or has projected that the basin will become overdrafted if present management conditions continue, in the most current bulletin of the department that characterizes the condition of the groundwater basin, and a detailed description by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), of the efforts being undertaken in the basin or basins to eliminate the long-term overdraft condition.

10910(f)(3) A detailed description and analysis of the amount and location of groundwater pumped by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), for the past five years from any groundwater basin from which the proposed project will be supplied. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historical use records.

A detailed description and analysis of the amount and location of groundwater that is projected to be pumped by the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), from any basin from which the proposed project will be supplied. The description and analysis shall be based on information that is reasonably available, including, but not limited to, historical use records.

10910(f)(4) An analysis of the sufficiency of the groundwater from the basin or basins from which the proposed project will be supplied to meet the projected water demand associated with the proposed project.

A water assessment shall not be required to include the information required by this paragraph if the public water system determines, as part of the review required by paragraph (1), that the sufficiency of groundwater necessary to meet the initial and projected water demand associated with the project was addressed in the description and analysis required by paragraph (4) of subdivision (b) of Section 10631.

The City's 2015 UWMP describes the City's available water supplies which include surface water purchased from CCWD and delivered through the Contra Costa Canal, and surface water pumped from the City's Sacramento/San Joaquin Rivers Delta intakes. A 240 MG Municipal Reservoir located within City limits stores water that is pumped from the Sacramento-San Joaquin Rivers and the Contra Costa Canal. Surface water is conveyed to the City's water treatment plant, treated, and then delivered to the City's water customers via the City's potable water distribution system. The City also receives non-potable recycled water delivered from Delta Diablo Sanitation District (DD).

The City's current and projected water supplies are shown in Table 6-1, which is based on Tables 6-8 and 6-9 of the City's 2015 UWMP.

Table 6-1. City of Antioch Normal Year Water Supplies – Current and Projected, MGY(a)

Water Supply Sources	2015(b)	2020	2025	2030	2035	2040
CCWD Surface Water(c)	3,915	4,099	4,309	4,538	4,785	5,044
Sacramento/San Joaquin Rivers Delta	409	2,460	2,460	2,460	2,460	2,460
Municipal Reservoir	197(d)	-	-	-	-	-
Recycled Water from DD(e) (non-potable)	79	326	489	489	489	489
Total	4,600	6,885	7,258	7,487	7,734	7,993

(a) Tables 6-8 and 6-9 from City of Antioch 2015 UWMP. MGY = Million Gallons per Year
(b) Actual deliveries are listed for 2015. The values for years 2020 through 2040 represent available supply.
(c) CCWD = Contra Costa Water District
(d) Supply from Municipal Reservoir represents water from the Delta or Canal that had been delivered in previous years and stored in the reservoir.
(e) DD = Delta Diablo Sanitation District

6.2 Surface Water

As described in the City's 2015 UWMP, the City is located within the CCWD service area and purchases Central Valley Project (CVP) water pumped from the Sacramento-San Joaquin Delta by CCWD, its wholesale supplier. CCWD has a contract with the U.S. Bureau of Reclamation (USBR) for 195,000 acre-feet per year (AFY) of CVP water. In May 2005, CCWD renewed their water service contract with the USBR for a period of 40 years through February 2045.

In 2015, approximately 85 percent of the City's total water supply was provided by CCWD. The City and CCWD have a contractual arrangement allowing the City to obtain such quantity of water as is necessary to meet 100 percent of its needs through the year 2028, subject to rationing restrictions in the event of drought or other extraordinary circumstances.

Approximately 9 percent of the City's total water supply in 2015 was obtained from the City's intakes on the Sacramento/San Joaquin Rivers Delta intakes. There is no quantity limitation on the City's appropriation from the Sacramento-San Joaquin Rivers Delta, provided the water is put to beneficial use. Beneficial use includes water diverted to the City's Municipal Reservoir.

Approximately 4 percent of the City's total water supply in 2015 was water stored in the City's Municipal Reservoir from previous years. This water was originally obtained from a combination of CCWD and the City's intakes on the Sacramento/San Joaquin Rivers Delta.

The City treats the majority of the surface water supply to drinking water standards but conveys a small portion of untreated water to the golf course for irrigation.

6.3 Groundwater

The City does not currently pump groundwater, and has no plans to pump groundwater from the local groundwater basin in the future.

6.4 Recycled water

In 2007, The City of Antioch and DD approved the Antioch Urban Reuse Project to provide recycled water to irrigation users in Antioch. In 2015, approximately 2 percent of the City's total water supply was provided by DD. The City currently uses recycled water to irrigate four City parks and portions of the Lone Tree Golf Course. Due to limitations on the legal beneficial uses of recycled water, recycled water use is not projected to increase beyond 489 MGY through the year 2040. As stated in the City's 2015 UWMP, new developments are being required to install recycled water facilities as part of their improvements.

6.5 Dry Year Water Supply Availability and Reliability

Water Code section 10910 (c)(4) requires that a WSA include a discussion with regard to *"whether total projected water supplies, determined to be available by the city or county for the project during normal, single dry, and multiple dry water years during a 20-year projection, will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses, including agricultural and manufacturing uses."* Accordingly, this WSA addresses these three hydrologic conditions through the year 2040.

A description of the City's water supply reliability is presented in Chapter 7 of the City's 2015 UWMP and is summarized below.

In conformance with California Water Code Division 5, Part 2.6, Section 10635, CCWD prepared an assessment of its water supply reliability. This analysis was provided to all wholesale municipal customers of CCWD for use in the preparation of their UWMPs.

The water supply reliability goal adopted by CCWD's Board of Directors is to meet at least 85 percent of demand during drought conditions and 100 percent of demand in normal years. The remaining 15 percent during drought conditions would be met by a combination of short-term water purchases and a voluntary short-term conservation program.

The projected water supplies from CCWD are not anticipated to incur supply deficits in normal years due to CCWD's long-term conservation program, existing CVP contract supply, and long-term water transfer agreement with East Contra Costa Irrigation District. CCWD's currently available and planned supplies are sufficient to meet their reliability goals and estimated water demands during normal, single dry and the first two years of a multi-year drought. In later years, supply shortfalls may occur in the second and third year of a multi-year drought. Supply reliability tables provided by CCWD are included in CCWD's 2015 UWMP. The maximum amount of short-term conservation expected by CCWD is 15 percent of supply.

As an example of CCWD's water supply reliability, in 2014, when the State Water Project allocations were 5 percent of Table A entitlements, CCWD was able to deliver 100 percent of its potable and raw water customers requested supply.

The City typically ceases diverting water from the Sacramento-San Joaquin Rivers Delta when the chloride concentration of the water exceeds 250 milligrams per liter (mg/l). This high chloride level occurs occasionally during dry years. The City ceased diversion in 1976/1977, and pumped only an average of seven days per year between 1986 and March 1991. For purposes of this WSA, and for the City's 2015 UWMP, the City has assumed pumping from the Sacramento-San Joaquin

Rivers Delta would be available in normal and wetter precipitation years, during a single year drought, and in the first year of a multiple-year drought, but would not be available in the second and third years of a multiple year drought. The City also assumed that recycled water will be available under all hydrologic conditions. A summary of the City's projected water supply during Normal, Single Dry, and Multiple-Dry Years is shown in Table 6-2.

Table 6-2. Summary of Projected Water Supply During Hydrologic Normal, Single-Dry, and Multiple-Dry Years City of Antioch, MGY[(a)]

Hydrologic Condition	2020	2025	2030	2035	2040
Normal Year	6,885	7,258	7,487	7,734	7,993
Single Dry Year[(b)]	6,885	7,258	7,487	7,734	7,993
Multiple-Dry Year - First Year[(c)]	6,885	7,258	7,487	7,734	7,993
Multiple-Dry Year - Second Year[(c)]	6,885	7,258	7,487	7,589	7,543
Multiple-Dry Year - Third Year[(c)]	6,229	6,581	6,787	6,865	6,867

(a) From City's 2015 UWMP Tables 7-3, 7-4, and 7-5 for 2020 through 2040. Calculated values based on assumptions listed below.

(b) CCWD anticipates no supply shortfalls in a single-year drought. City assumes all local water supplies and intakes would be available in a single dry year.

(c) CCWD anticipates the following supply shortfalls in a three-year drought scenario: 2020 (0%, 0%,10%), 2025 (0%,0%,10%), 2030 (0%,0%,10%), 2035 (0%,2%,12%), 2040 (0%,6%,15%). City assumes the Municipal Reservoir and the Delta intakes would be available only in the first year of a multi-year drought. Recycled water is assumed to be available under all hydrologic conditions.

7.0 DETERMINATION OF WATER SUPPLY SUFFICIENCY

0910(c)(4) If the city or county is required to comply with this part pursuant to subdivision (b), the water supply assessment for the project shall include a discussion with regard to whether the total projected water supplies, determined to be available by the city or county for the project during normal, single dry, and multiple dry water years during a 20-year projection, will meet the projected water demand associated with the proposed project, in addition to existing and planned future uses, including agricultural and manufacturing uses.

10911 (a) If, as a result of its assessment, the public water system concludes that its water supplies are, or will be, insufficient, the public water system shall provide to the city or county its plans for acquiring additional water supplies, setting forth the measures that are being undertaken to acquire and develop those water supplies. If the city or county, if either is required to comply with this part pursuant to subdivision (b), concludes as a result of its assessment, that water supplies are, or will be, insufficient, the city or county shall include in its water supply assessment its plans for acquiring additional water supplies, setting forth the measures that are being undertaken to acquire and develop those water supplies. Those plans may include, but are not limited to, information concerning all of the following:

The estimated total costs, and the proposed method of financing the costs, associated with acquiring the additional water supplies.

All federal, state, and local permits, approvals, or entitlements that are anticipated to be required in order to acquire and develop the additional water supplies.

Based on the consideration set forth in paragraphs (1) and (2), the estimated timeframes within which the public water system, or the city or county if either is required to comply with this part pursuant to subdivision (b), expects to able to acquire additional water supplies.

Based on the analysis described above, this WSA demonstrates that the City's existing and projected potable water supplies are sufficient to meet the City's existing and projected future potable water demands, including those future water demands associated with the Project, to the year 2040 under all hydrologic conditions as described below.

A comparison of the City's projected water supplies and demands is shown in Table 7-1 for Normal, Single Dry, and Multiple Dry Years. Table 7-1 is based on Tables 7-3, 7-4, and 7-5 from the City's 2015 UWMP. The difference of zero between supply and demand in Table 7-1 indicates that, in average precipitation years, the City will have sufficient water to meet its customers' needs through 2040.

