PRELIMINARY STORMWATER CONTROL PLAN

for

THE RANCH PROJECT

Subdivision 9249
City of Antioch, California

May 19, 2017

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I. EXECUTIVE SUMMARY

The Project is located on a 551.5-acre property in the City of Antioch, Contra Costa County, California, on the north and south banks of Sand Creek. Proposed is the construction of 311 acres of single-family low density homes, 53 acres of medium to low density singles family homes, a village center and fire station. APN number(s) for the property are 057-021-003, 057-010-003, & 057-010-002. The Project site is generally divided into two section the North and South, separated by Sand Creek. Each respective section will provide stormwater detention and treatment using separate multi-function stormwater facilities located at the lower (eastern) end of each respective watershed.

A special consideration with this site is that approximately 16.5 acres along the northern edge currently drain to a ditch system that appears to have been installed when properties to the north were developed. The ditch collects runoff and routes it to the storm drain infrastructure installed with the previous development. The existing ditch will be replaced as part of the Project and runoff from this area, as well as 2.8 acres of Dallas Ranch Road to the north will be collected, conveyed, and treated by the proposed North stormwater system.

To meet the requirements of the pertinent stormwater regulations, the Project will construct integrated management practices (IMPs) that provide for full bioretention treatment for all on-site runoff. In all cases, the IMPs utilize the "cistern + bioretention" sizing criteria taken directly from the latest version of the Stormwater C.3 Guidebook, where the term "cistern" signifies a separate storage volume in the form of a basin that meters flow out to a separate bioretention area in a controlled manner. The location of the Project also calls for strict compliance with the hydrograph modification management requirements established in Contra Costa County. Full compliance is demonstrated by sizing the IMPs per the Clean Water Program's IMP Calculator.

Additionally, the proposed stormwater basins will provide control of peak flow rates, up to and including the 100-year design event, per criteria established by the Contra Costa County Flood Control and Water Conservation District. The U.S. Army Corps of Engineers' HEC-HMS modeling platform was utilized to demonstrate that the proposed stormwater management infrastructure can mitigate for potential increases in peak flows during large design storm events.

The main body of this report explores the water quality calculations and implications as they apply to the proposed full build-out of the project, demonstrating that both the C.3 water-quality and hydromodification requirements are met. The report also addresses the peak flow control modeling and results to meet stormwater detention requirements, showing a reduction in peak flow rates to Sand Creek across a range of design storm events.

II. PROJECT DATA

Table 1. Project Data

Project Name/Number	The Ranch
Application Submittal Date	May 19, 2017
Project Location	West of Deer Valley Road, on both the North and South sides of Sand Creek
Name of Developer	Richland Communities
Project Phase No.	Full Build-out
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
Total Area of Land Disturbed (acres)	398.2
Total New Impervious Surface Area (sq. ft.)	8,418,774
Total Replaced Impervious Surface Area	0.0
Total Pre-Project Impervious Surface Area	8,790
Total Post-Project Impervious Surface Area	8,427,564 (excluding off-site areas)
50% Rule	Applies
Project Density	3.6 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
Hydrograph Modification Performance Compliance	Option 2

III. SETTING

III.A. Project Location and Description

The Cowan Property Development Project ("Project") is located within a total property boundary area of roughly 583 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.

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. The extension of Sand Creek Road to the east paralleling Sand Creek and connecting to Dallas Ranch Road at a proposed roundabout. A village center and fire station located along Deer Valley Road at the southeast end of the project site. A 5.1-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 153 acres of open space and trail networks for public access.

The Project proposes to construct a mix of land uses directly impacting 398.2 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. A setback has been provided along Sand Creek to a minimum of the top of bank if not more in some places where applicable. The area of Sand Creek within the set back with was not included in the total project area.

Table 2. Cowan Property Development Project Area Breakdown

Project Area Description	**Area** *(Acres)*
Low Density Residential	250.2
Roads	72.7
Med-Low Density Residential	41.0
Community Facilities (village center, fire station & park)	12.5
Tails and Open Space	128.3
Dallas Ranch Road (outside property boundary)	2.8
Stormwater Facilities	21.3
Total	**528.9**

III.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. An existing farm is located within the project boundary but will remain for the most part undisturbed. East of the project site, along Deer Valley Road is a 160-acre area slated for future expansion of a Kaiser Permanente complex and other development.

The Project is located on relatively level land along the main development areas that slopes slightly 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 of the Project site 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 include a limited amount of development as low-density residential. This area has a peak elevation of 481 feet. Sand Creek flows in a highly-incised channel through the site and ranges from 150 to 300 feet wide from top of bank to top of bank, with top of bank ranging in elevation from 300 feet at the upper (western) end of the Project to 230 feet on the lower (eastern) end of the Project. The creek bed elevations ranges from 274 feet to 210 feet over a stream distance of roughly 10,415 feet. This is equivalent to a channel slope of roughly 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 seasonal precipitation at the site is on the order of 14.4 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 B**). The soil types present are classified as hydrologic soil groups C and A under the Natural Resources Conservation Service's (NRCS) hydrologic soil group system (HSG).[2] The majority of the project site is underlain by C soils: Capay clay (CaA), Rincon clay loam (RbA), Altamont clay (AbE), and Altamont- Fontana complex (AcF). There is a small section of Group 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. The areas mapped for the

[1] Unless otherwise noted, all elevations reference the National Geodetic Vertical Datum of 1929 (NGVD 29).

[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.

stormwater basins are in soil class C; Capay clay for the southern basin and Rincon clay loam for the northern basin.

