Appendix U
Water Resources

1. Water Demand Analysis, April 2018
2. Water Supply Assessment, December 2018
3. Phase C Hydrology Study, May 2018
4. Approved Jurisdictional Determination, October 2018
5. Drainage, Erosion and Sedimentation Control Plan, April 2019

U.1 Water Demand Analysis, April 2018

RE Crimson Solar Project

by Sonoran West Solar Holdings, LLC

Water Demand Analysis

Project Number: 60487757

April 2018

Sonoran West Holdings, LLC
Recurrent Energy LLC
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Quality information

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Revision History

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1. Project Overview

1.1 Introduction

Sonoran West Solar Holdings, LLC (Applicant), a wholly owned subsidiary of Recurrent Energy LLC (RE), proposes to construct and operate the RE Crimson Solar Project (Project). This Project is a utility-scale solar photovoltaic (PV) and energy storage project that would be located in the Riverside East Solar Energy Zone/Development Leasing Area and within a Development Focus Area on federal lands managed by the Bureau of Land Management (BLM) within the California Desert Conservation Area planning area in unincorporated eastern Riverside County, approximately 13 miles west of Blythe, California (CA) (BLM CACA-051967). The Project would interconnect to the regional electrical grid at the Southern California Edison (SCE) 230-kilovolt (kV) Colorado River Substation (CRS), and would generate up to 350 megawatts (MW) of renewable energy using PV technology with up to 350 MW of integrated energy storage capacity.

The Project applicant is proposing to construct the project using a traditional construction approach consisting of desert tortoise exclusion fencing, a mow and roll approach to site preparation, compacted roads, and trenching for electrical lines; however, the applicant is actively investigating alternative low-environmental impact design (LEID) elements and the potential for those to reduce Project impacts. LEID elements include several potential design changes including:

1. Wildlife-friendly fencing during operations to allow desert tortoise, kit fox, and other wildlife access to the site.

2. Minimizing grading during site preparation and maintaining more onsite vegetation to facilitate post-construction residual habitat value and post-operations/site reclamation success.

3. Avoiding or limiting trenching by placing electrical wiring aboveground.

4. Placing transformer/inverter groups on elevated support structures in lieu of cement foundations.

The LEID elements would further minimize grading, trenching, and vegetation removal beyond traditional design approaches for PV projects with the objective of reducing overall long-term impacts for the Project. Although the incorporation of LEID elements could result in slight modifications to the panel block locations due to topographic constraints, the permitting boundary or limits of development would be the same with LEID elements incorporated. The comparative impacts of the tradition design approach versus design with LEID elements incorporated is not known; therefore, to facilitate appropriate analysis of the Project and allow for the incorporation of LEID elements where practicable and environmentally beneficial, the environmental technical analysis are based on the elements that result in the worst-case scenario for construction and operations.

The Project site consists of approximately 2,489 acres of BLM-administered land. A vicinity map showing the Permitting (Development) Boundary is presented on **Figure 1-1**. The block layouts may vary slightly with the incorporation LEID elements, but would remain within the Permitting Boundary. The total area for the Project (i.e., Permitting Boundary; 2,489 acres), includes a 2,465 acre solar field development area with approximately 1,859 acre of solar panels (array blocks) and 24 acres for linear facilities including access/perimeter roads with a 30 to 60 foot corridor width and gen-tie and powerline corridors at 150 feet. AECOM has conducted an evaluation of the water requirements for construction and operations of the Project. This evaluation is described in Task 1 of AECOM's Proposal for Assessment of Potential Water Supply Sources for the Project (AECOM 2017). This evaluation provides a check of the proposed water demands included in the Plan of Development (POD) for the Project (Recurrent Energy, 2017a). Water requirements for construction were estimated for both the Traditional Design and a design with the incorporation of LEID elements[1]. The estimates for water usage for construction and operations were based on information contained in the POD, project construction schedule (Recurrent Energy, 2017b), civil design drawings (Recurrent Energy, 2017c), and by making assumptions based on AECOM's prior experience with projects in the area, when detailed Project information was not available.

[1] For simplification of quantitative analyses and associated reporting, the Traditional Design was referred to as Option A and design with the incorporation of LEID elements is referred to as Option B.

1.2 Design Approach

1.2.1 Traditional Design

An estimated 2 million panels would be arranged on the site in the form of solar arrays. Structures supporting the PV modules would consist of steel piles (e.g., cylindrical pipes, H-beams, or similar), which would be driven into the soil using pneumatic techniques, such as a hydraulic attachment on the boom of a backhoe tractor.

The proposed traditional design is laid out primarily in 2-MW increments, each 2-MW increment would include an inverter-transformer station constructed on a concrete pad or steel skid, and would be centrally located within the PV module arrays. Each inverter-transformer station would contain up to four inverters, a transformer, a battery enclosure, and a switchboard. Underground cables would be installed to convey the direct current (DC) electricity from the panels to the inverters to convert the DC to alternating current (AC). Between 300 and 500 wooden poles would be installed across the entire site to convey energy to a central substation location which would transform voltage from 34.5 kV to 230 kV.

Energy storage may be achieved by either a battery or flywheel storage system capable of storing up to 350 MW of electricity. The storage system would consist of banks of batteries or flywheels housed in electrical enclosures located indoors within the Project energy storage facilities.

Access to the Project site would be provided via the existing paved Wiley's Well Road and Powerline Road to the CRS from Interstate 10 (I-10) to the north. The Project's on-site roadway system would include a perimeter road, access roads, and internal roads. These roads would be surfaced with gravel, compacted dirt, or another commercially available surface and would accommodate the Project operations and maintenance (O&M) activities.

1.2.2 Low Environmental Impact Design Elements

As presented above, the applicant has proposed potential LEID elements for the Project for consideration with the objective of evaluating alternative design approaches that may reduce environmental impacts or negative effects from the project. These elements include changes to the fencing design, grading approach, trenching and wiring, and elevation of inverter pads. To facilitate adequate analysis of potential design alternatives for the technical study, changes to the design were assessed for the potential LEID elements to determine the worst-case scenario. The design details with the incorporation of potential LEID elements are identical to those provided above for the traditional design, except for the following differences should LEID elements be incorporated:

- Solar blocks may be laid out in larger, 3- to 4-MW block sizes, requiring fewer inverter/transformer structures.
- Inverter/transformer equipment areas may be mounted on steel skids and installed on steel piers above the ground surface.
- Approximately 300 to 400 wooden AC transmission poles would be required in addition to the poles referenced under the traditional design to eliminate most trenching, which would result in the installation of up to 900 wooden poles in total.
- Access to the Project site would still be provided via the existing paved Wiley's Well Road and Powerline Road to the CRS via I-10; however, if the incorporation of elements results in fewer solar blocks, slightly fewer roads would be compacted and graded on-site.

1.3 Construction Schedule Details

2. The Project applicant is proposing to construct the project using a traditional construction approach. Construction of the Project would occur in three planned phases and require approximately 17 months to complete with construction expected to begin in late-2020.Assessment Methodology

2.1 Water Demand During Construction

The major water uses during construction are for compaction of site soil that is graded for development, and for dust control to ensure compliance with local air pollution control district regulations or permit conditions. Due to the possible variance of soil conditions at the site, AECOM has assumed a range of water demand for compaction (i.e., a low-end and high-end water demand) to accommodate the Traditional Design and the potential for incorporation of LEID elements. The development of a total construction water demand for the Project includes the following methodology and approach.

2.1.1 Methodology for Water Estimates for Soil Compaction

- The unit water demand for compaction (gallons per cubic yard) was estimated by determining the water demand for engineering compaction of site soil and adding an allowance for moisture loss at initial wetting. The water demand at time of initial soil wetting is the water needed to overcome ambient evaporation conditions at time of wetting, less the in-place soil moisture content. The moisture loss at time of soil wetting will vary depending on the in-place soil moisture content and the ambient evaporation conditions at time of wetting. A range (low to high) of water demand unit rates for compaction was developed for the soil compaction water demand by assuming the worst-case and best-case scenarios of soil moisture content and ambient evaporation condition. For example in winter (low-end case), site soil may contain in-place moisture and evaporation is expected be low. The opposite (high-end case) would occur in summer, where the site soil would be expected to be dry (have no in-place moisture content), and the evaporation rate would be expected to be high.
- Calculations using the low-end and high-end water unit rates are shown in Part A, item number 1 in Appendix A.
- The amount of soil that will be graded, excavated and compacted for the construction approaches were derived from conceptual design drawings provided (Recurrent Energy 2017c), the POD, and the assumptions described below based on experience on similar projects. These estimates are shown in Part A, item number 2 in Appendix A.
- The range of water demand for compaction was calculated from the product of the low-end and high-end water unit rate times the soil grading quantities for each design approach. The range of water demand for compaction is shown in Part A, item number 3 in Appendix A.

2.1.2 Methodology for Water Estimates for Dust Control

- AECOM determined a unit water demand rate for dust control (gallons per square yard) based on Mojave Desert Air Quality Control District guidance (Mojave Desert AQMD) (Mojave Desert AQMD, 1998). Calculations showing the water demand for dust control are shown in Part B, item number 1 in Appendix A.
- The estimate of duration for each construction phase was based on Project schedule provided and from the assumptions described below based on experience on similar projects. The phases of construction are listed in Part B, item number 2 in Appendix A.
- The areas of disturbance were based on the POD and assumptions described below. The estimated total disturbance area for each phase is shown in Part B, item number 3 in Appendix A.

- Using the unit water demand for dust control, the water demand for each phase of construction was estimated and summed to provide a project total requirement. This is shown in Part B item number 3 in Appendix A. A summary table with the total estimated construction water demand for the Project was prepared. See Summary Table at the beginning of Appendix A.

2.1.3 Assumptions

Because the design is still in the conceptual stage, this analysis of water demand is on the scale of **order of magnitude** and is based on information derived from the documents listed above. Project documents provide most information (such as area or length) but not all parameters (such as average depth) required for this analysis. Therefore, AECOM has included assumptions with the Project conditions derived from a Project reference (such as the POD) to develop the assumptions listed below:

- Soil at the site have similar geotechnical properties (regarding engineering compaction) as the Desert Sunlight Solar Project that was constructed north of Desert Center, located approximately 40 miles northwest of the Project site. The geotechnical properties from the Desert Sunlight Solar Project (Eberhart United Consultants [EUC] 2007) were used as surrogate for this evaluation because this Project is located on an alluvial fan at the base of the Palen Mountains, similar to the geographic setting of the RE Crimson Project.
- The moisture loss at time of initial soil wetting will vary depending on the natural soil conditions and ambient evaporation conditions at time of wetting.
  - The low-end water demand rate is based on the assumption that the natural soil condition has a high level of moisture content (approximately 1 percent [%]) and there is a 3% moisture loss upon wetting for compaction.
  - The high-end water demand rate is based on the assumption that the natural soil conditions has a low level of moisture content (0%) and there is a 5% moisture loss upon wetting for compaction.
- Excavation for installation of the tortoise fence is assumed to have side slopes of 1 to 1.5, so to bury the fence 18 inches; the trench would be 4.5 feet wide at grade. Excavation of soil for grading or smoothing is assumed to average a depth of 4 inches over the entire area with both design approaches.
- Excavation of soil for hydromodification/surface drainage is assumed to average a depth of 1 foot over the entire area that is disturbed for Traditional Design, and is assumed to average a depth of 0.5 foot over the entire area that is disturbed with the incorporation of LEID elements.
- Excavation of soil for constructing substations, operations and maintenance facility, and inverters will result in a level surface. Much of the site slopes at 1.5 percent; therefore, over a length of 400 feet, there is a 6-foot difference in elevation. To achieve a level surface for a 400-foot facility, it is assumed that an excavation of 3 feet from one-half of the area would be needed to fill the lower half by 3 feet.
- Trenches for conduits are assumed to be 5 feet wide, which is derived from a rounded average of the 3- to 6-foot width described in the POD. The assumed depth of 2 feet is based on a burial depth of 18 inches (POD) and assumes 6 inches of a sand bedding layer.
- Unit water demand rate for dust control is derived from Mojave Desert AQMD, 1998 and CA DWR Bulletin 73-39*.*
- Although the construction sequence in the POD does not describe an interior primary access road, AECOM assumes that the Project will build and maintain a road that extends from the extreme southwest corner of the site, north along the western perimeter, and then east to the extreme eastern perimeter of the site. This primary access road would be used throughout the construction to deliver materials from the laydown yard to the solar arrays and would connect to each solar array's access road. A total length of 35,000 feet is assumed for this road and further it is assumed that one half of the length of the road would be in use for the duration of the construction and thus require dust control.
- Although the construction sequence is not detailed in the POD, AECOM assumes that the grading for hydromodification/surface drainage and smoothing will be implemented at the same time dust control will

be conducted for both activities concurrently. Therefore, dust control is assumed to cover the average rate of land disturbance for this phase.

- Although the construction sequence is not detailed in the POD, AECOM further assumes that the installation of posts, tables, and PV panels will be installed in a sequence in separate but adjacent areas. Dust control will be needed for each of three activities: the installation of the posts, the installation of the tables; and the installation of PV panels. Therefore, dust control is assumed to cover three times the average rate of land disturbance for this phase.

Analysis spreadsheets in Appendix A include detailed assumptions.

2.2 Water Demand During Operation

Operational activities include solar module washing, maintenance of transformers, inverters, or other electrical equipment, road and fence repairs, vegetation/pest management, and site security. Solar modules would be washed as needed to maintain optimal electricity production (up to four times each year). AECOM has prepared a comparative estimate of the water demand during operation.

AECOM reviewed online articles to determine water demands during operation of other PV solar facilities for comparison to the RE Crimson Solar facility. These sources indicated that the water use during operation for a PV solar power facility is estimated to be 20 gallons per mega-watt-hour (MWh) (Solar Energy Industries Association, 2017) or ranges from 0 to 33 gallons per MWh (Journal of Contemporary Water Research and Education, 2013).

3. Results and Findings

3.1 Results of Analysis of Water Demand During Construction

The results of the water demand analysis and a comparison to the POD values are presented in **Table 3-1**. The estimate is a rough order of magnitude estimate that presents a range of total water demand for each design approach. The results of the analysis indicate that the water demands as presented in the POD are very similar to the range of water demand estimates provided in this analysis. Given the assumptions made for the water demand estimates, the water demand for the two design approach options, as presented in the POD, are reasonable.

Table 3-1
Summary of Results of Analysis of Water Demand during Construction

Design Approach[1]	Water Demand as presented in the POD (acre-feet)	Range of Water Demand from this Estimate (acre-feet)
Traditional Design	1,000	1,111 to 1,305
LEID Elements	600	504 to 520

Notes:

1. For simplification of quantitative analyses and associated reporting, the Traditional Design was referred to as Option A and design with the incorporation of LEID elements is referred to as Option B.

3.1.1 Comparison of Water Demand during Construction to other Solar Developments

As described in the scope of work for Task 1 of AECOM's February 17, 2017, proposal, AECOM prepared a comparison of the water demand for construction of other solar developments in the Chuckwalla basin and adjacent Palo Verde Groundwater basin to the water demand of the two design approaches as presented in the POD (referred to therein as Option A and Option B). The solar developments used for comparison of water demand and references are:

- Blythe Solar Power Project (NextEra, 2013),
- McCoy Solar Energy Project (AECOM, 2011),
- Desert Sunlight Solar Farm (Desert Sunlight, 2011), and

- Blythe Mesa Solar Project (Blythe Mesa, 2015)

Because these developments disturbed different areal extents and the length of construction were different, a water usage factor was calculated by dividing the total anticipated water demand by the area disturbed (acres) and by the length of construction (months). Evaluation of the solar developments water usage factors finds that these developments anticipated using between 0.006 acre-feet of water per acre disturbed and months of construction (acre-ft/acre-month) and 0.025 acre-ft/acre-month. The two options presented in the POD would use between 0.018 and 0.029 acre-feet/acre-month. The results of this comparative analysis are presented in **Table 3-2** and also indicate that the anticipated water use as presented in the POD is reasonable.

Table 3-2
Comparison of Water Usage for Other PV Projects to the Crimson Options

PV Project	Groundwater Basin	Acres	Construction Schedule (months)	Anticipated Construction Water Usage (acre-feet)	Anticipated Construction Water Usage Factor (acre-feet/ acre-month)	Operation Schedule (years)	Anticipated Operation Water Usage (acre-feet/year)	Anticipated Total Operational Water Usage (acre-feet)
Blythe Solar Power Project	Palo Verde Mesa	2,035	24	1,200	0.025	30	13-18	450-600
McCoy Solar Power Project	Palo Verde Mesa	4,573	28	650-750	0.006	30	30-45	900-1,320
Desert Sunlight	Chuckwalla	4,176	26	1,400	0.013	30-50	0.30	9-15
Blythe Mesa Solar Project	Palo Verde Mesa	3,660	36	1,354	0.010	20	345	6,900
Crimson Option	**Groundwater Basin**	**Disturbed Acres**	**Construction Schedule (months)**	**Anticipated Construction Water Usage (acre-feet)**	**Anticipated Construction Water Usage Factor (acre-feet / acre-month)**	**Operation Schedule (years)**	**Anticipated Operation Water Usage per Year (acre-feet)**	**Anticipated Total Operational Water Usage (acre-feet)**
Traditional Design	Palo Verde & Chuckwalla	2,274	15	1,000	0.029	30	22.4	672
LEID Elements	Palo Verde & Chuckwalla	1,983	17	600	0.018	30	22.4	672

3.2 Results of Analysis of Water Demand During Operation

Assuming that the 350-MW RE Crimson Solar facility will produce approximately 1,022,000 MWh per year (assuming an average of 8 hours per day, 365 days per year at 100% capacity) , the water demand during operation would be 63 acre-feet per year (based on 20 gallons per MWh)). Applying the range of 0 to 33 gallons per MWh water demand rate the operational water demand would be 0 to 104 acre-feet per year or average 52 acre-ft per year.. The POD proposes a water demand of 22 acre-feet of water per year during operation. This water demand usage is less than half of the estimated water demand usage as indicated by these published sources. However, this water demand usage is within the range of water demand usage possible, based on the range of water use during operation (from 0 to 33 gallons per MWh).

AECOM also reviewed the water demands during operation of other PV solar facilities as shown in **Table 3-2**. AECOM found that the water demand during operation of the other PV solar facilities would vary from 0 to 45 acre-ft per year. The POD proposed water demand of 22 acre-feet of water per year during operation is within the range of water demand usage of the other PV solar facilities.

4. Conclusions

The results of the analysis indicate that the water demands during construction as presented in the POD are very similar to the range of water demand estimates provided in this analysis. Given the assumptions made for the water demand estimates, the water demand for the two options, as presented in the POD, are reasonable. Furthermore, a comparative analysis of water demands during construction of other solar developments also indicates that the anticipated water use as presented in the POD for the two options is reasonable.

The water demand usage during operation is less than half of the estimated water demand usage as indicated by published sources. However, the water demand usage proposed in the POD is within the range of water demand usage of other PV solar facilities.

5. Limitations

It should be recognized that given the absence of detailed design data for the Project at the time of this analysis, there is a degree of uncertainty inherent with this water demand analysis. The acquisition of additional site-specific data (soil properties, detailed construction schedule, etc.), would reduce this uncertainty.

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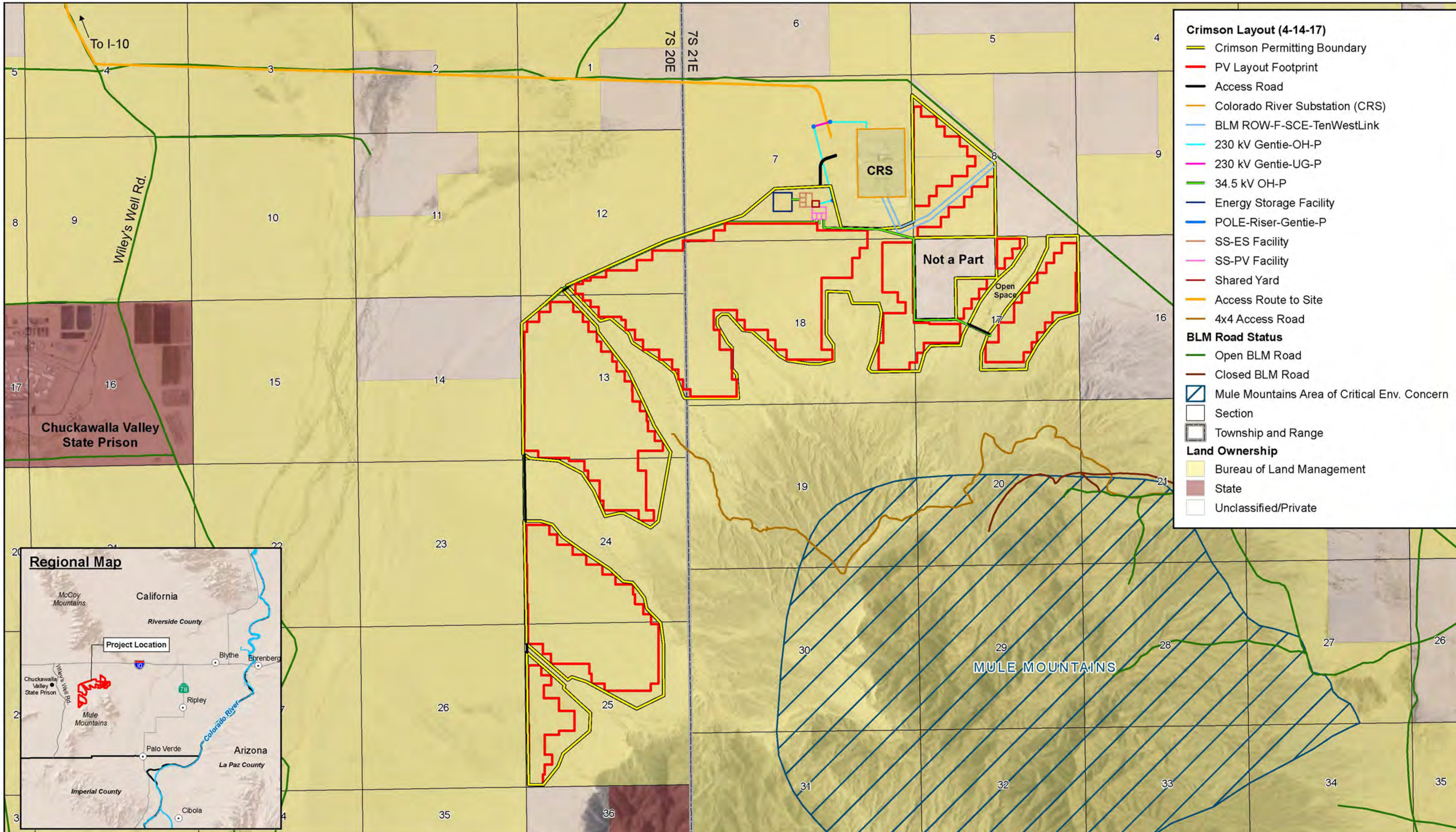
Figures



Source: Recurrent Energy, 2017. AECOM, 2017. esri, 2016.

3,000 0 3,000 Feet

Scale: 1:36,000 1 in = 3,000 feet

FIGURE 1-1
SITE VICINITY

DATE: 8/29/2017

Appendix A

Calculation Spreadsheets – Option A and Option B

SUMMARY

Total Water Estimate (Compaction and Dust Control) for Project Construction

Details for Water Estimate for compaction and dust control requirements are found in Parts A and B that follow

Description	Total Water Estimate in gallons (gal)	Total Water Estimate in Cubic Feet (CFT)	Total Water Estimate in Acre-feet (ac-ft)
Low end of range of Water Est. for Compaction & Dust Control	164,283,052	21,962,975	**504**
High end of range of Water Est. for Compaction & Dust Control	169,543,999	22,666,310	**520**

Details for Water Estimates for Compaction and Dust Control

PART A. Water Estimate for Compaction- Methodology

1. Use Procter density test results from Desert Sunlight Project geotechnical testing average
2. Develop a range of water estimates, assuming a low case based on existing water content of soil and no loss from evaporation up to a high case assuming that existing soil has 0% water content and evaporation loss is 3% during application/compaction
3. Estimate water use for compaction on a total and daily basis

1. Determine Unit Water Demand for compaction on a per cubic yard (of compacted soil) basis by Averaging density testing results from geotechnical report from Desert Sunlight solar project

EarthSystems Southwest (ESS) 01.19.2010 report dug 5 test pits and ran density curves for the soils

Reference: ESS report attachments with maximum dry density/moisture contents of Test Pit samples

Test Pit Location ID	Soil Type (ESS Geologic Mapping)	Max Dry Density (lb/cft)	Correspond Optimum Moisture %	% Sand
	Average	**128.1**	**8.5%**	**71%**

Assume that test pits represent site soils equally

Assume that site soils are compacted at optimum moisture contents

EUC 2007 reported inplace moisture content was measured at 1.1%, 1.0 %, and 0.9% (average of 1.0%)

Reference: Eberhart United Consultants (EUC); Phase 1 Geologic Recon. Report; Project, (06/21/07)

LOW CASE = Assume that Fill has in-place moisture content of 1%, and that moisture conditioning of fill has a 3% (dry soil basis) loss

HIGH CASE = Assume that Fill has existing moisture content of 0%, and that moisture conditioning of fill has a 5% (dry soil basis) loss

Water Estimates for Compaction and Dust Control
Crimson Solar Facility - Option B

	Averaged Max Dry Density (lb/CFT)	Correspond. Optimum Moisture %	Water Content % Estimated for Compaction	Unit Water required for Compaction (lb per CFT)	Unit Water required for Compaction (lb per CYD)	Unit Water required for Compaction (Gal per CYD)
Low range of Compaction water usage	128.1	8.5%	10.5%	13.5	363	44
High range of Compaction water usage	128.1	8.5%	13.5%	17.3	467	56

2. Basis for Water Est. Earth work quantities from Table 6-1 Comparison of Design Options POD, April 2017 and Assumptions

0 cubic yards of soil excavated and then filled for no tortoise fence

55370 cubic yards of soil excavated and then filled for 104 acres of module install at 0.33 ft deep average

220220 cubic yards of soil excavated and then filled for (1/2) of 91 acres of substation/O&M/inverters install at 3 ft deep average

0 cubic yards of soil excavated and then filled for aboveground conduit

146813 cubic yards of soil excavated and then filled for 91 acres of on-site hydromodification at an average of 0.5 inches depth

Chemical control- no soil graded

Long term exclusion- no grading

Earthwork will involve 422,403 TOTAL cubic yards of grading

422,403 CYD Grading for fence, area smoothing, substations and hydromodification and 0 cubic yards Trenches

Earthwork Assumptions

Smoothing grading of 104 acres for module install is an average change of 0.33 ft deep

Grading of 91 acres for substations/O&M site/Inverters is an average depth of 3 ft deep

Grading of 91 acres for hydromodification is an average depth of 1 ft deep

Construction Schedule for grading is (Crimson schedule dated 4/7/17 version)

Total grading period is 11 months,(48 weeks) at 5 days a week or total 240 days

No Factor of Safety

3. Est. Water Use for Compaction

	Total Water Estimated (gal)	Total Water Estimated (CFT)	Total Water Estimated (ac-ft)	Daily Water Requirement (GPD)	Daily Water requirement (ac-ft per Day)
Low end of range of Water Requirement for Compaction	18,413,315	2,461,673	57	76,722	0.2
High end of range of Water Requirement for Compaction	23,674,262	3,165,008	73	98,643	0.3

Water requirement on daily basis is an average and does not account for peak demands

PART B. Water Est. for Dust Control- Methodology

1. Using published sources to determine a water demand unit rate recommended for dust control
2. Determine schedule for dust control requirements
3. Determine dust control requirements for each step of project construction
4. Calculate water Est. (total and use per day)

1. Estimate unit water demand for dust control on a per square yard of unpaved area (can be a road)

Estimate unit rate for water application

Reference: Mojave Desert AQMD Emission Inventory Guidance for Mineral Handling and Process Industry
(based on USEPA AP-42 (9/98) on Unpaved Roads)

Item K, Dust Entrainment from Unpaved Roads, page 31, provides the following guidance

Reference Water application rate (I) is	0.11	gallons per square yard (MAQMD recommendation)
Frequency for water application (T) is	1	hours
Reference evaporation rate (A)	75	inches (average annual) from Class A Pan evaporation rate (MAQMD example)

Control efficiency (Cf) for any water application rate is derived from

Cf = 100-(0.0012*(A*D*T/I)   where D is Average Hourly traffic rate in vehicles/hour

Determine water application rate for site assuming equivalent control efficiency for

Avg. traffic rate	20	vehicles/hour
Cf =	84%	Control Efficiency derived for Project
Pan evaporation rate for Project is	158	inches (average annual) from Class A Pan evaporation rate

Reference CA DWR Bulletin 73-39 (11/79) Evaporation from Water Surfaces in CA, p 129

Calculate water application rate required for project adjusted for actual Class A evaporation rate applicable to area

I=	0.232	gallons per square yard (SYD)

Assume 10 hour construction days

Assume that areas are watered ~ten times each day during construction period (beginning, every 1 hour)

(I) Required per day for dust cont	2.32	gallons per square yard application rate

2. Description and Schedule of Site Activities Requiring Dust Control (from Project Schedule)

1. Site Preparation-
2. Grading-initial earthmoving for hydromodification and PV install/vegetation removal/cutting
3. Internal Road Maintenance
4. Active areas for Post Driving, Tilt table and PV module install
5. Install conduits
6. Inverters and Substation Construction

3. Basis for Water Estimate for Dust Control for each activity

1. Site Preparation-

Duration is	86	work days		First Row, Project Schedule Crimson PV continuous build, Low Impact construction 2107.04.17
				Assume that internal road (B.3.3) allows access to fence construction
Fence work area is	15	feet wide		Based on Table 6-1, line 1; 42 acres disturbed /23 miles of fence
Total length of fence is	121440	feet		or 23 miles of fence
Avg length for dust control	1412	feet per day		Based on 4-month duration
Apply water at daily rate				
Fence Active Construction area	2353	SYD per day		
Water Reqmnt	5456	GPD, based on	2.32	gallons per square yard application rate
Truck trips	1	trip/day based on	4000	gallons per truck trip
Total Water Req'd	469238	gallons or	1	ac-ft

2. Grading-initial earthmoving for hydromodification and PV install/vegetation removal/cutting

Dust Control for soil moving /cut & fill before compaction				
Duration is	215	work days		2nd to 3rd Row, Project Schedule Crimson PV continuous build, Low Impact construction 2107.04.17
Assume	2274	ac total for project grading		
or	11006160	Square Yards (SYD) total		
Rate-soil disturb	51191	SYD/day or	10.6	acres/day
Water Reqmnt	118681	GPD, based on	2.32	gallons per square yard application rate
Truck trips	30	trips/day based on	4000	gallons per truck trip
Total Water Req'd	25516330	gallons or	78	ac-ft

3. Internal Road Maintenance

Duration is	366	work days		1st to 6th Row, Project Schedule Crimson PV continuous build, Low Impact construction 2107.04.17
				Assume main access road is from east perimeter to NE corner and then to southern most perimeter
Assume roads are	20	feet wide		Based on POD description
Total length of road is	35000	feet		Rough estimate measured from Sheet 2.0 dated 5/10/17
Avg length for dust control	23333	feet		Assume 2/3 of road length average for duration of project will need dust control
Apply Road Palliative and then apply water at daily rate				
Road Maintenance area	51852	SYD per day average		
Water Reqmnt	120212	GPD, based on	2.32	gallons per square yard application rate
Truck trips	30	trips/day based on	4000	gallons per truck trip
Total Water Req'd	43937368	gallons or	135	ac-ft

4. Active areas for Post Driving, Tilt table and PV module install

Dust suppression for time period completion of PV panel installation, or the Active Work Area for PV install

Total Duration is	236.5	work days	2nd to 4th Row, Project Schedule Crimson PV continuous build, Low Impact construction 2107.04.17	
Total Disturbance	2208	total acres modules	Based on Table 6-1, line 2; 2088 acres disturbed	
Avg Disturbance/day	9.3	acres per day	Based on Total Acres disturbed / Total work days	

Note that there are 3 major activities- Post Driving, Tilt Table construction and PV module install, that will be performed in sequence such that each area is disturbed three times over project

or	135561	SYD for the active working areas (three times average) /day		
Water Reqmnt	314280	GPD, based on	2.32	gallons per square yard application rate
Truck trips	79	trips/day based on	4000	gallons per truck trip
Total Water Req'd	74327251	gallons or	228	ac-ft

5. Install conduits

Duration is	215	work days	5th Row, Project Schedule Crimson PV continuous build, Low Impact construction 2107.04.17

Assume that open trench area will need dust control

Trench Working Width	20	feet -derived from POD Table 6-1 53 ac divided by 22 miles of trench		
Total length of trench is		116,160	LF based on	Table 6-1 in the POD or 22 miles
Total Trench Working Area		258133	SYD	
Avg working area trench/day	1201	SYD/day trenching progress		

Water Reqmnt	2783	GPD, based on	2.32	gallons per square yard application rate
Truck trips	1	trips/day based on	4000	gallons per truck trip
Total Water Req'd	598448	gallons or	1.84	ac-ft

6. Inverters and Substation Construction

Duration is	258	work days		5th Row and 6th, Project Schedule Crimson PV continuous build, Low Impact construction 2107.04.17
Assume	91	ac total for project grading		
or	440440	Square Yards (SYD)		
Rate-soil disturb	1707	SYD/day		
Water Reqmnt	3958	gal/day, based on	2.32	gallons per square yard application rate
Truck trips	1	trips/day based on	4000	gallons per truck trip
Total Water Req'd	1021102	gallons or	3.1	ac-ft

3. Calculate Water Use for Dust Control

Milestone and Activities Going Forward (using above # designation)	Date	Total # Work Days	Water Est. (GPD) for Dust Control	Water Est. for Dust Control (CFT) per day	Water Est. for Dust Control (ac-ft per Day)	Total Water Dust Control (ac-ft) for Period	Total Water Dust Control (ac-ft) Cumul.
1. Site Preparation-	8/1/2020	86	5,456	729	0.02	1.44	1.44
2. Grading-initial earthmoving for hydromodification and PV install/vegetation removal/cutting	9/1/2020	215	118,681	15,866	0.36	78.31	79.8
3. Internal Road Maintenance	8/1/2020	365.5	120,212	16,071	0.37	134.85	214.6
4. Active areas for Post Driving, Tilt table and PV module install	9/1/2020	236.5	314,280	42,016	0.96	228.12	442.7
5. Install conduits	2/1/2021	215	2,783	372	0.01	1.84	444.6
6. Inverters and Substation Construction	2/1/2021	258	3,958	529	0.01	3.13	447.7
End of Construction Water Estimate for Dust Control							447.7

Item	**Dust Control Total Water Estimate (ac-ft)**	
1. Site Preparation-	1	
2. Grading-initial earthmoving for hydromodification and PV install/vegetation removal/cutting	78	
3. Internal Road Maintenance	135	
4. Active areas for Post Driving, Tilt table and PV module install	228	
5. Install conduits	2	
6. Inverters and Substation Construction	3	
TOTAL	448	ac-ft

U.2 Water Supply Assessment, December 2018

AECOM Imagine it. Delivered.

RE Crimson Solar Project

by Sonoran West Solar Holdings, LLC

Water Supply Assessment

Project Number: 60487757

December 2018

Quality information

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Figures

Tables

Acronyms and Abbreviations

°F	degrees Fahrenheit
AF	acre feet
AFY	acre feet per year
AB	Assembly Bill
CRA	Colorado River Aquaduct
CEQA	California Environmental Quality Act
CVGB	Chuckwalla Valley Groundwater Basin
CWP	California Water Plan
DWR	Department of Water Resources
IRWMP	Integrated Regional Water Management Plan
LEID	low environmental impact design
mg/L	milligrams per liter
MW	megawatt
PV	photovoltaic
PVID	Palo Verde Irrigation District
PVMGB	Palo Verde Mesa Groundwater Basin
Project	Crimson Solar Project
SB	Senate Bill
TDS	Total Dissolved Solids
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WMWD	Western Municipal Water District
WSA	Water Supply Assessment

1. Introduction

Senate Bill (SB) 610 amended the California Water Code (§ 10910, *et seq.*) to promote collaborative planning to "improve the link between information on water supply availability and certain land use decisions made by cities and counties" (California Department of Water Resources [DWR] 2003). SB 610 requires the preparation of a Water Supply Assessment (WSA) for any project that is subject to the California Environmental Quality Act (CEQA), provided it qualifies as a "project" and is not otherwise exempt under the relevant provisions of the Water Code. A WSA must examine the availability of an identified water supply under normal year, single-dry year, and multiple-dry year conditions over a 20-year projection, accounting for the projected water demand of the project in addition to other existing and planned future uses of the identified water supply.

1.1 Project Location and Description

Sonoran West Solar Holdings, LLC (applicant), a wholly owned subsidiary of Recurrent Energy (RE), proposes to construct and operate the RE Crimson Solar Project (Project). The Project would involve the construction, operation, and eventual decommissioning of a utility-scale solar photovoltaic (PV) and energy storage facility. The Project would be located on approximately 2,735 acres of federal public lands managed by the Bureau of Land Management (BLM). The Project site is located within the California Desert Conservation Area planning area in unincorporated eastern Riverside County, approximately 13 miles west of Blythe, California, within the BLM-designated Riverside East Solar Energy Zone/Development Leasing Area and Development Focus Area. The Project would interconnect to the regional electrical grid at the Southern California Edison 220-kilovolt Colorado River Substation, and would generate up to 350 megawatts (MW) of renewable energy using PV technology with up to 350 MW of integrated energy storage capacity. A vicinity map showing the permitting (development) boundary is presented on **Figure 1-1**.

The Project applicant is proposing to construct the Project using a traditional construction approach consisting of desert tortoise exclusion fencing, a mow and roll approach to site preparation, compacted roads, and trenching for electrical lines; however, the applicant is actively investigating alternative low environmental impact design (LEID) elements and the potential for those to reduce Project impacts.

Per the RE'sPlan of Development, water demand during construction for the Traditional Design is 1,000 acre feet (AF), and with the incorporation of all LEID elements is 600 AF. The principal uses for construction water will be dust control during site preparation, trenching, and panel installation, and along access ways during the construction phase, and would also be required for temporary construction trailers and fire safety requirements. The water demand for operations and maintenance (O&M) would be approximately 22 acre feet per year (AFY). The principal uses for operations and maintenance water will be for PV module washing. Additional potable water may be delivered for operations and maintenance staff domestic use. The Project is outside of the Palo Verde Irrigation District (PVID) service boundary and therefore cannot supply a long term water source to the project. However, PVID can supply water for short term projects; therefore, PVID water is an option for construction. Construction water will be suppled from either PVID, and/or new wells located on the Project site, or an off-site well located approximately 4 miles northeast of the Project in the PVMGB, or a combination of the three sources.

O&M water for the Project will be supplied from either new wells located on the Project site or an off-site well located approximately 4 miles northeast of the Project in the PVMGB, or a combination of the two sources. It is anticipated that any off-site water supply would be trucked to the site. Water will be stored in [enclosed tanks, off-site ponds, etc.] prior to use.

2. Regulatory Setting

SB 610 amended the California Water Code by requiring a WSA to be prepared for projects subject to CEQA unless otherwise exempt under the relevant provisions of the Water Code. The Project is subject to CEQA and may currently be considered a "Project" as defined by the Water Code because it is a proposed industrial facility occupying more than 40 acres of land.[1] A WSA must examine the availability of an identified water supply under normal year, single-dry year, and multiple-dry year conditions over a 20-year projection, accounting for the projected water demand of the project in addition to other existing and planned future uses of the identified water supply. Anticipated annual water demands from the Project are summarized in **Table 4.1-1** (Chapter 4).

2.1 Senate Bill 610 Applicability

The DWR published a Guidebook for Implementation of SB 610 in 2001 to assist water suppliers, cities and counties in integrating water and land use planning (DWR 2003). While the DWR has no regulatory authority concerning WSAs, this WSA is organized following the suggestions provided in the Guidebook to ensure this document provides the information required under SB 610.

Chapter 3 provides background on water resources in the Chuckwalla Valley and Palo Verde Mesa regions. **Chapter 4** documents water supplies relevant to the Project, identifies Project water demands, and assesses whether the projected water supply is sufficient or insufficient for the Project. **Chapter 5** provides the conclusions.

2.1.1 Existing Public Water Systems

A public water system is defined in Water Code § 10912 as "a system for the provision of piped water to the public for human consumption that has 3,000 or more service connections." The Palo Verde Irrigation District (PVID) is the nearest public water system to the Project. The PVID boundary is approximately 1.0 mile from the Project at its closest point. There is no public water system ("water supplier") for the Project, and Project water demand has not been assessed under existing WSAs.

2.1.2 Existing Water Management Plans

Public water systems are required by the California Water Code to prepare Urban Water Management Plans (UWMP) to carry out "long-term resource planning responsibilities to ensure adequate water supplies to meet existing and future demands for water" (Water Code § 10610.2). UWMPs are prepared using input from multiple water systems operating in the region and include assessment of the reliability of water supply over a 20-year period and account for known and projected water demands during that time, including during normal, single-dry, and multiple-dry water years. WSAs commonly incorporate assessment of project-related water demands from UWMPs and other assessments and plans.

The Project area is not located within the service area of any public water systems. There is no UWMP plan or Integrated Regional Water Management Plan Report (IRWMP) for the area. The

[1] Prior to January 1, 2018, the Water Code included an exception from it definition of "Project" and, hence, its WSA requirement, for proposed PV energy generation facilities approved on or after October 8, 2011, if the facility would demand no more than 75 AF of water annually. See Cal. Water Code, Section 10912(a)(5)(B) (2017 version). While legislative proposals to extend the PV exception have been pending in the California Legislature, as of the date of this WSA, such legislation has not been enacted. In the event this exception is extended as previously written, the Project would be exempt from the WSA requirement based on the amortized annual water use of the Project, which would be below 75 AFY.

City of Blythe, California has prepared a UWMP; however, the Project is located approximately 13 miles west of the city limits. Information from UWMPs describing water supply in the region is incorporated into this WSA. Assessments that provide information relevant to water supply in the Project region include the UWMP for the City of Blythe, and the updated IRWMP (City of Blythe 2011; WMWD 2008).

2.2 Groundwater Supply Evaluation

Water Code § 10910(f) requires that a WSA for a project that proposes the use of groundwater include an analysis of groundwater supply to satisfy the requirements listed below. The Water Code requirements are addressed in the sections that follow, as indicated in parentheses after each requirement:

1. A review of any information contained in the UWMP relevant to the identified water supply for the proposed project (Section 3.3.2);
2. A description of any groundwater basin or basins from which the proposed project will be supplied (**Section 3.2**);
3. 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 has the legal right to pump under the order or decree (**Section 3.2**);
4. A detailed description and analysis of the amount and location of groundwater pumped 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, historic use records (**Section 4**);
5. A detailed description and analysis of the amount and location of groundwater that is pumped 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, historic use records (**Section 4**); and
6. 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 (**Section 4**).

The Project proposes to use water from PVID (construction only) and/or new or existing groundwater wells that are not currently part of a public water system and, therefore, lack detailed records.

3. Water Resources

The Project is located within the Chuckwalla Hydraulic Unit watershed which overlies the Chuckwalla Valley Groundwater Basin (CVGB) and the Colorado Hydraulic Unit watershed which overlies the Palo Verde Mesa Groundwater Basin (PVMGB) (DWR 2014).

3.1 Surface Water Resources

3.1.1 Watersheds

Chuckwalla Hydraulic Unit

The western portion of the Project site is located within the Chuckwalla Hydraulic Unit (Chuckwalla Watershed), which covers approximately 1,960 square miles ranging from 350 to 3,800 feet in elevation, comprising the Palen and Chuckwalla Valleys and the surrounding mountains in eastern Riverside County and northern Imperial County (CRA 1999; DWR 1979) (**Figure 3-1**). The watershed is bounded by the Coxcomb, Granite, Palen, and Little Maria Mountains on the north, the Mule and McCoy Mountains on the east, the Chuckwalla, Little Chuckwalla, and Mule Mountains on the south, and the Eagle Mountains on the west. The climate in the Chuckwalla Watershed is typical of a semi-arid desert region, with mean daily temperatures from 64 degrees Fahrenheit (°F) to 108°F during the summer and 41°F to 66°F during the winter, and average annual precipitation of up to 4 inches (DWR 2004a, WRCC 2017).

Natural surface water is typically generated from storm water runoff in the hills and mountains surrounding the Chuckwalla and Palen Valleys, which flows via ephemeral streams into the valleys across alluvial fans and deeply excised washes. No perennial streams are located within the Chuckwalla Watershed (DWR 2004a). The Chuckwalla Watershed is a closed basin, which means that there is no outflow of surface or ground water from the basin unless it is conveyed by artificial means (e.g., canal) (Argonne 2013). Most drainages in the watershed terminate within or near the Palen, Ford, and several smaller dry lakes, which are located at topographic low points within the watershed. Surface water runoff that collects in these dry lakes evaporates quickly; therefore, most infiltration and groundwater recharge within the Chuckwalla Watershed is assumed to occur in the upgradient areas of the ephemeral streams and washes between the headwaters and the valley floor (CRBC 2000).

Colorado Hydraulic Unit

The eastern portion of the Project site is located within the Colorado Hydraulic Unit (Colorado Watershed), which covers approximately 1,950 square miles within California ranging from 300 to 4,300 feet in elevation, comprising the Parker and Palo Verde Valleys in eastern Riverside County, and smaller valleys in eastern Imperial County, and southern San Bernardino County (CRA 1999; DWR 1979) (**Figure 3-1**). The watershed is bounded by the Whipple and Turtle Mountains on the north, the Colorado River on the east, the Chocolate Mountains on the south, and the Chuckwalla, Mule and McCoy Mountains on the west. The climate in the Colorado Watershed is typical of a semi-arid desert region, with mean daily temperatures from 64 degrees °F to 108°F during the summer and 41°F to 66°F during the winter, and average annual precipitation of up to 4 inches (DWR 2004b, WRCC 2017).

Natural surface water is typically generated from percolation of storm water runoff in the hills and mountains surrounding the Parker and Palo Verde Valleys, which flows via ephemeral streams into the valley across alluvial fans and deeply excised washes. The valleys are drained by the McCoy Wash to the Colorado River (DWR 2004b). Most infiltration and groundwater recharge within the Colorado Watershed is assumed to occur in the upgradient areas of the ephemeral streams and washes between the headwaters and the valley floor (CRBC 2000).

3.1.2 Surface Water Supply

Surface water from the Colorado River supplied through the PVID is the primary source of water for agriculture in the area. Colorado River water is diverted at the Palo Verde Diversion Dam located at the northern end of the Palo Verde Valley and supplied through canals to the Palo Verde Valley and Palo Verde Mesa (PVID 2002). The PVID coverage area extends over most of the PVMGB; however, the western limits of the PVID service area end approximately 1 mile east of the Project. Because the Project does not lie within the PVID boundaries, a long-term water supply for the Project cannot be obtained from PVID; however, water may be obtained for temporary purposes, such as construction projects.

The Colorado River Aqueduct (CRA) passes through the northern portion of the CVGB and supplies Colorado River water to the Western Metropolitan Water District (WMWD 2008). The Project is not located within the WMWD service area.

3.1.3 Surface Water Quality

The surface water supplies are diverted from the Colorado River by PVID, which supplies non-potable water suitable for agricultural use (PVID 2002).

3.2 Groundwater Resources

The majority of water to be used during construction and O&M of the Project's solar facilities will be groundwater pumped from an existing nearby well located within the PVMGB and/or a new on-site well located within the CVGB or PVMGB. The groundwater basins underlying the Project location are not adjudicated, and owners of property overlying the basins possess the right to pump groundwater from the basin for reasonable beneficial use provided the water rights were never reserved or severed (DWR 2018).

3.2.1 Groundwater Basins

Chuckwalla Valley Groundwater Basin

The Project site lies in the Colorado River Hydrologic Region, which is subdivided into 28 groundwater basins (DWR 2013). The western portion of the Project site overlies the CVGB, a broad alluvial-filled valley which covers approximately 940 square miles and is fed by and generally underlies the Chuckwalla Watershed. The CVGB is bounded by the Coxcomb, Granite, Palen, and Little Maria Mountains to the north, the Mule and McCoy Mountains on the east, the Chuckwalla, Little Chuckwalla, and Mule Mountains on the south, and the Eagle Mountains on the west and underlies the Palen and Chuckwalla Valleys (**Figure 3-1**) (DWR 2004a; USGS 2013). Groundwater recharge is primarily provided by subsurface inflow from the Pinto Valley, Cadiz Valley, and Orocopia Groundwater Basins, and by percolation of runoff from the surrounding mountains and hills as well as precipitation to the valley floor (USGS 2013). Groundwater is produced by three main aquifers within the CVGB, including the Holocene-age alluvium, the Pleistocene-age Pinto Formation, and the Pliocene-age Bouse Formation. The Holocene-age alluvium is the most important aquifer in the CVGB and although faults may be present, there are no known barriers to inhibit groundwater flow (DWR 2004a).

Palo Verde Mesa Groundwater Basin

The eastern portion of the Project site overlies the PVMGB, an alluvial-filled valley which covers approximately 353 square miles and is fed by and generally underlies the central portion of the Colorado Watershed. The PVMGB is bounded by the Big Maria and Little Maria mountains to the north, the McCoy and Mule Mountains to the west, the Palo Verde Mountains to the south, and the Palo Verde Valley to the east (**Figure 3-1**) (DWR 2004b). The PVMGB is separated from the CVGB to the west by the McCoy and Mule Mountains. Groundwater recharge is primarily provided by percolation of runoff from the surrounding mountains and hills as well as precipitation to the valley floor and subsurface inflow through a gap in the McCoy and Mule Mountains. Groundwater is produced by one main aquifer within the PVMGB found in Quaternary-age alluvium and there are no known barriers to inhibit groundwater flow (DWR 2004b).

3.2.3 Groundwater Quality

Chuckwalla Valley Groundwater Basin

The groundwater quality in the principle aquifer in the CVGB is suitable for industrial uses. Total Dissolved Solids (TDS) range from 274 milligrams per liter (mg/L) to 12,300 mg/L within this aquifer, with higher water quality in the western portion of the basin where TDS ranges from 275 mg/L to 730 mg/L (DWR 2004a). Elevated levels of sulfate, chloride, fluoride, and TDS indicate groundwater would not be suitable for domestic supply without treatment. Elevated levels of boron, sodium and TDS would impair groundwater for agricultural supply unless treated (DWR 2004a).

Palo Verde Mesa Groundwater Basin

The groundwater quality in the PVMGB is suitable for agriculture and industrial uses. According to the DWR (1979) report, the TDS content of shallow groundwater in the basin ranges from 730 to 3,100 mg/L; however, one deep well in the southwest portion of the basin had a TDS content of 4,500 mg/L. Analyses of water from eleven public supply wells in the PVMGB show that TDS content ranges from 590 to 1,790 mg/L and averages approximately 1,089 mg/L (DWR 2004b). Elevated levels of arsenic, selenium, fluoride, chloride, boron, and sulfate indicate groundwater would not be suitable for domestic supply without treatment (DWR 2004b).

3.2.4 Recharge and Storage Capacity

Chuckwalla Valley Groundwater Basin

In the semi-arid CVGB, natural recharge primarily originates from runoff from the surrounding mountains in ephemeral streams that flow into underlying aquifers, in addition to recharge from irrigation, precipitation, aqueduct leakage, and underflow from adjacent areas including the Pinto and Cadiz valleys (Metzger 1973; DWR 1979). These sources naturally recharge the groundwater supplies in the CVGB and are important in maintaining a sustainable balance of stored groundwater. Groundwater movement in the CVGB has been reported to be southeasterly toward the Palo Verde Mesa (DWR 2004a).

Subsurface inflow from the Pinto Valley Groundwater Basin has been estimated to be 937 AFY (Argonne 2013). Argonne estimated aqueduct leakage from the CRA at 2,000 AFY. Infiltration via precipitation is most likely low due to evaporation (Metzger 1973). Recharge via irrigation water is unknown, although a fraction of applied irrigation water may act to recharge the basin through infiltration and deep percolation. Total natural recharge in the basin has been estimated to be 800 AFY (Argonne 2013). Natural recharge varies annually based on climate variability. Total recharge to CVGB is estimated to be 3,737 AFY.

The total storage capacity of the CVGB has been reported as 9.1 million AF (DWR 2004a). This storage capacity estimate does not reflect actual quantities of available groundwater within the CVGB. While the actual discharge from the CVGB is not known, the absence of significant changes in water level data in the CVGB over time suggest the groundwater basin is not in overdraft.

There are four groundwater monitoring wells located within 3 miles of the Project area within the CVGB that are regularly monitored by the USGS (USGS 2017). Depth to groundwater measured at these wells ranges from 152.73 to 236.91 feet over the past twelve years, with groundwater elevation remaining generally stable for each well over this same period. This data suggests that the groundwater basin is not in overdraft nor would it be reasonably expected to be so in the future even with the onset of the proposed Project construction and operational water use.

Palo Verde Mesa Groundwater Basin

Natural recharge in the semi-arid PVMGB primarily originates from runoff from the surrounding mountains in ephemeral streams that flow into underlying aquifers, in addition to recharge from irrigation, precipitation, and underflow from adjacent areas including the Chuckwalla and Rice Valleys (Metzger 1973; DWR 1979). These sources naturally recharge the groundwater supplies in the PVMGB and are important in maintaining a sustainable balance of stored groundwater. Groundwater movement in the PVMGB has been reported to be southeasterly toward the Palo Verde Valley (DWR 2004b).

Subsurface inflow from the CVGB has been estimated to be 400 AFY (DWR 2004b). Infiltration via precipitation is most likely minimal due to evaporation (Metzger 1973). Recharge via irrigation water diverted from the Colorado River and supplied to the Palo Verde Mesa via the PVID is unknown, although a fraction of applied irrigation water may act to recharge the basin through infiltration, deep percolation, and canal seepage. Recharge from applied irrigation water has been estimated at approximately 3,561 AFY (AECOM 2010). Total natural recharge in the basin has been estimated to be 800 AFY (DWR 2004b). Natural recharge varies annually based on climate variability. Total recharge to PVMGB is estimated to be 4,761 AFY. The total storage capacity of the PVMGB has been reported as 6.84 million AF (DWR 2004b).

While the actual discharge from the PVMGB is not known, the discharge for agricultural use may in the past have exceeded the natural recharge. The absence of significant changes in water level data in the PVMGB over time suggest a buffering effect from another source of recharge, such as the Colorado River, contributing to steady-state groundwater conditions (Metzger 1973). As such, the groundwater basin is not in overdraft nor would it be reasonably expected to be so in the future even with the onset of the proposed Project construction and O&M water use.

There is one groundwater monitoring well located within 3 miles of the Project site within the PVMGB that is regularly monitored by the USGS (USGS 2017). Depth to groundwater measured at this well ranges from 136.53 to 137.59 feet over the past twelve years, with groundwater elevation remaining generally stable over this same period.

3.3 Groundwater Management

California DWR's Bulletin 118 is a periodically updated record of California's groundwater resources that defines groundwater basin boundaries, describes hydrological characteristics of those basins, provides information on groundwater management, and forecasts future conditions. Bulletin 118 was last updated in 2016.[2] The 2016 update to Bulletin 118 does not provide a groundwater budget or estimates of overdraft for the CVGB or PVMGB (DWR 2004).

The California Statewide Groundwater Elevation Modeling Program prioritizes Bulletin 118 groundwater basins according to need for additional groundwater level monitoring. Basins are prioritized according to population overlying the basin, current and projected population growth, number of public supply wells, total number of wells, irrigated acreage, reliance on groundwater as primary source of water, and documented overdraft, subsidence, and water quality degradation. A leading indicator of basin priority is the reliance on groundwater as the primary source of water. The CVGB and PVMGB are both designated as low priority (DWR 2014).

The California Water Plan (CWP), also known as Bulletin 160, is the State's strategic plan for managing and developing water resources. The DWR updates the CWP every five years to present status and trends of available surface and groundwater resources and projected water demands; the most recent update to the CWP was completed in 2013 (DWR 2014). The 2013 CWP presents reports for ten hydrological regions covering the state. The CVGB or PVMGB are located within the Colorado River hydrologic region.

3.3.1 Water Budget and Safe Yield

The majority of groundwater users are not required to monitor and report their use in California. The DWR estimates extraction of groundwater across the state using land and water use information such as urban use reported by service districts, land use surveys, surface water use information, and reported extraction from voluntary reporting (DWR 2014). The DWR compiles groundwater use estimates into planning areas. There are six DWR planning areas in the Colorado River hydrologic region, including the Chuckwalla planning area, which approximates the land area overlying the CVGB, and the Colorado River planning area, which includes the land area overlying the PVMGB.

The DWR's estimate of average annual groundwater use in the Chuckwalla planning area between 2005 and 2010 was 4,700 AF, the second lowest of the six planning areas in the Colorado River hydrologic region, although the percentage of total water use supplied by groundwater in the Chuckwalla planning area was the highest in the hydrologic region, at 98% (DWR 2014). During the same timeframe, the DWR's estimate of average annual groundwater use in the Colorado River planning area was 10,800 AF, and the percentage of total water use supplied by groundwater in the Colorado River planning area was the second lowest in the hydrologic region at 2% (DWR 2014). The Colorado River planning area's relatively low reliance on groundwater compared to other planning areas in the region is likely due to the availability of water from the Colorado River for urban and agricultural uses (DWR 2014).

The 2013 CWP did not present a water budget showing the CVGB or PVMGB was in a state of overdraft, but noted reduced precipitation in the Colorado River basin and Sierra Nevada range would reduce the imported water supply for the Colorado River region and subsequent overpumping could cause potential overdraft of the regional groundwater basins (DWR 2014).

3.3.2 Supply Management Plans

Water Code § 10750-10755 was established with the intent of ensuring safe groundwater production and quality through basin-level groundwater management programs. As a direct result of this legislation, Assembly Bill (AB) 3030 instituted a systematic procedure for existing

[2] The 2016 interim update to Bulletin 118 did not address the Chuckwalla Valley or Palo Verde Mesa Groundwater Basins.

local agencies to develop these management programs through Groundwater Management Plans in 1992. As established under AB 3030, Groundwater Management Plans may be voluntarily developed and will include basin management objectives, cooperation with other agencies whose service area or boundary overlies the basin; maps of the plan area recharge areas, and adoption of monitoring protocols (DWR 2014). Subsequent legislation required public agencies to prepare and implement Groundwater Management Plans if an agency seeks state funds administered through the DWR to construct groundwater projects in 2002 (SB 1938), and in 2011 required that plans include a component that focuses on identifying groundwater recharge areas (DWR 2017). The Sustainable Groundwater Management Act of 2014 was enacted to further groundwater management in basins that are most threatened by overuse by prioritizing basins, establish sustainability plan requirements, form local groundwater management agencies and create timelines for management plans.

The City of Blythe, California, has prepared a UWMP; however, the Project is located outside the city limits and is not located within the service area of any public water systems. There is no public water system with the capacity to serve the Project, nor is there a groundwater basin management plan or UWMP covering the Project.

4. Water Supply Availability

The Project site is located in an area without a public water purveyor that can practicably provide a long-term water supply for the Project, as the PVID service area is located east of the Project site. While a water supply for the construction phase of the Project may be obtained from PVID, the only practicable long-term water sources for the Project are the underlying Chuckwalla Valley and Palo Verde Mesa Groundwater Basins. The Project water needs will be met via installation and utilization of an on-site well within the CVGB or the PVMGB, and/or utilization of an existing off-site groundwater well (ID 007S 021E 01C001S) within the PVMGB.

The Project would be located on 2,735 acres of undeveloped land. No known groundwater use occurs on the Project site, nor are there any known records of groundwater wells on the Project site. Locations of groundwater wells in the Project vicinity are depicted on **Figure 4-1**.

4.1 Project Water Demands

Project water demands are divided into construction and O&M phases. The majority of water use for the Project would occur during the initial 17-month construction phase (**Table 4.1-1**). The construction phase is anticipated to begin fall 2020. Water would primarily be used for dust control during site preparation, trenching, and panel installation, and along access ways during the construction phase, and would also be required for temporary construction trailers and fire safety requirements. Total quantity of water use during construction will vary depending on which construction alternative is selected. The peak annual water use during construction Option A is up to 1,000 AF in fall 2020 through fall 2021.

Table 4.1-1 Construction Phase Project Water Requirements

Year	2020 - 2021	
Design Option	**Traditional Design - Option A**	**LEID Elements - Option B**
Water Usage (AF)	1,000	600

The Project's operational water consumption is expected to be approximately 22 AFY, used for photovoltaic solar panel washing. Potable water would be imported for O&M staff consumption.

Table 4.1-2 identifies the Project's estimated annual water requirements over 20 years from the start of construction to satisfy the analysis time frame required under SB 610. The total maximum forecasted Project water use over 20 years is 1,418 AF. Maximum groundwater use over the term of construction and operation, which is estimated to be a period of approximately 31.4 years, is estimated to be 1,660 AF.

Table 4.1-2 20-year Annual Project Water Supply Requirements

Year	1	2	3	4	5	10(1)	15	20
Acre-feet	1,000	22	22	22	22	110	110	110
5-Year Average	-	-	-	-	217.6	22	22	22
Total (2)	*1,000*	*1,022*	*1,044*	*1,066*	*1,088*	*1,198*	*1,308*	*1,418*

Notes:
(1) 22 AFY for 5 years = 110 AF
(2) Total = running total of all water supply requirement from previous years

4.2 Projected Water Supply

Water supply for the construction phase of the Project may be obtained from PVID. Operational water supply for the Project would be provided via installation and utilization of an on-site well within the CVGB or PVMGB, and/or utilization of an existing off-site groundwater well within the PVMGB.

Water provided by PVID would be trucked into the Project site. The most feasible access point to provide water for the Project would be at a canal located near Interstate 10 and Highway 78. Use of water from the canals would require installing the appropriate infrastructure (i.e. pumping equipment) and creating adequate space for truck parking, to allow for ease of pumping water and filling water trucks on a daily basis. **Table 4.2.1** provides PVID's forecasted demand for normal, single-dry, and multiple-dry years through 2040. Supply is not provided in this table because PVID owns the Number 1 Priority for water of Colorado River flows in the Lower Basin States and is not at risk of losing diversion capability, other than a total ordered cutback by the Bureau of Reclamation. A single-dry year would not make a difference in PVID diversions. The Bureau of Reclamation has requested that if the flows out of snowpack areas for the river lessen in future years that PVID agree to an 8 percent decrease in water use. PVID has discussed an increased fallowing program to help hold elevations at Lake Mead if allowed to use an Intentionally Created Surplus account which allows water banking in Lake Mead and removal when water is more abundant. This reduction in water use is accounted for in the Multiple-Dry Year projections.

The existing off-site groundwater well (ID 007S 021E 01C001S) under consideration for Project water supply is located northeast of the Project in the PVMGB. This well is currently used to supply water for agricultural irrigation (**Figure 4-1**). Historical and projected supply and demand information is not currently available for this well.

Table 4.2-1 PVID Water Supply and Demand Projections[1]

Description	2020	2025	2030	2035	2040
Normal Year Projections (acre-feet)					
Palo Verde Irrigation District Demand	340,000	340,000	340,000	340,000	340,000
Metropolitan Water District Demand	100,000	100,000	100,000	100,000	100,000
Total Demand	440,000	440,000	440,000	440,000	440,000
Single-Dry Year Projections (acre-feet)					
Palo Verde Irrigation District Demand	340,000	340,000	340,000	340,000	340,000
Metropolitan Water District Demand	100,000	100,000	100,000	100,000	100,000
Total Demand	440,000	440,000	440,000	440,000	440,000
Multiple-Dry Year Projections, First Year[2] (acre-feet)					
Palo Verde Irrigation District Demand	340,000	340,000	340,000	340,000	340,000
Metropolitan Water District Demand	100,000	100,000	100,000	100,000	100,000

Total Demand	440,000	440,000	440,000	440,000	440,000

Source: PVID, Personal communication from Mr. Richard Gilmore, August 2, 2018.

Notes:

(1) Currently, Palo Verde Irrigation (PVID) is not at risk of losing diversion capability other than a total ordered cutback by the Bureau of Reclamation. PVID owns the Number 1 Priority for water of Colorado River flows in the Lower Basin States. A single dry year would not make a difference in PVID diversions.

(2) The Bureau of Reclamation has requested that if the flows out of snowpack areas for the river lessen in future years that PVID agree to an 8 percent decrease in water use. PVID has discussed an increased fallowing program to help hold elevations at Lake Mead if allowed to use an Intentionally Created Surplus account which allows water banking in Lake Mead and removal when water is more abundant. This reduction in water use is accounted for in the Multiple-Dry Year projections.

The Project proposes to use a maximum total of 1,660 AF of groundwater over the term of construction and operation, which is estimated to be a period of approximately 31.4 years. This volume of water represents about 0.00024 percent of the total estimated water storage volume for the PVMGB (6.84 million AF), and about 0.00018 percent of the total estimated water storage volume for the CVGB (9.1 million AF). Under construction Option B, the Project proposes to use a maximum total of 1,260 AF. This volume of water represents about 0.00018 percent of the total estimated water storage volume for the PVMGB, and about 0.00014 percent of the total estimated water storage volume for the CVGB.

5. Conclusions

The Project's water requirements would be most demanding during the 17-month construction phase, which is anticipated to begin in fall 2020 and require approximately 1,000 or 600 AF of water under Option A and Option B, respectively. Water supplied during construction would be used for dust control during site preparation, trenching, and panel installation, and would also be required for temporary construction trailers and fire safety requirements. Water for construction may be obtained from PVID, or from installation and utilization of an on-site well within the CVGB or the PVMGB, and/or utilization of an existing off-site groundwater well (ID 007S 021E 01C001S) within the PVMGB.

During Project operations, water demand would decrease considerably to 22 AFY and is expected to extend at least 30 years from the end of construction based on the anticipated life of solar panels. The Applicant intends to meet O&M water demand by pumping groundwater from an on-site well within the CVGB, and/or utilization of an existing off-site groundwater well (ID 007S021 E01 C001S) within the PVMGB. Groundwater basin data suggests that Project pumping will not significantly impact adjacent water supply wells nor the groundwater basin storage in either basin. The low pumping volume over the 31.4-year period (600 to 1,000 AF over the 17-month construction period and 22 AFY over the 30-year operational period) is relatively small compared to the total estimated water storage volumes for the PVMGB and CVGB and the rate at which the basins are recharged (3,737 AFY CVGB and 4,761 AFY PVMGB). Additionally, groundwater levels measured at USGS monitoring points near the Project report normal to above normal conditions and neither basin is considered to be in overdraft.

Given its fractional contribution to the total water use in the CVGB and PVMGB, the Project does not represent a considerable contribution to the water resource impacts on the basins, and will not cause overdraft conditions in either groundwater basin. Based on this assessment, it is determined that long-term water supply demands for the Project are relatively minor and can be met by available groundwater sources within the CVGB and PVMGB.

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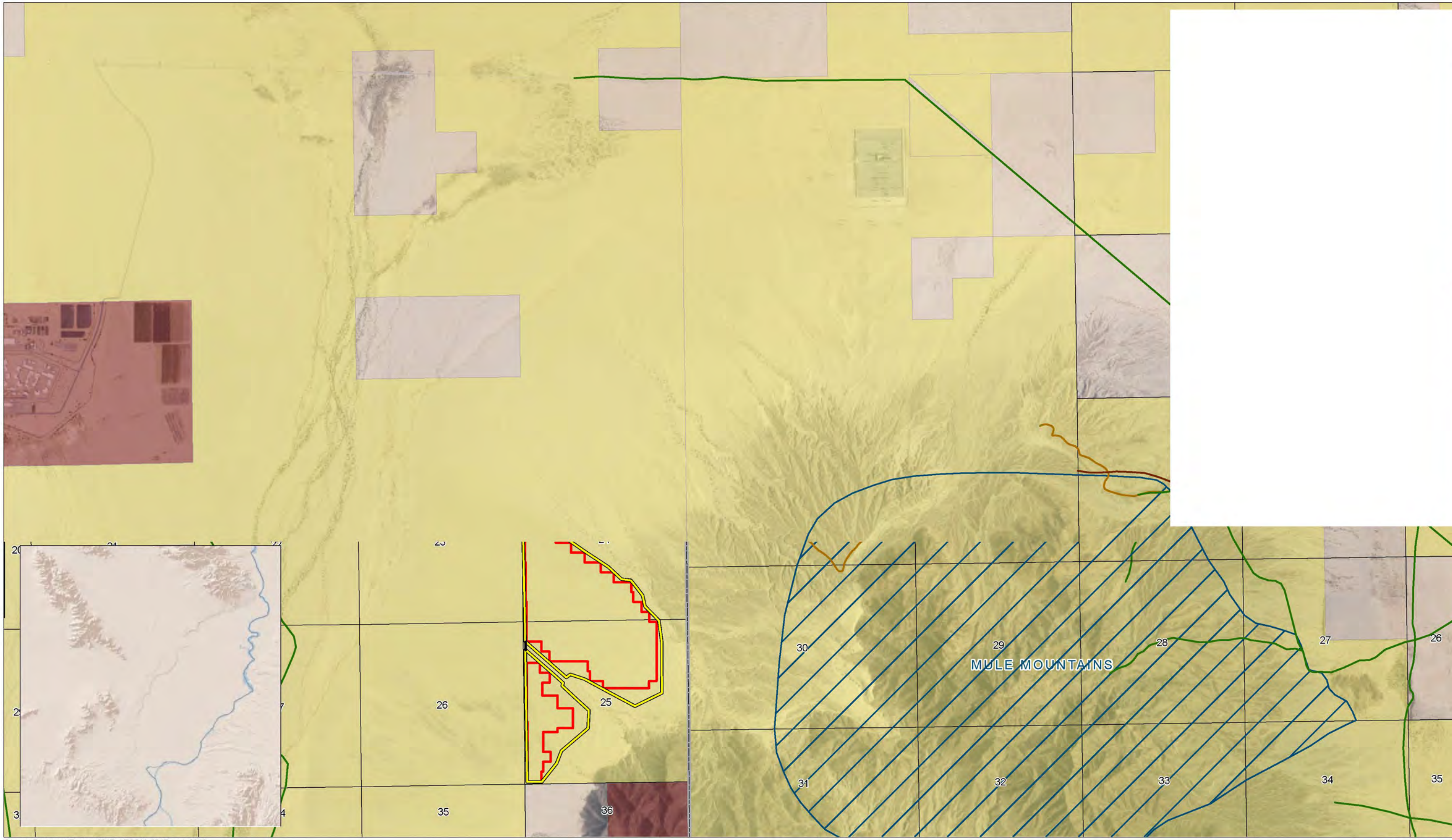
Figures



Source: Recurrent Energy, 2017. AECOM, 2017. esri, 2016.

3,000 0 3,000 Feet

Scale: 1:36,000 1 in = 3,000 feet

FIGURE 1-1
SITE VICINITY

DATE: 8/29/2017

RE Crimson Solar - Riverside County, CA

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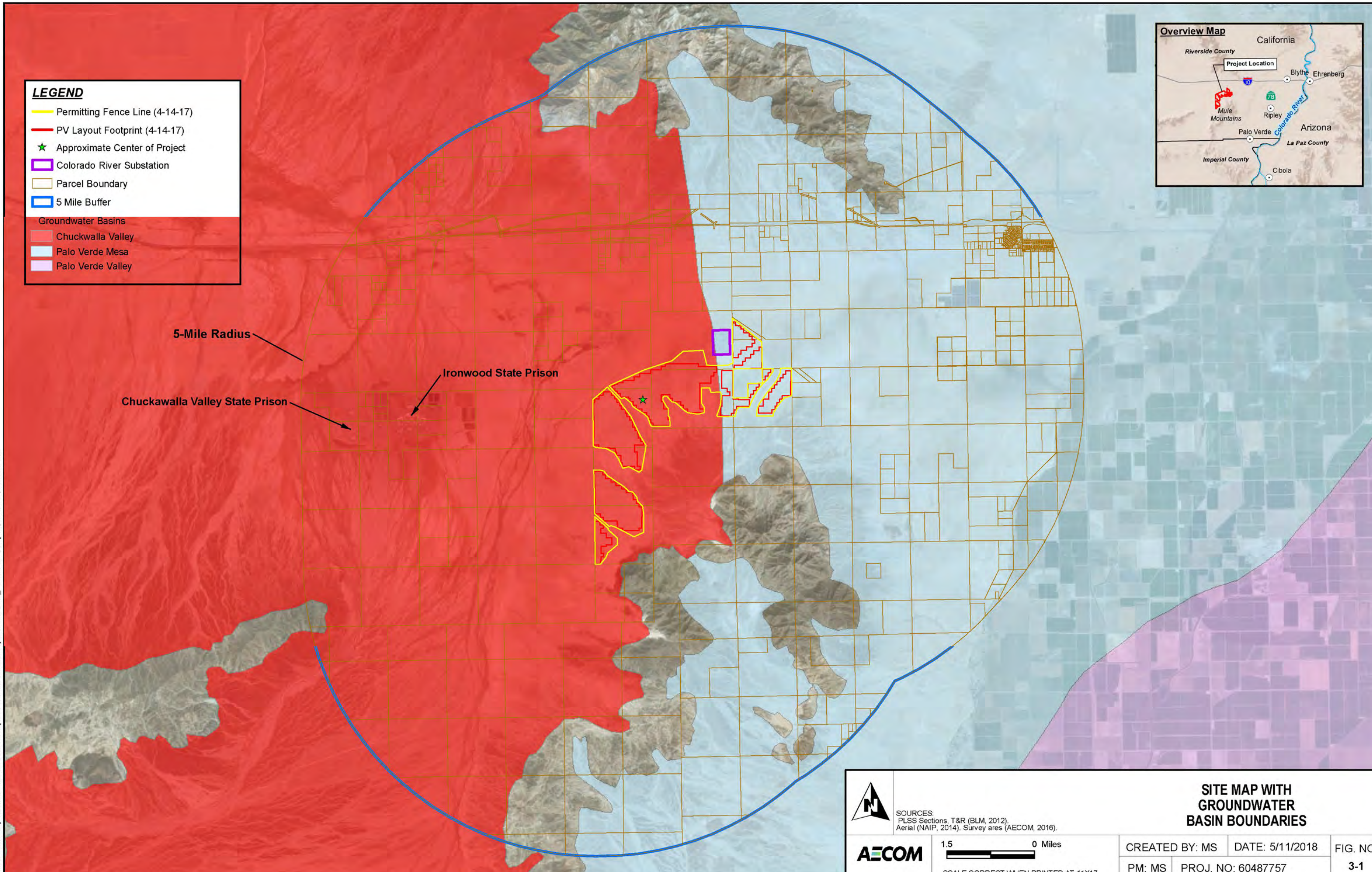

SOURCES:
PLSS Sections, T&R (BLM, 2012).
Aerial (NAIP, 2014). Survey ares (AECOM, 2016).

SITE MAP WITH GROUNDWATER BASIN BOUNDARIES

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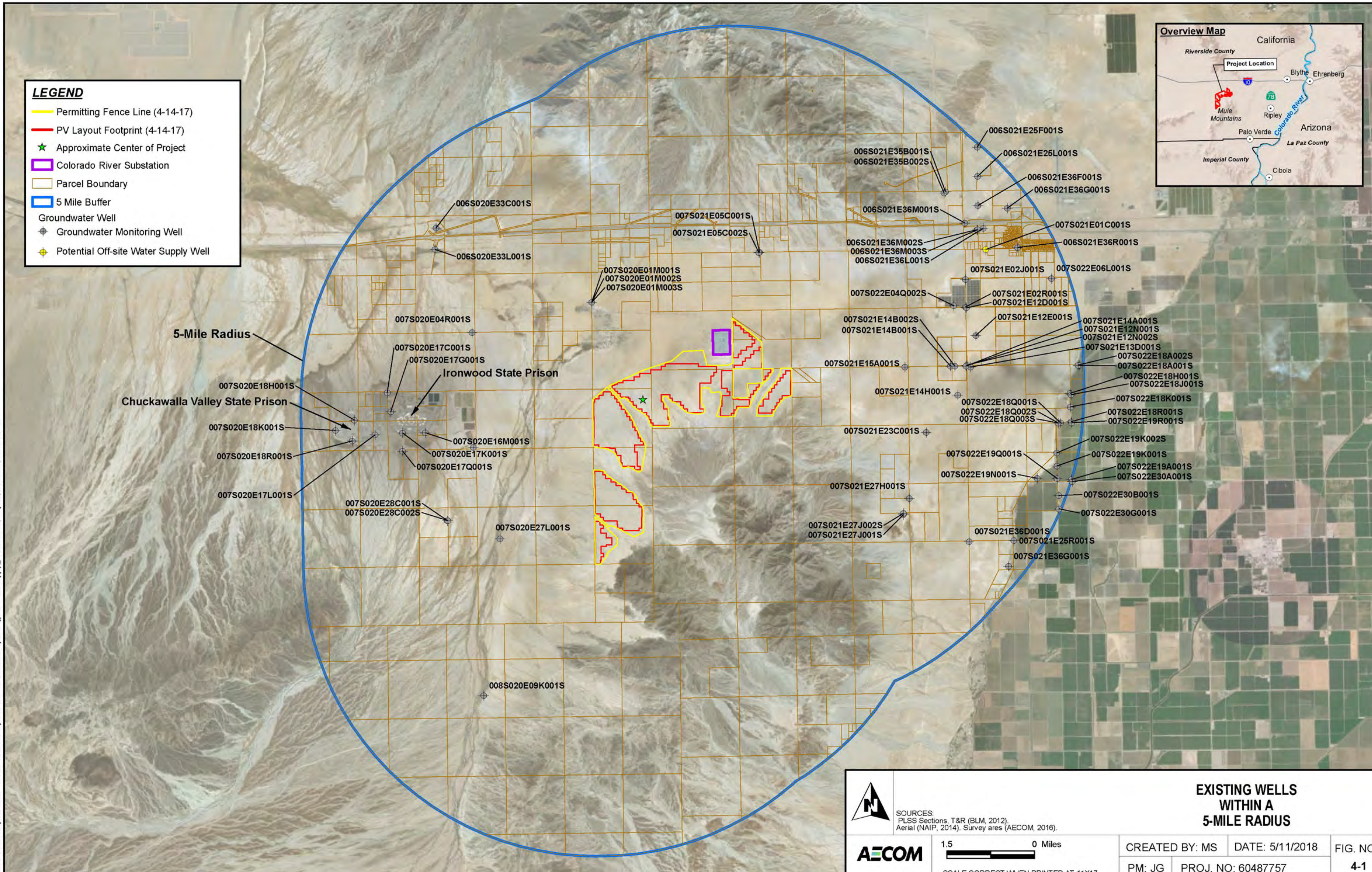

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U.3 Phase C Hydrology Study, May 2018

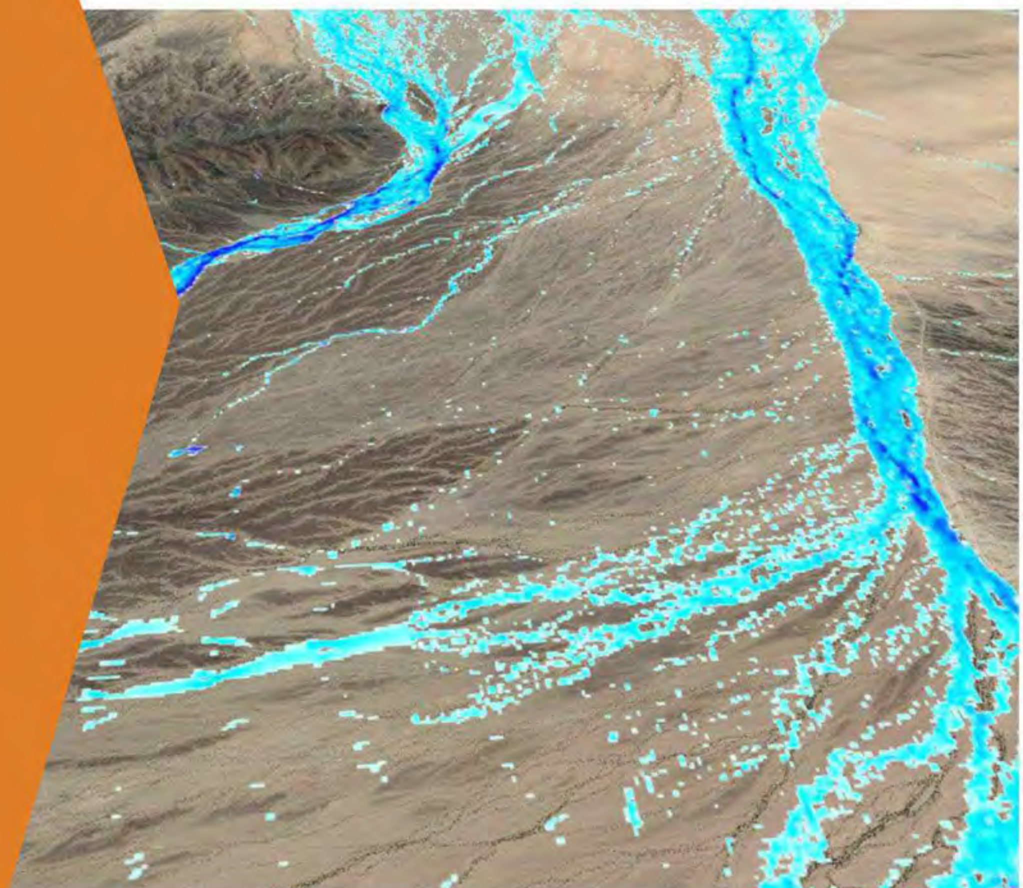
Westwood

PHASE C HYDROLOGY STUDY

RE Crimson Solar Project

Riverside County, CA

May, 2018



Prepared For: RECURRENT ENERGY

Westwood

Phase C Hydrology Study for

Crimson Solar Project

Prepared for:
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300 California Street, 8th Floor
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Project Number: 0007344.00
Date: May 30, 2018

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OVERVIEW

The purpose of this Phase C hydrology study is to analyze the hydrology of the proposed Crimson photovoltaic project ("the project") and provide design information for use in the engineering design.

This hydrology study covers the updated project area where the Crimson Solar Project will be developed. The project area encompasses approximately 2,489 acres in Riverside County, CA and the watershed encompasses 112,870 acres of land in Imperial and Riverside Counties, California; near the city of Blythe (Exhibit 1). The project will likely consist of solar panels, inverters, interconnection switchgear, and associated access roads. Due to the hydrologic characteristics associated with the flat, largely un-channelized terrain present in the area of interest, FLO-2D hydrologic/hydraulic modeling software was used to determine flow depths and velocities throughout the site.

The hydrologic modeling in this report was created using Flo-2D modeling software. Because of the complex and distributary nature of flow paths upstream and through the project site, FLO-2D hydrologic/hydraulic modeling software was utilized to determine flow depths and velocities throughout the site.

USGS SSURGO hydrologic soil group B & D (moderate to high runoff potential) covers the majority of the project boundary. The western edge of the watershed area is mainly classified as hydrologic soil group D (high runoff potential) extending towards the project site (Exhibit 3). The existing land cover in the area of interest and its nearby contributing watershed is shrubland (Exhibit 4).

A FEMA floodplain has not been determined near the project site. The project area is covered by FEMA FIRM panel 06065C3200G and 0605C3175G. The entire panel is designated as a FEMA Flood Hazard Zone D (Area of Undetermined Flood Hazard).

Overall, the analysis shows low water depth and velocities (Exhibits 6 and 7) across the majority of the site. During a 100 year storm the flood depths across the majority of the project area are less than 0.5 feet with velocities less than 1 foot/second. See Exhibits 6 and 7 for areas within the project with higher flood depths and velocities. Based on experience on similar projects, the site is suitable for the planned development by avoiding areas of high flood depths and velocities or elevating equipment in these areas.

DATA SOURCES

The models and methods for this project utilize a combination of public and private data as shown in Table 1.

Table 1: Data Sources

Data Type	Format	Source	Use
Elevation (5-Foot Contours)	Digital Terrain Model (DTM)	MapMART 5-Meter Dataset	Near site FLO-2D Model Elevations
Elevation (10-Foot Contours)	Digital Terrain Model (DTM)	USGS 10-Meter National Elevation Dataset	Offsite FLO-2D Model Elevations
Elevation (1-Foot Contours)	DTM	Recurrent Energy	Onsite Elevations within Project Boundary
Soils	Shapefile	USGS SSURGO Dataset	Curve Numbers
Precipitation	Text File	NOAA Atlas 14 Website	Design storms
HUC-12 Drainage Boundary	Shapefile	USGS	Define Model Extents
Site Boundary	DWG	Recurrent Energy	Define Model Extents
Aerial Photography	ArcGIS Map Service	USDA FSA	Reference

HYDROLOGIC MODELING

The proposed project site is located in Riverside County, California near the City of Blythe and the watershed extends south and west into Imperial County, California. The watershed is a mix of flat valley desert and mountainous terrain. Flood flows in the watershed generally flow from south to north. The mountainous terrain is characterized by sparsely vegetated undulating ridges and valleys. Rainfall forms channels flowing toward the valley floor. Upon reaching the valley floor, flood flows continue north toward the project area. The largest portion of the flow near the project area is conducted through a wash called Wiley's Wash. The wash then runs into a dry lakebed where it fills up and sits until infiltrated or evaporated. This dry lakebed is also fed by flows from the north where an area of mountainous terrain flows under I-10 and is conducted into the dry lake beds by a series of washes. The watershed area for the project was determined based on a combination of the HUC 12 boundaries and delineated watersheds.

The hydrologic modeling and report are classified as a Recurrent Energy "Phase C" analysis. The area of study has been increased from a prior study done by the Slater-Hanafan Group in order to give proper hydrologic consideration to the parcels that are proposed to have PV solar facilities constructed on them. This detailed report is adequate for the final project design and for submission of the project to government agencies for their review.