As indicated in Table 7-1, there is a projected supply deficit during the third year of a multi-year drought. The projected water supply deficit is approximately 16 percent of supply in 2040. This deficit would be closed by the City's short-term water demand reduction measures.

As shown in Table 7-1 and as discussed above, although the Project is not specifically identified in the City's 2015 UWMP, the Sand Creek Focus Area is included, and the City's growth projections (an additional 16,302 people from 2015 to 2040) and water demand projections (an additional 3,393 MGY from 2015 to 2040) accommodate the Project's potential population of 3,109 people and projected water demand of 176.3 MGY.

Table 7-1. Summary of Water Demand Versus Supply During Hydrologic Normal, Single-Dry, and Multiple-Dry Years for City of Antioch[(a)]

Supply and Demand Comparison						
		2020	2025	2030	2035	2040
Normal Year						
Supply Totals, MGY		6,885	7,258	7,487	7,734	7,993
Demand Totals, MGY		6,885	7,258	7,487	7,734	7,993
Difference, MGY		0	0	0	0	0
Difference as % of Supply		0%	0%	0%	0%	0%
Difference as % of Demand		0%	0%	0%	0%	0%
Single Dry Year						
Supply Totals, MGY		6,885	7,258	7,487	7,734	7,993
Demand Totals, MGY		6,885	7,258	7,487	7,734	7,993
Difference, MGY		0	0	0	0	0
Difference as % of Supply		0%	0%	0%	0%	0%
Difference as % of Demand		0%	0%	0%	0%	0%
Multiple Dry-Year Events						
Multiple-Dry Year First Year Supply	Supply Totals, MGY	6,885	7,258	7,487	7,734	7,993
	Demand Totals, MGY	6,885	7,258	7,487	7,734	7,993
	Difference, MGY	0	0	0	0	0
	Difference as % of Supply	0%	0%	0%	0%	0%
	Difference as % of Demand	0%	0%	0%	0%	0%
Multiple-Dry Year Second Year Supply	Supply Totals, MGY	6,885	7,258	7,487	7,589	7,543
	Demand Totals, MGY	6,885	7,258	7,487	7,734	7,993
	Difference, MGY	0	0	0	-145	-450
	Difference as % of Supply	0%	0%	0%	-2%	-6%
	Difference as % of Demand	0%	0%	0%	-2%	-6%
Multiple-Dry Year Third Year Supply	Supply Totals, MGY	6,229	6,581	6,787	6,865	6,867
	Demand Totals, MGY	6,885	7,258	7,487	7,734	7,993
	Difference, MGY	-656	-677	-700	-869	-1,126
	Difference as % of Supply	-11%	-10%	-10%	-13%	-16%
	Difference as % of Demand	-10%	-9%	-9%	-11%	-14%

(a) From Tables 5-2 (City of Antioch Historical and Projected Total Water Use) and 6-2 (Summary of Projected Water Supply During Hydrologic Normal, Single-Dry, and Multiple-Dry Years for City of Antioch).

8.0 WATER SUPPLY ASSESSMENT APPROVAL PROCESS

> *10910(g)(1) Subject to paragraph (2), the governing body of each public water system shall submit the assessment to the city or county not later than 90 days from the date on which the request was received. The governing body of each public water system, or the city or county if either is required to comply with this act pursuant to subdivision (b), shall approve the assessment prepared pursuant to this section at a regular or special meeting.*
>
> *10911(b) The city or county shall include the water supply assessment provided pursuant to Section 10910, and any information provided pursuant to subdivision (a), in any environmental document prepared for the project pursuant to Division 13 (commencing with Section 21000) of the Public Resources Code.*

The Antioch City Council must approve this WSA at a regular or special meeting. Furthermore, the City must include this WSA in the Draft EIR being prepared for the Project.

Because the Project includes more than 500 dwelling units, it is also subject to the requirements of SB 221 (Government Code section 66473.7). Under SB 221, approval by a city or county of residential subdivisions of 500 dwelling units or more requires a written verification of sufficient water supply from the water supplier. The verification is typically prepared prior to the adoption of the final subdivision map and ensures that the sufficient water supply is available to serve a new subdivision before construction begins.

9.0 REFERENCES

Ascent Environmental, *The Ranch at Antioch Development Standards and Design Guidelines,* October 2018.

CBG Engineering, *Water Phasing Plan for The Ranch*, December 2018.

City of Antioch 2015 Urban Water Management Plan, May 2016.

Dyett & Bhatia, City of Antioch Housing Element 2015-2023, April 2015.

LSA Associates, City of Antioch General Plan, November 2003.

Raney Planning & Management, *Draft Project Description for The Ranch Project*, 2017.

APPENDIX A

The Ranch Water Demand Projection

Table A-1. Detailed Potable Water Demand Projection for The Ranch

Land Use Data[a]				Potable Water Demand			
Proposed Land Use	Area, acres	Quantity	Units	Water Use Factor	Units	Average Water Demand, gpd	Annual Water Demand, MGY
Residential							
Single Family, Low Density[b]	140.5	543	DU	350	gpd/DU	190,050	69.4
Single Family, Medium Density[b]	38	212	DU	350	gpd/DU	74,200	27.1
Active Adult[c]	75	422	DU	235	gpd/DU	99,170	36.2
Subtotal	253.5	1,177				363,420	132.6
Non-Residential Water Connections							
Village Center (commercial)[d]	5	54,000	ft^2	0.2	gpd/ft^2	10,800	3.9
Fire Station[e]	2			-	-	-	-
Subtotal	7					10,800	3.9
Irrigated Areas							
Parks[f]	20			4.30	ac-ft/ac/yr	76,837	28.0
Irrigated Landscaping[f]	2.5			2.37	ac-ft/ac/yr	5,283	1.9
Subtotal	22.5					82,120	30.0
Non-irrigated Areas							
Open Space	229.5			0.00	ac-ft/ac/yr	-	-
Major Roadways	38			0.00	ac-ft/ac/yr	-	-
Staging Area	1			0.00	ac-ft/ac/yr	-	-
Subtotal	268.5					-	-
Grand Total	551.5					456,340	166.6

[a] Land use data based on The Ranch at Antioch Development Standards and Design Guidelines, Ascent Environmental, October 2018.

[b] Water Use Factor based on City's 2015 UWMP, Tables 3-2 and 4-3. Assumes 3.0 people per DU (from City's 2015 UWMP).

[c] Water Use Factor based on City's 2015 UWMP, Tables 3-2 and 4-3. Assumes 2.0 people per DU (WYA estimate).

[d] Commercial water usage varies depending on tenants. Retail and office likely use 0.1 gpd/ft^2, while restaurants would have much higher usage factors.

[e] Fire Station would not be constructed as part of the proposed project, but would be constructed later. Therefore, for the purpose of this WSA, no estimate was made for Fire Station water demand.

[f] Water Use Factor is derived in Table A-2. Assumes that all park and irrigated landscape acreage use the maximum applied water allowance (MAWA).

Notes:

Residential Water Use Factor = (year 2020 projected residential water use)/(year 2020 projected population) x (people per DU)

DU = Dwelling Unit

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L.2 - Preliminary Stormwater Control Plan

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PRELIMINARY STORMWATER CONTROL PLAN

for

THE RANCH

Subdivision 9249

City of Antioch, California

September 6, 2019

Richland Planned Communities, Inc.
3161 Michelson Drive
Irvine, California 92612

prepared by:

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Ramon, California 94583 (925)
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California 94710 (510) 704-1000

TABLE OF CONTENTS

Tables

Figures

Attachments

Appendix

This Stormwater Control Plan was prepared using the template dated February 2018.

I. PROJECT DATA

Table 1. Project Data

Project Name/Number	The Ranch
Application Submittal Date	September 2019
Project Location	APNs 057010002, 057010003, and 057021003. West of Deer Valley Road, on both the north and south sides of Sand Creek
Name of Developer	Richland Communities
Project Phase No.	Preliminary plan for entire project for CEQA review
Project Type and Description	Mixed use including residential, Village Center, and future fire station
Project Watershed	Sand Creek draining to Marsh Creek
Total Project Site Area (acres)	551.5 (property boundary as distinct from drainage area)
Total Area of Land Disturbed (acres)	373.6
Total New Impervious Surface Area (sq. ft.)	7,731,723
Total Replaced Impervious Surface Area	10,472
Total Pre-Project Impervious Surface Area	10,472
Total Post-Project Impervious Surface Area	7,731,723
50% Rule [*]	Applies
Project Density	4.6 units/acre (based on impacted area)
Applicable Special Project Categories	Does not apply
Percent LID and non-LID treatment	100% LID for all on-site developed areas
HM Compliance [†]	Applies

[*50% rule applies if:
Total Replaced Impervious Surface Area > 0.5 x Pre-Project Impervious Surface Area]

[†HM required (unless project meets one of the exemptions on *Guidebook* p. 9) if:
(Total New Impervious Surface Area + Total Replaced Impervious Surface Area) ≥ 1 acre]

II. SETTING

II.A. Project Location and Description

The Cowan Property Development Project ("Project") is located within a total property boundary area of roughly 551 acres in the City of Antioch, Contra Costa County. The Project bounds both sides of Sand Creek, a major left bank tributary of Marsh Creek. The project site is located upstream (west) from the Contra Costa County Flood Control District (CCCFCD) Upper Sand Creek Regional Flood Control Basin and west of Deer Valley Road and the Kaiser Permanente Antioch Medical Center. **Figure 1.** illustrates the project site overview.

The Project proposes to construct a mix of land uses directly impacting 322 acres within the site on the north and south sides of Sand Creek. Table 2. provides the overall project site area breakdown for the proposed development areas and open space areas that drain to proposed stormwater management facilities (noting that some of the latter area is outside the property boundaries). A setback of approximately 125 feet from the centerline of the creek has been provided along Sand Creek. Areas within this setback will be protected from development and are considered self-treating areas from the perspective of stormwater management.

Other major infrastructure associated with the project includes a southeaster extension of Dallas Ranch Road across the project site with a proposed bridge over Sand Creek to provide access to the southern development section. Sand Creek Road will connect Deer Valley Road to Dallas Ranch Road and will be aligned to the north of Sand Creek. The project will also include a Village Center and new fire station along the eastern boundary immediately west of Deer Valley Road. A 6+-acre community park will be located within the northern development section and link to sections of the trail network. The project also proposes to maintain roughly 229 acres of open space, trail networks and stormwater facilities for public access.