The pre-project drainage pattern for stormwater at the site consists entirely of sheetflow that follows the terrain draining to Sand Creek (see the attached Exhibit 1, Preliminary Hydrology Shed Boundary Exhibit). There are no organized watercourses of any kind on the site outside of Sand Creek itself and a man-made drainage ditch near the northern property boundary. The latter feature was constructed for the development to the north as a conveyance for runoff that was outside the development boundary and topographically drained to the north away from Sand Creek.

Post-project drainage patterns are illustrated in Exhibit 1. The development of the northern low-density residential area will remove the existing ditch along the northern side of the property, and the associated runoff will be conveyed in the proposed storm drain infrastructure to the North stormwater basin. For stormwater management planning purposes, the Project has been divided into two principal watersheds (Northern and Southern) and then further divided into sub-watersheds based on drainage and land use (N1- N8 and S1-S5). Each of the primary watersheds will have a stormwater basin which will provide water-quality treatment, flow-duration controls, and flood control functions as discussed in Section IV. All runoff will be directed to Sand Creek at two new outfall locations adjacent to the stormwater basins.

III.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 to ground water 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 16.5 acres of the Cowan property to the north. The existing ditch will be removed and the associated runoff collected and taken to the North stormwater basin.
- *No Exiting Creek Outfalls*. The outfall from the Stormwater Basins will each require a new outfall into Sand Creek, which will require a 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 the South storm water basin to avoid wetland impacts to the maximum extent practicable.

These constraints are offset by a few opportunities that include:

- *Preservation of Sand Creek.* The Projects presents an opportunity to preserve and enhance a section of Sand Creek that has remained essentially a natural stream to the present.

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 153 acres of open space and 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. The additional 5.1-acre park area within the common areas of the Project adds to the total pervious surfaces.
- *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 stormwater control basins*. The areas designated for the North and South stormwater basins are large enough to accommodate stormwater management for water-quality treatment and detention/hydromodification control purposes, while still preserving an appropriate set-back distance from the creek top of bank.

LOW IMPACT DEVELOPMENT DESIGN STRATEGIES

III.D. Optimization of Site Layout

III.D.1. Limitation of Development Envelope

As discussed previously, the Project will use a compact site design within the developed areas, freeing up substantial areas that will be preserved as park, trails, or open space. In fact, roughly 28 percent of the total property area will not be developed in any significant way.

III.D.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.D.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. Development closest to Sand Creek will be the two proposed stormwater management basins. A 50-foot setback from the identified wetland areas has been provided where appropriate.

III.D.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.D.5. Use of Drainage as a Design Element

The basins are located at the lower elevations of the project site to facilitate gravity flow, but they also provide aesthetic features for the neighboring developments, with the features designed to integrate into the surrounding open space, being characterized by curvilinear forms.

III.E. 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.F. 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.G. Feasibility Assessment of Harvesting and Use for Treatment and Flow-Control

III.G.1. Permeability of Site Soils

The maximum limiting permeability for soils underlying the site is 0.2 inches/hour. As discussed previously, this substantially limits the potential for infiltration based IMPs. Also, this is well below the 1.6-inch/hour threshold identified in the Stormwater C.3 Guidebook, and analysis of rainwater harvesting potential is required.

III.G.2. Potential Opportunities for Harvesting and Use

Opportunities for rainwater harvesting are strictly associated with the proposed impervious surfaces at the site. The project site has only limited commercial and retail space planned and there are no buildings with large roof areas.

III.G.3. Harvesting and Use Feasibility Calculations

Calculations related to the feasibility of harvesting follow directly from the methodology in the 6th Editions of the Stormwater C.3 Guidebook.

Table 3. Harvesting and Use Feasibility

A	*Impervious Area Description*	*Residential Development*	*Retail or Office*
B	*Square feet of impervious surface**	8,000,412	177,659
C	*Acres*	183.7	4.08
D	*Uses and Uage Units*	1307 (2.8 residents/unit)	888 (200 sf/employee)
E	*Toilet and Urinal Water Usage (gal/day)*	11,240	6130
F	*Water Use per Acre (gal/day/ acre)*	61.2	1,503
G	*Required demand (gal/day/acre)**	4,200	4,200
H	*Is Projected Use > Required Demand? (Column F > Column G?)*	No	No
I	*Can runoff be piped to an irrigated area 2.5x the impervious area (Column B)?*	No	No
J	*Is there any other consistent, reliable demand for the quantity in Column G?*	No	No

*Assume 85% impervious cover for Retail or Office areas

**Brentwood, per Table 4-3 in the C.3 manual

III.H. 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 two main drainage areas (Northern and

Southern) as shown in Exhibit 1. Sand Creek is used as a natural break for the watershed delineation with the respective drainage management areas and IMPs located on the north and south banks of the creek. The drainage areas will collect stormwater and drain to their respective IMP features specifically sized for the pertinent amount of impervious and pervious cover they treat. In both cases, the IMPs utilize the "cistern + bioretention" sizing criteria taken directly from the Stormwater C.3 Guidebook (6th 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 performance (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 to the North stormwater basin. The two stormwater basins are designed with full capacity to achieve the following C.3 functions:

- *North Stormwater Basin*. As shown in Table 7, the North Basin is sized for full treatment + flow control using the IMP Calculator. The bioretention area provided will be sufficient to handle the runoff from both the impervious and pervious portions of the northern drainage. In this case, the "cistern" volume (22.5 acre-feet) is sized to allow full HMP compliance with runoff metered out to the bioretention area at a rate to assure full water-quality treatment per C.3 criteria. This configuration will avoid excessive ponding depths in the bioretention area except under very large storm events (greater than the 10-year design storm). The combined volume of the cistern and bioretention areas of the basin will be available to limit peak flow rates to Sand Creek in very large events (including the Flood Control 100-year design storm)
- *South Stormwater Basin*. The South Basin is also sized for full treatment + flow control using the IMP Calculator. The bioretention area provided will be sufficient to handle the runoff from both the impervious and pervious portions of the southern drainage. In this case, the "cistern" volume is (25.49 acre-feet) to allow full HMP compliance. Overall, the functionality is analogous to that of the North Basin.