Hydrology Method Comparison

The Riverside County Flood Control and Water Conservation District (District) Hydrology Manual specifies the design hydrology methods and criteria currently required by the District. The District covers approximately the western half of Riverside County. The Crimson site is located outside of the District boundary but due to still being in Riverside County it is unknown if the regulations still apply. Due to this unknown the criteria were still followed. The District's Website lists the accepted hydrology software's that can be submitted. HEC-HMS was chosen to look at the hydrology of the site and also compare to the prior study done by the Slater-Hanafan Group. Using HEC-HMS and the method specified by the District the results are similar to those by the Slater Hanafan Group. However, these results have been determined to be unreasonable for a number of reasons. The results from HEC-HMS have a very short lag time and a very large peak flow. Comparing this to the Flo-2D results which have a longer lag time and smaller peak flow it was determined that HEC-HMS had a lag time that was unreasonably fast whereas the lag time for Flo-2D has a more reasonable hydrograph response. In order for the HEC-HMS flows to be accurate the water would have to be moving at speeds of around 16-18 fps which is highly unreasonable. A more reasonable velocity would be around 3-4 fps which is what the Flo-2D model shows. The reason for the slower velocities is due to the flat landscape which has an average slope of 0.009 ft/ft over the watershed. When a more reasonable lag time is input into HEC-HMS to achieve a velocity of 3-4 fps the results are similar to those from Flo-2D.

It is highly unlikely that the results from HEC-HMS method specified by the District are accurate at the Crimson Site. This is most likely due to the different land cover and slopes than what is assumed in the District's Hydrology Manual which was created for the western portion of Riverside County, not the eastern portion where the Crimson project is located. Due to the number of different ways to check the results it has been determined that Flo-2D achieves results that more accurately depict the conditions in the watershed.

FLO-2D

FLO-2D is a physical process model that routes rainfall runoff and flood hydrographs over flow surfaces or in channels using the dynamic wave approximation to the momentum equation. FLO-2D offers advantages over 1-D models and unit hydrograph methods by allowing for breakout flows and visualization of flows across a potential site. This is particularly useful on a flat site that receives offsite flows, such as the project site. The primary inputs are a DTM (elevation data), curve numbers and precipitation.

Precipitation data downloaded from NOAA Atlas 14 (Appendix A) for a 100-year, 24-hour storm was averaged to be 4.25 inches. The watershed was large enough that the difference in rainfall depths across the watershed had to be averaged. Rainfall is distributed in an SCS Type-II distribution pattern. .

Intermap (5M), USGS NED and ground survey data are incorporated into the DTM using the export to xyz file function in Global Mapper. These XYZ files are read directly into FLO-2D.

USDA-NRCS STATSGO soil data provides nearly full coverage of soil types within the FLO-2D modeled area. USDA-NRCS SSURGO soils data was unavailable for the project location and contributing watershed. Soils in the area are a classified as hydrologic group D in the western portion of the watershed and as hydrologic group B & D within the project boundary (Exhibit 3). Land cover was obtained from the USDA 2013 Crop Data Layer. Exhibit 4 displays Land Cover Classes for the entire watershed which is primarily shrubland as classified by the USDA. Runoff generated from the solar panels will flow to the edge of the panels and be allowed to drip onto the pervious surface below and allowed to disperse and infiltrate below the panels across the site.

FLO-2D Watershed Model

The potential contributing watershed for the project is around 175 square miles. Hydrologic modeling for the project was done with one watershed to accurately model the project's hydrology. The watershed was modeled using a larger 65' Flo-2D grid cell size model and then a smaller 40' Flo-2D grid cell size model. The larger model was used to obtain inflow hydrographs to input into the smaller grid cell size model for more refined results. The primary elevation source is the Intermap NEXTMap dataset and onsite topography data within the project boundary. Due to flat terrain and the complex nature of the interconnected washes in the area, some boundaries of the contributing watershed are poorly defined. The FLO-2D model area is sized to ensure all contributing flows are accounted for.

RESULTS AND DESIGN INFORMATION

Overall, the analysis shows relatively low water depths and velocities (Exhibits 6 and 7) across the proposed array. The maximum flooding through or near the array is ~1.5'. Based on experience on other similar projects, the site is generally suitable for the planned development and most hydrologic concerns can be addressed through detailed engineering design. The following design guidelines have been compiled for the final siting of solar development facilities on this site. If the proposed project footprint changes, the analysis should be revisited to ensure that all assumptions are still valid.

1. Electrical facilities and racking/modules should be elevated 1' above the 100-year peak flood depth as depicted in Exhibit 6.
2. Care should be taken when siting electrical facilities and racking/modules where depths are greater than 2 feet.
3. Basins are not expected and are not proposed in the civil design of the site. This may change during Riverside County's review of the project.
4. The proposed project is not expected to cause more than 1 foot of water surface rise and discharges the 100-year storm in a manner similar to the existing flow pattern. This should be revisited pending final design.

NEXT STEPS

1. This model/report should be updated at final design to ensure that assumptions remain valid.

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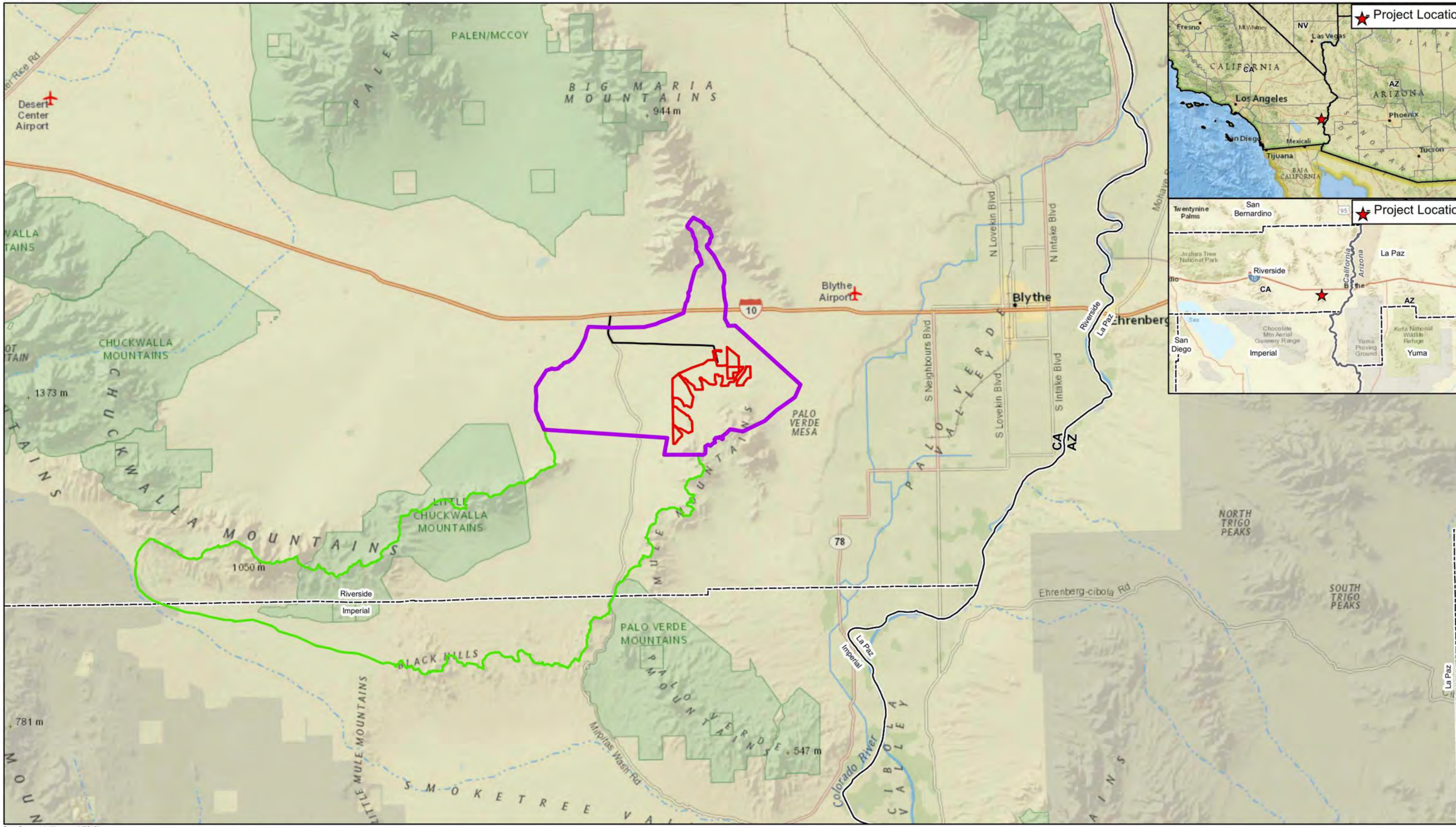
Exhibits



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Small Flo2D Boundary
- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

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0 4 Miles

Crimson Solar Project

Riverside County, California

Exhibit 1: Location Map

May 30, 2018

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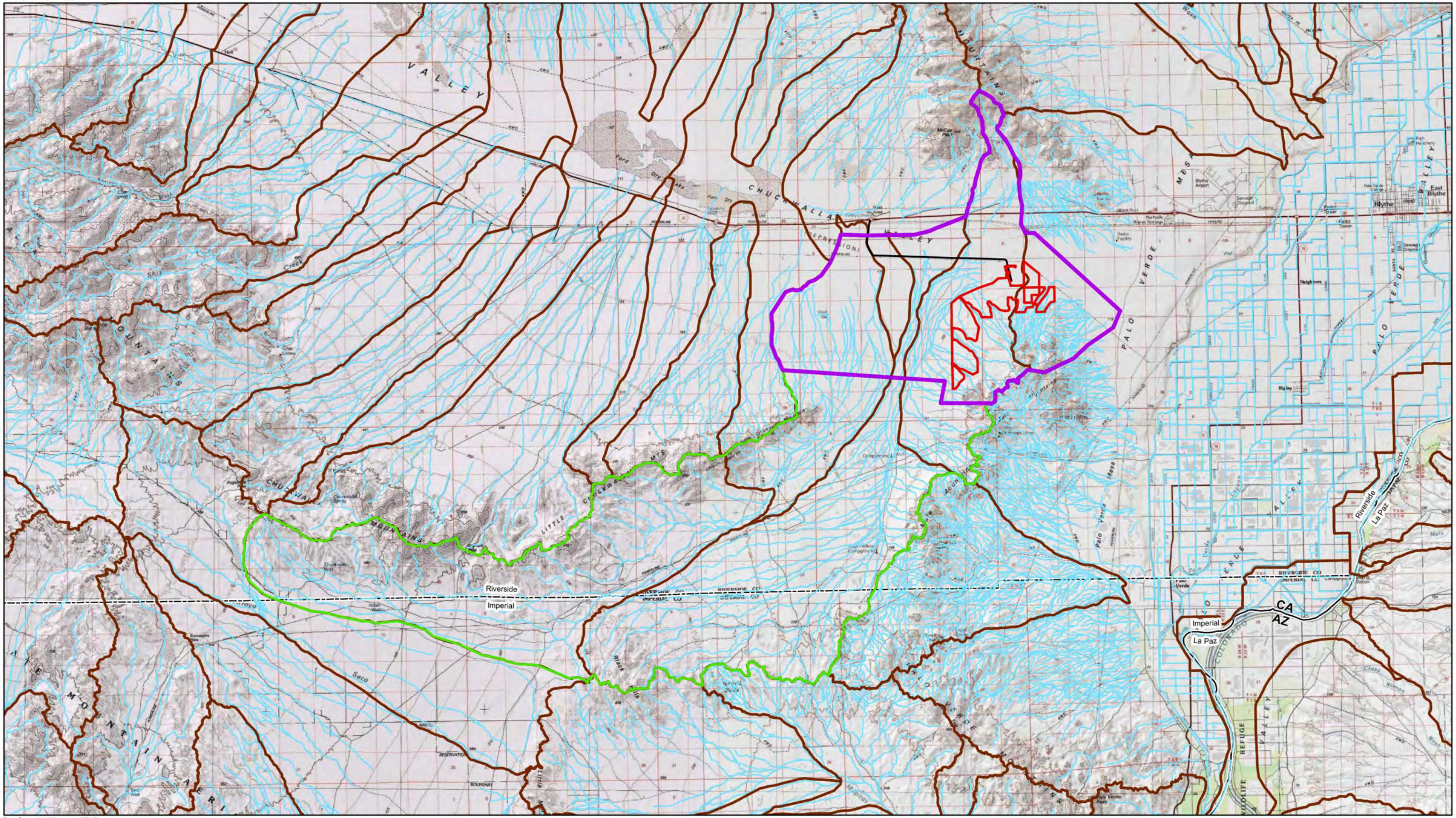


Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Small Flo2D Boundary
- Flo2D Boundary
- Project Boundary
- County Boundary
- HUC 12 Boundary
- NHD Flowline
- Power Line Road

N

0 3 Miles

Crimson Solar Project

Riverside County, California

Exhibit 2: Base Map

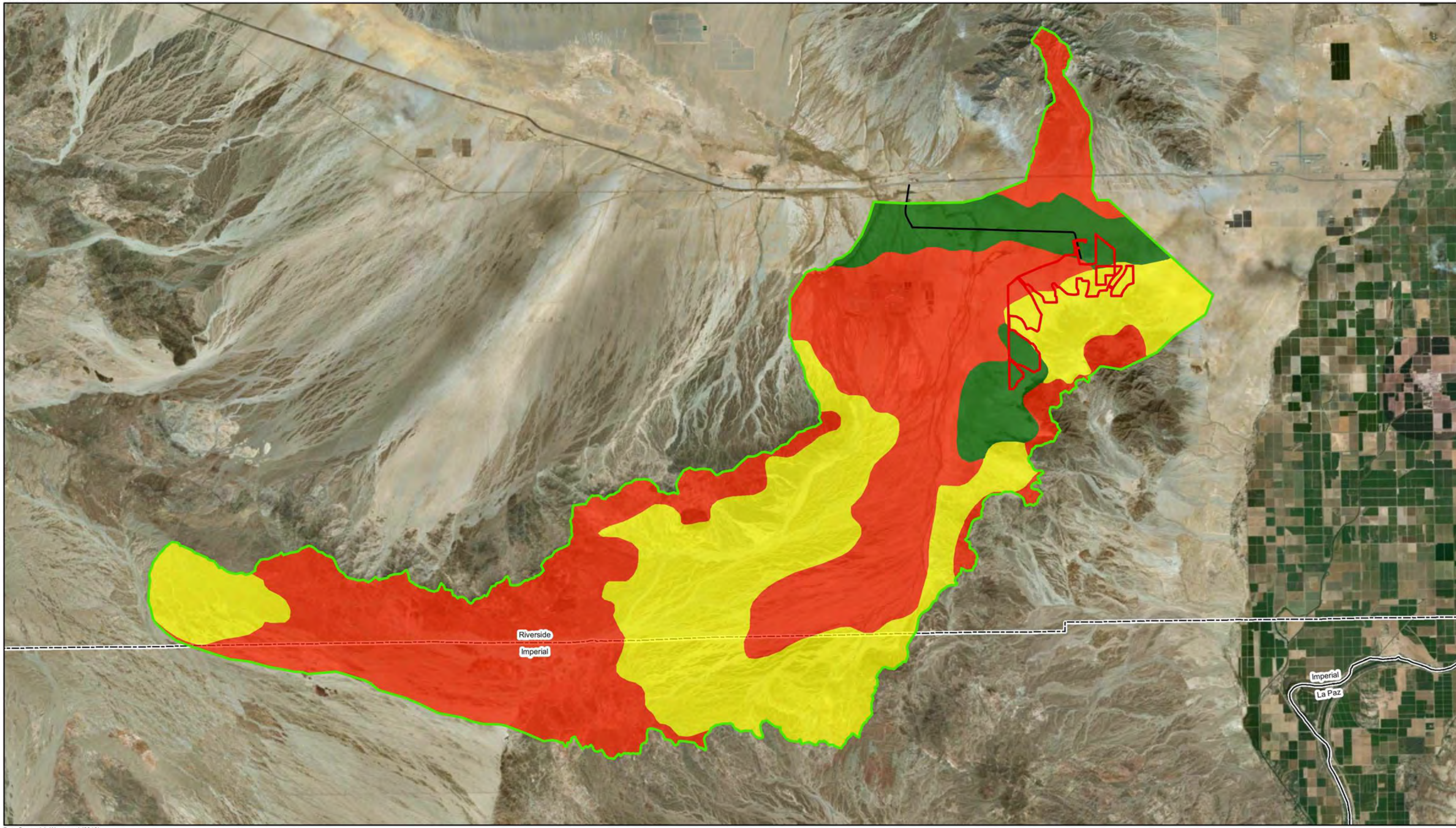
May 30, 2018

Westwood

Toll Free (888) 937-5150 westwoodps.com

Westwood Professional Services, Inc.

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex2BaseMap.mxd TJBrown 5/30/2018 3:02:22 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Hydrologic Soils Group

- A
- B
- D

N

Miles
0 2.5

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

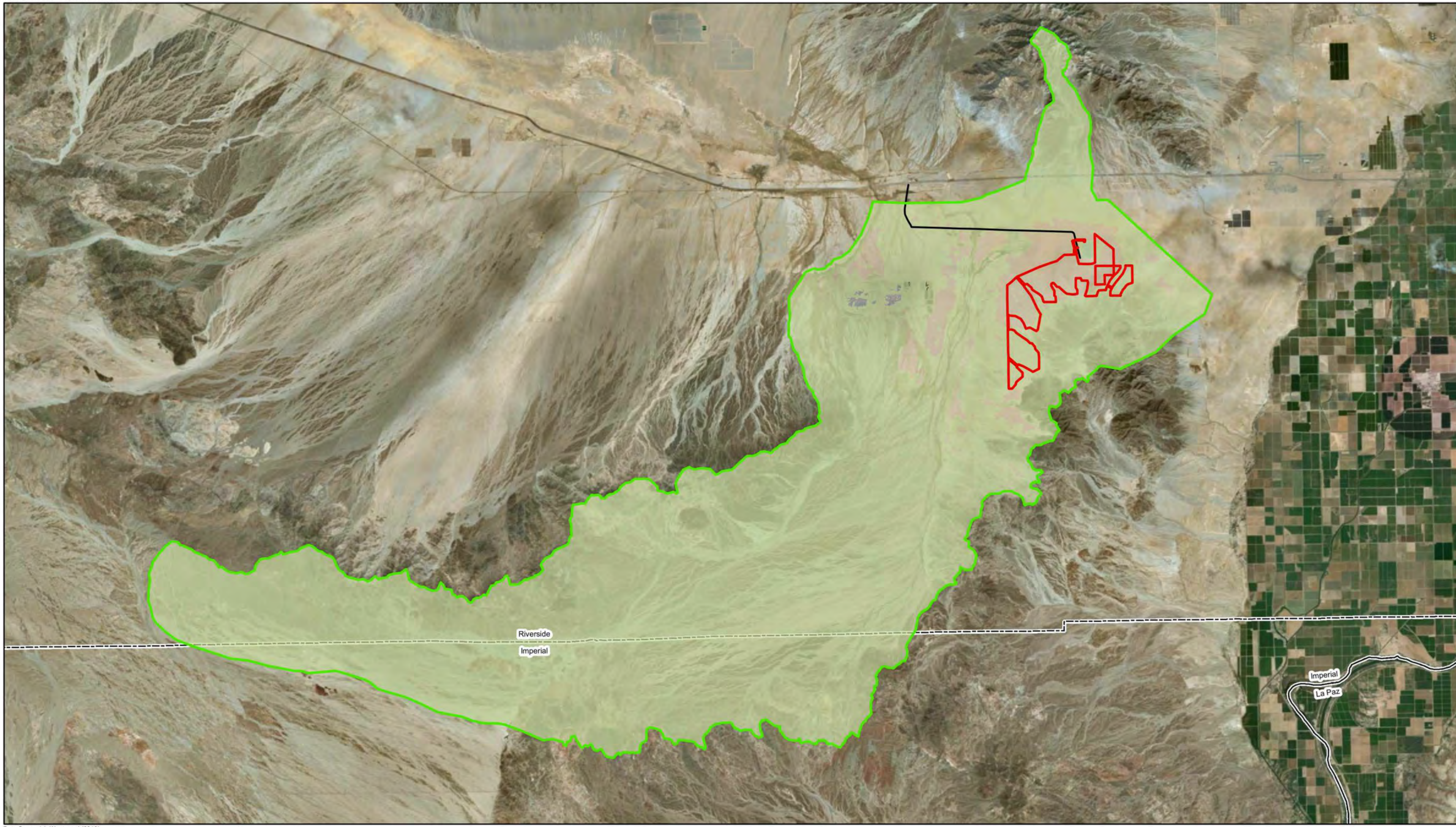
Crimson Solar Project

Riverside County, California

Exhibit 3: Soils Map

May 30, 2018

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex3SoilsMap.mxd TJBrown 5/30/2018 3:04:42 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Landcover

- Barren
- Developed Space
- Shrubland

N

0 2.5 Miles

Crimson Solar Project

Riverside County, California

Exhibit 4: Landcover Map

May 30, 2018

Westwood

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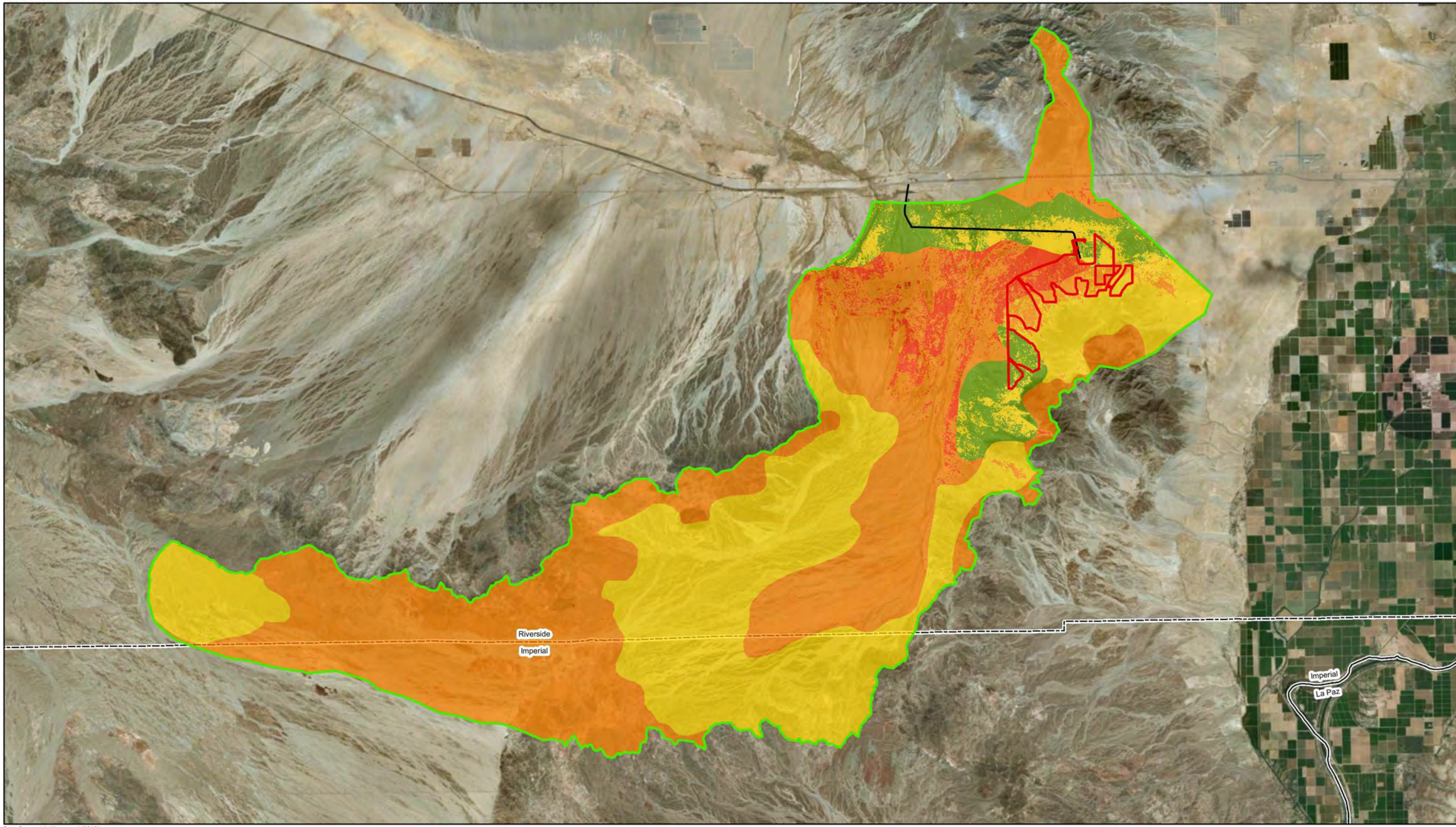
Westwood Professional Services, Inc.

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex4LandcoverMap.mxd TJBrown 5/30/2018 3:06:13 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Curve Number

40 - 49, 50 - 59, 60 - 69, 70 - 79, 80 - 89, 90 - 99

N

0 2.5 Miles

Crimson Solar Project

Riverside County, California

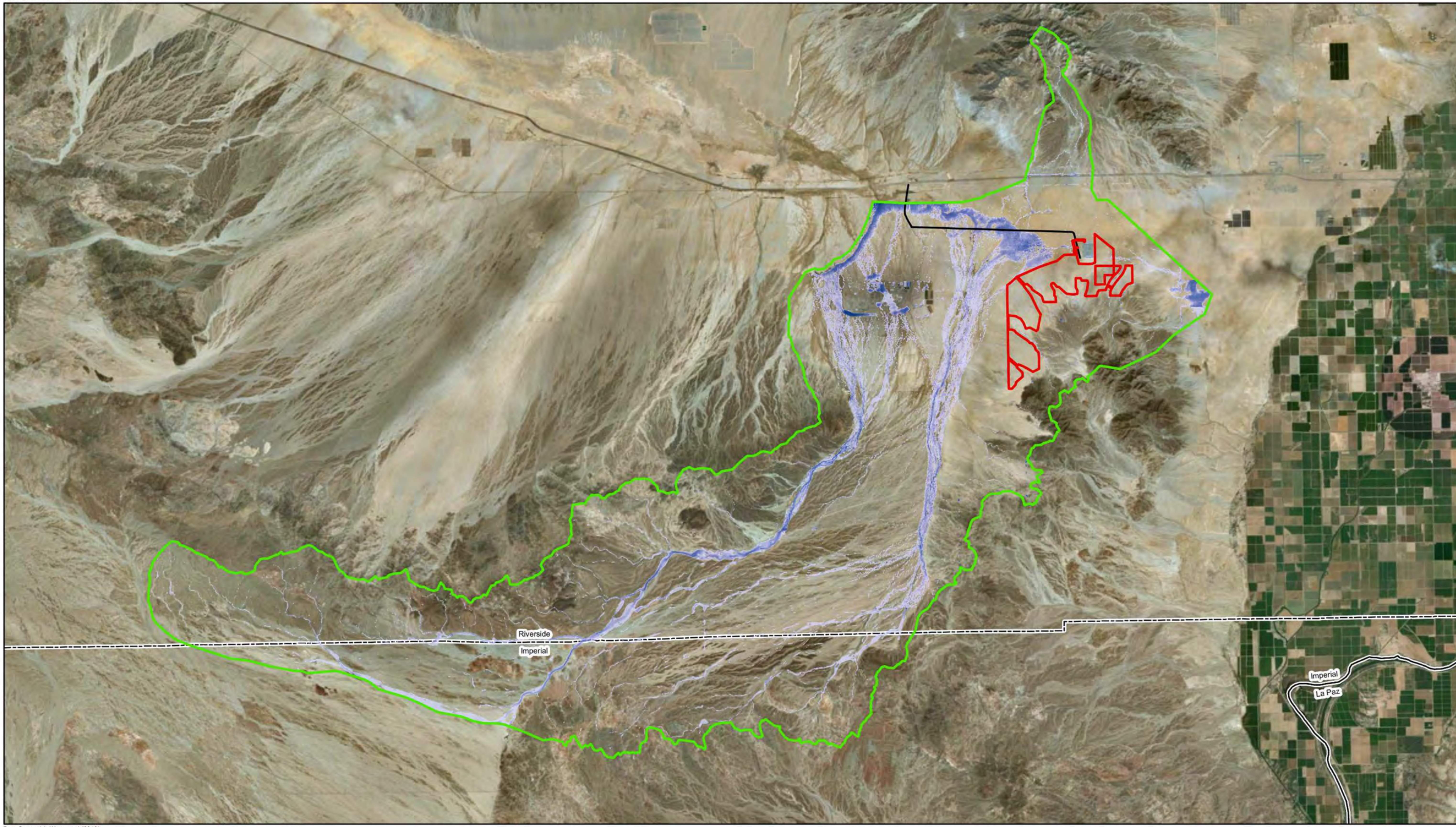
Exhibit 5: Curve Number Map

May 30, 2018

Westwood

Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex5CurveNuumberMap.mxd TJBrown 5/30/2018 3:07:46 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Legend

- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Max Flow Depth (ft)

0.50 - 1.00
1.01 - 1.50
1.51 - 2.00
2.01 - 2.50
2.51 - 3.00
3.01 - 4.00
4.01 - 5.00
5.01 - 6.00
6.01+

N

0 2.5 Miles

Crimson Solar Project

Riverside County, California

Exhibit 6: 100-Year Max Water Depth Map

May 30, 2018

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex6100YearMaxWaterDepthMap.mxd TJBrown 5/30/2018 3:14:30 PM

Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Peak Velocity (fps)

1.00 - 1.50 | 1.51 - 2.00 | 2.01 - 2.50 | 2.51 - 3.00 | 3.01 - 4.00 | 4.01 - 5.00 | 5.01+

N

0 — 2.5 Miles

Crimson Solar Project

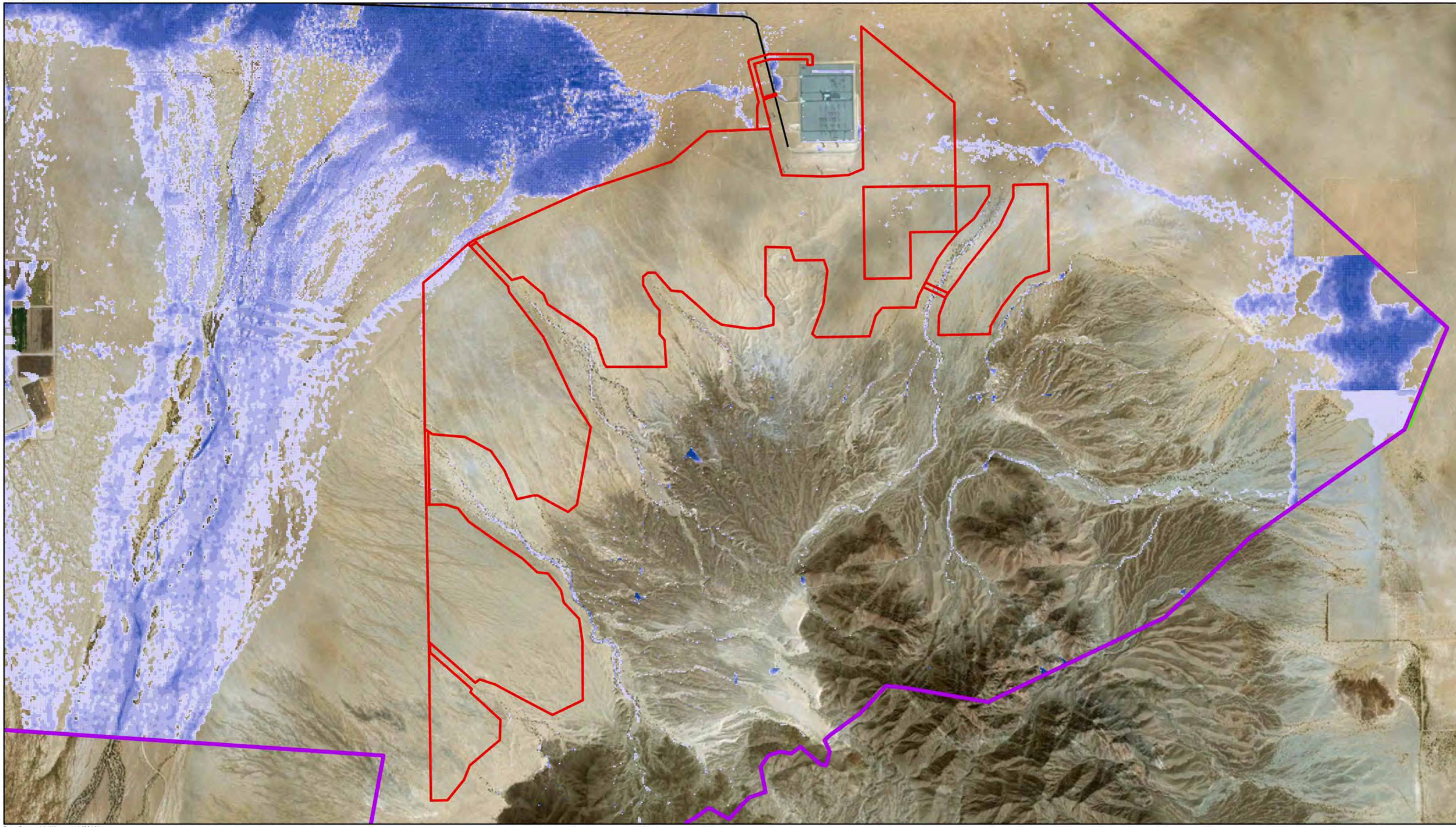
Riverside County, California

Exhibit 7: 100-Year Peak Velocity Map

May 30, 2018

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex7100YearPeakVelocityMap.mxd TJBrown 5/30/2018 3:17:08 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Small Flo2D Boundary
- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Max Flow Depth (ft)

0.50 - 1.00, 1.01 - 1.50, 1.51 - 2.00, 2.01 - 2.50, 2.51 - 3.00, 3.01 - 4.00, 4.01 - 5.00, 5.01 - 6.00, 6.01+

N

0 0.5 Miles

Crimson Solar Project

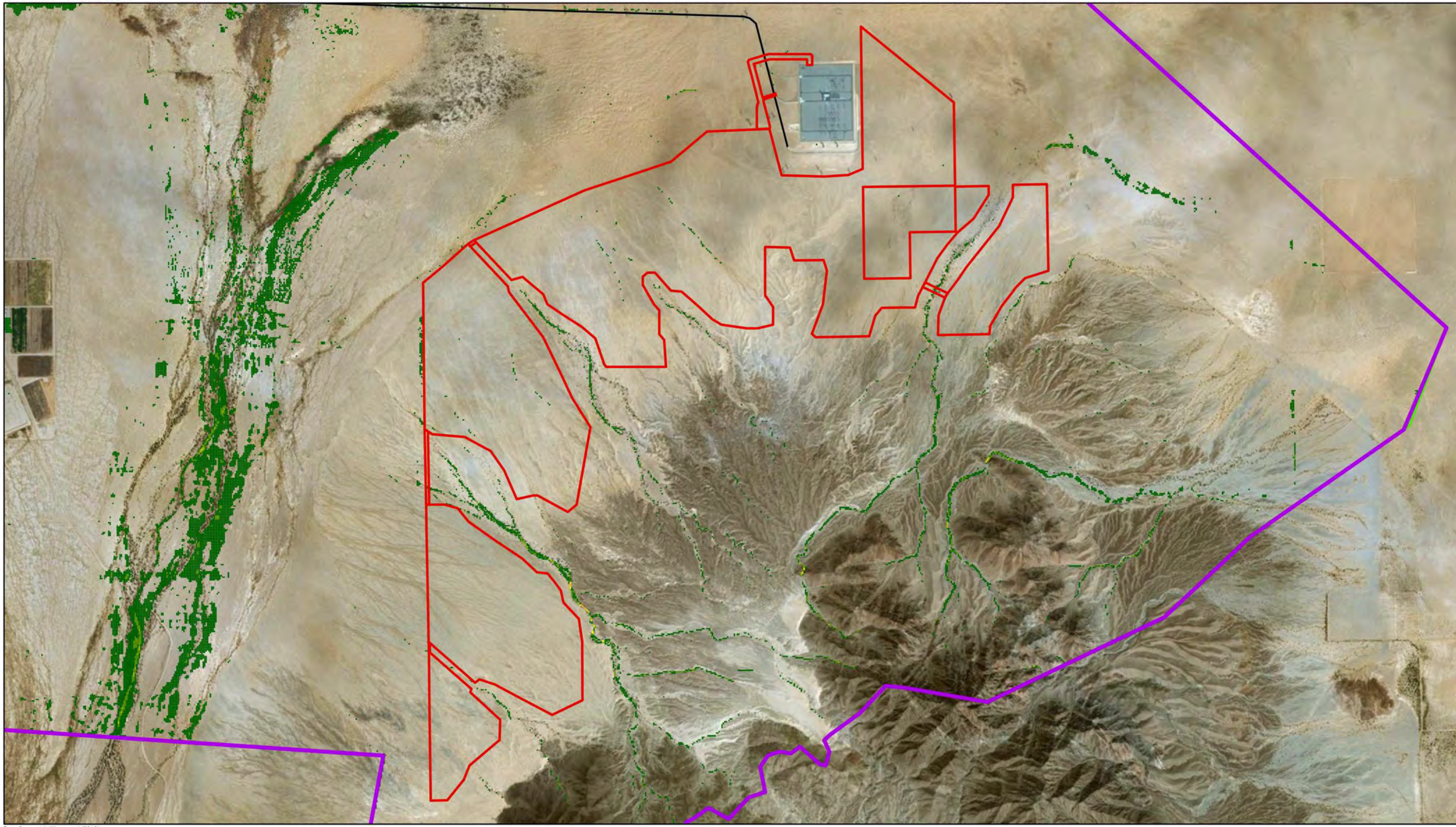
Riverside County, California

Exhibit 8: 100-Year Max Water Depth Project Area Map

May 30, 2018

Westwood
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex8100YearMaxWaterDepth_ProjectAreaMap.mxd TJBrown 5/30/2018 3:19:45 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Legend

- Small Flo2D Boundary
- Flo2D Boundary
- Project Boundary
- County Boundary
- Power Line Road

Peak Velocity (fps)

1.00 - 1.50, 1.51 - 2.00, 2.01 - 2.50, 2.51 - 3.00, 3.01 - 4.00, 4.01 - 5.00, 5.01+

N

0 0.5 Miles

Westwood

Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

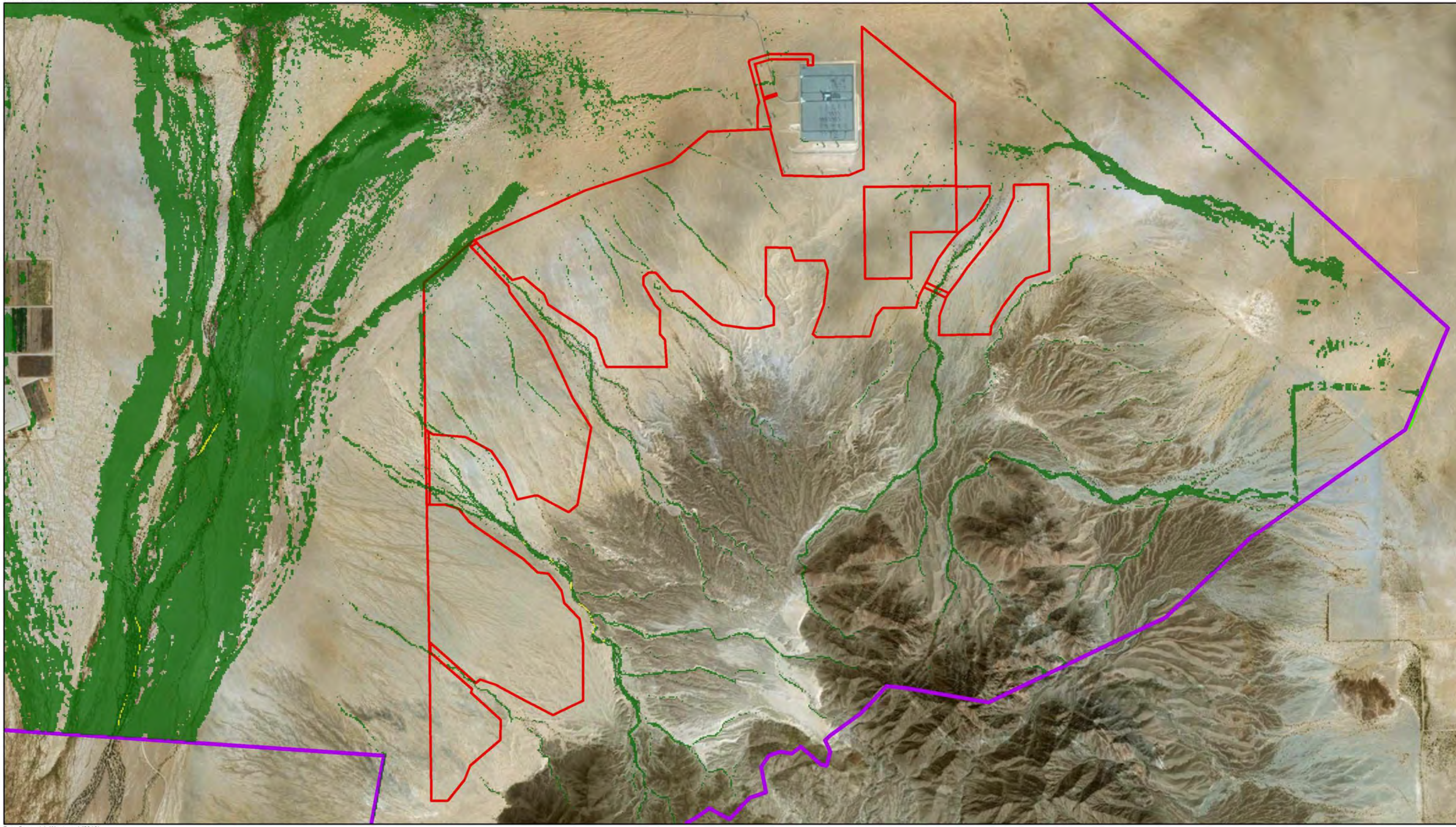
Crimson Solar Project

Riverside County, California

Exhibit 9: 100-Year Peak Velocity Project Area Map

May 30, 2018

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex9100YeaPeakVelocity_ProjectAreaMap.mxd TJBrown 5/30/2018 3:21:42 PM



Data Source(s): Westwood (2018)
ESRI NAIP Basemap Imagery (Accessed 2016),
USGS (2016).

Westwood

Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Legend

- Small Flo2D Boundary
- Flo2D Boundary
- Project Boundary
- County Boundary

Scour Depth (ft)

- 0.50 - 1.00
- 1.01 - 1.50
- 1.51+

N

0 0.5 Miles

Crimson Solar Project

Riverside County, California

Exhibit 10: 100-Year Scour Map

May 30, 2018

Map Document: N:\0007344.00\GIS\Hydro Exhibits\2018-05-30\2018-05-30_Crimson_Ex10100YeaScour_ProjectAreaMap.mxd TJBrown 5/30/2018 2:24:25 PM

Appendix A
Atlas 14 Rainfall Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Blythe, California, USA*
Latitude: 33.5491°, Longitude: -114.8434°
Elevation: 580.12 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.089 (0.075-0.108)	0.146 (0.122-0.176)	0.219 (0.183-0.265)	0.278 (0.230-0.339)	0.358 (0.286-0.452)	0.419 (0.328-0.541)	0.481 (0.367-0.637)	0.546 (0.405-0.744)	0.635 (0.451-0.903)	0.705 (0.483-1.04)
10-min	0.128 (0.107-0.154)	0.209 (0.175-0.252)	0.314 (0.262-0.380)	0.398 (0.330-0.486)	0.513 (0.410-0.648)	0.600 (0.470-0.775)	0.690 (0.526-0.913)	0.782 (0.580-1.07)	0.910 (0.646-1.29)	1.01 (0.693-1.49)
15-min	0.155 (0.130-0.186)	0.253 (0.211-0.305)	0.379 (0.317-0.459)	0.482 (0.399-0.588)	0.620 (0.496-0.783)	0.726 (0.568-0.937)	0.834 (0.636-1.10)	0.946 (0.701-1.29)	1.10 (0.781-1.56)	1.22 (0.838-1.80)
30-min	0.215 (0.180-0.259)	0.351 (0.293-0.423)	0.526 (0.439-0.637)	0.669 (0.553-0.816)	0.860 (0.688-1.09)	1.01 (0.788-1.30)	1.16 (0.883-1.53)	1.31 (0.973-1.79)	1.53 (1.08-2.17)	1.70 (1.16-2.50)
60-min	0.297 (0.249-0.358)	0.485 (0.406-0.585)	0.727 (0.607-0.880)	0.924 (0.765-1.13)	1.19 (0.951-1.50)	1.39 (1.09-1.80)	1.60 (1.22-2.12)	1.81 (1.34-2.47)	2.11 (1.50-3.00)	2.34 (1.61-3.45)
2-hr	0.409 (0.343-0.493)	0.633 (0.530-0.764)	0.925 (0.772-1.12)	1.16 (0.961-1.42)	1.48 (1.19-1.87)	1.73 (1.35-2.23)	1.98 (1.51-2.62)	2.24 (1.66-3.05)	2.60 (1.84-3.69)	2.88 (1.97-4.24)
3-hr	0.472 (0.395-0.568)	0.716 (0.599-0.864)	1.03 (0.863-1.25)	1.29 (1.07-1.58)	1.65 (1.32-2.08)	1.92 (1.50-2.47)	2.19 (1.67-2.90)	2.48 (1.84-3.38)	2.88 (2.04-4.09)	3.19 (2.19-4.70)
6-hr	0.569 (0.477-0.686)	0.847 (0.709-1.02)	1.21 (1.01-1.47)	1.51 (1.25-1.85)	1.92 (1.54-2.43)	2.24 (1.75-2.90)	2.57 (1.96-3.40)	2.91 (2.16-3.97)	3.39 (2.40-4.82)	3.76 (2.58-5.54)
12-hr	0.649 (0.544-0.782)	0.963 (0.806-1.16)	1.39 (1.16-1.68)	1.74 (1.44-2.12)	2.22 (1.78-2.81)	2.61 (2.04-3.37)	3.01 (2.30-3.98)	3.43 (2.54-4.68)	4.03 (2.86-5.73)	4.50 (3.08-6.63)
24-hr	0.813 (0.718-0.939)	1.21 (1.07-1.40)	1.75 (1.54-2.03)	2.21 (1.93-2.58)	2.86 (2.42-3.44)	3.38 (2.81-4.15)	3.93 (3.19-4.92)	4.51 (3.58-5.80)	5.33 (4.08-7.13)	6.00 (4.45-8.28)
2-day	0.904 (0.798-1.04)	1.35 (1.19-1.56)	1.96 (1.72-2.27)	2.47 (2.16-2.89)	3.21 (2.72-3.86)	3.80 (3.16-4.66)	4.42 (3.60-5.55)	5.09 (4.04-6.55)	6.05 (4.62-8.08)	6.83 (5.05-9.41)
3-day	0.952 (0.841-1.10)	1.42 (1.25-1.65)	2.06 (1.82-2.39)	2.61 (2.28-3.05)	3.39 (2.87-4.08)	4.01 (3.34-4.92)	4.68 (3.81-5.87)	5.39 (4.28-6.93)	6.40 (4.89-8.55)	7.23 (5.35-9.96)
4-day	1.01 (0.890-1.17)	1.51 (1.33-1.74)	2.19 (1.92-2.54)	2.77 (2.42-3.23)	3.59 (3.04-4.32)	4.25 (3.53-5.21)	4.95 (4.03-6.20)	5.70 (4.52-7.33)	6.76 (5.17-9.03)	7.63 (5.65-10.5)
7-day	1.05 (0.931-1.22)	1.58 (1.40-1.83)	2.29 (2.02-2.66)	2.89 (2.53-3.38)	3.74 (3.17-4.50)	4.41 (3.67-5.41)	5.13 (4.17-6.43)	5.88 (4.67-7.57)	6.95 (5.31-9.29)	7.82 (5.79-10.8)
10-day	1.09 (0.966-1.26)	1.64 (1.44-1.89)	2.37 (2.08-2.74)	2.98 (2.60-3.48)	3.84 (3.25-4.62)	4.52 (3.76-5.55)	5.24 (4.27-6.58)	6.01 (4.77-7.73)	7.09 (5.41-9.46)	7.96 (5.89-11.0)
20-day	1.22 (1.07-1.41)	1.79 (1.58-2.07)	2.56 (2.25-2.96)	3.20 (2.79-3.74)	4.10 (3.47-4.93)	4.82 (4.00-5.91)	5.57 (4.53-6.98)	6.37 (5.05-8.19)	7.51 (5.74-10.0)	8.44 (6.25-11.6)
30-day	1.33 (1.18-1.54)	1.94 (1.71-2.24)	2.74 (2.41-3.18)	3.42 (2.98-3.99)	4.36 (3.69-5.25)	5.11 (4.25-6.27)	5.91 (4.81-7.41)	6.76 (5.37-8.70)	7.98 (6.10-10.7)	8.98 (6.65-12.4)
45-day	1.50 (1.32-1.73)	2.14 (1.89-2.48)	3.00 (2.64-3.48)	3.73 (3.25-4.35)	4.74 (4.02-5.70)	5.55 (4.62-6.81)	6.41 (5.22-8.04)	7.34 (5.83-9.45)	8.68 (6.63-11.6)	9.79 (7.25-13.5)
60-day	1.67 (1.47-1.92)	2.34 (2.07-2.71)	3.25 (2.86-3.77)	4.02 (3.51-4.69)	5.10 (4.32-6.14)	5.97 (4.96-7.32)	6.89 (5.61-8.64)	7.91 (6.28-10.2)	9.38 (7.16-12.5)	10.6 (7.85-14.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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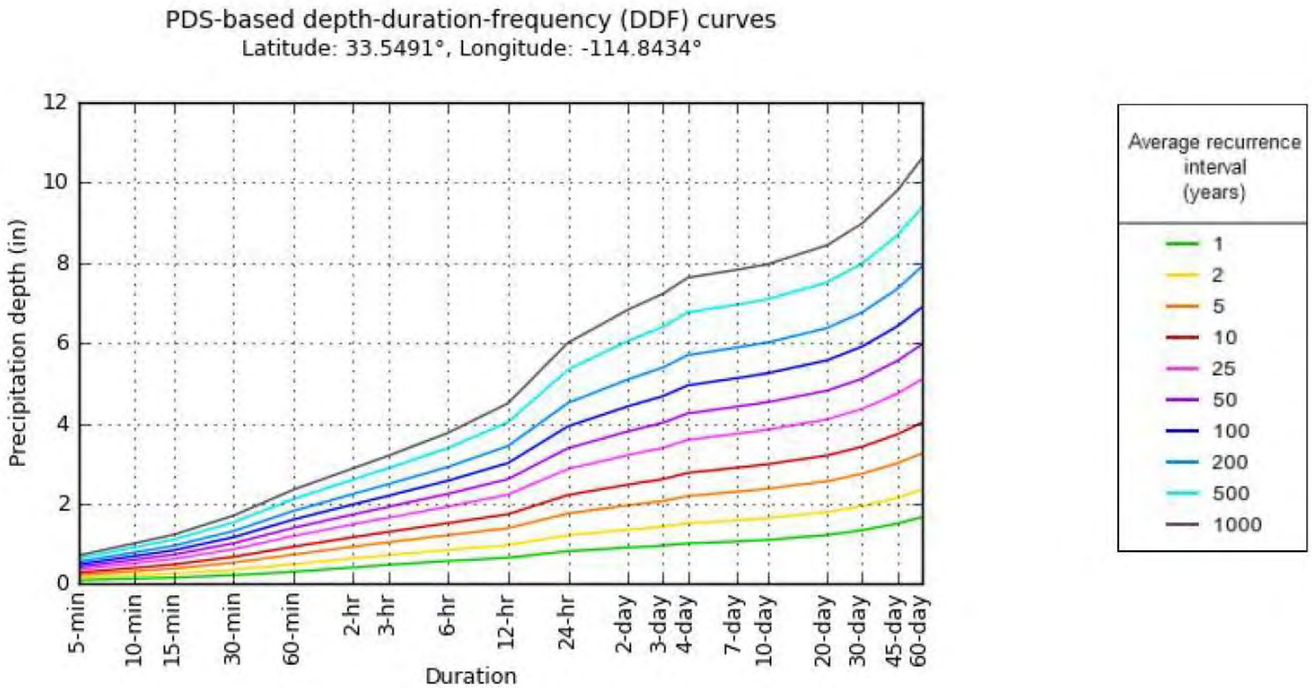
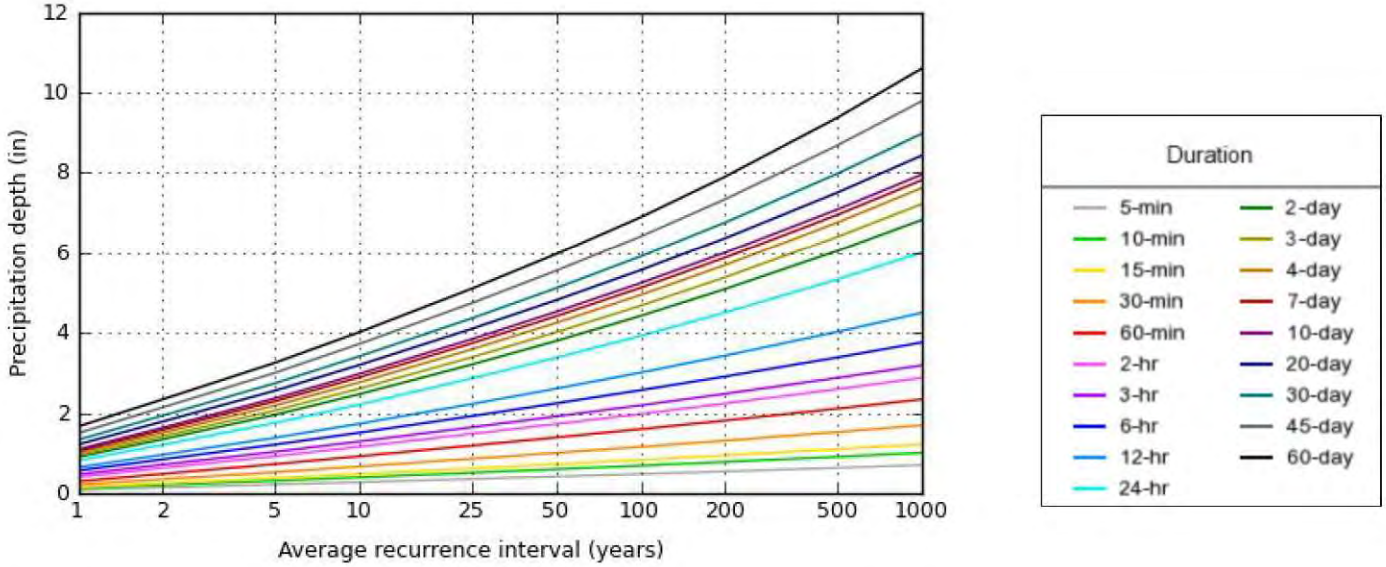
PF graphical





NOAA Atlas 14, Volume 6, Version 2

Created (GMT): Mon Dec 19 16:40:02 2016

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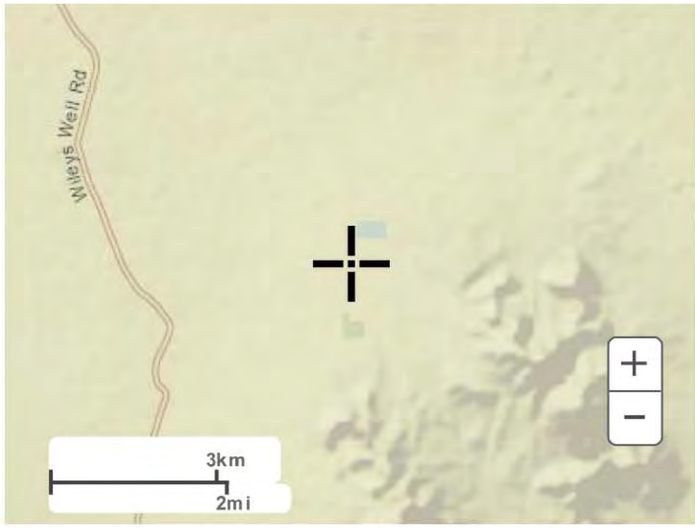
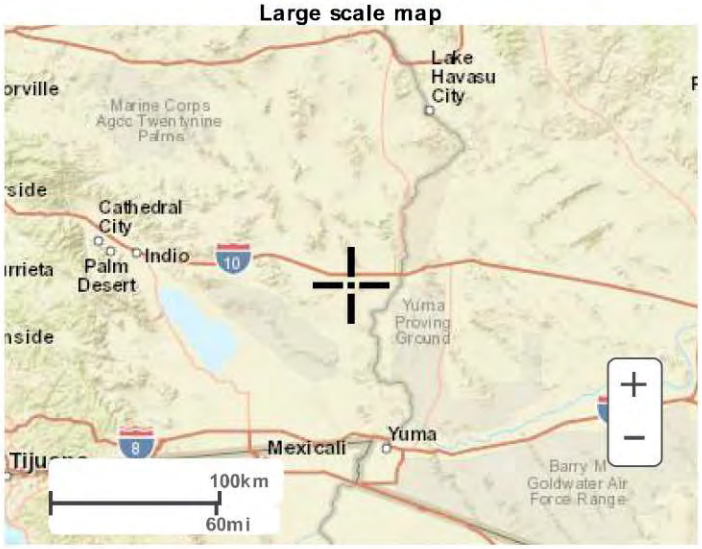
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 6, Version 2
Location name: Winterhaven, California, USA*
Latitude: 33.4472°, Longitude: -115.1613°
Elevation: 2282.62 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.087 (0.073-0.105)	0.139 (0.116-0.168)	0.211 (0.176-0.256)	0.276 (0.228-0.337)	0.371 (0.296-0.468)	0.451 (0.353-0.583)	0.540 (0.412-0.715)	0.641 (0.475-0.874)	0.795 (0.565-1.13)	0.930 (0.637-1.37)
10-min	0.125 (0.105-0.151)	0.199 (0.166-0.240)	0.303 (0.253-0.367)	0.395 (0.327-0.483)	0.531 (0.424-0.671)	0.646 (0.506-0.835)	0.774 (0.590-1.02)	0.919 (0.681-1.25)	1.14 (0.809-1.62)	1.33 (0.914-1.96)
15-min	0.151 (0.127-0.182)	0.241 (0.201-0.291)	0.367 (0.306-0.444)	0.478 (0.395-0.584)	0.642 (0.513-0.812)	0.782 (0.611-1.01)	0.936 (0.714-1.24)	1.11 (0.824-1.51)	1.38 (0.979-1.96)	1.61 (1.10-2.37)
30-min	0.213 (0.178-0.257)	0.339 (0.283-0.410)	0.516 (0.431-0.626)	0.673 (0.556-0.822)	0.905 (0.723-1.14)	1.10 (0.861-1.42)	1.32 (1.01-1.75)	1.57 (1.16-2.13)	1.94 (1.38-2.76)	2.27 (1.56-3.34)
60-min	0.294 (0.246-0.355)	0.468 (0.391-0.566)	0.713 (0.595-0.864)	0.929 (0.768-1.14)	1.25 (0.998-1.58)	1.52 (1.19-1.97)	1.82 (1.39-2.41)	2.16 (1.60-2.95)	2.68 (1.90-3.81)	3.14 (2.15-4.62)
2-hr	0.399 (0.334-0.482)	0.612 (0.511-0.739)	0.911 (0.759-1.10)	1.17 (0.970-1.43)	1.56 (1.25-1.97)	1.89 (1.48-2.44)	2.25 (1.71-2.97)	2.65 (1.97-3.61)	3.26 (2.32-4.64)	3.79 (2.60-5.59)
3-hr	0.460 (0.385-0.555)	0.695 (0.581-0.839)	1.03 (0.855-1.24)	1.31 (1.09-1.61)	1.74 (1.39-2.20)	2.10 (1.64-2.71)	2.50 (1.90-3.31)	2.94 (2.18-4.01)	3.61 (2.56-5.13)	4.19 (2.87-6.17)
6-hr	0.563 (0.472-0.680)	0.842 (0.704-1.02)	1.24 (1.03-1.50)	1.58 (1.30-1.93)	2.08 (1.67-2.63)	2.51 (1.96-3.24)	2.98 (2.27-3.94)	3.50 (2.59-4.77)	4.28 (3.04-6.08)	4.95 (3.40-7.30)
12-hr	0.665 (0.557-0.803)	0.997 (0.834-1.21)	1.47 (1.22-1.78)	1.88 (1.55-2.29)	2.48 (1.98-3.14)	2.99 (2.34-3.86)	3.55 (2.71-4.70)	4.17 (3.09-5.68)	5.10 (3.62-7.25)	5.89 (4.04-8.68)
24-hr	0.831 (0.735-0.958)	1.25 (1.11-1.45)	1.85 (1.63-2.15)	2.38 (2.08-2.78)	3.16 (2.68-3.81)	3.82 (3.17-4.69)	4.54 (3.69-5.70)	5.33 (4.22-6.88)	6.52 (4.96-8.74)	7.53 (5.55-10.4)
2-day	0.950 (0.840-1.09)	1.44 (1.27-1.66)	2.13 (1.88-2.46)	2.74 (2.40-3.19)	3.64 (3.09-4.38)	4.40 (3.66-5.40)	5.23 (4.25-6.57)	6.15 (4.87-7.93)	7.52 (5.72-10.1)	8.68 (6.40-12.0)
3-day	1.01 (0.895-1.17)	1.53 (1.35-1.77)	2.27 (2.00-2.62)	2.91 (2.55-3.40)	3.88 (3.29-4.67)	4.68 (3.90-5.75)	5.57 (4.53-6.99)	6.55 (5.18-8.44)	8.00 (6.09-10.7)	9.24 (6.81-12.8)
4-day	1.07 (0.947-1.23)	1.62 (1.43-1.87)	2.39 (2.10-2.76)	3.06 (2.68-3.58)	4.07 (3.45-4.90)	4.92 (4.09-6.04)	5.84 (4.75-7.34)	6.87 (5.44-8.86)	8.39 (6.39-11.2)	9.68 (7.14-13.4)
7-day	1.16 (1.02-1.33)	1.73 (1.53-2.00)	2.53 (2.23-2.92)	3.23 (2.82-3.77)	4.27 (3.62-5.13)	5.14 (4.28-6.31)	6.10 (4.96-7.66)	7.17 (5.68-9.25)	8.77 (6.67-11.7)	10.1 (7.46-14.0)
10-day	1.22 (1.08-1.41)	1.80 (1.59-2.08)	2.62 (2.31-3.03)	3.33 (2.91-3.88)	4.38 (3.71-5.26)	5.26 (4.37-6.46)	6.23 (5.06-7.82)	7.32 (5.79-9.43)	8.93 (6.80-12.0)	10.3 (7.60-14.3)
20-day	1.39 (1.23-1.60)	2.02 (1.78-2.33)	2.86 (2.52-3.31)	3.59 (3.14-4.19)	4.65 (3.94-5.60)	5.53 (4.60-6.79)	6.50 (5.28-8.16)	7.58 (6.00-9.78)	9.22 (7.02-12.4)	10.6 (7.83-14.7)
30-day	1.56 (1.38-1.80)	2.25 (1.99-2.59)	3.14 (2.77-3.64)	3.90 (3.41-4.55)	4.97 (4.22-5.99)	5.87 (4.88-7.20)	6.85 (5.57-8.60)	7.96 (6.30-10.3)	9.63 (7.33-12.9)	11.1 (8.17-15.4)
45-day	1.78 (1.57-2.05)	2.54 (2.24-2.93)	3.51 (3.10-4.06)	4.31 (3.77-5.03)	5.42 (4.59-6.52)	6.30 (5.24-7.74)	7.29 (5.92-9.15)	8.41 (6.65-10.8)	10.1 (7.68-13.5)	11.6 (8.54-16.0)
60-day	2.00 (1.77-2.31)	2.83 (2.50-3.27)	3.86 (3.41-4.47)	4.70 (4.11-5.48)	5.83 (4.94-7.01)	6.71 (5.58-8.24)	7.68 (6.24-9.64)	8.80 (6.97-11.3)	10.5 (7.99-14.1)	12.0 (8.86-16.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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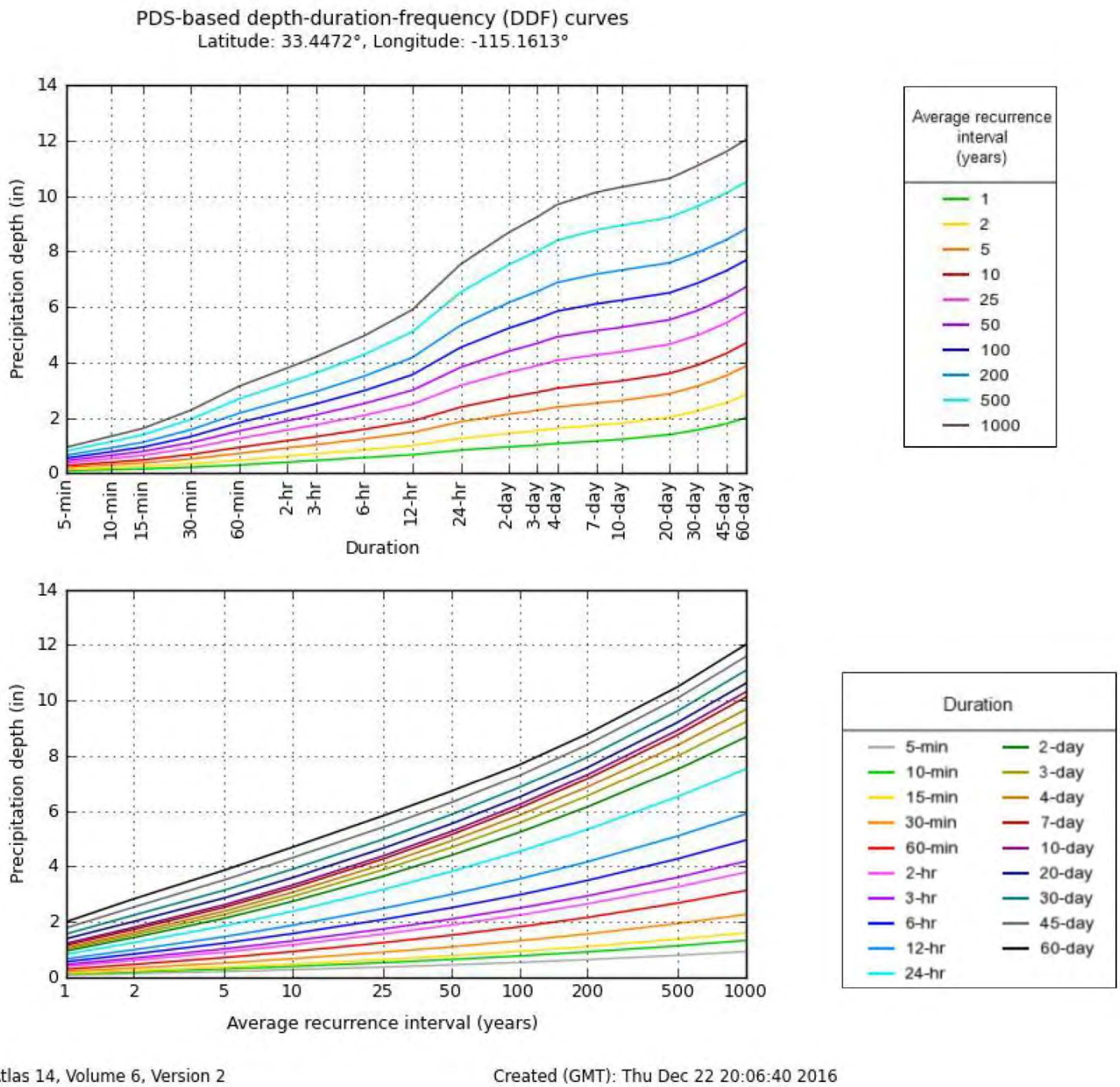
PF graphical



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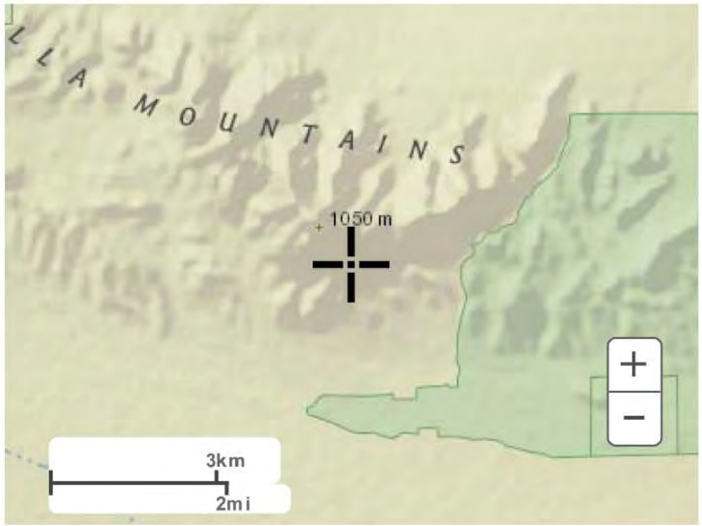
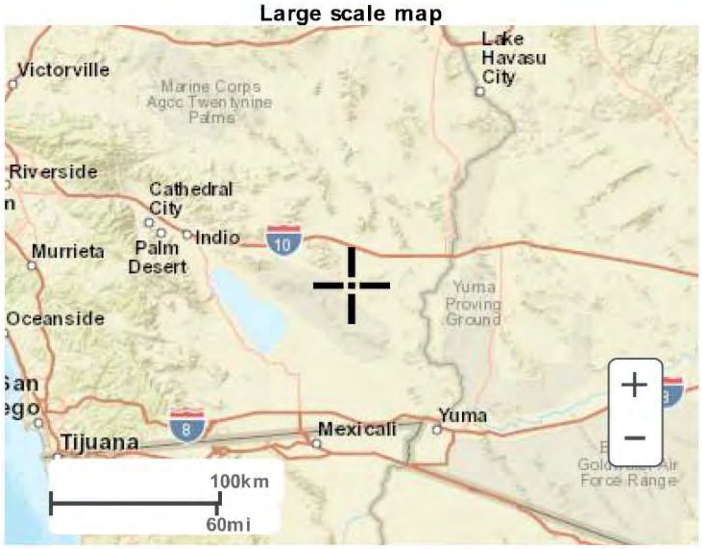
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map



Large scale aerial


Lake
Havasu
City
Victorville
Riverside
Cathedral
City
Indio
Murrieta
Palm
Desert
Oceanside
San
ego
Tijuana
Mexicali
Yuma
100km
60mi

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U.4 Approved Jurisdictional Determination, October 2018

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, LOS ANGELES DISTRICT
1451 RESEARCH PARK DRIVE, SUITE 100
RIVERSIDE, CALIFORNIA 92507-2154

October 29, 2018

SUBJECT: Approved Jurisdictional Determination

Priya Finnemore
ESA
550 West C Street Suite 750
San Diego, California 92101

Dear Ms. Finnemore:

I am responding to your request (File No. SPL-2018-00707) dated September 7, 2018, on behalf of the Bureau of Land Management, for an approved Department of the Army jurisdictional determination (JD) for the proposed Crimson Solar Project. The proposed project site is located on approximately 2,700 acres, south of Interstate 10 and north of Mule Mountain, approximately 13 miles west/southwest of the city of Blythe, in Riverside County, California (centered at approximately lat. 33.5689°N, long. -114.8372°W).

The Corps' evaluation process for determining whether or not a Department of the Army permit is needed involves two tests. If both tests are met, a permit would likely be required. The first test determines whether or not the proposed project is located within the Corps' geographic jurisdiction (i.e., it is within a water of the United States). The second test determines whether or not the proposed project is a regulated activity under Section 10 of the Rivers and Harbors Act or Section 404 of the Clean Water Act. This evaluation pertains only to geographic jurisdiction.

Based on available information, I have determined waters of the United States do not occur on the project site. The basis for our determination can be found in the enclosed Approved Jurisdictional Determination (JD) form.

The aquatic resources identified on the proposed project site in the project documentation you provided are intrastate isolated waters with no apparent interstate or foreign commerce connection. As such, the aquatic resources on the proposed project site are not currently regulated by the Corps of Engineers. This disclaimer of jurisdiction is only for Section 404 of the Clean Water Act. Other federal, state, and local laws may apply to your activities. In particular, you may need authorization from the California State Water Resources Control Board, the California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service.

This letter includes an approved jurisdictional determination for the proposed Crimson Solar Project. If you wish to submit new information regarding this jurisdictional determination, please do so within 60 days. We will consider any new information so submitted and respond within 60 days by either revising the prior determination, if appropriate, or reissuing the prior determination. If you object to this or any revised or reissued jurisdictional determination, you may request an administrative appeal under Corps regulations at 33 CFR Part 331. Enclosed you will find a Notification of Appeal Process (NAP) and Request for Appeal (RFA) form. If you wish to appeal this decision, you must submit a completed RFA form within 60 days of the date on the NAP to the Corps South Pacific Division Office at the following address:

Tom Cavanaugh
Administrative Appeal Review Officer
U.S. Army Corps of Engineers
South Pacific Division, CESPD-PDS-O, 2042B
1455 Market Street
San Francisco, California 94103-1399

In order for an RFA to be accepted by the Corps, the Corps must determine that it is complete, that it meets the criteria for appeal under 33 CFR Part 331.5 (see below), and that it has been received by the Division Office by **December 28, 2018**.

This determination has been conducted to identify the extent of the Corps' Clean Water Act jurisdiction on the particular project site identified in your request, and is valid for five years from the date of this letter, unless new information warrants revision of the determination before the expiration date. This determination may not be valid for the wetland conservation provisions of the Food Security Act of 1985. If you or your tenant are USDA program participants, or anticipate participation in USDA programs, you should request a certified wetland determination from the local office of the Natural Resources Conservation Service prior to starting work.

Thank you for participating in the regulatory program. If you have any questions, please contact me at (951) 276-6624 x263 or via e-mail at James.E.Mace@usace.army.mil. Please help me to evaluate and improve the regulatory experience for others by completing the customer survey form at http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey.

Sincerely,

MACE.JAMES.ETHAN.1231826501

Digitally signed by MACE.JAMES.ETHAN.1231826501
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MACE.JAMES.ETHAN.1231826501
Date: 2018.10.29 12:36:36 -07'00'

James E. Mace
Senior Project Manager
South Coast Branch
Regulatory Division

Enclosure(s)

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL			
Applicant:		File Number: SPL-2018-00707	Date: OCTOBER 29, 2018
Attached is:			See Section below
	INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)		A
	PROFFERED PERMIT (Standard Permit or Letter of permission)		B
	PERMIT DENIAL		C
X	APPROVED JURISDICTIONAL DETERMINATION		D
	PRELIMINARY JURISDICTIONAL DETERMINATION		E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/cecw/pages/reg_materials.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.

- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.

- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

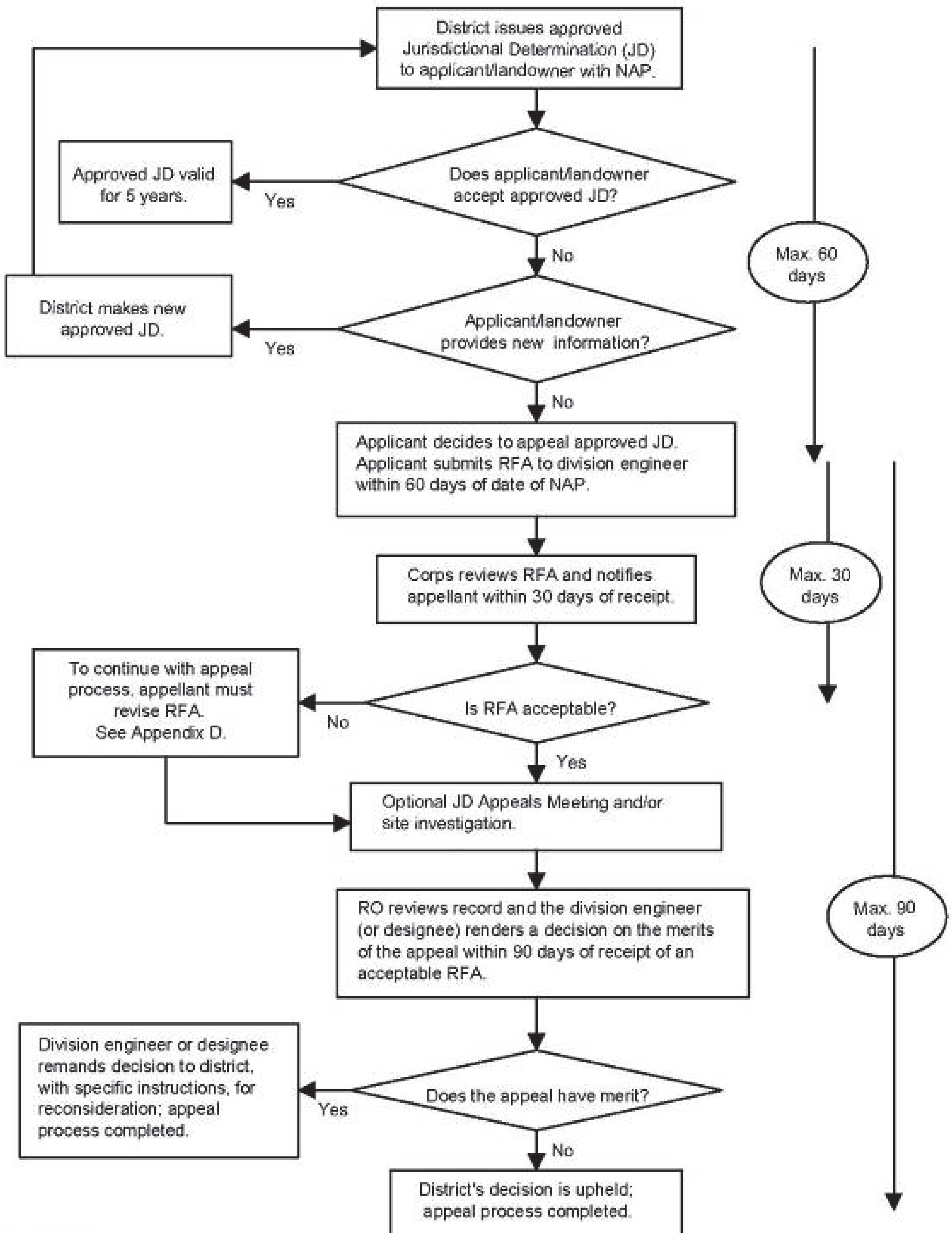
POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact:	If you only have questions regarding the appeal process you may also contact:
James Mace U.S. Army Corps of Engineers Los Angeles District 1451 RESEARCH PARK DRIVE, SUITE 100 RIVERSIDE, CALIFORNIA 92507-2154 Phone: (951) 276-6624 Email: James.E.Mace@usace.army.mil	Thomas J. Cavanaugh Administrative Appeal Review Officer, U.S. Army Corps of Engineers South Pacific Division 1455 Market Street, 2052B San Francisco, California 94103-1399 Phone: (415) 503-6574 Fax: (415) 503-6646 Email: thomas.j.cavanaugh@usace.army.mil

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

______________________________ Signature of appellant or agent.	Date:	Telephone number:

Administrative Appeal Process for Approved Jurisdictional Determinations



Appendix C

§ 331.5 Criteria.

(a) *Criteria for appeal* —(1) *Submission of RFA.* The appellant must submit a completed RFA (as defined at §331.2) to the appropriate division office in order to appeal an approved JD, a permit denial, or a declined permit. An individual permit that has been signed by the applicant, and subsequently unilaterally modified by the district engineer pursuant to 33 CFR 325.7, may be appealed under this process, provided that the applicant has not started work in waters of the United States authorized by the permit. The RFA must be received by the division engineer within 60 days of the date of the NAP.

(2) *Reasons for appeal.* The reason(s) for requesting an appeal of an approved JD, a permit denial, or a declined permit must be specifically stated in the RFA and must be more than a simple request for appeal because the affected party did not like the approved JD, permit decision, or the permit conditions. Examples of reasons for appeals include, but are not limited to, the following: A procedural error; an incorrect application of law, regulation or officially promulgated policy; omission of material fact; incorrect application of the current regulatory criteria and associated guidance for identifying and delineating wetlands; incorrect application of the Section 404(b)(1) Guidelines (see 40 CFR Part 230); or use of incorrect data. The reasons for appealing a permit denial or a declined permit may include jurisdiction issues, whether or not a previous approved JD was appealed.

(b) *Actions not appealable.* An action or decision is not subject to an administrative appeal under this part if it falls into one or more of the following categories:

(1) An individual permit decision (including a letter of permission or a standard permit with special conditions), where the permit has been accepted and signed by the permittee. By signing the permit, the applicant waives all rights to appeal the terms and conditions of the permit, unless the authorized work has not started in waters of the United States and that issued permit is subsequently modified by the district engineer pursuant to 33 CFR 325.7;

(2) Any site-specific matter that has been the subject of a final decision of the Federal courts;

(3) A final Corps decision that has resulted from additional analysis and evaluation, as directed by a final appeal decision;

(4) A permit denial without prejudice or a declined permit, where the controlling factor cannot be changed by the Corps decision maker (e.g., the requirements of a binding statute, regulation, state Section 401 water quality certification, state coastal zone management disapproval, etc. (See 33 CFR 320.4(j));

(5) A permit denial case where the applicant has subsequently modified the proposed project, because this would constitute an amended application that would require a new public interest review, rather than an appeal of the existing record and decision;

(6) Any request for the appeal of an approved JD, a denied permit, or a declined permit where the RFA has not been received by the division engineer within 60 days of the date of the NAP;

(7) A previously approved JD that has been superceded by another approved JD based on new information or data submitted by the applicant. The new approved JD is an appealable action;

(8) An approved JD associated with an individual permit where the permit has been accepted and signed by the permittee;

(9) A preliminary JD; or

(10) A JD associated with unauthorized activities except as provided in §331.11.

U.5 Drainage, Erosion and Sedimentation Control Plan, April 2019

Environment

Prepared for:
Sonoran West Solar Holdings, LLC.
Recurrent Energy, LLC

Prepared by:
AECOM
Camarillo, CA
60487757
April 2019

Drainage, Erosion, and Sediment Control Plan
RE Crimson Solar Power Project
Riverside County, California

AECOM Environment

Prepared for:
Sonoran West Solar Holdings, LLC.
Recurrent Energy, LLC

Prepared by:
AECOM
Camarillo, CA
60487757
April 2019

Drainage, Erosion, and Sediment Control Plan
RE Crimson Solar Power Project
Riverside County California

Prepared June 2018
Revised December 2018
Revised April 2019

Prepared By Roy Hauger, P.E. QSD

Reviewed By Jennifer Guigliano, CPESC, CPSWQ

Contents

List of Appendices

1.0 INTRODUCTION

1.1 Introduction and Project History

Sonoran West Solar Holdings, LLC (Applicant), a wholly owned subsidiary of Recurrent Energy LLC, proposes to construct and operate the RE Crimson Solar Project (Project), a utility-scale solar photovoltaic (PV) and energy storage project that would be located on federal lands managed by the Bureau of Land Management (BLM) within the California Desert Conservation Area (CDCA) planning area. A Plan of Development (POD) was prepared as part of the SF-299 application process for a Right-of-Way (ROW) Grant or Lease from BLM.

The Project site was formerly proposed for development as the Sonoran West Solar Energy Generating Station (Sonoran West Project) by BrightSource Energy with submittal of an SF-299 application for CACA-051967 in 2009. The former Sonoran West project design included a 540 MW dual-turbine power tower project on approximately 7,000 acres of a combination of BLM-managed and privately owned land. Thus the current revised proposal represents a substantial reduction in land use requirements and associated impacts (POD 2017). Please note that portions of the drainage studies conducted for the former Sonoran West Project are applicable to the RE Crimson Project and are discussed and referenced in this DESCP.

This DESCP presents the 30% Design Plans, the Hydrology Study and the Erosion, Sediment Transport and Sedimentation Study as well uses selected portions of the Drainage Study that was replaced by the Hydrology Study, for the Project.

1.2 Facility Vicinity Description

The proposed Project is located in unincorporated eastern Riverside County, approximately 13 miles west of Blythe, just north of Mule Mountain and just south of I-10, including portions of Sections 1, 2, 11, 12, 13, 24, 25 within Township 7 South, Range 20 East, and portions of Sections 6, 7, 8, 16, 17, 18 within Township 7 South, Range 21 East. The Project site consists of approximately 2,489 acres of BLM-administered land within the Riverside East Solar Energy Zone (SEZ) of the Western Solar Plan and within the Desert Renewable Energy Conservation Plan (DRECP) Development Focus Area (DFA). The Project is not sited within the adjacent Section 368 Federal Energy Corridor pursuant to the Westwide Energy Corridor Final Programmatic Environmental Impact Statement (PEIS), except for a short gen-tie line that would interconnect the Project to the CRS.

The Project site is situated at the eastern edge of the Chuckwalla Hydrologic Area and supports a broad alluvial fan that includes many braided washes and channels that converge into a primary channel flowing into an intra-state playa lake northwest of the Project site. This playa lake is not a Traditional Navigable Water; therefore, the channels in the Project area do not qualify as federal jurisdictional waters. See Exhibit C in Appendix B.

The site is surrounded by primarily BLM-managed lands and some private parcels. The site is located at the northern foot of the Mule Mountain Area of Critical Environmental Concern (ACEC). The SCE high-voltage transmission line and CRS are located directly north of the project site, and the Interstate 10 freeway is north of and parallel to those facilities. The site is located west of the proposed Desert Quartzite Solar Project, proposed by First Solar. Further northeast of the Desert

Quartzite project is the site of the recently approved Blythe Mesa Solar Project by RRG. Directly west of the site is designated critical habitat for desert tortoise, and further west is the Chuckwalla Desert Wildlife Management Area (DWMA) and Critical Habitat Unit (CHU) (POD 2017).