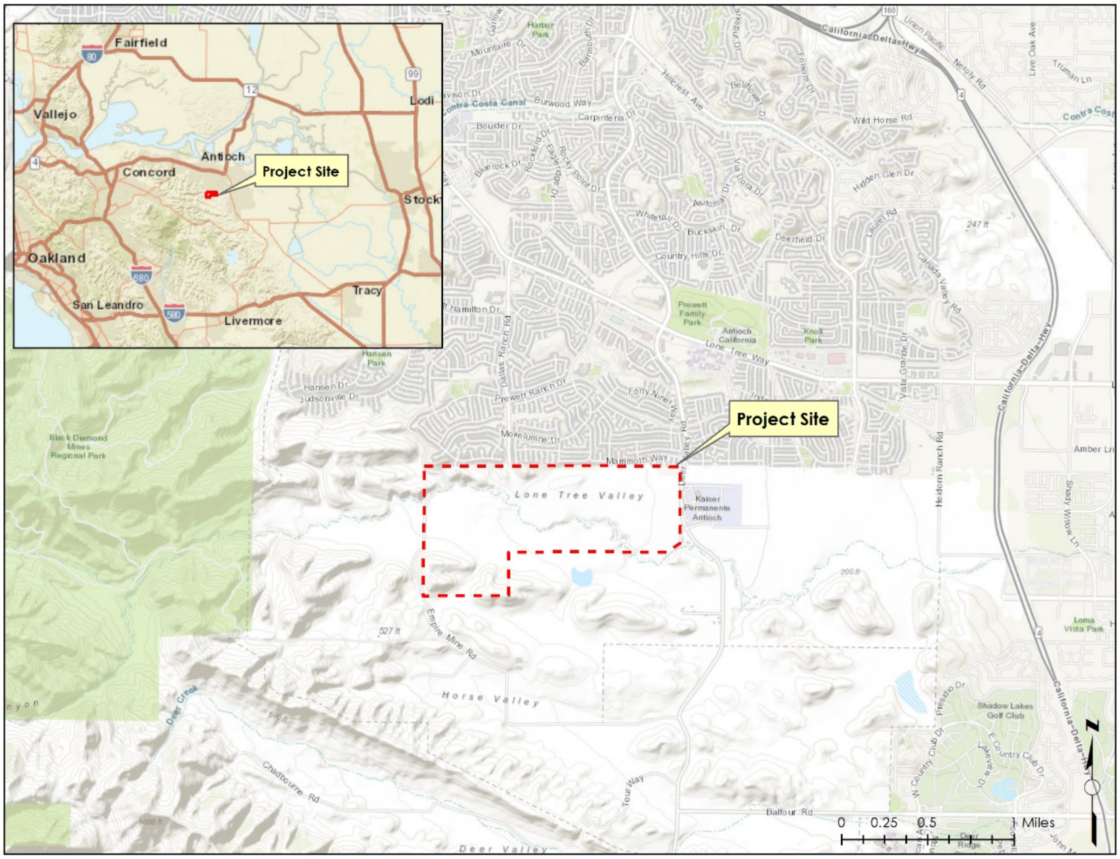

Figure 1. Project Vicinity Map

Table 2. Project Land Use Summary

Project Area Description	**Area** *(acres)*
Low Density Residential	140.5
Age Restricted Residential	75.0
Med-Low Density Residential	38.0
Community Facilities (village center, fire station, trail staging)	8.0
Parks & Landscape	22.5
Roads	38.0
Trails and Open Space	204.5
Stormwater Facilities	25.0
Total	551.5

II.B. Existing Site Features and Conditions

Currently, the project area is nearly undeveloped open-space/range land, consisting almost exclusively of grassland with mature oak and buckeye trees directly along the riparian corridor of Sand Creek. The site is bordered by Deer Valley Road to the east and Empire Mine Road to the west. To the north of the site is the Dallas Ranch Road Subdivision, with existing housing extending the total length of the northern property boundary. Lands to the south consist of undeveloped open-space / range land. Existing ranch buildings are located within the project boundary to the north of the creek.

The portions of the overall project area that are proposed for development are located on relatively level land that slopes generally parallel to Sand Creek with elevations ranging from 320 feet at the western boundary to 230 feet along the eastern boundary. [1] The slope across the main development areas are relatively constant at roughly 1.4 percent for the northern section and 1.2 percent for the southern section. The southern section backs up to a series of hills that will be preserved as open space. These hills have a peak elevation of 481 feet. Sand Creek flows from west to east through much of the project in a highly-incised channel with a bottom width as narrow as 10 feet and top of bank widths ranging from 150 to 300 feet. The creek bed elevations range from 274 feet to 210 feet over a stream distance of roughly 10,415 feet. This is equivalent to a channel slope of approximately 0.6 percent.

The climate characteristics of the site reflect the Mediterranean climate of central coastal regions of California. This climate regime is characterized by cool, wet winters and hot, dry summers. The lower elevation areas in eastern Contra Costa County lie within the rain shadow of the coastal mountain ranges that remove much of the moisture from incoming storm systems. The Mean Seasonal Isohyets Map prepared by Contra Costa County indicates that the mean annual precipitation at the site is on the order of 14.3 inches per year. Although the average rainfall is quite low, the site does experience the wide range in annual precipitation that accompany drought years and wet years such as those related to the El Niño Southern Oscillation (ENSO). For example, the minimum annual precipitation recorded at the nearby Antioch Pumping Plant was 5.6 inches (in Water Year 1976) and the maximum was 27.1 inches (in Water Year 1983).

Annual temperature patterns are typical of interior areas of the state, although somewhat tempered by cooling breezes originating at sea and in the San Francisco Bay system. Evaporation rates are quite high in summer; exceeding rainfall in all but the wettest winter months. Mean annual pan evaporation is likely on the order of 71 inches, or over five times mean annual precipitation, based on the record from the Antioch Pumping Plant (1955-1978).

Three primary soil types are mapped on the project site per the National Cooperative Soil Survey (**Appendix A**). The soil types present are classified as hydrologic soil groups A and C under the Natural Resources Conservation Service's (NRCS) hydrologic soil group system (HSG).[2] The majority of the project site is underlain by HGS C soils: Capay clay (CaA), Rincon clay loam (RbA),

---

[1] Unless otherwise noted, all elevations reference the North American Vertical Datum of 1988 (NAVD 88).

[2] The NRCS hydrologic soil groups (HSGs) divide all soil types into four categories based on the potential to produce runoff. Type A soils have the lowest runoff potential and typically have high infiltration rates. Type D soils have the highest runoff potential and typically have low infiltration rates and/or are shallow.

Altamont clay (AbE), and Altamont- Fontana complex (AcF). There is a small section of HSG A soils located in the southwest corner of the southern section of the site consisting of Briones loamy sand (BdE), but this area comprises only 1.5% of the project property and will not be developed. The areas mapped for the primary stormwater basins are in soil class C; Capay clay for the southern basin and Rincon clay loam for the northern basin.

Pre-project drainage patterns at the site are illustrated in the attached Exhibit 1. The majority of the project area currently drains via sheet flow and shallow swale flow directly to Sand Creek. There are two exceptions found in areas north of the creek. The first of these is a man-made ditch along the north central boundary of the project area that was constructed concurrently with the existing development to the north. This ditch currently conveys runoff from approximately 17.1 acres to the storm drain system located to the north of the project. The second drainage pathway exception is an area along the north portion of the site that drains via sheet flow easterly to Deer Valley Road where it is intercepted by a ditch along the western edge of the roadway and conveyed into 36-inch storm drain line that was constructed as part of the Kaiser medical complex. Runoff from this area (roughly 87.6 acres) is thus conveyed easterly along Wellness Way, to join an existing major trunk storm drain (double 84-inch pipes) that runs south to discharge into the Upper Sand Creek Detention Basin.

Post-project drainage patterns are illustrated in Exhibit 2. Overall drainage patterns will be maintained, with those areas currently draining directly to Sand Creek continuing to do so via the primary project integrated management practices (IMPs) consisting of large stormwater basins on the north and south sides of the creek (IMPs 4 and 5). The development of the northern low-density residential area will remove the existing ditch along the northern side of the property and redirect that runoff into the main northern project storm drain system, ultimately flowing to IMP 4. Three drainage management areas (DMAs 1 to 3) comprising a total of 28.9 acres will continue to drain to the 36-inch line at Deer Valley Road and Wellness Way. Runoff from the future Village Center and fire station sites will ultimately be routed to future IMPs that will be connected to the existing 24-inch storm drain that runs easterly under Sand Creek Road from Deer Valley Road. The latter areas will be developed as separate projects and are considered self-treating areas for the purposes of this Stormwater Control Plan.

An off-site area of approximately 2.8 acres comprising the existing southern end of Dallas Ranch Road currently drains onto the project property and will continue to do so in the post-project drainage configuration.

II.C. Opportunities and Constraints for Stormwater Control

The project presents several important constraints with respect to stormwater management, including the following:

- *Low soil permeability.* The soils underlying the project site are almost exclusively designated as HSG C, indicating very low infiltration potential. This significantly limits those IMPs that rely on direct infiltration of stormwater runoff as a water-quality control measure.
- *Off-site northern watershed.* A 2.8-acre section of land to the north of the site along Dallas Ranch Road is not within the Project boundary but drains to the site. The Project will need to provide stormwater management for this additional off-site watershed area.

- *Existing stormwater drainage ditch*. The drainage ditch along the north side of the Project currently conveys runoff from approximately 17.1 acres of the project property to the off-site storm drain system north. The existing ditch will be removed, and the associated runoff collected and routed as part of DMA 4.
- *No exiting creek outfalls*. The outfall from the primary stormwater basins (IMPs 4 and 5) will each require a new outfall into Sand Creek, with an associated limited amount of hardened surfaces to be added to the creek.
- *Wetland areas*. Some areas of seasonal wetlands have been identified in the area south of Sand Creek. This requires configuring project and associated stormwater management infrastructure to avoid wetland impacts to the maximum extent practicable.

These constraints are offset by a several notable opportunities that include:

- *Preservation of Sand Creek*. The Projects presents an opportunity to preserve and enhance a section of Sand Creek. Preservation of approximately 35 acres along the creek, including the creek corridor and upper banks, is integral to the project design.
- *Parks and open space*. The roughly 229 acres of open space and 20 acres of parks throughout the Project will provide wildlife habitat areas and a wildlife corridor, while significantly limiting the total amount of new impervious cover that will be constructed.
- *Sufficient hydraulic head*. The relief at the site allows stormwater runoff from the developed areas to be routed to, through, and away from treatment controls without pumping.
- *Space for IMPs*. The land plan includes sufficient areas to accommodate IMPs of sufficient size to fully manage stormwater runoff for water-quality treatment and detention/hydromodification control purposes, while still preserving an appropriate set-back distance from the creek top of bank.