With the planned addition of debris screens on the IMP overflows, 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 to the west of the site, the Project will configure both stormwater basins 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 IMP 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 below.

Should the Project be built in phases, the site will be divided into the Northern and Southern section. The stormwater facilities for each section will be built at the time of that section develops. No development area will be built without the associated stormwater management facilities.

IV. DOCUMENTATION OF DRAINAGE DESIGN

IV.A. Descriptions of each Drainage Management Area

IV.A.1. Table of Drainage Management Areas

Table 4. Summary of Northern Drainage Management Areas

Name	Surface Type	Area sq-ft	Area acres	Area sq-mi	Impervious %	Impervious Area sq-ft	Pervious Area sq-ft
N1	Total N1	5,867,794	134.71	0.210	50	2,933,897	2,933,897
	Low Density Residential	4,581,887	105.2	0.164	35		
	Road	1,285,907	29.5	0.046	100		
N2	Total N2	2,312,809	53.1	0.083	65	1,503,326	809,483
	Med-Low Density Residential	1,783,827	41.0	0.064	53		
	Road	528,982	12.1	0.019	100		
N3	Village Center	222,073	5.1	0.008	80	177,659	44,415
N4	Fire Station	97,451	2.2	0.003	80	77,960	19,490
N5	Trail	145,795	3.3	0.005	0	0	145,795
N6	Trail	467,825	10.7	0.017	0	0	467,825
N7	Park	224,257	5.1	0.008	15	33,639	190,619
N8	Dallas Ranch Road	123,633	2.8	0.004	40	49,453	74,180

Table 5. Summary of Southern Drainage Management Areas

Name	Surface Type	Area sq-ft	Area acres	Area sq-mi	Impervious %	Impervious Area sq-ft	Pervious Area sq-ft
S1	Total S1	7,670,469	176.1	0.275	46	3,563,189	4,107,280
	Low Density Residential	6,318,892	145.1		35		
	Roads	1,351,577	31.0		100		
S2	Open Space	704,903	16.2	0.025	0	0	704,903
S3	Open Space	1,104,545	25.4	0.040	0	0	1,104,545
S4	Open Space	1,546,801	35.5	0.055	0	0	1,546,801
S5	Open Space	1,620,799	37.2	0.058	0	0	1,620,799

IV.A.2. Drainage Management Area Descriptions

A description of the DMA and the drain paths in provided below, Exhibit 1 provides a map of the DMAs, without the impervious and pervious area separations. In the descriptions below, an "I" indicates that the area described includes impervious section of the DMA, and a "P" denotes the pervious sections.

N1 I, totaling 2,933,897square feet, drains the impervious surfaces located in northern section of the site. N1 I consists of the impervious surfaces, (concrete, asphalt and roofs) of the low-density residential development in the N1 hydrology shed boundary. At this preliminary design phase, it was assumed that low-density residential consists of 35% impervious surfaces[3]. Taking the total area of

[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.

the proposed roads as 100% impervious the total percent impervious for the N1 I DMA is 59%. N1 I drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N1 P, totaling 2,933,897square feet, drains the pervious landscape surfaces located in the N1 hydrology shed boundary of the site. N1 P drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N2 I, totaling 1,503,326 square feet, drains the impervious surfaces located in Northern section of the site. N2 I consists of the impervious surfaces, (concrete, asphalt and roofs) of the medium-low density residential development in the N1 hydrology shed boundary. At this preliminary design phase it was assumed that medium - low density residential consists of 53% impervious surfaces[4]. Taking the total area of the proposed roads with 100% impervious the total percent impervious for the N1 I DMA calculates out to 63% of the total N1 shed boundary. N2 I drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N2 P, totaling 809,483 square feet, drains the pervious landscape surfaces located in the N2 hydrology shed boundary of the site. N2 P drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N3 I, totaling 177,659 square feet, drains the impervious surfaces located in Northern section of the site. N3 I consists of the impervious surfaces, (concrete, asphalt and roofs) of the Village Center development in the N1 hydrology shed boundary. For the preliminary design the Village Center is assumed to have an impervious coverage of 80% of the total area. N3 I drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N3 P, totaling 44,415 square feet, drains the pervious landscape surfaces located in the N3 hydrology shed boundary of the site. N3 P drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N4 I, totaling 77,960 square feet, drains the impervious surfaces located in Northern section of the site. N4 1 I consists of the impervious surfaces, (concrete, asphalt and roofs) of the Fire Station development in the N1 hydrology shed boundary. For the preliminary design the Fire Station is assumed to have an impervious coverage of 80% of the total area. N4 I drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N4 P, totaling 19,490 square feet, drains the pervious landscape surfaces located in the N4 hydrology shed boundary of the site. N4 P drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N5 P, totaling 145,795 square feet, is considered a self-treating area and naturally drains under existing conditions. The N5 P is located in the northeast of the project site on the west side of Dallas Ranch Road. A trail network is proposed through the DMA, but will utilize permeable pavements and ensure that the total impervious surfaces are less than 5% of the total area. High flows (>10 year event) will directed to the storage basin component of the IMP-1: North Stormwater Basin.