1.3 Project Description

The Project would be located on approximately 2,489 acres of public lands. It would generate up to 350 megawatts (MW) of renewable energy using PV technology and would include up to 350 MW of integrated energy storage capacity. The Project would interconnect to the regional electrical grid at 230 Kilovolt (kV) at the existing Southern California Edison (SCE) Colorado River Substation (CRS).

The POD described the proposed project, along with expected construction, operation and decommissioning activities. The Project applicant is proposing to construct the project using traditional construction methods consisting of desert tortoise exclusion fencing, mow and roll of vegetation for site preparation, compacted roads, and trenching for electrical lines. The applicant is also actively investigating alternative low-environmental impact design (LEID) elements and the potential for those to reduce Project impacts. LEID elements include several potential design changes including:

1. Minimizing grading during site preparation and maintaining more onsite vegetation to facilitate post-construction residual habitat value and post-operations/site reclamation success.

2. Avoiding or limiting trenching by placing electrical wiring aboveground.

3. Placing transformer/inverter groups on elevated support structures in lieu of cement foundations.

The LEID elements would further minimize grading, trenching, and vegetation removal beyond traditional design approaches for PV projects with the objective of reducing overall long-term impacts for the Project. Although the incorporation of LEID elements could result in slight modifications to the module block locations due to topographic constraints, the permitting boundary or limits of development would be the same with LEID elements incorporated (POD 2017).

1.4 Drainage, Erosion, and Sediment Control Plan Elements

This DESCP includes the following elements.

A. **Regional and Vicinity Maps:** A Project regional and vicinity map is provided in Appendix A (30% Design Plans RE Crimson, LLC Cover Sheet T.100) together with drawing RE Current Sheet C.101 indicate the location of all project elements (construction site, laydown area, etc.) with depictions of all significant geographic features (Westwood 2018).

B. **Site Delineation Map:** Areas subject to soil disturbance for the Project (project site, laydown areas, linear facilities and any other project elements) are delineated showing boundary lines of construction areas and the location of existing and proposed structures, pipelines, roads, and drainage facilities. The Site 30% Design Plans are included in Appendix A (RE Crimson Sheets C.101 through C.104, Sheets C.200 through C.217 and Sheets C.300 and C.301) (Westwood 2018).

C. **Watercourses and Critical Areas Map:** The DESCP provides a map that shows the location of nearby watercourses including swales, intermittent streams, and drainage ditches, as well as their proximity to the Project. This map is included in Appendix B as

Exhibit C: Regional Watershed Map, (former) Sonoran West Solar Project and more detailed information is presented on Exhibit G, Existing Condition Onsite Drainage Map, Sonoran West Solar Project (Slater Hanifan 2012A).

D. **Drainage Map:** The DESCP provides topographic site maps showing existing and proposed drainage systems. The Site 30% Design Plans are included in Appendix A (RE Crimson Sheets C.200 through C.211) depict the drainage improvements, with a key plan found on each sheet

E. **Narrative of Project Site Drainage:** The DESCP includes a narrative of the drainage measures to be taken to protect the site and downstream facilities. The narrative is presented in Section 2 of this report.

F. **Clearing and Grading Plans:** The DESCP provides elevations, slopes, locations, and the extent of proposed grading as shown by the contours, and identifies areas to be preserved. Proposed contours are shown in conjunction with existing topography. The Site 30% Design Plans are contained in Appendix A (RE Crimson Sheets C.101 through C.104 and Sheets C.200 through C.217).

G. **Clearing and Grading Narrative:** The DESCP includes in-place estimates of quantities of material excavated and filled for the site and project elements whether such excavations or fill is temporary or permanent, and the amount of such material to be imported or exported. The narrative is presented in Section 3 of this plan.

H. **Soil, Wind and Water Erosion Control:** The DESCP describes the method for approval of chemical-based dust palliatives and soil bonding agents proposed for use on the Project (Section 4.2.2 and 4.3.4). Any materials used will be submitted for approval prior to use in accordance with an approved Dust Control Plan (DCP) prior to the start of construction.

I. **Best Management Practices Plan:** The DESCP includes a Best Management Practices Plan (BMPP) which identifies the location of site-specific BMPs (including dust control, entrance/exit stabilization, and erosion/sediment/drainage control BMPs) on the topographic site maps. The BMPP is presented as Section 4 of this report and also indicates specific soil, wind, and water erosion control methods. The BMPP also incorporates the 30% Design Plans included in Appendix A (RE Crimson Sheets C.200 through C.211 depicts the drainage improvements, with a key plan found on each sheet. Drawings RE Crimson Sheets C212 through C217 and Sheet C.300 provide additional drainage details) and the BMP Fact Sheets in Appendix C provide additional resources, as needed.

J. **Best Management Practices Narrative:** The DESCP describes the location, timing, and maintenance schedule of erosion and sediment control BMPs to be used prior to initial grading, during project element excavations and construction, final grading/stabilization, and post-construction. The narrative is presented in Section 4 of this report and also indicates specific soil, wind, and water erosion control methods. Separate BMP implementation schedules will be maintained, as needed, for each project element for each phase of construction and also the post-construction maintenance for structural BMPs once detailed design is completed. Given the living nature of BMP implementation, these schedules and plan updates will be updated as needed and retained at the RE Crimson site.

K. **Project Schedule:** The DESCP identifies the location of the site-specific BMPs to be employed during construction. The preliminary schedule is provided in Section 2.2.3, Table 2-1 of this report. Separate BMP implementation schedules will be provided, as needed, for each phase of construction once detailed design is completed.

L. **Erosion Control Drawings:** The DESCP includes the 30% Design Plans including the Grading and Erosion Control Plans in Appendix A (RE Crimson Sheets C.200 though C.217 and Sheet C.300). Given the dynamic nature of BMPs and erosion control measures, if changes to proposed erosion control measures are necessary, plans will be updated accordingly and revised plans will be retained on site.

M. **Monitoring Plan:** Monitoring activities shall include routine inspections. Information on the proposed monitoring activities for RE Crimson can be found in Section 5 and 6.

2.0 DRAINAGE

2.1 Existing Conditions

The RE Crimson Project site is located southwest of Blythe, California, within Riverside County. The site is located approximately 1.5 miles southeast of the intersection of Wiley's Well Road and I-10. The site is owned by the federal government and managed by the BLM and consists of approximately 2,489 ± acres of undeveloped terrain

The Location Map (Exhibit A in Appendix B) identifies significant geographical features in the vicinity, as well as adjacent project sites. Offsite flow tributary to the site is generated by the Mule Mountains to the south, the Chuckwalla Mountains to the southwest, and the McCoy Mountains to the north. Surface drainage is conveyed in a manner consistent with an alluvial fan system with flow and deposition, with the exception of a predominant wash located west of the project site, hereafter referred to as Wiley's Well Wash (Slater Hanifan 2012A).

2.1.1 Regional Watershed Information

The Riverside County Land Information System (RCLIS) website identifies regional watershed boundaries for Riverside County. Please see the Regional Watershed Map (Exhibit C in Appendix B) for reference to the regional watershed boundaries in relation to the former proposed Sonoran West Project site. The former Sonoran West Project site is located within the following two (2) regional watersheds:

- Ford Regional Watershed – The west portion of the site and the majority of the offsite area, including Wiley's Well Wash, are located within the Ford regional watershed and drain west to the Ford Dry Lake bed.
- Palo Verde Regional Watershed – The east portion of the site and a portion of offsite tributary area are located within the Palo Verde regional watershed and drain east toward the Palo Verde Valley.

The adjacent mountain ranges serve as tributary watershed divides. More specifically, the Mule Mountain and McCoy Mountain ranges serve as the divide between the Ford and Palo Verde regional watersheds. Note that a portion of the offsite tributary area extends south into Imperial County; however, it is still encompassed by the Ford regional watershed.

2.2 Proposed Project Site

2.2.1 On-site and Off-site Drainage

A Drainage Study was prepared in 2012 by the Slater Hanifan Group (Slater Hanifan Drainage Study) for the formerly proposed Sonoran West site (Slater Hanifan 2012A). The area included in the study is therefore larger than the currently proposed RE Crimson Solar Project, but includes the RE Crimson Solar Site. Onsite flow is conveyed both as overland flow, as well as in a series of washes that will be almost entirely avoided by the RE Crimson Project. The majority of the defined washes originate in the Mule Mountain Range and are relatively defined as they enter the upstream portion of the project site. However, the nature of the washes is that they fan out and become less defined as flow travels downstream and eventually flow becomes consistent with an alluvial fan system. The area of the site and offsite tributary area within the Ford regional watershed drains primarily to an existing depression area near the north central portion of the former Sonoran West site, and is outside of the RE Crimson Permitting Boundary. Stormwater will pond in the depression prior to flowing northwest to the existing Ford Dry Lake. The depression area has been identified as a critical area with respect to project planning and has been studied extensively as part of the formerly proposed Sonoran West Drainage Study (Slater Hanifan 2012A)). This area, including the offsite tributary area within the Palo Verde regional watershed drains east to the Palo Verde Valley (Slater Hanifan 2012A).

Since the Slater Hanifan Drainage Study was prepared for the former Sonoran West site, the footprint of the currently proposed development area has been reduced and the RE Crimson Solar Project has been revised to avoid the depression area identified in the 2012 study and discussed above. This area is designated as the flood area that will experience greater than 2 foot of water depth from a 100-year storm event as shown on the 30% Design Plans of the RE Crimson Solar Project.

2.2.2 FEMA Flood Zone Designation

The RE Crimson Solar Project, which is within the former proposed Sonoran West site, is located within unprinted FEMA FIRM Panel 06065C3200G indicating that the area has not yet been studied by FEMA and that no FEMA jurisdictional Special Flood Hazard Areas (SFHAs) impact the project site. In addition to FEMA designated flood zones, the California Department of Water Resources (DWR) has designated several ‘awareness floodplains’ throughout the State which denote locations of 100-year floodplains based upon best available data. Per the DWR website, the site is located within the Hopkins Well and Roosevelt Mine Awareness Floodplain Maps. Per the DWR Best Available Map (BAM) Web Viewer, no DWR Awareness Floodplains are delineated on these floodplain maps at this time; therefore, the RE Crimson Project site is not impacted by any DWR designated “awareness floodplains” (Slater Hanifan 2012A).

2.2.3 Construction Phasing

Pre-construction activities would commence in the third quarter of 2020, with desert tortoise clearance surveys being conducted in September of 2020. Construction activities would commence in the fourth quarter of 2020, and would be expected to be complete by December of 2022. (POD 2017)

Preliminary construction phasing would be as follows:

- Pre-construction Activities, including desert tortoise fence installation, geotechnical work, and UXO investigation: approximately 16 weeks
- Phase 1, Site Preparation: approximately 16 weeks
- Phase 2, PV Module System Installation: approximately 48 weeks, overlapping with Phase 1 by approximately 12 weeks
- Phase 3, Installation of Inverters, Substations, and Connection: approximately 38 weeks, overlapping with Phase 2 by approximately 25 weeks.

Table 2-1. Construction Phase Schedule

Construction Element	Site Preparation	Photovoltaic Module System Installation	Installation of Inverters, Substation & Connection
SOLAR FACILITY			
Length of Phase (work days)	78	232	116
ENERGY STORAGE SYSTEM			
Length of Phase (work days)	22	174	146

Incorporation of alternative design elements is not expected to materially alter the construction schedule or workforce.

The exact timing of installation of the energy storage component is unknown, but is expected to overlap with construction of the final phase of the solar facility (POD 2017).

2.3 Hydrologic Calculations Summary

A Drainage Study of the undeveloped project area was prepared for the larger, former Sonoran West Project (Slater Hanifan 2012A). A Hydrology Study (Westwood 2017) of the RE Crimson Project, classified as a Recurrent Energy "Phase C" analysis, was subsequently prepared. The Hydrology Study increased the area modeled from the prior Drainage Study in order to give proper hydrologic consideration to the parcels that are proposed to have PV solar facilities constructed on them. According to the Hydrology Study, "this detailed report is adequate for the final project design and for submission of the project to government agencies for their review". The Hydrology Study is incorporated into this DESCP by reference.

The Hydrology Study is summarized below in Section 2.3.1. Results and conclusions from the evaluation are summarized in Section 2.3.2.

2.3.1 Hydrology Modeling

As stated in the Hydrology Study (Westwood 2017) the project hydrology was modeled as follows:

The Riverside County Flood Control and Water Conservation District (District) Hydrology Manual specifies the design hydrology methods and criteria currently required by the District. The District covers approximately the western half of Riverside County. The RE Crimson site is located outside of the District boundary; however, Riverside County has not clarified if the regulations still apply. Due to this unknown the criteria were still followed. The District's Website lists the accepted hydrology software that can be submitted. (Westwood 2017)

The Hydrologic Modeling System (HEC-HMS) software model developed by the United States Army Corps of Engineers and the Flo-2D software model developed by Flow-2D Software, Inc. are on the list of currently accepted software (District, 2016).

The Hydrology Study (Westwood 2012) selected the HEC-HMS) software model to look at the hydrology of the site and also compare to the prior study done by the Slater Hanifan Group (2012A). Using the HEC-HMS modeling software and the method specified by the District the results are similar to those by the Slater Hanifan Group 2012 Drainage Study (Westwood 2017).

The Hydrology Study determined the HEC-HMS results to be unreasonable for a number of reasons. The Hydrology Study stated that: results from HEC-HMS have a very short lag time and a very large peak flow. Further the Hydrology Study reasoned that comparing this to the Flo-2D results which have a longer lag time and smaller peak flow, the Hydrology Study authors determined that HEC-HMS had a lag time that was unreasonably fast whereas the lag time for Flo-2D has a more reasonable hydrograph response. The Hydrology Study proposed that in order for the HEC-HMS flows to be accurate the water would have to be moving at speeds of around 16-18 feet per second (fps) which is highly unreasonable. The Hydrology Study findings were: A more reasonable velocity would be around 3-4 fps which is what the Flo-2D model shows. The reason for the slower velocities is due to the flat landscape which has an average slope of 0.009 ft./ft. over the watershed. When a more reasonable lag time is input into HEC-HMS to achieve a velocity of 3-4 fps the results are similar to those from Flo-2D (Westwood 2017).

The Hydrology Study concluded that: It is highly unlikely that the results from HEC-HMS method specified by the District are accurate at the RE Crimson Site. This is most likely due to the different land cover and slopes than what is assumed in the District's Hydrology Manual which was created for the western portion of Riverside County, not the eastern portion where the RE Crimson project is located. Due to the number of different ways to check the results it has been determined that Flo-2D achieves results that more accurately depict the conditions in the watershed (Westwood 2017).

2.3.1.1 Precipitation Data and Distribution

Precipitation data was downloaded from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 (NOAA Atlas 14, 2017) for use in the Hydrology Study (Westwood 2017) and determined an average for a 100-year, 24-hour storm to be 4.25 inches. According to the Hydrology Study, the watershed was large enough that the difference in rainfall depths across the watershed had to be averaged. The Hydrology Study distributed rainfall in an SCS Type-II distribution pattern Intermap (5M), and incorporated USGS NED ground survey data into the DTM using the export to XYZ file function in Global Mapper. These XYZ files were read directly into FLO-2D (Westwood 2017).

2.3.2 Hydrology Study Results

Overall, the Hydrology Study analysis shows relatively low water depths and velocities (Exhibits 6 and 7) across the proposed array. The Hydrology Study found that during a 100 year storm the flood depths across the majority of the project area are less than 0.5 feet with velocities less than 1 foot/second. Exhibits 6 and 7 in the Hydrology Study show areas within the project with higher flood depths and velocities (Note that these Exhibits are found in Appendix B). The results from the Hydrology Study are consistent with the findings for other similar projects in the region and indicate that the site is generally suitable for the planned development and most hydrologic concerns can be addressed through detailed engineering design.

The Hydrology Study compiled the following design guidelines for the final siting of solar development facilities on this site.

4. Electrical facilities and racking/modules should be elevated 1' above the 100-year peak flood depth as depicted in Exhibit 6 of the Hydrology Study.

5. Care should be taken when siting electrical facilities and racking/modules where depths are greater than 2 feet.

6. Recent experience in Riverside County shows that retention basins are required for solar projects but this should be verified during county permitting [if required].

7. The proposed project is not expected to cause more than 1 foot of water surface rise and discharges the 100-year storm in a manner similar to the existing flow pattern. This should be revisited pending final design.

As stated in the Hydrology Study, if the proposed project footprint changes, the analysis should be revisited to ensure that all assumptions are still valid. (Westwood 2017)

2.4 Erosion, Sediment Transport and Sedimentation Study Summary

An Erosion, Sediment Transport and Sedimentation Study (ESTS) (Slater Hanifan 2012B) was prepared to develop methodologies and complete computations necessary to quantify erosion, sediment transport and sedimentation potential throughout the former Sonoran West Project area. Specifically the ESTS summarized the potential scour and deposition depths, as well as the sediment volumes that can be anticipated within the former Sonoran West Project site, and within which the RE Crimson Project is currently located. As stated in the ESTS, the results presented in the ESTS are to be incorporated into the project design as appropriate. Please note that the ESTS analyzed erosion, sediment transport and sedimentation resulting from 100-year, 24-hour design storm flows, and excluded sediment transport resulting from wind and/or other natural processes. The ESTS was prepared using the results of the Drainage Study (Slater Hanifan 2012B).

2.4.1 ESTS Approach

The approach to the ESTS was to identify critical areas with respect to the erosion and sedimentation and then to apply different models/methods to quantify erosion or sedimentation or to apply a layered approach in which several methods were utilized to quantify sediment processes. Note that engineering judgment has been applied in the ESTS to determine reasonable results. In the case of general scour, three (3) analysis methods were considered and results from the worst-case analysis was recommended by the ESTS for use in design.

2.4.2 ESTS Scour Results

Total scour is the sum of the general scour that occurs over the entire site and local scour that occurs as a result of the solar panel pylons (note that the ESTS refers to the solar field collectors as heliotstats due to the BrightSource proposed technology for the former proposed Sonoran West Project; however, the current RE Crimson Solar Project 30% design is for PV solar panel tables).

As stated in the ESTS, general scour analysis for the larger former Sonoran West Project area found that 4,879 (75-foot by 75-foot) grid cells onsite out of a total 126,721 total grid cells will experience some level of scour. The ESTS found that scour depths ranged from -3.32 feet to -0.01 feet. There were 49 grid cells, ranked in descending order, that display scour depths greater than the 99-percentile scour depth. Based on the results of the FLO-2D analysis, as well as the engineering judgment and practicality that the ESTS authors applied to the analysis, the ESTS concluded that the calculated 99th percentile scour depth (0.44 feet) was considered an adequate balance of providing scour protection for the majority of the solar field while maintaining economic and construction feasibility.

Within the Alluvial Fan Areas, general scour was further examined in the ESTS utilizing the FEMA FAN Program. All three alluvial fan analyses resulted in the same predicted scour depth of 0.50 feet.

The ESTS analyzed local scour or localized erosion sedimentation that occurs at a pier or other flow obstruction using the Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 18 (Reference 4, HEC- 18). The ESTS found that for a solar panel pylon assumed to be round with a diameter of 8-inches and using the flow depth, Froude number, and velocity from the Drainage Study, the calculated maximum scour depth is 2.24 feet. The ESTS advised that with the model limits applied, the local scour depth is reduced to 3.0 times the pylon width. Assuming a pylon width of 8-inches, the ESTS calculated the local scour to be 2.0 feet.

In summary, the ESTS concluded that the design strategy for the project should be to design the solar field posts using the worst case total scour depths predicted in the 100-year storm event. The ESTS determined the worst case total scour to be 2.5 feet (Slater Hanifan 2012B).

2.4.3 Sediment Deposition Analysis and Results

The ESTS analyzed bed load deposition and wash load deposition to determine total sedimentation (the process by which sediments entrained in storm water deposit onto the ground surface). Total sedimentation consists of bed load deposition and wash load deposition.

The ESTS analysis for bed load deposition indicated that the sedimentation deposit depths on the lower slope regions are generally in the 0.1 foot to 0.5 foot range. The ESTS found that there are limited areas where the deposition depths are higher. These are located at the apex of the alluvial lenses. Therefore the ESTS calculated the 99^{th} percentile deposition depth for design to be 0.48 feet.

The ESTS wash load deposition analysis found that there is a portion of the area analyzed where the wash load deposition occurs and is designated as the Major Deposition area. This area is shown on Exhibit E in Appendix B. The ESTS analysis determined that the predicted wash load deposition would range from 0.0 feet to 3.74 feet in this area.

In summary the ESTS concluded that the bed load deposition and the wash load deposition depths are not additive since the two forms of deposition are assumed to occur at different locations within the project areas. Therefore the total deposition depth over the majority of the Sonoran West Project site (excluding the Major Deposition Area) can be assumed to be 0.48 feet and the total deposition depth within the Major Deposition Area ranges up to 3.74 feet (Slater Hanifan 2012B).

Review of the RE Crimson 30% Design Plans indicate that the Major Deposition area is co-located with the area indicated as having a flood depth of greater than 2 foot (Sheet C.100). This area is located north east and just outside of the proposed RE Crimson Permitting Boundary, thus the proposed development avoids this area.

3.0 CLEARING AND GRADING

3.1 Areas to be Cleared and Graded

3.1.1 Proposed Facility

The RE Crimson Project is located on exposed soil, desert pavement, and light brush consisting of mostly creosote bush and mesquite (POD 2017). Additional information regarding the existing conditions is available in the Biological Resources Technical Report (BRTR) for the RE Crimson Project (AECOM 2018).

3.1.2 Existing Vegetation Management during Construction

According to the POD, across flatter areas of the site, a mow and roll technique would be used to remove surface vegetation and keep root balls in place; vegetation would be mowed to within 6 inches of the ground surface with any stubs worked over with a roller. Across other areas, grubbing and grading would be required to support installation of site structures such as the onsite substation, inverter pads, roads, and Operations and Maintenance (O&M) facilities.

The POD found that if reduced grading LEID elements were incorporated, trimming vegetation exceeding 18-inches for module installation would occur and grading and grubbing could be limited to 5% in the module field. In addition, if vegetation at inverter/transformer stations was trimmed to 6 inches in height; soils beneath inverter/transformer stations would remain pervious, although these areas are conservatively considered to be impervious surfaces for the hydrology calculations (POD 2017).

3.1.3 Access Road

According to the POD, access to the Project site would be provided from the existing paved Powerline Road to the CRS. The Project's on-site roadway system would include a perimeter road, access roads, and internal roads. The perimeter road and main access roads (inclusive of those outside of fencing between development areas) would be approximately 20 to 30 feet wide and constructed to be consistent with facility maintenance requirements and BLM fire standards. These roads would be surfaced with gravel, compacted dirt, or another commercially available surface. Selection of the surface to be used will consider surfaces that minimize attracting animals to bask on the roadway. The road would provide a fire buffer, accommodate Project O&M activities such as cleaning of solar modules, and facilitate on site circulation for emergency vehicles (POD 2017).

Further the POD stated that internal roads would have permeable surfaces and be approximately 12 to 20 feet in width or as otherwise required by BLM FIRE standards. They would be treated to create a durable, dustless surface for use during construction and operation. This would not involve lime treatment but would likely involve surfacing with gravel, compacted native soil, or a dust palliative. Any dust palliatives would be approved by BLM prior to application (POD 2017).

3.2 Location of Disposal Areas, Fills, or Other Special Areas

As shown on the 30% Design Plans, there are selected locations designated for proposed grading. In these areas, the site cuts and fills quantities would be approximately balanced. Any excess cut would be dispersed on site at any localized low spots within the solar field that do not significantly impact surface hydrology. Excess material containing organics and not suited for structural fill will be dispersed on site (Westwood 2018).

In general the location of the solar panels and the general grading avoid the areas designated as microphyll woodlands on the 30% Design Plans. The solar field design also avoids the areas predicted by the hydrologic modeling to receive the higher (2 feet and greater) of flood depth. Flooding depths as developed by the Hydrology Study are shown on the Overall Site Plan, Sheet C.100 (Westwood, 2018).

3.3 Existing and Proposed Topography

At completion of the proposed facility, the grading on the solar fields will generally maintain the existing slopes. Each solar field area will have finish grade elevation consistent with the average existing elevation at that location. Surface grading will maintain the existing drainage patterns.

The 30% Design Plans show that the typical solar inverter on a concrete slab or a typical solar inverter on driven piles will be elevated above the existing ground to address flooding. Refer to Grading and Erosion Control Sheet C.301 for the typical solar inverter details. AECOM recommends that subsequent phases of the design use the findings of the Hydrology report to set appropriate elevations for the tops of slabs to prevent damage to the inverters from flooding.

3.4 Grading

According to the POD, across flatter areas of the site, a mow and roll technique would be used to remove surface vegetation and keep root balls in place; vegetation would be mowed to within 6 inches of the ground surface with any stubs worked over with a roller. Across portions of the site, grubbing and grading would be required to level rough or undulating areas of the site and to prepare soils for concrete foundations for substation equipment and inverters. Access road beds would also be grubbed, graded, and compacted. The site cut and fill would be approximately balanced; minimal import/export would be necessary (POD 2017). As shown on the 30% Design Drawings, the concept is that areas may require surface smoothing to ensure a uniform surface for the installation of solar equipment. (Westwood, 2018) The proposed grading will not produce a truly level site with equal elevations with the exception of areas proposed for concrete foundations for substation equipment and inverters.

In dispersed sections of the solar array field, there would be limited use of scrapers to perform grading. In general, portions of the site would be contoured to a smooth grade. This technique would only be utilized in areas where existing grade cannot accommodate perimeter fencing, roads, minimum panel clearances, or other equipment or structures (POD 2017). This is reflected on the 30% Design Drawings, where the isolated cut/fills are indicated by solid lines (defined as proposed interval contour line in the legend) that are delineated by proposed grading limits (GL). (Westwood, 2018) A qualitative review of the 30% design drawings indicates that less than 20% of the disturbed area is proposed as isolated cut/fills, however the grading plans are preliminary and not final (Table 3-1).

Table 3-1. Preliminary Grading Treatments for the Solar Array Field

Treatment	Acreage
Mow and Roll	2,088
Grubbing and Grading	303

As shown on the 30% Design Plan sheet T.100, the estimated amount of cut is 191,000 cubic yards and the estimated amount of fill is the same, 191,000 cubic yards. These estimates are in place estimates and assume no shrink or swell or no ground loss. In addition these estimates do not include trench spoils. All excavated soil will be used on site for grading and leveling purposes. No soil will be imported to or exported from the Project site. Excess cut would be dispersed on site at any localized low spots within the solar field that do not significantly impact surface hydrology. Excess material containing organics and not suited for structural fill will be dispersed on site (See Exhibit A, Westwood 2018).

As shown on the 30% Design Plan sheet C.300, typical exterior access roads, typical interior access roads and low water crossings details indicate that these locations will be cleared and grubbed to remove vegetation to allow compaction of the subgrade. (Westwood 2018)

3.5 Scour

The 30% Design Plans do not show the depth of the solar tracker supports to address scour. Refer to Grading and Erosion Control Sheet C.301 for the typical solar tracker support. AECOM recommends that subsequent phases of the design use the findings of the ESTS or update this study to appropriate size the solar tracker support depths.

4.0 BEST MANAGEMENT PRACTICES PLAN

4.1 BMPs included in the 30% Design

The 30% Design Erosion Control Plans that are included in Appendix A indicate five proposed BMPs will be employed at the Project. These are:

1. Temporary Silt Fencing is proposed to be installed on selected downstream perimeters of the grading areas during construction until site stabilization. A total of 40,500 linear feet is estimated for the project. Locations of silt fencing are shown on the 30% Design Grading and Erosion Control Plan sheets C.200 to C.211. Details are shown on sheet C.300 in Appendix A.
2. Permanent Low Water Crossings are proposed to be installed in major washes between development areas. Locations are shown on Grading and Erosion Control Plan sheets C.204, C.207, and C.209. Details are shown on sheet C.300 in Appendix A.
3. A temporary Rock (or Stabilized) Construction entrance is proposed at the north end of the project to connect to the existing road (See Sheet C.200 in Appendix A). Details are shown on sheet C.300 in Appendix A.
4. Permanent Stabilized Construction Roadways are proposed throughout the Project development areas to be used on the 16-foot wide interior access roads. Locations of the interior access roads are shown on the sheets C.200 to C.211. Details are shown on sheet C.300 in Appendix A.
5. Temporary Wind Erosion BMPs that employs water or dust pallatives are proposed throughout the project during construction until site stabilization as shown on the sheets C.200 to C.211

4.2 Additional BMPs

This DESCP recognizes that additional BMPs beyond those shown in the 30% Design plans may be needed to address storm water erosion and control. The additional BMPS listed below are recommended as needed to support the project.

The following sections present standard construction Best Management Practices (BMPs), all of which are described in the CASQA Construction BMP Manual (2009). The CASQA manual provides comprehensive details on BMP selection and implementation and may be obtained and reviewed by managers for all construction contractors that may have an impact on implementation of this DESCP.

There are six groups of BMP categories: Erosion Control, Sediment Control, Tracking Control, Wind Erosion Control, Non-Storm Water Management, and Waste Management and Materials Pollution Control. Each section below presents a general discussion of the recommended construction BMPs for storm water pollution prevention in the proposed facility. Additional details on the specific CASQA BMPs recommended are included in Section 4.3 for each respective category. As needed, the DESCP will be updated during detailed design to reflect each BMP to be utilized during each construction phase. While performing the work, the contractors may implement additional control measures if necessary.

Appropriate site personnel will receive training on installing and maintaining BMPs. Recommended BMPs are shown on BMP Fact Sheets in Appendix C. As part of this DESCP, a current set of BMP drawings will be maintained in the project construction trailer. The DESCP must be updated as needed to reflect modified or new BMPs that are being implemented on site.

A Construction Site Monitoring Program (CSMP) is presented in Section 5 below.

Erosion control shall be implemented prior to the defined rainy season (generally October 15 through April 15). A preliminary schedule of construction activities and commercial operations is discussed in Section 2.2.3. The schedule of construction activities will be updated as needed to reflect project status.

4.2.1 BMPs Prior to Initial Grading

Temporary silt fences and fiber rolls, alone or in combination, will be constructed as needed around the perimeter of the areas to be graded prior to any earthwork movement. The silt fence and fiber rolls are intended to minimize the potential for sediment leaving the disturbed areas, and to minimize the potential for sediment originating upstream of the disturbed areas entering the site. Silt fences may be combined with desert tortoise exclusion fencing as long as the fence functions effectively for both purposes. Combined fencing shall be coordinated with the Designated Biologist and resource agencies as appropriate.

These BMPs will be amended in the field for special consideration of drainage paths that enter and exit the Project site and for low spots along the Project perimeter. At these locations, the accumulation of sediment from a storm event or events may overtop or overwhelm silt fences or fiber rolls. For the locations of discernible drainage paths that enter or exit the site or low spots along the Project perimeter, additional BMPs will be considered. These additional BMPs will include the following:

- A series of temporary fiber rolls or gravel bag berms or temporary silt dike can be installed at low spots or for minor drainage paths that enter or exit the site.
- Temporary sedimentation basins with rip rap lined outfalls or sediment traps with lined outfalls can be installed at locations of drainage paths that enter and exit the site

These additional BMPs will be sized to perform effectively using CASQA guidance or any other suitable method that produces adequate results.

The BMPs may be further amended in the field for special consideration for steep areas that are along the Project site perimeter. Areas of steep slopes along the perimeter may require high-capacity sediment control devices, closer spacing, and/or more frequent maintenance in order not to allow sediment to overtop the BMP and render it ineffective.

4.2.2 BMPs During Project Construction

This Project will implement the following practices for effective BMPs during construction:

- Soil stabilization BMPs shall be deployed prior to the start of ground disturbing activities.
- Soil stabilization BMPs shall be inspected and repaired and/or supplemented as appropriate within 48 hours (2 business days) prior to forecasted qualifying rain events A qualifying rain event is a rain event that (1) produces a discharge for at least one drainage area; and, (2) is preceded by 48 hours with no discharge from any drainage area. Until site experience establishes a quantifiable rain fall amount for the amount of rain that produces a

discharge, the threshold will be a rain event predicted by NOAA (for the closest weather station) to be 0.5 inches or more with a 50% or more probability. Rain events are separated with a period of no recorded rain in 48 hours or more.

- Install temporary erosion control measures per approved plans. Modify the type and placement of BMPs as required throughout the construction period to verify effective erosion control throughout the Project site and work areas.
- Maintain temporary devices at regular intervals throughout the defined rainy season until post-construction stabilization is complete and effective.

Silt fences, fiber rolls, and gravel bag berms, as noted above, shall continue to be used and maintained during project construction. Silt fences or rock check dams will also be utilized, as needed, upstream of the inlet of all culverts to prevent sediment build-up within the culvert structure. All products containing straw used on this project shall be certified weed-free. All products intended for permanent use shall be composed entirely of biodegradable materials. Materials containing plastic mesh, monofilament netting, or any other non-biodegradable materials will not be accepted on site.

Sufficient supplies of erosion control, sediment control, and wind erosion materials, and the labor and equipment needed to install them, shall be available on site for prompt maintenance and replacement as required to assure effectiveness throughout the construction period, and until effective, post-construction stabilization is in place and effective.

The project includes linear facilities such as the access road and the transmission line (KV Crossing on design drawings). These linear components have been designed and are presented in separate design drawings (see Sheets C.213 to C.216 in Appendix B). BMPs for linear facilities would include similar measures as those defined above for the solar site. During construction of transmission lines, towers, and underground utilities, appropriate BMPs such as silt fences fiber rolls, or other appropriate BMPs shall be installed around the disturbed area and maintained until the disturbed soil in each construction location has been stabilized. Areas of temporary disturbance will be restored in accordance with an approved revegetation plan. Areas of permanent disturbance will be stabilized using compaction, non-toxic soil stabilizers, revegetation, and/or other dust control measures as appropriate.

It is anticipated there will be times during construction when BMPs in place may interfere with construction activities. When this occurs, the Contractor and Resident Engineer shall address each situation individually. Some mitigation measures may include local berms or ditches, sediment barriers, or simply removing and relocating existing BMPs.

When concrete practices are underway several concrete specific BMPs shall be in place (see Section 4.3.5). Concrete curing, finishing, and paving and grinding operations BMPs will be used, as needed, to prevent any concrete materials from coming in contact with storm water runoff. Specific areas for concrete waste management, hazardous waste management, etc. shall be established in well-defined areas with signs to inform drivers of each station.

Dust control will be continuously implemented throughout the duration of construction and until post-construction stabilization is complete. Dust control measures are listed in Section 4.3.4 below, and include application of potable water or water with a chemical soil binder to exposed soil surfaces and stockpiles. When water is used, a sufficient amount will be applied to the soil to keep the wind from transporting it yet not excessive amounts to create runoff. A DCP will contain a selection of proposed soil stabilizers. Some, if not all, proposed dust palliatives, soil bonding, and weighting agents will be used. Selected soil binders will be required to be non-toxic to plants, wildlife, and humans.

4.2.3 Stabilization BMPs After Final Grading

Non-active or completed construction areas will be stabilized within 7 working days of final grading or no less than one day prior to forecasted high winds or qualifying rain events, whichever is sooner. Soil binders shall be used to prevent wind or soil erosion in completed areas. If soil binders alone are not effective, other BMPs will be applied to effectively control erosion, potentially including silt fences, fiber rolls, rock check dams, gravel bag berms, or a combination of methods.

The intent of this approach is to support the approach of allowing natural flow patterns to redevelop across the site. This is the desert ecosystem with dynamic drainages which move routinely in response to storm events, wind events, vegetation, etc. The Project is proposing minimal grading and is not proposing to do active management across the solar array areas, but rather to allow the microtopography to remain and flows to continue to cross the site. This may result in movement of some of the smaller flow paths across the site during different storm events. Erosion or sediment controls would only be relevant in areas where scour or erosion would affect structures or affect downstream flows offsite, or result in excessive erosion and/or sediment transport inconsistent with the natural drainage patterns of the site prior to construction.

New worker parking and laydown areas shall continue to be stabilized throughout the construction process with silt fences, check dams, and fiber rolls to prevent runoff from vehicles and materials leaving the site.

4.2.4 BMPs for Post Construction

Once construction of the project is completed, all temporary areas used for worker parking, material storage, and laydown areas shall be cleared of debris, stabilized, and returned to existing conditions. This shall be done by grading and de-compacting soil to its original conditions prior to construction activities. No permanent BMPs are anticipated to be required beyond restoration of temporarily impacted areas in accordance with an approved revegetation plan. Consistent with this expectation, no permanent BMPs are identified in the 30% design submittal.

Permanent BMPs anticipated at wash crossings associated with the access road are shown on the 30% Design drawings.

4.3 Project BMPs – CASQA Measures

The RE Crimson Project will implement appropriate measures during each phase of construction and post-construction to minimize the potential for impacts to water quality as defined above. This section provides the specific CASQA BMPs proposed for each of the six BMP categories (Erosion Control; Sediment Control; Tracking Controls; Soil, Wind, and Water Erosion Controls; Non-Storm Water Management BMPs; Waste Management and Materials Pollution Controls) as well as general good housekeeping practices. The CASWQ sheets for each BMP are included in Appendix C.

4.3.1 Erosion Controls

Erosion control BMPs protect the soil surface by covering and/or binding soil particles. The following are erosion control measures that will be used, as needed, during all phases of the Project:

- EC-1, Scheduling
- EC-2, Preservation of Existing Vegetation
- EC-3, Hydraulic Mulch
- EC-5, Soil Binders
- EC-10, Velocity Dissipation Devices
- EC-15, Soil Preparation/Roughening

4.3.2 Sediment Controls

Sediment controls are structural measures that are intended to complement and enhance the selected erosion control measures and reduce sediment discharges from active construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water. This project will implement the following practices as needed, for effective sediment control:

- SE-1, Silt Fence,
- SE-2 Sedimentation Basin
- SE-3, Sediment Trap
- SE-4, Check Dams (if needed)
- SE-5, Fiber Rolls
- SE-6, Gravel Bag Berm
- SE-7, Street Sweeping and Vacuuming
- SE-12- Temporary Silt Dike

4.3.3 Tracking Controls

Tracking controls will be implemented to reduce sediment from entering public or private roads. These controls will be implemented on a routine basis or for any visual accumulation of sediments. Tire washes will be used in conjunction with stabilized construction entrances/exits as needed. Final locations will be determined during final design. Wash water will be supplied by the construction wells identified for the Project and will be transported to the wash areas by truck.

The following are tracking control measures that will be used as needed, during all phases of the Project:

- TC-1, Stabilized Construction Entrance/Exit
- TC-2, Stabilized Construction Roadway
- SE-7, Street Sweeping and Vacuuming

4.3.4 Soil, Wind, and Water Erosion Controls

Wind erosion controls will be implemented to control dust from the construction site. Wind erosion control will be achieved through the use of potable water or the addition of a soil binder to exposed soil surfaces and stockpiles during grading activities in all phases. When potable water is used, a sufficient amount will be applied to the soil in order to keep the wind from transporting it yet not excessive amounts to create runoff.

The DCP for the project will contain a selection of proposed soil stabilizers as previously noted.

Stockpiles will be covered and bermed (either fiber rolls or gravel bags) when not actively being utilized.

The following are wind erosion control measures that will be used, as needed, during all phases of the Project:

- EC-5, Soil Binders
- WE-1, Wind Erosion Control
- WM-3, Stockpile Management

4.3.5 Non-Storm Water Management BMPs

Non-stormwater management BMPs are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source or eliminating off-site discharge. These practices involve day-to-day operations of the construction site and are usually under the control of the contractor. These BMPs are also referred to as “good housekeeping practices” which involve keeping a clean, orderly construction site. The following BMPs will be used, as needed, to control non-storm water pollution on the construction site:

- NS-1, Water Conservation Practices
- NS-3, Paving and Grinding Operations
- NS-6, Illicit Connection/Discharge
- NS-7, Potable Water/Irrigation
- NS-8, Vehicle and Equipment Cleaning
- NS-9, Vehicle and Equipment Fueling
- NS-10, Vehicle and Equipment Maintenance
- NS-12, Concrete Curing
- NS-13, Concrete Finishing

4.3.6 Waste Management and Materials Pollution Controls

Waste management and materials pollution control BMPs, like non-stormwater management BMPs, are source control BMPs that prevent pollution by limiting or reducing potential pollutants at their source before they come in contact with stormwater.

Waste management consists of implementing procedural and structural BMPs for handling, storing and disposing of wastes generated by a construction project to prevent the release of waste materials into storm water runoff through proper management of the following types of wastes: solid, sanitary, concrete, hazardous, and equipment-related washes. The following BMPs will be used, as appropriate, to handle materials and control construction site wastes:

- WM-1, Material Delivery and Storage

- WM-2, Material Use
- WM-3, Stockpile Management
- WM-4, Spill Prevention and Control
- WM-5, Solid Waste Management
- WM-6, Hazardous Waste Management
- WM-7, Contaminated Soil Management
- WM-8, Concrete Waste Management
- WM-9, Sanitary/Septic Waste Management
- WM-10, Liquid Waste Management

4.3.7 Good Housekeeping Practices

4.3.7.1 General Practices

Good site management (i.e., "housekeeping") measures shall be implemented for construction materials that could potentially be a threat to water quality if discharged. At a minimum, the good housekeeping measures shall consist of the following:

- Identify the products used and/or expected to be used and the end products that are produced and/or expected to be produced. This does not include materials and equipment that are designed to be outdoors and exposed to environmental conditions (i.e., poles, equipment pads, cabinets, conductors, insulators, bricks, etc.).
- Cover and berm loose stockpiled construction materials that are not scheduled to be re-disturbed for at least 14 days.
- Cover and berm loose stockpiled construction materials in accordance with applicable BMPs at least 48 hours prior to forecasted qualifying rain events. A qualifying rain event is a rain event that (1) produces a discharge for at least one drainage area; and, (2) is preceded by 48 hours with no discharge from any drainage area. Until site experience establishes a quantifiable rain fall amount for the amount of rain that produces a discharge, the threshold will be a rain event predicted by NOAA (for the closest weather station) to be 0.5 inches or more with a 50% or more probability
- Store chemicals in accordance with manufacturer’s directions with respect to environmental conditions, and in watertight containers with appropriate secondary containment to prevent any spillage or leakage, or in a storage shed providing complete enclosure.

4.3.7.2 Waste Management

The project will implement good housekeeping measures for waste management, which at a minimum shall consist of the following:

- Preventing disposal of any rinse or wash waters or materials on impervious or pervious site surfaces.
- Ensuring the containment of sanitation facilities (e.g., portable toilets) to prevent discharges of pollutants to the stormwater drainage system or receiving water.
- Staking porta-potties to the ground and ensuring doors are equipped with latches.
- Cleaning or replacing sanitation facilities and inspecting them regularly for leaks and spills.

- Maintaining effective covers on waste disposal containers.
- Preventing discharges from waste disposal containers to the stormwater drainage system or receiving water.
- Containing and securely protecting stockpiled material from wind and rain at all times unless actively being used.
- Developing a spill response and implementation procedure prior to commencement of construction activities. This includes requirements that equipment and materials for cleanup of spills shall be available on site; that spills and leaks shall be cleaned up immediately and disposed of properly; and that appropriate spill response personnel are assigned and trained.
- Ensuring the containment of concrete washout areas and other washout areas that may contain additional pollutants to prevent discharge into the underlying soil and onto the surrounding areas.

4.3.7.3 Vehicle Storage

Good housekeeping for vehicle storage and maintenance shall be implemented which, at a minimum, shall consist of the following:

- Preventing oil, grease, or fuel from leaking into the ground, storm drains or surface waters.
- Placing drip pans beneath vehicles or equipment that are stored onsite.
- Implementing appropriate BMPs whenever equipment or vehicles are fueled, maintained, or stored.
- Repairing or removing leaking equipment from the site.
- Cleaning leaks immediately and disposing of leaked materials properly.

4.3.7.4 Non-Storm Water

The Project will practice proper management of non-stormwater by:

- Implementing measures to control all non-stormwater discharges during construction.
- Washing vehicles in approved vehicle washes so as to prevent non-stormwater discharges to surface waters.
- Cleaning paved roads in such a manner as to prevent unauthorized non-stormwater discharges from reaching surface water.

5.0 MONITORING PLAN

5.1 Construction Site BMP Monitoring

Inspections of installed BMPs will be conducted by qualified staff who has received project specific BMP training as follows:

- Weekly
- Prior to a forecast storm event
- After a rain event that causes runoff from the construction site
- At 24-hour intervals during extended rain events

Inspections will be performed daily by qualified staff or a designee with appropriate training to verify that the appropriate BMPs for stormwater and non-stormwater are being implemented in the following construction site locations:

- Areas where land disturbance or active construction is occurring (including staging areas)
- Areas where soil excavations or soil spoil stockpiles are located
- Road surfaces that may have excess excavated materials
- Areas for storage of construction materials such as chemicals

Personnel associated with or specifically assigned to the implementation and maintenance of BMPs will be trained to inspect, maintain, recognize, and report abnormal/adverse situations so they can be quickly corrected.

5.2 Project Drainage System Monitoring and Maintenance during Construction

Inspections of installed drainage system components will be conducted by qualified staff who has received project specific BMP training as follows:

- Monthly during the rainy season, otherwise quarterly, or
- After a rain event that causes runoff from the construction site

The engineered wash crossings shall be kept relatively free of impediments to flowing water, erosion/scour damage to fences or PV support posts shall be promptly repaired, and vegetation/weeds shall be managed by the requirements listed below.

- **Sediment**

  Excess sediment on the upstream fences or in the engineered wash crossings or culverts (if used at the project) shall be collected and relocated onsite. Special attention must be made at fence crossings of the channels.

- **Vegetation/Weeds**

  It is anticipated that vegetation control would not be of concern until such time as the vegetation exceeds 8" to 10" in height. Noxious weeds shall be removed as they appear in accordance with an approved Weed Management Plan. Mass groups of vegetation in the drainage wash shall be thinned to prevent blockage of stormwater flows.

- **Debris**

  Trash and loose debris shall be collected from around fences, the wash crossing or culverts and disposed of in a proper manner. Special attention must be made at fence crossings at washes.

- **Erosion and Scour**

  Erosion and scour may be a continuing problem in the desert environment. Prompt action shall be taken when signs of erosion and scour first appear at support structures before they become major repairs. In addition to the periodic inspections of the drainage structures, inspections shall be made after any significant rainfall event (i.e., has the potential to result in flow onsite)[1].

At a minimum, repairs and/or management actions need to be promptly implemented when the problem 1) causes or could cause significant damage to the project, adjacent property, or structural elements of the project, 2) is a public safety concern, or 3) negatively affects adjacent plant communities or poses a hazard to wildlife. Adaptive management techniques may be required to prevent a recurrence of the problem.

A log of inspections shall be kept on site and updated each time an inspection is performed. Each entry shall indicate the date the inspection was performed, observations made, and measures taken to repair site along with any other applicable information such as photographs, etc.

[1] A significant event can be considered equivalent to the California State Water Resources Control Board qualifying storm event which is defined as “a precipitation event that: (1) produces a discharge for at least one drainage area; and, (2) is preceded by 48 hours with no discharge from any drainage area”.

6.0 POST CONSTRUCTION MONITORING PLAN

Routine inspection and maintenance will need to be performed after the Project has been constructed.

The entire property shall be inspected at a minimum of once per year for adverse erosion conditions and sediment built-up and also after any significant rainfall event (e.g., an event that has the potential to result in flow onsite). Any places found to have rills or gullies shall be fixed by re-grading the area and stabilizing the soil. Support structures will be inspected for detrimental erosion. Erosion repair activities shall be conducted as soon as practicable. The number of erosion repairs undertaken and the quantity of sediment relocated to repair the eroded areas in a given year depends on the frequency and extent of past maintenance activities, as well as weather and hydrologic conditions during recent years. If erosion persists in an area, rip-rap may be added or other appropriate BMPs will be considered for the repair.

Debris collection and blockage removal will be conducted on an as-needed basis. Trash or vegetation debris may also cause a blockage of drainage facilities and require removal. Spoils, trash, or any debris should be removed off site to an approved disposal facility..

Drainage facilities, including wash crossings (Arizona-style or culverts), shall be inspected at a minimum of twice per year, in the spring and in the fall, for accumulated sediment and for detrimental erosion, and after significant rain events. Sediment removal or erosion repair activities shall be conducted within the wash crossing during periods of no runoff. The number of sediment removal or erosion repair projects undertaken and the quantity of sediment removed or added in a given year depends on the frequency and extent of past maintenance activities, as well as weather and hydrologic conditions during recent years. Sediment removal or erosion repair needs following wet winters with higher than usual runoff, upstream slope erosion, and sediment delivery to (and transport within) the wash crossing will likely be greater than maintenance requirements following an average or dry winter.

Attention shall be made over time to monitor the settlement of wash crossings or culverts structures if incorporated into the design. The inlet and outlet inverts of culverts shall be maintained to convey runoff through the culvert as originally intended. Inspections shall also be made downstream of the culverts to monitor any potential for erosion to the channel. Wash crossings or any culverts will be inspected on a quarterly basis during the rainy season or on an annual basis to verify they are functioning as originally intended.

7.0 REFERENCES

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Appendix A

30% Design Plans- Grading and Erosion Control

RE Crimson, LLC.

350-MW AC Solar Array
Riverside County, CA
30% Design Plans

PROJECT OWNER/DEVELOPER
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PROJECT CIVIL ENGINEER OF RECORD
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PHONE: (952) 906-7459

Earthwork		
Item	Cut	Fill
Site Grading	191,000 CY	191,000 CY
Total	191,000 CY	191,000 CY

QUANTITIES SHOWN ARE IN-PLACE ESTIMATES
NO SHRINK OR SWELL IS ASSUMED
NO GROUND LOSS IS INCLUDED
NO TRENCH SPOILS ARE INCLUDED
NO TOPSOIL STRIPPING INCLUDED
*CONTRACTOR SHALL REFER TO PROJECT GEOTECHNICAL REPORT FOR ASSUMPTIONS FOR SOIL LOSSES

Item	Quantity
Security Fence Length	124,190 LF
24' Swing Gates	9 EA.
Access Road Centerline Length	276,060 LF
Silt Fence	40,500 LF
Rock Construction Entrance	1 EA.

Sheet List Table

Regional Map

SOURCE: MAP DATA ©2018 GOOGLE (NOT TO SCALE)

Vicinity Map

SOURCE: MAP DATA ©2018 GOOGLE (NOT TO SCALE)

PROJECT DESCRIPTION
350 MW-AC TRACKER SOLAR ARRAY PROJECT

PROJECT LOCATION
LATITUDE= 33° 34' 15.10"
LONGITUDE= -114° 50' 27.79"

PROJECT COORDINATE SYSTEM
NAD83 CALIFORNIA STATE PLANES, ZONE VI, US FOOT

BASIS OF ELEVATION
CONTOURS SHOWN WERE GENERATED FROM THE ALTA SURVEY PROVIDED BY LAND DESIGN ASSOCIATES ON 01/19/2018

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Westwood
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Revisions:

Designed: BTB
Checked: ADC
Drawn: JLB
Record Drawing by/date:

Prepared for:

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RE Crimson, LLC.
Riverside County, CA

Date: 04/06/2018 Sheet: T.100

Cover

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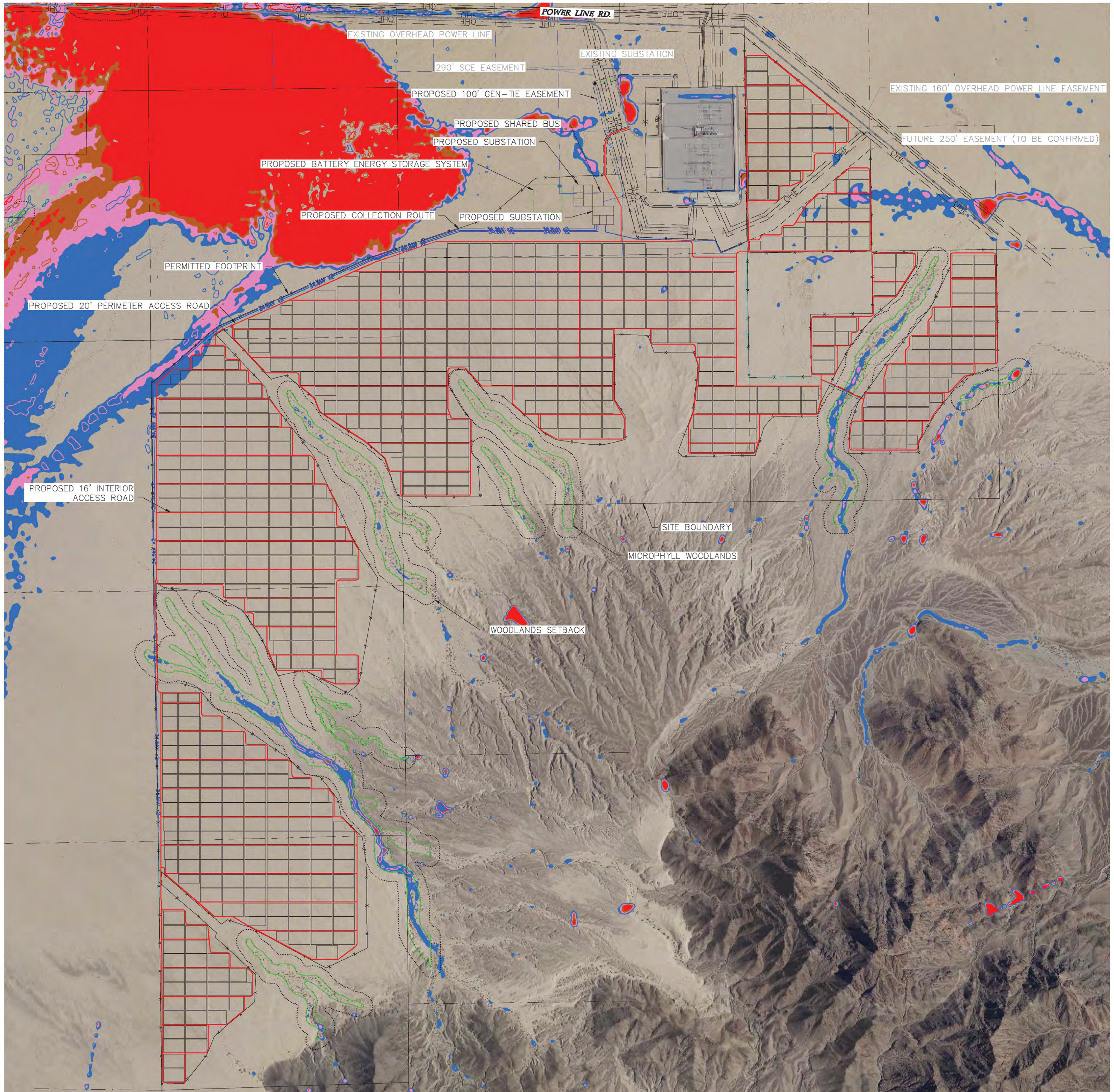

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LEGEND:

SITE BOUNDARY
EXISTING SECTION LINE
EXISTING OVERHEAD POWER LINE EASEMENT
EXISTING ROAD EASEMENT
EXISTING GRAVEL ROAD
EXISTING PAVED ROAD
EXISTING RIGHT OF WAY
EXISTING ADJACENT PROPERTY LINE
MICROPHYLL WOODLANDS
WOODLANDS SETBACK LINE
OHE — EXISTING OVERHEAD POWER LINE
EXISTING LOT LINES
PERMITTED FOOTPRINT
PROPOSED SOLAR ARRAY
PROPOSED ACCESS ROAD
34.5 kV — 34.5 kV COLLECTION ROUTE
34.5kV x2 — 34.5 kV COLLECTION ROUTE
0.5'–1.0' FLOOD DEPTH
1.0'–1.5' FLOOD DEPTH
1.5'–2.0' FLOOD DEPTH
>2.0' FLOOD DEPTH

N

0' 1200' 2400' 3600'

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Overall Site Plan

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Riverside County, CA

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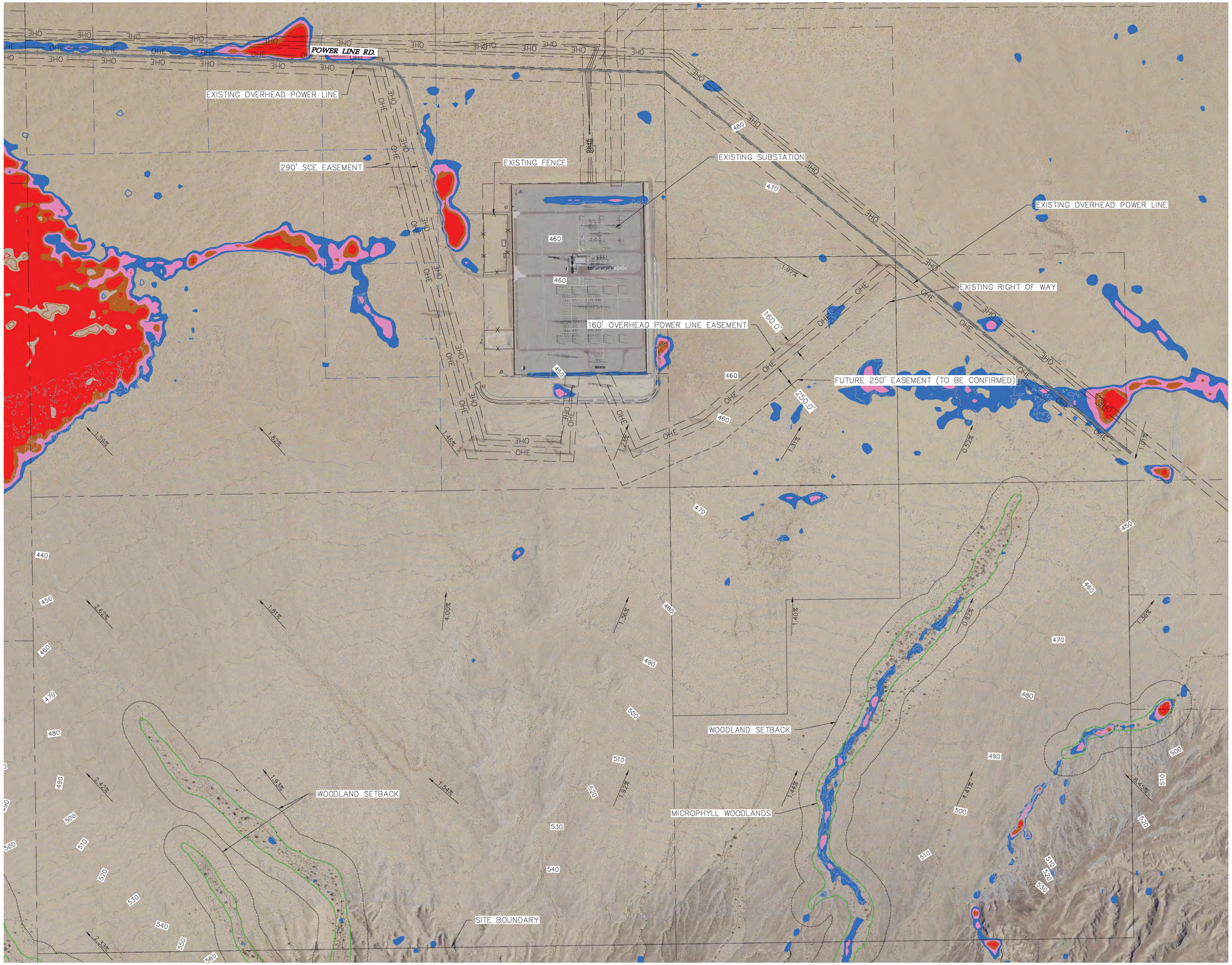
Overall Grading Plan



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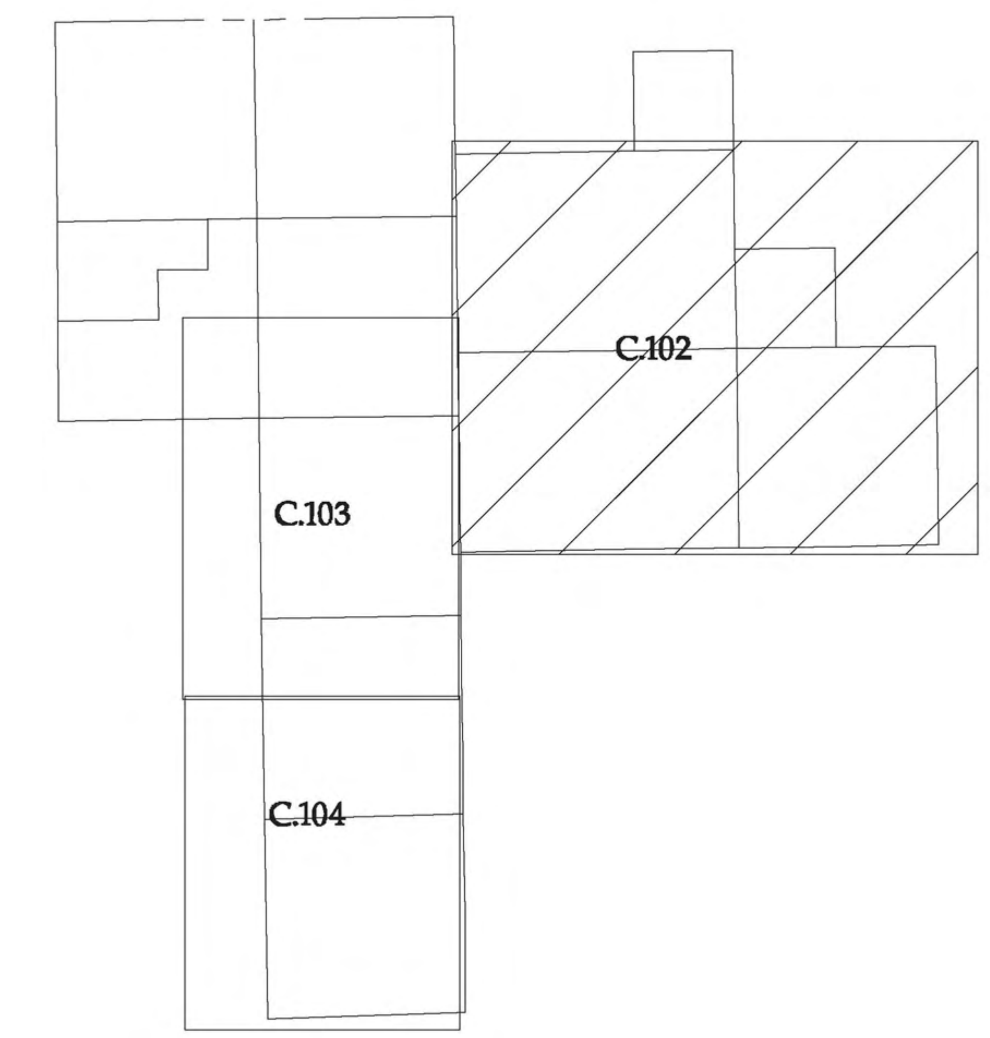
- EXISTING LOT LINES
- 1070 — EXISTING INDEX CONTOUR LINE
- 1071 — EXISTING INTERVAL CONTOUR LINE
- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

KEY MAP:



0' 600' 1200' 1800'

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RE Crimson, LLC.

Riverside County, CA

Existing Conditions-1

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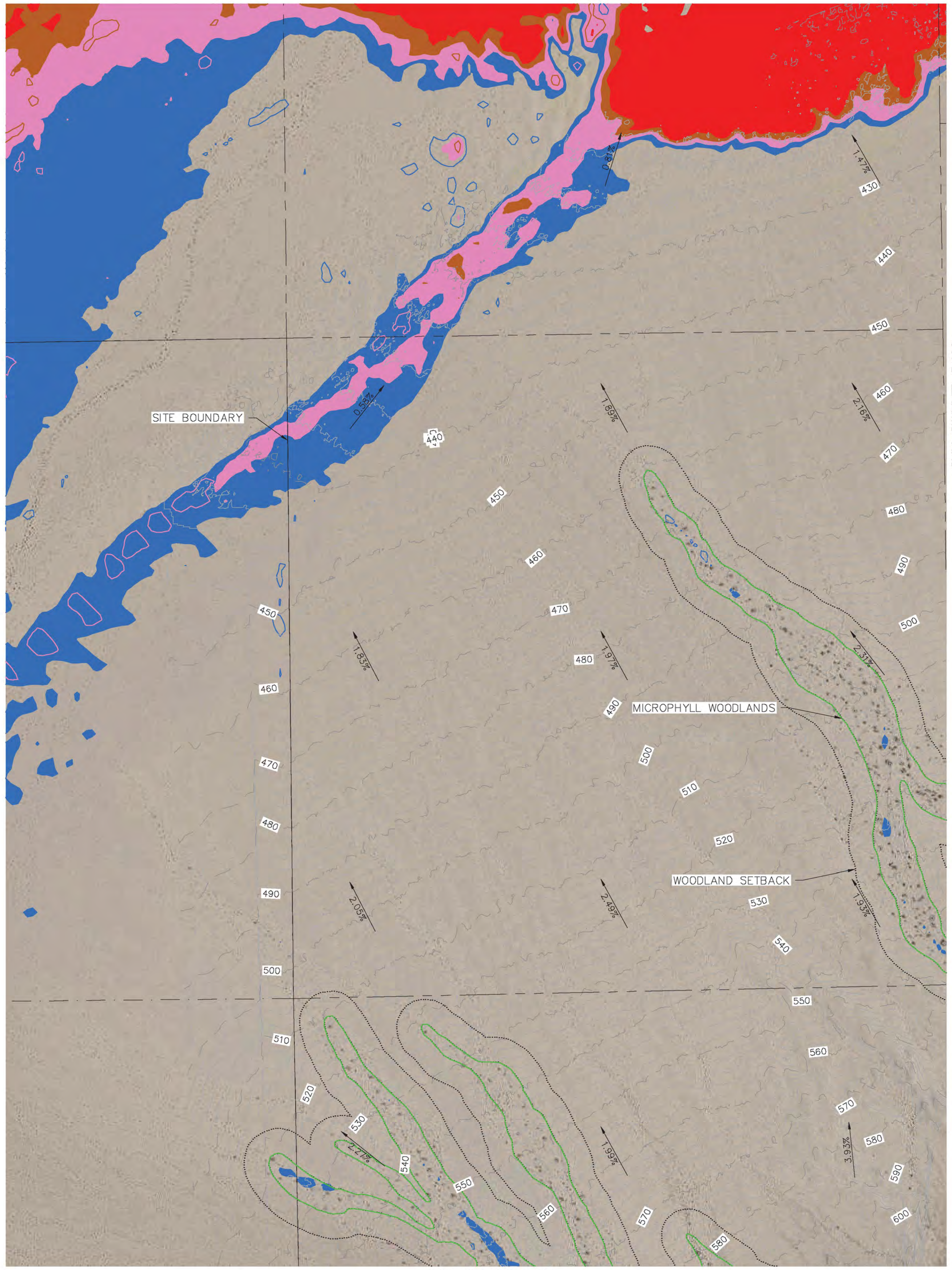

SEE SHEET C.102

SEE SHEET C.104

LEGEND:

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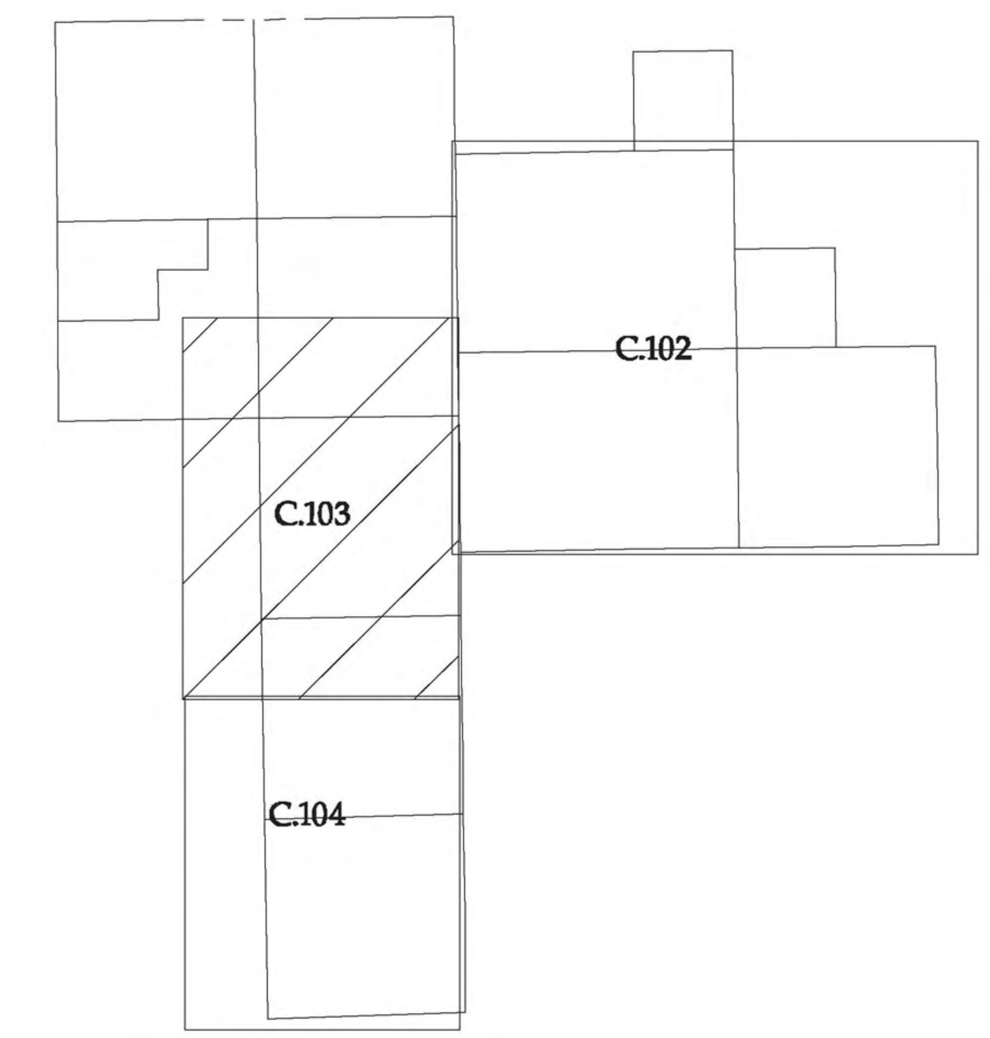

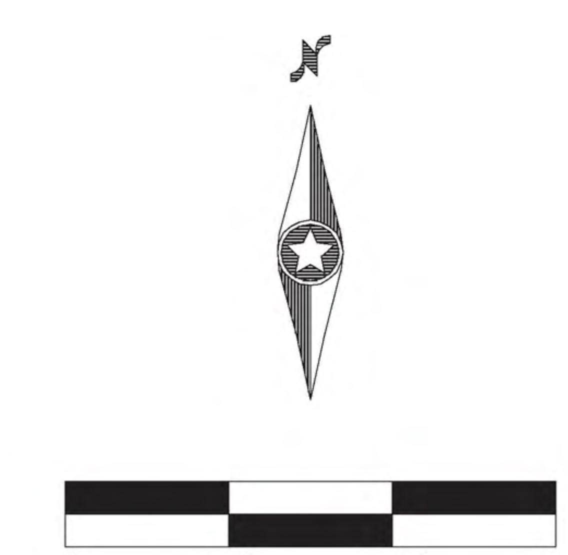

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Existing Conditions-2

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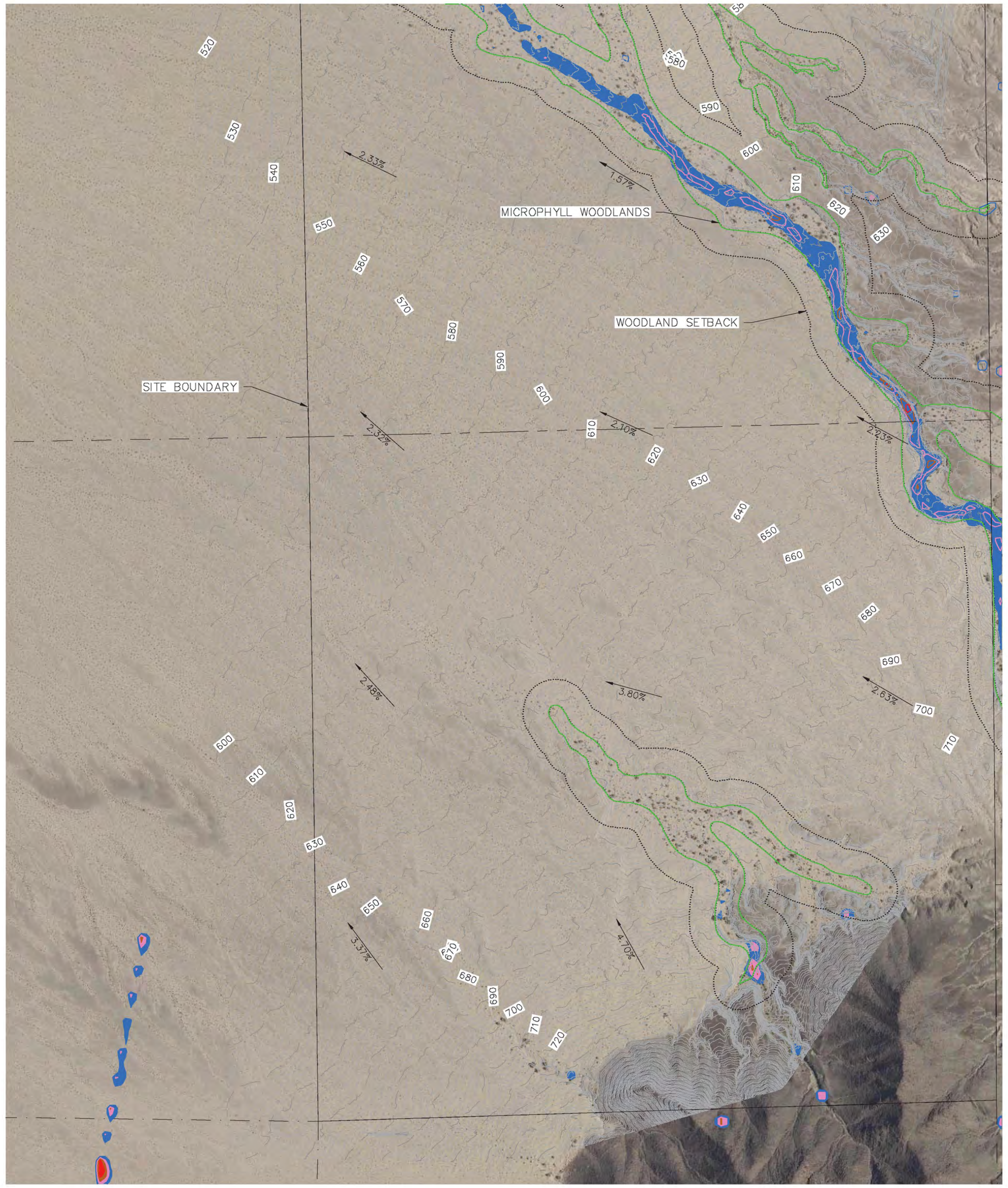

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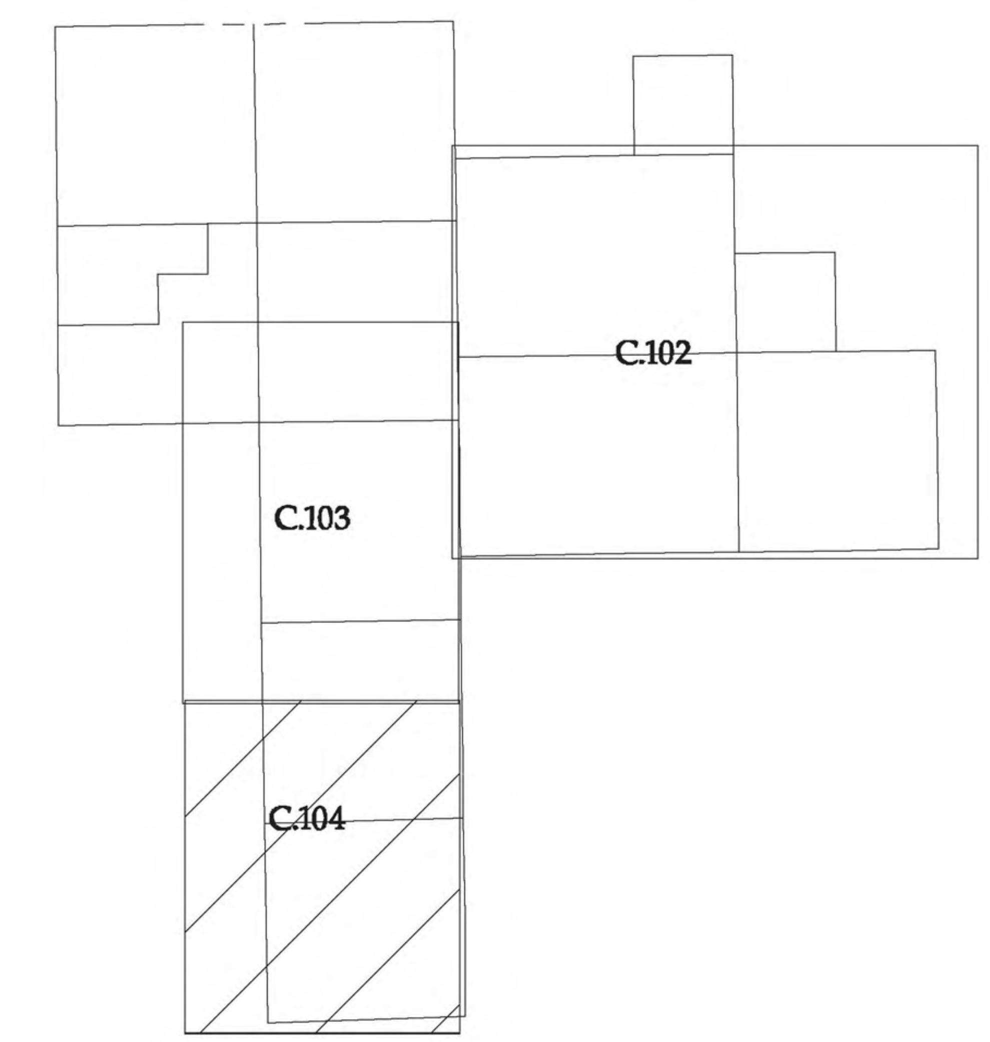
- >2.0' FLOOD DEPTH

KEY MAP:



0' 600' 1200' 1800'

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Fax (952) 937-5822 Minnetonka, MN 55343
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Westwood Professional Services, Inc.

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Checked: ADC
Drawn: JLB
Record Drawing by/date:

Prepared for:

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(415) 675 - 1500

RE Crimson, LLC.
Riverside County, CA

Date: 04/06/2018 Sheet: C.104

Existing Conditions-3

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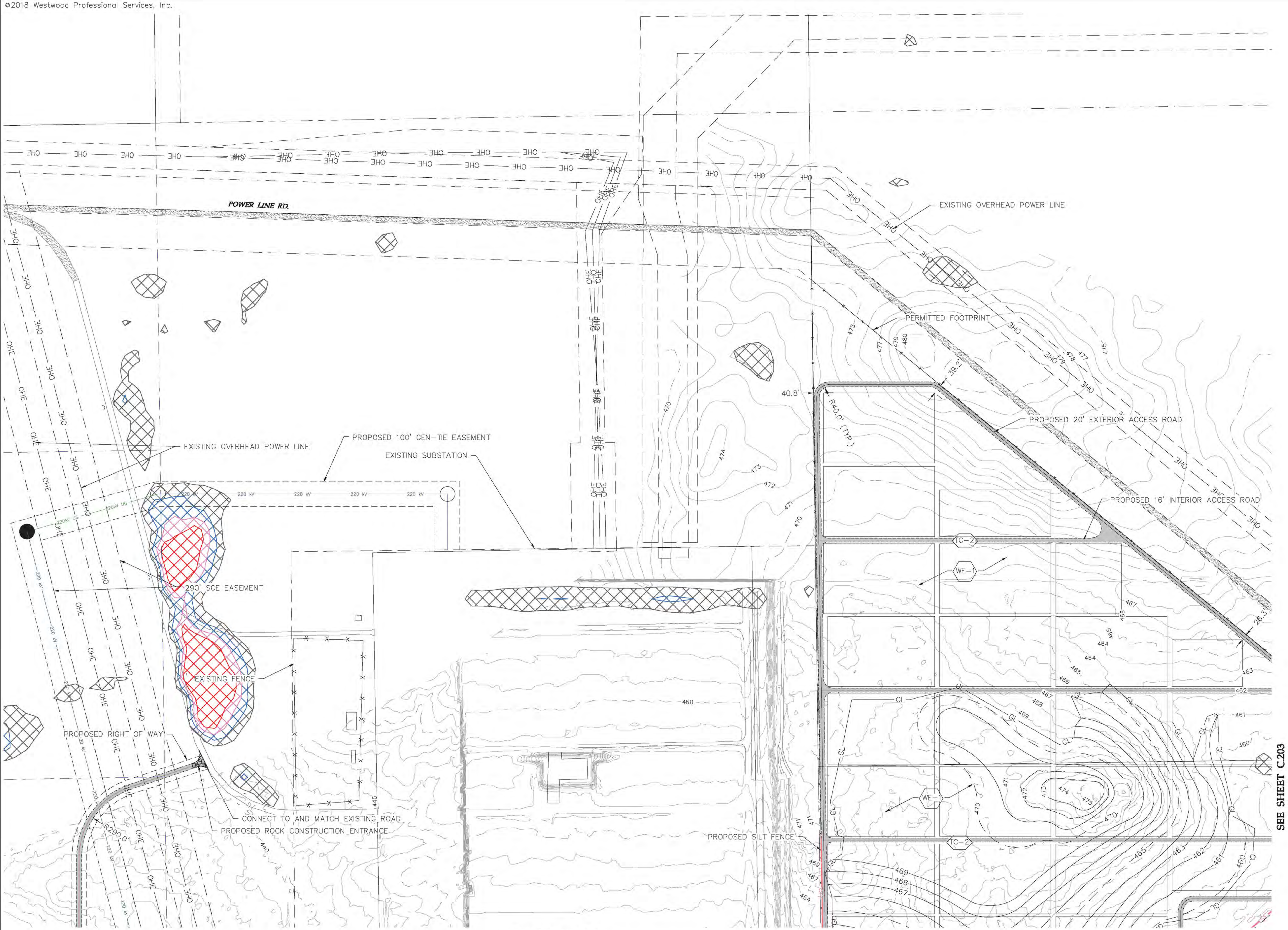


SEE SHEET C.202

LEGEND:

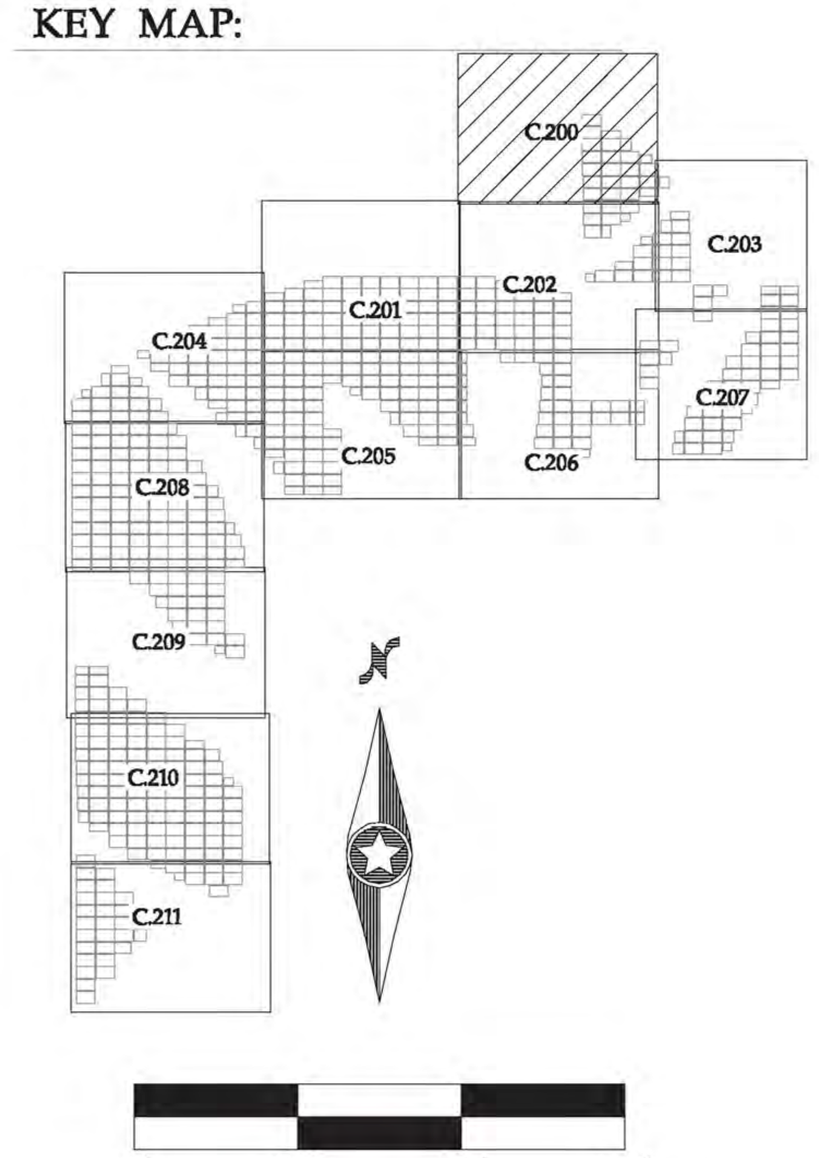
	SITE BOUNDARY
	EXISTING SECTION LINE
	EXISTING OVERHEAD POWER LINE EASEMENT
	EXISTING ROAD EASEMENT
	EXISTING RIGHT OF WAY
	EXISTING ADJACENT PROPERTY LINE
	MICROPHYLL WOODLANDS
	WOODLANDS SETBACK LINE
	EXISTING SHRUBS
OHE	EXISTING OVERHEAD POWER LINE
	EXISTING LOT LINE
1070	EXISTING INDEX CONTOUR LINE
1071	EXISTING INTERVAL CONTOUR LINE
1070	PROPOSED INDEX CONTOUR LINE
1071	PROPOSED INTERVAL CONTOUR LINE
GL	PROPOSED GRADING LIMITS
	PERMITTED FOOTPRINT
	PROPOSED SOLAR ARRAY
	PROPOSED EXTERIOR 20' ACCESS ROAD
	PROPOSED INTERIOR 16' ACCESS ROAD
34.5 kV	34.5 kV COLLECTION ROUTE
34.5kV x2	34.5 kV COLLECTION ROUTE
220kV UG	220 kV UNDERGROUND POWER LINE
220 kV	220 kV OVERHEAD POWER LINE
	PROPOSED LOW WATER CROSSING
	0.5'–1.0' FLOOD DEPTH
	1.0'–1.5' FLOOD DEPTH
	1.5'–2.0' FLOOD DEPTH
	>2.0' FLOOD DEPTH

EROSION CONTROL:

SF	PERIMETER CONTROL: SILT FENCE
	SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
WE-1	WIND EROSION: WATER AND/OR DUST PALLIATIVES
TC-2	STABILIZED CONSTRUCTION ROADWAY

NOTES:
1. DESIGN ASSUMPTIONS
   1.1. MAX SLOPE: 10%
   1.2. INTERIOR ROAD WIDTH: 16 FT.
   1.3. EXTERIOR ROAD WIDTH: 20 FT.
   1.4. MINIMUM ROAD OUTER WALL TO WALL RADIUS: 38 FT.
2. PROJECT QUANTITIES SHOWN ON PLAN SET ARE PRELIMINARY AND ARE MEANT FOR GENERAL DISCUSSION AND GENERAL PRICING PURPOSES
3. GRADING DESIGN SHOWN IS PRELIMINARY AND NOT FINAL.
4. AREAS MAY REQUIRE SURFACE SMOOTHING TO ENSURE A UNIFORM SURFACE FOR THE INSTALLATION OF SOLAR EQUIPMENT.