III. LOW IMPACT DEVELOPMENT DESIGN STRATEGIES

III.A. Optimization of Site Layout

III.A.1. Limitation of development envelope

As discussed previously, the project land plan will use a compact site design within the developed areas, freeing up substantial areas that will be preserved in the form of parks, trails, creek corridor, and open space. In fact, roughly 35 percent of the total property area will not be developed in any significant way.

III.A.2. Preservation of natural drainage features

No natural drainage features will be impacted by the project. The only significant such feature is Sand Creek itself, for which the entire corridor will be preserved.

III.A.3. Setbacks from creeks, wetlands, and riparian habitats

As per above, the banks of Sand Creek along the project property and the adjoining upland areas will remain undeveloped as part of the recognized 125-foot setback from the creek centerline. A 50-foot setback from the identified wetland areas has been provided where appropriate.

III.A.4. Minimization of imperviousness

Imperviousness is limited primarily through the clustering of development to reduce the overall developed area footprint and preservation of extensive open space areas.

III.A.5. Use of drainage as a design element

All IMPs will be located at the lower elevations of the project site to facilitate gravity flow and will be designed as aesthetic features for the neighboring development, with the facilities designed to integrate into the surrounding open space using curvilinear forms and appropriate landscaping.

III.B. Use of Permeable Pavements

The project does not propose the use of permeable pavers given the very low infiltration capacity of the underlying soils.

III.C. Dispersal of Runoff to Pervious Areas

The limited infiltration capacity of the soils at the site precludes any significant use of runoff dispersal as a stormwater management approach.

III.D. Bioretention or other Integrated Management Practices

To meet the requirements of the pertinent stormwater regulations, the project will construct integrated management practices (IMPs) that provide for full bioretention treatment of all on-site runoff. To meet this objective, the project is divided into five main drainage management areas (DMAs) as shown in Exhibit 2. Within each DMA, a gravity-flow storm drain system will collect stormwater and convey it to an IMP feature specifically sized for the pertinent amount of impervious and pervious cover. In all cases, the IMPs utilize the "cistern + bioretention" sizing criteria taken directly from the Stormwater C.3 Guidebook (7th Edition). The term "cistern" in this case should be recognized as signifying a separate storage volume, in the form of a traditional open basin, which is used to meter flow out to a separate bioretention area in a controlled manner.

The location of the project site in the middle reaches of the Sand Creek watershed also calls for strict compliance with the hydrograph modification plan (HMP) requirements established in Contra Costa County. Full HMP compliance is achieved across the board by sizing the IMPs per calculations using the Clean Water Program's IMP Calculator (see Section IV) for treatment + flow control.

As discussed in Section II, the Project will also provide remedial water-quality treatment for approximately 2.8 acres along Dallas Ranch Road to the north of the site. Runoff from this area will be collected and conveyed as part of DMA 4. All IMPs are designed with full capacity to achieve the traditional C.3 functions for water-quality remediation (through bioretention treatment) and hydromodification management. With the planned addition of debris screens on the IMP outlets, the proposed facilities will provide full compliance with the currently-effective trash TMDL requirements.

Despite the recent completion of the Upper Sand Creek Detention Basin just downstream of the site, the project will configure all IMPs to provide mitigation for any potential increase in peak flow rates from storms larger than the 10-year event (smaller storms are mitigated by the flow control sizing included in the hydromodification control design). This functionality is provided for Contra Costa County Flood Control design storms up to the 100-year event by proper allowances for high-stage storage and appropriate sizing of the high-flow release structures in each facility. The associated modeling and results are discussed in Appendix B.

IV. DOCUMENTATION OF DRAINAGE DESIGN

IV.A. Descriptions of each Drainage Management Area

IV.A.1. Tables of Drainage Management Areas

Table 3. Summary of Northeastern DMA 1 and DMA 2

		Area			Impervious		Pervious
Name	**Surface Type**	*sq-ft*	*acres*	*sq-mi*	*%*	*sq-ft*	*sq-ft*
O1	Total O1	624,611	14.9	0.022	47	295,601	329,010
	Low Density Residential	506,169	13.0	0.018	35	177,159	329,010
	Major Roads	118,442	1.9	0.004	100	118,442	0
O2	Total O2	493,065	11.3	0.018	63	310,094	182,971
	Med Density Residential	389,301	10.3	0.014	53	206,330	182,971
	Major Roads	103,764	1.0	0.004	100	103,764	0
Storm	Stormwater Facilities	104,326	2.4	0.004	100	104,326	0
TOTAL	**DMA 1 & DMA 2**	**1,222,002**	**28.6**	**0.04**	**58**	**710,021**	**511,981**

Table 4. Summary of Northeastern DMA 3

		Area			Impervious		Pervious
Name	**Surface Type**	*sq-ft*	*acres*	*sq-mi*	*%*	*sq-ft*	*sq-ft*
O3	Total O3	25,037	0.6	0.001	83	20,730	4,308
	SW & LS	8,615	0.2	0.000	50	4,308	4,308
	Road	16,422	0.4	0.001	100	16,422	0
Storm	Stormwater Facilities	10,534	0.2	0.000	100	10,534	0
TOTAL	**DMA 3**	**35,571**	**0.8**	**0.001**	**88**	**31,263**	**4,308**

Table 4. Summary of Northern DMA 4

Name	Surface Type	Area sq-ft	Area acres	Area sq-mi	Impervious %	Impervious sq-ft	Pervious sq-ft
N1	Total N1	5,462,424	125.40	0.196	35.9	1,961,289	3,501,135
	Low Density Residential	4,064,148	93.30	0.146	35	1,422,452	2,641,696
	Parks/Landscape	248,292	5.70	0.009	10	24,829	223,463
	Open Space	635,976	14.60	0.023	0	0	635,976
	Major Road	514,008	11.80	0.018	100	514,008	0
N2	Total N2	1,964,556	45.10	0.070	65.1	1,279,836	684,720
	Med Density Residential	1,206,612	27.70	0.043	53	639,504	567,108
	Parks/Landscape	130,680	3.00	0.005	10	13,068	117,612
	Major Road	627,264	14.40	0.023	100	627,264	0
N3	Total N3	544,500	12.50	0.020	6.4	34,848	509,652
	Parks/Landscape	348,480	8.00	0.013	10	34,848	313,632
	Open Space	196,020	4.50	0.007	0	0	196,020
N4	Dallas Ranch Road	121,968	2.80	0.004	40	48,787	73,181
N5	Open Space	135,036	3.10	0.005	0	0	135,036
Storm	Stormwater Facilities	555,473	12.75	0	100	555,473	0
TOTAL	**DMA 4**	**8,783,957**	**201.65**	**0.315**	**44**	**3,880,233**	**4,903,723**

Table 5. Summary of Southern DMA 5

Name	Surface Type	Area sq-ft	Area acres	Area sq-mi	Impervious %	Impervious sq-ft	Pervious sq-ft
S1	Total S1	5,645,376	129.60	0.203	48	2,703,551	2,941,825
	Low Density Residential	1,485,396	34.10	0.053	35	519,889	965,507
	Parks/Landscape	252,648	5.80	0.009	10	25,265	227,383
	Open Space	213,444	4.90	0.008	0	0	213,444
	Major Road	426,888	9.80	0.015	100	426,888	0
	Active Adult (medium density)	3,267,000	75.00	0.117	53	1,731,510	1,535,490
S2	Open Space	3,606,768	82.80	0.129	0	0	3,606,768
S3	Open Space	1,620,432	37.20	0.058	0	0	1,620,432
S4	Open Space (Future Development)	1,546,380	35.50	0.055	0	0	1,546,380
Storm	Stormwater Facilities	406,654	9.34	0.015	100	406,654	0
TOTAL	**DMA 5**	**12,825,610**	**294.44**	**0.460**	**24**	**3,110,206**	**9,715,405**

IV.A.2. Drainage Management Area Descriptions

A description of the DMAs and the drainage paths in provided below, while Exhibit 2 provides a map of the DMAs, without the impervious and pervious area separations.

DMA 1, totaling 624,611 square feet, encompasses the area designated O1, and includes the low-density residential areas at the very northeastern corner of the project. Total impervious cover within this DMA (excluding the IMPs) is 47 percent.[3] DMA 1 drains to the combined IMP 1-2 proposed for an area immediately west of Deer Valley Road. Note that this area is labelled "O1" on Exhibit 2 and includes minor subsequent revisions to the land use areas.

DMA 2, totaling 493,065 square feet**,** including the medium-density residential areas to the south of DMA 1. Total impervious cover within this DMA is 63 percent. DMA 2 drains to the combined IMP 1-2 proposed for an area immediately west of Deer Valley Road. Note that this area is labelled "O2" on Exhibit 2.

DMA 3, totaling 25,037 square feet, includes a portion of roadway that cannot be connected to other IMPs due to elevation constraints. Total impervious cover within this DMA is 83 percent. DMA 3 drains to the IMP 3 proposed for an area immediately west of Deer Valley Road. Note that this area is labelled "O3" on Exhibit 2.

DMA 4, totaling 8,783,957 square feet, encompasses the areas designated N1, N2, N3, N4, and N5 on Exhibit 2. Development within these areas includes both low- and medium-density residential areas as well as parks, open space, and the aforementioned portion of the existing Dallas Ranch Road that drains into the project. Total impervious cover within this DMA is 40 percent, excluding the area of the associated IMP. DMA 4 drains to the IMP 4, a large multi-function stormwater basin that will be constructed north of Sand Creek.

DMA 5, totaling 12,825,610 square feet, encompasses the areas designated S1, S2, S3, and S4 on Exhibit 2. Development within these areas includes low-density residential and active adult areas as well as parks and open space. Total impervious cover within this DMA is 22 percent, excluding the area of the associated IMP. DMA 5 drains to the IMP 5, a large multi-function stormwater basin that will be constructed south of Sand Creek. It is important to note that essentially all of the areas called out as S3 and S4 open space lie outside of the property boundary but drain towards the project and will be collected by the project storm drain system.

