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Docket Number:	23-OPT-02
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TN #:	261851-7
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Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	2/18/2025 2:20:37 PM
Docketed Date:	2/18/2025

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DCEP0002301	DCEP0002303	Re: Darden Clean Energy Project (23-OPT-02) - currently proposed BIO mitigation measures	12/11/2024
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DCEP0002378	DCEP0002382	RE: FW: Darden- Discrepancy with electric grid interconnection description with California ISO description	1/10/2025
DCEP0002383	DCEP0002385	FW: Darden draft solar plan	1/10/2025
DCEP0002386	DCEP0002386	Darden draft solar plan	1/6/2025
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DCEP0002392	DCEP0002395	RE: Additional Information for the Air Quality Section - 23-OPT-02 Darden	1/8/2025

DCEP0002396	DCEP0002397	Re: Darden- Request to docket draft ATC for AQ staff use	1/6/2025
DCEP0002398	DCEP0002399	Fwd: Darden Clean Energy Project (23-OPT-2) - SUP-DR-AQ-3 clarification	1/6/2025
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DCEP0002410	DCEP0002413	Re: [EXTERNAL] RE: Darden draft solar plan	1/14/2025
DCEP0002414	DCEP0002434	Kosciuch et al. 2020 solar fatality summary.pdf	
DCEP0002435	DCEP0002452	Kosciuch etal 2021 birds & solar.pdf	
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DCEP0002486	DCEP0002486	Figure 5.2-6a Overview_Farmland Mapping_01.17.2025.jpg	
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DCEP0002488	DCEP0002491	Re: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report	1/23/2025
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DCEP0002493	DCEP0002494	Stormwater Management Responses 2025-01-23.docx	
DCEP0002495	DCEP0002499	Re: FW: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report	1/22/2025
DCEP0002500	DCEP0002502	Re: Darden-Request for updates to three land use figures	1/22/2025
DCEP0002503	DCEP0002505	FW: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report	1/22/2025
DCEP0002506	DCEP0002508	RE: Darden-Request for updates to three land use figures	1/22/2025
DCEP0002509	DCEP0002510	Darden Clean Energy Project (23-OPT-02) - Notice of Receipt of Opt-In Application and Request for CDFW MOU Coordination	11/13/2023

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 12/6/2024 10:00:32 PM
To: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
CC: Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Darden Clean Energy Project (23-OPT-02) - Appendix V document request

Hi Ann,

The four reports were just submitted to the docket with a request for confidential cover. Hopefully your team is able to access those immediately for review.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Mon, Dec 2, 2024 at 8:42 AM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

Hi Becky,

Hope you had a nice holiday weekend! Do you have an update on if the Swainson's hawk files are available to share?

Thanks!

Ann

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, November 20, 2024 11:38 AM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
Subject: Re: Darden Clean Energy Project (23-OPT-02) - Appendix V document request

Hi Ann,

I'll check on the availability of these materials and if they can be shared privately or publicly.

Thanks,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Wed, Nov 20, 2024 at 12:28 PM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

Hi Becky,

Would you be able to provide the following citations from Appendix V Swainson's Hawk Conservation Strategy_Darden Clean Energy (TN 253021)? CEC BIO staff do not have access to these documents.

> Estep Environmental Consulting. 2011. The Distribution and Abundance of Nesting Swainson's Hawks in the Vicinity of the Proposed RE Tranquillity LLC Solar Generation Facility
> _____. 2011. The Distribution and Abundance of Nesting Swainson's Hawks in the Vicinity of the Proposed RE Tranquillity LLC Solar Generation Facility
> _____. 2013. Swainson's Hawk and Other Raptor Foraging Use of Solar Array Fields within an Agricultural Landscape in Sacramento County. 27 pp.
> _____. 2016. The Distribution and Abundance of Nesting Swainson's Hawks in the Vicinity of the Proposed RE Scarlet Solar Generation Facility. Prepared for RE Scarlet LLC. September.
> _____. 2021. Swainson's Hawk and Other Raptor Foraging Use of Solar Array Fields within an Agricultural Landscape in Sacramento County. Year 2. 41 pp.

Could you please let us know if you are able to provide this information in a timely manner?

Thanks!