KEY MAP:



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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.200

Grading & Erosion Control Plan-1

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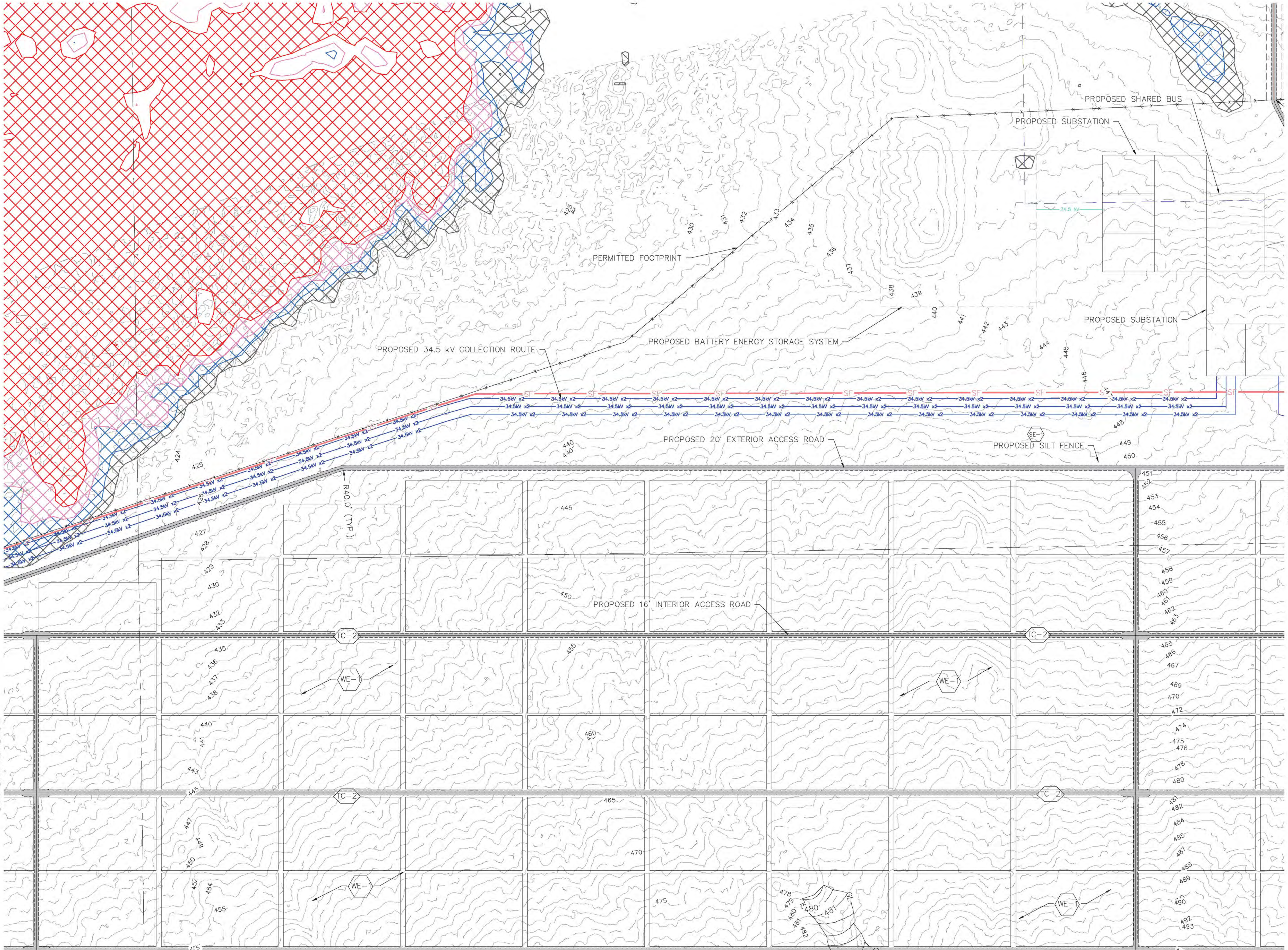

LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
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- >2.0' FLOOD DEPTH

EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:
1. DESIGN ASSUMPTIONS
   1.1. MAX SLOPE: 10%
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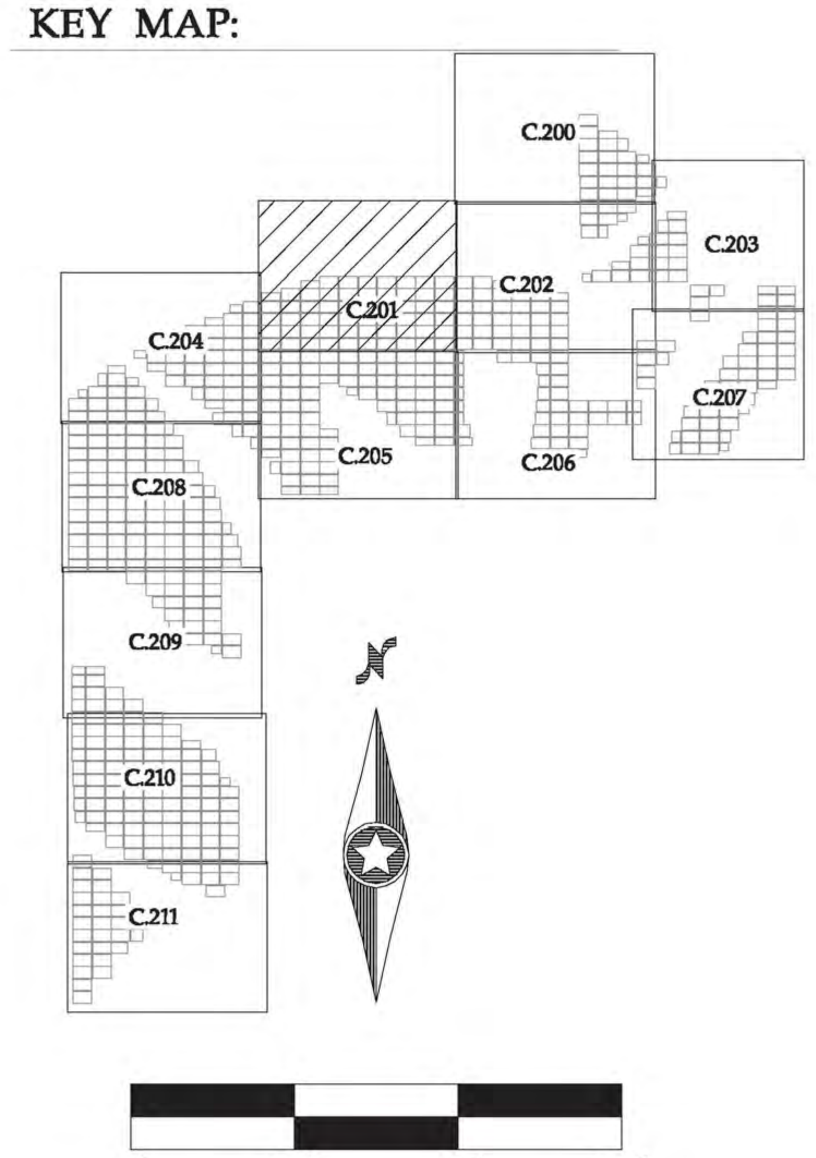
KEY MAP:



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Revisions:

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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.201

Grading & Erosion Control Plan-2

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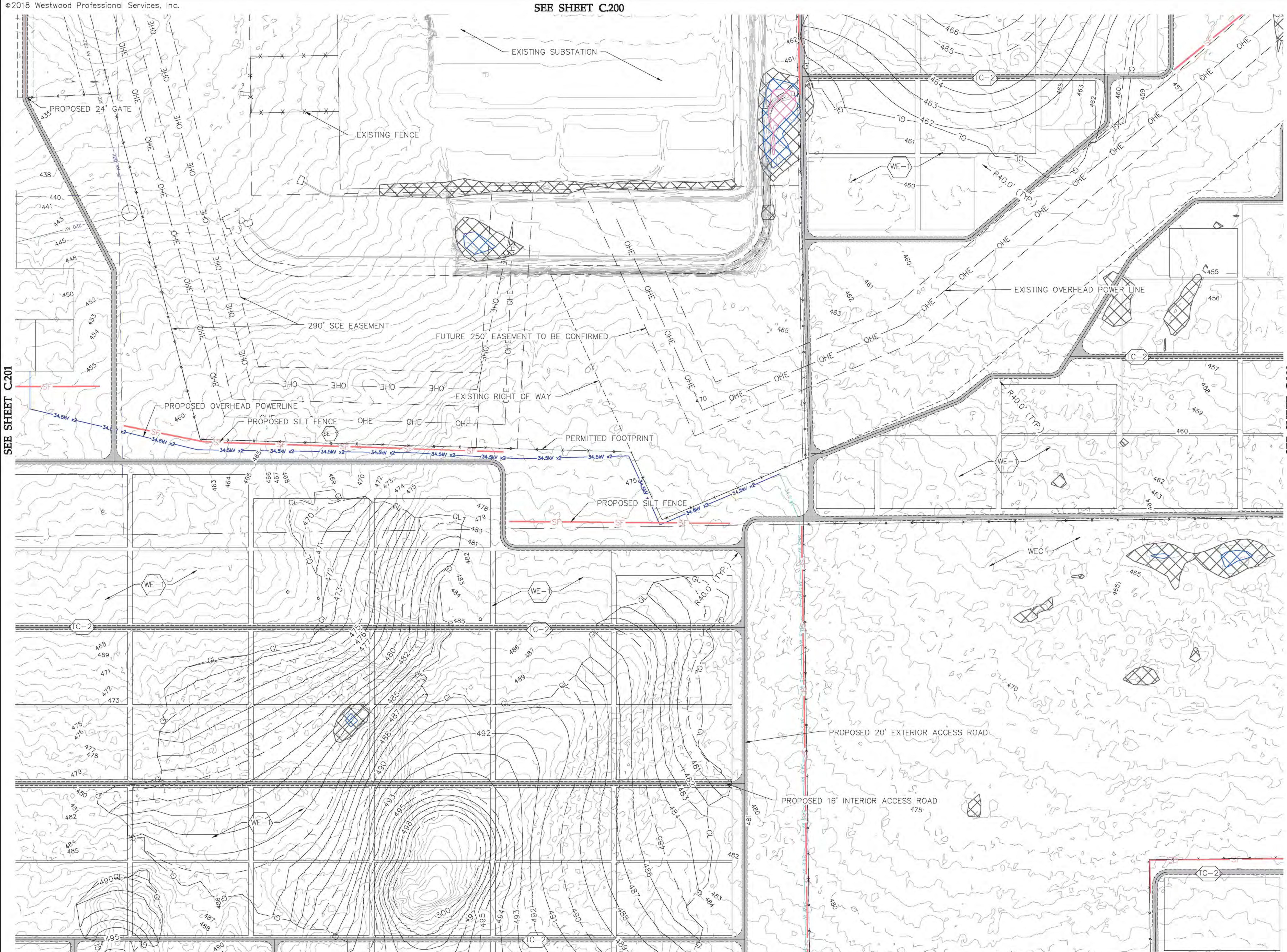

SEE SHEET C.206

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LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
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EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
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NOTES:
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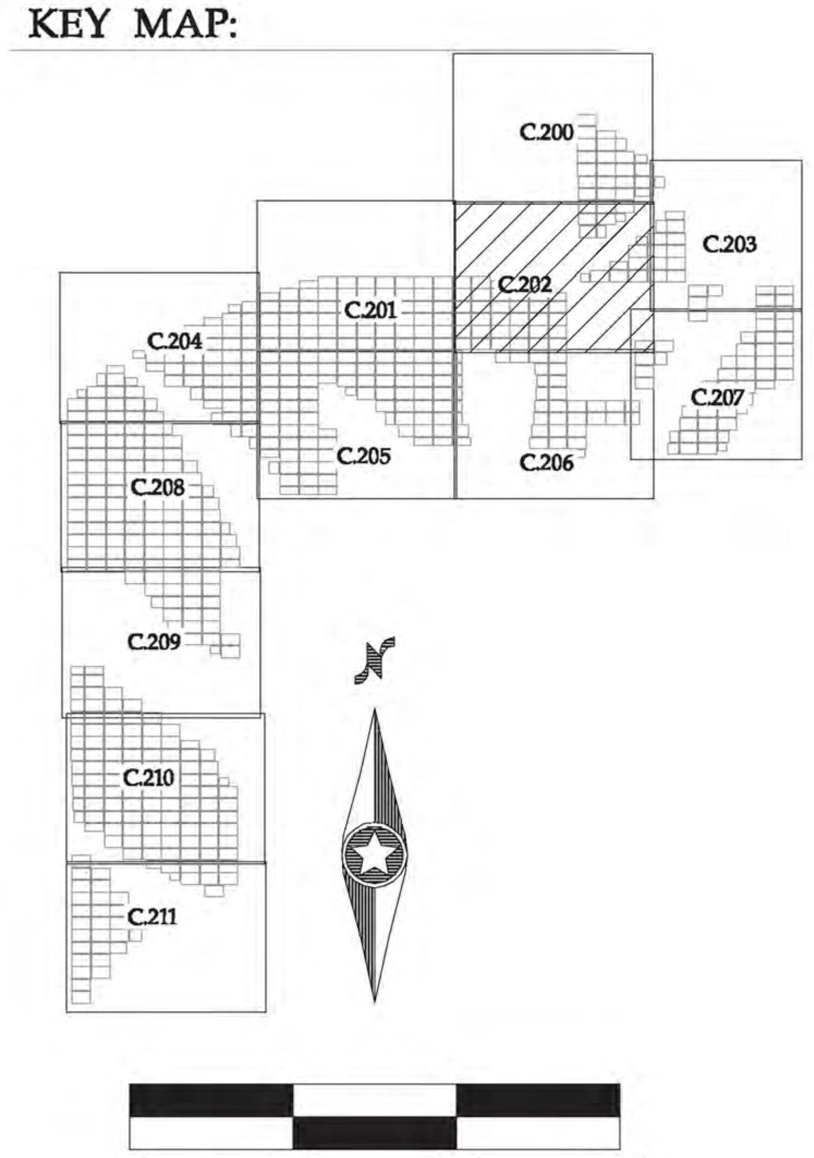

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Date: 04/06/2018 Sheet: C.202

Grading & Erosion Control Plan-3

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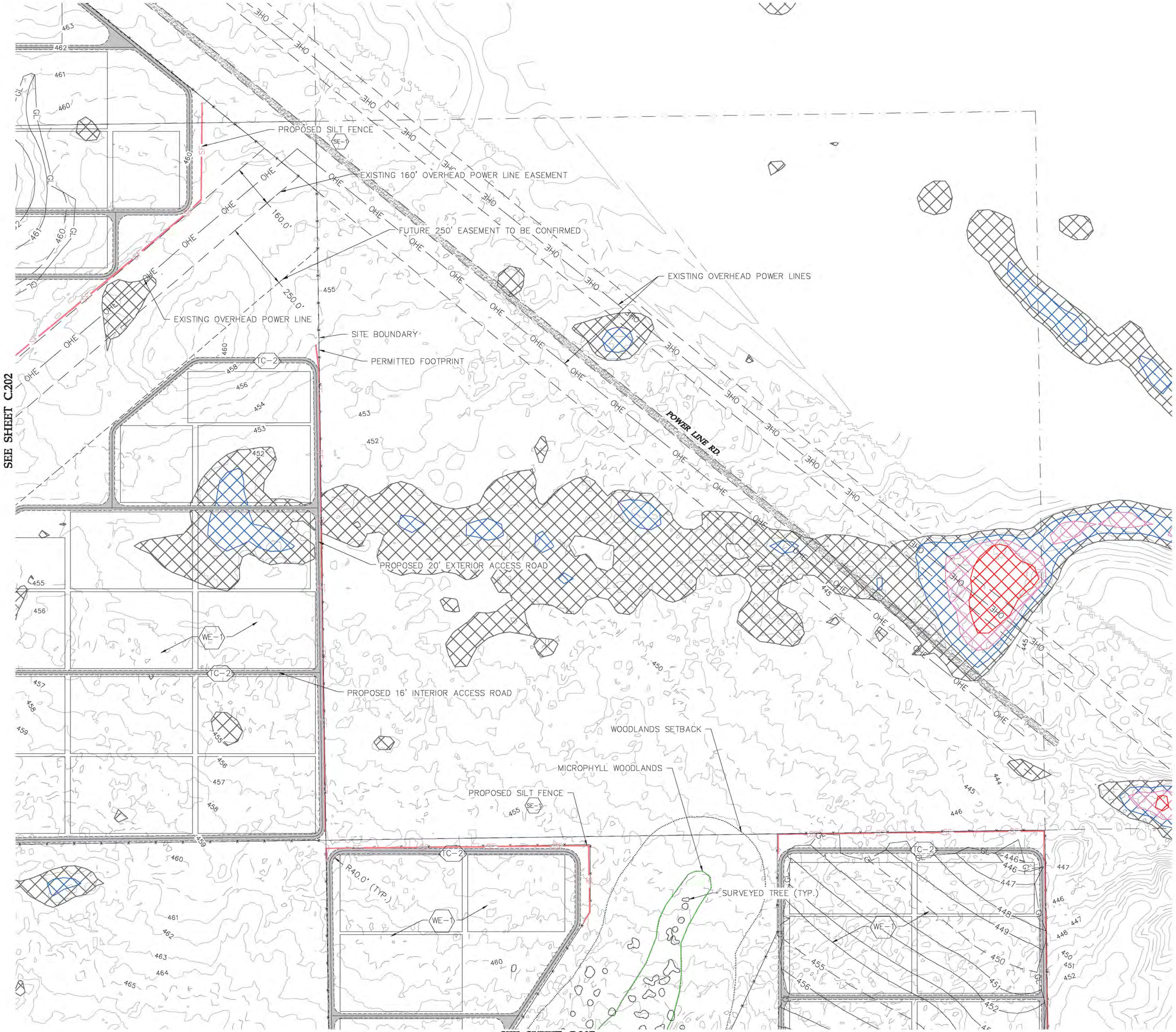

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220 kV — 220 kV OVERHEAD POWER LINE
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0.5'–1.0' FLOOD DEPTH
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>2.0' FLOOD DEPTH

EROSION CONTROL:

SF — PERIMETER CONTROL: SILT FENCE
SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:
1. DESIGN ASSUMPTIONS
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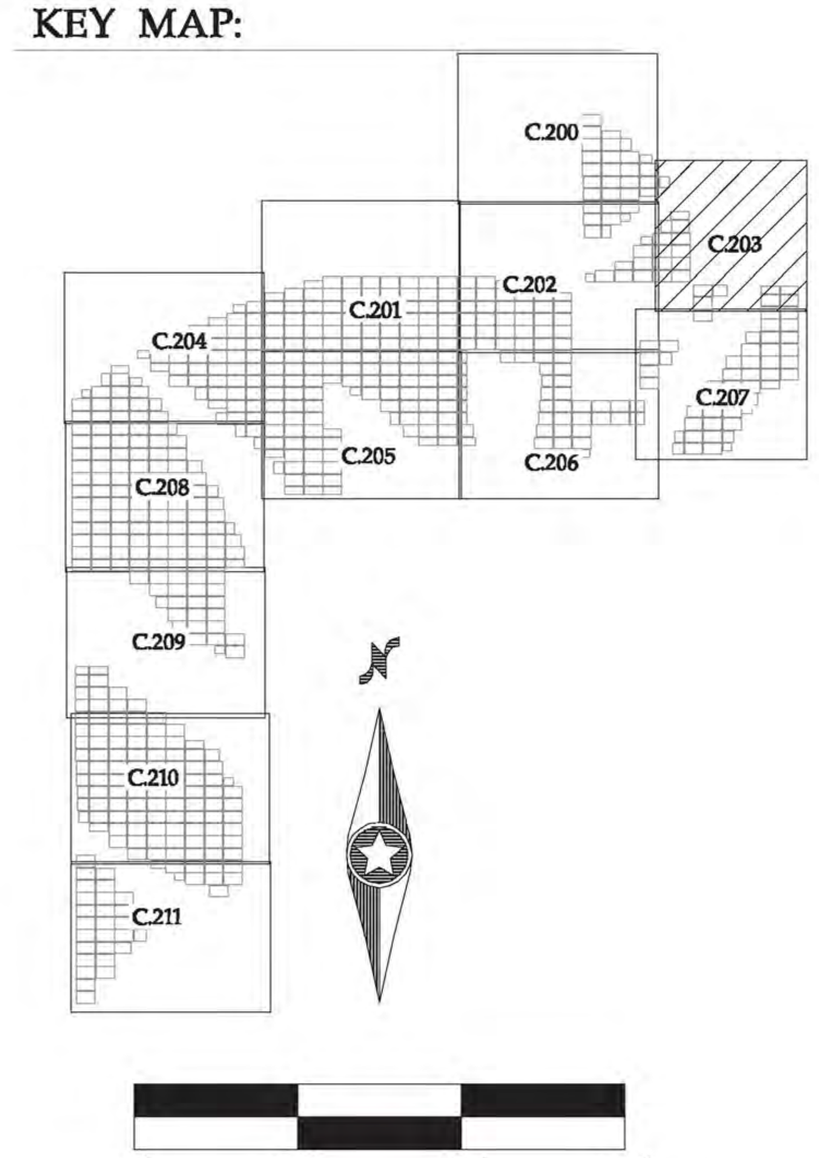

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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.203

Grading & Erosion Control Plan-4

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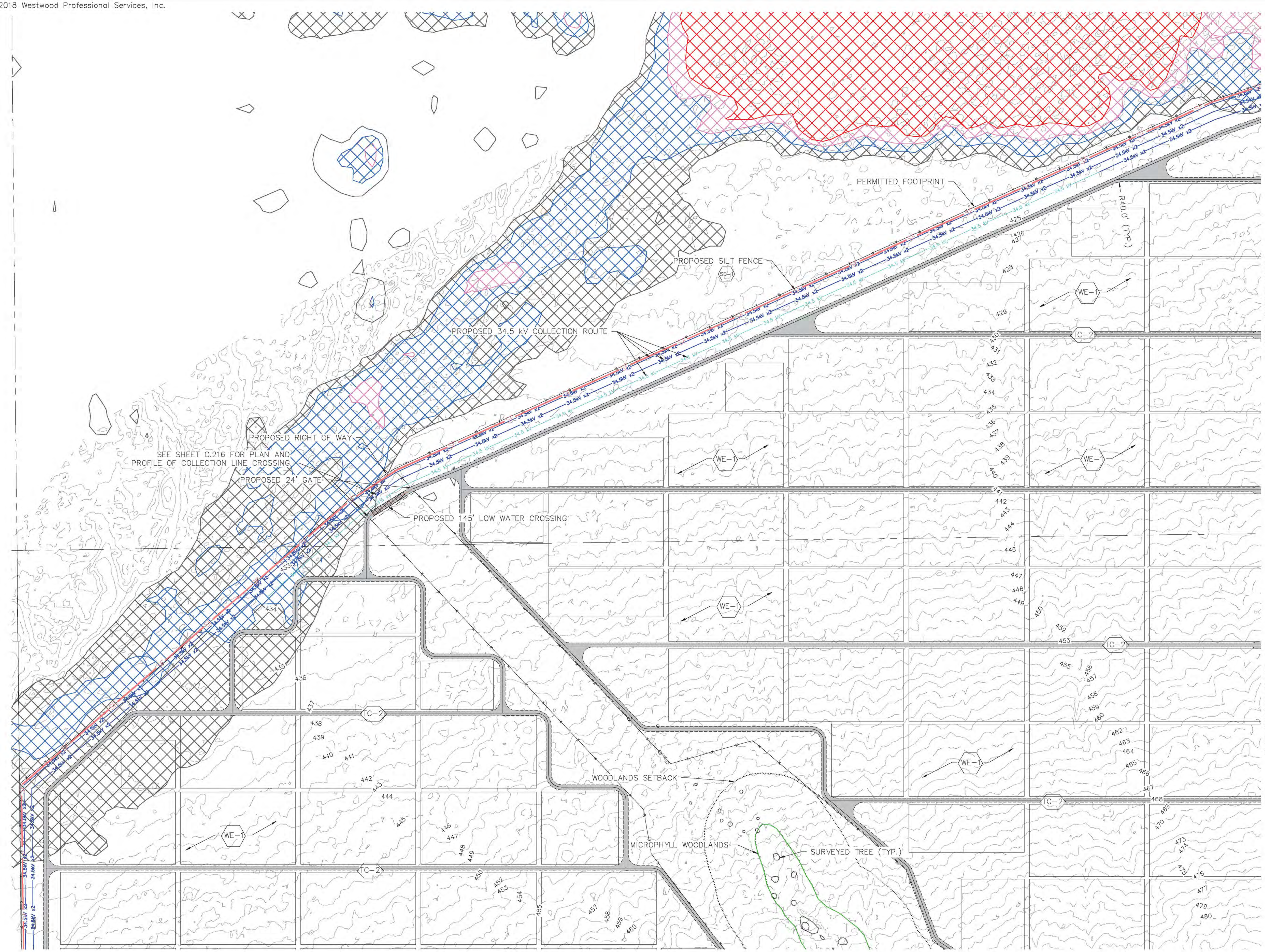

SEE SHEET C.201

SEE SHEET C.205

SEE SHEET C.208

LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
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- 220kV UG — 220 kV UNDERGROUND POWER LINE
- 220 kV — 220 kV OVERHEAD POWER LINE
- PROPOSED LOW WATER CROSSING
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- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
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EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:
1. DESIGN ASSUMPTIONS
   1.1. MAX SLOPE: 10%
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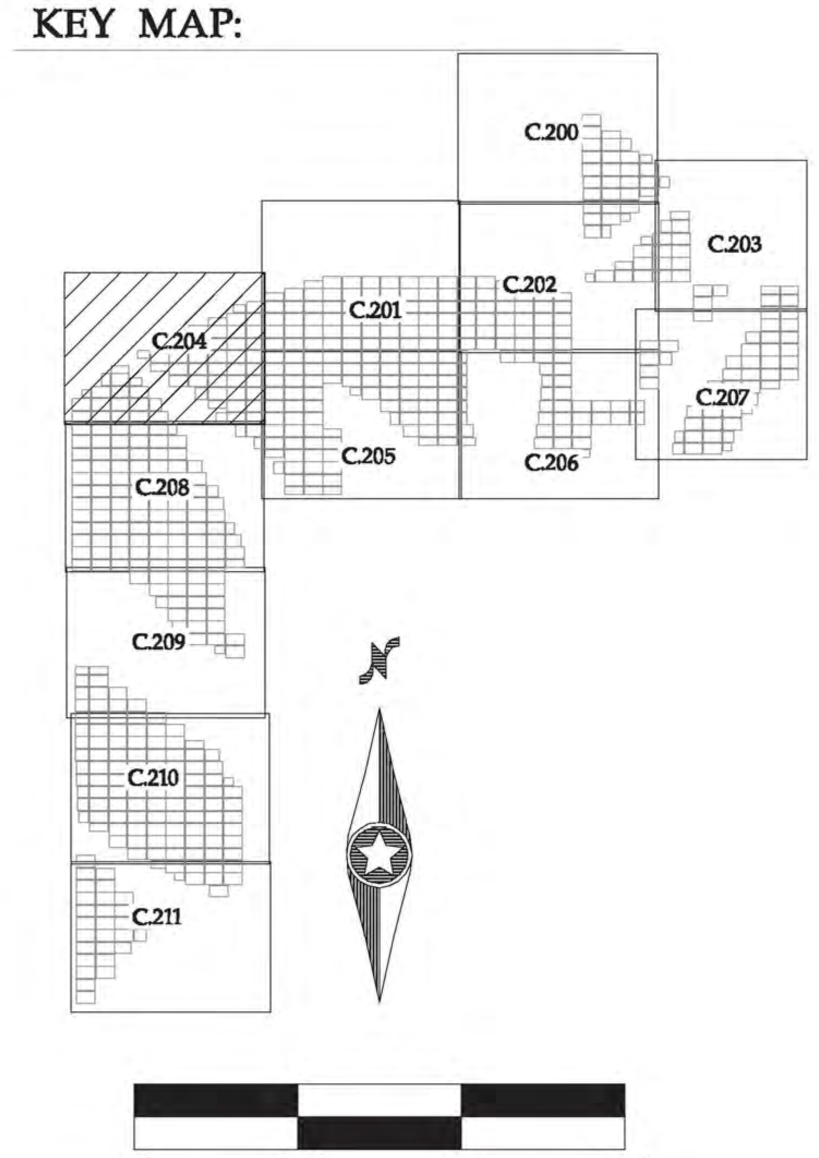

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Westwood Professional Services, Inc.

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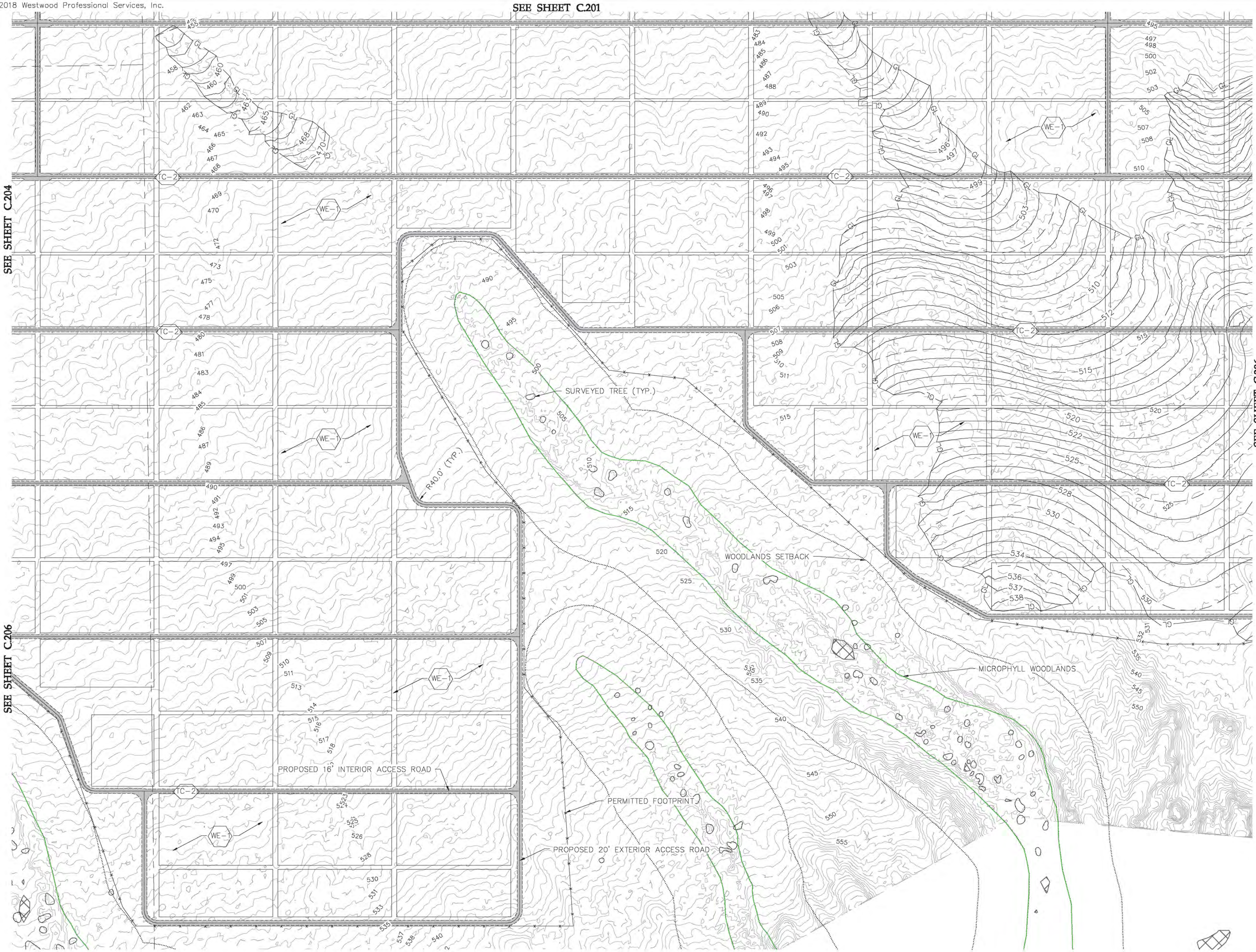
Riverside County, CA

Date: 04/06/2018 Sheet: C.204

Grading & Erosion Control Plan-5



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LEGEND:

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- 220kV UG — 220 kV UNDERGROUND POWER LINE
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EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
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NOTES:

1. DESIGN ASSUMPTIONS
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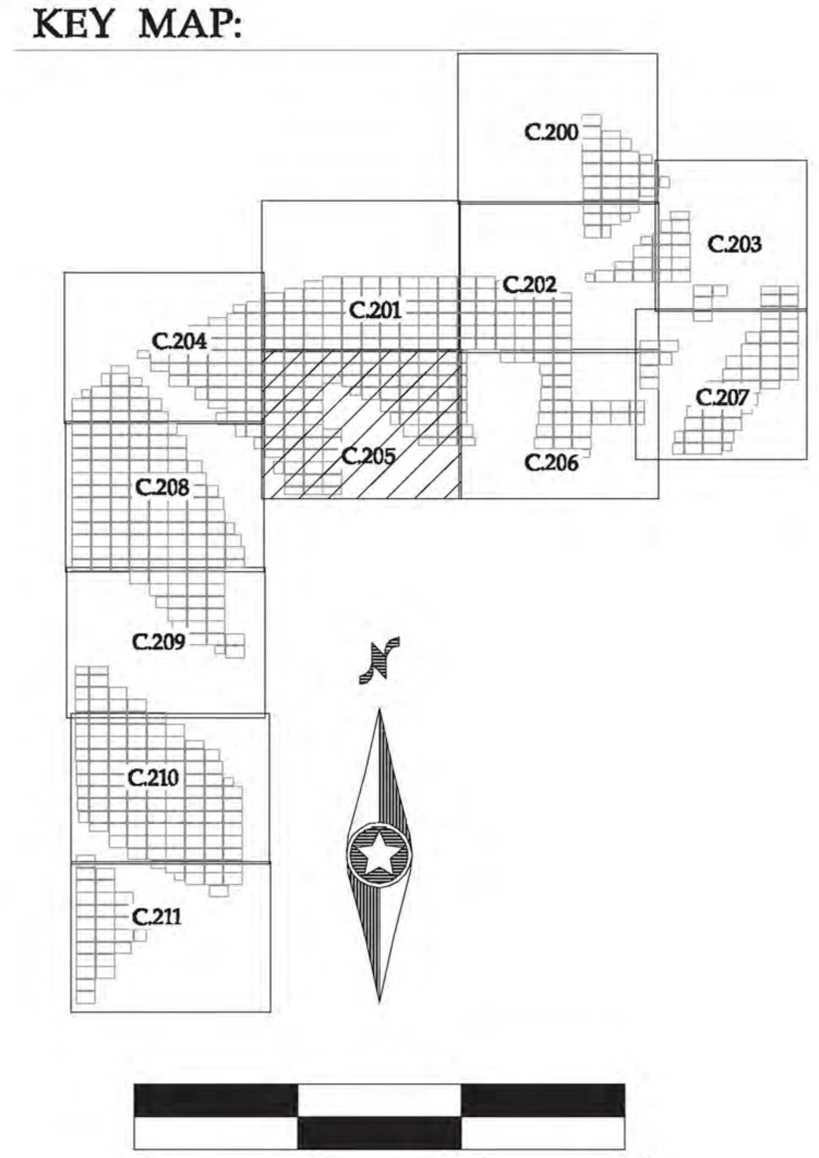

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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.205

Grading & Erosion Control Plan-6

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LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
- EXISTING ADJACENT PROPERTY LINE
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EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:

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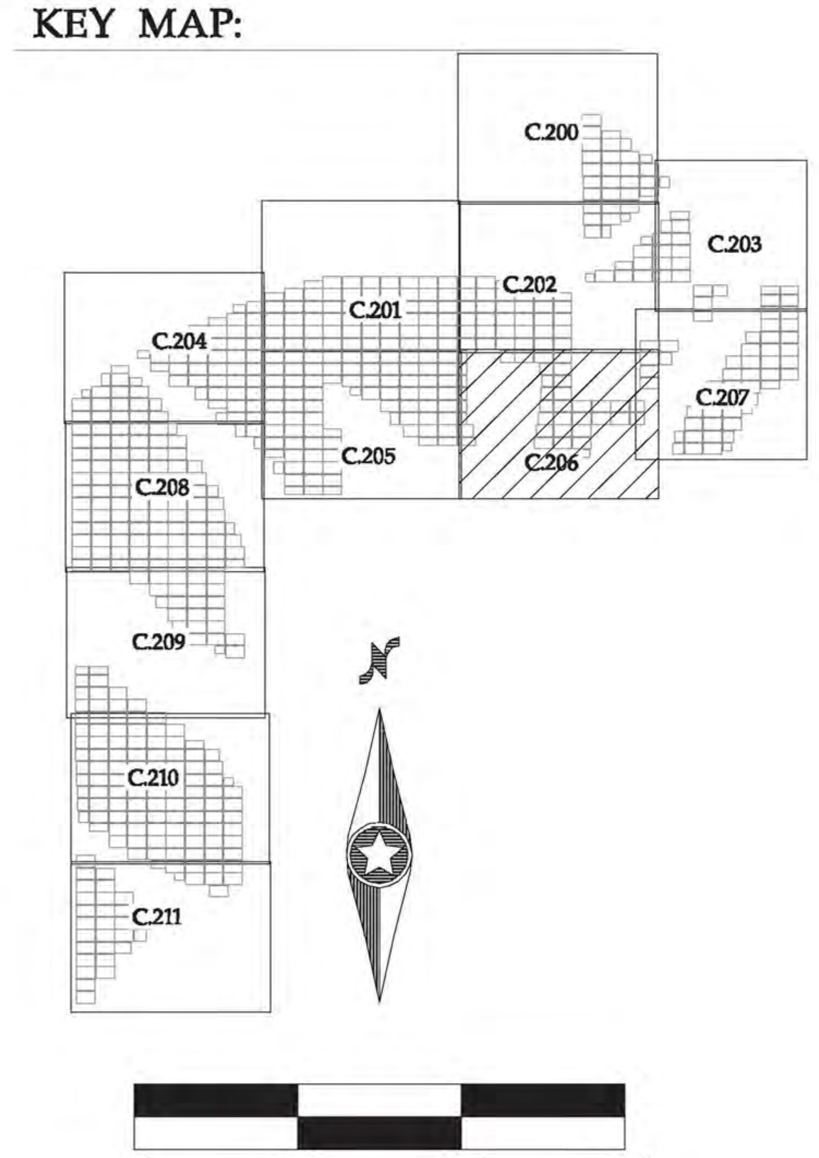

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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.206

Grading & Erosion Control Plan-7

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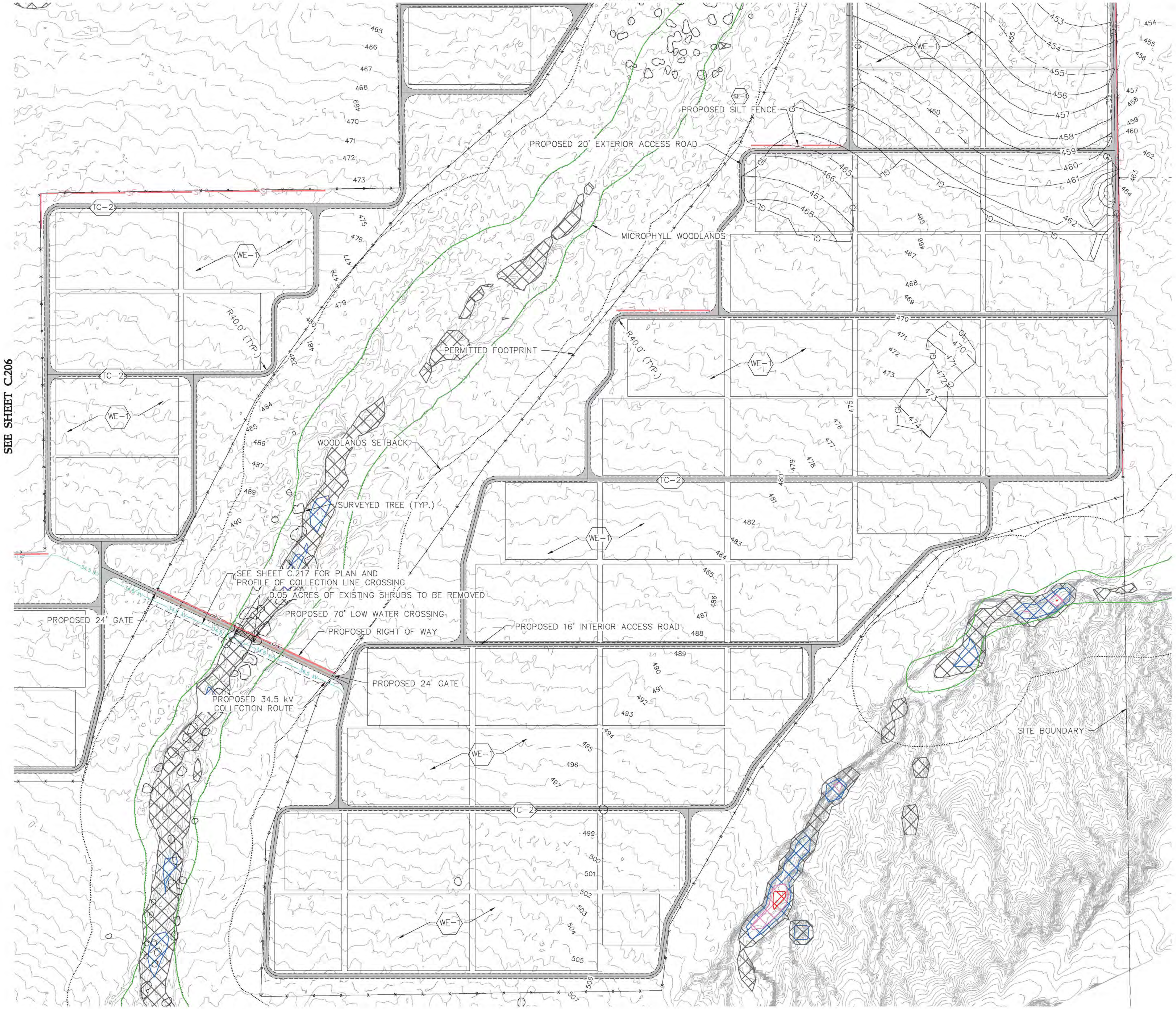
SEE SHEET C.203

SEE SHEET C.206



LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
- EXISTING ADJACENT PROPERTY LINE
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
- EXISTING SHRUBS
- OHE — EXISTING OVERHEAD POWER LINE
- EXISTING LOT LINE
- 1070 — EXISTING INDEX CONTOUR LINE
- 1071 — EXISTING INTERVAL CONTOUR LINE
- 1070 — PROPOSED INDEX CONTOUR LINE
- 1071 — PROPOSED INTERVAL CONTOUR LINE
- GL — PROPOSED GRADING LIMITS
- PERMITTED FOOTPRINT
- PROPOSED SOLAR ARRAY
- PROPOSED EXTERIOR 20' ACCESS ROAD
- PROPOSED INTERIOR 16' ACCESS ROAD
- 34.5 kV — 34.5 kV COLLECTION ROUTE
- 34.5kV x2 — 34.5 kV COLLECTION ROUTE
- 220kV UG — 220 kV UNDERGROUND POWER LINE
- 220 kV — 220 kV OVERHEAD POWER LINE
- PROPOSED LOW WATER CROSSING
- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

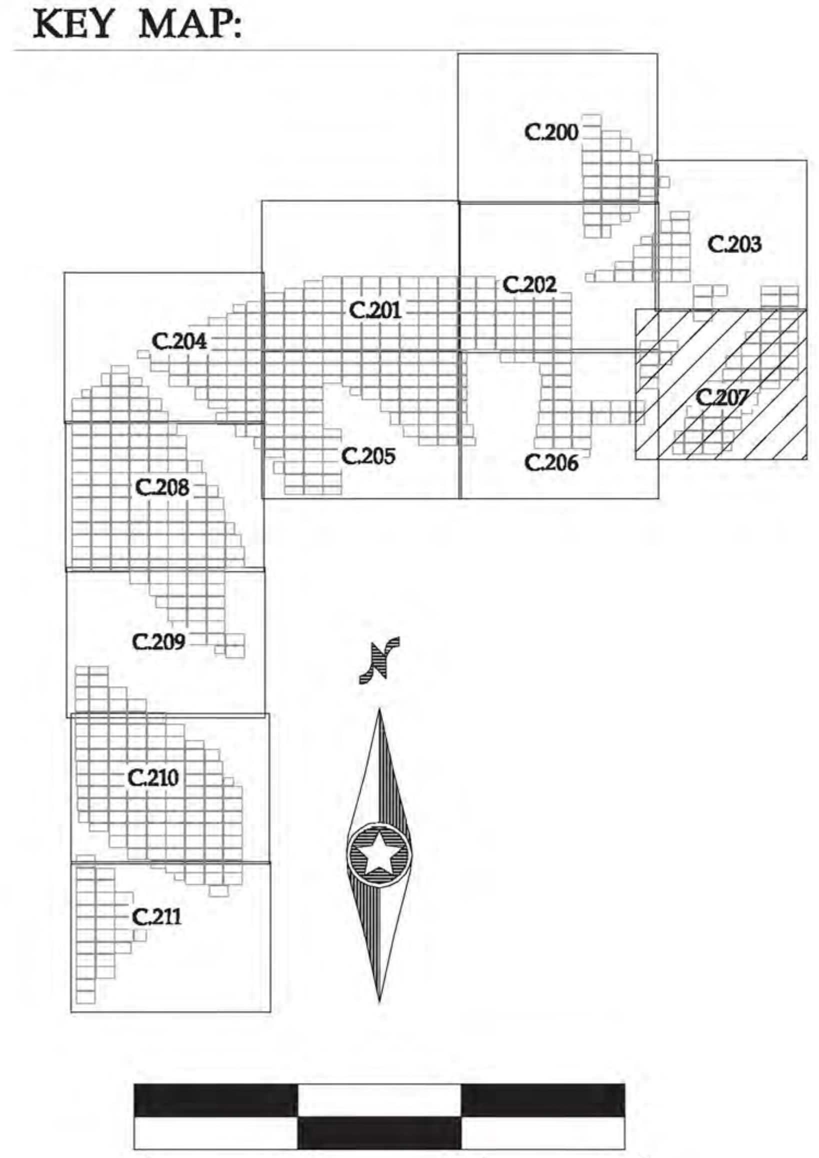
EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:

1. DESIGN ASSUMPTIONS
   - 1.1. MAX SLOPE: 10%
   - 1.2. INTERIOR ROAD WIDTH: 16 FT.
   - 1.3. EXTERIOR ROAD WIDTH: 20 FT.
   - 1.4. MINIMUM ROAD OUTER WALL TO WALL RADIUS: 38 FT.
2. PROJECT QUANTITIES SHOWN ON PLAN SET ARE PRELIMINARY AND ARE MEANT FOR GENERAL DISCUSSION AND GENERAL PRICING PURPOSES
3. GRADING DESIGN SHOWN IS PRELIMINARY AND NOT FINAL.
4. AREAS MAY REQUIRE SURFACE SMOOTHING TO ENSURE A UNIFORM SURFACE FOR THE INSTALLATION OF SOLAR EQUIPMENT.

KEY MAP:



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Designed: BTB
Checked: ADC
Drawn: JLB
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Prepared for:

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300 CALIFORNIA STREET, 7TH FLOOR
SAN FRANCISCO, CA 94104 USA
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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.207

Grading & Erosion Control Plan-8

SEE SHEET C.204

SEE SHEET C.205

SEE SHEET C.209

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LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
- EXISTING ADJACENT PROPERTY LINE
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
- EXISTING SHRUBS
- OHE — EXISTING OVERHEAD POWER LINE
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- 1070 — EXISTING INDEX CONTOUR LINE
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- PROPOSED EXTERIOR 20' ACCESS ROAD
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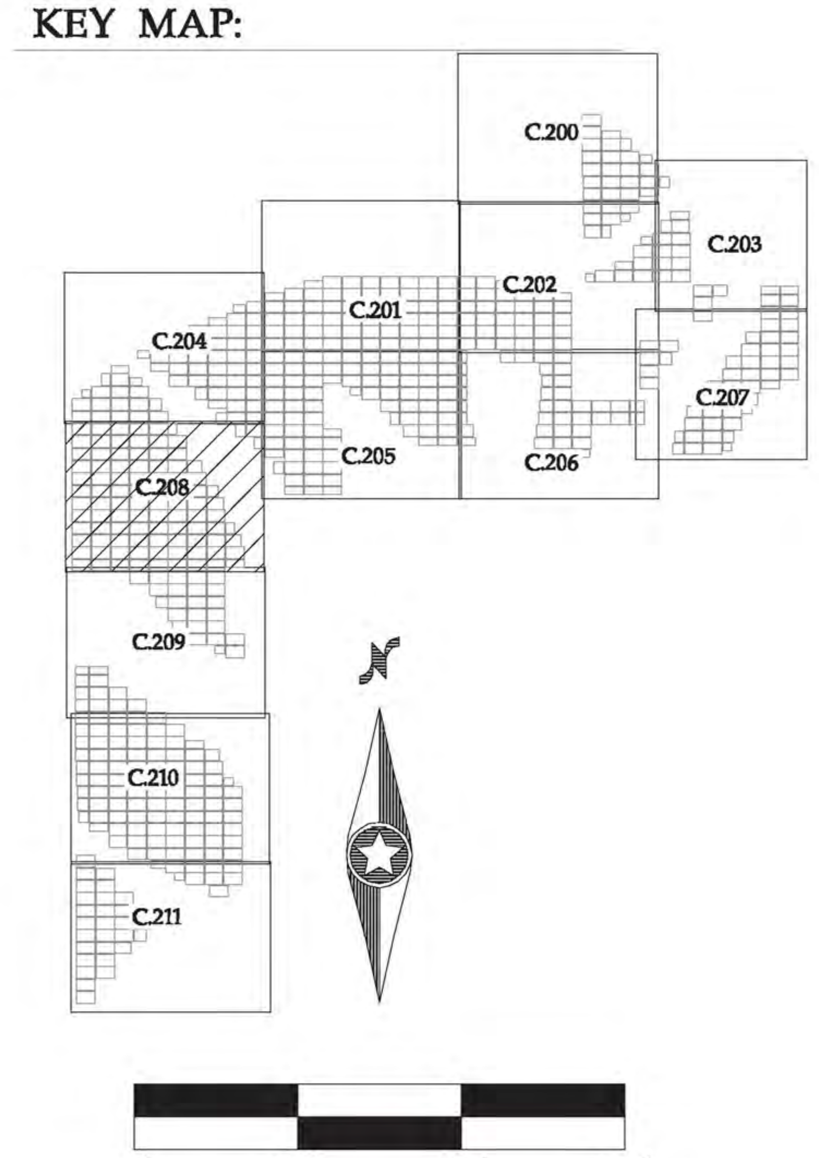
- 34.5 kV — 34.5 kV COLLECTION ROUTE
- 34.5kV x2 — 34.5 kV COLLECTION ROUTE
- 220kV UG — 220 kV UNDERGROUND POWER LINE
- 220 kV — 220 kV OVERHEAD POWER LINE
- PROPOSED LOW WATER CROSSING
- 0.5'-1.0' FLOOD DEPTH
- 1.0'-1.5' FLOOD DEPTH
- 1.5'-2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:
1. DESIGN ASSUMPTIONS
   1.1. MAX SLOPE: 10%
   1.2. INTERIOR ROAD WIDTH: 16 FT.
   1.3. EXTERIOR ROAD WIDTH: 20 FT.
   1.4. MINIMUM ROAD OUTER WALL TO WALL RADIUS: 38 FT.
2. PROJECT QUANTITIES SHOWN ON PLAN SET ARE PRELIMINARY AND ARE MEANT FOR GENERAL DISCUSSION AND GENERAL PRICING PURPOSES
3. GRADING DESIGN SHOWN IS PRELIMINARY AND NOT FINAL.
4. AREAS MAY REQUIRE SURFACE SMOOTHING TO ENSURE A UNIFORM SURFACE FOR THE INSTALLATION OF SOLAR EQUIPMENT.

KEY MAP:



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RECURRENT ENERGY
300 CALIFORNIA STREET, 7TH FLOOR
SAN FRANCISCO, CA 94104 USA
(415) 675 - 1500

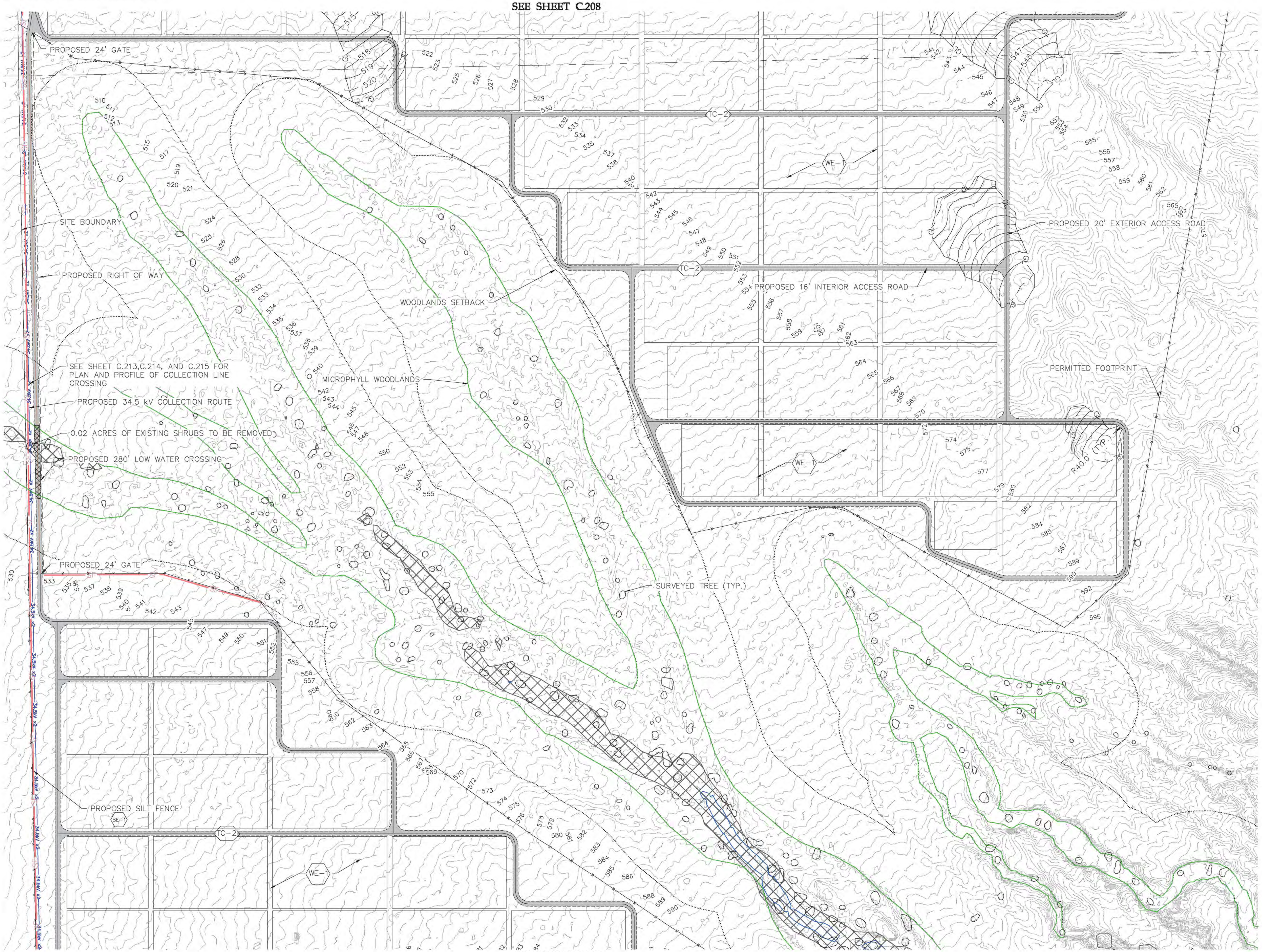
RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.208

Grading & Erosion Control Plan-9

SEE SHEET C.208



SEE SHEET C.210

Call 48 Hours before digging:
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LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
- EXISTING ADJACENT PROPERTY LINE
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- 220kV UG — 220 kV UNDERGROUND POWER LINE
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- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:
1. DESIGN ASSUMPTIONS
   - 1.1. MAX SLOPE: 10%
   - 1.2. INTERIOR ROAD WIDTH: 16 FT.
   - 1.3. EXTERIOR ROAD WIDTH: 20 FT.
   - 1.4. MINIMUM ROAD OUTER WALL TO WALL RADIUS: 38 FT.
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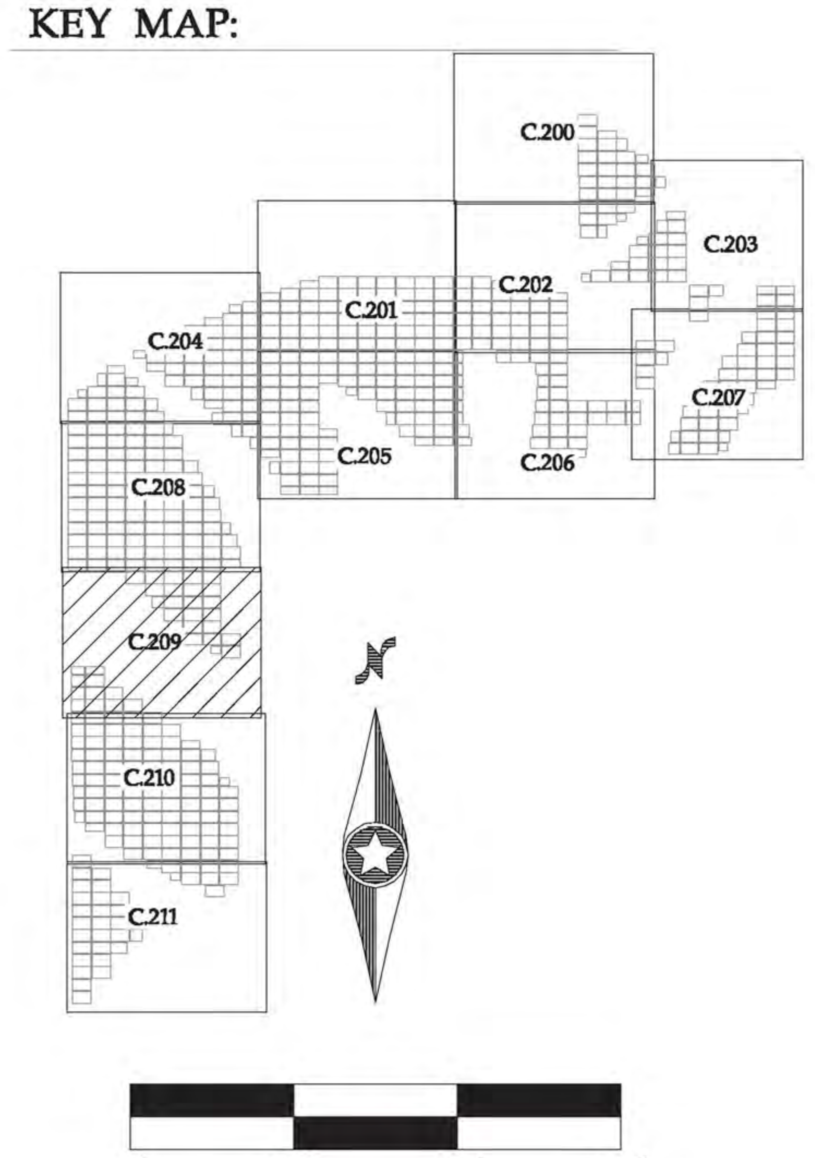
KEY MAP:



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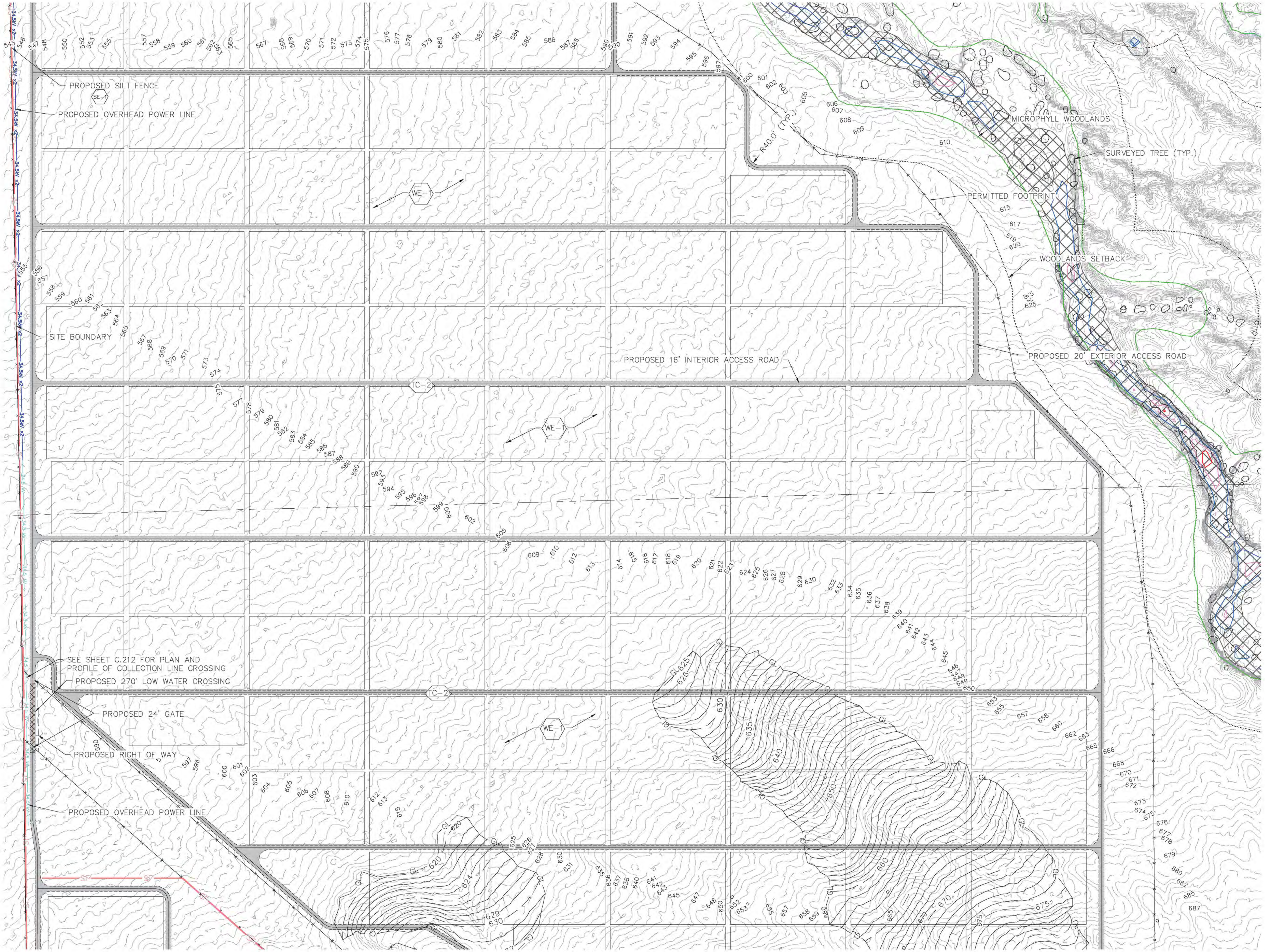
RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.209

Grading & Erosion Control Plan-10

SEE SHEET C.209



SEE SHEET C.211

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LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
- EXISTING ADJACENT PROPERTY LINE
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- 220kV UG — 220 kV UNDERGROUND POWER LINE
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- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:

1. DESIGN ASSUMPTIONS
   - 1.1. MAX SLOPE: 10%
   - 1.2. INTERIOR ROAD WIDTH: 16 FT.
   - 1.3. EXTERIOR ROAD WIDTH: 20 FT.
   - 1.4. MINIMUM ROAD OUTER WALL TO WALL RADIUS: 38 FT.
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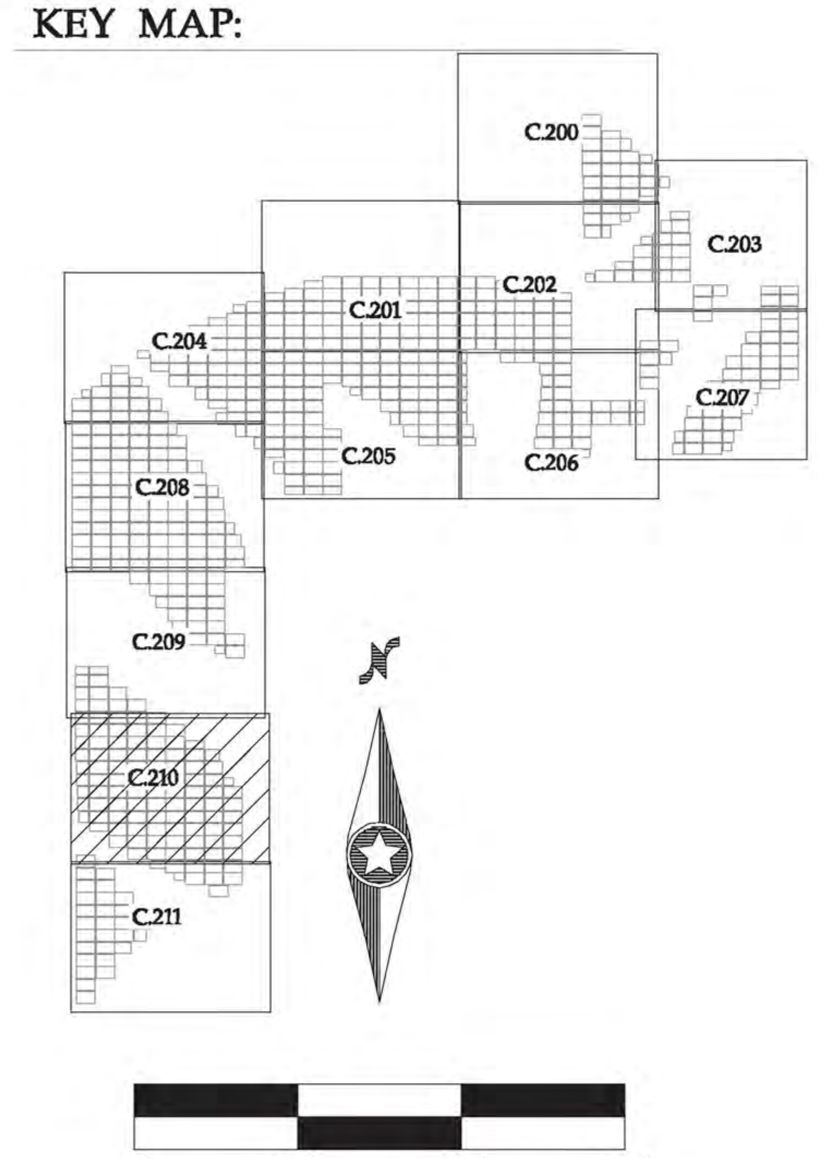
KEY MAP:



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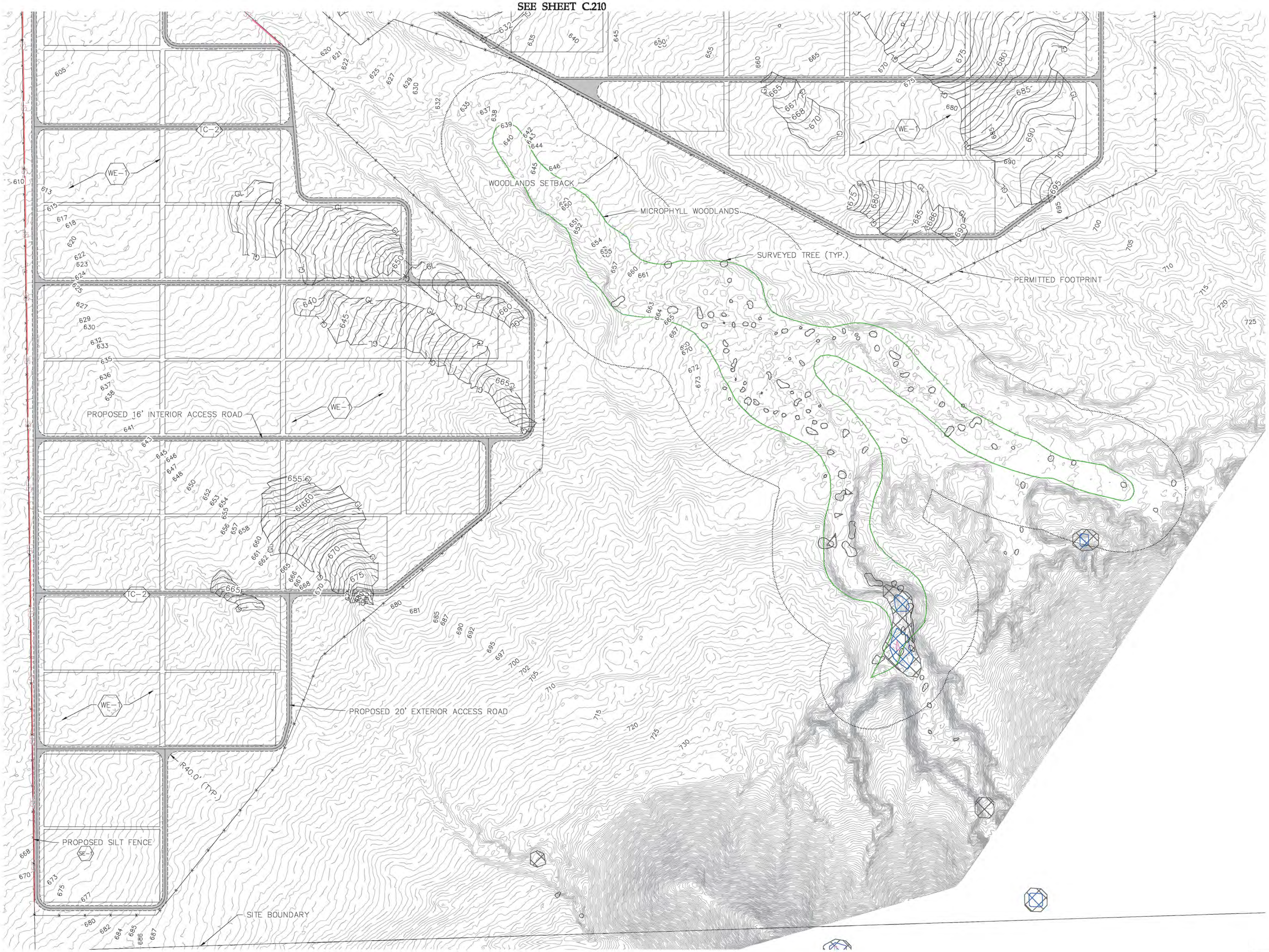
RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.210

Grading & Erosion Control Plan-11

SEE SHEET C.210



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LEGEND:

- SITE BOUNDARY
- EXISTING SECTION LINE
- EXISTING OVERHEAD POWER LINE EASEMENT
- EXISTING ROAD EASEMENT
- EXISTING RIGHT OF WAY
- EXISTING ADJACENT PROPERTY LINE
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
- EXISTING SHRUBS
- OHE — EXISTING OVERHEAD POWER LINE
- EXISTING LOT LINE
- 1070 — EXISTING INDEX CONTOUR LINE
- 1071 — EXISTING INTERVAL CONTOUR LINE
- 1070 — PROPOSED INDEX CONTOUR LINE
- 1071 — PROPOSED INTERVAL CONTOUR LINE
- GL — PROPOSED GRADING LIMITS
- PERMITTED FOOTPRINT
- PROPOSED SOLAR ARRAY
- PROPOSED EXTERIOR 20' ACCESS ROAD
- PROPOSED INTERIOR 16' ACCESS ROAD
- 34.5 kV — 34.5 kV COLLECTION ROUTE
- 34.5kV x2 — 34.5 kV COLLECTION ROUTE
- 220kV UG — 220 kV UNDERGROUND POWER LINE
- 220 kV — 220 kV OVERHEAD POWER LINE
- PROPOSED LOW WATER CROSSING
- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

EROSION CONTROL:

- SF — PERIMETER CONTROL: SILT FENCE
- SEDIMENT TRACKOUT CONTROL: ROCK CONSTRUCTION ENTRANCE
- WE-1 — WIND EROSION: WATER AND/OR DUST PALLIATIVES
- TC-2 — STABILIZED CONSTRUCTION ROADWAY

NOTES:

1. DESIGN ASSUMPTIONS
   - 1.1. MAX SLOPE: 10%
   - 1.2. INTERIOR ROAD WIDTH: 16 FT.
   - 1.3. EXTERIOR ROAD WIDTH: 20 FT.
   - 1.4. MINIMUM ROAD OUTER WALL TO WALL RADIUS: 38 FT.
2. PROJECT QUANTITIES SHOWN ON PLAN SET ARE PRELIMINARY AND ARE MEANT FOR GENERAL DISCUSSION AND GENERAL PRICING PURPOSES
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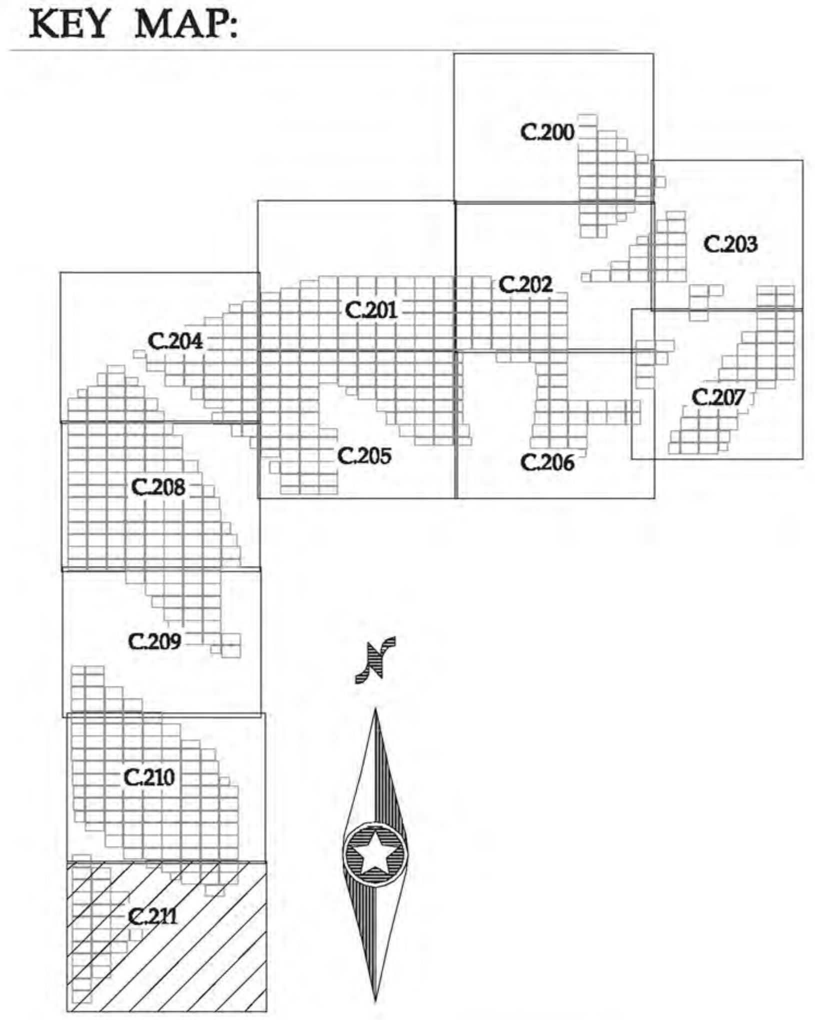
KEY MAP:



0' 200' 400' 600'

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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.211

Grading & Erosion Control Plan-12

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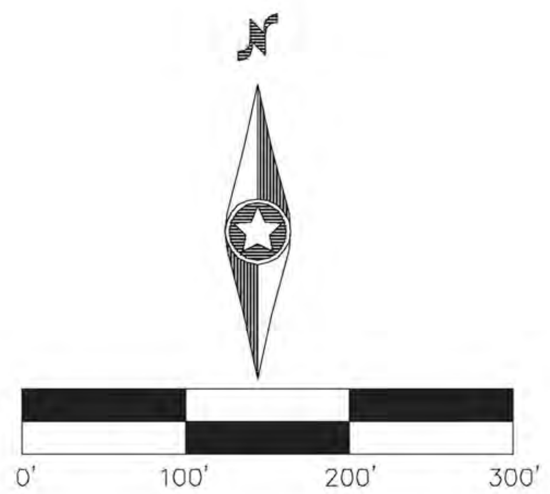
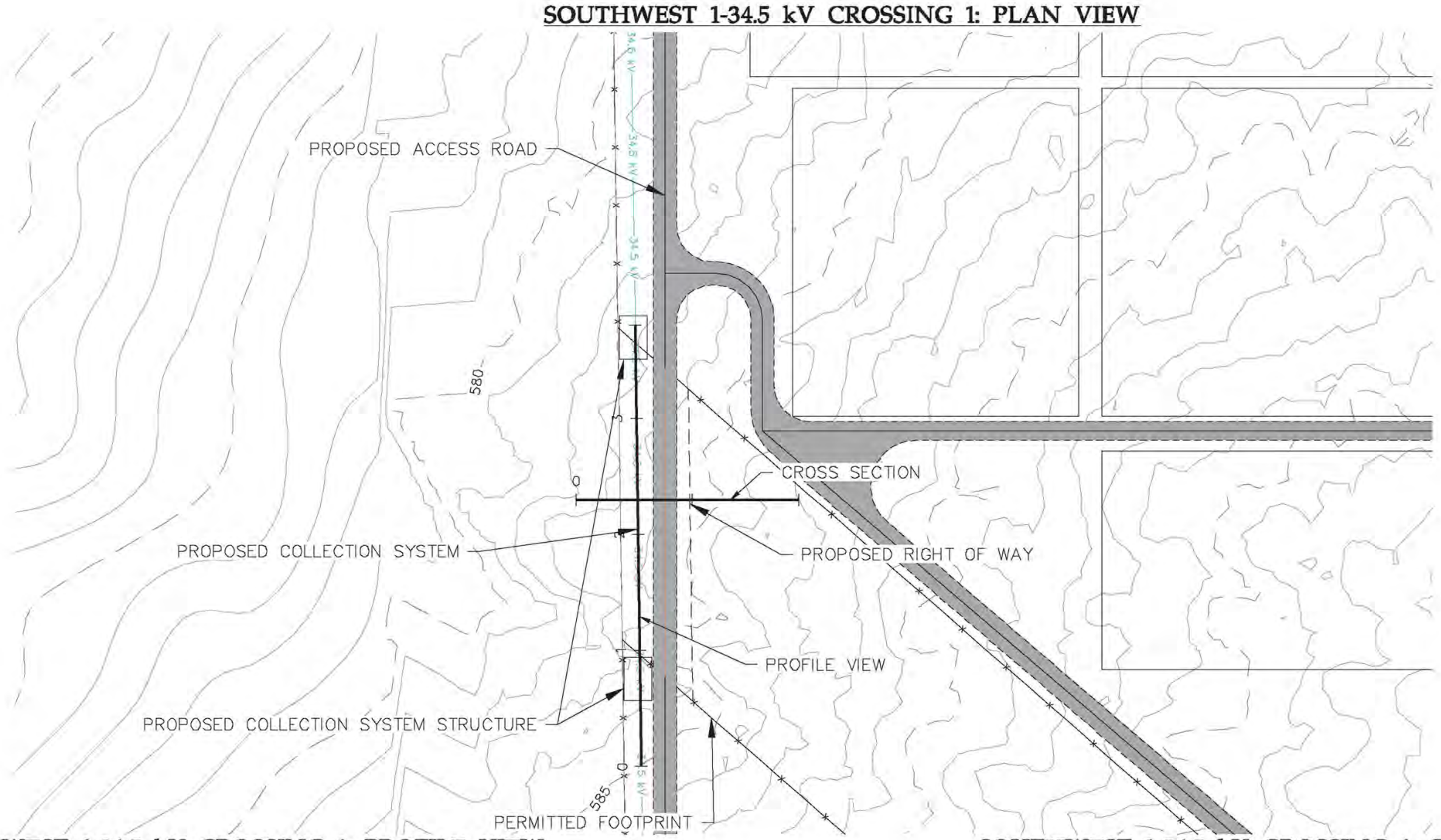
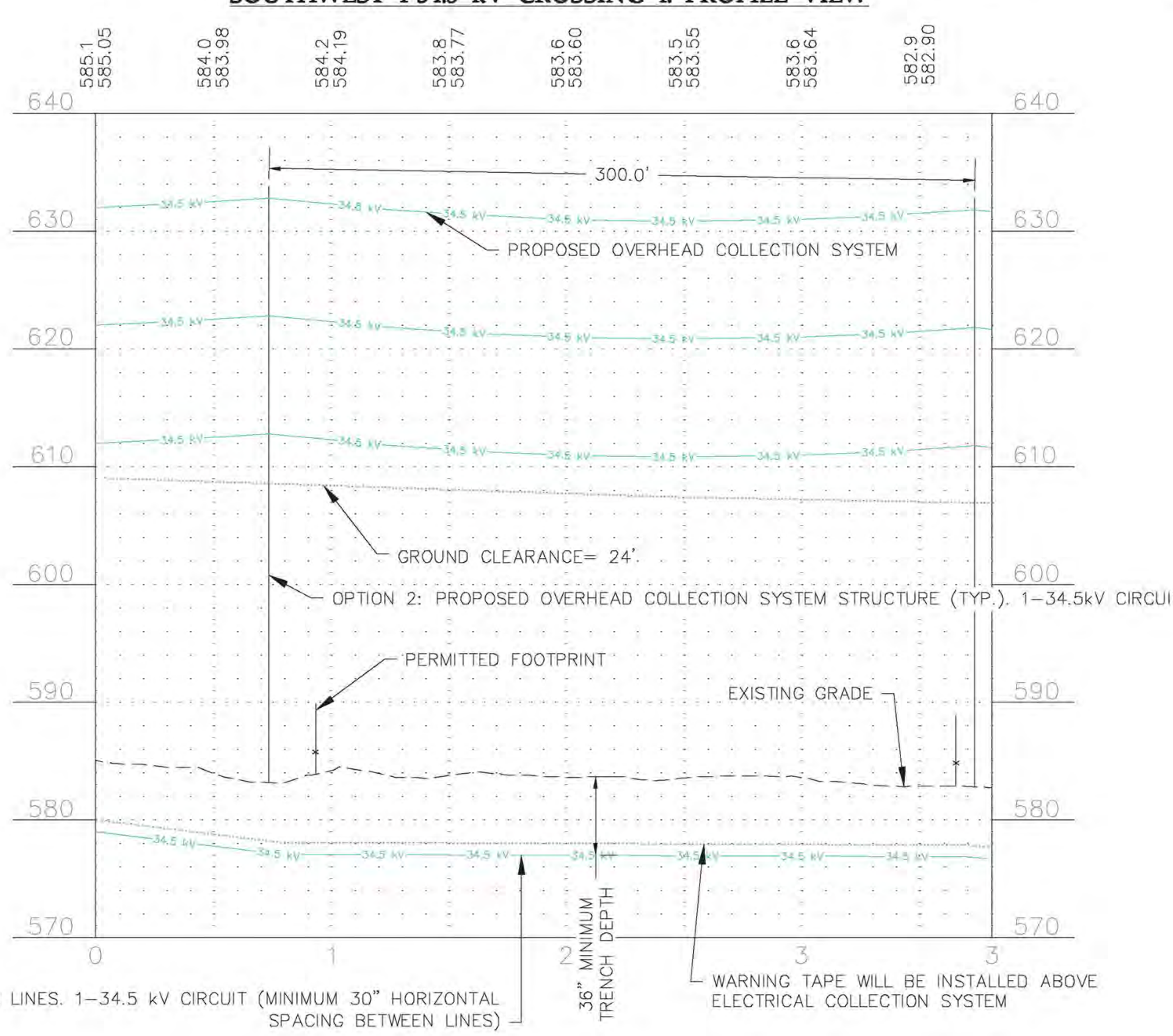


SOUTHWEST 1-34.5 kV CROSSING 1: PLAN VIEW

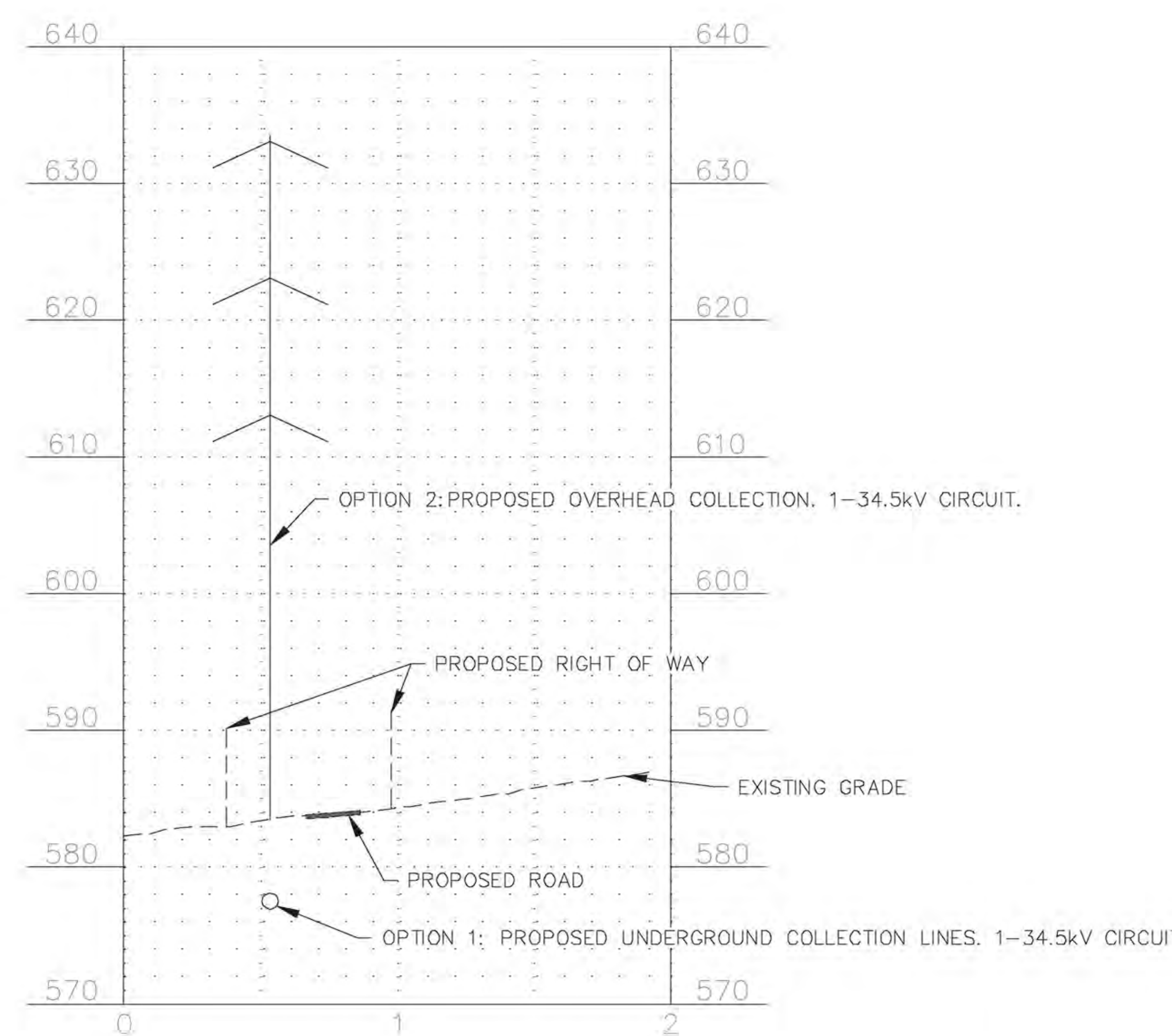


SOUTHWEST 1-34.5 kV CROSSING 1: PROFILE VIEW



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

SOUTHWEST 1-34.5 kV CROSSING 1: CROSS SECTION



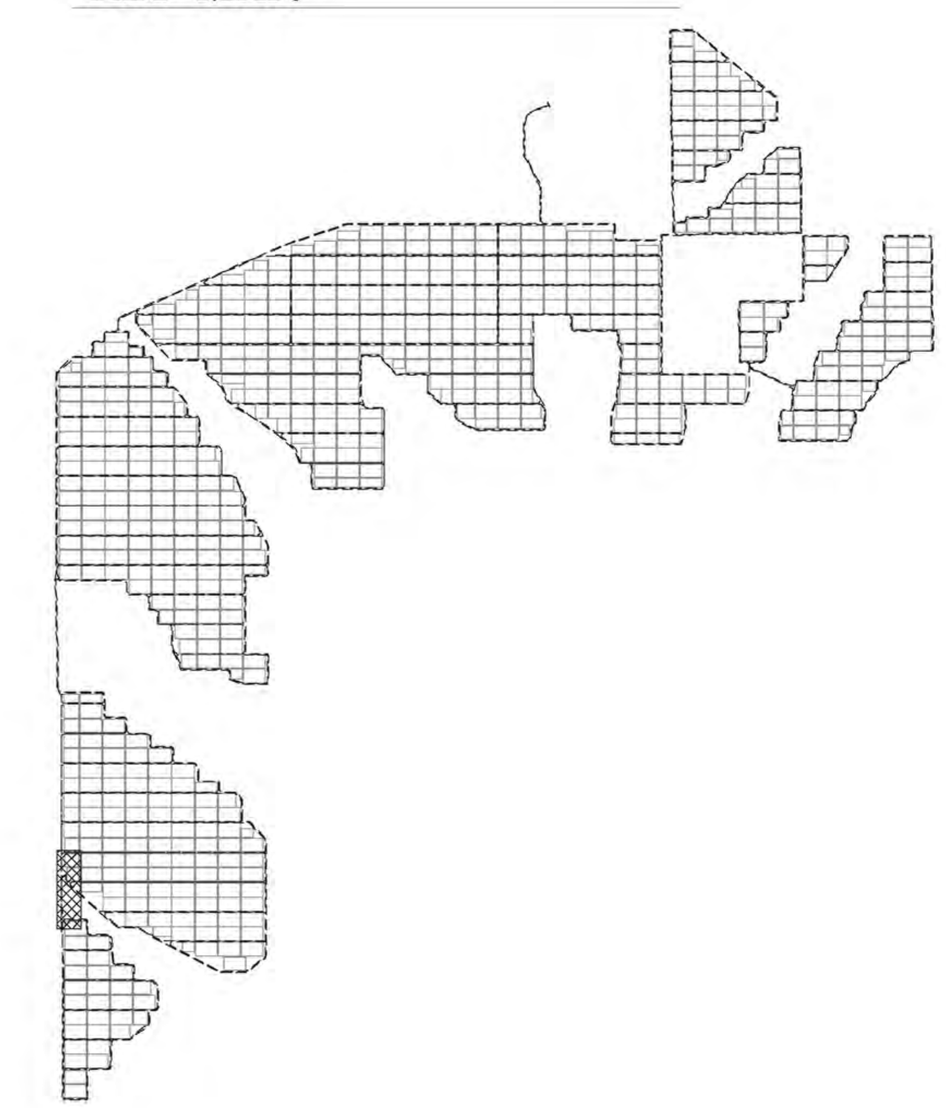
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

LEGEND:

- SITE BOUNDARY
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
- 1070 — EXISTING INDEX CONTOUR LINE
- 1071 — EXISTING INTERVAL CONTOUR LINE
- PERMITTED FOOTPRINT
- PROPOSED SOLAR ARRAY
- PROPOSED EXTERIOR 20' ACCESS ROAD
- PROPOSED INTERIOR 16' ACCESS ROAD
- 34.5 kV — 34.5 kV COLLECTION ROUTE
- 34.5kV x2 — 34.5 kV COLLECTION ROUTE
- PROPOSED RIGHT OF WAY
- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

NOTES:
1. 34.5 kV COLLECTION METHOD TO BE DETERMINED WITH FINAL DESIGN.