The project also includes several areas that are not given DMA designations per se. These include all areas within the protected Sand Creek corridor as well as the Village Center and future fire station locations (the latter two appear with designations "O3" and "O4" on Exhibit 2). These areas are considered self-treating either because there will no development (Sand Creek corridor) or because they will be developed separately and will provide yet-to-be-designed stormwater control measures.

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[3] Percent impervious based on development taken from CCCFCD Standard Runoff Coefficients for the Rational Method. Low Density Residential is R-20 zoning, and Med-Low Density Residential is R-50 zoning.

IV.B. Integrated Management Practice Descriptions

IV.B.1. *Areas Draining to Non-LID Treatment*

There are no areas draining to non-LID treatment.

IV.C. Tabulation and Sizing Calculations

Sizing calculations using the C.3 IMP Calculator are included as an attachment to this plan. Several of the IMPs, particularly IMP 4 and 5 were, previously preliminarily designed for larger overall contributing drainage areas. The IMP calculator results therefore show these features to be significantly over-sized per the facility footprints shown on the exhibits. Where appropriate the facility sizes will be optimized during final design, naturally with continued compliance with all pertinent water quality, hydromodification, and peak flow requirements.

IMP 1-2 is a double-bay cistern + bioretention stormwater facility that is proposed for the northeast corner of the overall project. It will accommodate runoff from DMAs 1 and 2. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 122,173 cubic feet. This compares to a preliminary proposed volume of 122,885 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 7,631 square feet, while the preliminary proposed floor area is 9,402 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 1-2 will be connected to the existing 36-inch trunk storm drain that runs east from Deer Valley Road along the alignment of Wellness Way.

IMP 3 is a double-bay cistern + bioretention stormwater facility that is proposed adjacent to Deer Valley Road and south of IMP 1-2. It will accommodate runoff from DMA 3. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 4,228 cubic feet. This compares to a preliminary proposed volume of 4,251 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 264 square feet, while the preliminary proposed floor area is 310 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 3 will also be connected to the existing 36-inch trunk storm drain that runs east from Deer Valley Road along the alignment of Wellness Way.

IMP 4 is a double-bay cistern + bioretention stormwater facility that is proposed along the southern property boundary north of Sand Creek. It will accommodate runoff from DMA 4. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 799,416 cubic feet. This compares to a preliminary proposed volume of 805,491 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 49,929 square feet, while the preliminary proposed floor area is 72,719 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 4 will drain via a new outfall to Sand Creek.

IMP 5 is a double-bay cistern + bioretention stormwater facility that is proposed adjacent to the Sand Creek corridor directly south of the creek. It will accommodate runoff from DMA 4. Per the IMP Calculator the minimum required storage volume for the detention bay ("cistern") is 1,009,280 cubic feet. This compares to a preliminary proposed volume of 1,013,579 cubic feet. The IMP Calculator indicates that the minimum floor area for the bioretention bay is 63,037 square feet, while the preliminary proposed floor area is 65,310 square feet. The facility will include an orifice to restrict outflow from the detention bay to the bioretention bay such that flow control is achieved for hydromodification management in addition to full water-quality treatment via bioretention and full trash capture as well. IMP 5 will drain via a new outfall to Sand Creek on the south bank of the creek.

V. SOURCE CONTROL MEASURES

V.A. Site activities and potential sources of pollutants

Control of pollutant sources limits the release of pollutants into the stormwater system and serves an important early role in reducing urban pollutants. The Project has the following potential sources of stormwater pollutants:

- Dumping of wash water or other pollutants into storm drain inlets;
- Pesticides used for indoor or structural pest control;
- Fertilizer, pesticide and herbicides use for maintenance of parks, and residential yards and gardens;
- Nutrient loading from household pets;
- Vehicle washing;
- Other vehicle related pollutants such as heavy metals, oil and grease; and
- Plazas, sidewalks and parking lots.

V.B. Source Control Table

Table 6. Source Controls (see next page)

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*
On-site dumping into storm drain inlets	All accessible inlets will be marked with the words "No Dumping! Drains to Sand Creek" or similar wording.	Markings will be periodically repainted or replaced. Inlets and pipes conveying stormwater to all IMPs will be inspected and maintained as part of the Project Operations and Maintenance Plan. Provide stormwater pollution prevention information to new site homeowners.
Indoor and structural pest control		Provide Integrated Pest Management (IPM) information to owners, lessees, and operators.
Landscape / outdoor pesticide use	Preserve existing native trees, shrubs, and ground cover to the maximum extent possible. Minimize irrigation and runoff and promote infiltration where appropriate. Minimize the use of fertilizers and pesticides. Use pest-resistant plants, especially adjacent to hardscape, when possible. Use plantings appropriate to the site soils, slopes, climate, sun, wind land use, air movement, ecological consistency, and plant interactions.	
Vehicle washing		Stormwater pollution prevention information will be distributed to homeowners.
Roofing, gutters, and trim	Do not utilize roofing, gutter, or architectural trim materials made of copper or other unprotected metals that would leach into the storm water runoff.	
Private Drive and Sidewalks		Owners, lessees, and operators will be encouraged to sweep sidewalks regularly to prevent the accumulation of litter and debris. Debris from pressure washing shall be collected to prevent entry into the storm drain system. Wash water containing any cleaning agent or degreaser shall be collected and discharged to the sanitary sewer and not discharged to a storm drain.
Fire Sprinkler Test Water	Provide means to drain fire sprinkler test water to sanitary sewer system.	See note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com
Air Conditioning	Air conditioner condensation shall be directed to landscaped areas or plumbed to the sanitary sewer.	
Plazas, sidewalks, and parking lots		Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect wash water containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm draining to prevent entry into the storm drain system.

V.C. Features, Materials, and Methods of Construction of Source Control BMPs

Regular monitoring and maintenance are integral to the successful implementation of this Stormwater Control Plan. This includes programmed and documented inspection of all facilities described herein and the prompt remedy of any defects identified.

VI. STORMWATER FACILITY MAINTENANCE

VI.A. Ownership and Responsibility for Maintenance in Perpetuity

The stormwater management facilities identified in this SCP will be owned and managed by the future homeowners' association (HOA).

The HOA will provide a comprehensive Stormwater Control Operations and Maintenance Plan (OMP) to the City and County for review and approval prior to the issuance of any building permits. This will also be contingent on the recording of the pertinent Operations and Maintenance Agreements and rights-of-way necessary to clarify the responsibilities and procedures to be followed over the both the near- and long-term.

VI.B. Summary of Maintenance Requirements for Each Stormwater Facility

A full enumeration of O&M requirements will be provided in the OMP discussed above, which will include specific checklists covering all monitoring and maintenance activities associated with the ongoing functionality of the IMPs for both treatment and flow control.

- Proper maintenance of bioretention facilities will include such actions as:
- Regular inspection of the physical features in each basin including inlet and outlet structures, trash racks, side slopes, and access ramps.
- Monitoring of water drawdown rates to verify proper infiltration through the bioretention medium.
- Remedial maintenance including replacement/leveling of mulch, reconditioning/replacement of the biofiltration medium, and clean-out of underdrain piping.
- Regular inspection of maintenance of vegetation, including pruning, replanting as needed, and control of non-desired species.

VII. CONSTRUCTION PLAN C.3 CHECKLIST

As of the date of this report, only preliminary permitting plans have been generated for this project.

VIII. CERTIFICATIONS

The selection, sizing, and preliminary design of stormwater treatment and other control measures in this plan meet the requirements of Regional Water Quality Control Board Order R2-2015-0049.

August 23, 2019

By

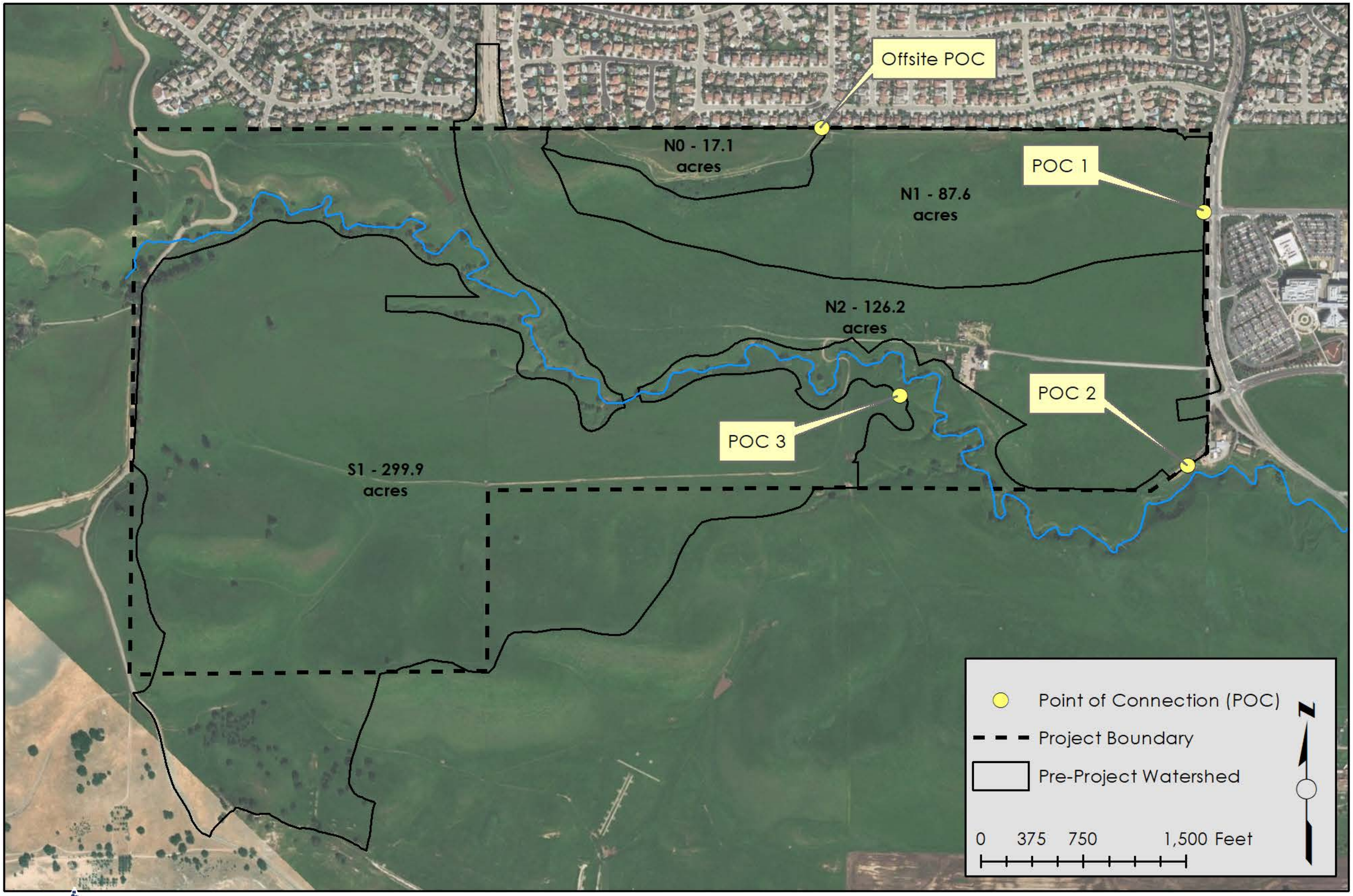
Edward D. Ballman, P.E.