N6 P, totaling 467,825square feet, is considered a self-treating area and naturally drains under existing conditions. The N6 P is located in the northeast of the project site on the east side of Dallas Ranch Road. A trail network is proposed through the DMA, but will utilize permeable pavements and ensure that the total impervious surfaces are less than 5% of the total area. High flows (>10 year event) will directed to the storage basin component of the IMP-1: North Stormwater Basin.

N7 I, totaling 33,639 square feet, drains the impervious surfaces located in northern section of the site. N7 I consists of the impervious surfaces, (concrete and asphalt) located within the proposed park in the N1 hydrology shed boundary. At this preliminary design phase, it was assumed that a park would consist of 15% impervious surfaces. N1 I drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N7 P, totaling 190,619 square feet, drains the pervious landscape surfaces located in the N7 hydrology shed boundary of the site, consisting of park and open space. N7 P drains to the storage basin component ('cistern") of IMP-1: North Stormwater Basin.

N8 I and P, this area includes 123,633 total square feet that consist of a portion of the existing Dallas Ranch Road corridor north of the site that will be conveyed to the North Stormwater Basin.

S1 I, totaling 3,563,189 square feet, drains the impervious surfaces located in southwest section of the site. S1 I consists of the impervious surfaces, (concrete, asphalt and roofs) of the low-density residential development in the S1 hydrology shed boundary. At this preliminary design phase, it was assumed that low density residential consists of 35% impervious surfaces[4]. Taking the total area of the proposed roads as 100% impervious the total percent impervious for the S1 I DMA calculates out to 46%. The S1 I area drains to the storage basin component ('cistern") of IMP-2: South Stormwater Basin.

S1 P, totaling 4,107,280 square feet, drains the pervious landscape surfaces located in the S1 hydrology shed boundary of the site. S1 P drains to the storage basin component ('cistern") of IMP-2.

S2 P, totaling 704,903 square feet, is considered open space and will be a self-treating area that will maintain the existing conditions drainage pattern. The S2 P area is located in the southwest of the project site. A trail network is proposed through the DMA, but will utilize permeable pavements, such that the total impervious surfaces are less than 5% of the total area. High flows (>10-year event) will directed to the storage basin component of IMP-2.

[4] 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.

S3 P, totaling 1,104,545 square feet, is considered open space and will be a self-treating area that will maintain the existing conditions drainage pattern. The S3 P is located in the southwest of the project site near Empire Mine Road. A trail network is proposed through the DMA, but will utilize permeable pavements, such that the total impervious surfaces are less than 5% of the total area. High flows (>10-year event) will directed to the storage basin component of IMP-2.

S4 P, totaling 1,546,801 square feet, is considered open space and will be a self-treating area that will maintain the existing conditions drainage pattern. The S4 P is located in the middle southern section of the project site. High flows (>10-year event) will directed to the storage basin component of IMP-2.

S5 P, totaling 1,620,799 square feet, is considered open space and will be a self-treating area that will maintain the existing conditions drainage pattern. The S5 P is located in the southwest of the project bordering Empire Mine Road. High flows (>10-year event) will directed to the storage basin component of IMP-2.

IV.B. Tabulation and Sizing Calculations

IV.B.1. Information Summary for IMP Design

Table 6. Summary of IMP Design Information

Total Project Area (Square Feet)	22,647,369
Mean Annual Precipitation	14.3 inches
IMPs Designed For:	Treatment + Flow Control

IV.B.2. Self-Treating Areas

The Project does not utilize self-treating areas as part of the stormwater management strategy.

IV.B.3. Self-Retaining Areas

The Project does not utilize self-retaining areas as part of the stormwater management strategy.

IV.B.4. Areas Draining to Self-Retaining Areas

Since there the Project does not include self-retaining area, there are no areas draining to such features.

IV.B.5. Areas Draining to IMPs

Areas draining to IMP features are explicitly sized using the treatment + flow control routine in the Clean Water Program's IMP calculator. Sizing was based on the Cistern + Bioretention facility sizing. The respective calculations are summarized in Tables 7 through 8 below. The calculations for the Northern basin were adjusted to account for the additional area that will be contributing post-development. To account for the fact the pre-development area is less than the post-development area the sizing for the outlet orifice was based on the pre-development area, which generated a smaller flowrate and a more conservative approach to the orifice sizing.

Table 7. IMP Sizing Calculations for the Northern Basin (IMP-1)

IMP Name: North IMP (Soil Type: C)

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor	IMP Sizing			
					IMP Sizing Factor	Rain Adjustment Factor	Minimum Area or Volume	Proposed Area or Volume
North imperv	5,045,041	Concrete or Asphalt	1	5,045,041				
North Perv	4,891,109	Landscape	0.5	2,445,555				
			Total	7,490,596				
					0.013	0.614	59,750	63,702
					0.105	1.216	956,661	980,000
							Maximum Underdrain Flow (cfs)	8.09
							Orifice Diameter (in)	12.0

Table 8. IMP Sizing Calculations for Southern Basin (IMP-2)

IMP Name: South IMP (Soil Type: C)

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor	IMP Sizing			
					IMP Sizing Factor	Rain Adjustment Factor	Minimum Area or Volume	Proposed Area or Volume
South Imperv	3,759,066	Concrete or Asphalt	1	3,759,066				
South Perv	8,810,149	Landscape	0.5	4,405,075				
			Total	8,164,141				
					0.013	0.614	65,123	78,302
					0.105	1.216	1,042,683	1,075,888
							Maximum Underdrain Flow (cfs)	10.95
							Orifice Diameter (in)	12.72

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 9. Sources and Source Control Measures

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.