KEY MAP:



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Date: 04/06/2018 Sheet: C.212

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RE Crimson, LLC.
Riverside County, CA

Southwest 1-34.5 KV Crossing-1

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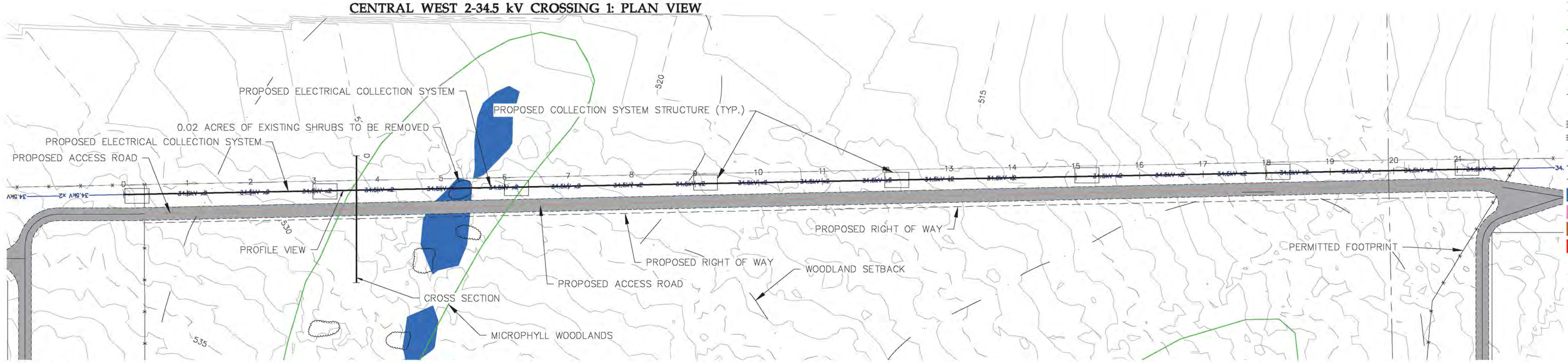
CENTRAL WEST 2-34.5 kV CROSSING 1: PLAN VIEW



0' 100' 200' 300'

LEGEND:

	SITE BOUNDARY
	MICROPHYLL WOODLANDS
	WOODLANDS SETBACK LINE
1070	EXISTING INDEX CONTOUR LINE
1071	EXISTING INTERVAL CONTOUR LINE
	PERMITTED FOOTPRINT
	PROPOSED SOLAR ARRAY
	PROPOSED EXTERIOR 20' ACCESS ROAD
	PROPOSED INTERIOR 16' ACCESS ROAD
34.5 kV	34.5 kV COLLECTION ROUTE
34.5kV x2	34.5 kV COLLECTION ROUTE
	PROPOSED RIGHT OF WAY
	0.5'–1.0' FLOOD DEPTH
	1.0'–1.5' FLOOD DEPTH
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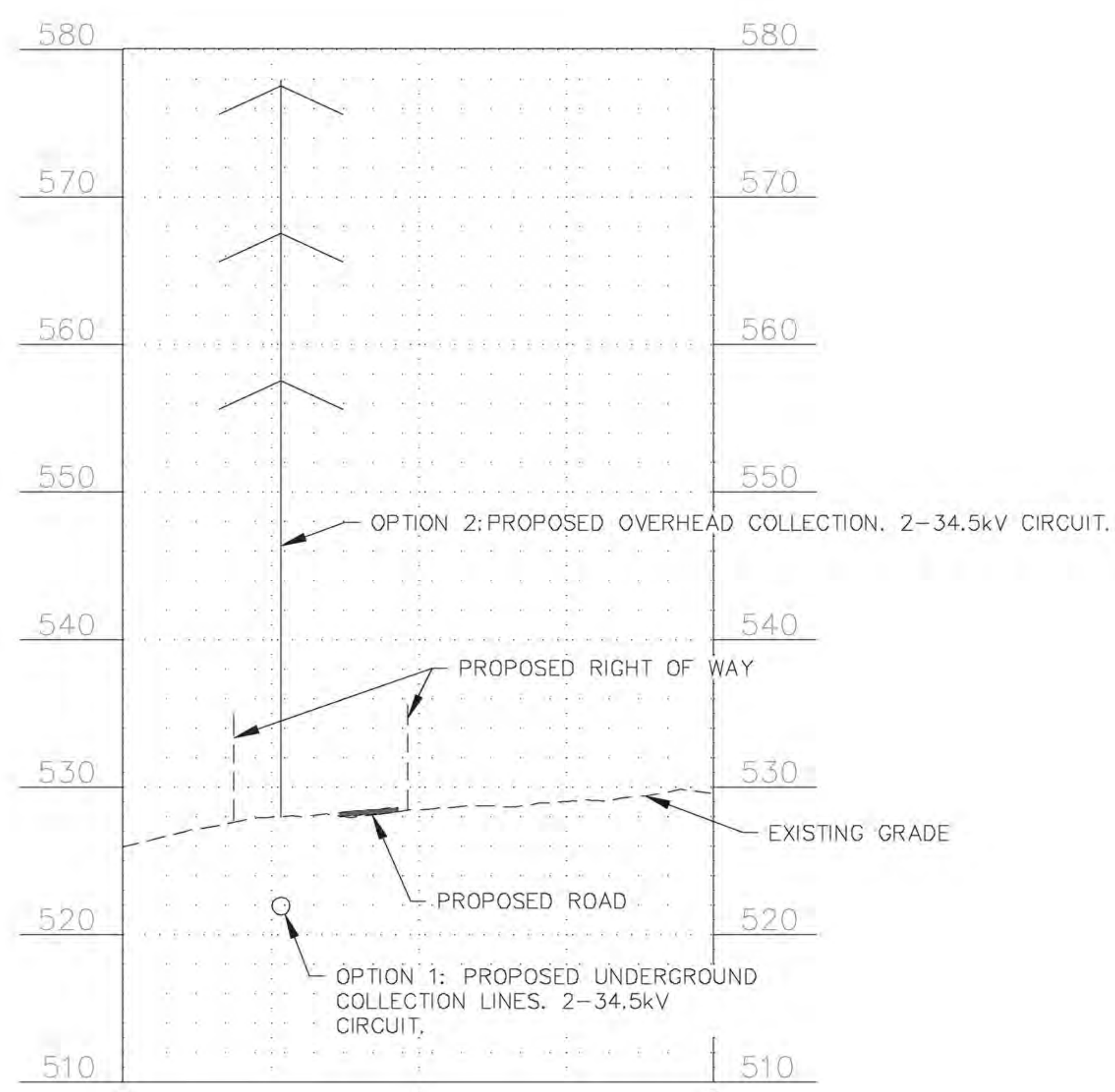
	>2.0' FLOOD DEPTH

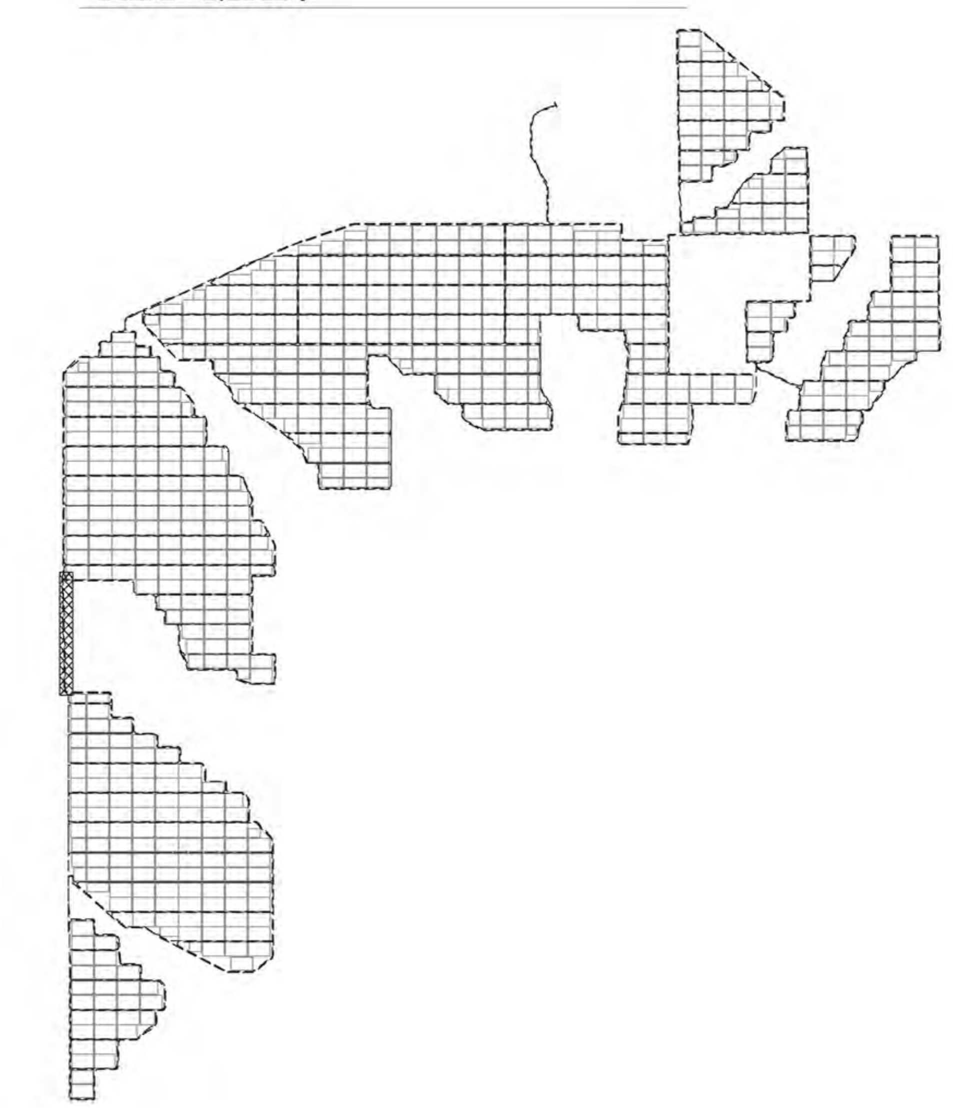
NOTES:
1. 34.5 kV COLLECTION METHOD TO BE DETERMINED WITH FINAL DESIGN.

CENTRAL WEST 2-34.5 kV CROSSING 1: CROSS SECTION



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

KEY MAP:



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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.213

Central West 2-34.5 KV Crossing-1

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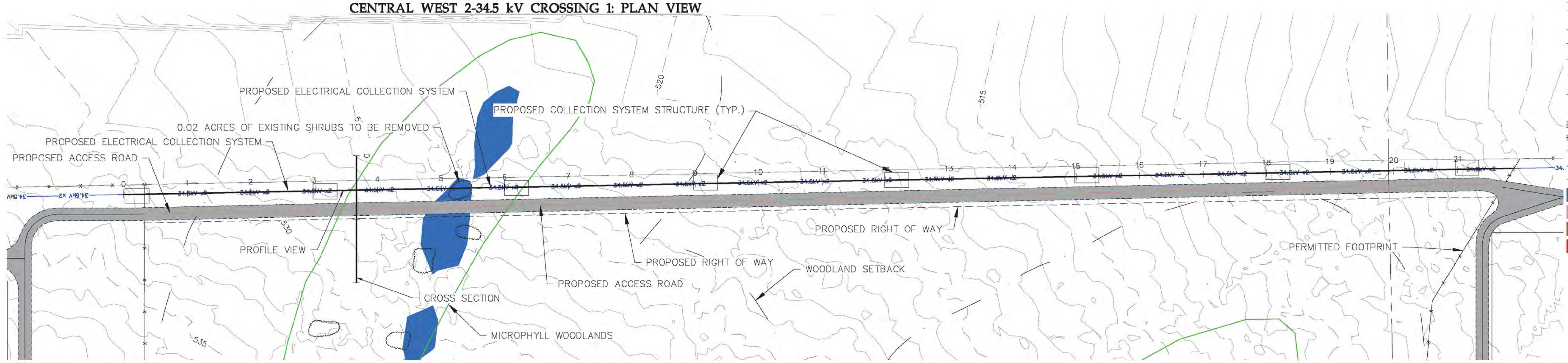
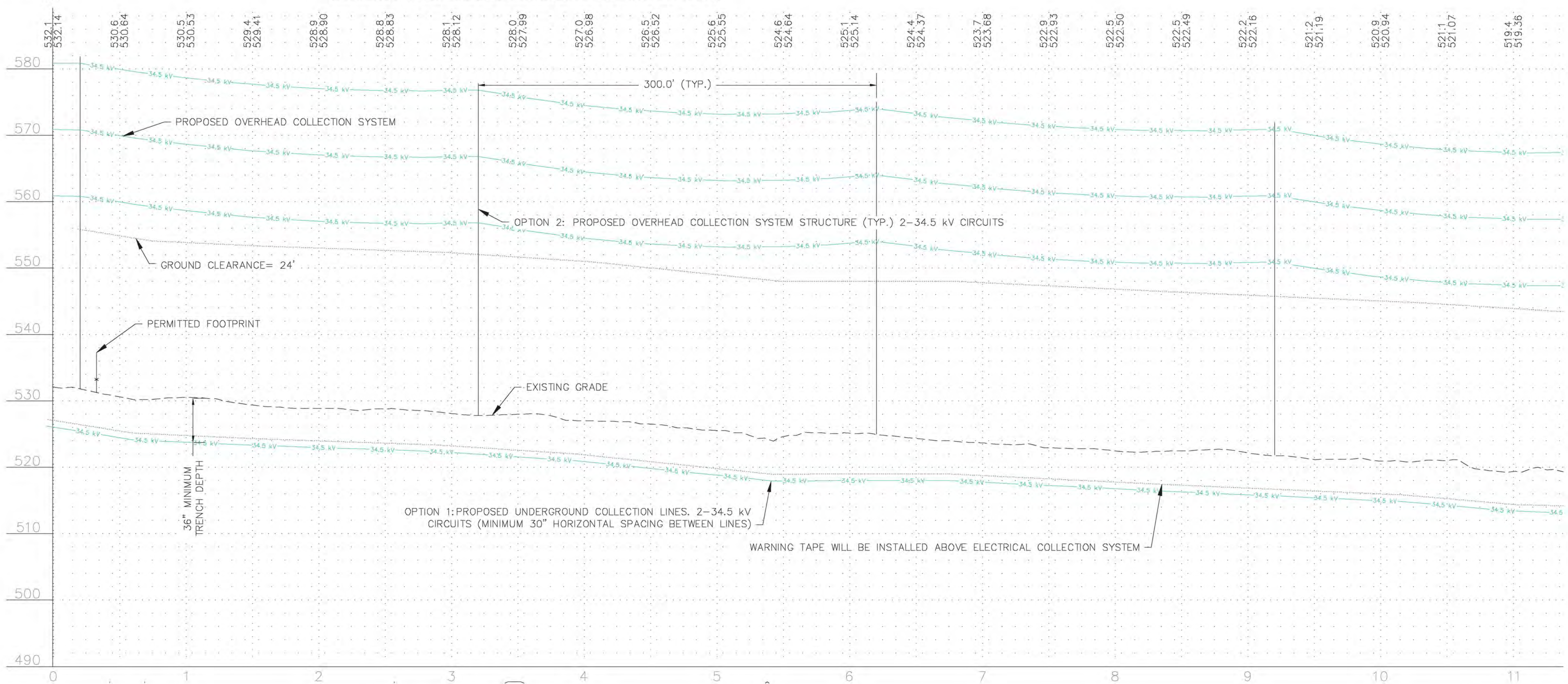
CENTRAL WEST 2-34.5 kV CROSSING 1: PLAN VIEW



0' 100' 200' 300'

CENTRAL WEST 2-34.5 kV CROSSING 1: PROFILE VIEW



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

LEGEND:

- SITE BOUNDARY
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
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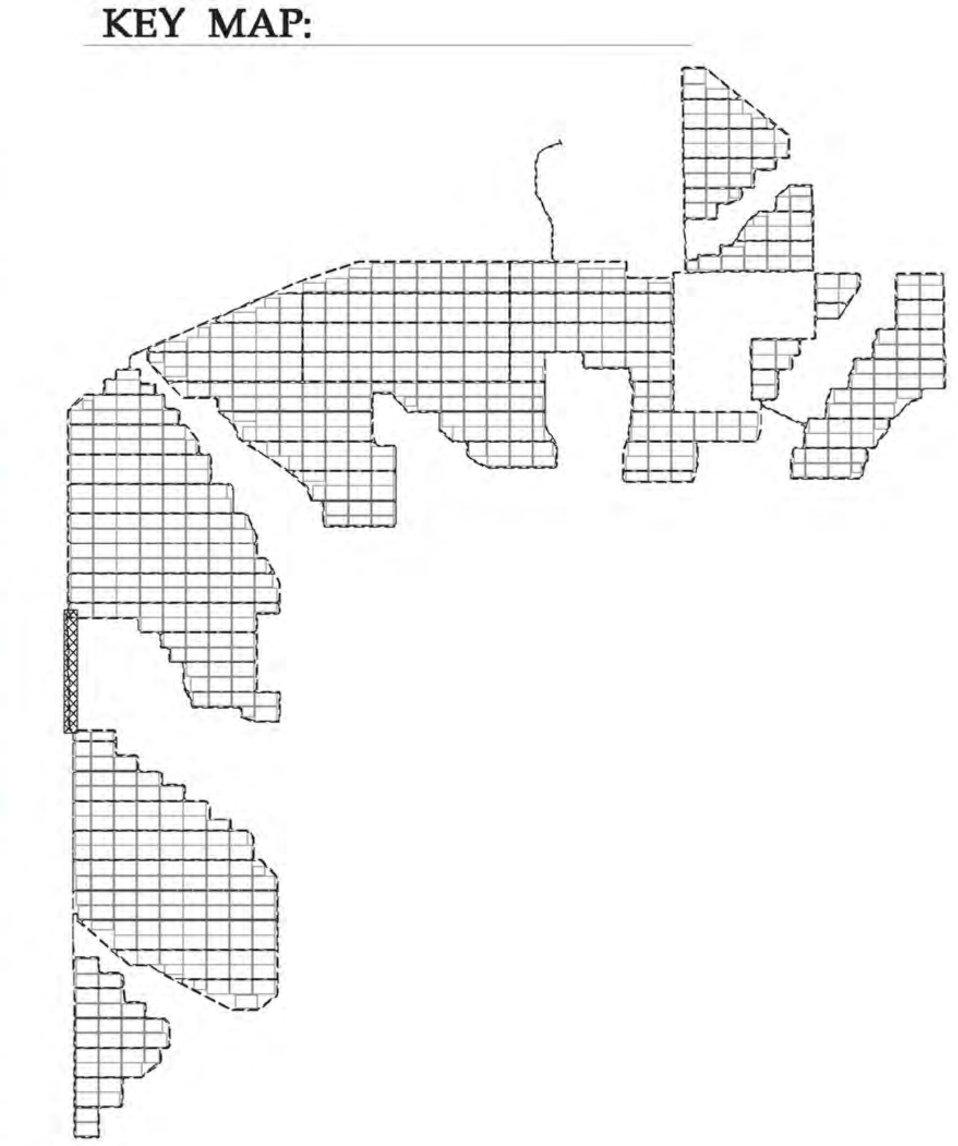
- >2.0' FLOOD DEPTH

NOTES:
1. 34.5 kV COLLECTION METHOD TO BE DETERMINED WITH FINAL DESIGN.

KEY MAP:



0015053-CROSSING.dwg

Date: 04/06/2018 Sheet: C.214

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Phone (952) 937-5150 12701 Whitewater Drive, Suite 300
Fax (952) 937-5822 Minnetonka, MN 55343
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Revisions:

Designed:	BTB
Checked:	ADC
Drawn:	JLB
Record Drawing by/date:	

Prepared for:

RECURRENT ENERGY
300 CALIFORNIA STREET, 7TH FLOOR
SAN FRANCISCO, CA 94104 USA
(415) 675 - 1500

RE Crimson, LLC.

Riverside County, CA

Central West 2-34.5 KV Crossing-2

Call 48 Hours before digging:
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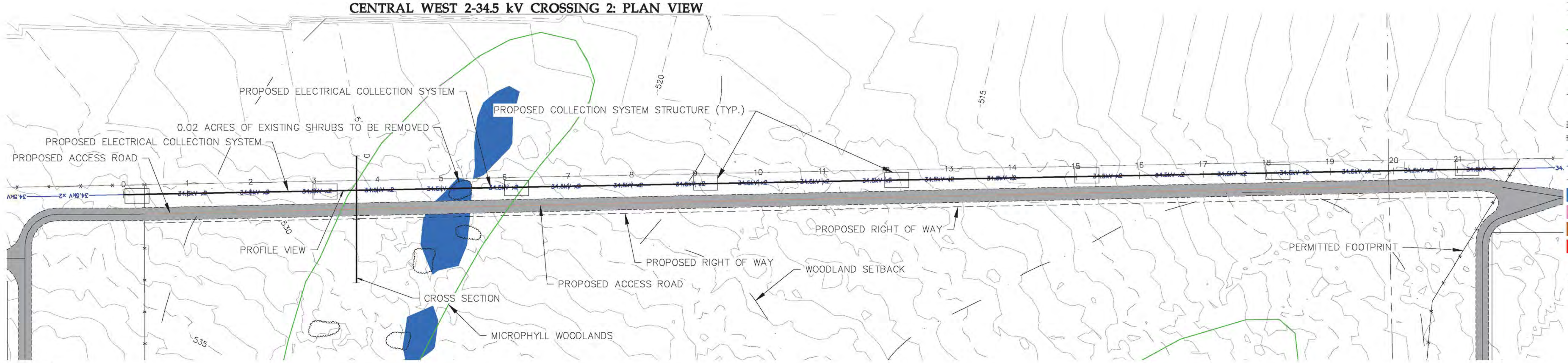
Common Ground Alliance

CENTRAL WEST 2-34.5 kV CROSSING 2: PLAN VIEW



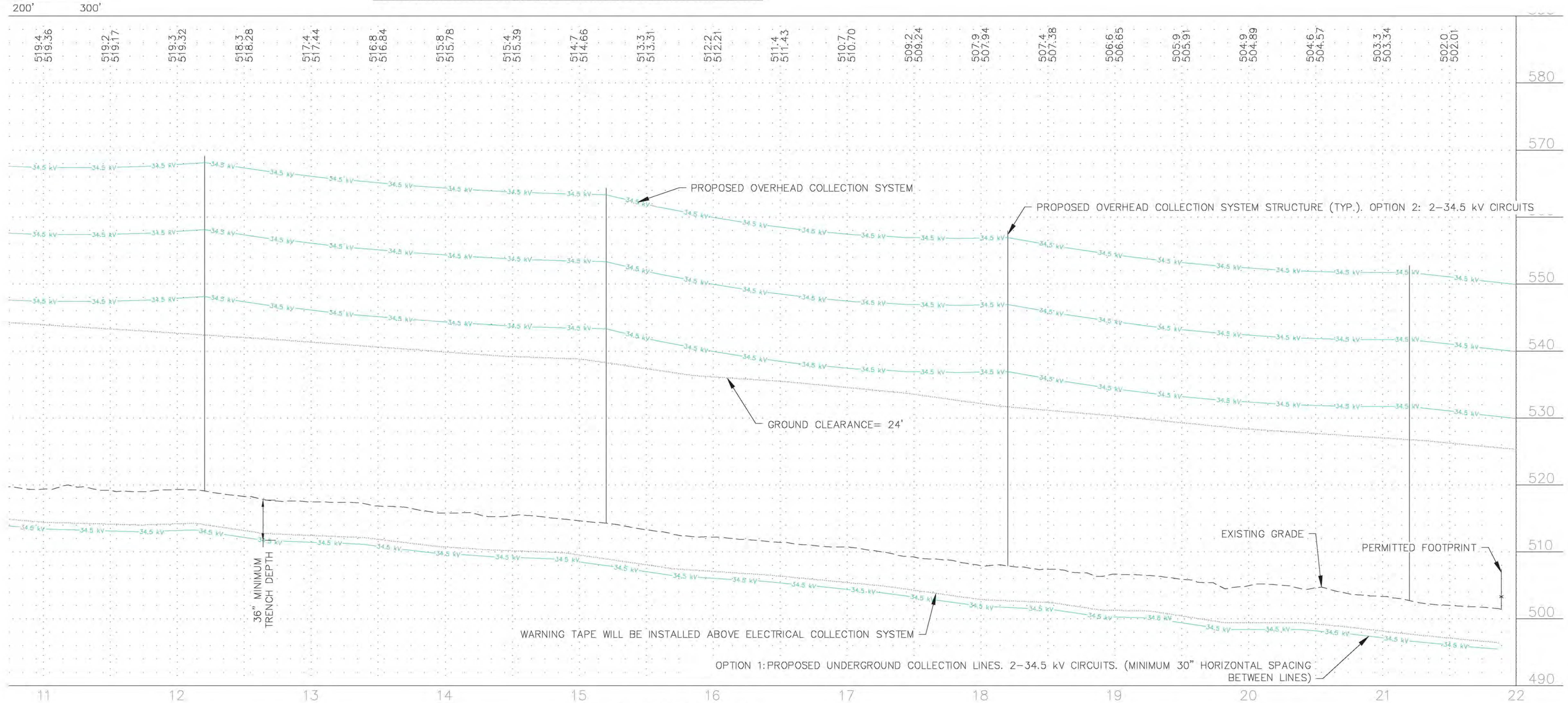
0' 100' 200' 300'

LEGEND:

SITE BOUNDARY
MICROPHYLL WOODLANDS
WOODLANDS SETBACK LINE
1070 EXISTING INDEX CONTOUR LINE
1071 EXISTING INTERVAL CONTOUR LINE
PERMITTED FOOTPRINT
PROPOSED SOLAR ARRAY
PROPOSED EXTERIOR 20' ACCESS ROAD
PROPOSED INTERIOR 16' ACCESS ROAD
34.5 kV COLLECTION ROUTE
34.5 kV COLLECTION ROUTE
PROPOSED RIGHT OF WAY
0.5'–1.0' FLOOD DEPTH
1.0'–1.5' FLOOD DEPTH
1.5'–2.0' FLOOD DEPTH
>2.0' FLOOD DEPTH

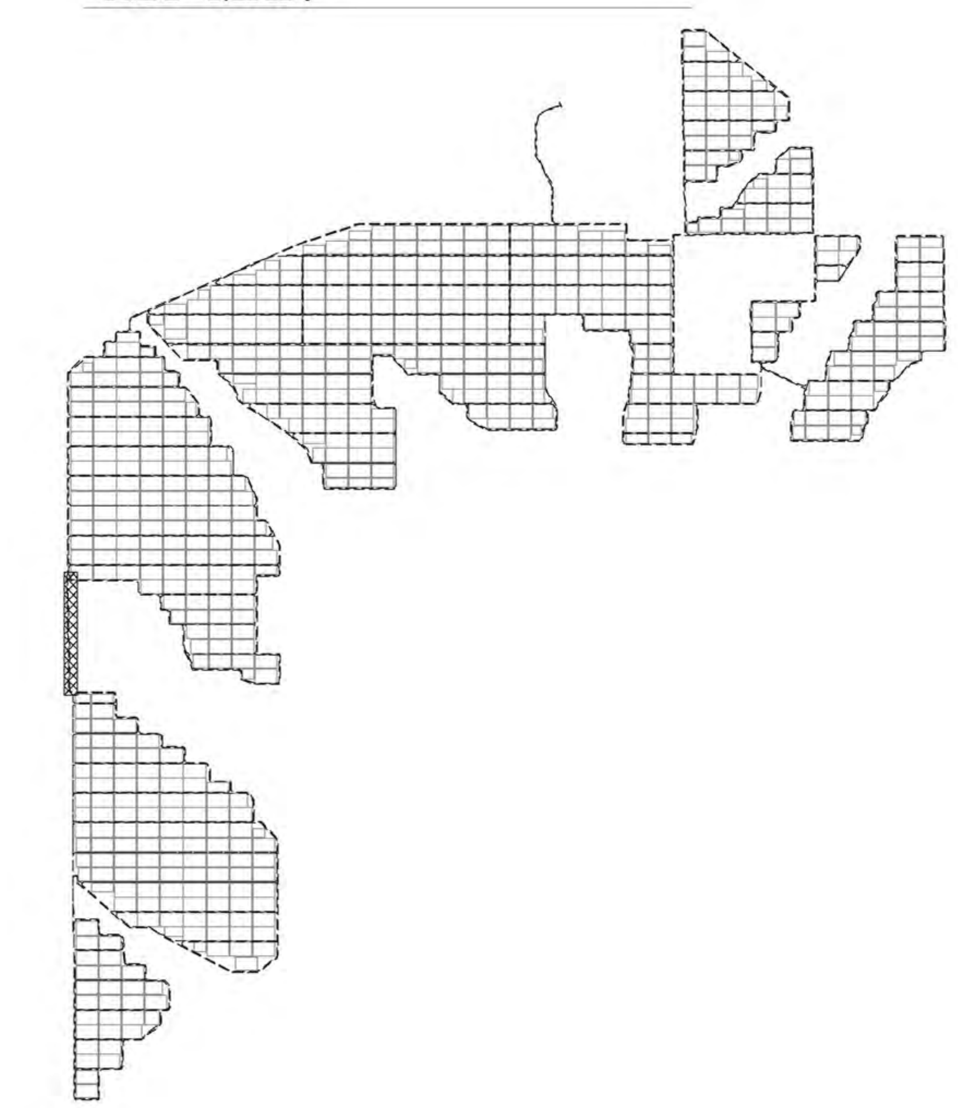
NOTES:
1. 34.5 kV COLLECTION METHOD TO BE DETERMINED WITH FINAL DESIGN.

CENTRAL WEST 2-345 kV CROSSING 2: PROFILE VIEW



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

KEY MAP:



0015053–CROSSING.dwg

Date: 04/06/2018 Sheet: C.215

RE Crimson, LLC.

Riverside County, CA

Central West 2-34.5 KV Crossing-3

Prepared for:

RECURRENT ENERGY
300 CALIFORNIA STREET, 7TH FLOOR
SAN FRANCISCO, CA 94104 USA
(415) 675 - 1500

Revisions:

Designed: BTB
Checked: ADC
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Record Drawing by/date:

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Westwood Professional Services, Inc.

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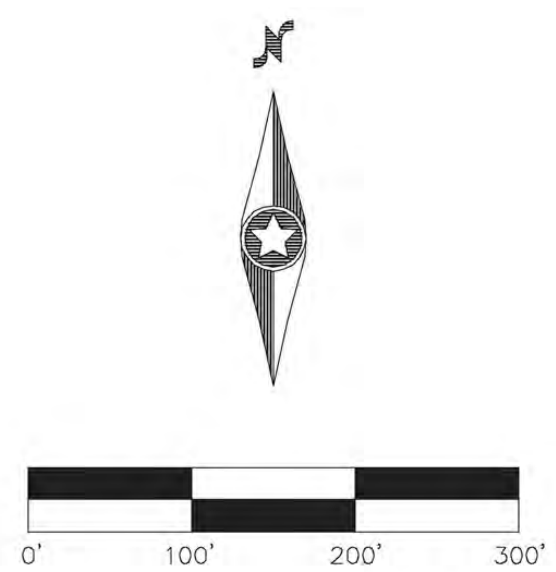
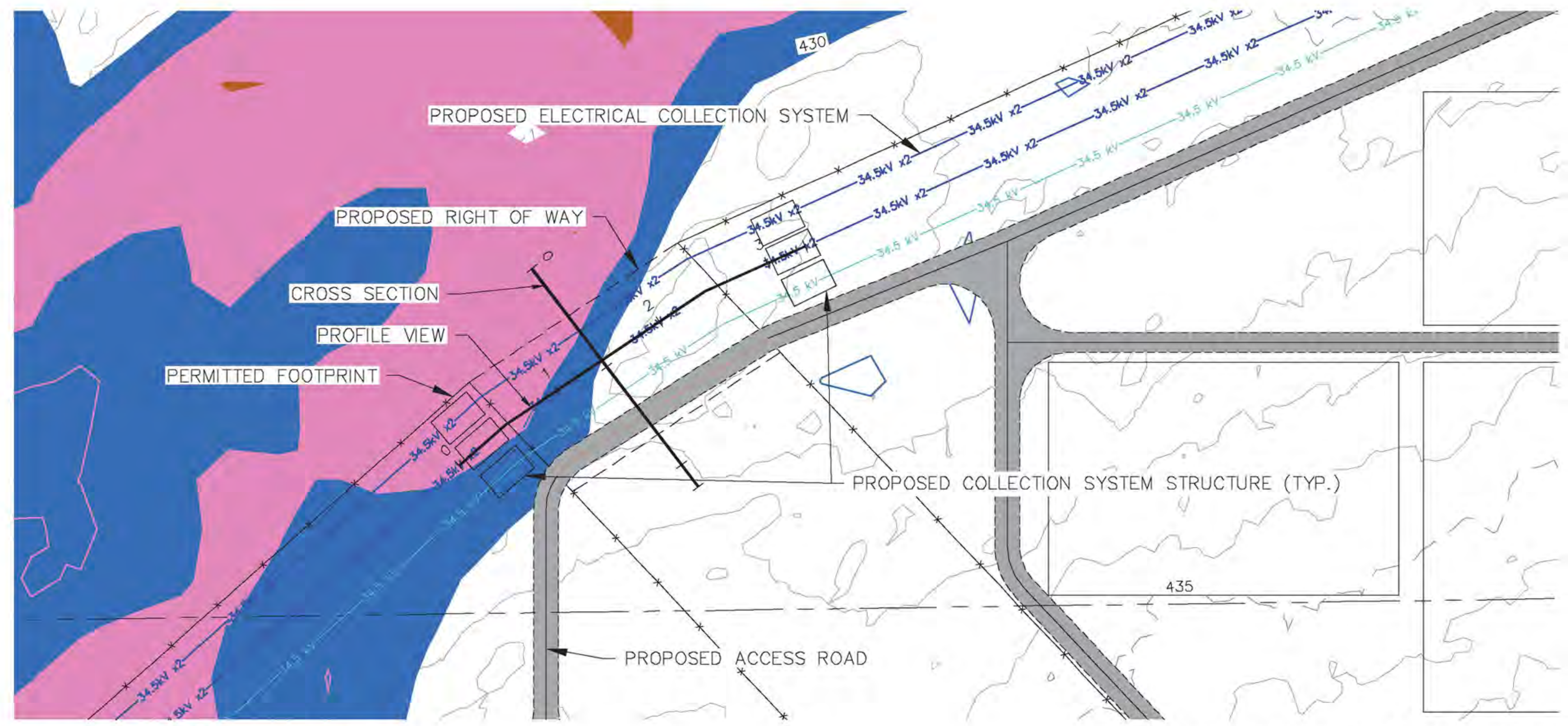
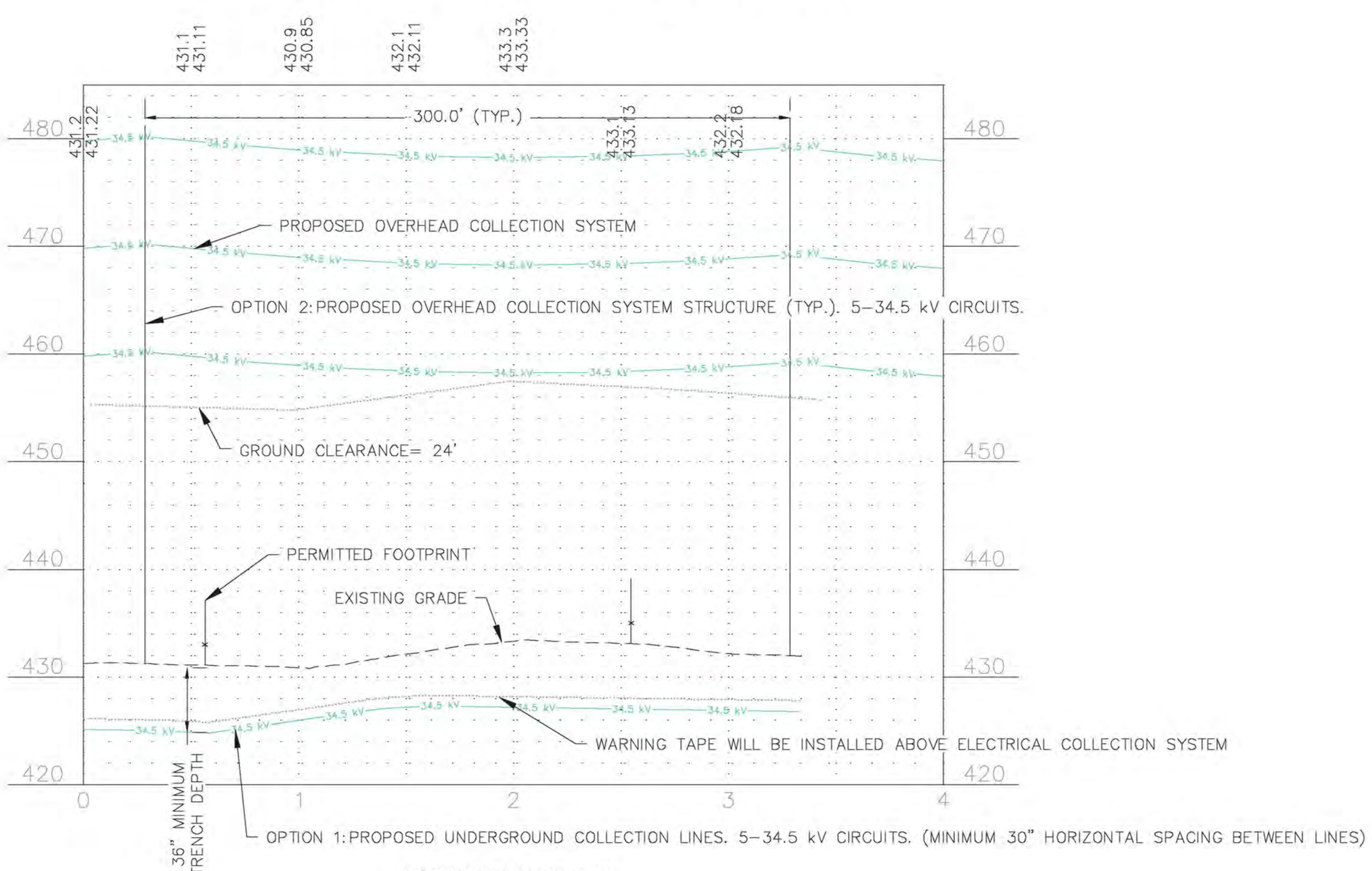
811 or call811.com
Common Ground Alliance

NORTHWEST 5-34.5 kV CROSSING 1: PLAN VIEW



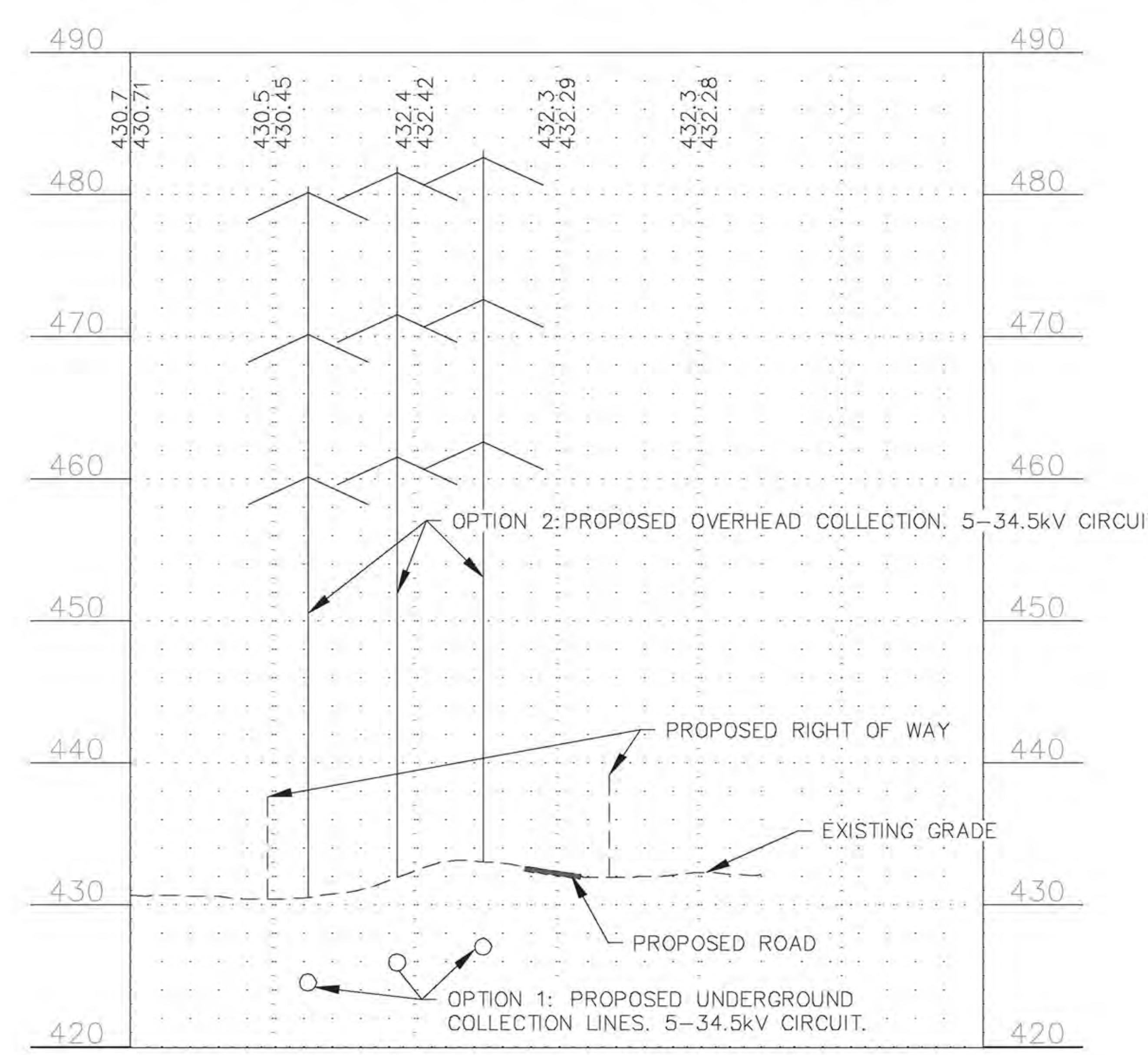


NORTHWEST 5-34.5 kV CROSSING 1: PROFILE VIEW



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

NORTHWEST 5-34.5 kV CROSSING 1: CROSS SECTION



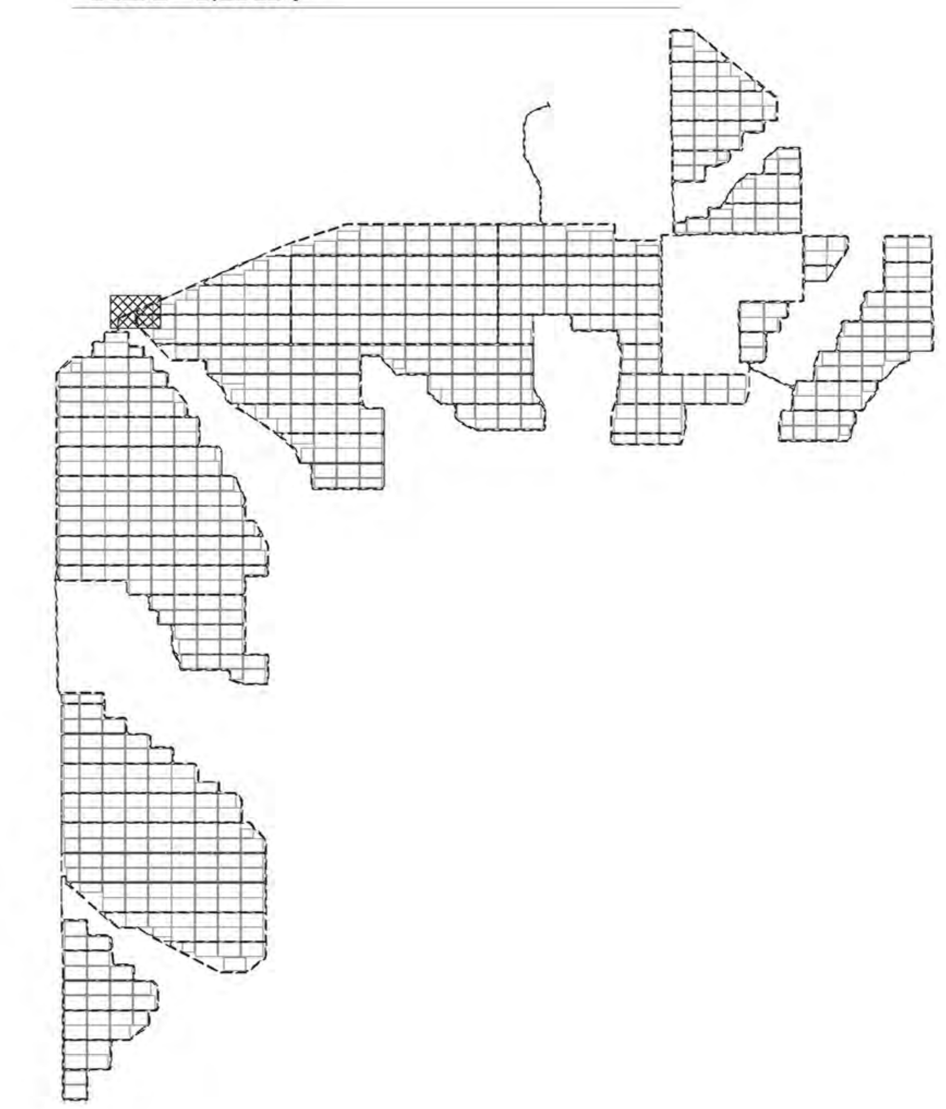
HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

LEGEND:

- SITE BOUNDARY
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
- EXISTING INDEX CONTOUR LINE (1070)
- EXISTING INTERVAL CONTOUR LINE (1071)
- PERMITTED FOOTPRINT
- PROPOSED SOLAR ARRAY
- PROPOSED EXTERIOR 20' ACCESS ROAD
- PROPOSED INTERIOR 16' ACCESS ROAD
- 34.5 kV COLLECTION ROUTE
- 34.5 kV COLLECTION ROUTE (34.5kV x2)
- PROPOSED RIGHT OF WAY
- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

NOTES:
1. 34.5 kV COLLECTION METHOD TO BE DETERMINED WITH FINAL DESIGN.

KEY MAP:



0015053–CROSSING.dwg

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Westwood Professional Services, Inc.

Revisions:

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Checked: ADC
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Record Drawing by/date:

Prepared for:

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SAN FRANCISCO, CA 94104 USA
(415) 675 - 1500

RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.216

Northwest 5-34.5 KV Crossing-1

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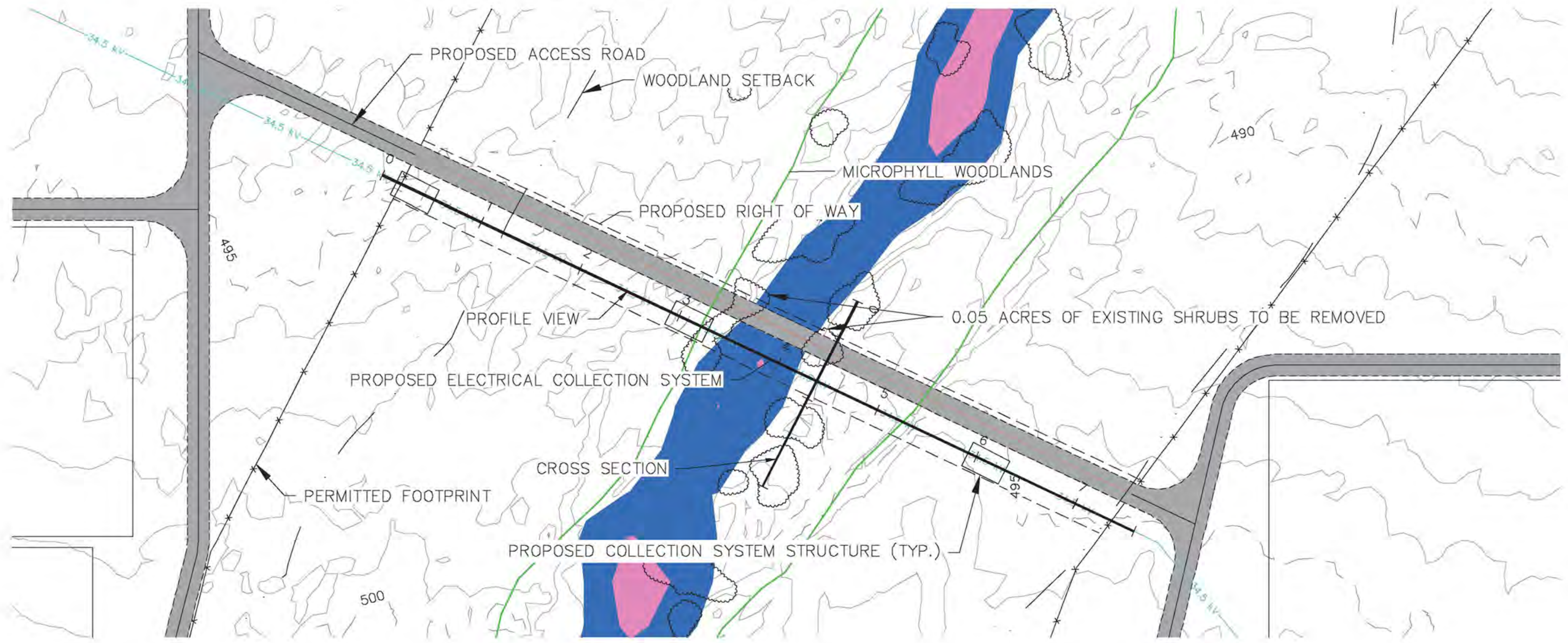
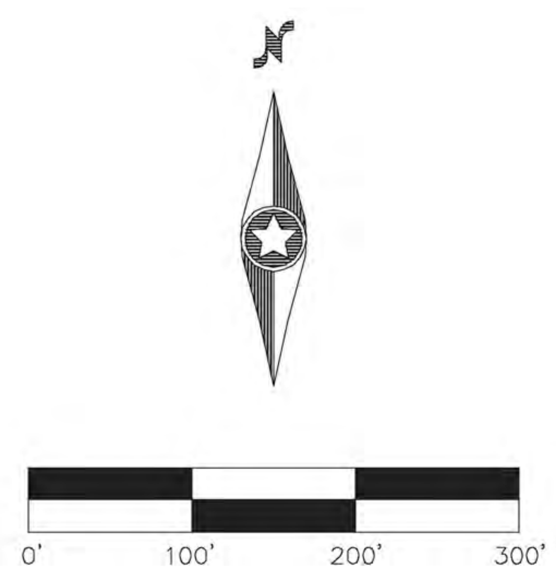
EAST 1-34.5 kV CROSSING 1: PLAN VIEW



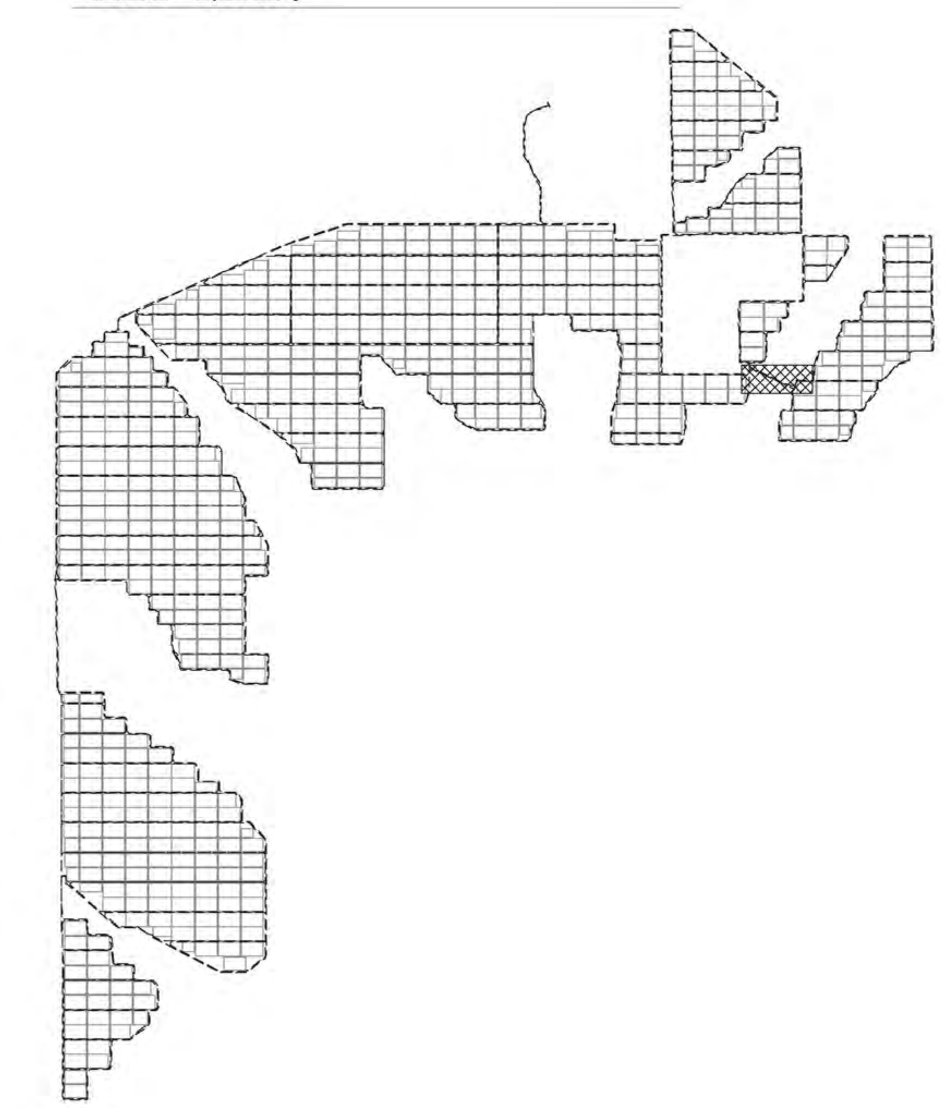


LEGEND:

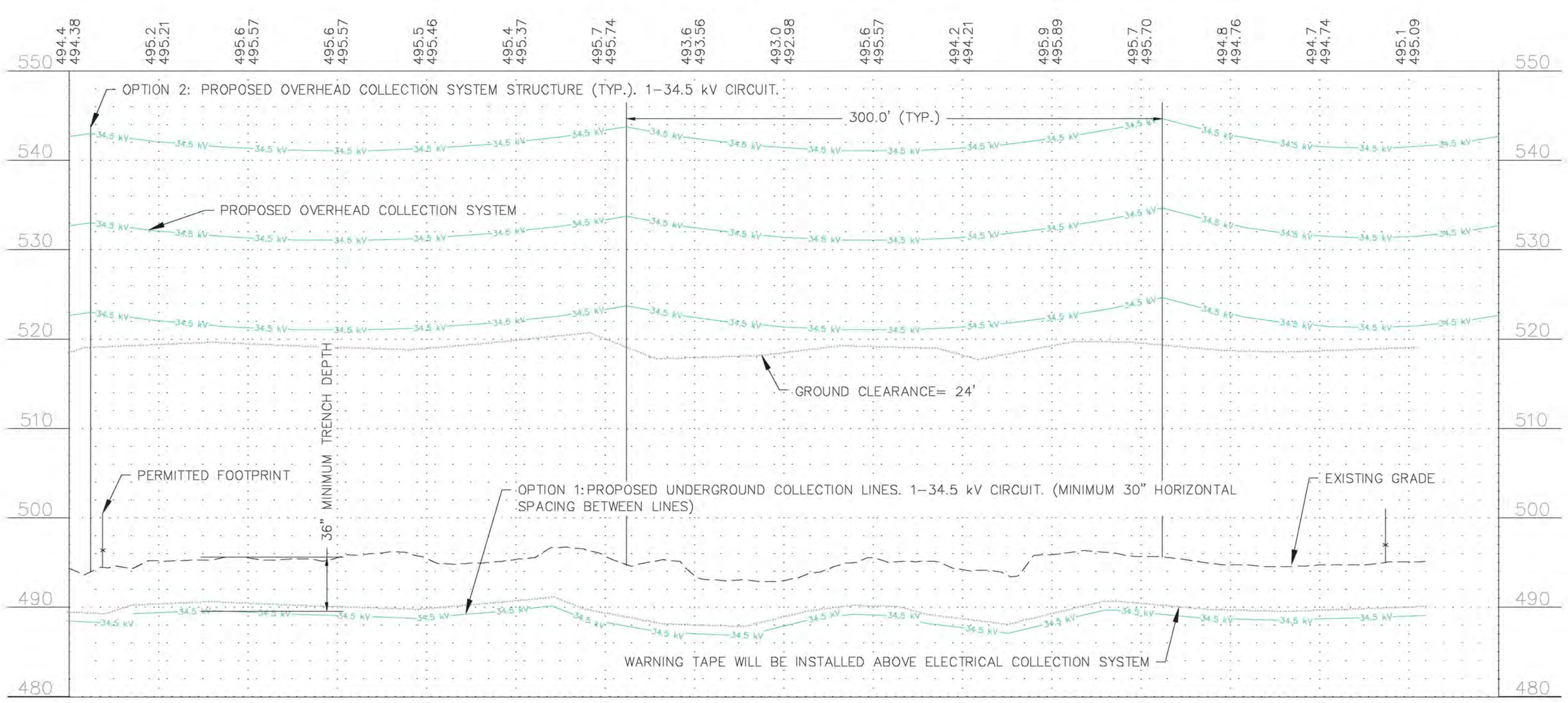
- SITE BOUNDARY
- MICROPHYLL WOODLANDS
- WOODLANDS SETBACK LINE
- 1070 EXISTING INDEX CONTOUR LINE
- 1071 EXISTING INTERVAL CONTOUR LINE
- PERMITTED FOOTPRINT
- PROPOSED SOLAR ARRAY
- PROPOSED EXTERIOR 20' ACCESS ROAD
- PROPOSED INTERIOR 16' ACCESS ROAD
- 34.5 kV 34.5 kV COLLECTION ROUTE
- 34.5kV x2 34.5 kV COLLECTION ROUTE
- PROPOSED RIGHT OF WAY
- 0.5'–1.0' FLOOD DEPTH
- 1.0'–1.5' FLOOD DEPTH
- 1.5'–2.0' FLOOD DEPTH
- >2.0' FLOOD DEPTH

NOTES:
1. 34.5 kV COLLECTION METHOD TO BE DETERMINED WITH FINAL DESIGN.

KEY MAP:

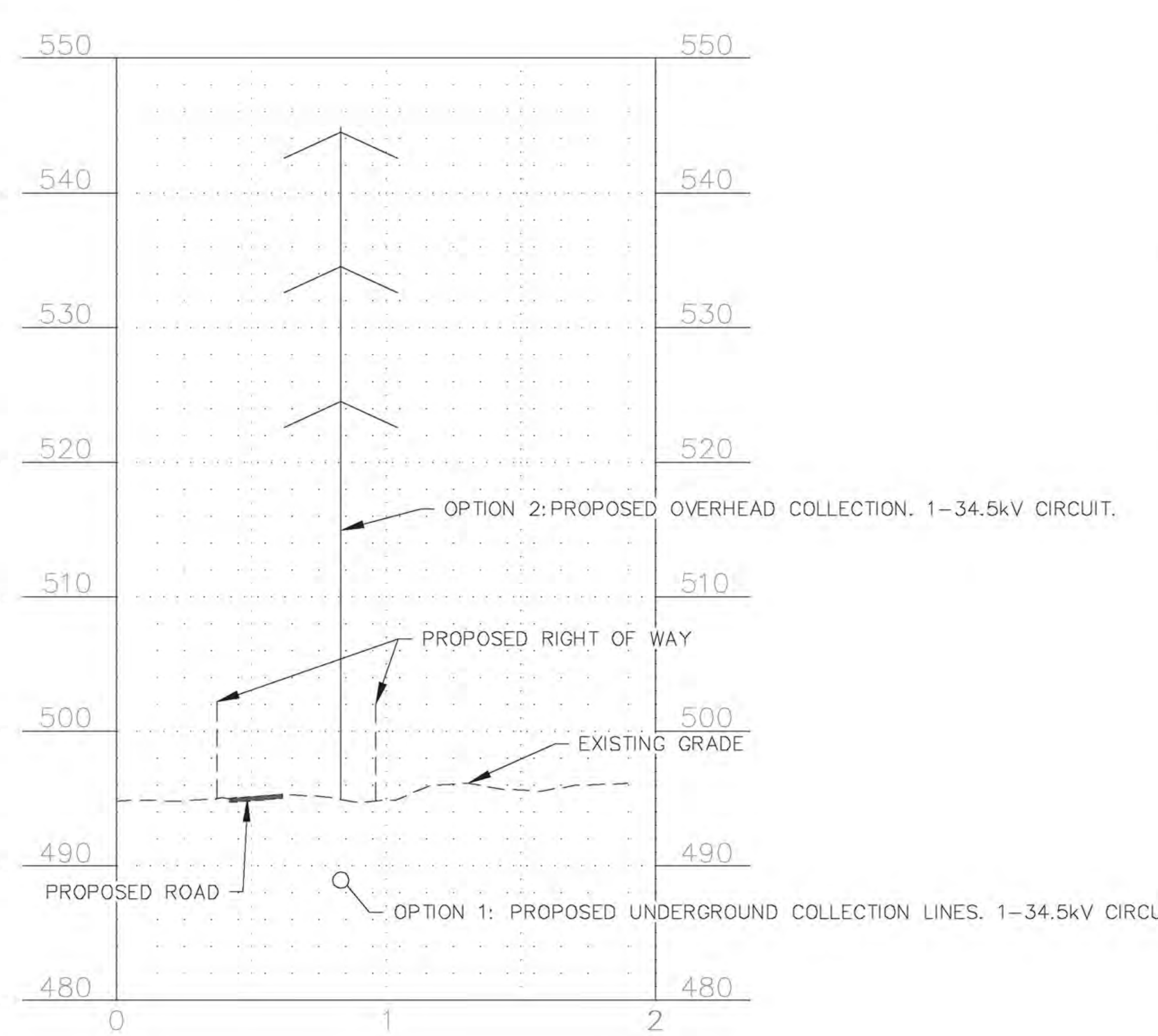


EAST 1-34.5 kV CROSSING 1: PROFILE VIEW



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

EAST 1-34.5 kV CROSSING 1: CROSS SECTION



HORIZONTAL SCALE 1"=50'
VERTICAL SCALE 1"=10'

0015053–CROSSING.dwg

Westwood

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RE Crimson, LLC.

Riverside County, CA

Date: 04/06/2018 Sheet: C.217

East 1-34.5 KV Crossing-1

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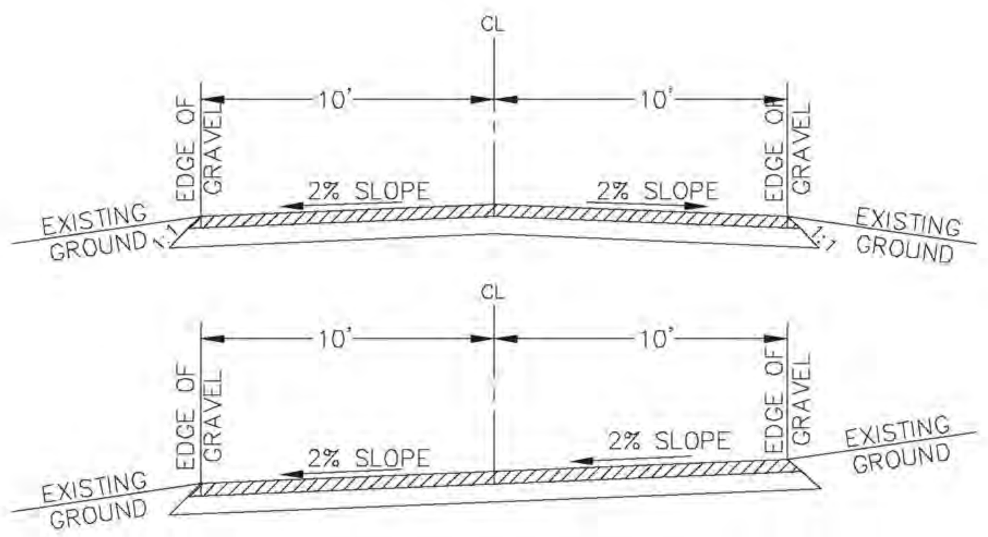
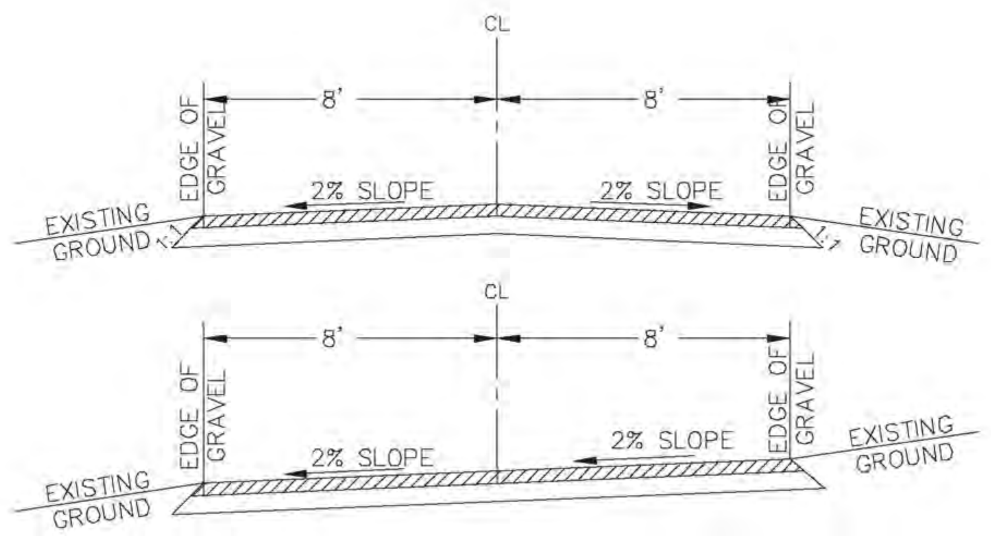


20' ACCESS ROADWAY

NOTES:
1. CONTRACTOR SHALL CONSTRUCT CROSS-SLOPE ROAD SECTION WHERE ACCESS ROADS ARE CONSTRUCTED ON A SIDE SLOPE, AND WHERE OTHERWISE NOTED ON PLANS, TO ENSURE THAT ROADS AND SHOULDERS REMAIN WELL DRAINED AT ALL TIMES.

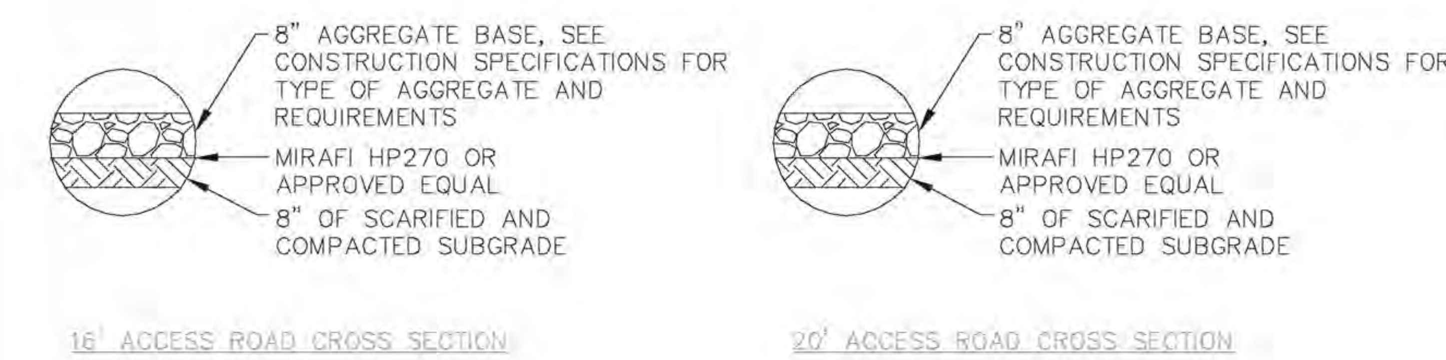
Westwood | TYPICAL EXTERIOR SOLAR ACCESS ROAD | LAST REVISED: 11/07/14 | RD01



16' ACCESS ROADWAY

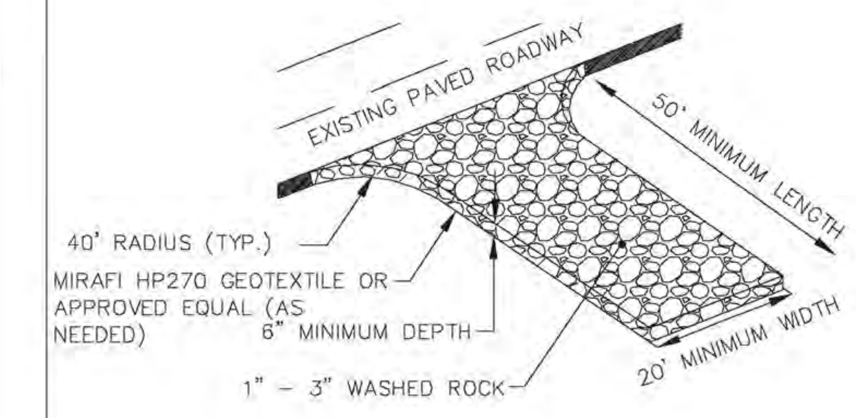
NOTES:
1. CONTRACTOR SHALL CONSTRUCT CROSS-SLOPE ROAD SECTION WHERE ACCESS ROADS ARE CONSTRUCTED ON A SIDE SLOPE, AND WHERE OTHERWISE NOTED ON PLANS, TO ENSURE THAT ROADS AND SHOULDERS REMAIN WELL DRAINED AT ALL TIMES.

Westwood | TYPICAL INTERIOR SOLAR ACCESS ROAD | LAST REVISED: 11/07/14 | RD01



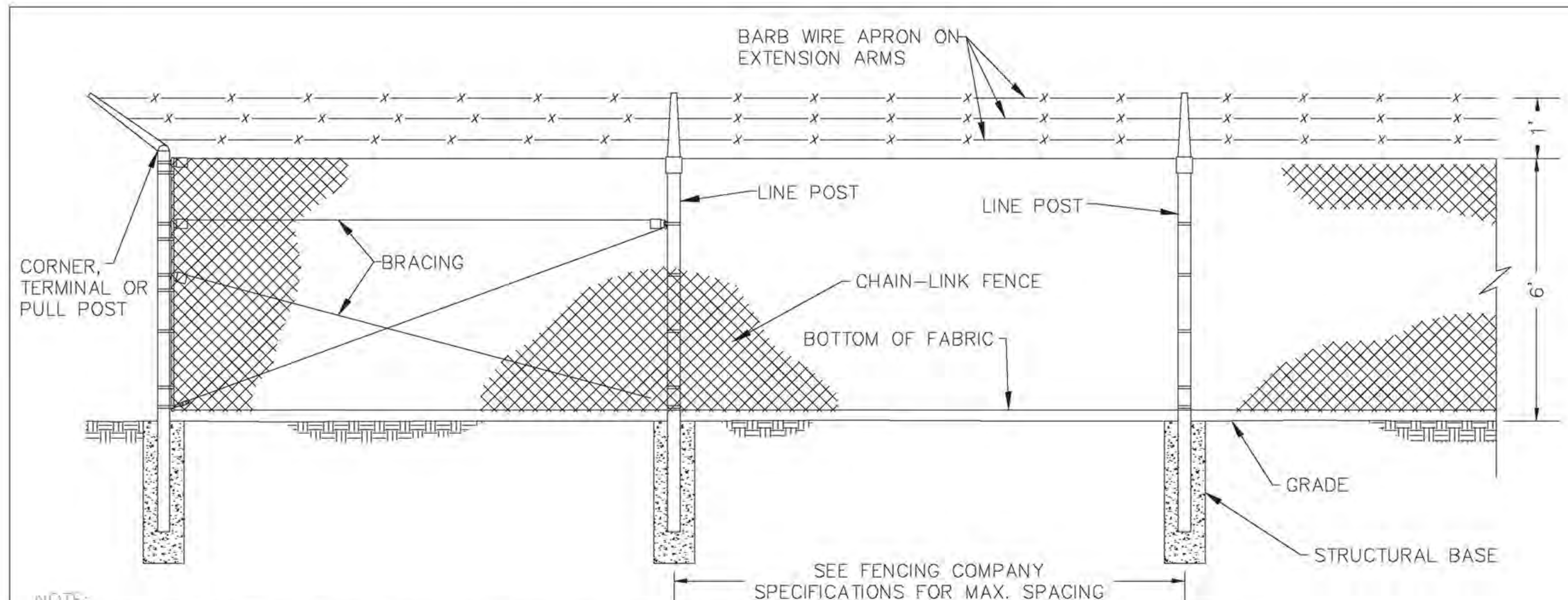
NOTE:
1. STRUCTURAL SECTIONS SHOWN ARE THE MINIMUM THICKNESS REQUIREMENTS DURING NORMAL FIELD CONDITIONS. THE SECTIONS MAY NEED TO BE INCREASED BASED ON ACTUAL FIELD CONDITIONS AT THE TIME OF CONSTRUCTION. CONDITIONS INCLUDE BUT ARE NOT LIMITED TO CONSTRUCTION DURING UNUSUALLY WET PERIODS, OR IN LOW/WET AREAS.
2. FINAL DESIGN MAY PROVIDE A DIFFERENT CROSS SECTION

Westwood | TYPICAL STRUCTURAL CROSS SECTIONS | LAST REVISED: 11/07/14 | RD02



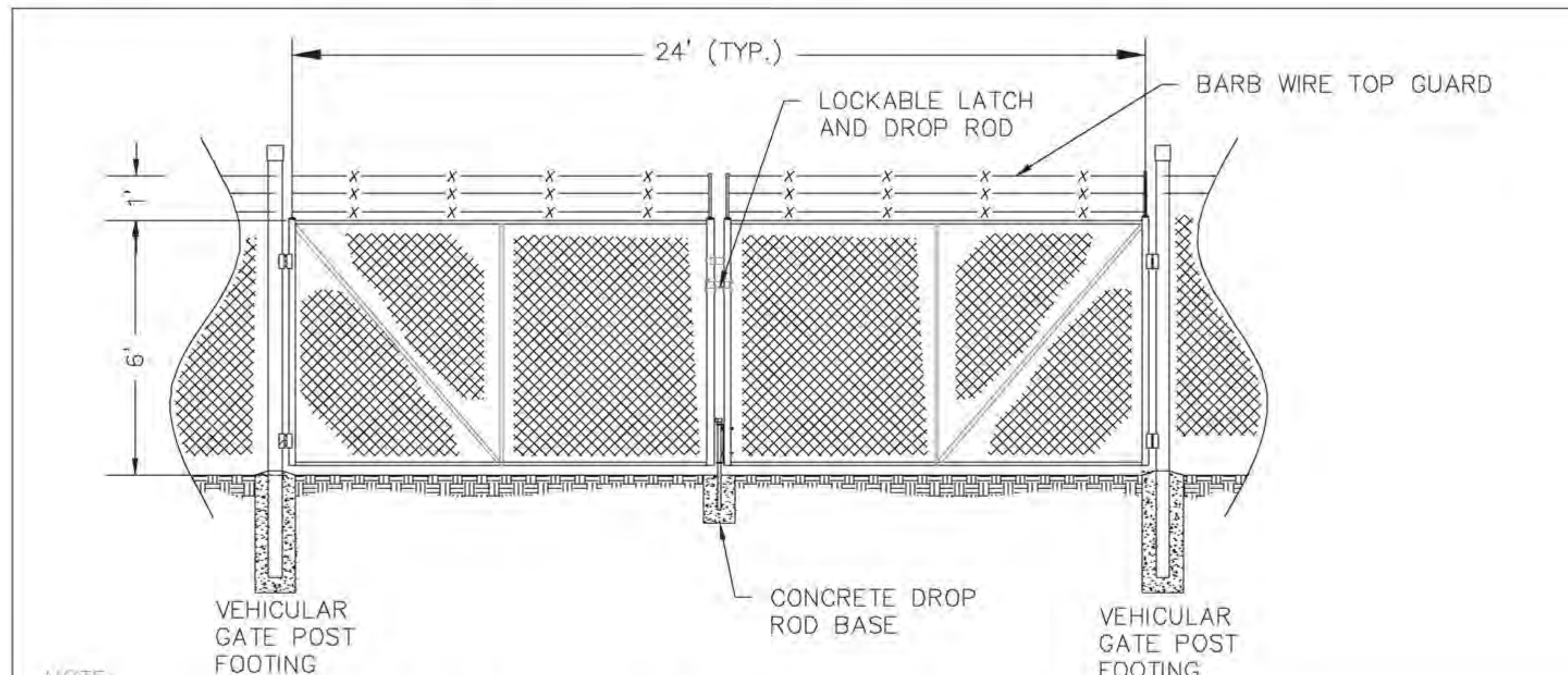
NOTE:
ROCK CONSTRUCTION ENTRANCE SHOULD BE A MINIMUM THICKNESS OF 6" AND CONTAIN MAXIMUM SIDE SLOPES OF 4:1. ROCK ENTRANCE SHOULD BE INSPECTED AND MAINTAINED REGULARLY. ROCK ENTRANCE LENGTH MAY NEED TO BE EXTENDED IN CLAY SOILS.