RCE #64095

ATTACHMENTS

ATTACHMENT 1

Stormwater Control Plan Exhibits



Balance Hydrologics, Inc.

Exhibit 1. Pre-Project Hydrology Sheds, The Ranch, City of Antioch, Contra Costa County, California

AREA SUMMARY		
SUB AREA	AREA (ACRES)	LAND USE
N1	125.4	LDR, PARKS/LS, OPEN SPACE, MAJOR ROADWAY
N2	45.1	MDR, PARKS/LS, MAJOR ROADWAY
N3	12.5	PARKS/LS, OPEN SPACE
N4	2.8	EXISTING ROADWAY
N5	3.1	OPEN SPACE
TOTAL	188.9	
S1	129.6	LDR, AA, PARKS/LS, OPEN SPACE, MAJOR ROADWAY
S2	82.8	OPEN SPACE
S3	37.2	OPEN SPACE
S4	35.5	OPEN SPACE
TOTAL	285.1	
O1	14.9	LDR, MAJOR ROADWAY
O2	11.3	MDR, MAJOR ROADWAY
O3	0.6	ROADWAY
O4	5.0	VILLAGE CENTER
O5	2.0	FIRE STATION
TOTAL	33.8	

EXHIBIT 2
HYDROLOGY
SHED BOUNDARY EXHIBIT
COWAN PROPERTY

CITY OF ANTIOCH   CONTRA COSTA COUNTY   CALIFORNIA

0' 300' 900' 1,200'

SCALE: 1" = 300'   DATE: SEPTEMBER 5, 2019

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ATTACHMENT 2

IMP Sizing Calculator Output

IMP Name: IMP 1-2 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
DMA 1-2_Imp	657,240	Concrete or Asphalt	1	657,240
DMA 1-2_Perv	578,956	Landscape	0.5	289,478
			Total	946,718

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	7,552	9,402
Volume	0.105	1.216	120,910	122,885

Maximum Underdrain Flow (cfs)	1.08
Orifice Diameter (in)	4.68

IMP Name: IMP 3 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
DMA 3_Imp	30,954	Concrete or Asphalt	1	30,954
DMA 3_Perv	4,308	Landscape	0.5	2,154
			Total	33,108

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	264	310
Volume	0.105	1.216	4,228	4,251

Maximum Underdrain Flow (cfs)	0.03
Orifice Diameter (in)	0.94

IMP Name: IMP 4 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
North_Imp	3,807,514	Concrete or Asphalt	1	3,807,514
North_Perv	4,903,723	Landscape	0.5	2,451,862
			Total	6,259,376

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	49,929	72,719
Volume	0.105	1.216	799,416	805,491

Maximum Underdrain Flow (cfs)	7.59
Orifice Diameter (in)	10.45

IMP Name: IMP 5 (Soil Type: C)
IMP Type: Cistern + Bioretention Facility
Soil Type: C

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
South_Imp	3,044,896	Concrete or Asphalt	1	3,044,896
South_Perv	9,715,405	Landscape	0.5	4,857,703
			Total	7,902,599

IMP Sizing

	IMP Sizing Factor	Rain Adjust-ment Factor	Minimum Area or Volume	Proposed Area or Volume
Area	0.013	0.614	63,037	65,310
Volume	0.105	1.216	1,009,280	1,013,579

Maximum Underdrain Flow (cfs)	11.12
Orifice Diameter (in)	12.65

APPENDICES

APPENDIX A

Soil Report

United States Department of Agriculture

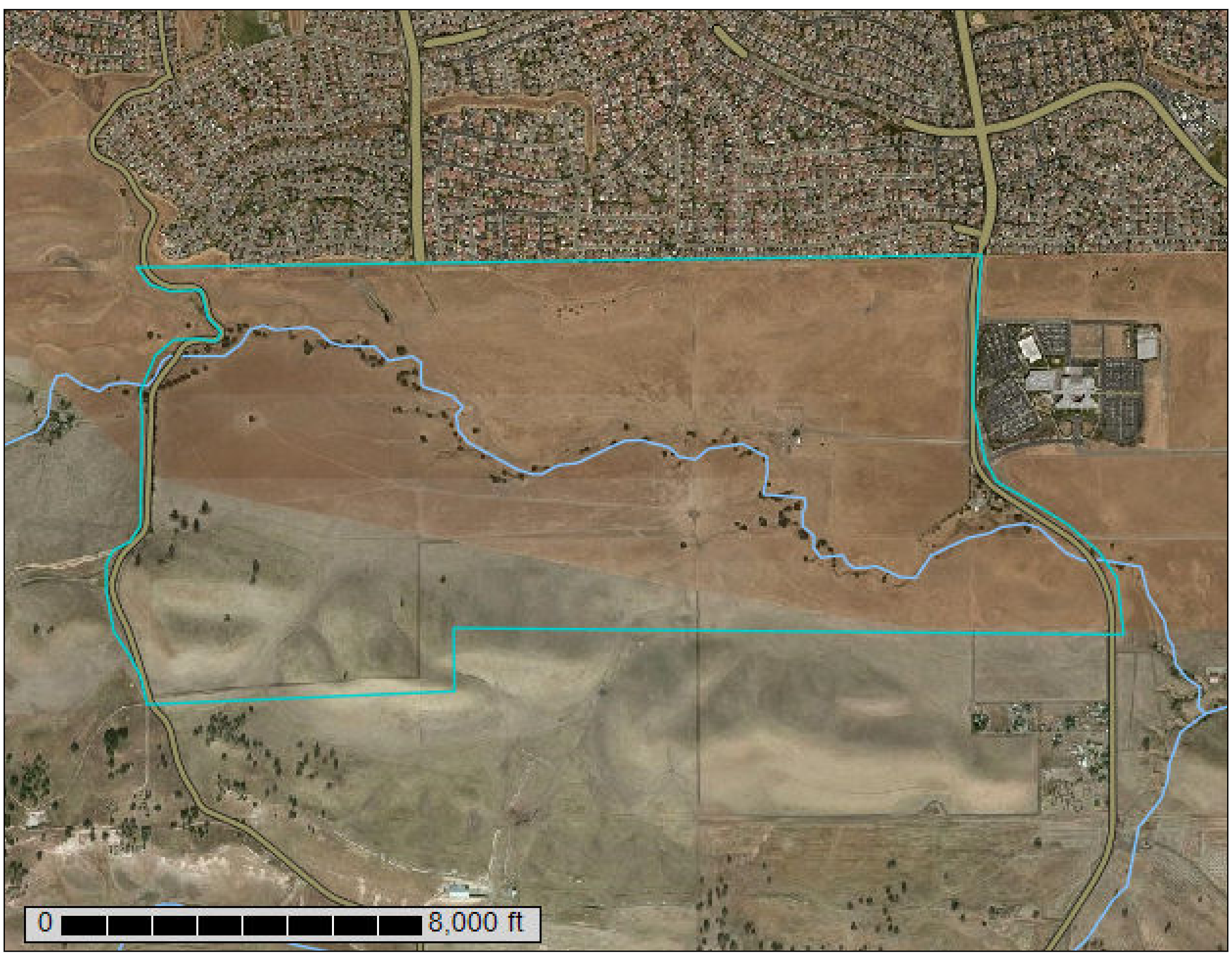
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Contra Costa County, California



May 19, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:16,200 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Contra Costa County, California
Survey Area Data: Version 13, Sep 21, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 12, 2010—Jun 3, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Contra Costa County, California (CA013)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
AbD	Altamont clay, 9 to 15 percent slopes, MLRA 15	101.5	14.2%
AbE	Altamont clay, 15 to 30 percent slopes, MLRA 15	119.5	16.7%
AcF	Altamont-Fontana complex, 30 to 50 percent slopes	44.7	6.2%
BdE	Briones loamy sand, 5 to 30 percent slopes	8.9	1.2%
CaA	Capay clay, 0 to 2 percent slopes	245.7	34.3%
Cc	Clear Lake clay, 0 to 15 percent slopes, MLRA 15	0.1	0.0%
RbA	Rincon clay loam, 0 to 2 percent slopes, MLRA 14	196.0	27.4%
Totals for Area of Interest		**716.4**	**100.0%**