Ann

Ann Crisp
Senior Environmental Planner
Siting and Environmental Branch
Siting, Transmission and Environmental Protection Division
1-916-352-0543

California Energy Commission
Website: www.energy.ca.gov

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 12/6/2024 8:22:19 PM
To: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
CC: Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Darden Clean Energy Project (23-OPT-02) - informal request for Water information
Attachments: 2023-04-14_Darden_Prelim Stormwater Mgmt Report.pdf

Hi Ann,

I am going to send the report documents now through Kiteworks due to the size. Hopefully you will have a kiteworks notification in your inbox in a few minutes.

Thanks,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Tue, Nov 19, 2024 at 4:35 PM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

Hi Becky,

Thanks for addressing this request. Any questions please let me know.

Thanks!

Ann

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Tuesday, November 19, 2024 8:27 AM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>
Subject: Re: Darden Clean Energy Project (23-OPT-02) - informal request for Water information

Hi Ann,

Thanks for sending this request so we can review and respond quickly. We will work on gathering this data and submit through the docket. I'll respond to this email to let you know when the items have been submitted.

Thank you,

Becky Moores

INTERSECT POWER
(e) becky.moores@intersectpower.com

On Fri, Nov 15, 2024 at 3:53 PM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

Hi Becky,

While evaluating the application with respect to removal of the green hydrogen component, Water staff determined that the applicant's Data Request Response Set 4 (TN 256296) did not fully respond to Data Request DR WATER-19.

Detention basins are identified in Sections 5.13.1.2, 5.13.1.6, and 5.13.3.2 of the Application as a means of controlling the rate of stormwater runoff. In addition, Data Request Response Set 4, DR WATER-19 (TN 256296) includes Figure 4 which indicates the detention basins would be located at the northeast corner of (16) proposed drainage areas. However, the irregular shape of the detention basins shown in Figure 4 suggests the haphazard ponding of stormwater. Moreover, although details regarding detention basin design are presented in the applicant's Data Request Response Set 4 (TN 256296), a 2D Hydraulic Model and a Preliminary Drainage Report prepared by the applicant are heavily cited in the application materials and Data Request Responses, but was not provided by the applicant.

Please provide a preliminary design drawing of a typical detention basin, 2D Hydraulic Model, and Preliminary Drainage Report to further demonstrate how stormwater will be controlled.

Could you please let us know if you are able to provide this information in a timely manner?

Thanks,

Ann

Ann Crisp
Senior Environmental Planner
Siting and Environmental Branch
Siting, Transmission and Environmental Protection Division
1-916-352-0543

California Energy Commission
Website: www.energy.ca.gov


STATE OF CALIFORNIA
ENERGY COMMISSION

PRELIMINARY DRAINAGE REPORT

Darden Clean Energy Project

Fresno County, California

APRIL 2023

PREPARED FOR:

IP Darden I, LLC

PREPARED BY:

Westwood

Preliminary Drainage Report

Darden Clean Energy Project

Fresno County, California

Prepared For:

Intersect Power
6450 Southwest Gemini Dr.
PMB #68743
Beaverton, OR 970008

Prepared By:

Westwood
12701 Whitewater Drive, Suite 300
Minnetonka, MN 55343
(952) 937-5150

Project Number: R0037938.00
Date: April 14, 2023

Westwood

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Introduction

The purpose of this report is to summarize the proposed stormwater management for the Darden Clean Energy Project ("the project"). This report was prepared to meet water quantity and quality requirements per Fresno County, as well as requirements per state of California requirements and was submitted for the client in conjunction with the conceptual site plan and will need to be revised as design proceeds.

The project site is proposed within a 9,139-acre property boundary and will encompass approximately 8,897 acres of developed area. The project is located approximately 30 miles southwest of the city of Fresno in Fresno County, California. The site's current use is agricultural row crops along with a small number of residential homes and roads.

The area below the proposed solar panels is assumed to be pervious due to the area between and beneath the panels being vegetated. The proposed use of the site will be a solar facility consisting of approximately 8,606 acres of natural desert vegetation and 291 acres of the new impervious surface including gravel access roads, inverters, substation, and other associated solar infrastructure. These values are based on a conservative initial preliminary design and will be updated as design changes.

Minimal grading will be proposed on site and existing drainage patterns will be maintained. Stormwater management practices including detention basins are proposed on site to meet the requirements of the county and state.