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*
Landscape / outdoor pesticide use	Final Landscape plans will: 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. Washwater 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.	

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*
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 for Source Control BMPs

Stormwater Facility Maintenance

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.

V.D. 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.

V.E. 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.

VI. CONSTRUCTION PLAN C.3 CHECKLIST

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

Table 10. Construction Plan C.3 Checklist

Stormwater Control Plan Page #	*BMP Description*	*See Plan Sheet #s*
Page	IMP-1: Northern Storage Basin	Future Plans
Page	IMP-1: Northern Bioretention Basin	Future Plans
Page	IMP-2: Southern Storage Basin	Future Plans
Page	IMP-2: Southern Bioretention Basin	Future Plans

VII. FLOOD CONTROL MANAGEMENT

VII.A. 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 towns has generated a need to manage the flood risk for the residents and businesses in east Contra Costa County.

The 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 Contra Costa Flood Control and Water Conservation District (FCD) defined drainage area 104 for Sand Creek. Sand Creek is the largest tributary in the lower Marsh Creek Watershed, as it contributes approximately 15 square miles of drainage to Marsh Creek. 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 with the flood control element of the Project is to mitigate flow increases to the Upper Sand Creek Basin, and minimize impacts to the peak flow levels at the Project. To ensure that flows into Upper Sand Creek Basin is not impacted, the Project designed the onsite stormwater detention basins to have post-development flows less than or equal to the pre-development flows, for the 100-year design storm event. The peak flows in Sand Creek were also estimated to determine the peak water surface elevations, such that the discharge locations would not be impacted by flood flows.

VII.B. Sand Creek Peak Flows

The presence of Upper Sand Creek Basin will provide significant flood control for the area downstream of the Project. 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, preliminary calculations were completed. Peak flows in Sand Creek were estimated from review of historical documentation on the watershed and Upper Sand Creek Basin[5,6].

---

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

[6] 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

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. To account for the difference in drainage area at the Project site, a prorated equivalent watershed area was used. The drainage area of Sand Creek upstream of the project site is 7.3 square miles[7]. Using direct linear reduction, the flow at the Project site would be 66% of the Upper Sand Creek Basin flows, or 1870 cfs. The 10-year and 2-years 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 was used to represent the flows at the Project. From the modeling results provided, the 10-year 12-hour flow is estimated to be 905 cfs, and the 2-year 3-hour flows is estimated as 210 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 AutoCAD Hydraflow Express program was utilized, which applies the Manning's equation to user input values. Two typical cross sections were taken from the topographic survey data at each discharge location. The slope for the reach at the Southern Basin outfall was taken as 0.54%, and the Northern Basin reach as 0.66%. A Manning's roughness of 0.03 was applied to both sites based on field observations.

The results from the Sand Creek peak stream flow 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 Hydraflow modeling are presented in Table 11. Sand Creek Water Surface Elevation Modeling Results.Table 11.

Table 11. Sand Creek Water Surface Elevation Modeling Results.

Storm Event	Flow	Parameter	Southern	Northern
	(cfs)		*(ft)*	*(ft)*
100 year -12 hour	1870	Calculated Water Depth (ft)	8.8	11.0
		Water Surface Elevation	226.8	221.0
10 year -12 hour	905	Calculated Water Depth	6.4	8.0
		Water Surface Elevation	224.4	218.0
2 year -3 hour	210	Calculated Water Depth	3.1	4.2
		Water Surface Elevation	221.1	214.2
		Basin Bottom Elevation	243.0	218.0

[7] USGS StreamStats - accessed January 10, 2017, from the downstream boundary of the project site.

VII.C. 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. For the purpose of the modeling, the site was divided into two watershed areas, the Southern and Northern Sections.

Modeling was completed using the U.S. Army Corps of Engineers' HEC-HMS software package parameterized per guidelines prepared by Flood Control 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 two multi-purpose stormwater basins as shown in Exhibit 1. 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 preliminary storage basin and a secondary bioretention basin. The stage/storage relationships used for these basins in the modeling are presented in Appendix A.
>
> *Flood control design storms.* Appendix A also includes information on the design storms that were used in the analysis to demonstrate compliance with Flood Control requirements. 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.* Appendix A also provides information on the assumed infiltration rates and lag time calculations. The HEC-HMS parameters and modeling 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 12 and excerpts from the modeling output are included in Appendix A. Important results and findings include the following:

> *Pre-project peak flow rates.* For the Northern Basin, predicted peak pre-project flow for the 10-year, 3-hour design storm was modeled to be the largest of the 10-year events at 84.0 cfs. The 100-year 24-hour storm produced a peak flow rate of 161.1 cfs. For the Southern Basin, predicted peak pre-project flow for the 10-year, 3-hour design storm was modeled to be the largest of the 10-year events at 129.4 cfs. The 100-year 24-hour storm produced a peak flow rate of 240.7 cfs.

Peak flow rates with detention. As shown in Table 12, the Northern and Southern Basins provide sufficient storage to mitigate pre-development flows to the post-development peak flow rates. For the Northern Basin, the modeling showed a reduction in the peak flow rate for the 10-year 3-hour storm from 84 cfs per-development to 9.3 cfs post-development. For the 100-year 24-hour event flows were reduced from 161.1 cfs pre-development to 95.4 post-development. For the Southern Basin, the modeling showed a reduction in the peak flow rate for the 10-year 3-hour storm from 129.4 cfs per-development to 10.2 cfs post-development. For the 100-year 24-hour event flows were reduced from 240.7 cfs pre-development to 104.3 post-development.