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

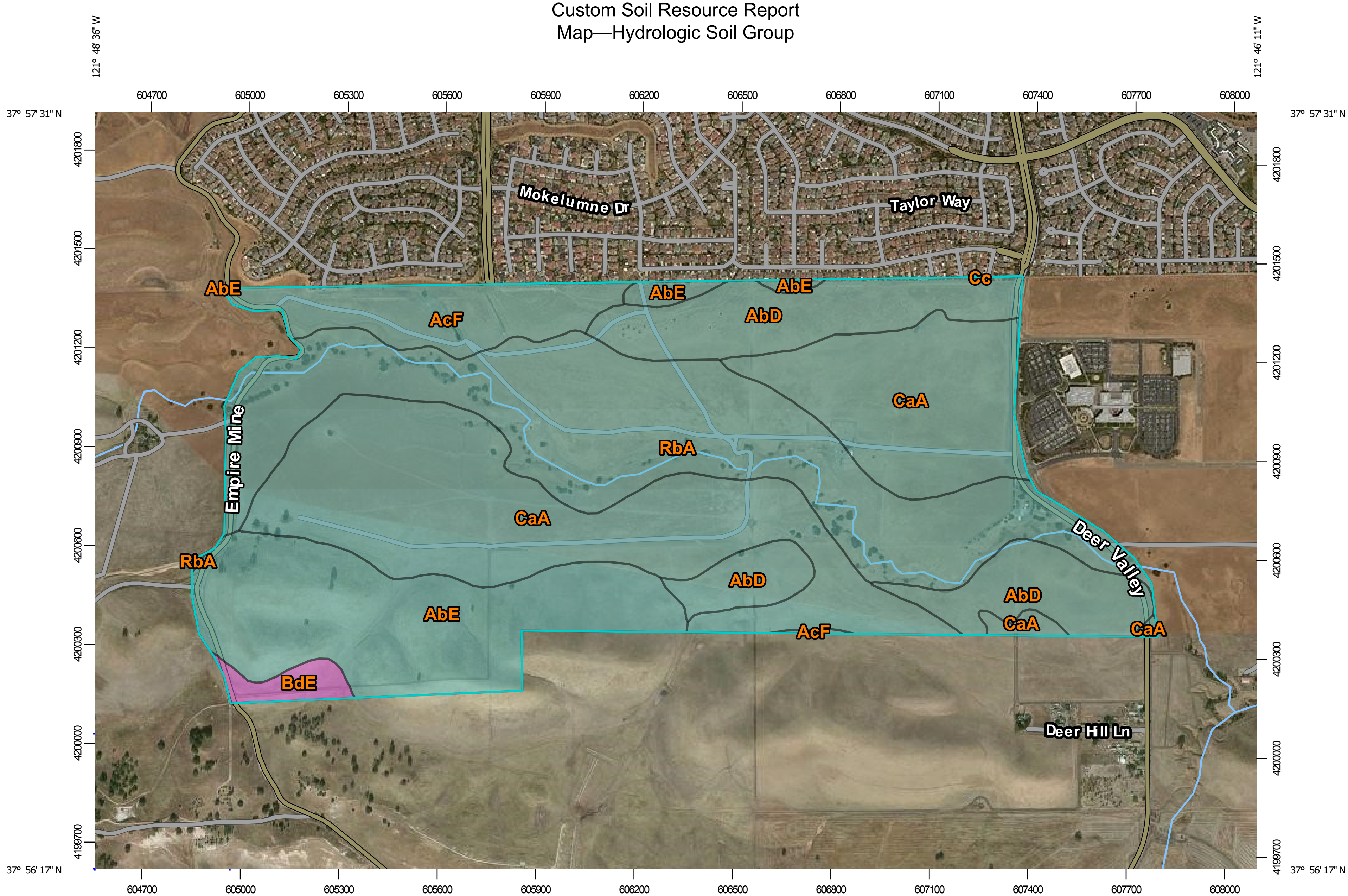
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Map—Hydrologic Soil Group



Map Scale: 1:16,200 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Contra Costa County, California
Survey Area Data: Version 13, Sep 21, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 12, 2010—Jun 3, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Contra Costa County, California (CA013)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AbD	Altamont clay, 9 to 15 percent slopes, MLRA 15	C	101.5	14.2%
AbE	Altamont clay, 15 to 30 percent slopes, MLRA 15	C	119.5	16.7%
AcF	Altamont-Fontana complex, 30 to 50 percent slopes	C	44.7	6.2%
BdE	Briones loamy sand, 5 to 30 percent slopes	A	8.9	1.2%
CaA	Capay clay, 0 to 2 percent slopes	C	245.7	34.3%
Cc	Clear Lake clay, 0 to 15 percent slopes, MLRA 15	C	0.1	0.0%
RbA	Rincon clay loam, 0 to 2 percent slopes, MLRA 14	C	196.0	27.4%
Totals for Area of Interest			**716.4**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Aggregation is the process by which a set of component attribute values is reduced to a single value that represents the map unit as a whole.

A map unit is typically composed of one or more "components". A component is either some type of soil or some nonsoil entity, e.g., rock outcrop. For the attribute being aggregated, the first step of the aggregation process is to derive one attribute value for each of a map unit's components. From this set of component attributes, the next step of the aggregation process derives a single value that represents the map unit as a whole. Once a single value for each map unit is derived, a thematic map for soil map units can be rendered. Aggregation must be done because, on any soil map, map units are delineated but components are not.

For each of a map unit's components, a corresponding percent composition is recorded. A percent composition of 60 indicates that the corresponding component typically makes up approximately 60% of the map unit. Percent composition is a critical factor in some, but not all, aggregation methods.

The aggregation method "Dominant Condition" first groups like attribute values for the components in a map unit. For each group, percent composition is set to the sum of the percent composition of all components participating in that group. These groups now represent "conditions" rather than components. The attribute value associated with the group with the highest cumulative percent composition is returned. If more than one group shares the highest cumulative percent composition, the corresponding "tie-break" rule determines which value should be returned. The "tie-break" rule indicates whether the lower or higher group value should be returned in the case of a percent composition tie. The result returned by this aggregation method represents the dominant condition throughout the map unit only when no tie has occurred.

Component Percent Cutoff: None Specified

Components whose percent composition is below the cutoff value will not be considered. If no cutoff value is specified, all components in the database will be considered. The data for some contrasting soils of minor extent may not be in the database, and therefore are not considered.

Tie-break Rule: Higher

The tie-break rule indicates which value should be selected from a set of multiple candidate values, or which value should be selected in the event of a percent composition tie.

APPENDIX B

Peak Flow Management (Flood Control)

Regional Flood Control Perspective

Historically, the land use in the Marsh Creek and Sand Creek watershed has been predominantly orchards, cattle ranching and dryland farming. The rapid urbanization of the surrounding cities has generated a need to manage the flood risk for locations in east Contra Costa County.

The Contra Costa Flood Control and Water Conservation District (FCD) developed the Marsh Creek Watershed Plan in 1992, to address and mitigate the flood risks. Part of the Marsh Creek Watershed Plan included the construction of Upper and Lower Sand Creek Basins, expansion of Deer Creek Detention Basin, and expansion of the Marsh Creek Reservoir.

The project site lays with in the FCD's defined Drainage Area 104, which includes the upper portions of the Sand Creek watershed. Sand Creek is the largest tributary in the lower Marsh Creek watershed, as it contributes approximately 15 square miles of drainage to Marsh Creek at the confluence in the City of Brentwood. Two flood control basins were built along the Sand Creek watershed to mitigate for urbanization and reduce flood risks in the downstream Marsh Creek urbanized areas. The Upper and Lower Sand Creek Basins, with the Upper Sand Creek Basin being completed in 2014.

The Upper Sand Creek Basin is located approximately 1.3 miles downstream of the Project. Horse Creek watershed joins upstream of the Upper Sand Creek Basin but downstream of the Project.

The objectives within the flood control element of The Ranch project are to mitigate flow increases to the Upper Sand Creek Basin and avoid adverse impacts to peak flow levels at points of discharge from the project. To ensure that flows into Upper Sand Creek Basin are not impacted, the project will include on-site stormwater facilities (IMPs) that will have capacities and outlet works to assure that post-development flows are less than or equal to the pre-development flows, for FCD design storm events ranging from the 10- to the 100-year storm. The peak flows in Sand Creek were also modeled to assess the water surface elevations to inform the design of stormwater outfalls and bridges that are proposed over the course of full build-out.

Sand Creek Peak Flows

The presence of Upper Sand Creek Basin will provide significant flood control for the areas downstream of that facility. However, it is fully-appropriate for the project to control peak flow rates to avoid adverse impacts in the reach of the creek down to the Upper Sand Creek Basin. To aid in identifying appropriate elevations for infrastructure along the creek and to characterize flood risk, a hydraulic model was completed. Peak flows in Sand Creek were estimated from review of historical documentation on the watershed and Upper Sand Creek Basin[1,2].

From the Hydrology and Hydraulic report for the Sand Creek watershed, the flows to the Upper Sand Creek Basin include a drainage area of 11.0 square miles and produce a peak flow of 2,818 cfs for the 100-year, 12-hour storm. Although the project site is located over 3,400 feet upstream of the Upper Sand Creek Basin, the full peak flow values for the USCB were used to represent a conservative modeling approach. The 10-year and 2-year flows were provided by Contra Costa Flood Control as the results in the Hydrology and Hydraulics, Sand Creek Watershed Report. The watershed identified as "Area A thru C" was used to represent the flows at the Project. From the modeling results provided, the 10-year, 12-hour flow is estimated to be 1,430 cfs, and the 2-year, 3-hour flows is estimated as 360 cfs.

Water surface elevations were calculated for the reach encompassing the proposed discharge locations for each of the stormwater basins. The peak flows described above were applied to the channel cross sections to estimate the associated water surface elevation. To calculate the water surface elevations the Army Corps of Engineers' HEC-RAS modeling platform was utilized. The modeling inputs and methodology used in the simulation of peak flows in Sand Creek are further described in the memorandum prepared by Balance Hydrologics and attached herein as Appendix C.

The results from the Sand Creek peak hydraulic modeling analysis indicate that the flows in Sand Creek will be well contained within the banks of the highly-incised stream corridor. This also corroborates the currently-effective floodplain mapping prepared by the Federal Emergency Management Agency, which shows the 100-year flood event contained within the channel. The calculated water surface elevations were used to identify appropriate basin floor elevations for the adjacent stormwater basins. The results of the HEC-RAS modeling are presented in Table B-1 below.

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[1] GEI Consultants, 2010, Upper Sand Creek Detention Basin Design Report. Contra Costa County Flood Conservation District.

[2] Contra Costa County Flood Control, 2008, Hydrology and Hydraulics, Sand Creek Watershed, Study of Upper Sand Creek Basin, Lower Sand Creek Basin, and Sand Creek Hydraulics

Table B-1. Sand Creek Water Surface Elevation Modeling Results.

Storm Event	Flow	Parameter	Outfall Location IMP 5	Outfall Location IMP4
	(cfs)		*(ft)*	*(ft)*
100 year -12 hour	2,818	Calculated Water Depth (ft)	13.2	14.2
		Water Surface Elevation	230.0	225.2
10 year -12 hour	1,430	Calculated Water Depth	10.2	10.0
		Water Surface Elevation	227.0	221.0
2 year -3 hour	360	Calculated Water Depth	5.4	4.7
		Water Surface Elevation	222.2	215.7

Stormwater Peak Flow Attenuation Modeling

The peak flows from pre- and post-development conditions were evaluated to assess the appropriate detention volume to mitigate the increase in runoff that will occur from development of the area. Pre-project drainage areas were defined using the project topographic base and post-project drainage areas corresponded to the DMAs used in the analysis and sizing of the IMPs for water-quality and hydromodification compliance.

Modeling was completed using the U.S. Army Corps of Engineers' HEC-HMS software package parameterized per guidelines prepared by the FCD for the 10-year and 100-year storm design conditions.