Westwood | ROCK CONSTRUCTION ENTRANCE | LAST REVISED: 02/02/15 | GD05



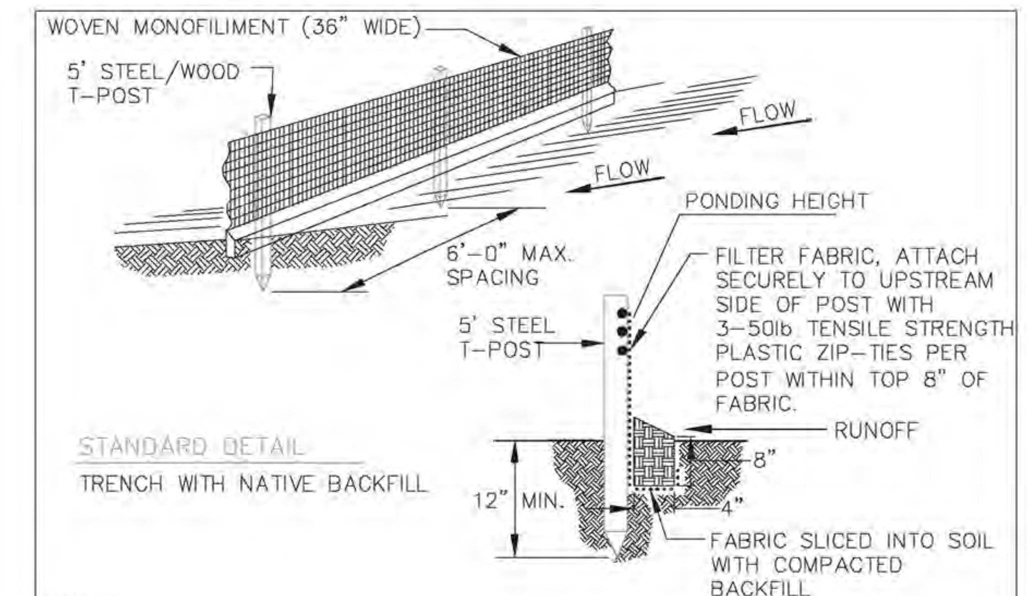
NOTE:
1. FENCE AND GATE TYPE TO BE APPROVED BY OWNER PRIOR TO CONSTRUCTION
2. STRUCTURAL DESIGN TO BE PROVIDED BY FENCE SUPPLIER
3. DIMENSIONS AND INFORMATION SHOWN ABOVE ARE FOR REFERENCE ONLY. ACTUAL DIMENSIONS AND INFORMATION TO BE PROVIDED BY MANUFACTURER/SUPPLIER
4. FENING TO BE USED SHALL BE BLACK VINYL CHAIN LINK

Westwood | CHAIN-LINK SECURITY FENCE DETAIL | (NOT TO SCALE) | LAST REVISED: 08/04/16 | FN01



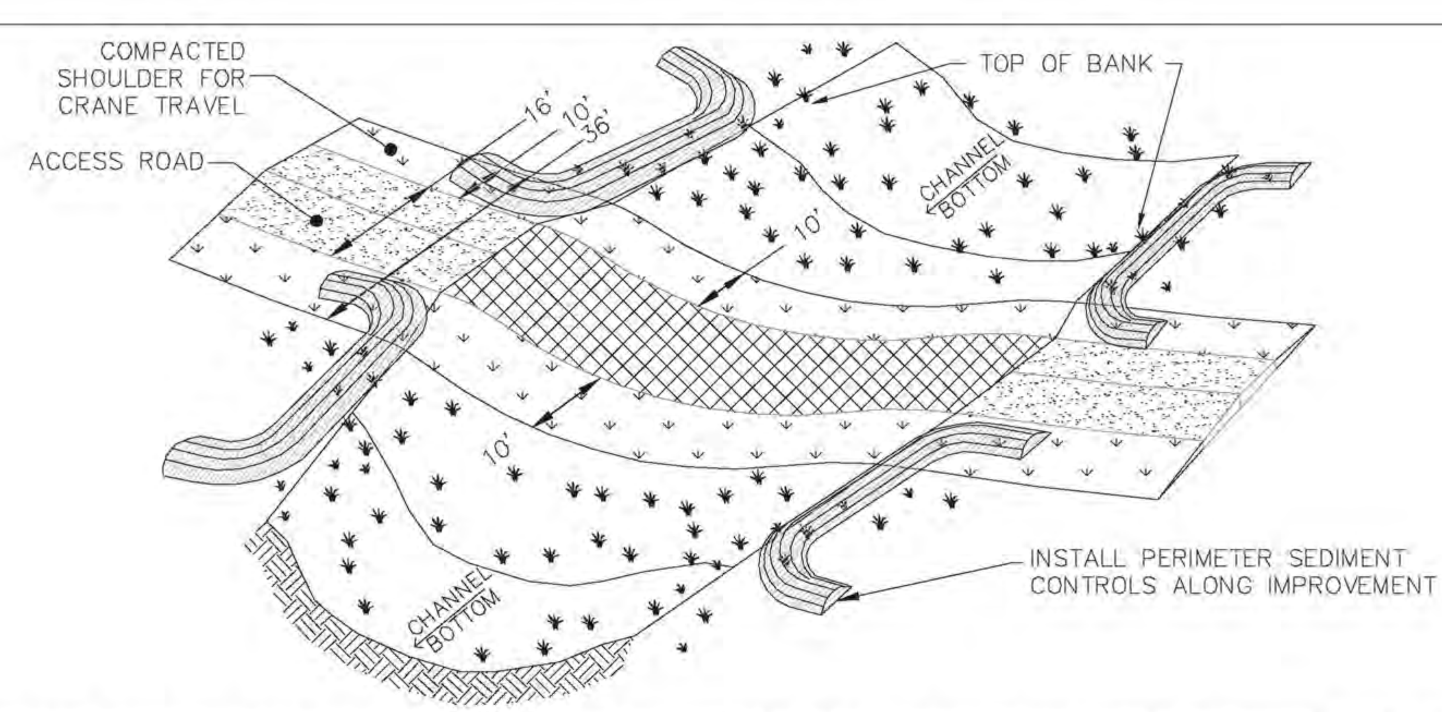
NOTE:
1. FENCE AND GATE TYPE TO BE APPROVED BY OWNER PRIOR TO CONSTRUCTION
2. STRUCTURAL DESIGN TO BE PROVIDED BY FENCE SUPPLIER
3. DIMENSIONS AND INFORMATION SHOWN ABOVE ARE FOR REFERENCE ONLY. ACTUAL DIMENSIONS AND INFORMATION TO BE PROVIDED BY MANUFACTURER/SUPPLIER
4. A KNOX PAD LOCK WILL BE PLACE ON CHAINED GATES OR KNOX BOX WITH GATE ACCESS KEYS WILL BE MOUNTED AT THE MAIN ENTRANCE FOR FIRE DEPARTMENT ACCESS.

Westwood | CHAIN-LINK SECURITY SWING GATE | LAST REVISED: 08/04/16 | FN05



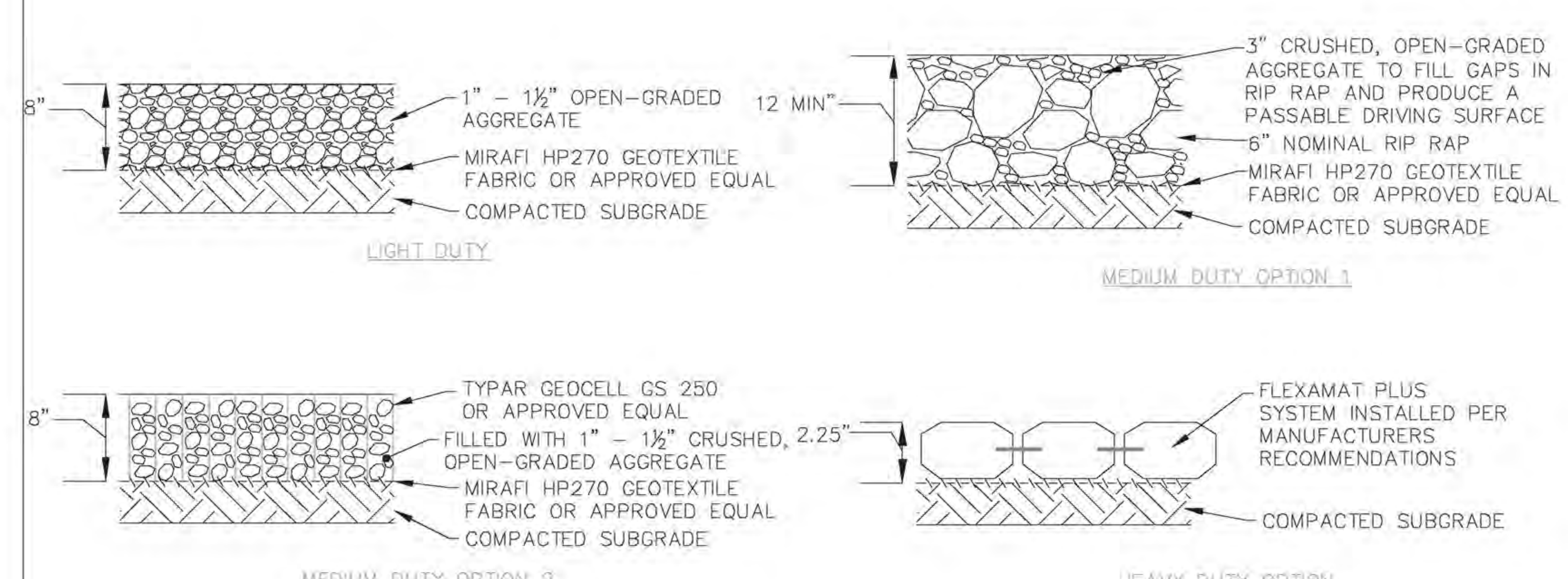
NOTE:
1. INSPECT AND REPAIR FENCE AFTER EACH STORM EVENT AND REMOVE SEDIMENT WHEN ACCUMULATED TO 1/2 THE HEIGHT OF THE FABRIC OR MORE.
2. REMOVED SEDIMENT SHALL BE DEPOSITED TO AN AREA THAT WILL NOT CONTRIBUTE SEDIMENT OFF-SITE AND CAN BE PERMANENTLY STABILIZED.
3. SILT FENCE SHALL BE PLACED ON SLOPE CONTOURS TO MAXIMIZE PONDING EFFICIENCY.
4. ALL ENDS OF THE SILT FENCE SHALL BE WRAPPED UPSLOPE SO THE ELEVATION OF THE BOTTOM OF FABRIC IS HIGHER THAN "PONDING HEIGHT".

Westwood | SILT FENCE | SE-1 | LAST REVISED: 11/24/14



NOTE:
1. CHANNEL SIDE SLOPES MAY REQUIRE MODIFICATION TO CONSTRUCT THE ACCESS ROAD THROUGH THE CHANNEL THAT MEETS COMPONENT DELIVERY REQUIREMENTS.
2. THE ACCESS ROAD SHALL CROSS THE CHANNEL AS CLOSE TO 90-DEGREES AS POSSIBLE.
3. THE FINISHED ACCESS ROAD SURFACE SHALL BE AT AN ELEVATION THAT ALLOWS WATER TO FLOW THROUGH THE CHANNEL UNIMPEDED AND WITHOUT PONDING UPSTREAM OF THE ROAD OR ON THE ROAD SURFACE.
4. ARMORED SURFACE TREATMENT OF THE ROAD SURFACE SHALL EXTEND THROUGH THE CHANNEL BOTTOM AND UP THE CHANNEL SIDE SLOPES TO THE OBSERVED TOP OF BANK OF THE CHANNEL.
5. REFER TO DETAIL RD11B FOR ARMORED SURFACE TREATMENT OPTIONS.

Westwood | LOW WATER CROSSING | LAST REVISED: 03/09/17 | RD11



Westwood | ARMORED SURFACE TREATMENTS AT LOW WATER CROSSINGS | LAST REVISED: 11/30/17 | RD11B

0015053-DTFD1.dwg

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Fax (952) 937-5822 Minnetonka, MN 55343
Toll Free (888) 937-5150 westwoodps.com
Westwood Professional Services, Inc.

Revisions:

Designed: BTB
Checked: ADC
Drawn: JLB
Record Drawing by/date:

Prepared for:
RECURRENT ENERGY
300 CALIFORNIA STREET, 7TH FLOOR
SAN FRANCISCO, CA 94104 USA
(415) 675 - 1500

RE Crimson, LLC.
Riverside County, CA

Date: 04/06/2018 Sheet: C.300

Construction Details-1

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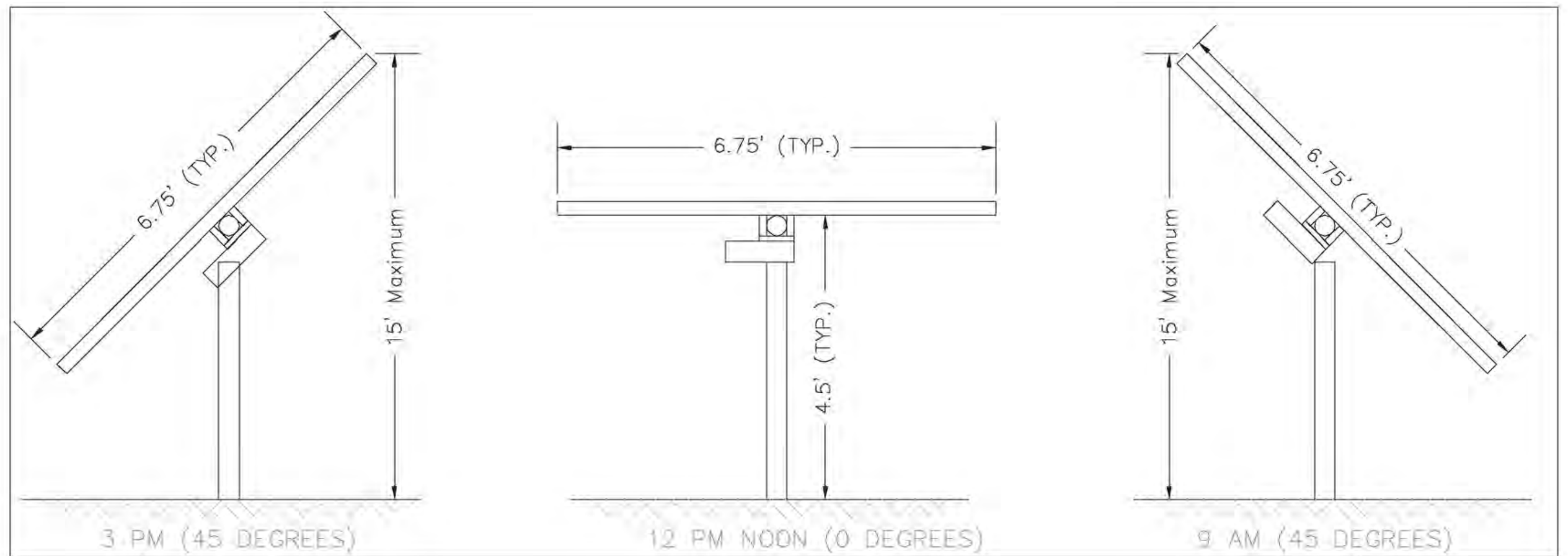
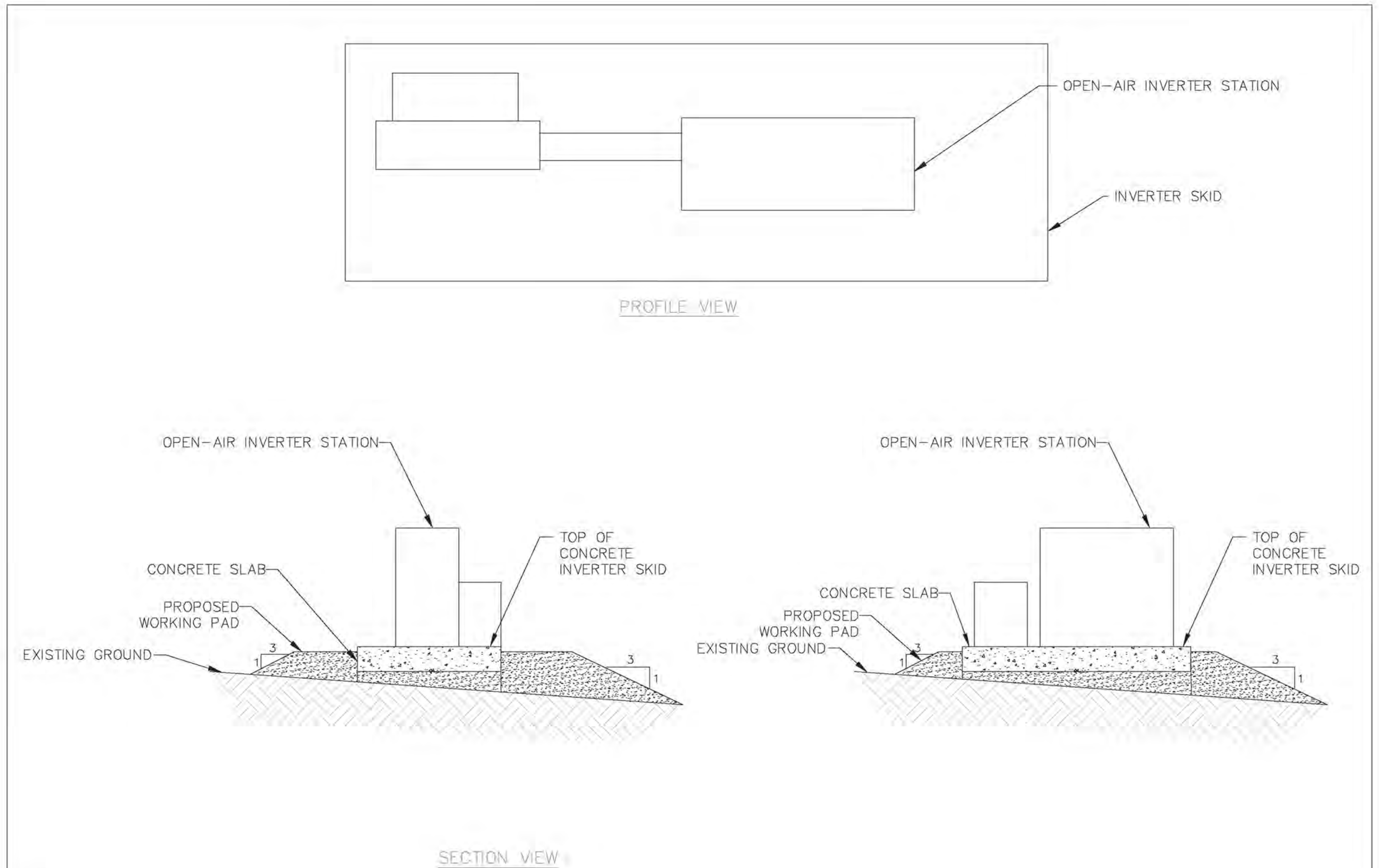
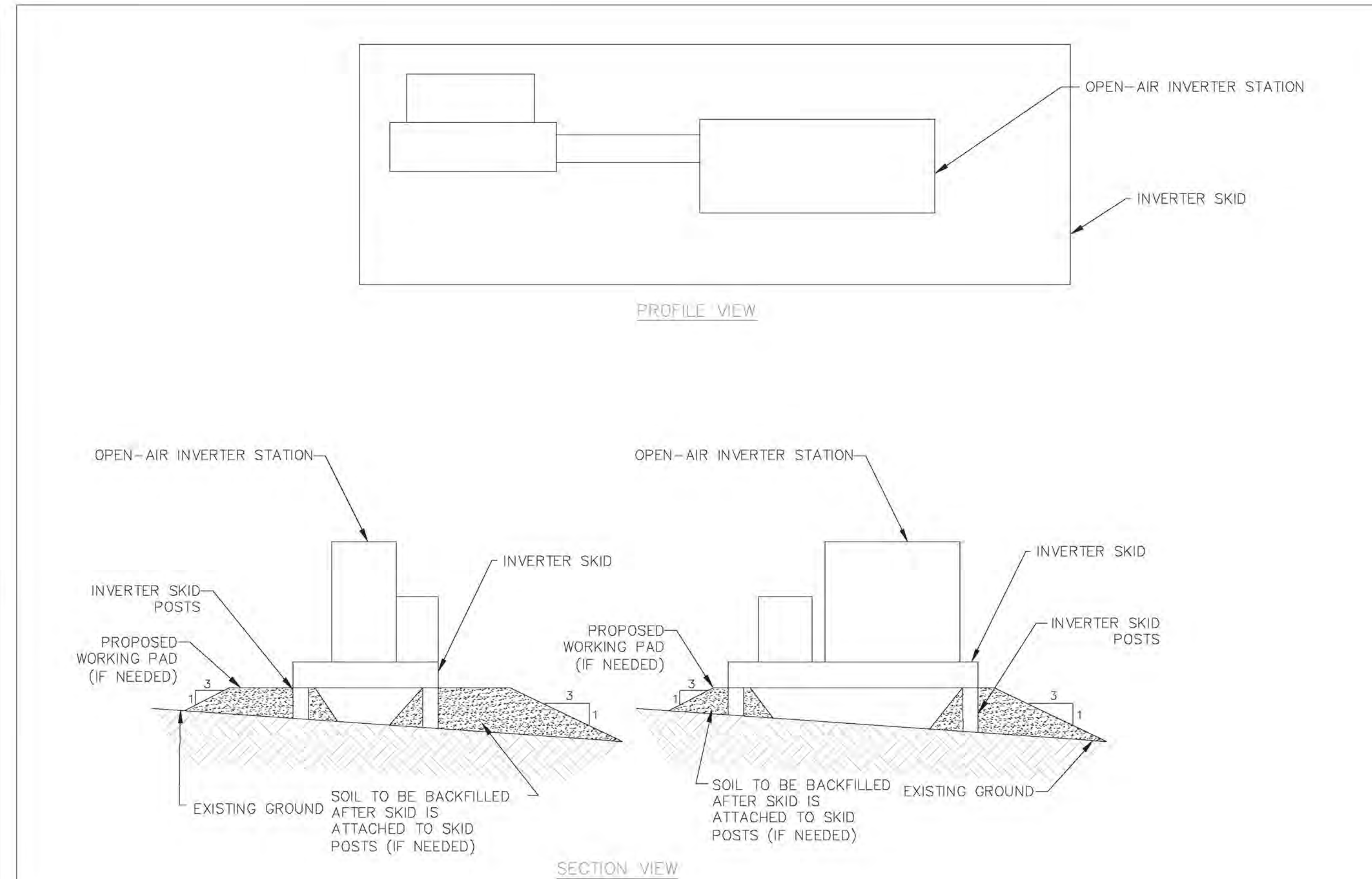


Westwood	TYPICAL SOLAR TRACKER PROFILE VIEWS (9 A.M., 12 P.M., 3 P.M.)	LAST REVISED: 09/29/15 TRK01



Westwood	TYPICAL SOLAR INVERTER ON CONCRETE SLAB	LAST REVISED: 08/20/15 INV02



Westwood	TYPICAL SOLAR INVERTER ON DRIVEN PILES	LAST REVISED: 08/20/15 INV03

0015053-DTF01.dwg

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Westwood Professional Services, Inc.

Revisions:

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Checked: ADC
Drawn: JLB
Record Drawing by/date:

Prepared for:

RECURRENT ENERGY
300 CALIFORNIA STREET, 7TH FLOOR
SAN FRANCISCO, CA 94104 USA
(415) 675 - 1500

RE Crimson, LLC.

Riverside County, CA

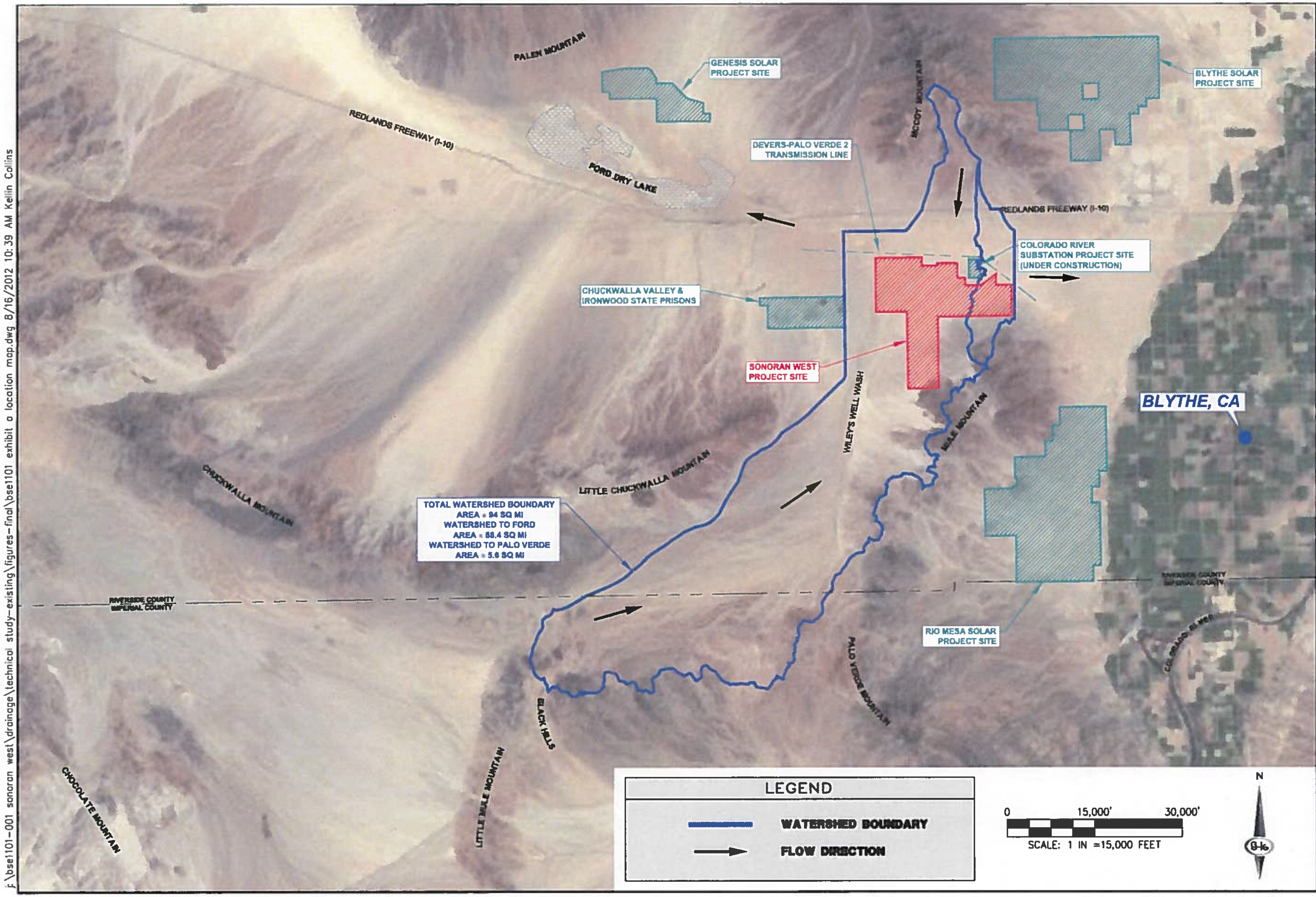
Date: 04/06/2018 Sheet: C.301

Construction Details-2

Appendix B

Exhibits and Supporting Figures

f:\bse1101-001 sonoran west\drainage\technical study-existing\figures-final\bse1101 exhibit a location map.dwg 8/16/2012 10:39 AM Kelin Collins



SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS

NO.	DESCRIPTION	DATE	BY	APP.

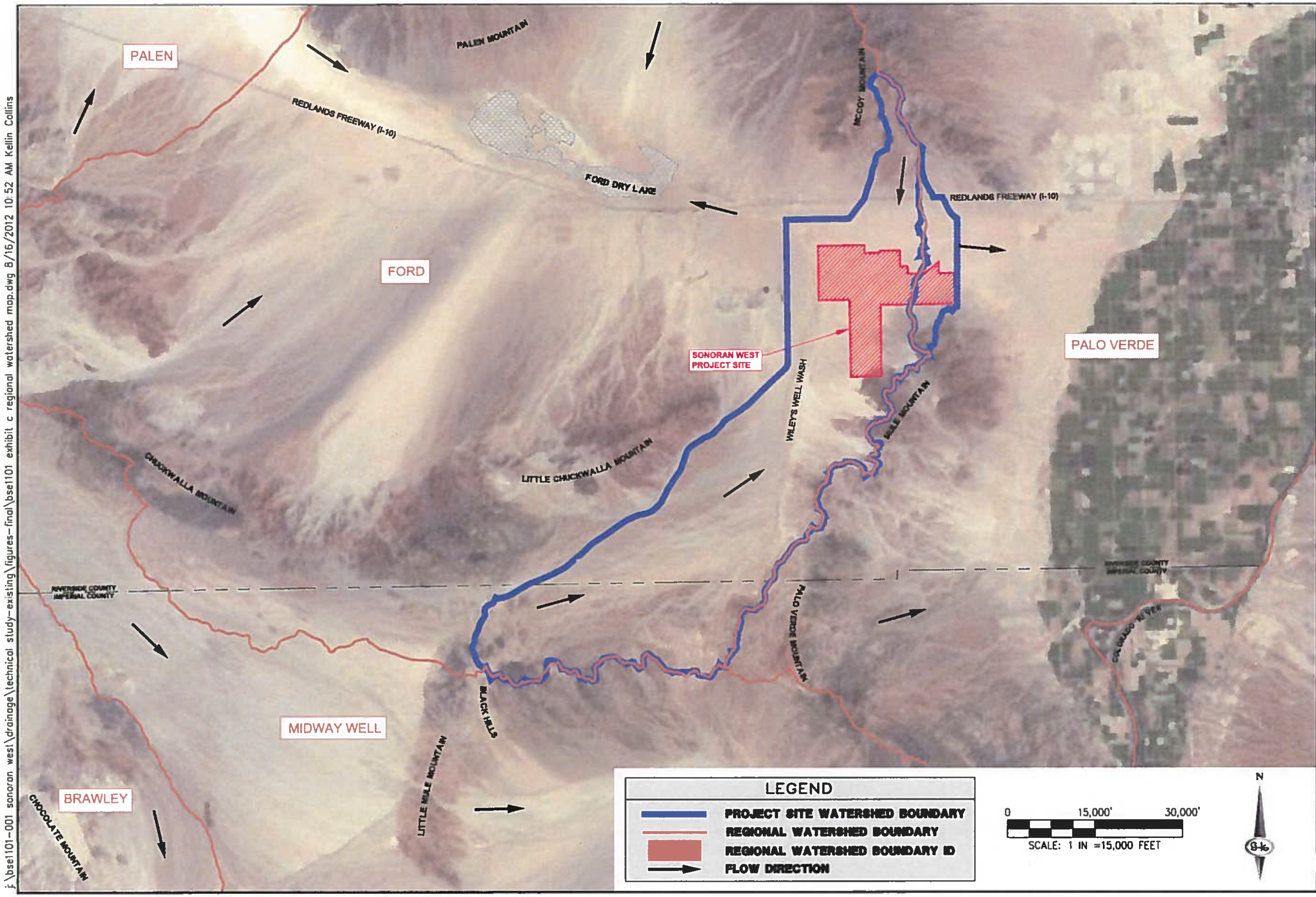
BRIGHTSOURCE ENERGY, INC.

SONORAN WEST SOLAR PROJECT

LOCATION MAP

DATE: 08/30/2012
DRAFTER: KC
DESIGNER: KC
CHECKED: MJF/KCR
PROJECT NO. BSE1101.001

EXHIBIT A
SHEET 1 OF 1



SLATER HANIFAN GROUP
CONSULTING ENGINEERS & PLANNERS

NO.	DESCRIPTION	DATE	BY	APP. DATE	APP.

BRIGHTSOURCE ENERGY, INC.

SONORAN WEST SOLAR PROJECT

REGIONAL WATERSHED MAP

DATE: 08/30/2012

DRAFTER: KC

DESIGNER: KC

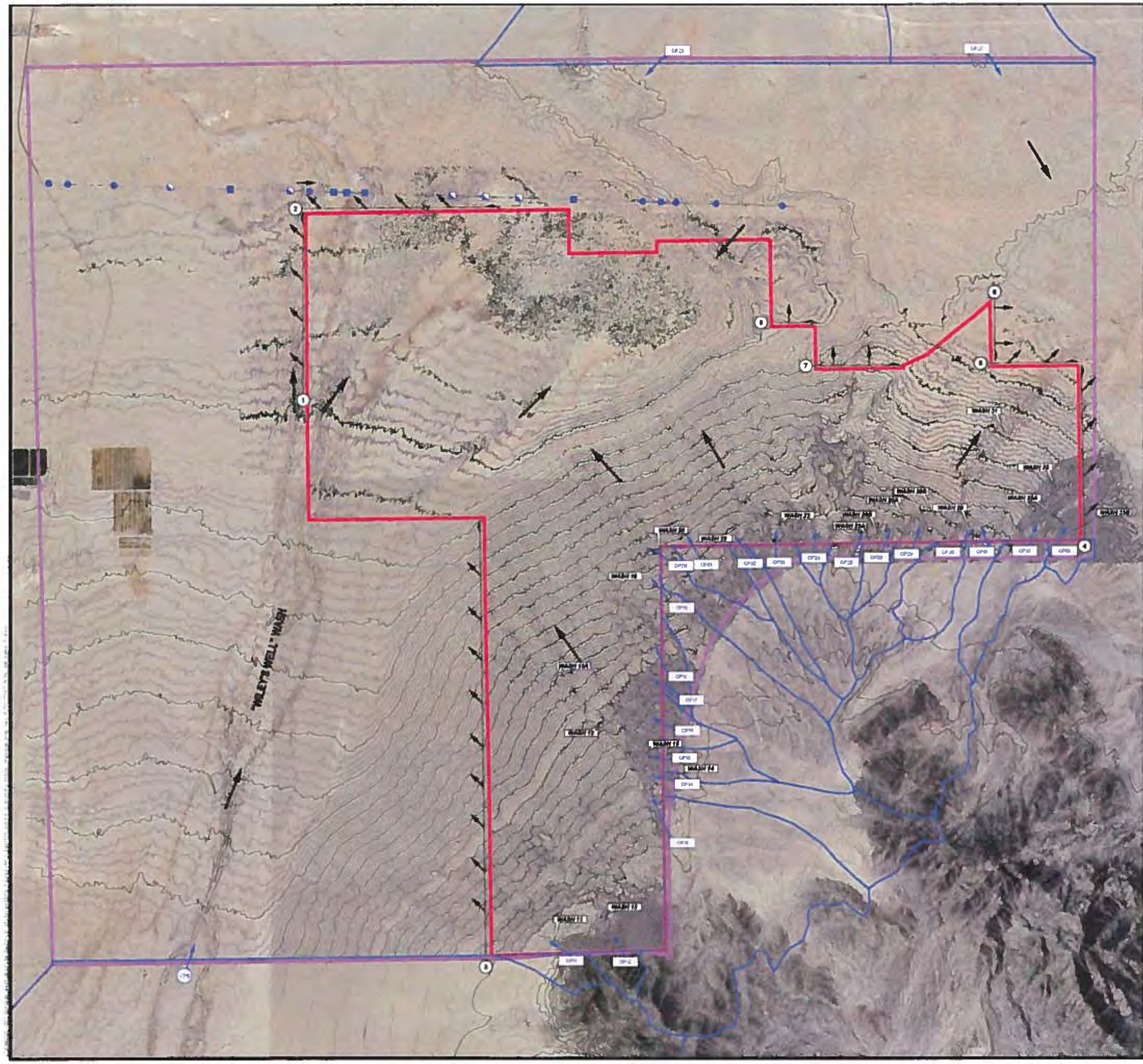
CHECKED: MJF/KCR

PROJECT NO. BSE1101.001

EXHIBIT C

SHEET 1 OF 1

j:\bse1101-001 sonoran west\drainage\technical study-existing\figures-final\bse1101 exhibit c regional watershed map.dwg 8/16/2012 10:52 AM Kellin Collins



FLO-2D Inflow Summary Existing Condition						
HEC-1 Basin / Concentration Point ID	Q_{100} (cfs)	Q_{50} (cfs)	Q_{25} (cfs)	Q_{10} (cfs)	FLO-2D Grid Element	Floodplain (FP) and/or Channel (CH)
OF11	20	16	12	7	75117	FP
OF12	20	17	14	11	83733	FP
OF13	290	239	183	129	90245	FP
OF14	108	87	68	48	90861	FP
OF15	25	20	15	10	91157	FP
OF16	15	12	9	6	91993	FP
OF17	3	2	2	1	92529	FP
OF18	12	13	8	5	92791	FP
OF19	120	95	73	48	93802	FP
OF20	58	46	35	22	90825	FP
OF21	27	22	16	13	98138	FP
OF22	20	16	12	7	80185	FP
OF23	51	41	31	20	99415	FP
OF24	7	6	5	3	101282	FP
OF25	20	16	12	8	103703	FP
OF26	12	10	8	5	105916	FP
OF27	277	232	189	136	109754	FP
OF28	1,628	1 364	1 108	790	111370	FP
OF29	34	27	21	13	114400	FP
OF30	39	31	24	15	116420	FP
OF31	196	164	131	91	123662	FP
OF32	36	29	22	14	123884	FP
OF33	12	10	8	5	115613	FP
CP5	14 225	11,252	8 544	5,386	15389	FP

FLO-2D Floodplain Cross Section Summary Existing Condition								
Cross Section	100-Year		50-Year		25-Year		10-Year	
	Max Q (cfs)	Max Depth (ft)	Max Q (cfs)	Max Depth (ft)	Max Q (cfs)	Max Depth (ft)	Max Q (cfs)	Max Depth (ft)
CS1	654	0.4	439	0.32	278	0.28	129	0.18
CS2	8 467	2.4	5 460	2.02	3 425	1.84	1 507	1.13
CS3*	1 458	0.14	1,152	0.13	936	0.11	421	0.07
CS4	153	0.06	117	0.05	84	0.04	37	0.03
CS5	420	0.26	337	0.23	254	0.2	156	0.16
CS6	236	0.34	160	0.27	91	0.21	32	0.12
CS7*	25	0.06	18	0.05	11	0.04	5	0.03
CS8*	30	0.08	21	0.07	13	0.05	4	0.05

* [illegible]

LEGEND

- PROJECT SITE
- FLO-2D BOUNDARY (ONSITE HYDROLOGIC ANALYSIS)
- OFFSITE BASIN BOUNDARY
- FLOW DIRECTION
- FLO-2D INFLOW NODE AND FLOW DIRECTION (FROM OFFSITE HEC-1 ANALYSIS CONCENTRATION POINT)
- FLO-2D INFLOW NODE AND FLOW DIRECTION (FROM OFFSITE HEC-1 ANALYSIS BASIN)
- FLO-2D FLOODPLAIN CROSS SECTION AND FLOW DIRECTION
- 24-INCH RCP CULVERT
- DUAL 24-INCH RCP CULVERT
- 3-FT X 6-FT RCB CULVERT
- DUAL 3-FT X 6-FT RCB CULVERT

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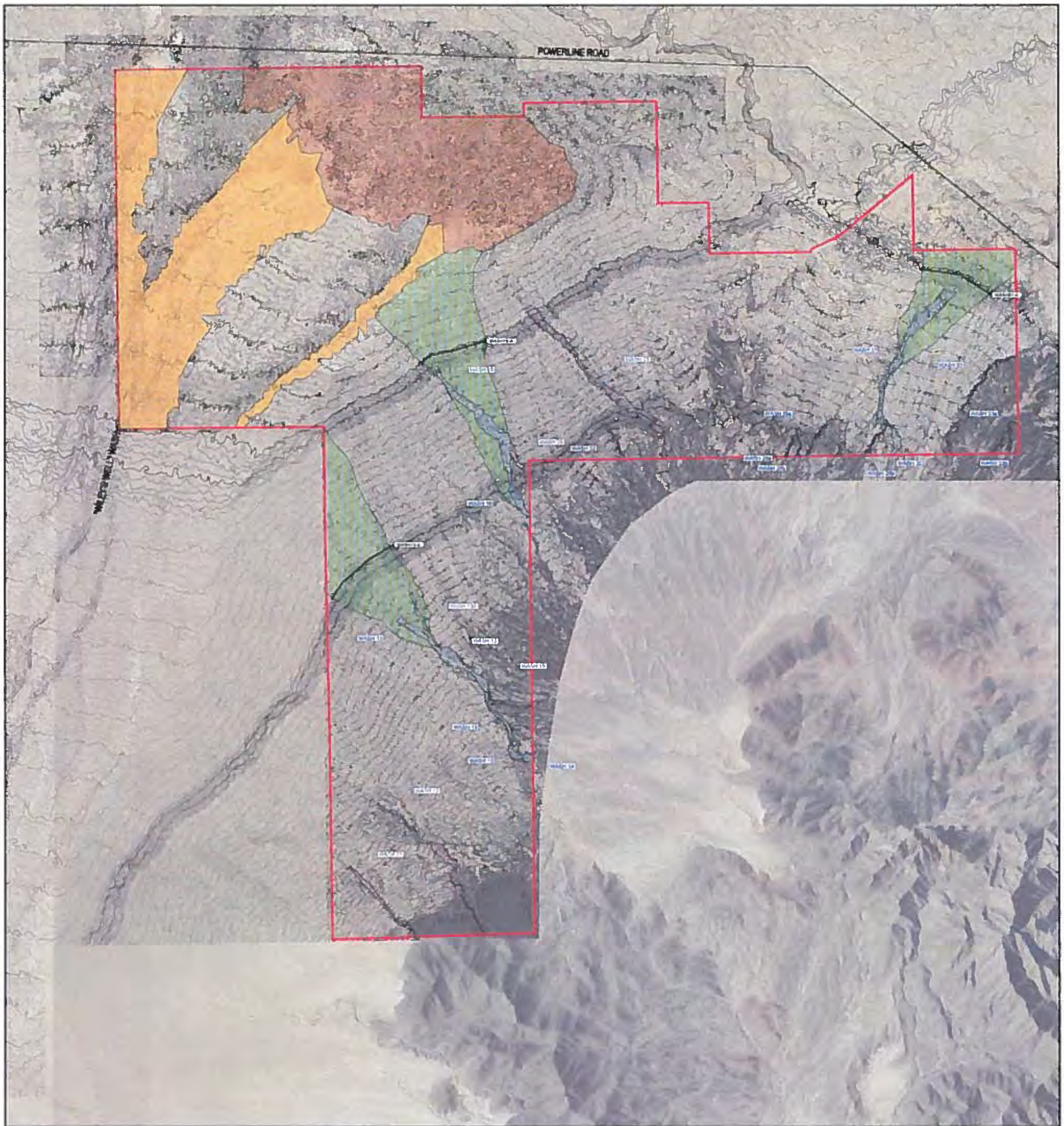
BRIGHTSOURCE ENERGY, INC.
SONORAN WEST SOLAR PROJECT
EXISTING CONDITION ONSITE DRAINAGE MAP

BSE1101.001

EXHIBIT G



Summary of Analyses Performed								
Process	Sub-Process	Method of Analysis	Wiley's Well Wash Corridor	Major Flow Corridors	Minor Flow Corridors	Alluvial Fan Areas	Physical Scour Sections	Major Deposition Area
SCOUR	General Scour	Zeller-Fullerton Method	x	x	x	x	x	x
		FEMA FAN Analysis				x		
		Physical Section Analysis					x	
		Zeller (1981) Equation		x	x			
	Local Scour	FHWA Equation		x	x			
SEDIMENT TRANSPORT	Bed Load	Zeller-Fullerton Method	x	x	x	x	x	x
	Wash Load	MUSLE Equation						x
SEDIMENTATION	Bed Load Deposition	Zeller-Fullerton Method	x	x	x	x	x	x
	Wash Load Deposition	MUSLE Equation						x

LEGEND

- PROJECT SITE
- MAJOR FLOW CORRIDOR
- MINOR FLOW CORRIDOR
- WILEY'S WELL WASH CORRIDOR
- ALLUVIAL FAN AREA
- MAJOR DEPOSITION AREA
- ID — PHYSICAL SCOUR SECTION

N

EXHIBIT A

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SONORAN WEST SOLAR PROJECT

EROSION AND SEDIMENTATION KEY MAP

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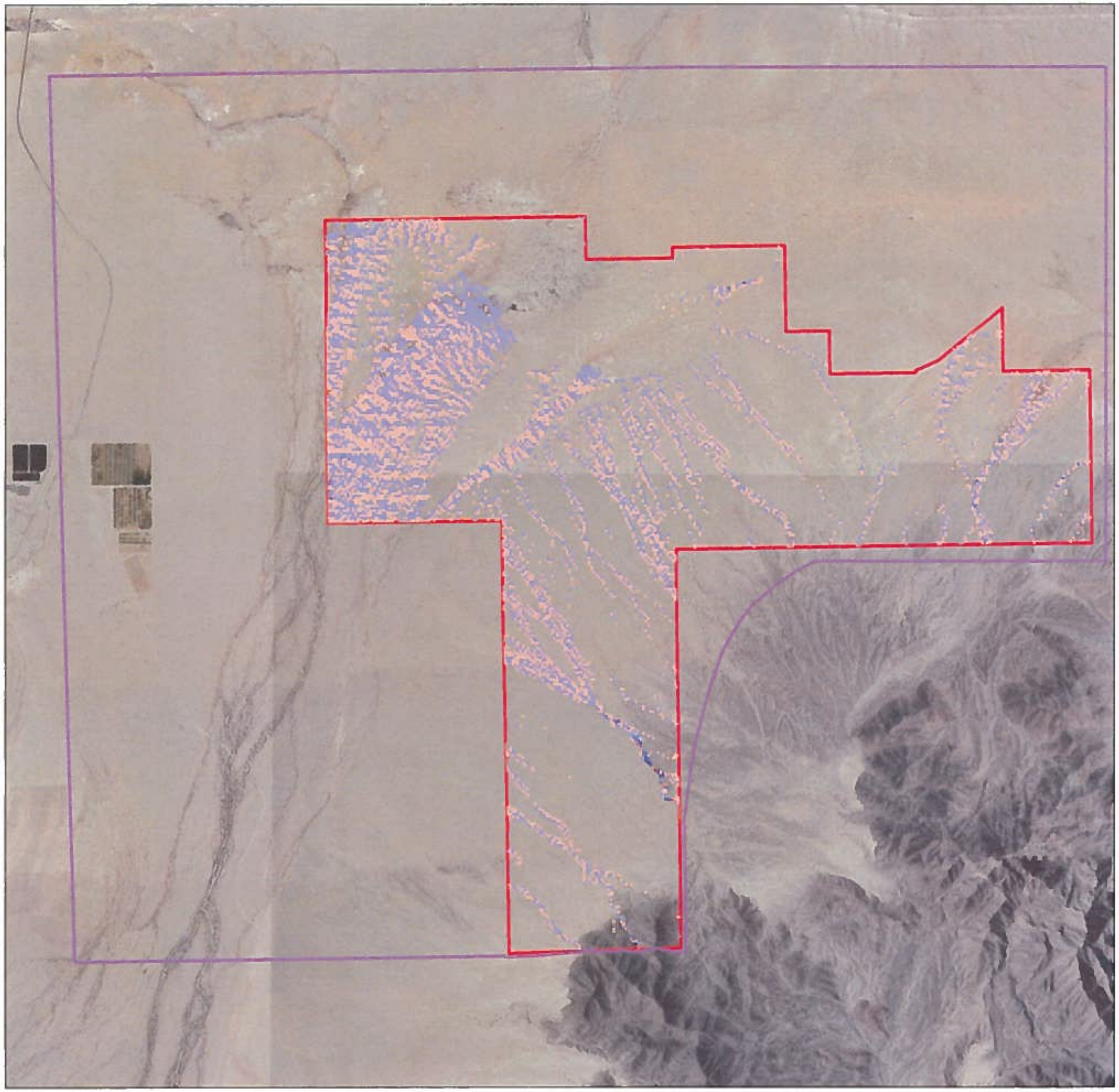
P.28 → Appendix B



0 1,000 2,000 4,000

1" = 2000'

Legend

- PROJECT SITE
- FLO-2D BOUNDARY

Deposition

Depth

- 0.01 - 0.49 FT
- 0.50 - 0.99 FT
- 1.00 - 1.99 FT
- 2.00 - 2.99 FT
- < 3.00 FT

Scour

Depth

- 0.01 - 0.49 FT
- 0.50 - 0.99 FT
- 1.00 - 1.99 FT
- 2.00 - 2.99 FT
- < 3.00 FT

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BRIGHTSOURCE ENERGY, INC.

SONORAN WEST SOLAR PROJECT

FLO-2D SCOUR AND DEPOSITION MAP(ZELLER-FULLERTON METHOD)

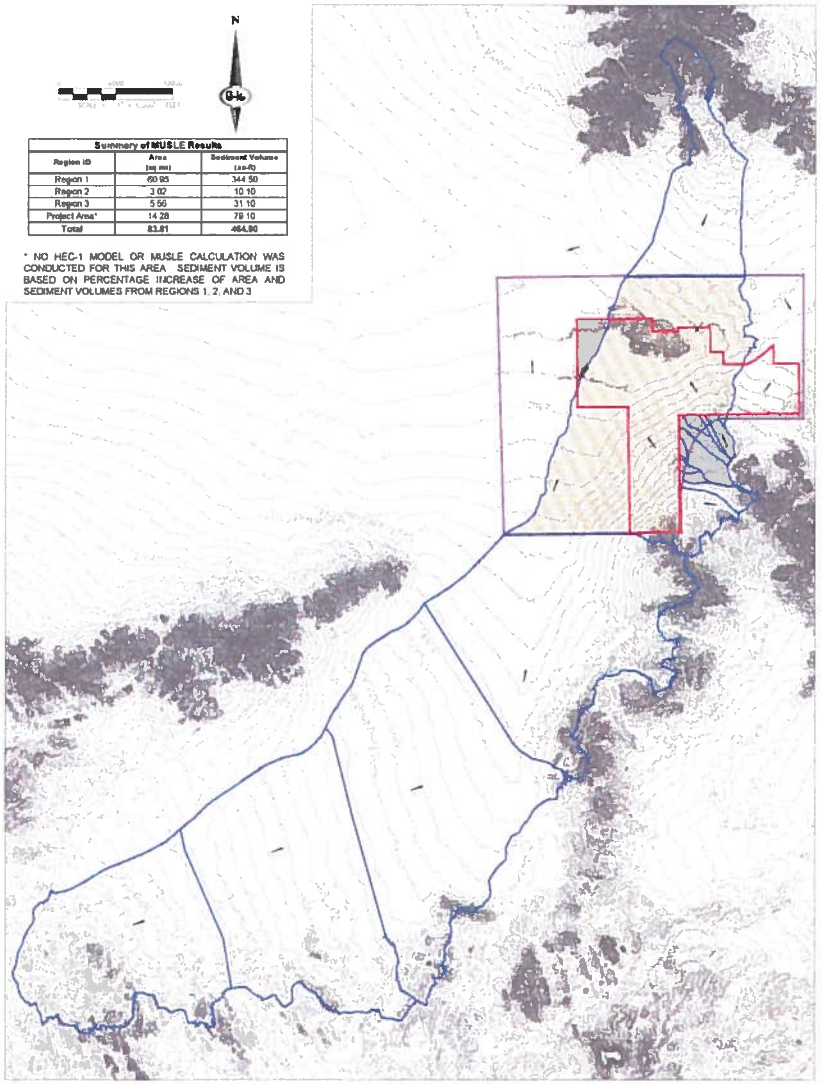
SEPT 2012

WJM

KCR

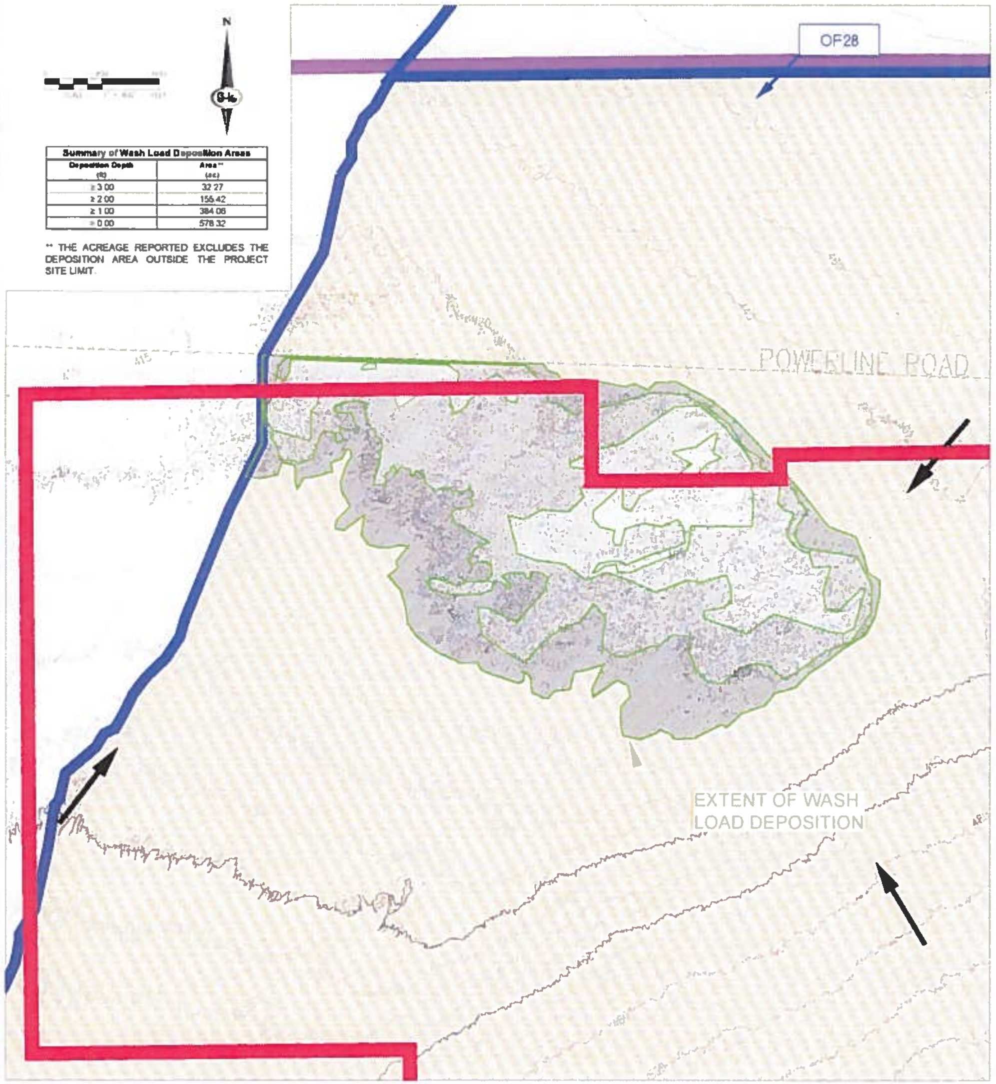
BSE1001.001

EXHIBIT C



Summary of MUSLE Results		
Region ID	Area (sq mi)	Sediment Volume (ac-ft)
Region 1	60 95	344 50
Region 2	3 02	10 10
Region 3	5 56	31 10
Project Area*	14 28	79 10
Total	83.81	464.80

* NO HEC-1 MODEL OR MUSLE CALCULATION WAS CONDUCTED FOR THIS AREA SEDIMENT VOLUME IS BASED ON PERCENTAGE INCREASE OF AREA AND SEDIMENT VOLUMES FROM REGIONS 1, 2, AND 3



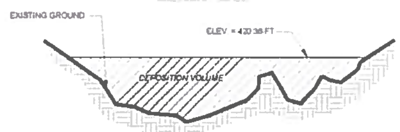
Summary of Wash Load Deposition Areas	
Deposition Depth (ft)	Area** (ac)
≥ 3 00	32 27
≥ 2 00	155.42
≥ 1 00	384 06
> 0 00	578 32

** THE ACREAGE REPORTED EXCLUDES THE DEPOSITION AREA OUTSIDE THE PROJECT SITE LIMIT.

LEGEND

PROJECT SITE
FLO-2D BOUNDARY (ONSITE HYDROLOGIC ANALYSIS)
AREA TRIBUTARY TO MAJOR DEPOSITION AREA
CONCENTRATION POINT ID (FROM MODIFIED OFFSITE HEC-1 ANALYSIS)
DRAINAGE BASIN ID (FROM MODIFIED OFFSITE HEC-1 ANALYSIS)
PROJECT AREA
REGION 1 CALCULATION AREA
REGION 2 CALCULATION AREA
REGION 3 CALCULATION AREA
FLOW DIRECTION
UP TO 1.00-FT OF DEPOSITION
1.01-FT TO 2.00-FT OF DEPOSITION
2.01-FT TO 3.00-FT OF DEPOSITION
3.01-FT TO 3.74-FT OF DEPOSITION

DEPOSITION DETAIL



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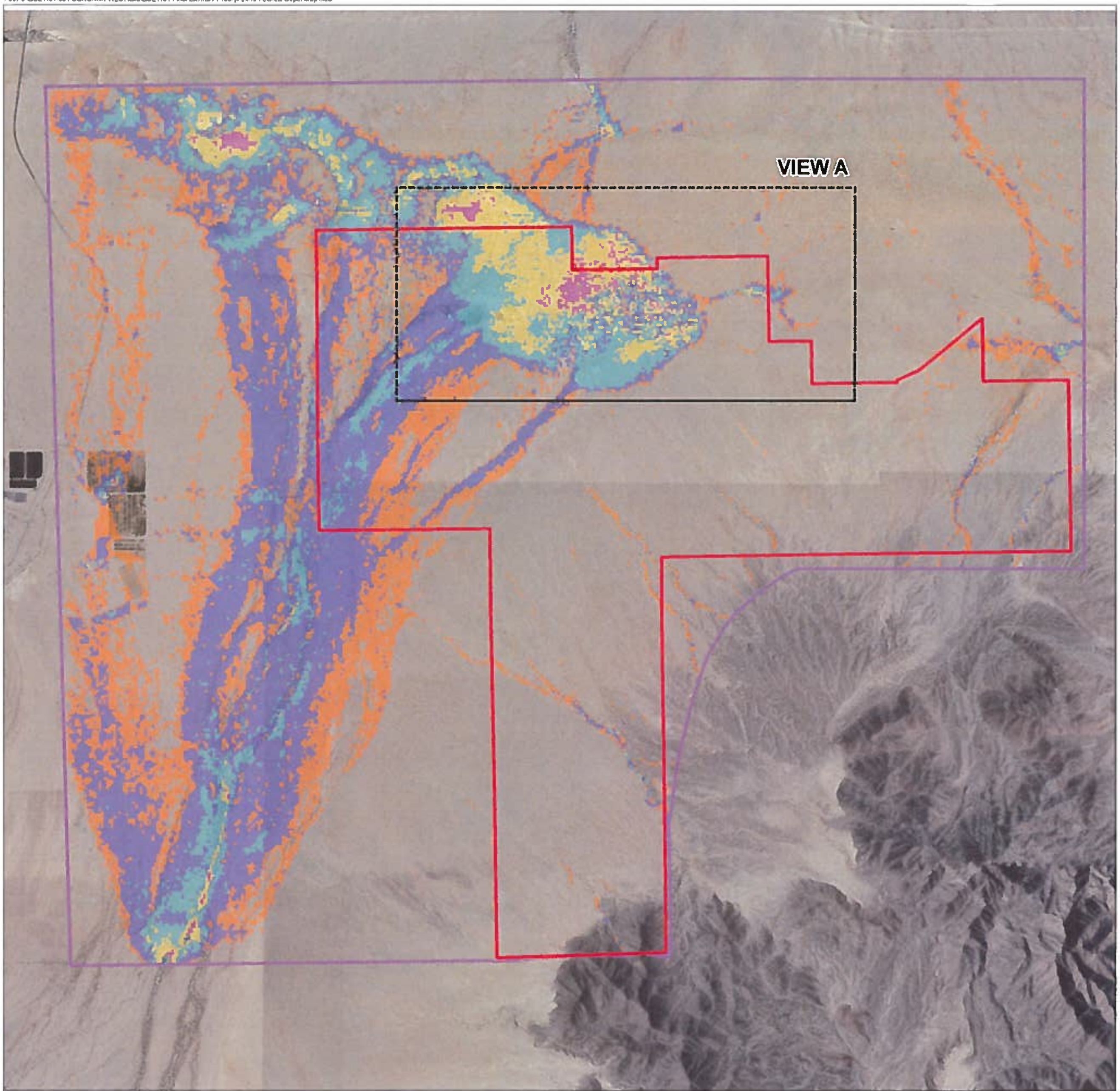
BRIGHTSOURCE ENERGY, INC.
SONORAN WEST SOLAR PROJECT
WASH LOAD DEPOSITION EXHIBIT (MUSLE)

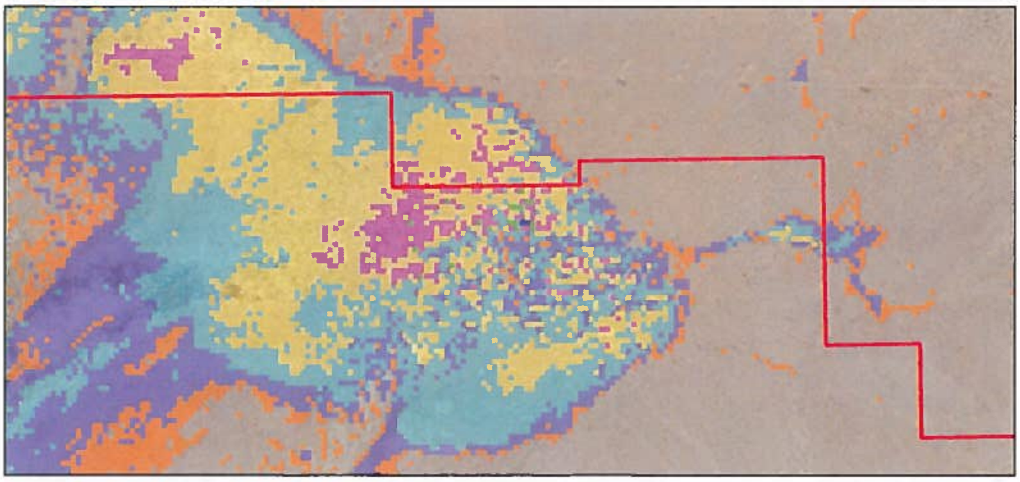
PROJECT NO. BSE1101.001

EXHIBIT E

Path: J:\BSE1101-001 SONORAN WEST\GIS\BSE1101 Final EXHIBIT 1 100-yr 24-hr FLO-2D Depth Map.mxd



VIEW A (N.T.S.)



N

Legend

- PROJECT SITE BOUNDARY
- FLO-2D BOUNDARY
- 0.51 - 1.00-FT
- 1.01 - 2.00-FT
- 2.01 - 3.00-FT
- 3.01 - 4.00-FT
- 4.01 - 5.00-FT
- 5.01 - 6.00-FT
- 6.01 - 7.00-FT
- >7.00-FT

EXHIBIT 1	BSE1101.001	MJF/KCR	KC	08/30/2012	BRIGHTSOURCE ENERGY, INC. SONORAN WEST SOLAR PROJECT 100-YR 24-HR FLO-2D DEPTH MAP

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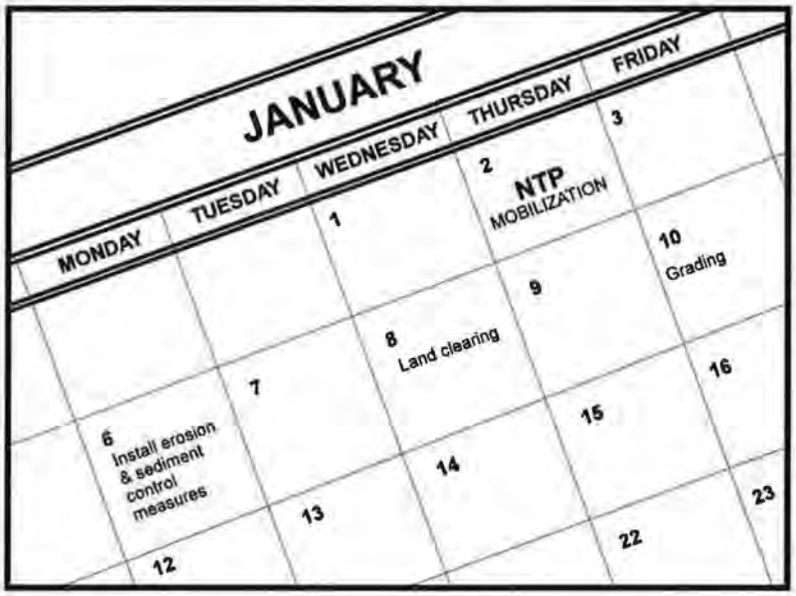
CONSULTING ENGINEERS & PLANNERS

Appendix C
CASQA BMP Handbook Fact Sheets

Scheduling EC-1



Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.

- Plan the project and develop a schedule showing each phase

Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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of construction. Clearly show how the rainy season relates to soil disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

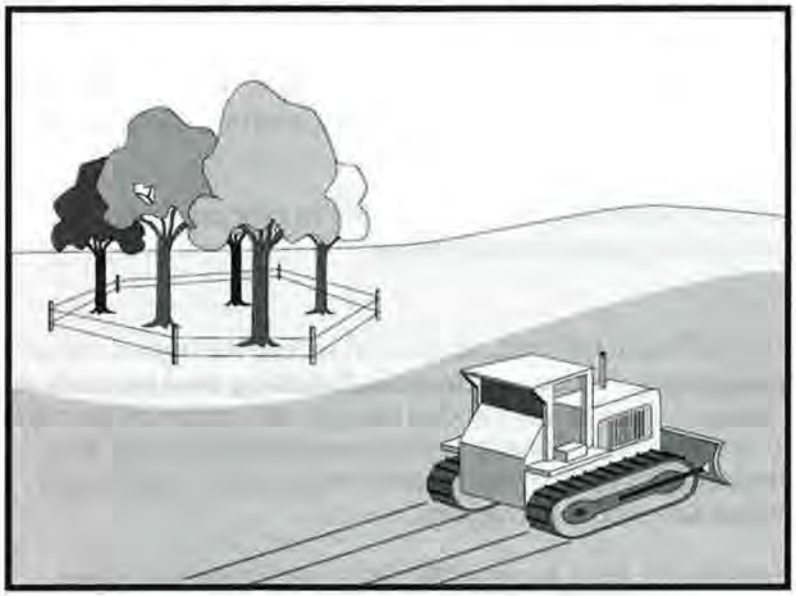
Inspection and Maintenance

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs, or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.

- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.

- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.

- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.

- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.

- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.

  - Orange colored plastic mesh fencing works well.

  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.

- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.

- Consider the impact of grade changes to existing vegetation and the root zone.

- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.

- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

Costs

There is little cost associated with preserving existing vegetation if properly planned during the project design, and these costs may be offset by aesthetic benefits that enhance property values. During construction, the cost for preserving existing vegetation will likely be less than the cost of applying erosion and sediment controls to the disturbed area. Replacing vegetation inadvertently destroyed during construction can be extremely expensive, sometimes in excess of $10,000 per tree.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar, and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization
  - Fertilize stressed or damaged broadleaf trees to aid recovery.
  - Fertilize trees in the late fall or early spring.

  - Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.

- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

References

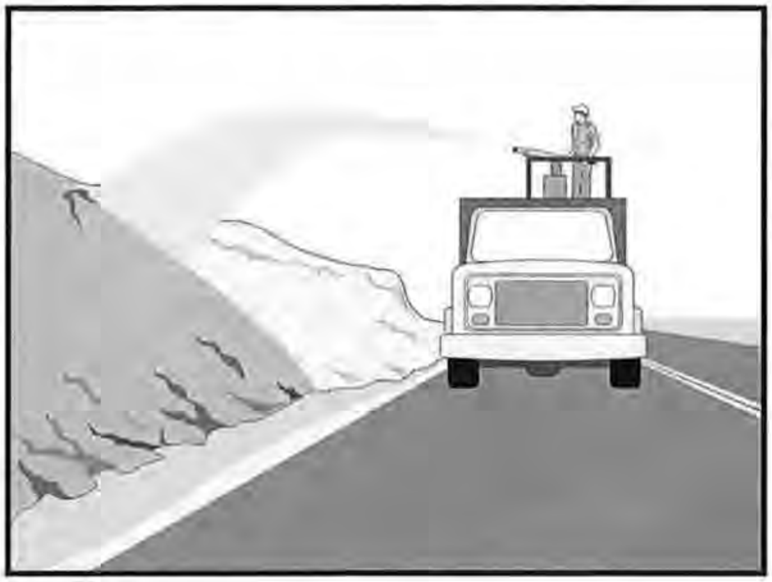
County of Sacramento Tree Preservation Ordinance, September 1981.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for The Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Hydraulic Mulch EC-3



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

EC-14 Compost Blanket

EC-16 Non-Vegetative Stabilization

Description and Purpose

Hydraulic Mulch consists of various types of fibrous materials mixed with water and sprayed onto the soil surface in slurry form to provide a layer of temporary protection from wind and water erosion.

Suitable Applications

Hydraulic mulch as a temporary, stand alone, erosion control BMP is suitable for disturbed areas that require temporary protection from wind and water erosion until permanent soil stabilization activities commence. Examples include:

- Rough-graded areas that will remain inactive for longer than permit-required thresholds (e.g., 14 days) or otherwise require stabilization to minimize erosion or prevent sediment discharges.
- Soil stockpiles.
- Slopes with exposed soil between existing vegetation such as trees or shrubs.
- Slopes planted with live, container-grown vegetation or plugs.
- Slopes burned by wildfire.

Hydraulic mulch can also be applied to augment other erosion control BMPs such as:

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- In conjunction with straw mulch (see EC-6 Straw Mulch) where the rate of hydraulic mulch is reduced to 100-500 lbs per acre and the slurry is applied over the straw as a tackifying agent to hold the straw in place.
- Supplemental application of soil amendments, such as fertilizer, lime, gypsum, soil bio-stimulants or compost.

Limitations

In general, hydraulic mulch is not limited by slope length, gradient or soil type. However, the following limitations typically apply:

- Most hydraulic mulch applications, particularly bonded fiber matrices (BFMs), require at least 24 hours to dry before rainfall occurs.
- Temporary applications (i.e., without a vegetative component) may require a second application in order to remain effective for an entire rainy season.
- Treatment areas must be accessible to hydraulic mulching equipment.
- Availability of water sources in remote areas for mixing and application.
- As a stand-alone temporary BMP, hydraulic mulches may need to be re-applied to maintain their erosion control effectiveness, typically after 6-12 months depending on the type of mulch used.
- Availability of hydraulic mulching equipment may be limited just prior to the rainy season and prior to storms due to high demand.
- Cellulose fiber mulches alone may not perform well on steep slopes or in course soils.

Implementation

- Where feasible, it is preferable to prepare soil surfaces prior to application by roughening embankments and fill areas with a crimping or punching type roller or by track walking.
- The majority of hydraulic mulch applications do not necessarily require surface/soil preparation (See EC-15 Soil Preparation) although in almost every case where re-vegetation is included as part of the practice, soil preparation can be beneficial. One of the advantages of hydraulic mulch over other erosion control methods is that it can be applied in areas where soil preparation is precluded by site conditions, such as steep slopes, rocky soils, or inaccessibility.
- Avoid mulch over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Hydraulic mulching is generally performed utilizing specialized machines that have a large water-holding/mixing tank and some form of mechanical agitation or other recirculation method to keep water, mulch and soil amendments in suspension. The mixed hydraulic slurry can be applied from a tower sprayer on top of the machine or by extending a hose to areas remote from the machine.

- Where possible apply hydraulic mulch from multiple directions to adequately cover the soil. Application from a single direction can result in shadowing, uneven coverage and failure of the BMP.
- Hydraulic mulch can also include a vegetative component, such as seed, rhizomes, or stolons (see EC-4 Hydraulic Seed).
- Typical hydraulic mulch application rates range from 2,000 pounds per acre for standard mulches (SMs) to 3,500 pounds per acre for BFMs. However, the required amount of hydraulic mulch to provide adequate coverage of exposed topsoil may appear to exceed the standard rates when the roughness of the soil surface is changed due to soil preparation methods (see EC-15 Soil Preparation) or by slope gradient.
- Other factors such as existing soil moisture and soil texture can have a profound effect on the amount of hydraulic mulch required (i.e. application rate) applied to achieve an erosion-resistant covering.
- Avoid use of mulch without a tackifier component, especially on slopes.
- Mulches used in the hydraulic mulch slurry can include:
  - Cellulose fiber
  - Thermally-processed wood fibers
  - Cotton
  - Synthetics
  - Compost (see EC-14, Compost Blanket)
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Categories of Hydraulic Mulches

Standard Hydraulic Mulch (SM)

Standard hydraulic mulches are generally applied at a rate of 2,000 pounds per acre and are manufactured containing around 5% tackifier (i.e. soil binder), usually a plant-derived guar or psyllium type. Most standard mulches are green in color derived from food-color based dyes.

Hydraulic Matrices (HM) and Stabilized Fiber Matrices (SFM)

Hydraulic matrices and stabilized fiber matrices are slurries which contain increased levels of tackifiers/soil binders; usually 10% or more by weight. HMs and SFMs have improved performance compared to a standard hydraulic mulch (SM) because of the additional percentage of tackifier and because of their higher application rates, typically 2,500 – 4,000 pounds per acre. Hydraulic matrices can include a mixture of fibers, for example, a 50/50 blend of paper and wood fiber. In the case of an SFM, the tackifier/soil binder is specified as a polyacrylamide (PAM).

Bonded Fiber Matrix (BFM)

Bonded fiber matrices (BFMs) are hydraulically-applied systems of fibers, adhesives (typically guar based) and chemical cross-links. Upon drying, the slurry forms an erosion-resistant blanket that prevents soil erosion and promotes vegetation establishment. The cross-linked adhesive in the BFM should be biodegradable and should not dissolve or disperse upon re-wetting. BFMs are typically applied at rates from 3,000 to 4,000 lbs/acre based on the manufacturer's recommendation. BFMs should not be applied immediately before, during or immediately after rainfall or if the soil is saturated. Depending on the product, BFMs typically require 12 to 24 hours to dry and become effective.

Mechanically-Bonded Fiber Matrices (MBFM)

Mechanically-bonded fiber matrices (MBFMs) are hydraulically applied systems similar to BFM that use crimped synthetic fibers and PAM and are typically applied to a slope at a higher application rate than a standard BFM.

Hydraulic Compost Matrix (HCM)

Hydraulic compost matrix (HCM) is a field-derived practice whereby finely graded or sifted compost is introduced into the hydraulic mulch slurry. A guar-type tackifier can be added for steeper slope applications as well as any specified seed mixtures. A HCM can help to accelerate seed germination and growth. HCMs are particularly useful as an in-fill for three-dimensional re-vegetation geocompo sites, such as turf reinforcement mats (TRM) (see EC-7 Geotextiles and Mats).

Costs

Average installed costs for hydraulic mulch categories are is provided in Table 1, below.

Table 1
HYDRAULIC MULCH BMPs
INSTALLED COSTS

BMP	Installed Cost/Acre
Standard Hydraulic Mulching (SM)	\$1,700 - \$3,600 per acre
Hydraulic Matrices (HM) and Stabilized Fiber Matrices	
Guar-based	\$2,000 - \$4,000 per acre
PAM-based	\$2,500 - \$5,610 per acre
Bonded Fiber Matrix (BFM)	\$3,900 - \$6,900 per acre
Mechanically Bonded Fiber Matrix (MBFM)	\$4,500 - \$6,000 per acre
Hydraulic Compost Matrix (HCM)	\$3,000 - \$3,500 per acre

Source: Caltrans Soil Stabilization BMP Research for Erosion and Sediment Controls, July 2007

Inspection and Maintenance

- Maintain an unbroken, temporary mulched ground cover throughout the period of construction when the soils are not being reworked.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected

weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Compare the number of bags or weight of applied mulch to the area treated to determine actual application rates and compliance with specifications.

References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Controlling Erosion of Construction Sites, Agricultural Information #347, U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service – SCS).

Guides for Erosion and Sediment Control in California, USDA Soils Conservation Service, January 1991.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Soil Erosion by Water, Agriculture Information Bulletin #513, U.S. Department of Agriculture, Soil Conservation Service.

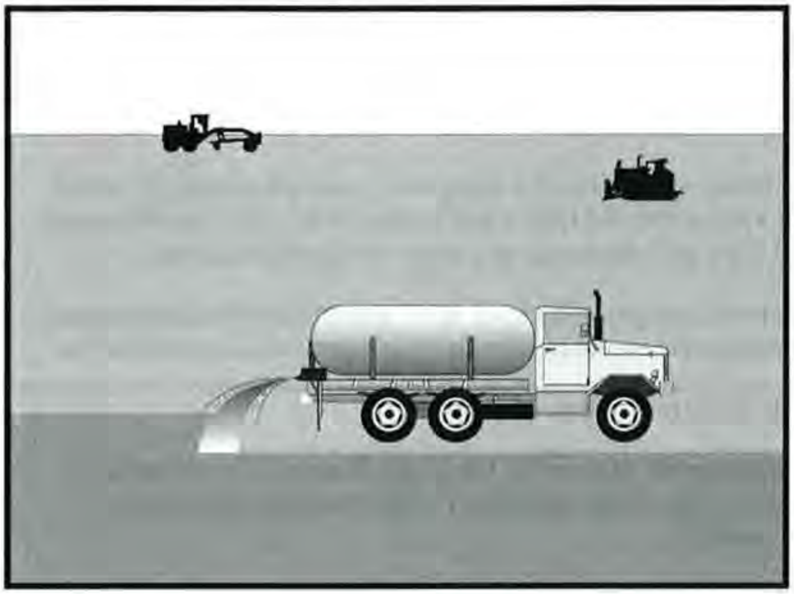
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Soil Binders — EC-5



Categories

EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

Description and Purpose

Soil binding consists of application and maintenance of a soil stabilizer to exposed soil surfaces. Soil binders are materials applied to the soil surface to temporarily prevent water and wind induced erosion of exposed soils on construction sites.

Suitable Applications

Soil binders are typically applied to disturbed areas requiring temporary protection. Because soil binders, when used as a stand-alone practice, can often be incorporated into the soil, they are a good alternative to mulches in areas where grading activities will soon resume. Soil binders are commonly used in the following areas:

- Rough graded soils that will be inactive for a short period of time
- Soil stockpiles
- Temporary haul roads prior to placement of crushed rock
- Compacted soil road base
- Construction staging, materials storage, and layout areas

Limitations

- Soil binders are temporary in nature and may need reapplication.

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- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer. Soil binders may need reapplication after a storm event.

- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.

- Plant-material-based soil binders do not generally hold up to pedestrian or vehicular traffic across treated areas as well as polymeric emulsion blends or cementitious-based binders.

- Soil binders may not sufficiently penetrate compacted soils.

- Some soil binders are soil texture specific in terms of their effectiveness. For example, polyacrylamides (PAMs) work very well on silt and clayey soils but their performance decreases dramatically in sandy soils.

- Some soil binders may not perform well with low relative humidity. Under rainy conditions, some agents may become slippery or leach out of the soil.

- Soil binders may not cure if low temperatures occur within 24 hours of application.

- The water quality impacts of some chemical soil binders are relatively unknown and some may have water quality impacts due to their chemical makeup.

Implementation

General Considerations

- Soil binders should conform to local municipality specifications and requirements.

- Site soil types will dictate appropriate soil binders to be used.

- A soil binder must be environmentally benign (non-toxic to plant and animal life), easy to apply, easy to maintain, economical, and should not stain paved or painted surfaces. Soil binders should not pollute stormwater when cured. Obtain a Material Safety Data Sheet (MSDS) from the manufacturer to ensure non-toxicity.

- Stormwater runoff from PAM treated soils should pass through one of the following sediment control BMP prior to discharging to surface waters.

  - When the total drainage area is greater than or equal to 5 acres, PAM treated areas should drain to a sediment basin.

  - Areas less than 5 acres should drain to sediment control BMPs, such as a sediment trap, or a series of check dams. The total number of check dams used should be maximized to achieve the greatest amount of settlement of sediment prior to discharging from the site. Each check dam should be spaced evenly in the drainage channel through which stormwater flows are discharged off site.

- Performance of soil binders depends on temperature, humidity, and traffic across treated areas.

- Avoid over spray onto roads, sidewalks, drainage channels, existing vegetation, etc.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Selecting a Soil Binder

Properties of common soil binders used for erosion control are provided on Table 1 at the end of this Fact Sheet. Use Table 1 to select an appropriate soil binder. Refer to WE-1, Wind Erosion Control, for dust control soil binders.

Factors to consider when selecting a soil binder include the following:

- Suitability to situation - Consider where the soil binder will be applied, if it needs a high resistance to leaching or abrasion, and whether it needs to be compatible with any existing vegetation. Determine the length of time soil stabilization will be needed, and if the soil binder will be placed in an area where it will degrade rapidly. In general, slope steepness is not a discriminating factor for the listed soil binders.
- Soil types and surface materials - Fines and moisture content are key properties of surface materials. Consider a soil binder's ability to penetrate, likelihood of leaching, and ability to form a surface crust on the surface materials.
- Frequency of application - The frequency of application is related to the functional longevity of the binder, which can be affected by subgrade conditions, surface type, climate, and maintenance schedule.
- Frequent applications could lead to high costs. Application frequency may be minimized if the soil binder has good penetration, low evaporation, and good longevity. Consider also that frequent application will require frequent equipment clean up.

Plant-Material-Based (Short Lived, <6 months) Binders

Guar: Guar is a non-toxic, biodegradable, natural galactomannan-based hydrocolloid treated with dispersant agents for easy field mixing. It should be mixed with water at the rate of 11 to 15 lb per 1,000 gallons. Recommended minimum application rates are as follows:

Application Rates for Guar Soil Stabilizer

Slope (H:V):	Flat	4:1	3:1	2:1	1:1
lb/acre:	40	45	50	60	70

Psyllium: Psyllium is composed of the finely ground muciloid coating of plantago seeds that is applied as a dry powder or in a wet slurry to the surface of the soil. It dries to form a firm but rewettable membrane that binds soil particles together, but permits germination and growth of seed. Psyllium requires 12 to 18 hours drying time. Application rates should be from 80 to 200 lb/acre, with enough water in solution to allow for a uniform slurry flow.

Starch: Starch is non-ionic, cold water soluble (pre-gelatinized) granular cornstarch. The material is mixed with water and applied at the rate of 150 lb/acre. Approximate drying time is 9 to 12 hours.

Plant-Material-Based (Long Lived, 6-12 months) Binders

Pitch and Rosin Emulsion: Generally, a non-ionic pitch and rosin emulsion has a minimum solids content of 48%. The rosin should be a minimum of 26% of the total solids content. The soil stabilizer should be non-corrosive, water dilutable emulsion that upon application cures to a water insoluble binding and cementing agent. For soil erosion control applications, the emulsion is diluted and should be applied as follows:

- For clayey soil: 5 parts water to 1 part emulsion
- For sandy soil: 10 parts water to 1 part emulsion

Application can be by water truck or hydraulic seeder with the emulsion and product mixture applied at the rate specified by the manufacturer.

Polymeric Emulsion Blend Binders

Acrylic Copolymers and Polymers: Polymeric soil stabilizers should consist of a liquid or solid polymer or copolymer with an acrylic base that contains a minimum of 55% solids. The polymeric compound should be handled and mixed in a manner that will not cause foaming or should contain an anti-foaming agent. The polymeric emulsion should not exceed its shelf life or expiration date; manufacturers should provide the expiration date. Polymeric soil stabilizer should be readily miscible in water, non-injurious to seed or animal life, non-flammable, should provide surface soil stabilization for various soil types without totally inhibiting water infiltration, and should not re-emulsify when cured. The applied compound typically requires 12 to 24 hours drying time. Liquid copolymer should be diluted at a rate of 10 parts water to 1 part polymer and the mixture applied to soil at a rate of 1,175 gallons/acre.

Liquid Polymers of Methacrylates and Acrylates: This material consists of a tackifier/sealer that is a liquid polymer of methacrylates and acrylates. It is an aqueous 100% acrylic emulsion blend of 40% solids by volume that is free from styrene, acetate, vinyl, ethoxylated surfactants or silicates. For soil stabilization applications, it is diluted with water in accordance with the manufacturer's recommendations, and applied with a hydraulic seeder at the rate of 20 gallons/acre. Drying time is 12 to 18 hours after application.

Copolymers of Sodium Acrylates and Acrylamides: These materials are non-toxic, dry powders that are copolymers of sodium acrylate and acrylamide. They are mixed with water and applied to the soil surface for erosion control at rates that are determined by slope gradient:

Slope Gradient (H:V)	lb/acre
Flat to 5:1	3.0 – 5.0
5:1 to 3:1	5.0 – 10.0
2:1 to 1:1	10.0 – 20.0

Poly-Acrylamide (PAM) and Copolymer of Acrylamide: Linear copolymer polyacrylamide for use as a soil binder is packaged as a dry flowable solid, as a liquid. Refer to the manufacturer's recommendation for dilution and application rates as they vary based on liquid or dry form, site conditions and climate.

- Limitations specific to PAM are as follows:

- Do not use PAM on a slope that flows into a water body without passing through a sediment trap or sediment basin.

- The specific PAM copolymer formulation must be anionic. Cationic PAM should not be used in any application because of known aquatic toxicity problems. Only the highest drinking water grade PAM, certified for compliance with ANSI/NSF Standard 60 for drinking water treatment, should be used for soil applications.

- PAM designated for erosion and sediment control should be "water soluble" or "linear" or "non-cross linked".

- PAM should not be used as a stand-alone BMP to protect against water-based erosion. When combined with mulch, its effectiveness increases dramatically.

Hydro-Colloid Polymers: Hydro-Colloid Polymers are various combinations of dry flowable poly-acrylamides, copolymers and hydro-colloid polymers that are mixed with water and applied to the soil surface at rates of 55 to 60 lb/acre. Drying times are 0 to 4 hours.