The large difference in flow rates is due to the hydromodification flow restrictions that occur during the smaller events and restrict the outflow.

The model results indicate that, in general, the stormwater facilities presented in the preliminary design for the Project would adequately address peak flow attenuation for the project site.

Table 12. HEC-HMS Stormwater Detention Modeling Results, Cowan Ranch Property, Contra Costa County.

	Design Storm	**Peak Discharge at Outlet (cfs)**	
		Pre-Project	Post-project (detained)
Northern Basin	10-year 3-hour	84.0	9.3
	10-year 24-hour	81.7	23.0
	100-year 3-hour	144.6	79.7
	100-year 24-hour	161.1	95.4
Southern Basin	10-year 3-hour	129.4	10.2
	10-year 24-hour	126.1	10.3
	100-year 3-hour	218.6	89.4
	100-year 24-hour	240.7	104.3

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 R2-2009-0074 and Order R2-2011-0083.

5/19/2017

Edward D. Ballman, P.E. Date

RCE #64095

AREA SUMMARY		
SUB AREA	AREA (ACRES)	LAND USE
N1	134.7	LOW DENSITY
N2	53.1	MEDIUM LOW DENSITY
N3	5.1	VILLAGE CENTER
N4	2.2	FIRE STATION
N5	3.3	TRAIL
N6	10.7	TRAIL
N7	5.1	PARK
N8	2.8	EXISTING DEVELOPED
TOTAL	217.0	
S1	176.1	LOW DENSITY
S2	16.2	OPEN SPACE
S3	25.4	OPEN SPACE
S4	35.5	OPEN SPACE
S5	37.2	OPEN SPACE
TOTAL	290.4	

PRELIMINARY
HYDROLOGY SHED BOUNDARY EXHIBIT
COWAN PROPERTY

CITY OF ANTIOCH CONTRA COSTA COUNTY CALIFORNIA

0' 300' 900' 1,200'

SCALE: 1" = 300' DATE: MAY 16, 2017

Carlson, Barbee & Gibson, Inc.
CIVIL ENGINEERS • SURVEYORS • PLANNERS
2633 CAMINO RAMON, SUITE 350
SAN RAMON, CALIFORNIA 94583
(925) 866-0322

5/16/2017 2:02 PM

G:\1133\ACAD\1133-020\ACAD\EXHIBITS\XB_003_HYDROLOGY SHED BOUNDARY_REV3.DWG

APPENDIX A:

HMS Modeling Inputs

Table A1. Infiltration and time lag calculations for stormwater detention modeling, Cowan Ranch Property, Contra Costa County

Pre-project

Shed	Area		Impervious	Infiltration	N	L		Lc		Elevation High	Elevation Low	Slope	Lag
	(acres)	*(sq miles)*	*(acres)*	*(in/hr)*		*(ft)*	*(miles)*	*(feet)*	*(miles)*	*(ft)*	*(ft)*	*(ft/mile)*	*(hours)*
North	213.1	0.33	0.0	0.17	0.075	7,015	1.3	3,355	0.64	323	228	72	0.75
South	290.3	0.45	0.0	0.17	0.075	6,206	1.2	3,097	0.59	396	256	119	0.63

Post-project

Shed	Area		Impervious	Infiltration	N	L		Lc		Elevation High	Elevation Low	Slope	Lag
	(acres)	*(sq miles)*	*(acres)*	*(in/hr)*		*(ft)*	*(miles)*	*(ft)*	*(miles)*	*(ft)*	*(ft)*	*(ft/mile)*	*(hours)*
North	229.6	0.36	115.8	0.08	0.025	7,112	1.3	2,738	0.52	323	228	71	0.23
South	290.3	0.45	86.3	0.12	0.050	6,532	1.2	3,151	0.60	396	256	113	0.44

Table A2. Design storm coefficients and rainfall totals, Cowan Ranch Property, Contra Costa County

MSP =	14.30 inches

Duration	Factor C1		Factor C2		Rainfall Depth (inches)	
	10-year	100-year	10-year	100-year	10-year	100-year
3-hour	0.434	0.620	0.0516	0.0760	1.17	1.71
6-hour	0.520	0.760	0.0760	0.1120	1.61	2.36
12-hour	0.588	0.888	0.1112	0.1632	2.18	3.22
24-hour	0.636	0.968	0.1584	0.2352	2.90	4.33

Site watesheds are at 14.3 inches mean seasonal precipitation per CCCFC Figure B-166.