Input Parameters and Assumptions

The input parameters used in the storm drain modeling are summarized below:

Project watersheds: Runoff from the project site will be routed to the four multi-purpose stormwater basins as shown in Exhibit 2. These basins will perform both detention and water quality functions and are used to meet the C.3 stormwater requirements for hydromodification. As described above each stormwater facility has two areas separated by an internal berm: a detention bay and a secondary bioretention bay.

Flood control design storms. All storm total and intensity information was based on a mean annual precipitation (MAP) of 14.3 inches per the isohyetal mapping provided by Flood Control. Based on the size of the site the design storms included 10-year and 100-year return period events with durations of 3-, 6-, 12-, and 24-hours. Total design rainfall ranges from 1.17 inches for the 10-year, 3-hour event up to 4.33 inches for the 100-year, 24-hour storm.

Hydrograph routing parameters. Information on the assumed infiltration rates and lag time calculations followed the guidance provided by Flood Control for lag time and S-curve for hydrograph development.

Peak Flow Modeling Results

The HEC-HMS model results are summarized in Table B-2. Important results and findings include the following:

Pre-project peak flow rates. Peak flow rates for the 10-year design storm range from 43.2 cfs at Point of Concentration (PoC) 1 at the existing 36-inch storm drain at Deer Valley Road and Wellness Way to 54.6 cfs for PoC 2 (future IMP4 outfall, N2 on Exhibit 1), and 164.7 cfs for PoC 3 (future IMP 5 outfall, S on Exhibit 1). While the 3-hour design storm produces the highest peaks for the 10-year event, the 24-hour event gives the highest pre-project peaks. These range from 80.1, to 102.3, and 296.5 cfs for the three PoCs.

Peak flow rates with detention. As shown in Table B-2, the various IMPs provide sufficient storage to mitigate post-development flows to well below the pre-development peak flow rates. Since overall runoff volume is so important for peak flow attenuation, the 24-hour design storms are the most conservative in all the post-project cases. For the PoC 1, the modeling showed a reduction in the peak flow rate for the 10-year, 24-hour storm from 41.4 cfs pre-project to 2.9 cfs post-project. The reductions are particularly pronounced for PoCs 2 and 3 where the reductions were from 52.3 to 6.8 cfs and from 158.0 to 10.7 cfs respectively. For the 100-year, 24-hour event flows were reduced from 80.1 to 6.8 for PoC 1, from 102.3 to 33.3 cfs for PoC 2, and from 296.5 to 68.7 cfs for PoC 3.

The large difference in flow rates is due to the fact that each of the IMPs were also sized to provide hydromodification control and the associated storage capacities and outflow restrictions are such that the single event storms are easily accommodated, even when flow through the bioretention media is discounted as per FCD modeling guidelines.

The model results show that the stormwater facilities presented in the preliminary design for the project will adequately address peak flow attenuation for the site.

Table B-2. HEC-HMS Stormwater Detention Modeling Results for The Ranch

	Design Storm	Peak Discharge at Outlet (cfs)	
		Pre-Project	Post-project (detained)
POC 1 (IMPs 1-2 and 3)	10-year 3-hour	43.2	0.9
	10-year 24-hour	41.4	2.9
	100-year 3-hour	72.3	2.6
	100-year 24-hour	80.1	6.8
POC 2 (IMP 4)	10-year 3-hour	54.6	4.4
	10-year 24-hour	52.3	6.8
	100-year 3-hour	92.6	5.6
	100-year 24-hour	102.3	33.3
POC 3 (IMP 5)	10-year 3-hour	164.7	9.8
	10-year 24-hour	158.0	10.7
	100-year 3-hour	270.4	41.6
	100-year 24-hour	296.5	68.7

APPENDIX C

Hydraulic Modeling Summary for Sand Creek

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PO Box 1077 • Truckee, CA 96160 • (530) 550-9776
www.balancehydro.com • email: office@balancehydro.com

April 26, 2019

Mr. Andrea Bellanca
Carlson, Barbee & Gibson, Inc.
2633 Camino Ramon, Suite 350
San Ramon, CA 94583

RE: Summary of Hydraulic Modeling along Sand Creek near Cowan Ranch, Antioch, California.

Dear Mr. Andrea Bellanca,

As requested, a hydraulic analysis of the reach of Sand Creek near Cowan Ranch has been completed. The intent of the analysis is to estimate the water surface elevations and channel velocities under the 100-year storm event at three locations for proposed bridge crossings and three locations for proposed stormwater basin outlets.

Modeling Approach and Assumptions

The section of Sand Creek that flows adjacent to the project site is located about 3,400 feet upstream of the Upper Sand Creek detention basin, which is owned and operated by Contra Costa County Flood Control (CCCFC). This 2.8-mile section of Sand Creek has been classified as Zone A by the Federal Emergency Management Agency (FEMA) and shows approximate inundation boundaries for the 100-year water surface elevation. FEMA has performed more detailed studies of Sand Creek from its confluence with Marsh Creek upstream to the Heidon Ranch Road crossing which is located over two miles downstream from the project site. Since no detailed study has been performed along the section of Sand Creek adjacent to the project site, a hydraulic model was prepared to analyze the 100-year water surface elevation and channel velocities. The Army Corps of Engineers' HEC-RAS modeling platform was used to analyze the reach. As with any hydraulic analysis, a number of assumptions were used. Several of the most important are summarized below:

Cross-section geometry. The topographic mapping of the creek section was provided by Carlson, Barbee & Gibson, Inc (CBG). The topographic data covered the project site and analyzed creek section. In total, the 2.8-mile section of Sand Creek includes 95 modeled cross sections with locations indicated on the model workmap as Figure 1.0 through Figure 1.4. All elevation information presented on the workmap and used in the model is referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29)[1].

Manning's roughness coefficients. The Manning's roughness coefficients (or 'n' values) were estimated based on observed vegetation cover and channel geometry from a site visit performed on March 15, 2019. High-water mark observations were documented at specific locations along Sand Creek for reference of the hydraulic model parameters. Based on field observations, all cross sections were assigned a uniform 'n' value of 0.045 and 0.04 for the overbank and channel areas, respectively. Representative photographs of the modeled reach are included as Figure 2.

Channel crossing. The existing channel crossings include a 12.5-foot diameter corrugated metal pipe (CMP), a 24-inch diameter steel gas pipeline that daylights about 15 feet above the channel bottom, and a 30-inch thick wooden vehicular bridge. The existing CMP culvert is located at the most downstream end of the modeled creek section and extends about 50 feet underneath Deer Valley Road with concrete wingwalls constructed at both the inlet and outlet. The bottom three feet of the culvert has been completely covered with sediment reducing the effective height of the pipe to 9.5 feet. The existing gas pipeline runs perpendicular to the channel flow at about 15 feet above the channel bottom. The pipeline crossing is supported by a steel support structure with two 7-inch diameter steel poles spaced about 7.5 feet apart. The existing vehicular bridge is constructed from wooden railroad ties that are stacked 30-inches thick from the bridge deck to the bottom chord. It was assumed that the existing wooden bridge will be removed during construction and was therefore not accounted for in the hydraulic model. Representative photographs of the channel crossings used in the hydraulic model are included as Figure 3.

Starting water surface elevation. The downstream boundary condition was defined using a normal depth calculation assuming a slope of 0.00435 based on an average downstream channel gradient.

Flood discharge estimate. The 100-year discharge rate for the modeled section of Sand Creek was determined from the Draft Sand Creek Watershed Hydrology and Hydraulics report prepared by the CCCFC in 2005. The draft report estimates a 100-year discharge rate of 2,818 cubic feet per second (cfs) for the reach of Sand Creek directly upstream of the Upper Sand Creek detention basin. Correspondence with CCCFC on April 4, 2019, confirmed that the 2,818 cfs discharge rate was used as the basis for the final design of the Upper Sand Creek basin. Since the analyzed creek section is located over 3,400 feet upstream of the Upper Sand Creek basin and does not include the 1,240-acre watershed of Horse Valley Creek, this 100-year discharge rate represents a conservative estimate for the modeled reach of Sand Creek. An excerpt of the Draft Sand Creek Watershed Hydrology and Hydraulics report is included as Appendix A.

[1] The reported elevation values are referenced in NGVD 29 for consistency with the existing topography data. To convert elevations to the North American Vertical Datum of 1988 (NAVD 88) at the project site, a correction value of 2.515 feet should be added to the NGVD 29 elevations. (NAVD 88 = NVGD 29 + 2.515').

Modeling Results

The output of the HEC-RAS modeling is included as Appendix B. A tabular summary of the calculated 100-year water surface elevation and channel velocities for the areas of interest is included as Table 1. The proposed bridges are represented by the cross sections located at river stations 2840, 5890, and 9354. These cross sections are placed directly upstream of the proposed bridge locations. The proposed stormwater basin outlets are represented by the cross sections located at river stations 2367, 4583, and 5828. A summary of the modeled water surface elevation and velocities for the areas of interest is included as Table 2.

The middle and upper sections of the modeled reach meander through areas of narrow ravines with near vertical walls reaching heights of more than 80 feet above the channel bed. These areas cause sudden changes in the channel geometry that restrict flow and result in abrupt increases in the channel velocities causing hydraulic jumps to form at distinct locations. These locations can be observed in the model profile view shown in Appendix B.

A sensitivity analysis was performed on the model to assess the variability in water surface elevations and channel velocities with varying Manning 'n' values. The analysis showed that increasing the 'n' values by 20% caused the average channel velocity to decrease by about 6.6% and the average water surface elevation to increase by about 4.0%. In contrast, decreasing the 'n' values by 20% resulted in the average channel velocity increasing by about 8.3% and the water surface elevation decreasing by about 4.2%.

Closing

We appreciate the opportunity to provide this hydraulic analysis for Sand Creek near Cowan Ranch. Do not hesitate to contact us if you have any questions or comments related to the items discussed here.

Sincerely,

BALANCE HYDROLOGICS, Inc.

Josh Alexander, E.I.T.
Engineer/Hydrologist

Teresa Garrison, P.E.
Senior Engineer

Enclosures: Table 1. Summary of HEC-RAS Output for Bridge and Stormwater Basin Outlet Locations, Sand Creek at Cowan Ranch
Figure 1.0 HEC-RAS Workmap Overview
Figure 1.1 HEC-RAS Workmap
Figure 1.2 HEC-RAS Workmap
Figure 1.3 HEC-RAS Workmap
Figure 1.4 HEC-RAS Workmap
Appendix A. Excerpt from the Draft Sand Creek Hydrology and Hydraulics Report
Appendix B. HEC-RAS Output Report