Data Sources

TABLE 1: DATA SOURCES

Task	Format	Source	Use
Elevation	5-meter DTM	Intermap	Onsite Model Elevations
Landcover	Shapefile	USDA 2021 Crop Data Layer	Existing Landcover
Soils	Shapefile	USGS SSURGO Dataset	Curve Numbers
Precipitation	PDF File	NOAA Atlas 14	Design Storms
Site Boundary	KMZ	Intersect Power	Define Model Extents
2014 Aerial Photography	ArcGIS Map Service	USDA FSA	Reference
Hydrology Report	PDF	Intersect Power	Hydrology Information

Site Conditions

Site Location

The project site is proposed within a 9,139 acre property boundary and will encompass approximately 8,897 acres. The project is located approximately 30 miles southwest of the city of Fresno in Fresno County, California. See Exhibit 1 for a map of the project location.

Topography Description

The existing topographic information used in this analysis was 5-meter DTM data obtained from Intermap, which was used for onsite elevations. The site is generally flat with slopes around 1%-2.5%.

Drainage Patterns

Onsite runoff is split into 16 drainage areas based on discharge locations and flow paths. Drainage areas are shown in Exhibits 5 & 6. The site sheet flows in one direction and discharges to the northeast. Discharge locations are shown in Exhibits 5 & 6.

FEMA Flood Zones

Intersect Power has completed a 2-D hydraulic study on 12/15/2022 to determine flood hazards for the project location that details FEMA on site. Potential impacts to the FEMA Zones will be assessed as design progresses, and the county will be reached out to for relevant requirements. See Exhibits 5 and 6 for the FEMA Zones within the project area.

Soils

SSURGO soils information was downloaded and incorporated into the analysis. The site consists primarily of Hydrologic Soil Group (HSG) D soils with some locations with HSG C. Type C soils have moderate runoff potential and low infiltration rates. Type D soils have high runoff potential and low infiltration rates. Low infiltration rates can cause localized flooding in low areas for extended periods on site. See Exhibit 3 for the soils distribution throughout the site.

Landcover

A review of aerial photographs and the USDA 2021 Crop Data Layer shows that the site is currently used and has historically been used for agricultural row crops. See Exhibit 4 for a map of the landcover throughout the site.

Requirements

State and Fresno County requirements have been reviewed for the project. All requirements determined to be relevant to the project are summarized below.

Construction Stormwater Requirements

Information on the construction stormwater management for the project will be included as a separate study.

Stormwater Management Requirements

The following requirements need to be met for the project.

TABLE 2: STORMWATER MANAGEMENT REQUIREMENTS

Agency	Location of Requirements	Water Quantity Requirement	Water Quality Requirement	Other
State of California	California SMARTS Calculator	Post Construction Runoff Rates < Pre Construction Runoff Rates	N/A	Rational method must be used for runoff calculations
Fresno County - Fresno Metropolitan Flood Control District	https://www.fresnofloodcontrol.org/	Post Construction Runoff Volume < Pre Construction Runoff Volume	0.5 * (Composite Runoff Coefficient) * (Impervious Area)	Rational method must be used for runoff calculations

Methodology

Existing and proposed conditions are modeled using the Rational Method.

Hydrology

The Rational Method was used in the modeling for predicting direct runoff. Runoff coefficients were assigned by reviewing the soil and landcover for each drainage area and referencing the Fresno County Improvements Manual for corresponding values.

The Metropolitan Flood Control District Post-Development Standards Technical Manual requires the 100-year 48-hour rainfall data be used for the analysis. The intensity from this storm for each drainage area was determined by HydroCAD extrapolating from an IDF curve from Atlas 14 Data based on individual times of concentration.

TABLE 3: RAINFALL TABLE

Drainage Area	100-year 48-hour Rainfall Intensity
1	0.44
2	0.46
3	0.41
4	0.44
5	0.30
6	0.28
7	0.49
8	0.63
9	0.42
10	0.37
11	0.29

Drainage Area	100-year 48-hour Rainfall Intensity
12	0.32
13	0.32
14	0.29
15	0.39
16	0.39

Stormwater Management Approach

A solar project differs greatly from other commercial or residential developments. When constructed, a solar project will include solar panels, at-grade gravel access roads, and other electrical equipment. The panels will be mounted above the ground with a low maintenance natural vegetation below. Due to the area between and beneath the panels being vegetated, panels are not considered an impervious surface. While solar projects may require grading, the existing terrain is smoothed to accommodate array installation, rather than significant changes to grades or slopes, and the grading is designed to maintain existing drainage patterns. Access roads are installed at grade and allow for runoff to sheet flow through the proposed vegetation which provides treatment and reduction in runoff.