Cementitious-Based Binders

Gypsum: This is a formulated gypsum based product that readily mixes with water and mulch to form a thin protective crust on the soil surface. It is composed of high purity gypsum that is ground, calcined and processed into calcium sulfate hemihydrate with a minimum purity of 86%. It is mixed in a hydraulic seeder and applied at rates 4,000 to 12,000 lb/acre. Drying time is 4 to 8 hours.

Applying Soil Binders

After selecting an appropriate soil binder, the untreated soil surface must be prepared before applying the soil binder. The untreated soil surface must contain sufficient moisture to assist the agent in achieving uniform distribution. In general, the following steps should be followed:

- Follow manufacturer's written recommendations for application rates, pre-wetting of application area, and cleaning of equipment after use.

- Prior to application, roughen embankment and fill areas.

- Consider the drying time for the selected soil binder and apply with sufficient time before anticipated rainfall. Soil binders should not be applied during or immediately before rainfall.

- Avoid over spray onto roads, sidewalks, drainage channels, sound walls, existing vegetation, etc.

- Soil binders should not be applied to frozen soil, areas with standing water, under freezing or rainy conditions, or when the temperature is below 40°F during the curing period.

- More than one treatment is often necessary, although the second treatment may be diluted or have a lower application rate.

- Generally, soil binders require a minimum curing time of 24 hours before they are fully effective. Refer to manufacturer's instructions for specific cure time.

- For liquid agents:
  - Crown or slope ground to avoid ponding.
  - Uniformly pre-wet ground at 0.03 to 0.3 gal/yd² or according to manufacturer's recommendations.
  - Apply solution under pressure. Overlap solution 6 to 12 in.
  - Allow treated area to cure for the time recommended by the manufacturer; typically at least 24 hours.
  - Apply second treatment before first treatment becomes ineffective, using 50% application rate.
  - In low humidities, reactivate chemicals by re-wetting with water at 0.1 to 0.2 gal/yd².

Costs

Costs vary according to the soil stabilizer selected for implementation. The following are approximate installed costs:

Soil Binder	Cost per Acre (2000)[1]	Estimated Cost per Acre (2009)[2]
Plant-Material-Based (Short Lived) Binders	\$700-\$900	\$770-\$990
Plant-Material-Based (Long Lived) Binders	\$1,200-\$1,500	\$1,320-\$1,650
Polymeric Emulsion Blend Binders	\$700 -\$1,500	\$770-\$1,650
Cementitious-Based Binders	\$800-\$1,200	\$880-\$1,350

1. Source: Erosion Control Pilot Study Report, Caltrans, June 2000.

2. 2009 costs reflect a 10% escalation over year 2000 costs. Escalation based on informal survey of industry trends. Note: Expected cost increase is offset by competitive economic conditions.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Areas where erosion is evident should be repaired and BMPs re-applied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require re-application of BMPs.
- Reapply the selected soil binder as needed to maintain effectiveness.

Table 1 Properties of Soil Binders for Erosion Control

Evaluation Criteria	Binder Type			
	Plant Material Based (Short Lived)	**Plant Material Based (Long Lived)**	**Polymeric Emulsion Blends**	**Cementitious-Based Binders**
Relative Cost	Low	Moderate to High	Low to High	Low to Moderate
Resistance to Leaching	High	High	Low to Moderate	Moderate
Resistance to Abrasion	Moderate	Low	Moderate to High	Moderate to High
Longevity	Short to Medium	Medium	Medium to Long	Medium
Minimum Curing Time before Rain	9 to 18 hours	19 to 24 hours	0 to 24 hours	4 to 8 hours
Compatibility with Existing Vegetation	Good	Poor	Poor	Poor
Mode of Degradation	Biodegradable	Biodegradable	Photodegradable/ Chemically Degradable	Photodegradable/ Chemically Degradable
Labor Intensive	No	No	No	No
Specialized Application Equipment	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher	Water Truck or Hydraulic Mulcher
Liquid/Powder	Powder	Liquid	Liquid/Powder	Powder
Surface Crusting	Yes, but dissolves on rewetting	Yes	Yes, but dissolves on rewetting	Yes
Clean Up	Water	Water	Water	Water
Erosion Control Application Rate	Varies (1)	Varies (1)	Varies (1)	4,000 to 12,000 lbs/acre

(1) See Implementation for specific rates.

References

Erosion Control Pilot Study Report, State of California Department of Transportation (Caltrans), June 2000.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

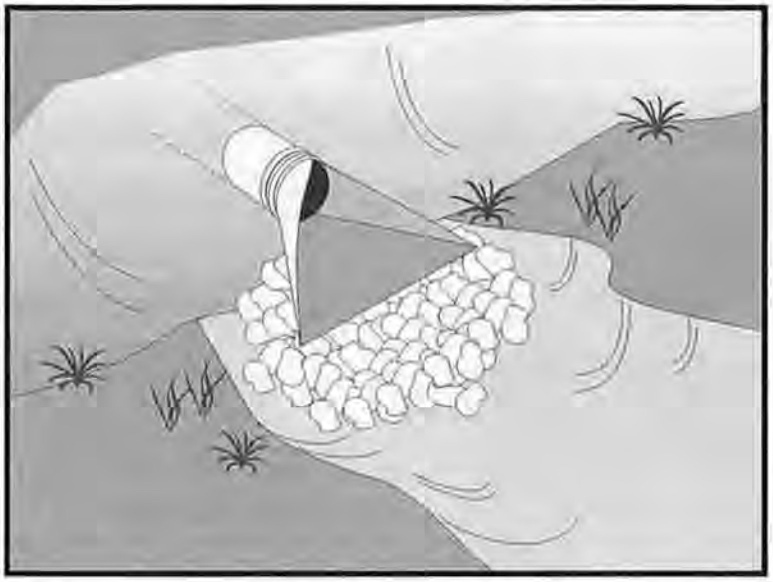
Sedimentation and Erosion Control, An Inventory of Current Practices Draft, US EPA, April 1990.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Velocity Dissipation Devices EC-10



Categories		
EC	Erosion Control	☑
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.

- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in velocity dissipation devices.

Implementation

General

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 5 year flow for temporary structures planned for one rainy season, or the 10 year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.

- Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
- Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.
- Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.
- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur. Minimize areas of standing water by removing sediment blockages and filling scour depressions.
- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.
- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.
- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

County of Sacramento Improvement Standards, Sacramento County, May 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

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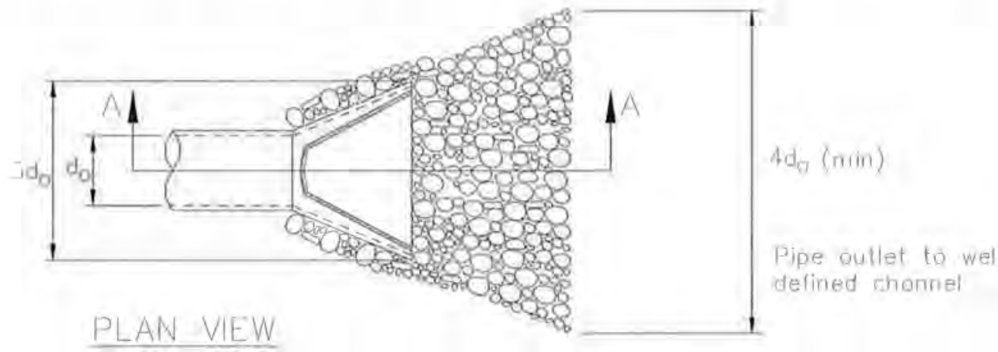
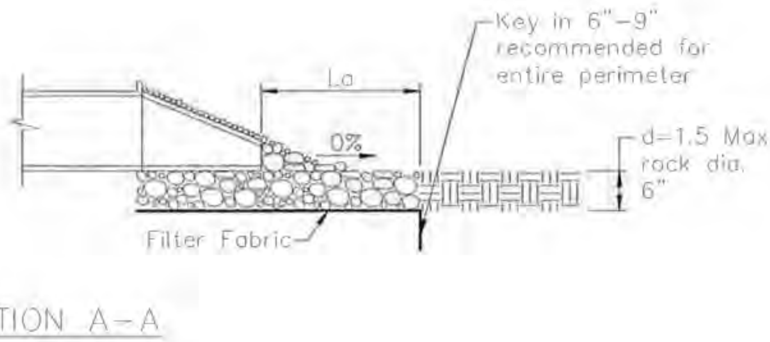
Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.





Pipe Diameter inches	Discharge ft^3/s	Apron Length, La ft	Rip Rap D_{50} Diameter Min inches
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Registered Civil Engineer
Source: USDA - SCS

Soil Preparation/Roughening EC-15

Categories

EC	Erosion Control	☑
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-7 Geotextiles and Mats

Description and Purpose

Soil Preparation/Roughening involves assessment and preparation of surface soils for BMP installation. This can include soil testing (for seed base, soil characteristics, or nutrients), as well as roughening surface soils by mechanical methods (including sheepsfoot rolling, track walking, scarifying, stair stepping, and imprinting) to prepare soil for additional BMPs, or to break up sheet flow. Soil Preparation can also involve tilling topsoil to prepare a seed bed and/or incorporation of soil amendments, to enhance vegetative establishment.

Suitable Applications

Soil preparation: Soil preparation is essential to proper vegetative establishment. In particular, soil preparation (i.e. tilling, raking, and amendment) is suitable for use in combination with any soil stabilization method, including RECPs or sod. Soil preparation should not be confused with roughening.

Roughening: Soil roughening is generally referred to as track walking (sometimes called imprinting) a slope, where treads from heavy equipment run parallel to the contours of the slope and act as mini terraces. Soil preparation is most effective when used in combination with erosion controls. Soil Roughening is suitable for use as a complementary process for controlling erosion on a site. Roughening is not intended to be used as a stand-alone BMP, and should be used with perimeter controls, additional erosion control measures, grade breaks, and vegetative establishment for maximum effectiveness. Roughening is intended to only affect surface soils and should not compromise slope stability or overall compaction. Suitable applications for soil roughening include:

- Along any disturbed slopes, including temporary stockpiles, sediment basins, or compacted soil diversion berms and swales.
- Roughening should be used in combination with hydraulically applied stabilization methods, compost blanket, or straw mulch; but should not be used in combination with RECPs or sod because roughening is intended to leave terraces on the slope.

Limitations

- Preparation and roughening must take place prior to installing other erosion controls (such as hydraulically applied stabilizers) or sediment controls (such as fiber rolls) on the faces of slopes.
- In such cases where slope preparation is minimal, erosion control/revegetation BMPs that do not require extensive soil preparation - such as hydraulic mulching and seeding applications - should be employed.
- Consideration should be given to the type of erosion control BMP that follows surface preparation, as some BMPs are not designed to be installed over various types of tillage/roughening, i.e., RECPs (erosion control blankets) should not be used with soil roughening due to a "bridging" effect, which suspends the blanket above the seed bed.
- Surface roughness has an effect on the amount of mulch material that needs to be applied, which shows up as a general increase in mulch material due to an increase in surface area (Topographic Index -see EC-3 Hydraulic Mulching).

Implementation

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

General

A roughened surface can significantly reduce erosion. Based on tests done at the San Diego State Erosion Research Laboratory, various roughening techniques on slopes can result in a 12 - 76% reduction in the erosion rate versus smooth slopes.

Materials

Minimal materials are required unless amendments and/or seed are added to the soil. The majority of soil roughening/preparation can be done with equipment that is on hand at a normal construction site, such as bull dozers and compaction equipment.

Installation Guidelines

Soil Preparation

- Where appropriate or feasible, soil should be prepared to receive the seed by disking or otherwise scarifying the surface to eliminate crust, improve air and water infiltration and create a more favorable environment for germination and growth.
- Based upon soil testing conducted, apply additional soil amendments (e.g. fertilizers, additional seed) to the soil to help with germination. Follow EC-4, Hydroseeding, when selecting and applying seed and fertilizers.

Cut Slope Roughening:

- Stair-step grade or groove the cut slopes that are steeper than 3:1.
- Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.
- Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
- Do not make individual vertical cuts more than 2 feet (0.6 m) high in soft materials or more than 3 feet (0.9 m) high in rocky materials.
- Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening:

- Place on fill slopes with a gradient steeper than 3:1 in lifts not to exceed 8 inches (0.2 m), and make sure each lift is properly compacted.
- Ensure that the face of the slope consists of loose, uncompacted fill 4-6 inches (0.1-0.2 m) deep.
- Use grooving or tracking to roughen the face of the slopes, if necessary.
- Do not blade or scrape the final slope face.

Roughening for Slopes to be Mowed:

- Slopes which require mowing activities should not be steeper than 3:1.
- Roughen these areas to shallow grooves by track walking, scarifying, sheepsfoot rolling, or imprinting.
- Make grooves close together (less than 10 inches), and not less than 1 inch deep, and perpendicular to the direction of runoff (i.e., parallel to the slope contours).
- Excessive roughness is undesirable where mowing is planned.

Roughening With Tracked Machinery:

- Limit roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.
- Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.
- Seed and mulch roughened areas as soon as possible to obtain optimum seed germination and growth.

Costs

Costs are based on the additional labor of tracking or preparation of the slope plus the cost of any required soil amendment materials.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Check the seeded slopes for signs of erosion such as rills and gullies. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

- Inspect BMPs weekly during normal operations, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

References

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Categories

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WE	Wind Erosion Control	
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Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-stormwater discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.
- Direct construction water runoff to areas where it can soak

into the ground or be collected and reused.

- Authorized non-stormwater discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Costs

The cost is small to none compared to the benefits of conserving water.

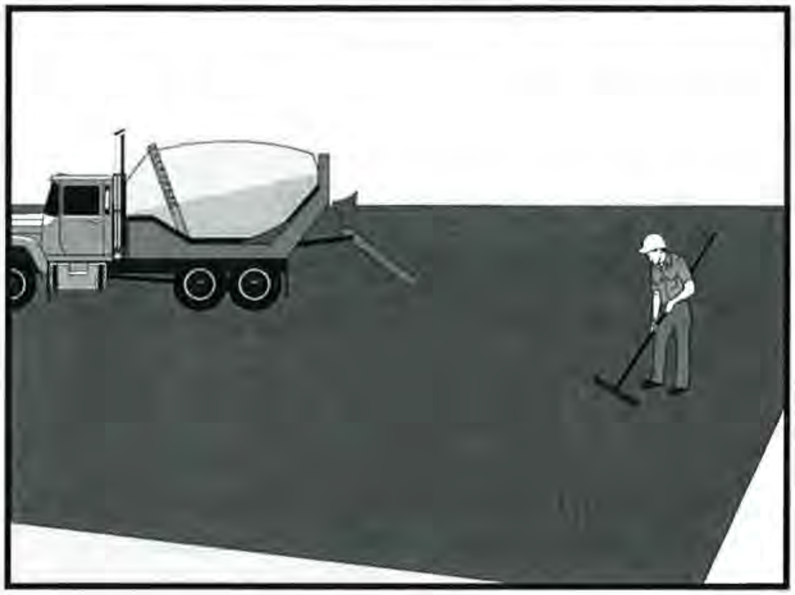
Inspection and Maintenance

- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-stormwater discharges.
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges are occuring.
- Repair water equipment as needed to prevent unintended discharges.
  - Water trucks
  - Water reservoirs (water buffalos)
  - Irrigation systems
  - Hydrant connections

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Paving and Grinding Operations NS-3



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☒

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH and turbidity (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials associated with paving and grinding operations, including mortar, concrete, and cement and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute stormwater runoff or discharge to the storm drain system or watercourses.

Limitations

- Paving opportunities may be limited during wet weather.
- Discharges of freshly paved surfaces may raise pH to environmentally harmful levels and trigger permit violations.

Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is forecasted.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent stormwater runon (see WM-1, Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or to trap and filter sediment.
- Stockpile material removed from roadways away from drain inlets, drainage ditches, and watercourses. These materials should be stored consistent with WM-3, Stockpile Management.
- Disposal of PCC (Portland cement concrete) and AC (asphalt concrete) waste should be in conformance with WM-8, Concrete Waste Management.

Saw Cutting, Grinding, and Pavement Removal

- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- When paving involves AC, the following steps should be implemented to prevent the discharge of grinding residue, uncompacted or loose AC, tack coats, equipment cleaners, or unrelated paving materials:
  - AC grindings, pieces, or chunks used in embankments or shoulder backing should not be allowed to enter any storm drains or watercourses. Install inlet protection and perimeter controls until area is stabilized (i.e. cutting, grinding or other removal activities are complete and loose material has been properly removed and disposed of)or permanent controls are in place. Examples of temporary perimeter controls can be found in EC-9, Earth Dikes and Drainage Swales; SE-1, Silt Fence; SE-5, Fiber Rolls, or SE-13 Compost Socks and Berms
  - Collect and remove all broken asphalt and recycle when practical. Old or spilled asphalt should be recycled or disposed of properly.
- Do not allow saw-cut slurry to enter storm drains or watercourses. Residue from grinding operations should be picked up by a vacuum attachment to the grinding machine, or by sweeping, should not be allowed to flow across the pavement, and should not be left on the surface of the pavement. See also WM-8, Concrete Waste Management, and WM-10, Liquid Waste Management.
- Pavement removal activities should not be conducted in the rain.
- Collect removed pavement material by mechanical or manual methods. This material may be recycled for use as shoulder backing or base material.

- If removed pavement material cannot be recycled, transport the material back to an approved storage site.

Asphaltic Concrete Paving

- If paving involves asphaltic cement concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Vacuum or sweep loose sand and gravel and properly dispose of this waste by referring to WM-5, Solid Waste Management.
  - Old asphalt should be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.

Portland Cement Concrete Paving

- Do not wash sweepings from exposed aggregate concrete into a storm drain system. Collect waste materials by dry methods, such as sweeping or shoveling, and return to aggregate base stockpile or dispose of properly. Allow aggregate rinse to settle. Then, either allow rinse water to dry in a temporary pit as described in WM-8, Concrete Waste Management, or pump the water to the sanitary sewer if authorized by the local wastewater authority.

Sealing Operations

- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate should not be allowed to enter any storm drain or water courses. Apply temporary perimeter controls until structure is stabilized (i.e. all sealing operations are complete and cured and loose materials have been properly removed and disposed).
- Inlet protection (SE-10, Storm Drain Inlet Protection) should be used during application of seal coat, tack coat, slurry seal, and fog seal.
- Seal coat, tack coat, slurry seal, or fog seal should not be applied if rainfall is predicted to occur during the application or curing period.

Paving Equipment

- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials and dispose of in accordance with the applicable regulations. See NS-10, Vehicle and Equipment Maintenance, WM-4, Spill Prevention and Control, and WM-10, Liquid Waste Management.
- Substances used to coat asphalt transport trucks and asphalt spreading equipment should not contain soap and should be non-foaming and non-toxic.
- Paving equipment parked onsite should be parked over plastic to prevent soil contamination.
- Clean asphalt coated equipment offsite whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris as described in WM-5, Solid Waste Management. Any cleaning onsite should follow NS-8, Vehicle and Equipment Cleaning.

Thermoplastic Striping

- Thermoplastic striper and pre-heater equipment shutoff valves should be inspected to ensure that they are working properly to prevent leaking thermoplastic from entering drain inlets, the stormwater drainage system, or watercourses.
- Pre-heaters should be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move.
- Do not pre-heat, transfer, or load thermoplastic near drain inlets or watercourses.
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material.

Raised/Recessed Pavement Marker Application and Removal

- Do not transfer or load bituminous material near drain inlets, the stormwater drainage system, or watercourses.
- Melting tanks should be loaded with care and not filled to beyond six inches from the top to leave room for splashing.
- When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.
- On large-scale projects, use mechanical or manual methods to collect excess bituminous material from the roadway after removal of markers.

Costs

- All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of paving and grinding operations.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sample stormwater runoff required by the General Permit.
- Keep ample supplies of drip pans or absorbent materials onsite.
- Inspect and maintain machinery regularly to minimize leaks and drips.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Hot Mix Asphalt-Paving Handbook AC 150/5370-14, Appendix I, U.S. Army Corps of Engineers, July 1991.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Illicit Connection/Discharge NS-6

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the SWPPP and handled as set forth in the SWPPP.

Implementation

Planning

- Review the SWPPP. Pre-existing areas of contamination should be identified and documented in the SWPPP.

- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.

- Inspect site regularly during project execution for evidence

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of illicit connections, illegal dumping or discharges.

- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General** – unlabeled and unidentifiable material should be treated as hazardous.
- **Solids** - Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids** - signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Abnormal water flow during the dry weather season
- **Urban Areas** - Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season
  - Unusual flows in sub drain systems used for dewatering
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects
- **Rural Areas** - Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season
  - Non-standard junction structures
  - Broken concrete or other disturbances at or near junction structures

Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local stormwater management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local stormwater management agency for further information.

Costs

Costs to look for and report illicit connections and illegal discharges and dumping are low. The best way to avoid costs associated with illicit connections and illegal discharges and dumping is to keep the project perimeters secure to prevent access to the site, to observe the site for vehicles that should not be there, and to document any waste or hazardous materials that exist onsite before taking possession of the site.

Inspection and Maintenance

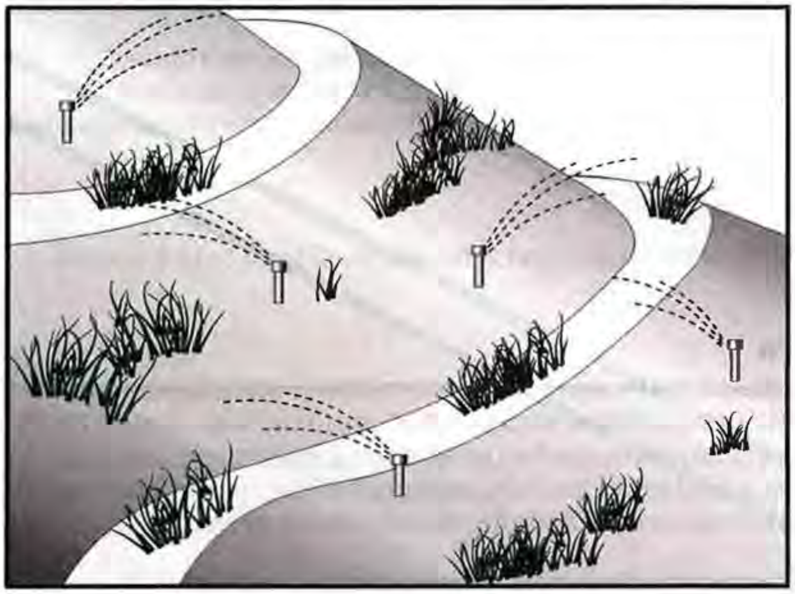
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Potable Water/Irrigation consists of practices and procedures to manage the discharge of potential pollutants generated during discharges from irrigation water lines, landscape irrigation, lawn or garden watering, planned and unplanned discharges from potable water sources, water line flushing, and hydrant flushing.

Suitable Applications

Implement this BMP whenever potable water or irrigation water discharges occur at or enter a construction site.

Limitations

None identified.

Implementation

- Direct water from offsite sources around or through a construction site, where feasible, in a way that minimizes contact with the construction site.
- Discharges from water line flushing should be reused for landscaping purposes where feasible.
- Shut off the water source to broken lines, sprinklers, or valves as soon as possible to prevent excess water flow.
- Protect downstream stormwater drainage systems and watercourses from water pumped or bailed from trenches excavated to repair water lines.
- Inspect irrigated areas within the construction limits for

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excess watering. Adjust watering times and schedules to ensure that the appropriate amount of water is being used and to minimize runoff. Consider factors such as soil structure, grade, time of year, and type of plant material in determining the proper amounts of water for a specific area.

Costs

Cost to manage potable water and irrigation are low and generally considered to be a normal part of related activities.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events..
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Repair broken water lines as soon as possible.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.

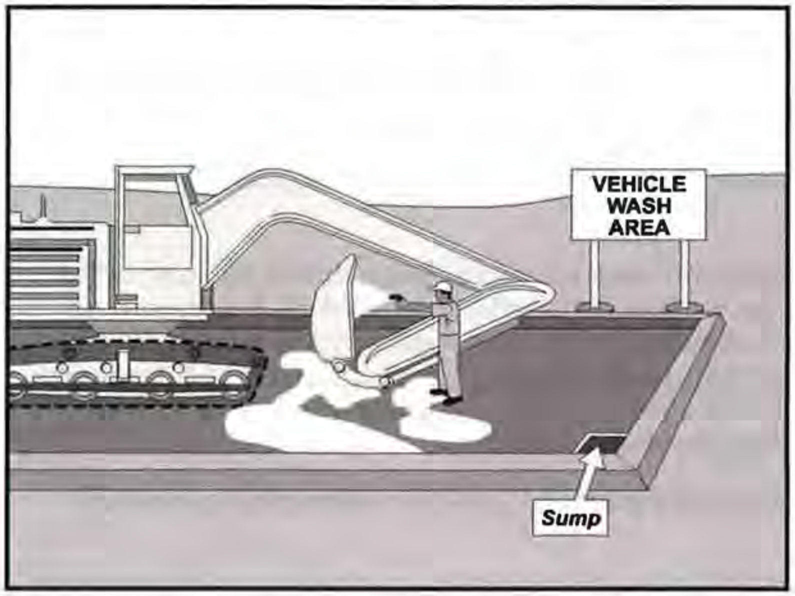
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle and Equipment Cleaning NS-8



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

If washing operations are to take place onsite, then:

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- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried, and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

Costs

Cleaning vehicles and equipment at an offsite facility may reduce overall costs for vehicle and equipment cleaning by eliminating the need to provide similar services onsite. When onsite cleaning is needed, the cost to establish appropriate facilities is relatively low on larger, long-duration projects, and moderate to high on small, short-duration projects.

Inspection and Maintenance

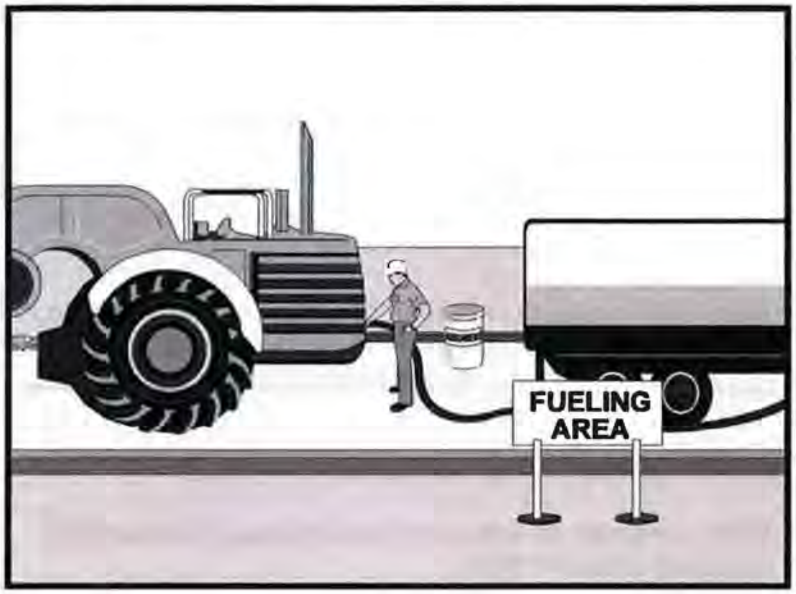
- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance is minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

Vehicle and Equipment Fueling NS-9



Categories

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SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage "topping-off" of fuel tanks.
- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks, and should

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be disposed of properly after use.

- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff, and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

Costs

- All of the above measures are low cost except for the capital costs of above ground tanks that meet all local environmental, zoning, and fire codes.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.

- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References

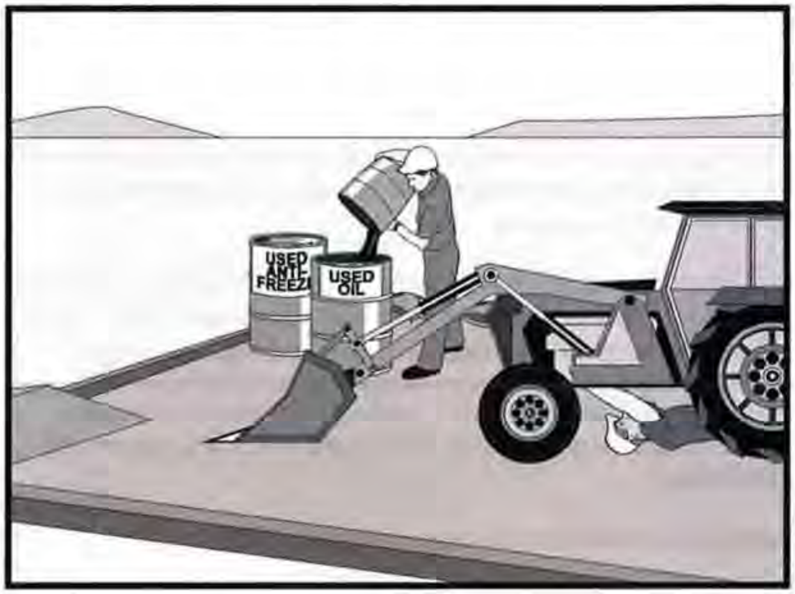
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Vehicle & Equipment Maintenance NS-10



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8, Vehicle and Equipment Cleaning, and NS-9, Vehicle and

Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.

- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff, and should be located at least 50 ft from downstream drainage facilities and watercourses.

- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.

- Place a stockpile of spill cleanup materials where it will be readily accessible.

- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.

- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.

- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.

- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.

- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.

- Train employees and subcontractors in proper maintenance and spill cleanup procedures.

- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.

- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.

- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.

- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.

- Do not place used oil in a dumpster or pour into a storm drain or watercourse.

- Properly dispose of or recycle used batteries.

- Do not bury used tires.

- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.

- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.

- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,- trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Costs

All of the above are low cost measures. Higher costs are incurred to setup and maintain onsite maintenance areas.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Keep ample supplies of spill cleanup materials onsite.

- Maintain waste fluid containers in leak proof condition.

- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately or the problem vehicle(s) or equipment should be removed from the project site.

- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

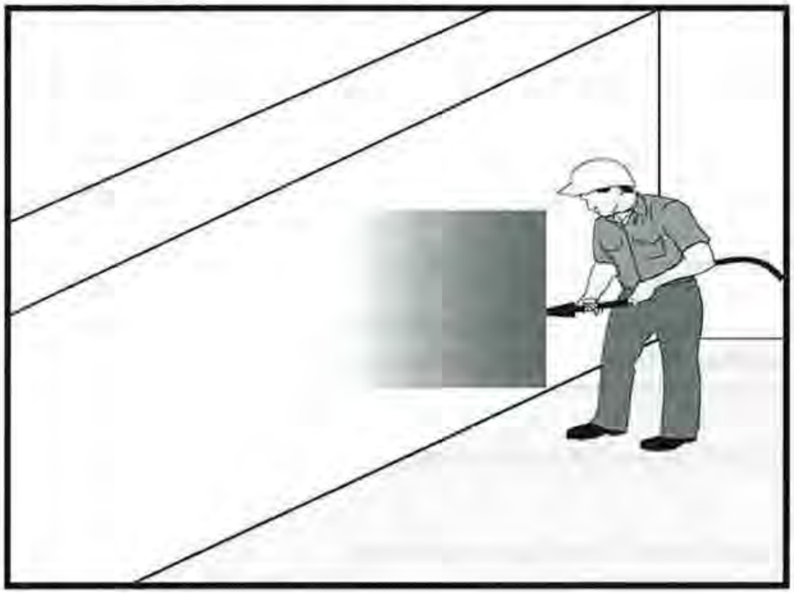
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Concrete Curing NS-12



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods.

Concrete and its associated curing materials have basic chemical properties that can raise the pH of water to levels outside of the permitted range. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Proper procedures and care should be taken when managing concrete curing materials to prevent them from coming into contact with stormwater flows, which could result in a high pH discharge.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

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Limitations

- Runoff contact with concrete waste can raise pH levels in the water to environmentally harmful levels and trigger permit violations.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface, but does not allow any runoff of the compound.
- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.
- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for evaporation or other means of removal in accordance with all applicable permits. See WM-8 Concrete Waste Management.
- Collect cure water at the top of slopes and transport to a concrete waste management area in a non-erosive manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Education

- Educate employees, subcontractors, and suppliers on proper concrete curing techniques to prevent contact with discharge as described herein.
- Arrange for the QSP or the appropriately trained contractor's superintendent or representative to oversee and enforce concrete curing procedures.

Costs

All of the above measures are generally low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sample non-stormwater discharges and stormwater runoff that contacts uncured and partially cured concrete as required by the General Permit.
- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

References

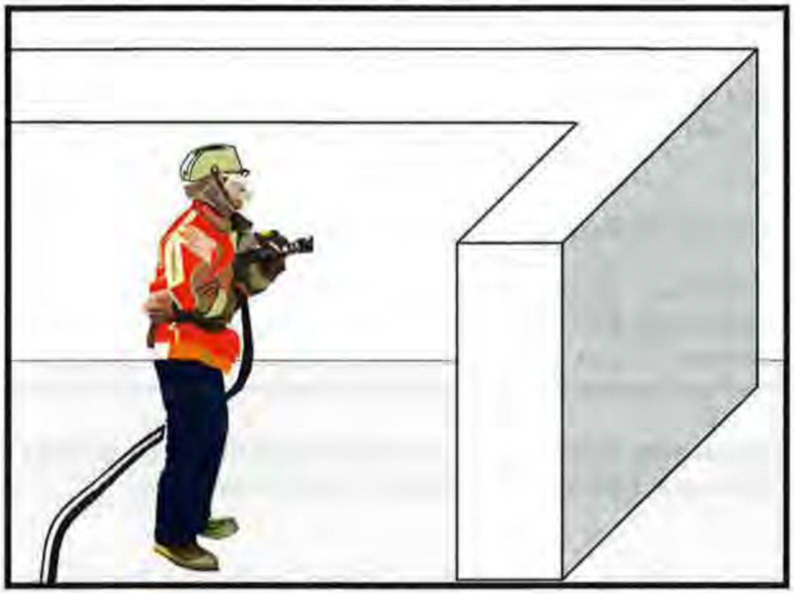
Blue Print for a Clean Bay-Construction-Related Industries: Best Management Practices for Stormwater Pollution Prevention; Santa Clara Valley Non Point Source Pollution Control Program, 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Concrete Finishing NS-13



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☑
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Concrete and its associated curing materials have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

- Runoff contact with concrete waste can raise pH levels in the water to environmentally harmful levels and trigger permit violations.

Implementation

- Collect and properly dispose of water from high-pressure water blasting operations.

- Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.

- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 Dewatering Operations.

- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.

- Refer to WM-8, Concrete Waste Management for disposal of concrete debris.

- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.

- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Education

- Educate employees, subcontractors, and suppliers on proper concrete finishing techniques to prevent contact with discharge as described herein.

- Arrange for the QSP or the appropriately trained contractor's superintendent or representative to oversee and enforce concrete finishing procedures.

Costs

These measures are generally of low cost.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Sample non-stormwater discharges and stormwater runoff that contacts concrete dust and debris as required by the General Permit.

- Sweep or vacuum up debris from sandblasting at the end of each shift.
- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.
- Inspect containment structures for damage prior to use and prior to onset of forecasted rain.

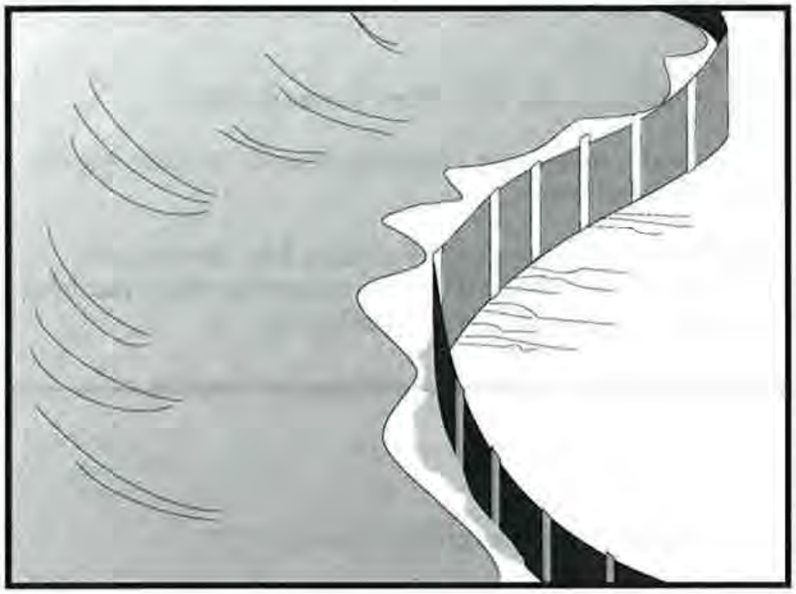
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Silt Fence SE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☑
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Legend:

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☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-10 Storm Drain Inlet Protection

SE-14 Biofilter Bags

Description and Purpose

A silt fence is made of a woven geotextile that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They could also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion and around inlets within disturbed areas (SE-10). Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Around inlets.
- Below other small cleared areas.

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Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause a flooding hazard. Runoff typically ponds temporarily on the upstream side of silt fence.
- Do not use silt fence to divert water flows or place across any contour line. Fences not constructed on a level contour, or fences used to divert flow will concentrate flows resulting in additional erosion and possibly overtopping or failure of the silt fence.
- Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.
- Not effective unless trenched and keyed in.
- Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
- Do not use on slopes subject to creeping, slumping, or landslides.

Implementation

General

A silt fence is a temporary sediment barrier consisting of woven geotextile stretched across and attached to supporting posts, trenched-in, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.
- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.

- Silt fences should remain in place until the disturbed area is permanently stabilized, after which, the silt fence should be removed and properly disposed.
- Silt fence should be used in combination with erosion source controls up slope in order to provide the most effective sediment control.
- Be aware of local regulations regarding the type and installation requirements of silt fence, which may differ from those presented in this fact sheet.

Design and Layout

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Woven geotextile material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Standard vs. Heavy Duty Silt Fence

Standard Silt Fence

- Generally applicable in cases where the slope of area draining to the silt fence is 4:1 (H:V) or less.
- Used for shorter durations, typically 5 months or less
- Area draining to fence produces moderate sediment loads.

Heavy Duty Silt Fence

- Use is generally limited to 8 months or less.
- Area draining to fence produces moderate sediment loads.
- Heavy duty silt fence usually has 1 or more of the following characteristics, not possessed by standard silt fence.
  - Fence fabric has higher tensile strength.
  - Fabric is reinforced with wire backing or additional support.
  - Posts are spaced closer than pre-manufactured, standard silt fence products.
  - Posts are metal (steel or aluminum)

Materials

<u>Standard Silt Fence</u>

- Silt fence material should be woven geotextile with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

Heavy-Duty Silt Fence

- Some silt fence has a wire backing to provide additional support, and there are products that may use prefabricated plastic holders for the silt fence and use metal posts or bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement for health and safety purposes.

Installation Guidelines – Traditional Method

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line of the proposed silt fence (trenches should not be excavated wider or deeper than necessary for proper silt fence installation).

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength geotextile is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench.

- When extra-strength geotextile and closer post spacing are used, the mesh support fence may be eliminated.

- Woven geotextile should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, geotextile should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with native material and compacted.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where, due to specific site conditions, a 3 ft setback is not available, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and more difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.
- Cross barriers should be a minimum of $^1/_3$ and a maximum of ½ the height of the linear barrier.
- See typical installation details at the end of this fact sheet.

Installation Guidelines - Static Slicing Method

- Static Slicing is defined as insertion of a narrow blade pulled behind a tractor, similar to a plow blade, at least 10 inches into the soil while at the same time pulling silt geotextile fabric into the ground through the opening created by the blade to the depth of the blade. Once the gerotextile is installed, the soil is compacted using tractor tires.
- This method will not work with pre-fabricated, wire backed silt fence.
- Benefits:
    - Ease of installation (most often done with a 2 person crew). In addition, installation using static slicing has been found to be more efficient on slopes, in rocky soils, and in saturated soils.
    - Minimal soil disturbance.
    - Greater level of compaction along fence, leading to higher performance (i.e. greater sediment retention).
    - Uniform installation.
    - Less susceptible to undercutting/undermining.

Costs

- It should be noted that costs vary greatly across regions due to available supplies and labor costs.
- Average annual cost for installation using the traditional silt fence installation method (assumes 6 month useful life) is $7 per linear foot based on vendor research. Range of cost is $3.50 - $9.10 per linear foot.
- In tests, the slicing method required 0.33 man hours per 100 linear feet, while the trenched based systems required as much as 1.01 man hours per linear foot.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair undercut silt fences.

- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence should be inspected and maintained regularly.
- Remove silt fence when upgradient areas are stabilized. Fill and compact post holes and anchor trench, remove sediment accumulation, grade fence alignment to blend with adjacent ground, and stabilize disturbed area.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group-Working Paper, USEPA, April 1992.

Sedimentation and Erosion Control Practices, and Inventory of Current Practices (Draft), UESPA, 1990.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

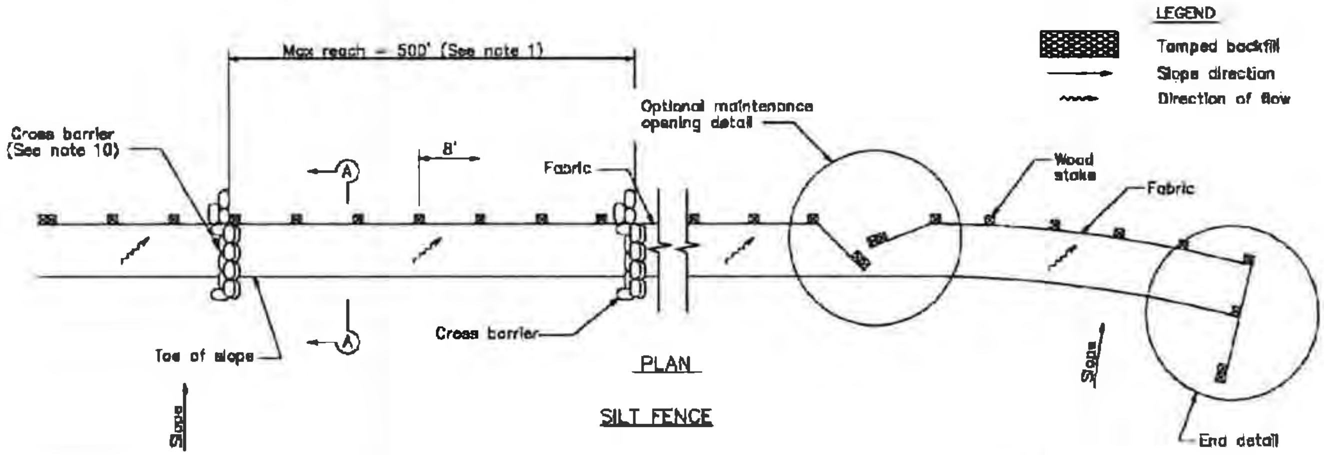
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

U.S. Environmental Protection Agency (USEPA). Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices. U.S. Environmental Protection Agency, Office of Water, Washington, DC, 1992.

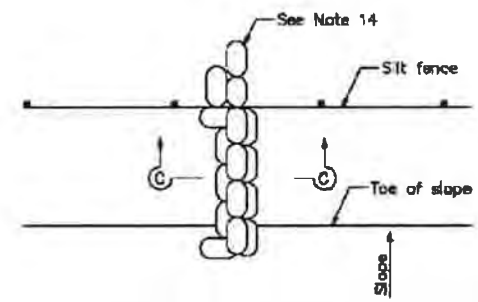
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

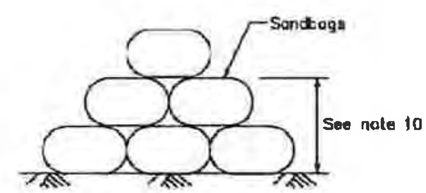


PLAN

SILT FENCE



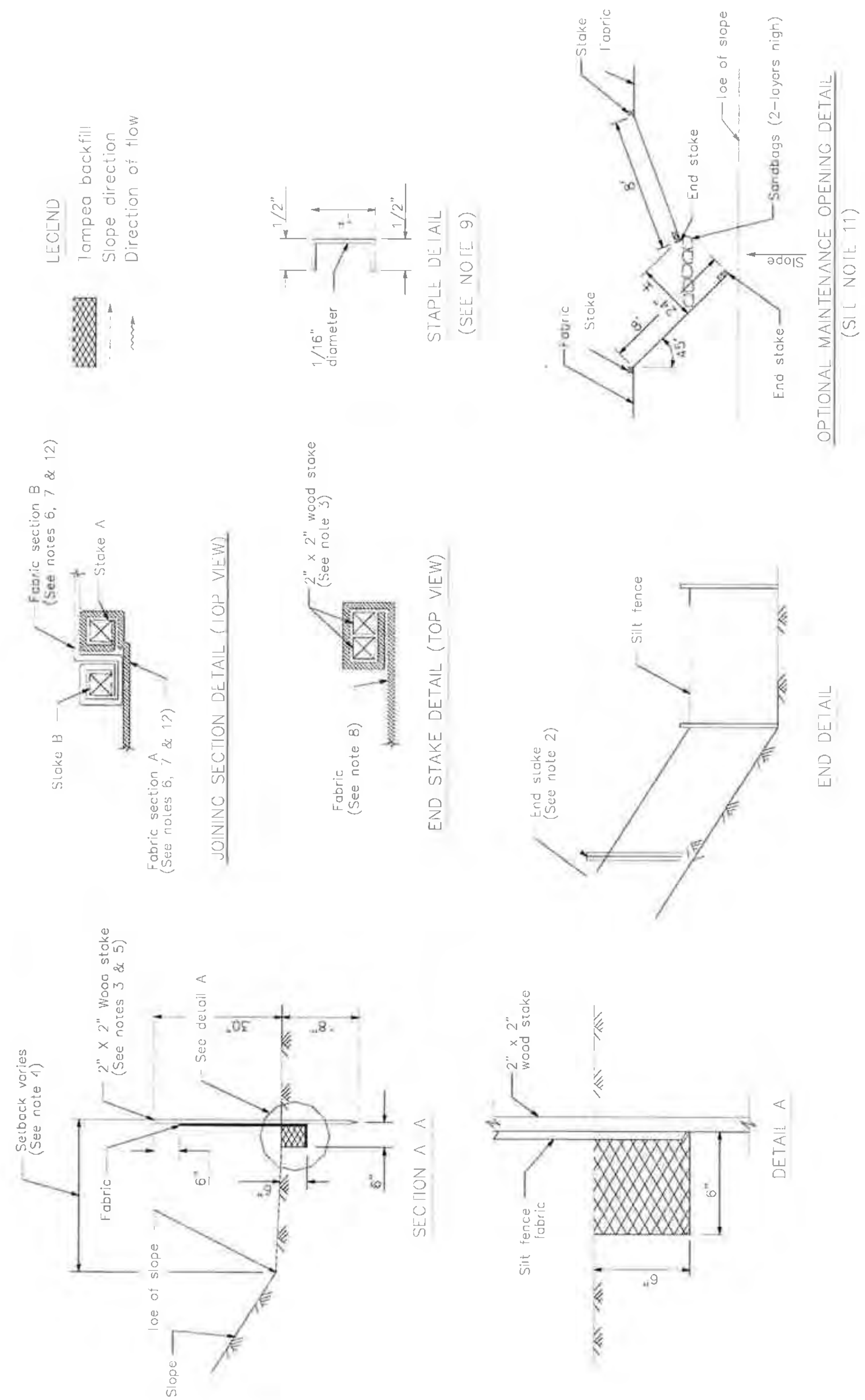
CROSS BARRIER DETAIL



SECTION C–C

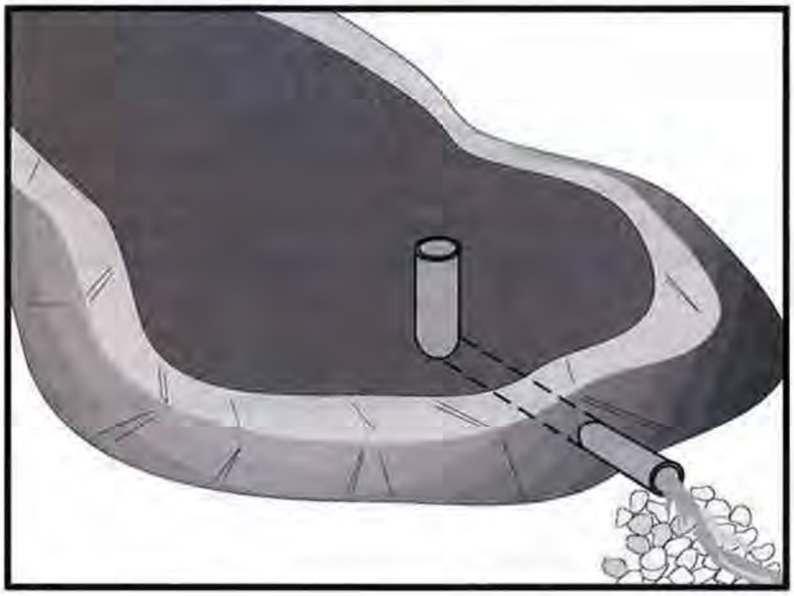
NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. The last 8'–0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'–0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow–through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.
14. Add 3–4 bags to cross barrier on downgradient side of silt fence as needed to prevent bypass or undermining and as allowable based on site limits of disturbance.



LEGEND
Tamped backfill
Slope direction
Direction of flow
1/2"
1"
1/2"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
Toe of slope
Sandbags (2-layers high)
End stake
8'
Slope
Fabric
Stake
8'
2'
45°
End stake
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)
Fabric section B
(See notes 6, 7 & 12)
Stake A
Stake B
Fabric section A
(See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake
(See note 3)
Fabric
(See note 8)
END STAKE DETAIL (TOP VIEW)
Silt fence
End stake
(See note 2)
END DETAIL
Setback varies
(See note 4)
2" X 2" Wood stake
(See notes 3 & 5)
See detail A
30"
8"
Fabric
6"
6"
6"
Toe of slope
Slope
SECTION A A
2" x 2" wood stake
Silt fence fabric
6"
6"
DETAIL A

Sediment Basin SE-2



Categories

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Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Sediment basin design guidance presented in this fact sheet is intended to provide options, methods, and techniques to optimize temporary sediment basin performance and basin sediment removal. Basin design guidance provided in this fact sheet is not intended to guarantee basin effluent compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment basins should be used in conjunction with a comprehensive system of BMPs that includes:

- Diverting runoff from undisturbed areas away from the basin
- Erosion control practices to minimize disturbed areas on-site
  and to provide temporary stabilization and interim sediment controls (e.g., stockpile perimeter control, check dams, perimeter controls around individual lots) to reduce the basin's influent sediment concentration.

At some sites, sediment basin design enhancements may be required to adequately remove sediment. Traditional (aka "physical") enhancements such as alternative outlet configurations or flow deflection baffles increase detention time and other techniques such as outlet skimmers preferentially drain flows with lower sediment concentrations. These "physical" enhancement techniques are described in this fact sheet. To further enhance sediment removal particularly at sites with fine soils or turbidity sensitive receiving waters, some projects may need to consider implementing Active Treatment Systems (ATS) whereby coagulants and flocculants are used to enhance settling and removal of suspended sediments. Guidance on implementing ATS is provided in SE-11.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres and evaluated on a site by site basis
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- As a general guideline, sediment basins are suitable for drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres. However, the tributary area should be evaluated on a site by site basis.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this fact sheet are only effective in removing sediment down to about the silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical (or other appropriate method) treatment is used in addition to the sediment basin.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from California Department of Water Resources Division of Safety of Dams (http://www.water.ca.gov/damsafety/).

- Water that stands in sediment basins longer than 96 hours may become a source of mosquitoes (and midges), particularly along perimeter edges, in shallow zones, in scour or below-grade pools, around inlet pipes, along low-flow channels, and among protected habitats created by emergent or floating vegetation (e.g. cattails, water hyacinth), algal mats, riprap, etc.

- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure expected to be used during active construction in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to convey runoff to the basin inlet.

Many development projects in California are required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins if properly designed and maintained can trap a significant amount of the sediment that flows into them. However, traditional basins do not remove all inflowing sediment. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. Locations best suited for a sediment basin are generally in lower elevation areas of the site (or basin tributary area) where site drainage would not require significant diversion or other means to direct water to the basin but outside jurisdictional waterways. However, as necessary, drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). . The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

Construct before clearing and grading work begins when feasible.

- Do not locate the basin in a jurisdictional stream.

- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft must obtain approval from the Division of Dam Safety. Local dam safety requirements may be more stringent.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

When designing a sediment basin, designers should evaluate the site constraints that could affect the efficiency of the BMP. Some of these constraints include: the relationship between basin capacity, anticipated sediment load, and freeboard, available footprint for the basin, maintenance frequency and access, and hydraulic capacity and efficiency of the temporary outlet infrastructure. Sediment basins should be designed to maximize sediment removal and to consider sediment load retained by the basin as it affects basin performance.

Three Basin Design Options (Part A) are presented below along with a Typical Sediment/Detention Basin Design Methodology (Part B). Regardless of the design option that is selected, designers also need to evaluate the sediment basin capacity with respect to sediment accumulation (See *"Step 3. Evaluate the Capacity of the Sediment Basin")*, and should incorporate approaches identified in *"Step 4. Other Design Considerations"* to enhance basin performance.

A) Basin Design Options:

Option 1:

Design sediment basin(s) using the standard equation:

$$A_s = \frac{1.2Q}{V_s} \qquad \text{(Eq. 1)}$$

Where:

A_s = Minimum surface area for trapping soil particles of a certain size

V_s = Settling velocity of the design particle size chosen (V_s = 0.00028 ft/s for a design particle size of 0.01 mm at 68°F)

1.2 = Factor of safety recommended by USEPA to account for the reduction in basin efficiency caused due to turbulence and other non ideal conditions.

$Q = CIA$ (Eq.2)

Where

Q = Discharge rate measured in cubic feet per second

C = Runoff coefficient (unitless)

I = Peak rainfall intensity for the 10-year, 6-hour rain event (in/hr)

A = Area draining into the sediment basin in acres

The design particle size should be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the Vs used should be 100 percent of the calculated settling velocity.

This sizing basin method is dependent on the outlet structure design or the total basin length with an appropriate outlet. If the designer chooses to utilize the outlet structure to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a minimum of twice the basin width; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). If the designer chooses to utilize the basin length (with appropriate basin outlet) to control the flow duration in the basin, the basin length (distance between the inlet and the outlet) should be a specifically designed to capture 100% of the design particle size; the depth should not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity).

The basin should be located on the site where it can be maintained on a year-round basis and should be maintained on a schedule to retain the 2 ft of capacity.

Option 2:

Design pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 1.

Option 3:

The use of an equivalent surface area design or equation provided that the design efficiency is as protective or more protective of water quality than Option 1.

B) Typical Sediment/Detention Basin Design Methodology:

Design of a sediment basin requires the designer to have an understanding of the site constraints, knowledge of the local soil (e.g., particle size distribution of potentially contributing soils), drainage area of the basin, and local hydrology. Designers should not assume that a sediment basin for location A is applicable to location B. Therefore, designers can use this factsheet as guidance but will need to apply professional judgment and knowledge of the site to design an effective and efficient sediment basin. The following provides a general overview of typical design methodologies:

Step 1. Hydrologic Design

- Evaluate the site constraints and assess the drainage area for the sediment basin. Designers should consider on- and off-site flows as well as changes in the drainage area associated with site construction/disturbance. To minimize additional construction during the course of the project, the designer should consider identifying the maximum drainage area when calculating the basin dimensions.
- If a local hydrology manual is not available it is recommended to follow standard rational method procedures to estimate discharge. The references section of this factsheet provides a reference to standard hydrology textbooks that can provide standard methodologies. If local rainfall depths are not available, values can be obtained from standard precipitation frequency maps from NOAA (downloaded from http://www.wrcc.dri.edu/pcpnfreq.html).

Step 2. Hydraulic Design

- Calculate the surface area required for the sediment basin using Equation 1. In which discharge is estimated for a 10-yr 6-hr event using rational method procedure listed in local hydrology manual and Vs is estimated using Stokes Law presented in Equation 3.

$$V_s = 2.81d^2 \qquad \text{(Eq.3)}$$

Where

V_s = Settling velocity in feet per second at 68°F

d = diameter of sediment particle in millimeters (smallest soil grain size determined by wet sieve analysis or fine silt (0.01 mm [or 0.0004 in.])

- In general the basin outlet design requires an iterative trial and error approach that considered the maximum water surface elevation, the elevation versus volume (stage-storage) relationship, the elevation verses discharge (stage-discharge) relationship, and the estimated inflow hydrograph. To adequately design the basins to settle sediment, the outlet configuration and associated outflow rates can be estimated by numerous methodologies. The following provides some guidance for design the basin outlet:
  - An outlet should have more than one orifice.
  - An outlet design typically utilizes multiple horizontal rows of orifices (approximately 3 or more) with at least 2 orifices per row (see Figures 1 and 2 at the end of this fact sheet).
  - Orifices can vary in shape.
  - Select the appropriate orifice diameter and number of perforations per row with the objective of minimizing the number of rows while maximizing the detention time.

- The diameter of each orifice is typically a maximum of 3-4 inches and a minimum of 0.25-0.5 inches.
- If a rectangular orifice is used, it is recommended to have minimum height of 0.5 inches and a maximum height of 6 inches.
- Rows are typically spaced at three times the diameter center to center vertically with a minimum distance of approximately 4 inches on center and a maximum distance of 1 foot on center.
- To estimate the outflow rate, each row is calculated separately based on the flow through a single orifice then multiplied by the number of orifices in the row. This step is repeated for each of the rows. Once all of the orifices are estimated, the total outflow rate versus elevation (stage-discharge curve) is developed to evaluate the detention time within the basin.
- Flow through a single orifice can be estimated using an Equation 4:

$$Q = BC'A(2gH)^{0.5} \qquad \text{(Eq.4)}$$

Where
Q = Discharge in ft^3/s
C′ = Orifice coefficient (unitless)
A = Area of the orifice (ft^2)
g = acceleration due to gravity (ft^3/s)
H = Head above the orifice (ft)
B = Anticipated Blockage or clogging factor (unitless), It is dependent on anticipated sediment and debris load, trash rack configuration etc, so the value is dependent on design engineers professional judgment and/or local requirements (B is never greater than 1 and a value of 0.5 is generally used)

  - Care must be taken in the selection of orifice coefficient ("C′"); 0.60 is most often recommended and used. However, based on actual tests, Young and Graziano (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:
    - C′ = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or
    - C′ = 0.80 when the material is thicker than the orifice diameter
- If different sizes of orifices are used along the riser then they have to be sized such that not more than 50 percent of the design storm event drains in one-third of the drawdown time (to provide adequate settling time for events smaller than the design storm event) and the entire volume drains within 96 hours or as regulated by the local vector control agency. If a basin fails to drain within 96 hours, the basin must be pumped dry.

- Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.
- Floating Outlet Skimmer: The floating skimmer (see Figure 3 at the end of this fact sheet is an alternative outlet configuration (patented) that drains water from upper portion of the water column. This configuration has been used for temporary and permanent basins and can improve basin performance by eliminating bottom orifices which have the potential of discharging solids. Some design considerations for this alternative outlet device includes the addition of a sand filter or perforated under drain at the low point in the basin and near the floating skimmer. These secondary drains allow the basin to fully drain. More detailed guidelines for sizing the skimmer can be downloaded from http://www.fairclothskimmer.com/.
- Hold and Release Valve: An ideal sediment/detention basin would hold all flows to the design storm level for sufficient time to settle solids, and then slowly release the storm water. Implementing a reliable valve system for releasing detention basins is critical to eliminate the potential for flooding in such a system. Some variations of hold and release valves include manual valves, bladder devices or electrically operated valves. When a precipitation event is forecast, the valve would be close for the duration of the storm and appropriate settling time. When the settling duration is met (approximately 24 or 48 hours), the valve would be opened and allow the stormwater to be discharged at a rate that does not resuspend settled solids and in a non-erosive manner. If this type of system is used the valve should be designed to empty the entire basin within 96 hours or as stipulated by local vector control regulations.

Step 3. Evaluate the Capacity of the Sediment Basin

- Typically, sediment basins do not perform as designed when they are not properly maintained or the sediment yield to the basin is larger than expected. As part of a good sediment basin design, designers should consider maintenance cycles, estimated soil loss and/or sediment yield, and basin sediment storage volume. The two equations below can be used to quantify the amount of soil entering the basin.
- The Revised Universal Soil Loss Equation (RUSLE, Eq.5) can be used to estimate annual soil loss and the Modified Universal Soil Equation (MUSLE, Eq.6) can be used to estimate sediment yield from a single storm event.

$$A = R \times K \times LS \times C \times P \qquad \text{(Eq.5)}$$

$$Y = 95(Q \times q_p)^{0.56} \times K \times LS \times C \times P \qquad \text{(Eq.6)}$$

Where:

A = annual soil loss, tons/acre-year

R = rainfall erosion index, in 100 ft.tons/acre.in/hr

K = soil erodibility factor, tons/acre per unit of R

LS = slope length and steepness factor (unitless)

C = vegetative cover factor (unitless)

P = erosion control practice factor (unitless)

Y = single storm sediment yield in tons

Q = runoff volume in acre-feet

q_p = peak flow in cfs

- Detailed descriptions and methodologies for estimating the soil loss can be obtained from standard hydrology text books (See References section).

- Determination of the appropriate equation should consider construction duration and local environmental factors (soils, hydrology, etc.). For example, if a basin is planned for a project duration of 1 year and the designer specifies one maintenance cycle, RUSLE could be used to estimate the soil loss and thereby the designer could indicate that the sediment storage volume would be half of the soil loss value estimated. As an example for use of MUSLE, a project may have a short construction duration thereby requiring fewer maintenance cycles and a reduced sediment storage volume. MUSLE would be used to estimate the anticipated soil loss based on a specific storm event to evaluate the sediment storage volume and appropriate maintenance frequency.

- The soil loss estimates are an essential step in the design and it is essential that the designer provide construction contractors with enough information to understand maintenance frequency and/or depths within the basin that would trigger maintenance. Providing maintenance methods, frequency and specification should be included in design bid documents such as the SWPPP Site Map.

- Once the designer has quantified the amount of soil entering the basin, the depth required for sediment storage can be determined by dividing the estimated sediment loss by the surface area of the basin.

Step 4. Other Design Considerations

- Consider designing the volume of the settling zone for the total storm volume associated with the 2-year event or other appropriate design storms specified by the local agency. This volume can be used as a guide for sizing the basin without iterative routing calculations. The depth of the settling zone can be estimated by dividing the estimated 2-yr storm volume by the surface area of the basin.

- The basin volume consists of two zones:

  - A sediment storage zone at least 1 ft deep.

  - A settling zone at least 2 ft deep.

  - The basin depth must be no less than 3 ft (not including freeboard).

- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 96 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 96-hour limit is specified to mitigate vector control concerns.

- Confirmation of the basin performance can be evaluated by routing the design storm (10-yr 6-hr, or as directed by local regulations) through the basin based on the basin volume (stage-storage curve) and the outlet design (stage-discharge curve based on the orifice configuration or equivalent outlet design).
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.
  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap (or equivalent protection) on fill slopes.
  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.
- Rock, vegetation or appropriate erosion control should be used to protect the basin inlet, outlet, and slopes against erosion.
- The total depth of the sediment basin should include the depth required for sediment storage, depth required for settling zone and freeboard of at least 1 foot or as regulated by local flood control agency for a flood event specified by the local agency.
- The length to settling depth ratio (L/SD) should be less than 200.
- The basin alignment should be designed such that the length of the basin is more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet. If the site topography does not allow for this configuration baffles should be installed so that the ratio is satisfied. If a basin has more than one inflow point, any inflow point that conveys more than 30 percent of the total peak inflow rate has to meet the required length to width ratio.
- An alternative basin sizing method proposed by Fifield (2004) can be consulted to estimate an alternative length to width ratio and basin configuration. These methods can be considered as part of Option 3 which allows for alternative designs that are protective or more protective of water quality.
- Baffles (see Figure 4 at the end of this fact sheet) can be considered at project sites where the existing topography or site constraints limit the length to width ratio. Baffles should be constructed of earthen berms or other structural material within the basin to divert flow in the basin, thus increasing the effective flow length from the basin inlet to the outlet riser. Baffles also reduce the change of short circuiting and allows for settling throughout the basin.
- Baffles are typically constructed from the invert of the basin to the crest of the emergency spillway (i.e., design event flows are meant to flow around the baffles and flows greater than the design event would flow over the baffles to the emergency spillway).

- Use of other materials for construction of basin baffles (such as silt fence) may not be appropriate based on the material specifications and will require frequent maintenance (maintain after every storm event). Maintenance may not be feasible when required due to flooded conditions resulting from frequent (i.e., back to back) storm events. Use of alternative baffle materials should not deviate from the intended purpose of the material, as described by the manufacturer.
- Sediment basins are best used in conjunction with erosion controls.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.
- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen, although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

The cost of a sediment basin is highly variable and is dependent of the site configuration. To decrease basin construction costs, designers should consider using existing site features such as berms or depressed area to site the sediment basin. Designers should also consider potential savings associated with designing the basin to minimize the number of maintenance cycles and siting the basin in a location where a permanent BMP (e.g., extended detention basin) is required for the project site.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level and as required by local requirements. It is recommended that at a minimum, basins be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the basin must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance should be managed properly. The sediment should be appropriately evaluated and used or disposed of accordingly. Options include: incorporating sediment into earthwork on the site (only if there is no risk that sediment is contaminated); or off-site export/disposal at an appropriate location (e.g., sediment characterization and disposal to an appropriate landfill).
- Remove standing water from basin within 96 hours after accumulation.
- If the basin does not drain adequately (e.g., due to storms that are more frequent or larger than the design storm or other unforeseen site conditions), dewatering should be conducted in accordance with appropriate dewatering BMPs (see NS-2) and in accordance with local permits as applicable.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

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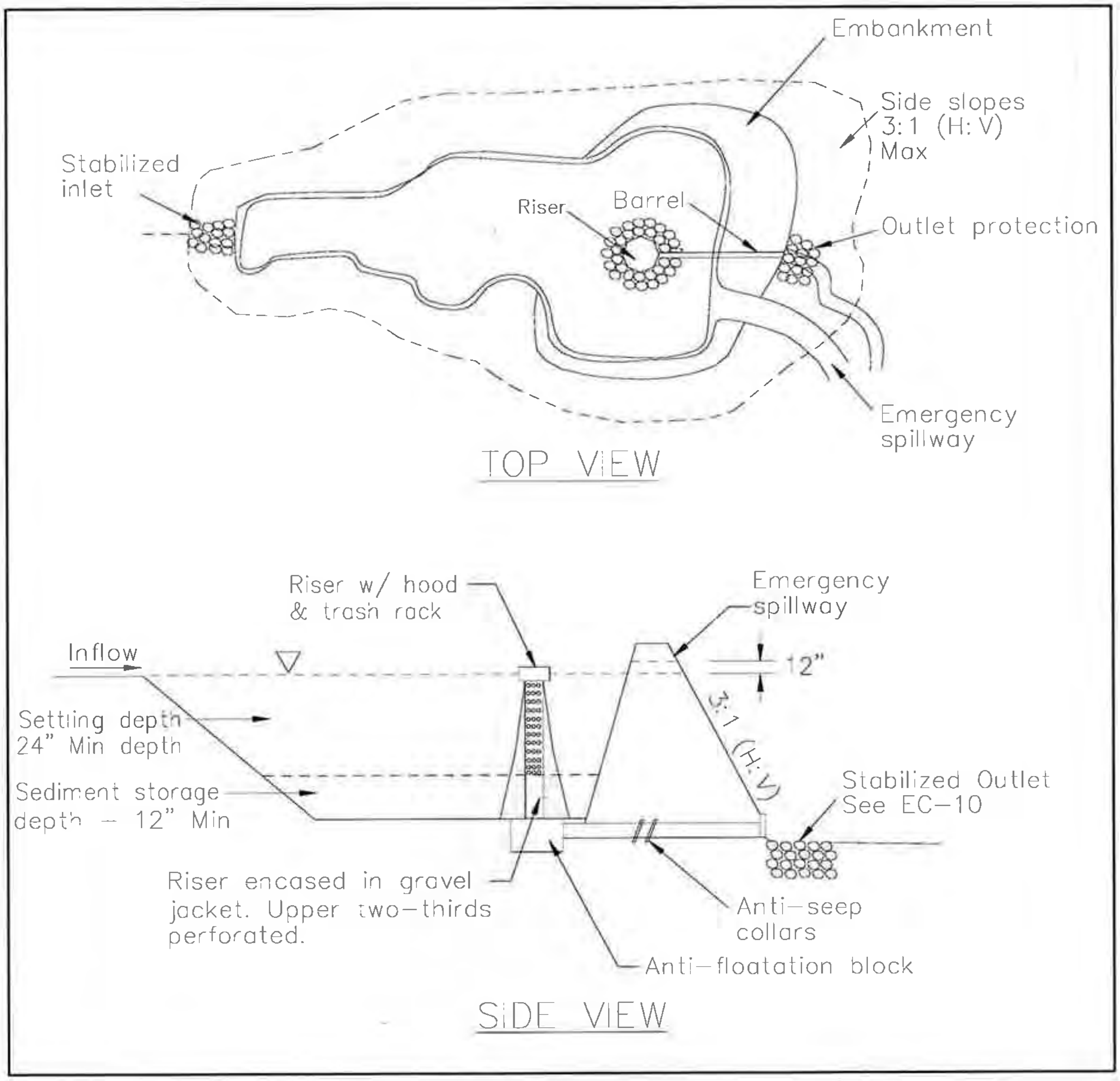


FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN
MULTIPLE ORIFICE DESIGN
NOT TO SCALE

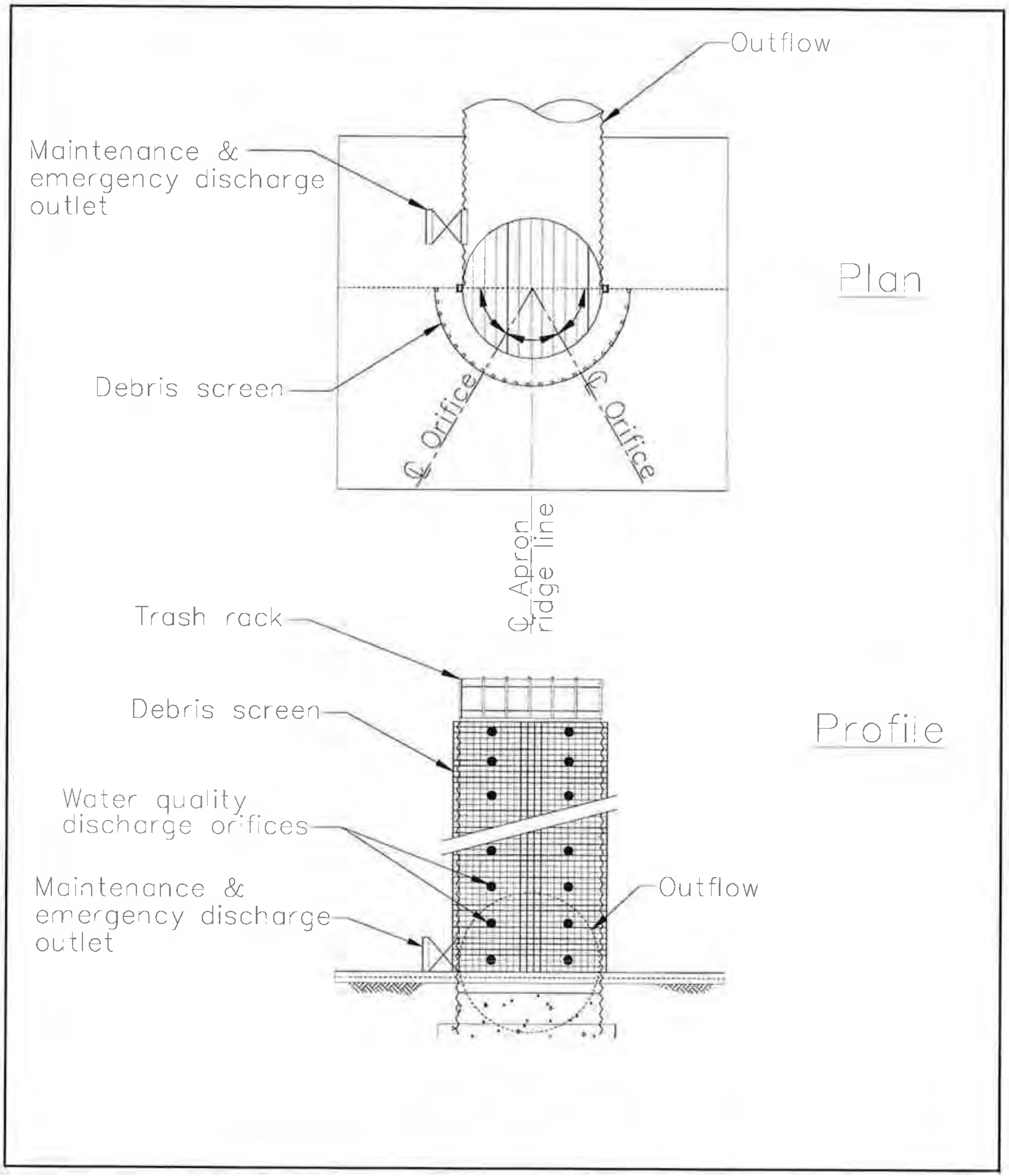


FIGURE 2: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

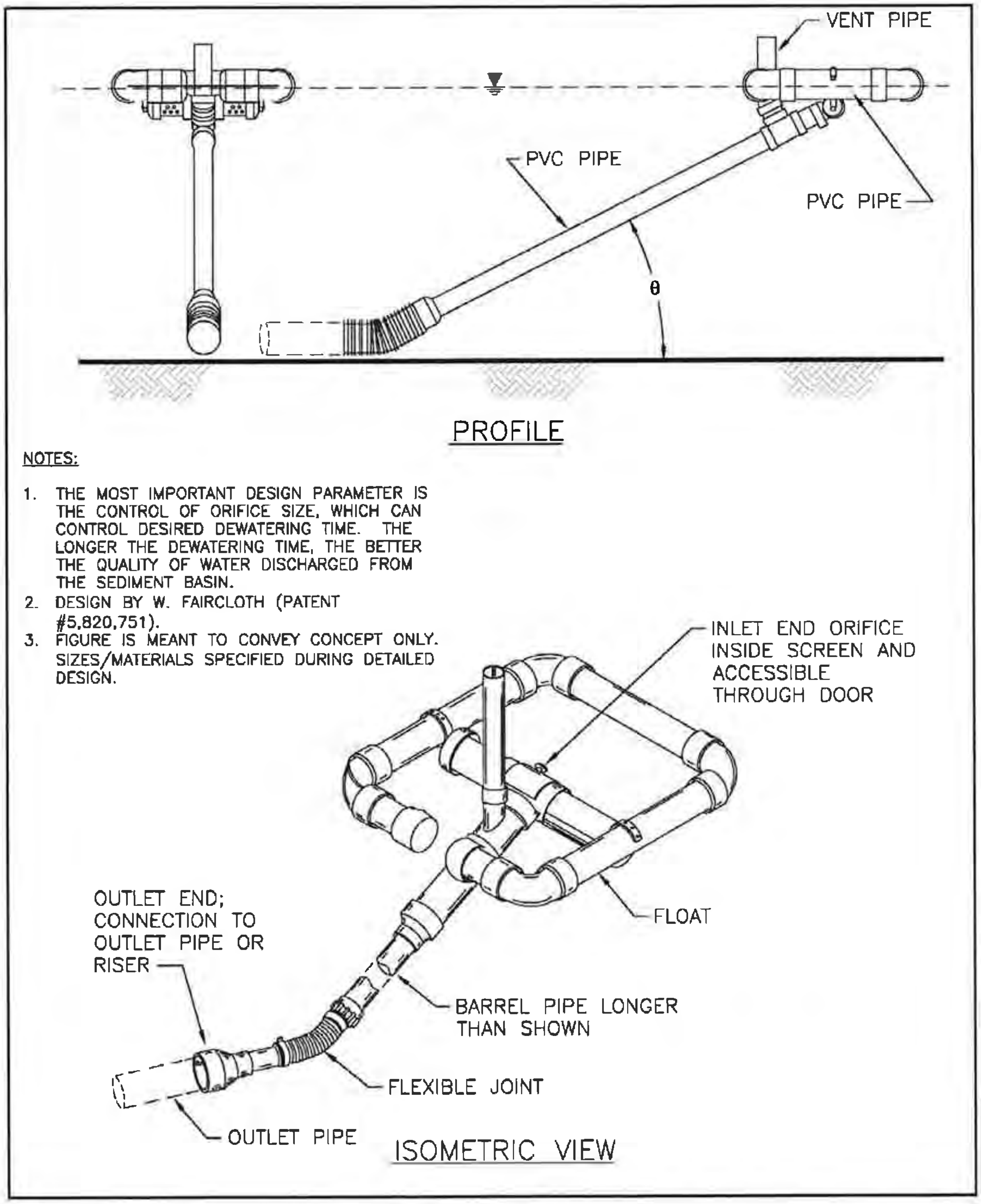


FIGURE 3: TYPICAL SKIMMER

NOT TO SCALE

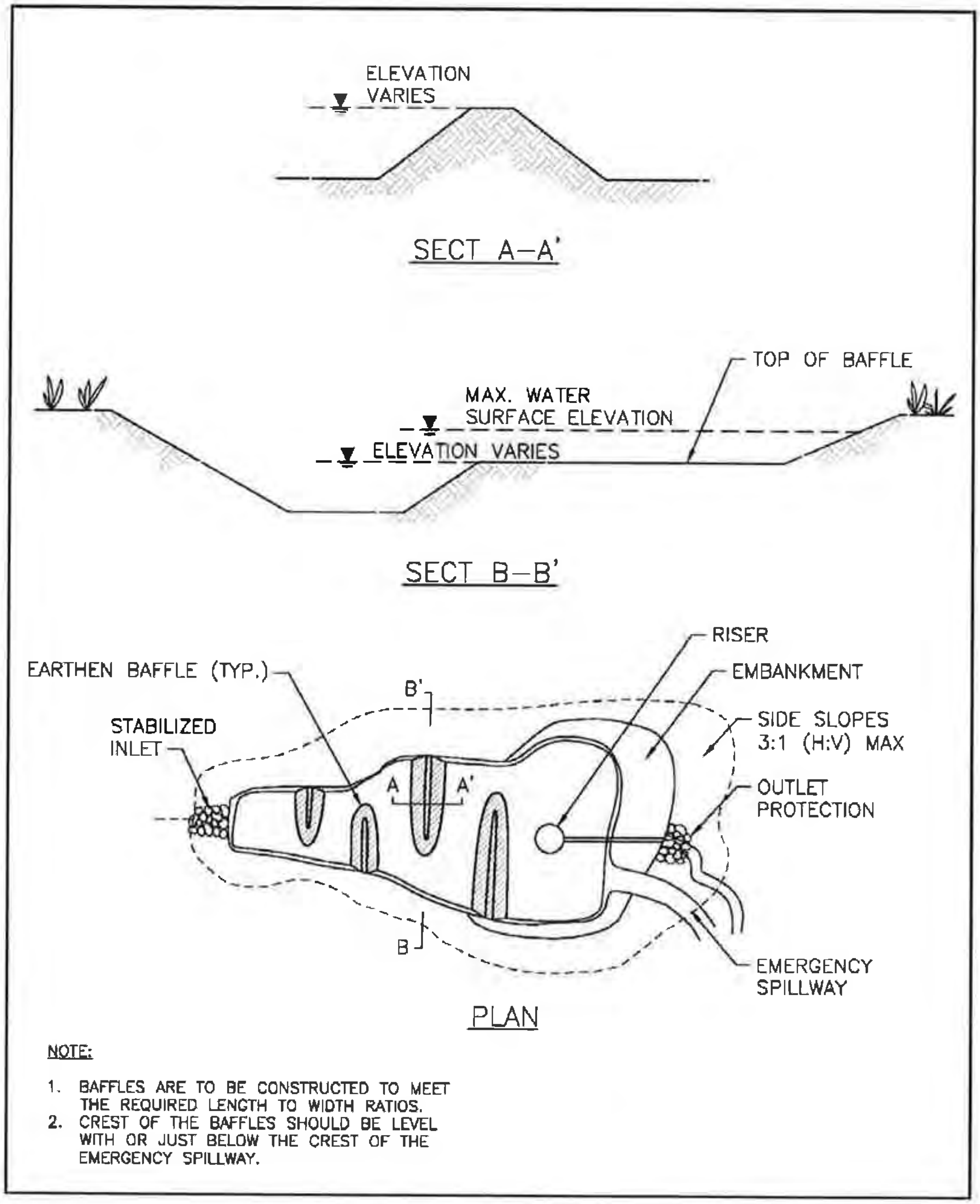
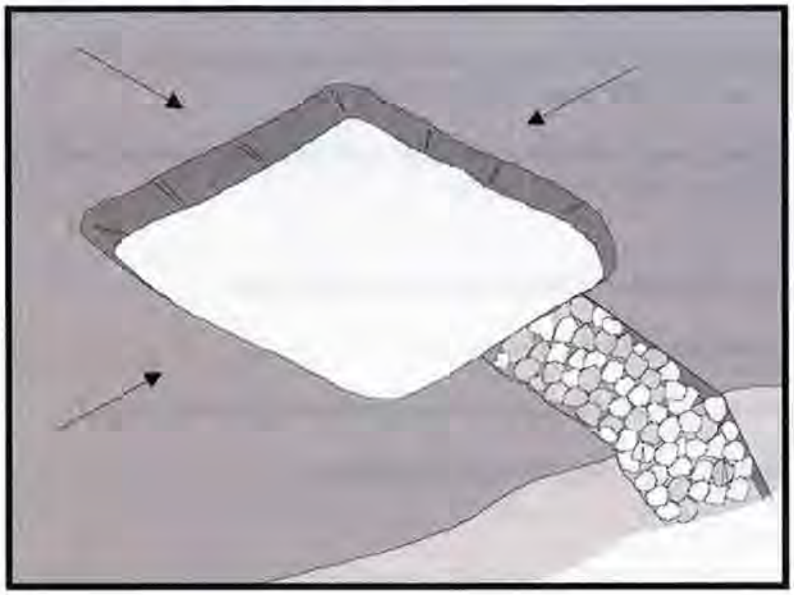


FIGURE 4: TYPICAL TEMPORARY SEDIMENT BASIN WITH BAFFLES

NOT TO SCALE



Categories		
EC	Erosion Control	
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-2 Sediment Basin (for larger areas)

Description and Purpose

A sediment trap is a containment area where sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out or before the runoff is discharged by gravity flow. Sediment traps are formed by excavating or constructing an earthen embankment across a waterway or low drainage area.

Trap design guidance provided in this fact sheet is not intended to guarantee compliance with numeric discharge limits (numeric action levels or numeric effluent limits for turbidity). Compliance with discharge limits requires a thoughtful approach to comprehensive BMP planning, implementation, and maintenance. Therefore, optimally designed and maintained sediment traps should be used in conjunction with a comprehensive system of BMPs.

Suitable Applications

Sediment traps should be considered for use:

- At the perimeter of the site at locations where sediment-laden runoff is discharged offsite.
- At multiple locations within the project site where sediment control is needed.
- Around or upslope from storm drain inlet protection measures.
- Sediment traps may be used on construction projects where the drainage area is less than 5 acres. Traps would be

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placed where sediment-laden stormwater may enter a storm drain or watercourse. SE-2, Sediment Basins, must be used for drainage areas greater than 5 acres.

- As a supplemental control, sediment traps provide additional protection for a water body or for reducing sediment before it enters a drainage system.

Limitations

- Requires large surface areas to permit infiltration and settling of sediment.
- Not appropriate for drainage areas greater than 5 acres.
- Only removes large and medium sized particles and requires upstream erosion control.
- Attractive and dangerous to children, requiring protective fencing.
- Conducive to vector production.
- Should not be located in live streams.

Implementation

Design

A sediment trap is a small temporary ponding area, usually with a gravel outlet, formed by excavation or by construction of an earthen embankment. Its purpose is to collect and store sediment from sites cleared or graded during construction. It is intended for use on small drainage areas with no unusual drainage features and projected for a quick build-out time. It should help in removing coarse sediment from runoff. The trap is a temporary measure with a design life of approximately six months to one year and is to be maintained until the site area is permanently protected against erosion by vegetation and/or structures.

Sediment traps should be used only for small drainage areas. If the contributing drainage area is greater than 5 acres, refer to SE-2, Sediment Basins, or subdivide the catchment area into smaller drainage basins.

Sediment usually must be removed from the trap after each rainfall event. The SWPPP should detail how this sediment is to be disposed, such as in fill areas onsite, or removal to an approved offsite dump. Sediment traps used as perimeter controls should be installed before any land disturbance takes place in the drainage area.

Sediment traps are usually small enough that a failure of the structure would not result in a loss of life, damage to home or buildings, or interruption in the use of public roads or utilities. However, sediment traps are attractive to children and can be dangerous. The following recommendations should be implemented to reduce risks:

- Install continuous fencing around the sediment trap or pond. Consult local ordinances regarding requirements for maintaining health and safety.
- Restrict basin side slopes to 3:1 or flatter.

Sediment trap size depends on the type of soil, size of the drainage area, and desired sediment removal efficiency (see SE-2, Sediment Basin). As a rule of thumb, the larger the basin volume the greater the sediment removal efficiency. Sizing criteria are typically established under the local grading ordinance or equivalent. The runoff volume from a 2-year storm is a common design criteria for a sediment trap. The sizing criteria below assume that this runoff volume is 0.042 acre-ft/acre (0.5 in. of runoff). While the climatic, topographic, and soil type extremes make it difficult to establish a statewide standard, the following criteria should trap moderate to high amounts of sediment in most areas of California:

- Locate sediment traps as near as practical to areas producing the sediment.
- Trap should be situated according to the following criteria: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where failure would not cause loss of life or property damage, and (3) to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area.
- Trap should be sized to accommodate a settling zone and sediment storage zone with recommended minimum volumes of 67 yd^3/acre and 33 yd^3/acre of contributing drainage area, respectively, based on 0.5 in. of runoff volume over a 24-hour period. In many cases, the size of an individual trap is limited by available space. Multiple traps or additional volume may be required to accommodate specific rainfall, soil, and site conditions.
- Traps with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and traps capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the trap outlet and bypass structures.
- The outlet pipe or open spillway must be designed to convey anticipated peak flows.
- Use rock or vegetation to protect the trap outlets against erosion.
- Fencing should be provided to prevent unauthorized entry.