Table A3. North Basin Detention characteristics, Cowan Ranch Property, Contra Costa County

Stage-storage-discharge

Elevation *(feet)*	Stage *(feet)*	Area *(acres)*	Storage *(ac-ft)*	Q Total *(cfs)*
220.00	0.00	4.91	0.0	0.0
221.00	1.00	5.09	5.0	3.8
222.00	2.00	5.28	10.2	5.3
223.00	3.00	5.47	15.6	6.5
224.00	4.00	5.67	21.1	7.5
224.62	4.62	5.79	22.5	8.1
225.00	5.00	5.96	24.7	78.2
226.00	6.00	6.12	30.8	494.6
227.00	7.00	6.29	37.0	1110.1
228.00	8.00	6.45	43.3	1873.3

Orifice Dimensions

Type ---	Diameter *(ft)*	Flowline *(ft)*	Shape ---
Low Orifice	1.00	220.00	Circular

Weir Dimensions

Type ---	Width *(ft)*	Flowline *(ft)*	Shape ---
Overflow Weir	100.00	224.62	Rectangular

Table A4. South Basin Detention characteristics, Cowan Ranch Property, Contra Costa County

Stage-storage-discharge

Elevation *(feet)*	Stage *(feet)*	Area *(acres)*	Storage *(ac-ft)*	Q Total *(cfs)*
245.00	0.00	2.97	0.00	0.0
246.00	1.00	3.17	1.53	4.0
247.00	2.00	3.31	3.18	5.7
248.00	3.00	3.45	4.96	6.9
249.00	4.00	3.60	6.87	8.0
250.00	5.00	3.75	8.92	8.9
251.00	6.00	3.90	11.10	9.8
252.00	7.00	4.05	12.24	10.6
252.60	7.60	4.14	13.42	11.0
253.00	8.00	4.25	14.63	87.2
254.00	9.00	4.37	15.88	508.9

Orifice Dimensions

Type	Diameter	Flowline	Shape
---	*(ft)*	*(ft)*	---
Low Orifice	1.03	245.00	Circular

Weir Dimensions

Type	Width	Flowline	Shape
---	*(ft)*	*(ft)*	---
Overflow Weir	100.00	252.60	Square

Table A5. North Basin Biodetention characteristics, Cowan Ranch Property, Contra Costa County

Stage-storage-discharge

Elevation *(feet)*	**Stage** *(feet)*	**Area** *(acres)*	**Storage** *(ac-ft)*	**Q Total** *(cfs)*
218.00	0.00	1.46	0.00	0.0
219.00	1.00	1.57	1.52	0.0
220.00	2.00	1.68	3.14	36.3
221.00	3.00	1.79	4.88	72.9
222.00	4.00	1.91	6.72	89.1
223.00	5.00	2.02	8.69	104.8
224.00	6.00	2.14	10.77	115.7
225.00	7.00	2.37	13.03	150.1
226.00	8.00	2.46	15.44	189.1
227.00	9.00	2.54	17.94	231.0
228.00	10.00	2.63	20.53	275.7

Riser Dimensions

Type ---	**Diameter** *(ft)*	**Flowline** *(ft)*	**Shape** ---
Overflow Riser	2.50	219.00	Circular

Table A6. South Basin Biodetention characteristics, Cowan Ranch Property, Contra Costa County

Stage-storage-discharge

Elevation *(feet)*	Stage *(feet)*	Area *(acres)*	Storage *(ac-ft)*	Q Total *(cfs)*
243.00	0.00	1.69	0.00	0.0
244.00	1.00	1.95	1.82	0.0
245.00	2.00	2.11	3.85	42.0
246.00	3.00	2.27	6.04	118.8
247.00	4.00	2.43	8.39	218.2
248.00	5.00	2.59	10.90	336.0
249.00	6.00	2.76	13.58	469.6

Weir Dimensions

Type ---	Width *(ft)*	Flowline *(ft)*	Shape ---
Overflow Weir	14.00	244.00	Rectangular

APPENDIX B:

Soil Report

United States Department of Agriculture

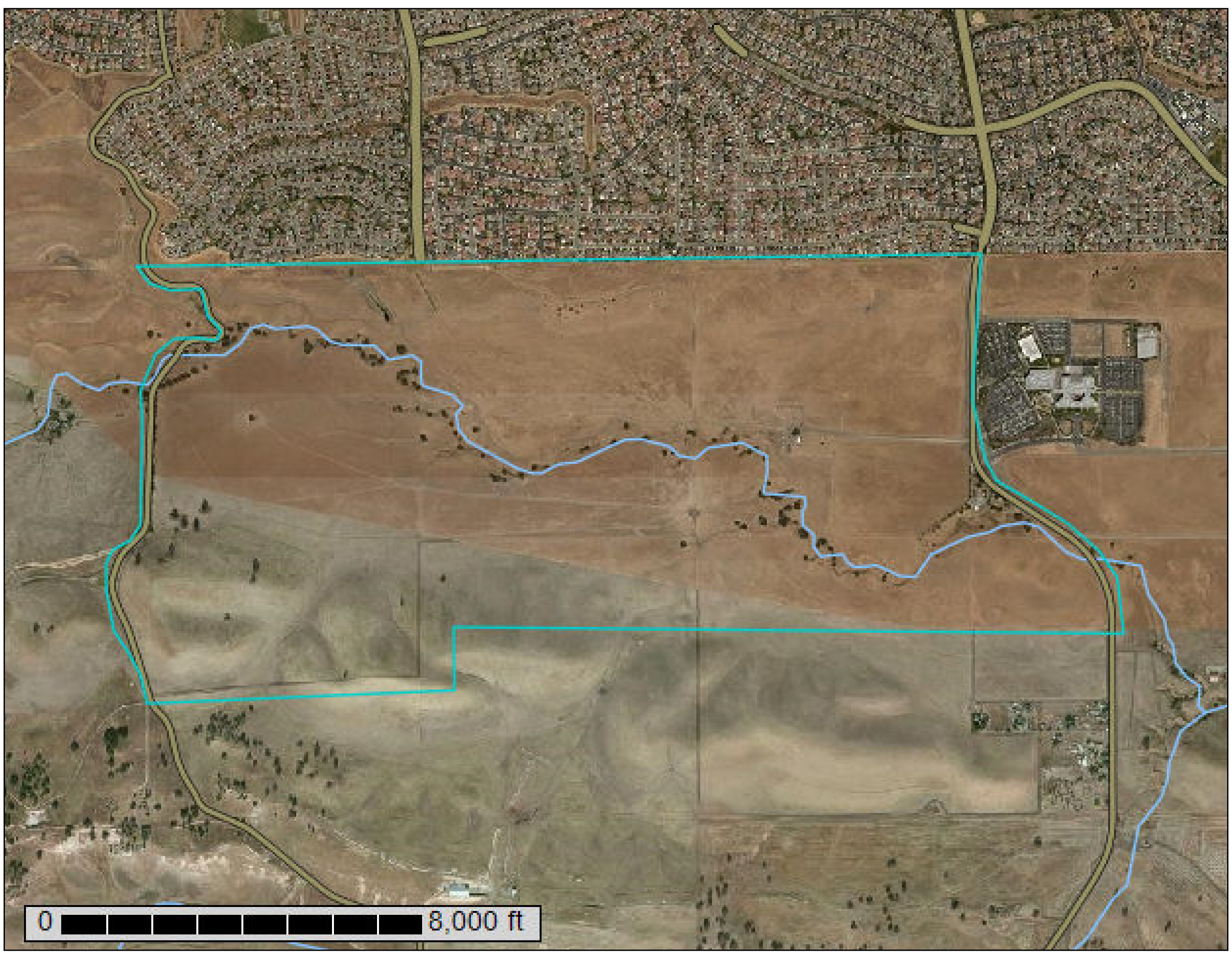
NRCS

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

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.

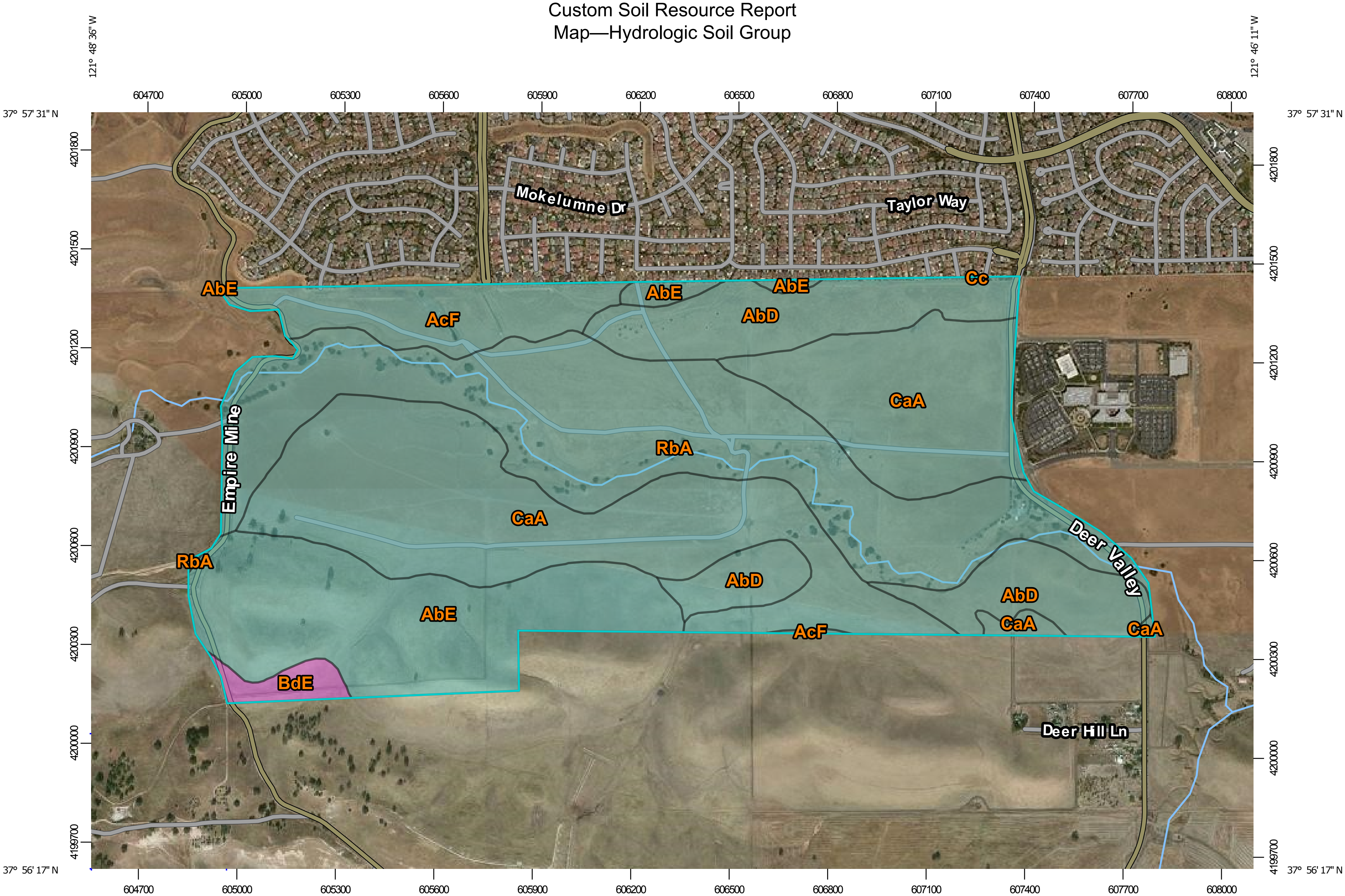
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

N

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

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)

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

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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.