The proposed substation, O&M pad, and BESS will be a raised pad and runoff from these areas will sheet flow to basins that outlet similar to existing conditions.

In addition to typical stormwater management BMPs, the recommended approach for solar projects should include the following: limit the amount of impervious surfaces to reduce runoff, minimize the amount of grading to promote sheet flow, and the planting of natural vegetation on the site to provide both runoff reduction and treatment.

Modeling

The site is modeled in existing and proposed conditions in order to complete the water quantity analysis required. Runoff coefficients were found using the Partial Fresno County Improvement Standards Manual to calculate the appropriate C values. See Appendix D for table and equation referenced.

Existing Conditions

The existing site consists of row crops. Runoff coefficient values for rational method calculations were assigned based on the landcover and soil types, see Table 4 for a summary of existing conditions.

TABLE 4: EXISTING CONDITIONS COVER

Cover	Runoff Coefficient	Area (ac)
Row Crops, Poorly Infiltrating Soils	0.49	8,897.60
Total		8,897.60

Proposed Conditions

The use of the site will be a solar facility. The solar modules will be located above grade with low maintenance desert vegetation below the proposed array and a small percentage of impervious areas. An assumption was made that 0.2% of each drainage area was impervious from the proposed piles on site. See Table 5 below for a summary of proposed conditions.

TABLE 5: PROPOSED CONDITIONS COVER

Cover	Runoff Coefficient	Area (ac)
Roads/Substation/BESS Gravel	0.35	269.72
O&M Pad and Piles	1.00	21.49
Low Maintenance Desert Vegetation	0.45	8,605.99
Total		8,897.60

*Areas under Panels are considered vegetated cover, see Stormwater Management Approach section for details.

Results

The results of the various analyses are described below.

Water Quantity Analysis

Stormwater quantity calculations for the site were prepared using the Rational Method. The proposed site meets the rate control requirements of the state. Table 6 shows a summary of the runoff rates for the required storm event for each drainage area. Calculations are included in Appendix A. Basins were not included in the water quantity analysis due to the model showing a reduction in runoff rates and volumes without them.

TABLE 6: RUNOFF RATE SUMMARY

Location	100-year 48-hour Runoff (cfs)	
	Existing	Proposed
1	137.0	125.4
2	135.2	123.6
3	127.4	116.6
4	133.9	122.6
5	74.8	68.5
6	105.2	96.4
7	110.6	99.8
8	61.8	57.0
9	129.7	118.6
10	114.8	105.1
11	92.86	85.0
12	103.2	94.5
13	49.5	45.3
14	90.3	82.6
15	121.3	111.1

Location	Existing	Proposed
16	59.2	54.3
Total	1,646.7	1,506.4

Water Quality Analysis

Treatment of the stormwater quality volume for the site will be provided for each discharge location with proposed detention basins. The basins have been sized to retain 0.5" of runoff over the proposed impervious surfaces, per the county requirement. The initial design is based off conservative impervious estimates and these values will be updated as the project develops further.

See the following equations for basin storage capacity and required storage volume.

$$(Permanent\ Storage)\ V_s = 0.5CA$$

Where,

V_s = Retention basin storage capacity in acre feet or cubic feet.

C = Composite runoff coefficient (Dimensionless)

A = Drainage area in acres or square feet

The basin design capacity shall be calculated using the pyramidal frustum volume equation below.

$$V = \frac{\left[A_B + A_{WS} + (A_B * A_{WS})^{\frac{1}{2}}\right] * D_W}{3}$$

Where,

V = Basin design capacity in cubic feet

A_{WS} = Area of water surface in square feet

A_B = Area of bottom in Square feet

D_W = Average depth of water in feet not including freeboard depth

Table 7 shows the required and provided storage volumes for each discharge location. The provided storage was calculated using the county's volume equation above for the preliminary basin locations shown in Exhibit 6. Calculations can be found in Appendix B.