Installation

Sediment traps can be constructed by excavating a depression in the ground or creating an impoundment with a small embankment. Sediment traps should be installed outside the area being graded and should be built prior to the start of the grading activities or removal of vegetation. To minimize the area disturbed by them, sediment traps should be installed in natural depressions or in small swales or drainage ways. The following steps must be followed during installation:

- The area under the embankment must be cleared, grubbed, and stripped of any vegetation and root mat. The pool area should be cleared.
- The fill material for the embankment must be free of roots or other woody vegetation as well as oversized stones, rocks, organic material, or other objectionable material. The embankment may be compacted by traversing with equipment while it is being constructed.
- All cut-and-fill slopes should be 3:1 or flatter.
- When a riser is used, all pipe joints must be watertight.

- When a riser is used, at least the top two-thirds of the riser should be perforated with 0.5 in. diameter holes spaced 8 in. vertically and 10 to 12 in. horizontally. See SE-2, Sediment Basin.

- When an earth or stone outlet is used, the outlet crest elevation should be at least 1 ft below the top of the embankment.

- When crushed stone outlet is used, the crushed stone used in the outlet should meet AASHTO M43, size No. 2 or 24, or its equivalent such as MSHA No. 2. Gravel meeting the above gradation may be used if crushed stone is not available.

Costs

Average annual cost per installation and maintenance (18 month useful life) is $0.73 per ft^3 ($1,300 per drainage acre). Maintenance costs are approximately 20% of installation costs.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect outlet area for erosion and stabilize if required.

- Inspect trap banks for seepage and structural soundness, repair as needed.

- Inspect outlet structure and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.

- Inspect fencing for damage and repair as needed.

- Inspect the sediment trap for area of standing water during every visit. Corrective measures should be taken if the BMP does not dewater completely in 96 hours or less to prevent vector production.

- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the trap capacity. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at an appropriate location.

- Remove vegetation from the sediment trap when first detected to prevent pools of standing water and subsequent vector production.

- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs per NS-2 shall be implemented at all times during dewatering activities.

References

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Metzger, M.E., D.F. Messer, C.L. Beitia, C.M. Myers, and V.L. Kramer, The Dark Side of Stormwater Runoff Management: Disease Vectors Associated with Structural BMPs, 2002.

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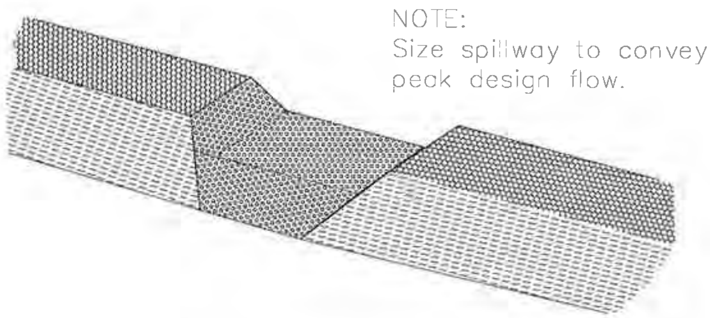
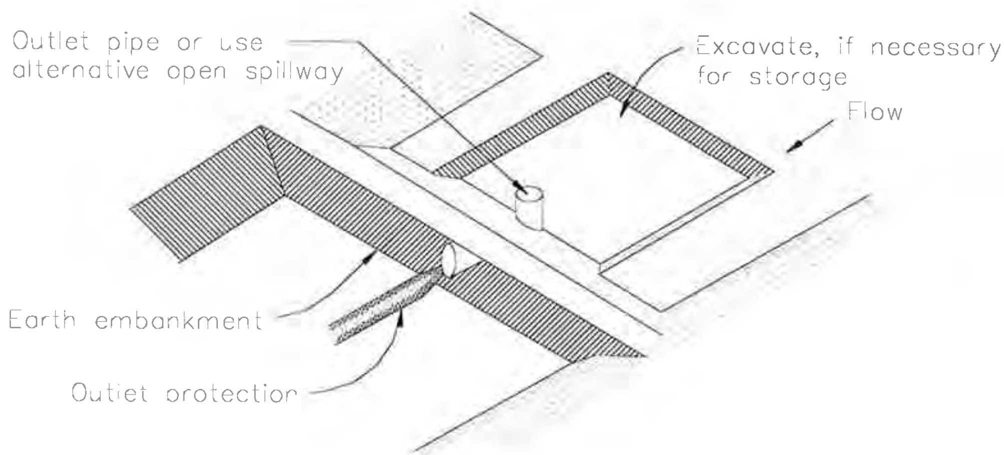
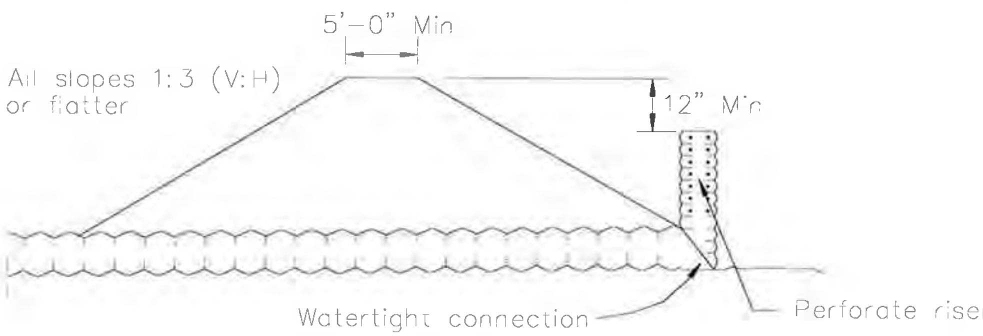


TYPICAL OPEN SPILLWAY

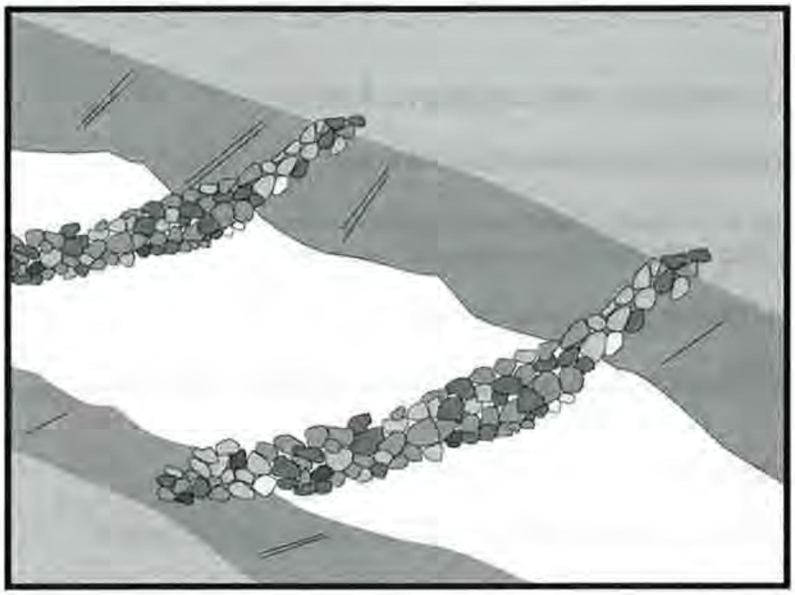




EMBANKMENT SECTION THRU RISER

TYPICAL SEDIMENT TRAP
NOT TO SCALE

Check Dams SE-4



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing scour and channel erosion by reducing flow velocity and increasing residence time within the channel, allowing sediment to settle.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.
- To act as a grade control structure.

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Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion potential or sediment-laden flow is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.
- Do not construct check dams with straw bales or silt fence.
- Water suitable for mosquito production may stand behind check dams, particularly if subjected to daily non-stormwater discharges.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Using check dams to reduce channel slope reduces the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Thus, check dams are dual-purpose and serve an important role as erosion controls as well as as sediment controls. Note that use of 1-2 isolated check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity should be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, either:

- Don't use check dams. Consider alternative BMPs, or.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam (see "Spacing Between Check Dams" detail at the end of this fact sheet). The center section of the dam should be lower than the edge sections (at least 6 inches), acting as a spillway, so that the check dam will direct flows to the center of the ditch or swale (see "Typical Rock Check Dam" detail at the end of this fact sheet). Bypass or side-cutting can occur if a sufficient spillway is not provided in the center of the dam.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products can also be used as check dams (e.g. HDPE check dams, temporary silt dikes (SE-12)), and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam should completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel. It is recommended that abutments be extended 18 in. into the channel bank. Rock can be graded such that smaller diameter rock (e.g. 2-4 in) is located on the upstream side of larger rock (holding the smaller rock in place); increasing residence time.

Log check dams are usually constructed of 4 to 6 in. diameter logs, installed vertically. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

See fiber rolls, SE-5, for installation of fiber roll check dams.

Gravel bag and sand bag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet (see "Gravel Bag Check Dam" detail at the end of this fact sheet).

Manufactured products, such as temporary silt dikes (SE-12), should be installed in accordance with the manufacturer's instructions. Installation typically requires anchoring or trenching of products, as well as regular maintenance to remove accumulated sediment and debris.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- For multiple check dam installation, backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap should be cleaned following each storm event.

- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.

Materials

- Rock used for check dams should typically be 8-12 in rock and be sufficiently sized to stay in place given expected design flows in the channel. Smaller diameter rock (e.g. 2 to 4 in) can be placed on the upstream side of larger rock to increase residence time.
- Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms.
- Sandbags used for check dams should conform to SE-8, Sandbag Barrier.
- Fiber rolls used for check dams should conform to SE-5, Fiber Rolls.
- Temporary silt dikes used for check dams should conform to SE-12, Temporary Silt Dikes.

Installation

- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section (pyramid approach). Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Upper rows or gravel and sand bags shall overlap joints in lower rows.
- Fiber rolls should be trenched in, backfilled, and firmly staked in place.
- Install along a level contour.
- HDPE check dams, temporary silt dikes, and other manufactured products should be used and installed per manufacturer specifications.

Costs

Cost consists of labor costs if materials are readily available (such as gravel on-site). If material must be imported, costs will increase. For other material and installation costs, see SE-5, SE-6, SE-8, SE-12, and SE-14.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, rolls, etc. Replace bags or rolls that have degraded or have become damaged.

- If the check dam is used as a sediment capture device, sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Inspect areas behind check dams for pools of standing water, especially if subjected to daily non-stormwater discharges.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References

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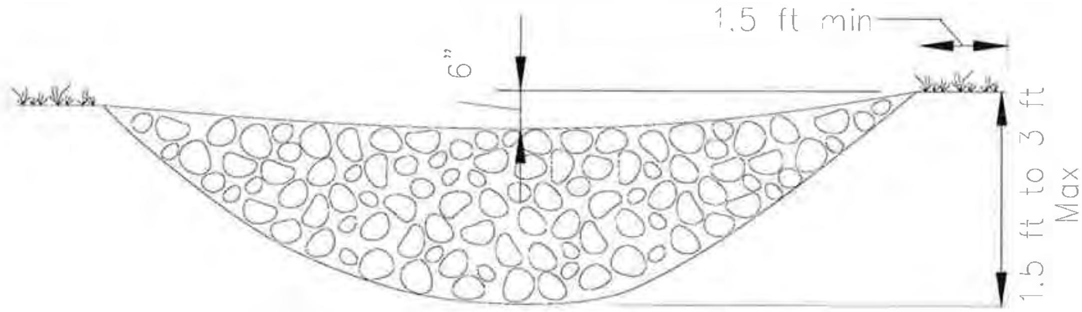
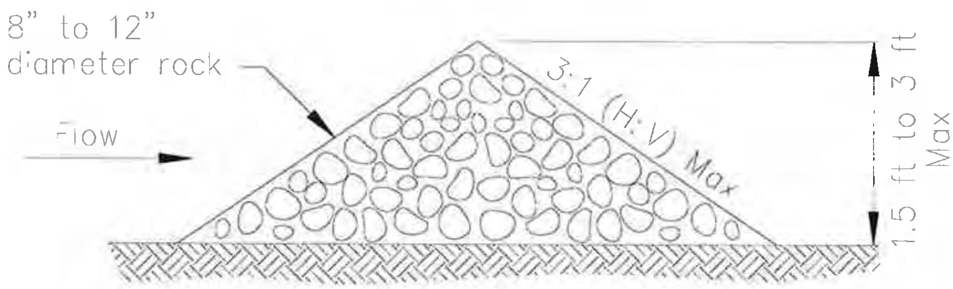
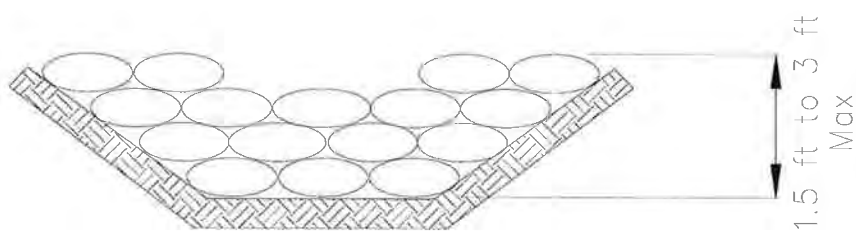


ELEVATION

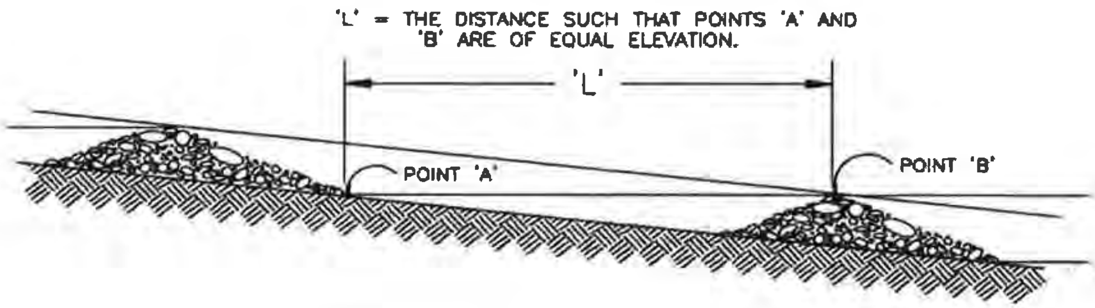


TYPICAL ROCK CHECK DAM SECTION

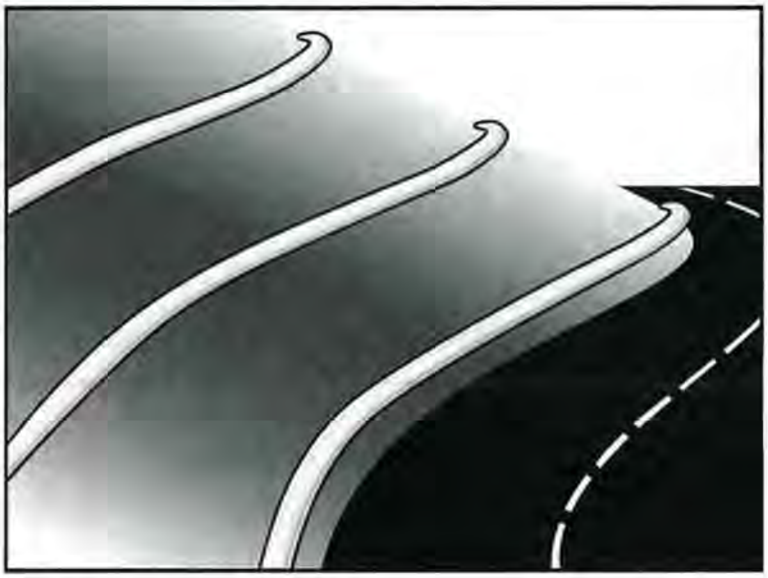
ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE



SPACING BETWEEN CHECK DAMS



Categories		
EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

A fiber roll consists of straw, coir, or other biodegradable materials bound into a tight tubular roll wrapped by netting, which can be photodegradable or natural. Additionally, gravel core fiber rolls are available, which contain an imbedded ballast material such as gravel or sand for additional weight when staking the rolls are not feasible (such as use as inlet protection). When fiber rolls are placed at the toe and on the face of slopes along the contours, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff (through sedimentation). By interrupting the length of a slope, fiber rolls can also reduce sheet and rill erosion until vegetation is established.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
- At the end of a downward slope where it transitions to a steeper slope.
- Along the perimeter of a project.
- As check dams in unlined ditches with minimal grade.
- Down-slope of exposed soil areas.
- At operational storm drains as a form of inlet protection.

- Around temporary stockpiles.

Limitations

- Fiber rolls are not effective unless trenched in and staked.
- Not intended for use in high flow situations.
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.
- Rolls typically function for 12-24 months depending upon local conditions.

Implementation

Fiber Roll Materials

- Fiber rolls should be prefabricated.
- Fiber rolls may come manufactured containing polyacrylamide (PAM), a flocculating agent within the roll. Fiber rolls impregnated with PAM provide additional sediment removal capabilities and should be used in areas with fine, clayey or silty soils to provide additional sediment removal capabilities. Monitoring may be required for these installations.
- Fiber rolls are made from weed free rice straw, flax, or a similar agricultural material bound into a tight tubular roll by netting.
- Typical fiber rolls vary in diameter from 9 in. to 20 in. Larger diameter rolls are available as well.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Prepare the slope before beginning installation.
- Dig small trenches across the slope on the contour. The trench depth should be ¼ to 1/3 of the thickness of the roll, and the width should equal the roll diameter, in order to provide area to backfill the trench.

- It is critical that rolls are installed perpendicular to water movement, and parallel to the slope contour.
- Start building trenches and installing rolls from the bottom of the slope and work up.
- It is recommended that pilot holes be driven through the fiber roll. Use a straight bar to drive holes through the roll and into the soil for the wooden stakes.
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into the trench.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.
- See typical fiber roll installation details at the end of this fact sheet.

Removal

- Fiber rolls can be left in place or removed depending on the type of fiber roll and application (temporary vs. permanent installation). Typically, fiber rolls encased with plastic netting are used for a temporary application because the netting does not biodegrade. Fiber rolls used in a permanent application are typically encased with a biodegradeable material and are left in place. Removal of a fiber roll used in a permanent application can result in greater disturbance.
- Temporary installations should only be removed when up gradient areas are stabilized per General Permit requirements, and/or pollutant sources no longer present a hazard. But, they should also be removed before vegetation becomes too mature so that the removal process does not disturb more soil and vegetation than is necessary.

Costs

Material costs for regular fiber rolls range from $20 - $30 per 25 ft roll.

Material costs for PAM impregnated fiber rolls range between 7.00-$9.00 per linear foot, based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP should be periodically removed

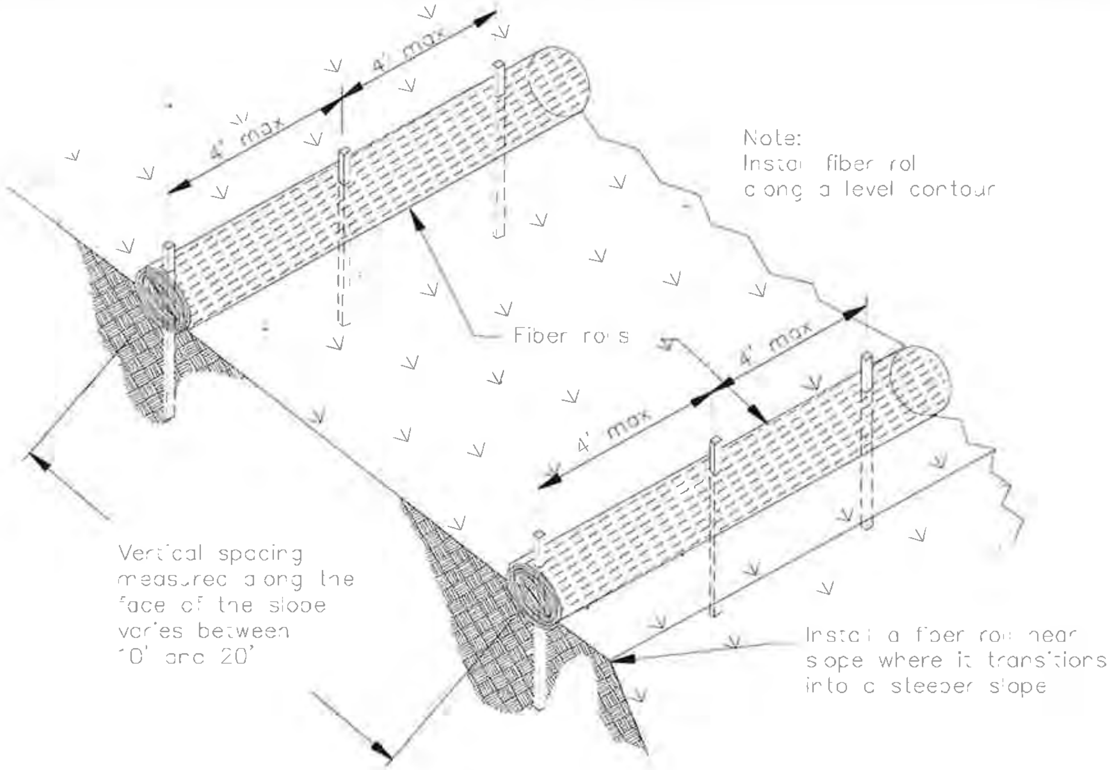
in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-third the designated sediment storage depth.

- If fiber rolls are used for erosion control, such as in a check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.
- Repair any rills or gullies promptly.

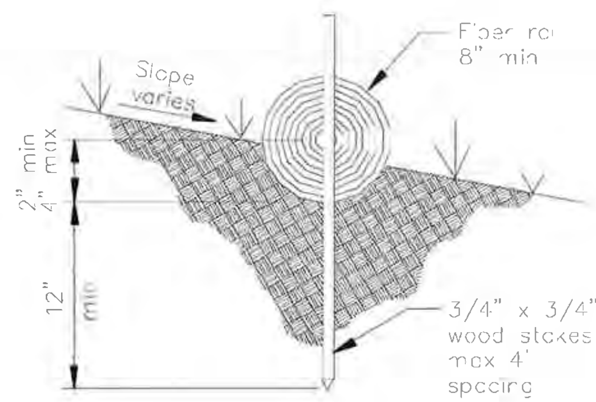
References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

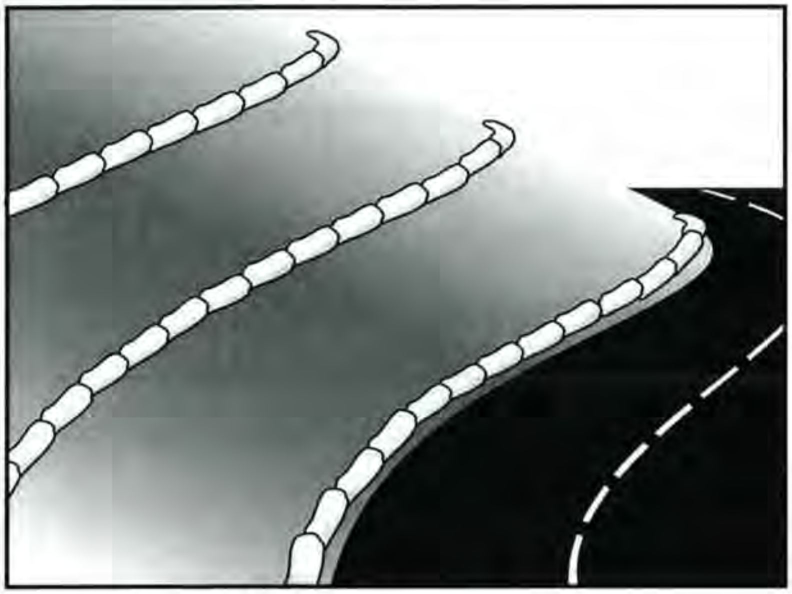


TYPICAL FIBER ROLL INSTALLATION
N.T.S.



ENTRENCHMENT DETAIL
N.T.S.

Gravel Bag Berm SE-6



Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-8 Sandbag Barrier

SE-14 Biofilter Bags

Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As a linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

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- At the top of slopes to divert runoff away from disturbed slopes.

- As chevrons (small check dams) across mildly sloped construction roads. For use check dam use in channels, see SE-4, Check Dams.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Durability of gravel bags is somewhat limited and bags may need to be replaced when installation is required for longer than 6 months.
- Easily damaged by construction equipment.
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers, but are more porous. Generally, gravel bag berms should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate gravel bag berms on level contours.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Gravel bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

Slope inclination 2:1 (H:V) or greater: Gravel bags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, gravel bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the gravel bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more layer construction
  - Top width = 12 in. minimum for one or two layer construction
  - Side slopes = 2:1 (H:V) or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more layer construction.
  - Top width = 12 in. minimum for one or two layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.

- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal, and may vary based on locally available materials.

- ***Fill Material:*** Fill material should be 0.5 to 1 in. crushed rock, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Costs

Material costs for gravel bags are average and are dependent upon material availability. \$2.50-3.00 per filled gravel bag is standard based upon vendor research.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.

- Reshape or replace gravel bags as needed.

- Repair washouts or other damage as needed.

- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Remove gravel bag berms when no longer needed and recycle gravel fill whenever possible and properly dispose of bag material. Remove sediment accumulation and clean, re-grade, and stabilize the area.

References

Handbook of Steel Drainage and Highway Construction, American Iron and Steel Institute, 1983.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Categories		
EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.

- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Costs

Rental rates for self-propelled sweepers vary depending on hopper size and duration of rental. Expect rental rates from \$58/hour (3 yd^3 hopper) to \$88/hour (9 yd^3 hopper), plus operator costs. Hourly production rates vary with the amount of area to be swept and amount of sediment. Match the hopper size to the area and expect sediment load to minimize time spent dumping.

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Labor Surcharge and Equipment Rental Rates, State of California Department of Transportation (Caltrans), April 1, 2002 – March 31, 2003.

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Description and Purpose

Temporary silt dikes are pre-manufactured devices that are typically specified and installed for semi-permanent drainage and sediment control on the perimeter of disturbed sites or stockpiles and as check dams within channels.

Suitable Applications

Temporary silt dikes are generally used in areas as a substitute for fiber rolls and silt fences to slow down runoff water, divert drainage or contain fines and sediment. A temporary silt dike typically consists of a triangular foam or recycled rubber core covered in geotextile fabric. Temporary silt dikes are a linear control and have a variety of profiles (triangular, round, and square). Temporary silt dikes may be suitable for:

- On paved surfaces for perimeter protection.
- As check structures in channels.
- Along the perimeter of disturbed sites in lieu of silt fence.
- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles or material/equipment storage areas.
- At the interface between graveled driveways and pavement.
- Along the toe of exposed and erodible slopes.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Temporary silt dike exposed to sunlight will need to be replaced more frequently due to photo-degradation.
- Reshape or replace sections of damaged temporary silt dike as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove temporary silt dikes when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of properly.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Temporary Silt Dike SE-12

Categories

EC	Erosion Control	☒
SE	Sediment Control	☑
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Description and Purpose

Temporary silt dikes are pre-manufactured devices that are typically specified and installed for semi-permanent drainage and sediment control on the perimeter of disturbed sites or stockpiles and as check dams within channels.

Suitable Applications

Temporary silt dikes are generally used in areas as a substitute for fiber rolls and silt fences to slow down runoff water, divert drainage or contain fines and sediment. A temporary silt dike typically consists of a triangular foam or recycled rubber core covered in geotextile fabric. Temporary silt dikes are a linear control and have a variety of profiles (triangular, round, and square). Temporary silt dikes may be suitable for:

- On paved surfaces for perimeter protection.
- As check structures in channels.
- Along the perimeter of disturbed sites in lieu of silt fence.
- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles or material/equipment storage areas.
- At the interface between graveled driveways and pavement.
- Along the toe of exposed and erodible slopes.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☒
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Roll

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

Limitations

- Temporary silt dikes require additional measures to adhere to asphalt in cold and windy climates, as glue may not adhere adequately to the pavement.
- Temporary silt dikes may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the barrier, possibly causing flooding or bypass if sufficient space does not exist to accommodate ponding.
- Temporary silt dikes may require frequent maintenance especially when used near vehicle traffic or to detain concentrated flows (e.g. check dams or inlet protection).
- When used to detain concentrated flows, maintenance requirements increase.

Implementation

General

When appropriately placed, temporary silt dikes intercept and slow sheet flow runoff, causing temporary ponding. The temporary ponding provides quiescent conditions allowing sediment to settle. The core is porous, which allows the ponded runoff to flow slowly through the silt dike, releasing the runoff as sheet flows. Generally, temporary silt dikes should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control or as a non-stormwater perimeter control.

Design and Layout

- Temporary silt dikes used on soil should be attached to the ground per manufacturer specifications.
- Temporary silt dikes used on asphalt or concrete may be attached using a variety of methods, including nailing the dikes to the pavement, or using a high strength adhesive.
- Follow manufacturer specifications when installing temporary silt dikes.
- Allow sufficient space up slope from the silt dikes to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, temporary silt dike should be set back three feet from the slope toe to facilitate cleaning. Where site conditions do not allow set back, the silt dike may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Butt ends of temporary silt dike tightly. Overlaps should be sealed in accordance with the manufacturer's detail.

Materials

- Several manufactured products are available.

Costs

- Silt dike averages $35-45 per 7 ft. section.

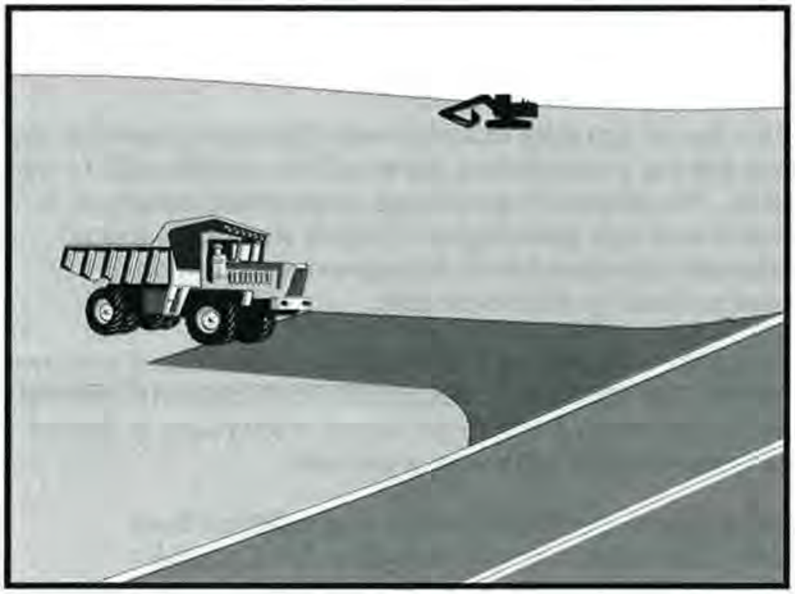
Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Temporary silt dike exposed to sunlight will need to be replaced more frequently due to photo-degradation.
- Reshape or replace sections of damaged temporary silt dike as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove temporary silt dikes when no longer needed. Remove sediment accumulation and clean, re-grade, and stabilize the area. Removed sediment should be incorporated in the project or disposed of properly.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.



Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

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Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft or maximum site will allow, and 10 ft minimum width or to accommodate traffic.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.

- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

- Designate combination or single purpose entrances and exits to the construction site.

- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.

- Implement SE-7, Street Sweeping and Vacuuming, as needed.

- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.

- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.

- Keep all temporary roadway ditches clear.

- Check for damage and repair as needed.

- Replace gravel material when surface voids are visible.

- Remove all sediment deposited on paved roadways within 24 hours.

- Remove gravel and filter fabric at completion of construction

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

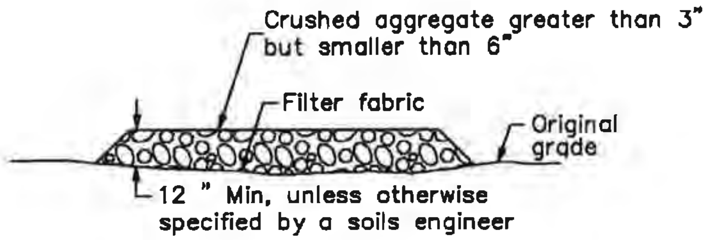
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

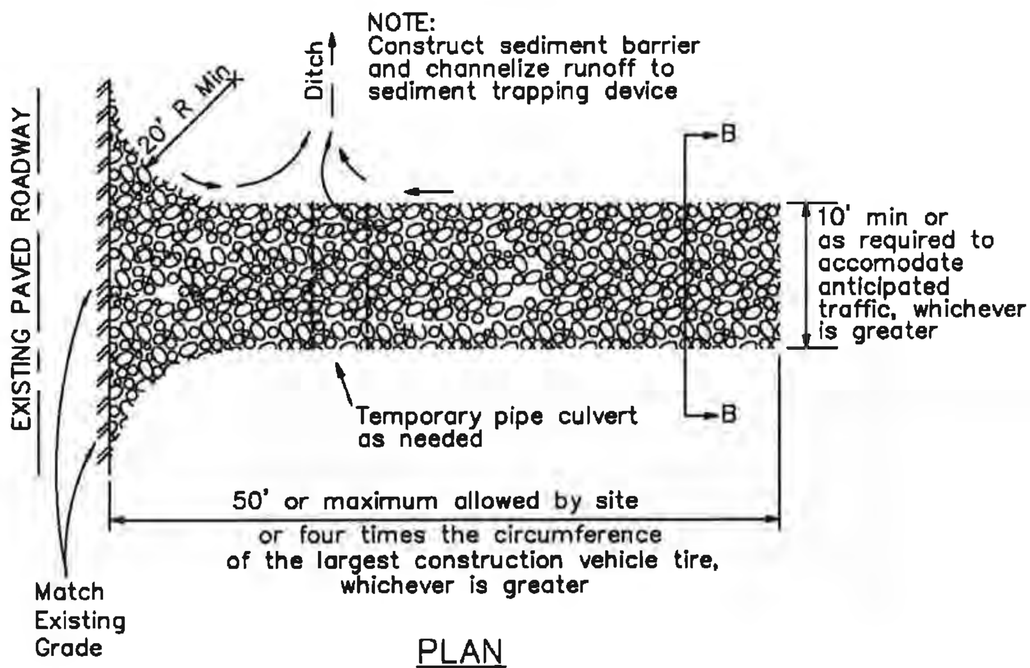
Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

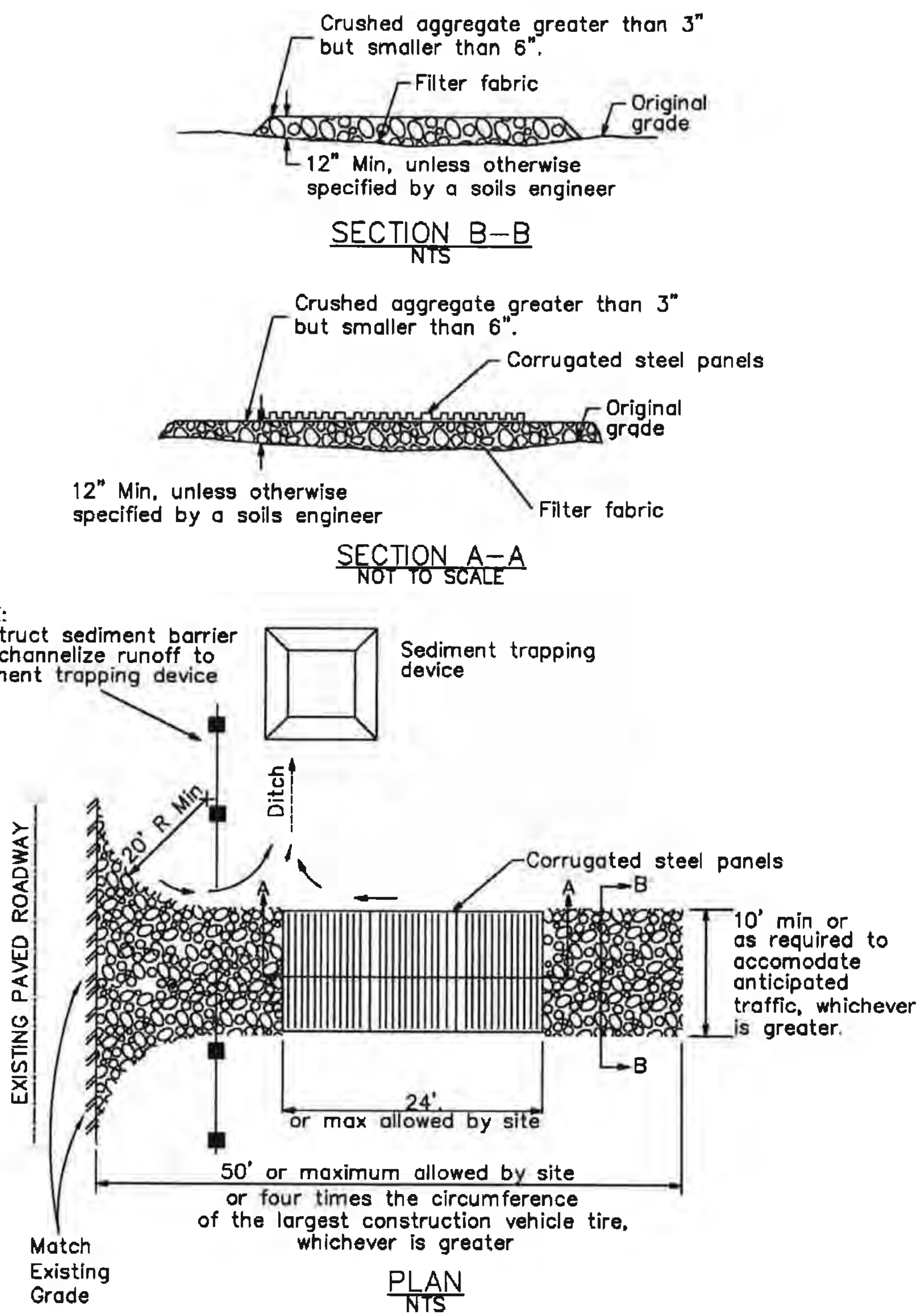
Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.



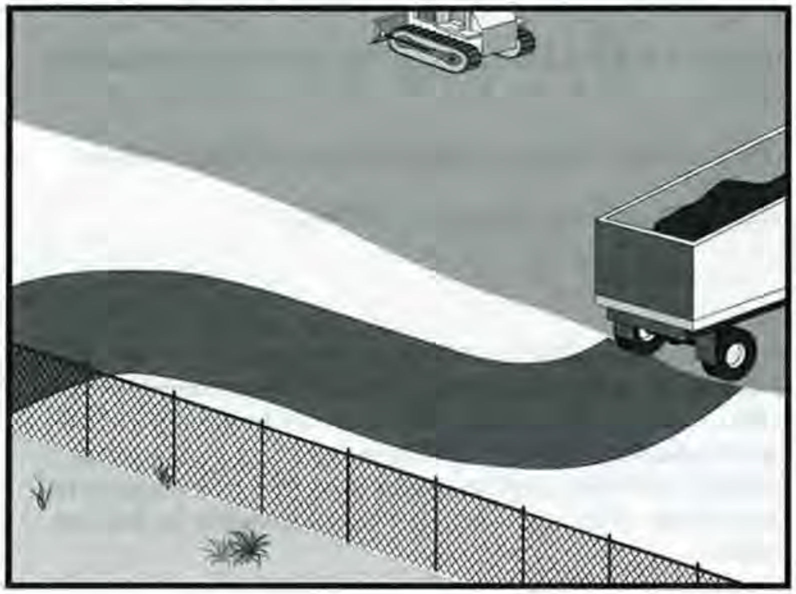
SECTION B–B
NTS



PLAN
NTS


Crushed aggregate greater than 3" but smaller than 6".
Filter fabric
Original grade
12" Min, unless otherwise specified by a soils engineer
SECTION B-B
NTS
Crushed aggregate greater than 3" but smaller than 6".
Corrugated steel panels
Original grade
12" Min, unless otherwise specified by a soils engineer
Filter fabric
SECTION A-A
NOT TO SCALE
NOTE:
Construct sediment barrier and channelize runoff to sediment trapping device
Sediment trapping device
Ditch
20' R Min
EXISTING PAVED ROADWAY
Corrugated steel panels
A
A
B
B
10' min or as required to accomodate anticipated traffic, whichever is greater.
24', or max allowed by site
50' or maximum allowed by site or four times the circumference of the largest construction vehicle tire, whichever is greater
Match Existing Grade
PLAN
NTS

Stabilized Construction Roadway TC-2



Categories

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access
  - Construction during wet weather
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather
  - Where dust is a problem during dry weather
  - Adjacent to water bodies
  - Where poor soils are encountered

Limitations

- The roadway must be removed or paved when construction is complete.
- Certain chemical stabilization methods may cause stormwater or soil pollution and should not be used. See WE-1, Wind Erosion Control.

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CALIFORNIA STORMWATER QUALITY ASSOCIATION

- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-10, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.

- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.

- Coordinate materials with those used for stabilized construction entrance/exit points.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Keep all temporary roadway ditches clear.

- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.

- Periodically apply additional aggregate on gravel roads.

- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

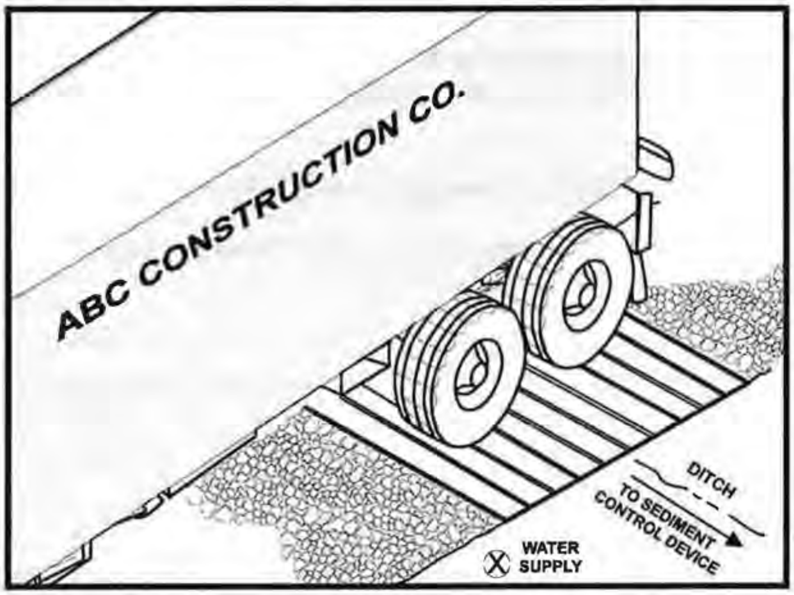
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Entrance/Outlet Tire Wash TC-3



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

TC-1 Stabilized Construction Entrance/Exit

Description and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.

Limitations

- The tire wash requires a supply of wash water.
- A turnout or doublewide exit is required to avoid having entering vehicles drive through the wash area.
- Do not use where wet tire trucks leaving the site leave the road dangerously slick.

Implementation

- Incorporate with a stabilized construction entrance/exit. See TC-1, Stabilized Construction Entrance/Exit.
- Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but smaller than 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.

- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.

- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.

- Implement SC-7, Street Sweeping and Vacuuming, as needed.

Costs
Costs are low for installation of wash rack.

Inspection and Maintenance
- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.

- Inspect routinely for damage and repair as needed.

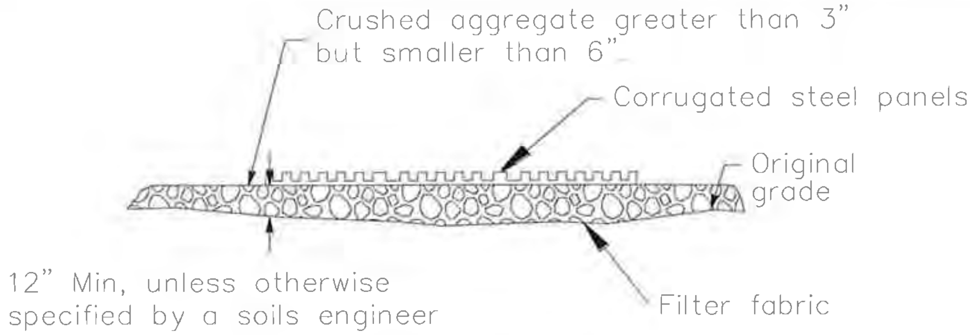
References
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

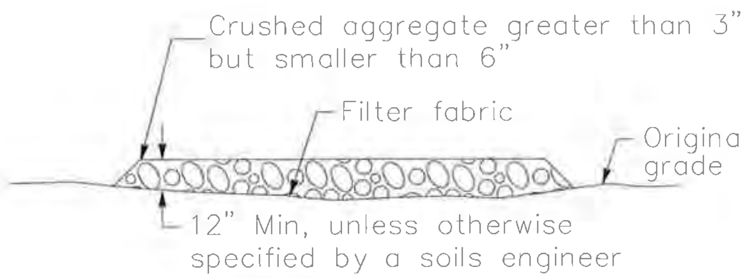
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

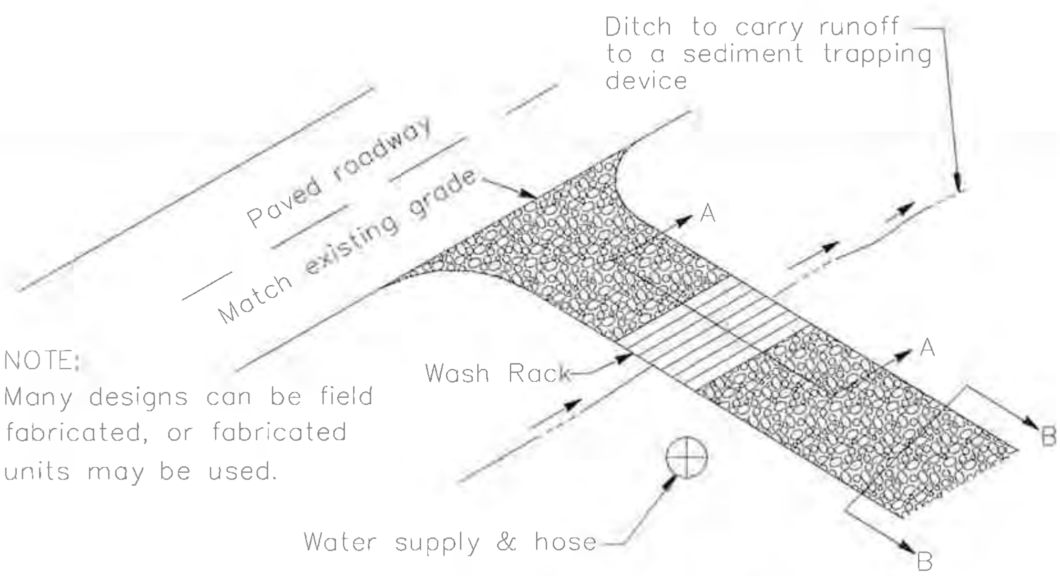
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.



SECTION A–A
NOT TO SCALE



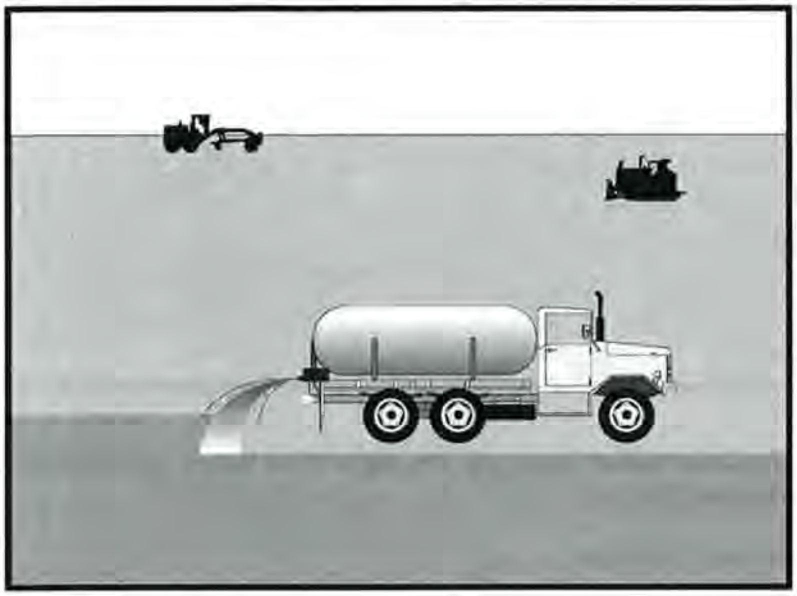
SECTION B–B
NTS



NOTE:
Many designs can be field fabricated, or fabricated units may be used.

TYPICAL TIRE WASH
NOT TO SCALE

Wind Erosion Control WE-1



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	☑
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-5 Soil Binders

Description and Purpose

Wind erosion or dust control consists of applying water or other chemical dust suppressants as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

California's Mediterranean climate, with a short "wet" season and a typically long, hot "dry" season, allows the soils to thoroughly dry out. During the dry season, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking and dust generated by construction equipment. Site conditions and climate can make dust control more of an erosion problem than water based erosion. Additionally, many local agencies, including Air Quality Management Districts, require dust control and/or dust control permits in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. Wind erosion control is required to be implemented at all construction sites greater than 1 acre by the General Permit.

Suitable Applications

Most BMPs that provide protection against water-based erosion will also protect against wind-based erosion and dust control requirements required by other agencies will generally meet wind erosion control requirements for water quality protection. Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period (generally less than a few hours) and should be applied daily (or more often) to be effective.
- Over watering may cause erosion and track-out.
- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Chemical dust suppression agents may have potential environmental impacts. Selected chemical dust control agents should be environmentally benign.
- Effectiveness of controls depends on soil, temperature, humidity, wind velocity and traffic.
- Chemical dust suppression agents should not be used within 100 feet of wetlands or water bodies.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.
- If the soil surface has minimal natural moisture, the affected area may need to be pre-wetted so that chemical dust control agents can uniformly penetrate the soil surface.

Implementation

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table presents dust control practices that can be applied to varying site conditions that could potentially cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures include minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph or less, and controlling the number and activity of vehicles on a site at any given time.

Chemical dust suppressants include: mulch and fiber based dust palliatives (e.g. paper mulch with gypsum binder), salts and brines (e.g. calcium chloride, magnesium chloride), non-petroleum based organics (e.g. vegetable oil, lignosulfonate), petroleum based organics (e.g. asphalt emulsion, dust oils, petroleum resins), synthetic polymers (e.g. polyvinyl acetate, vinyls, acrylic), clay additives (e.g. bentonite, montimorillonite) and electrochemical products (e.g. enzymes, ionic products).

Site Condition	Dust Control Practices							
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Temporary Gravel Construction Entrances/Equipment Wash Down	Synthetic Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X			X
Disturbed Areas Subject to Traffic			X	X	X	X		X
Material Stockpiles		X	X	X			X	X
Demolition			X			X	X	
Clearing/ Excavation			X	X				X
Truck Traffic on Unpaved Roads			X	X	X	X	X	
Tracking					X	X		

Additional preventive measures include:

- Schedule construction activities to minimize exposed area (see EC-1, Scheduling).
- Quickly treat exposed soils using water, mulching, chemical dust suppressants, or stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Restrict construction traffic to stabilized roadways within the project site, as practicable.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality

Control Board (RWQCB) requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."

- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and wheel wash areas.
- Stabilize inactive areas of construction sites using temporary vegetation or chemical stabilization methods.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater and should meet all applicable regulatory requirements.

Costs

Installation costs for water and chemical dust suppression vary based on the method used and the length of effectiveness. Annual costs may be high since some of these measures are effective for only a few hours to a few days.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check areas protected to ensure coverage.
- Most water-based dust control measures require frequent application, often daily or even multiple times per day. Obtain vendor or independent information on longevity of chemical dust suppressants.

References

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

California Air Pollution Control Laws, California Air Resources Board, updated annually.

Construction Manual, Chapter 4, Section 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative", California Department of Transportation (Caltrans), July 2001.

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Material Delivery and Storage WM-1

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:
☑ **Primary Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in watertight containers and/or a completely enclosed designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

- Asphalt and concrete components
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Chemicals must be stored in water tight containers with appropriate secondary containment or in a storage shed.
- When a material storage area is located on bare soil, the area should be lined and bermed.
- Use containment pallets or other practical and available solutions, such as storing materials within newly constructed buildings or garages, to meet material storage requirements.
- Stack erodible landscape material on pallets and cover when not in use.
- Contain all fertilizers and other landscape materials when not in use.
- Temporary storage areas should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be available on-site for all materials stored that have the potential to effect water quality.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located away from waterways, if possible.
  - Avoid transport near drainage paths or waterways.
  - Surround with earth berms or other appropriate containment BMP. See EC-9, Earth Dikes and Drainage Swales.
  - Place in an area that will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.

- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- Keep ample spill cleanup supplies appropriate for the materials being stored. Ensure that cleanup supplies are in a conspicuous, labeled area.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose of materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Materials should be covered prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or completely enclosed storage sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous wastes.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.
- If spills or leaks of materials occur that are not contained and could discharge to surface waters, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

Cost

- The largest cost of implementation may be in the construction of a materials storage area that is covered and provides secondary containment.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Keep storage areas clean and well organized, including a current list of all materials onsite.
- Inspect labels on containers for legibility and accuracy.

- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

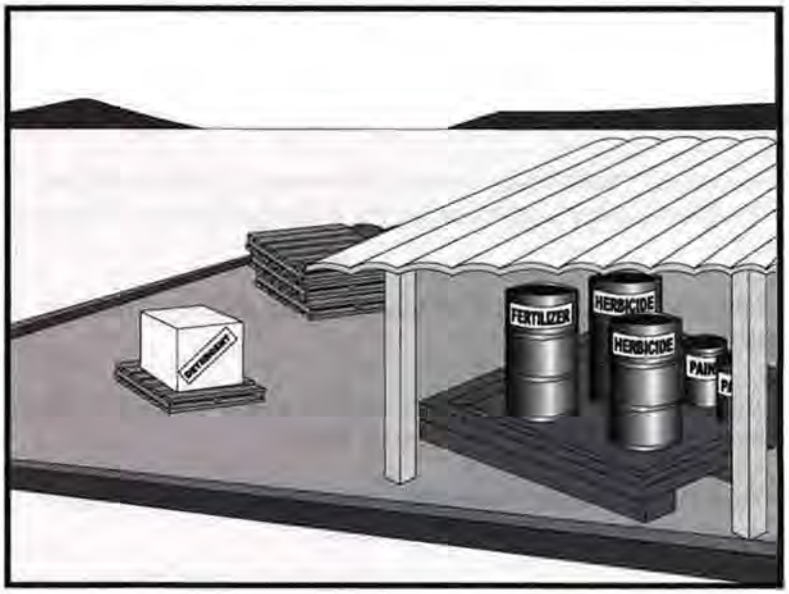
References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides
- Fertilizers
- Detergents
- Petroleum products such as fuel, oil, and grease
- Asphalt and other concrete components
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Other materials that may be detrimental if released to the environment

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite.
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Train personnel who use pesticides. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct onsite inspections.
- The preferred method of termiticide application is soil injection near the existing or proposed structure foundation/slab; however, if not feasible, soil drench application of termiticides should follow EPA label guidelines and the following recommendations (most of which are applicable to most pesticide applications):
  - Do not treat soil that is water-saturated or frozen.
  - Application shall not commence within 24-hours of a predicted precipitation event with a 40% or greater probability. Weather tracking must be performed on a daily basis prior to termiticide application and during the period of termiticide application.
  - Do not allow treatment chemicals to runoff from the target area. Apply proper quantity to prevent excess runoff. Provide containment for and divert stormwater from application areas using berms or diversion ditches during application.
  - Dry season: Do not apply within 10 feet of storm drains. Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds).
  - Wet season: Do not apply within 50 feet of storm drains or aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds) unless a vegetative buffer is present (if so, refer to dry season requirements).
  - Do not make on-grade applications when sustained wind speeds are above 10 mph (at application site) at nozzle end height.
  - Cover treatment site prior to a rain event in order to prevent run-off of the pesticide into non-target areas. The treated area should be limited to a size that can be backfilled and/or covered by the end of the work shift. Backfilling or covering of the treated area shall be done by the end of the same work shift in which the application is made.
  - The applicator must either cover the soil him/herself or provide written notification of the above requirement to the contractor on site and to the person commissioning the

application (if different than the contractor). If notice is provided to the contractor or the person commissioning the application, then they are responsible under the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA) to ensure that: 1) if the concrete slab cannot be poured over the treated soil within 24 hours of application, the treated soil is covered with a waterproof covering (such as polyethylene sheeting), and 2) the treated soil is covered if precipitation is predicted to occur before the concrete slab is scheduled to be poured.

- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydraulic application. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals before predicted rainfall.
- Train employees and subcontractors in proper material use.
- Supply Material Safety Data Sheets (MSDS) for all materials.
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris.
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted, or contain for proper disposal off site. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical.
- Document the location, time, chemicals applied, and applicator's name and qualifications.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.
- Discontinue use of erodible landscape material within 2 days prior to a forecasted rain event and materials should be covered and/or bermed.

- Provide containment for material use areas such as masons' areas or paint mixing/preparation areas to prevent materials/pollutants from entering stormwater.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Ensure employees and subcontractors throughout the job are using appropriate practices.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

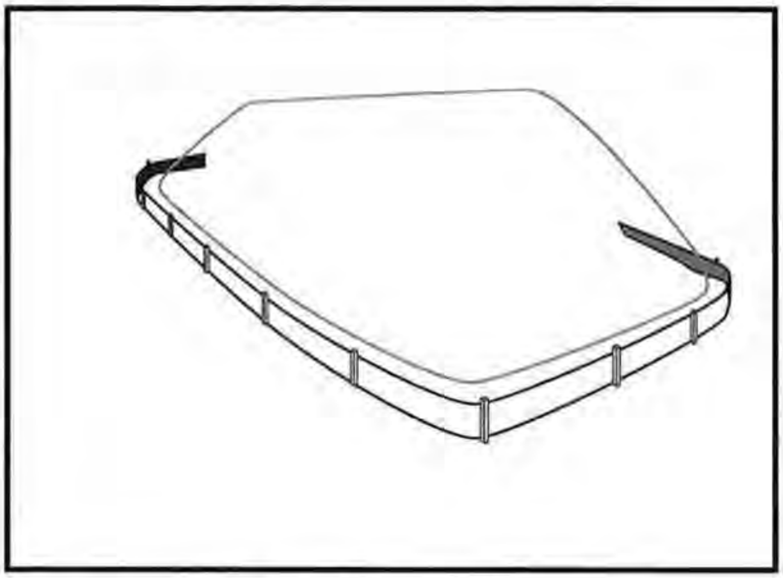
Comments on Risk Assessments Risk Reduction Options for Cypermethrin: Docket No. OPP–2005–0293; California Stormwater Quality Association (CASQA) letter to USEPA, 2006.Environmental Hazard and General Labeling for Pyrethroid Non-Agricultural Outdoor Products, EPA-HQ-OPP-2008-0331-0021; USEPA, 2008.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Stockpile Management

WM-3



Categories

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, soil amendments, sand, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other loose materials.

Limitations

- Plastic sheeting as a stockpile protection is temporary and hard to manage in windy conditions. Where plastic is used, consider use of plastic tarps with nylon reinforcement which may be more durable than standard sheeting.
- Plastic sheeting can increase runoff volume due to lack of infiltration and potentially cause perimeter control failure.
- Plastic sheeting breaks down faster in sunlight.
- The use of plastic materials should be avoided when feasible and photodegradable plastics should not be used.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- On larger sites, a minimum of 50 ft separation from concentrated flows of stormwater, drainage courses, and inlets is recommended.

- All stockpiles are required to be protected immediately if they are not scheduled to be used within 14 days.

- Protect all stockpiles from stormwater run-on using temporary perimeter sediment barriers such as compost berms (SE-13), temporary silt dikes (SE-12), fiber rolls (SE-5), silt fences (SE-1), sandbags (SE-8), gravel bags (SE-6), or biofilter bags (SE-14). Refer to the individual fact sheet for each of these controls for installation information.

- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.

- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.

- Place bagged materials on pallets and under cover.

- Ensure that stockpile coverings are installed securely to protect from wind and rain.

- Some plastic covers withstand weather and sunlight better than others. Select cover materials or methods based on anticipated duration of use.

Protection of Non-Active Stockpiles

Non-active stockpiles of the identified materials should be protected further as follows:

Soil stockpiles

- Cover and project soil stockpiles with soil stabilization measures and a temporary perimeter sediment barrier at all times.

- Consider temporary vegetation for topsoil piles that will be stockpiled for extended periods.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- Provide covers and protect these stockpiles with a temporary perimeter sediment barrier at all times.

Stockpiles of "cold mix"

- Cover cold mix stockpiles and place them on plastic sheeting (or comparable material) and surround the stockpiles with a berm all times.

Stockpiles of fly ash, stucco, hydrated lime

- Cover stockpiles of materials that may raise the pH of runoff (i.e., basic materials) with plastic and surround the stockpiles with a berm at all times.

Stockpiles/Storage of wood (Pressure treated with chromated copper arsenate or ammoniacal copper zinc arsenate)

- Cover treated wood with plastic sheeting (or comparable material) and surround with a berm at all times.

Protection of Active Stockpiles

Active stockpiles of the identified materials should be protected as follows:

- All stockpiles should be covered and protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" and treated wood, and basic materials should be placed on and covered with plastic sheeting or comparable material and surrounded by a berm prior to the onset of precipitation.
- The downstream perimeter of an active stockpile should be protected with a linear sediment barrier or berm and runoff should be diverted around or away from the stockpile on the upstream perimeter.

Costs

For cost information associated with stockpile protection refer to the individual erosion or sediment control BMP fact sheet considered for implementation (For example, refer to SE-1 Silt Fence for installation of silt fence around the perimeter of a stockpile.)

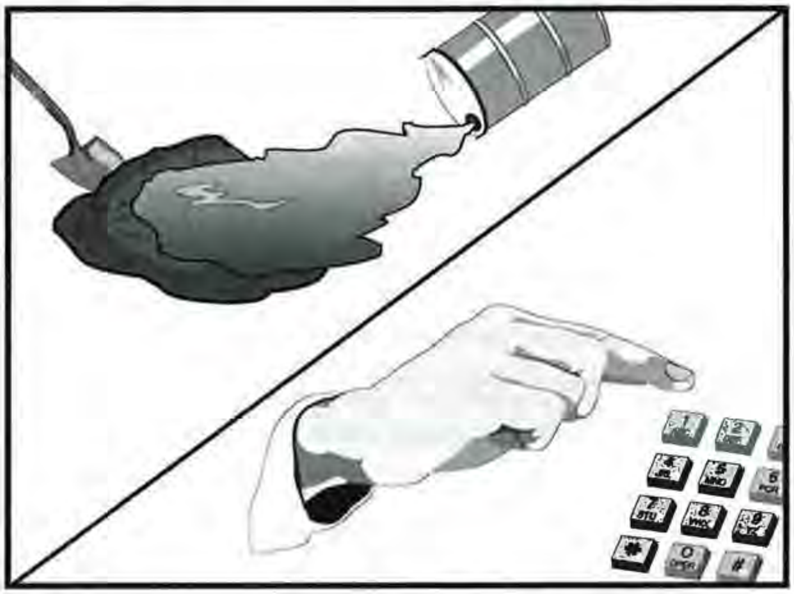
Inspection and Maintenance

- Stockpiles must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- It may be necessary to inspect stockpiles covered with plastic sheeting more frequently during certain conditions (for example, high winds or extreme heat).
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.
- Sediment shall be removed when it reaches one-third of the barrier height.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Spill Prevention and Control WM-4



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

Costs

Prevention of leaks and spills is inexpensive. Treatment and/ or disposal of contaminated soil or water can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Solid Waste Management

WM-5

Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials
- Highway planting wastes, including vegetative material,

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plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Cover waste containers at the end of each work day and when it is raining.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Costs

All of the above are low cost measures.

Inspection and Maintenance

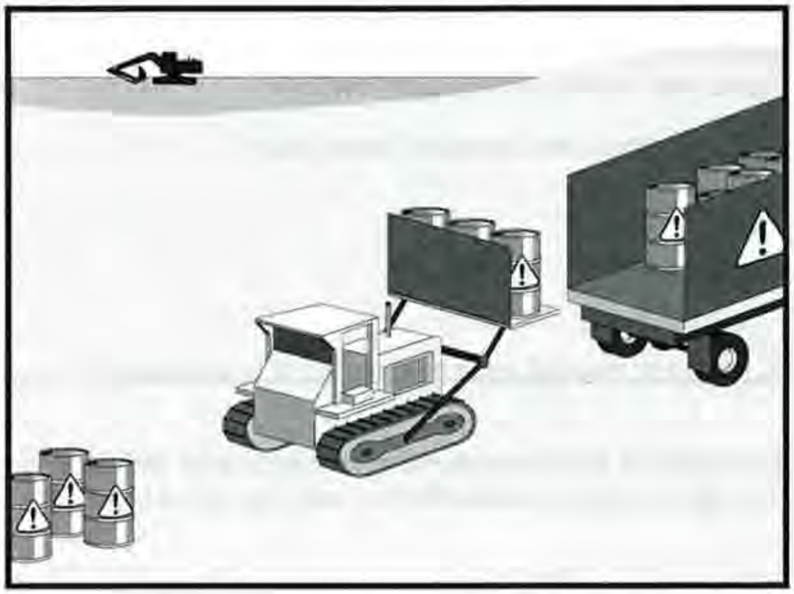
- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

References

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Asphalt Products
- Concrete Curing Compounds
- Pesticides
- Palliatives
- Acids
- Septic Wastes
- Paints
- Stains
- Solvents
- Wood Preservatives
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

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In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled and wastes should not be mixed.
- Unless watertight, containers of dry waste should be stored on pallets.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.
- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.
- The following actions should be taken with respect to temporary contaminant:
  - Ensure that adequate hazardous waste storage volume is available.
  - Ensure that hazardous waste collection containers are conveniently located.
  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
  - Minimize production or generation of hazardous materials and hazardous waste on the job site.
  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.
  - Segregate potentially hazardous waste from non-hazardous construction site debris.
  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events..
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.
- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.
- A copy of the hazardous waste manifests should be provided.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Contaminated Soil Management WM-7

Categories		
EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents	
Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives
None

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the

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plans, specifications, and SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

Costs

Prevention of leaks and spills is inexpensive. Treatment or disposal of contaminated soil can be quite expensive.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.

- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

References

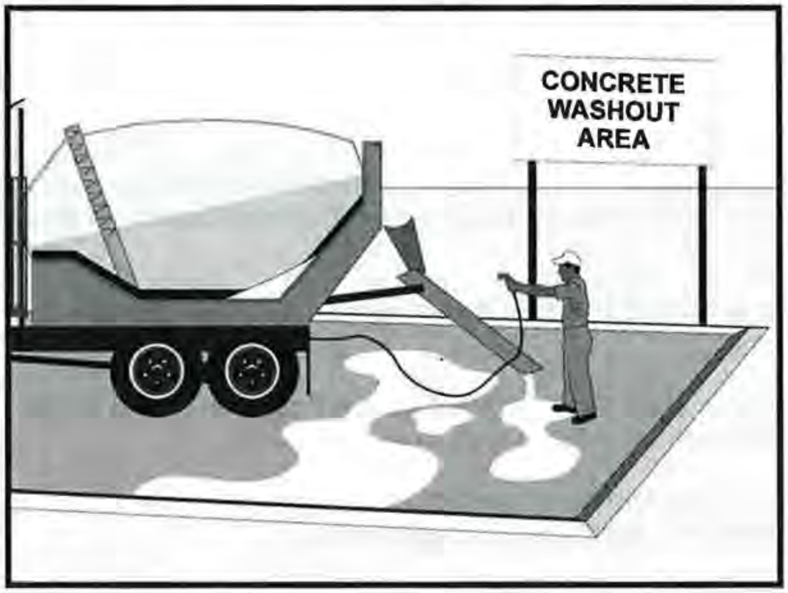
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Concrete Waste Management WM-8



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	☒
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Prevent the discharge of pollutants to stormwater from concrete waste by conducting washout onsite or offsite in a designated area, and by employee and subcontractor training.

The General Permit incorporates Numeric Effluent Limits (NEL) and Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials, including mortar, concrete, stucco, cement and block and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows and raising pH to levels outside the accepted range.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result from demolition activities.
- Slurries containing portland cement concrete (PCC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition.

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- Concrete trucks and other concrete-coated equipment are washed onsite.
- Mortar-mixing stations exist.
- Stucco mixing and spraying .
- See also NS-8, Vehicle and Equipment Cleaning.

Limitations

- Offsite washout of concrete wastes may not always be possible.
- Multiple washouts may be needed to assure adequate capacity and to allow for evaporation.

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Store dry and wet materials under cover, away from drainage areas. Refer to WM-1, Material Delivery and Storage for more information.
- Avoid mixing excess amounts of concrete.
- Perform washout of concrete trucks in designated areas only, where washout will not reach stormwater.
- Do not wash out concrete trucks into storm drains, open ditches, streets, streams or onto the ground. Trucks should always be washed out into designated facilities.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout:
    - On larger sites, it is recommended to locate washout areas at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
    - Washout wastes into the temporary washout where the concrete can set, be broken up, and then disposed properly.
    - Washout should be lined so there is no discharge into the underlying soil.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.
- See typical concrete washout installation details at the end of this fact sheet.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.

- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.
- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.

Concrete Demolition Wastes

- Stockpile concrete demolition waste in accordance with BMP WM-3, Stockpile Management.
- Dispose of or recycle hardened concrete waste in accordance with applicable federal, state or local regulations.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below).
- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- Saw-cut concrete slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine or by sweeping. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement. See also NS-3, Paving and Grinding Operations; and WM-10, Liquid Waste Management.
- Concrete slurry residue should be disposed in a temporary washout facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry. Dispose of dry slurry residue in accordance with WM-5, Solid Waste Management.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Temporary washout facilities should be lined to prevent discharge to the underlying ground or surrounding area.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete wash out.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of or recycled offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of or recycle hardened concrete on a regular basis.
- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft; however, smaller sites or jobs may only need a smaller washout facility. With any washout, always maintain a sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Materials used to construct the washout area should conform to the provisions detailed in their respective BMPs (e.g., SE-8 Sandbag Barrier).
  - Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
  - Alternatively, portable removable containers can be used as above grade concrete washouts. Also called a "roll-off"; this concrete washout facility should be properly sealed to prevent leakage, and should be removed from the site and replaced when the container reaches 75% capacity.
- Temporary Concrete Washout Facility (Type Below Grade)
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

- The base of a washout facility should be free of rock or debris that may damage a plastic liner.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and properly disposed or recycled in accordance with federal, state or local regulations. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and properly disposed or recycled in accordance with federal, state or local regulations..
- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Costs

All of the above are low cost measures. Roll-off concrete washout facilities can be more costly than other measures due to removal and replacement; however, provide a cleaner alternative to traditional washouts. The type of washout facility, size, and availability of materials will determine the cost of the washout.

Inspection and Maintenance

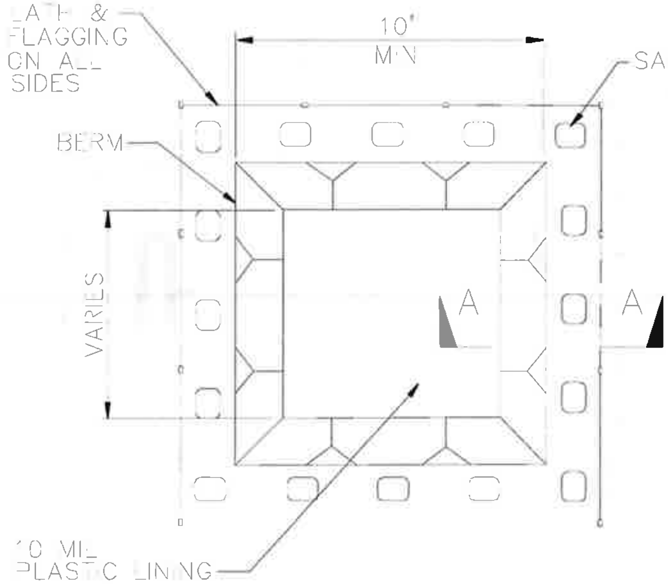
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and properly disposed or recycled in accordance with federal, state or local regulations.
- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.
- Inspect washout facilities for damage (e.g. torn liner, evidence of leaks, signage, etc.). Repair all identified damage.

References

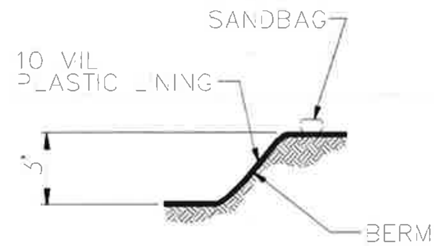
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000, Updated March 2003.

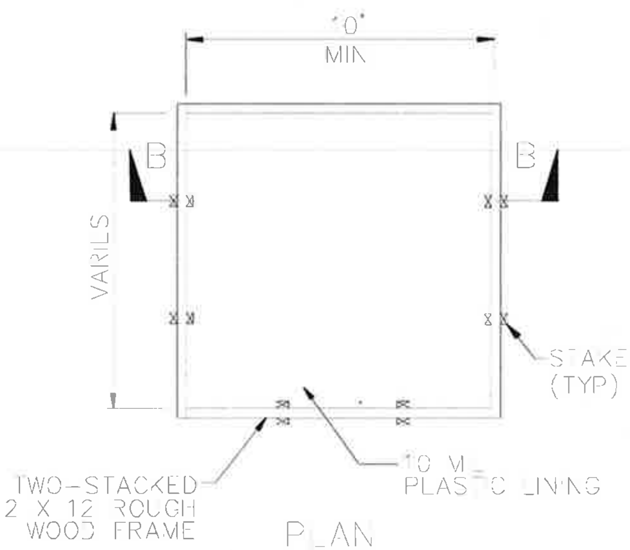
Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



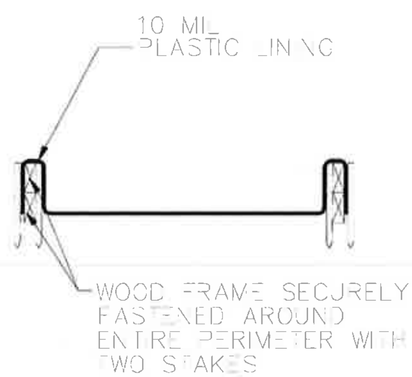
PLAN
NOT TO SCALE
TYPE "BELOW GRADE"



SECTION A-A
NOT TO SCALE



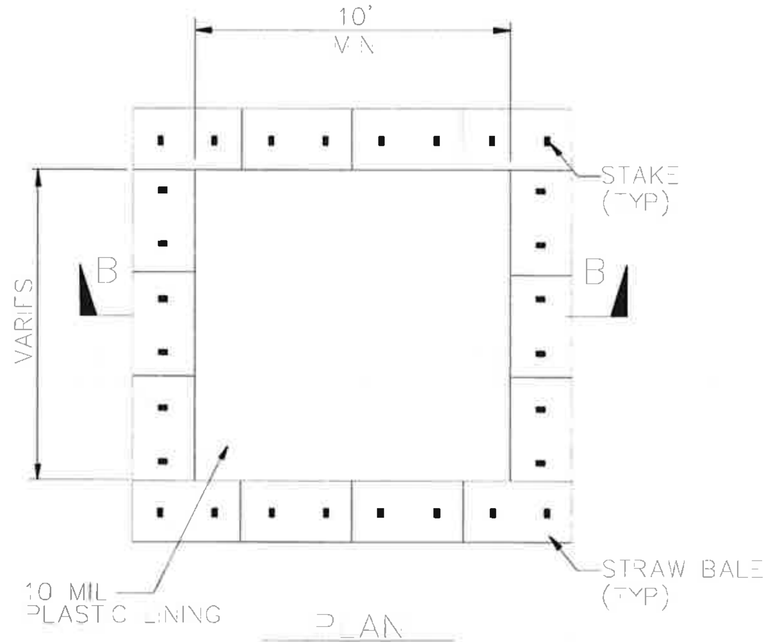
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"



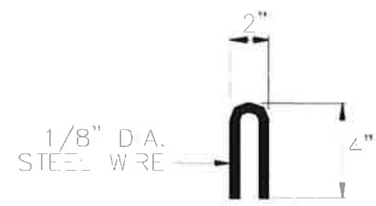
SECTION B-B
NOT TO SCALE

NOTES

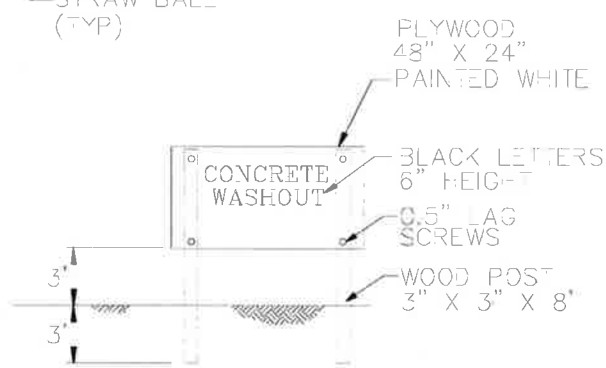
1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.



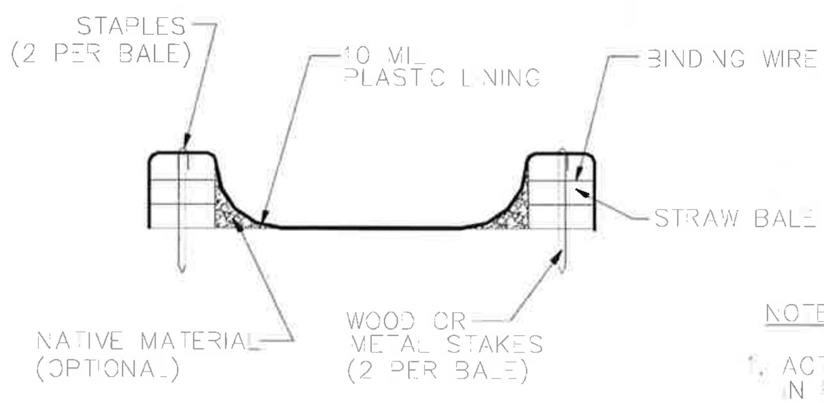
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE" WITH STRAW BALES



STAPLE DETAIL



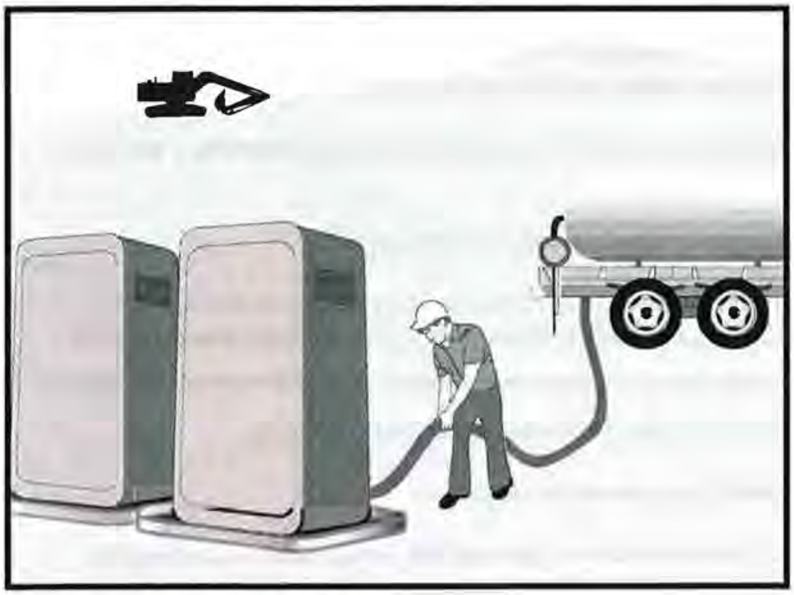
CONCRETE WASHOUT SIGN DETAIL
(OR EQUIVALENT)



SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. If site conditions allow, place portable facilities a minimum of 50 feet from drainage conveyances and traffic areas. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.

- Temporary sanitary facilities must be equipped with containment to prevent discharge of pollutants to the stormwater drainage system of the receiving water.
- Consider safety as well as environmental implications before placing temporary sanitary facilities.
- Wastewater should not be discharged or buried within the project site.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.
- If a spill does occur from a temporary sanitary facility, follow federal, state and local regulations for containment and clean-up.

Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce the use of sanitary facilities (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Costs

All of the above are low cost measures.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Arrange for regular waste collection.

- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.

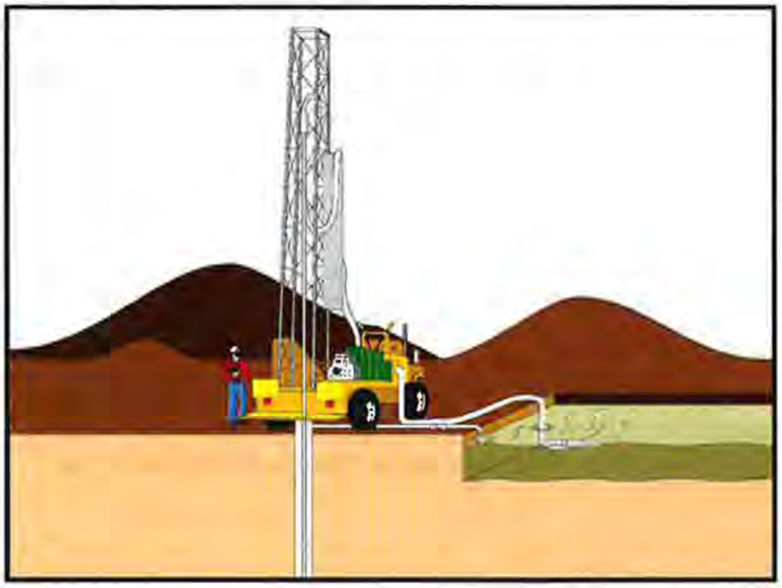
- If spills or leaks from sanitary or septic facilities occur that are not contained and discharge from the site, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), March 2003.

Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

Liquid Waste Management WM-10



Categories

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	☑

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

Description and Purpose

Liquid waste management includes procedures and practices to prevent discharge of pollutants to the storm drain system or to watercourses as a result of the creation, collection, and disposal of non-hazardous liquid wastes.

Suitable Applications

Liquid waste management is applicable to construction projects that generate any of the following non-hazardous by-products, residuals, or wastes:

- Drilling slurries and drilling fluids
- Grease-free and oil-free wastewater and rinse water
- Dredgings
- Other non-stormwater liquid discharges not permitted by separate permits

Limitations

- Disposal of some liquid wastes may be subject to specific laws and regulations or to requirements of other permits secured for the construction project (e.g., NPDES permits, Army Corps permits, Coastal Commission permits, etc.).
- Liquid waste management does not apply to dewatering operations (NS-2 Dewatering Operations), solid waste management (WM-5, Solid Waste Management), hazardous wastes (WM-6, Hazardous Waste Management), or concrete slurry residue (WM-8, Concrete Waste

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Management).

- Typical permitted non-stormwater discharges can include: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated pumped ground water; discharges from potable water sources; foundation drains; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; flows from riparian habitats and wetlands; and discharges or flows from emergency fire fighting activities.

Implementation

General Practices

- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.

- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage device, waterway, or receiving water.

- Educate employees and subcontractors on liquid waste generating activities and liquid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

- Verify which non-stormwater discharges are permitted by the statewide NPDES permit; different regions might have different requirements not outlined in this permit.

- Apply NS-8, Vehicle and Equipment Cleaning for managing wash water and rinse water from vehicle and equipment cleaning operations.

Containing Liquid Wastes

- Drilling residue and drilling fluids should not be allowed to enter storm drains and watercourses and should be disposed of.

- If an appropriate location is available, drilling residue and drilling fluids that are exempt under Title 23, CCR § 2511(g) may be dried by infiltration and evaporation in a containment facility constructed in conformance with the provisions concerning the Temporary Concrete Washout Facilities detailed in WM-8, Concrete Waste Management.

- Liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud, should be contained and not allowed to flow into drainage channels or receiving waters prior to treatment.

- Liquid wastes should be contained in a controlled area such as a holding pit, sediment basin, roll-off bin, or portable tank.

- Containment devices must be structurally sound and leak free.

- Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.

- Precautions should be taken to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in WM-4, Spill Prevention and Control.

- Containment areas or devices should not be located where accidental release of the contained liquid can threaten health or safety or discharge to water bodies, channels, or storm drains.

Capturing Liquid Wastes

- Capture all liquid wastes that have the potential to affect the storm drainage system (such as wash water and rinse water from cleaning walls or pavement), before they run off a surface.

- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.

- Use a sediment trap (SE-3, Sediment Trap) for capturing and treating sediment laden liquid waste or capture in a containment device and allow sediment to settle.

Disposing of Liquid Wastes

- A typical method to handle liquid waste is to dewater the contained liquid waste, using procedures such as described in NS-2, Dewatering Operations, and SE-2, Sediment Basin, and dispose of resulting solids per WM-5, Solid Waste Management.

- Methods of disposal for some liquid wastes may be prescribed in Water Quality Reports, NPDES permits, Environmental Impact Reports, 401 or 404 permits, and local agency discharge permits, etc. Review the SWPPP to see if disposal methods are identified.

- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.

- For disposal of hazardous waste, see WM-6, Hazardous Waste Management.

- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

Costs

Prevention costs for liquid waste management are minimal. Costs increase if cleanup or fines are involved.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Remove deposited solids in containment areas and capturing devices as needed and at the completion of the task. Dispose of any solids as described in WM-5, Solid Waste Management.
- Inspect containment areas and capturing devices and repair as needed.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.