TABLE 7: BASIN STORAGE SUMMARY

Basin ID	Proposed Impervious (ac)	Required Storage Volume (ac-ft)	Designed Storage Volume (ac-ft)
B01	18.8	3.8	6.3
B02	18.7	3.7	4.6
B03	18.5	3.7	4.1
B04	16.0	3.2	3.4
B05	13.8	1.7	2.8

Basin ID	Proposed Impervious (ac)	Required Storage Volume (ac-ft)	Designed Storage Volume (ac-ft)
B06	19.4	3.9	11.7
B07	41.0	7.0	7.1
B08	22.1	6.3	9.6
B09	19.6	3.9	5.8
B10	16.6	3.3	3.8
B11	17.3	3.5	7.6
B12	17.4	3.5	5.3
B13	10.3	2.1	4.5
B14	20.4	4.1	6.3
B15	15.1	1.4	2.1
B16	6.2	1.8	3.1
Total	291.2	56.8	88.0

Stormwater Management Practices

Basin Calculations

The proposed basins must meet various county requirements. See Table 8 below for a summary of the basin design factors. A more detailed basin design will be provided as the project progresses.

TABLE 8: DETAILED BASIN REQUIREMENTS

Item	Requirement
Freeboard	Min. 1' from 100-year HWL to top of berm

Crossing Sizing

Crossing locations and sizing will be reviewed as the design progresses. Due to the topography of the site being flat, minimal crossings are anticipated.

Conclusion

The proposed site was designed to meet the water quantity requirements of California with the addition of water quality requirements for Fresno County. The proposed site consists of detention basins to capture and treat runoff from the proposed impervious surfaces. The change in landcover provides a reduction in runoff from existing to proposed conditions. The analysis is based of a conservative preliminary layout and will be updated as the project progresses.

References Cited

National Engineering Handbook, Part 630 Hydrology. Chapter 9 Hydrologic Soil-Cover Complexes. USDA. NRCS. 210-VI-NEH, July 2004

Intermap, 5-meter LAS, Elevation data, Accessed March 2023,

https://www.intermap.com/

Web soil survey. Retrieved March 2023, from https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

USGS. USGS water resources: About USGS water resources. Retrieved March 2023, from https://water.usgs.gov/GIS/huc.html

USDA 2021 Crop Data Layer, Landcover data, retrieved March 2023, from https://www.nass.usda.gov/Research_and_Science/Cropland/SARS1a.php

Exhibits

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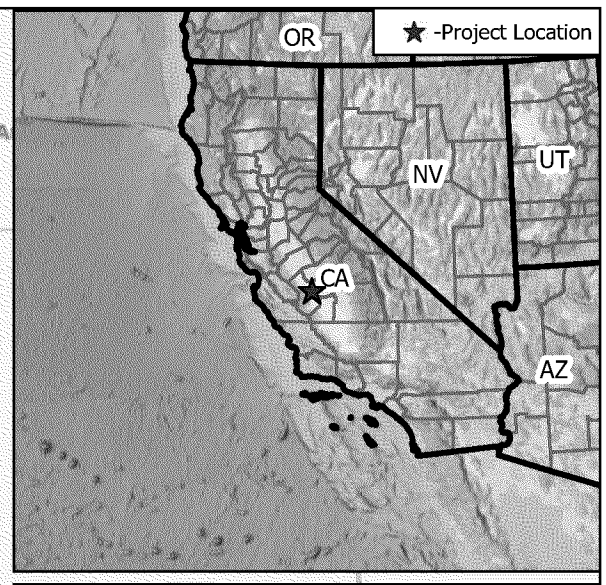
Location Map - | 4/13/2023 8:53 AM | KMZangel



Imont Ave
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Fresno Slough
S James Rd
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ietta Farm
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33
Colorado Ave
San Joaquin
W Manning Ave
W Manning Ave
S Colorado Ave
W Floral Ave
33
S Derrick Ave
S San Mateo Ave
McMullin
Colorado Ave
Helm
S Lassen Ave
e Rocks
Cantua Creek
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S Conejo Ave
W Harlan Ave
Mt Whitney Ave
Mt Whitney Ave
Five Points
5
Westside
California Aqueduct
Fresno Coalinga Rd
S Lassen Ave
5
W Oakland Ave
Calflax
W Oakland Ave

Data Source(s): Westwood (2023); Esri WMS Basemap Imagery (Accessed 2023); USGS (2023); FEMA (2023); USDA (2023)

Legend

Property Boundary

County Boundary

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Darden Clean Energy Project

Fresno County, CA

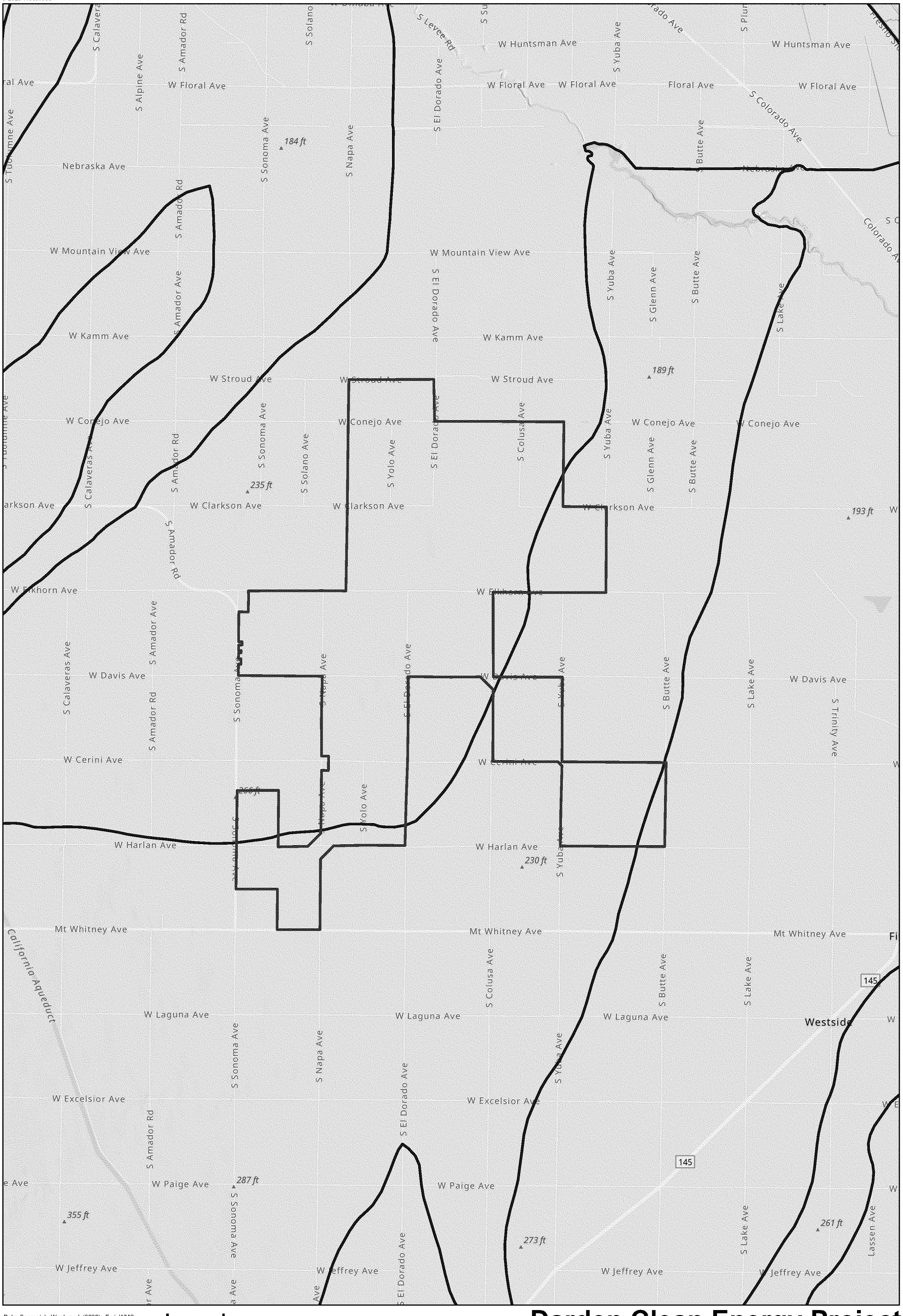
N

0 2 Miles

Exhibit 1: Location Map

April 13, 2023

N:\0037938.00_GIS_Data_SHP\SWMR Exhibits\Darden Solar Project\Darden Solar Project.aprx
Base Hydrologic Map - Base Hydrologic Map | 4/13/2023 9:07 AM | KMZangel



Data Source(s): Westwood (2023); Esri WMS Basemap Imagery (Accessed 2023); USGS (2023); FEMA (2023); USDA (2023)

Legend

- Property Boundary
- HUC-12 Boundary
- County Boundary
- NHD Flowlines

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N

0 4,000 Feet

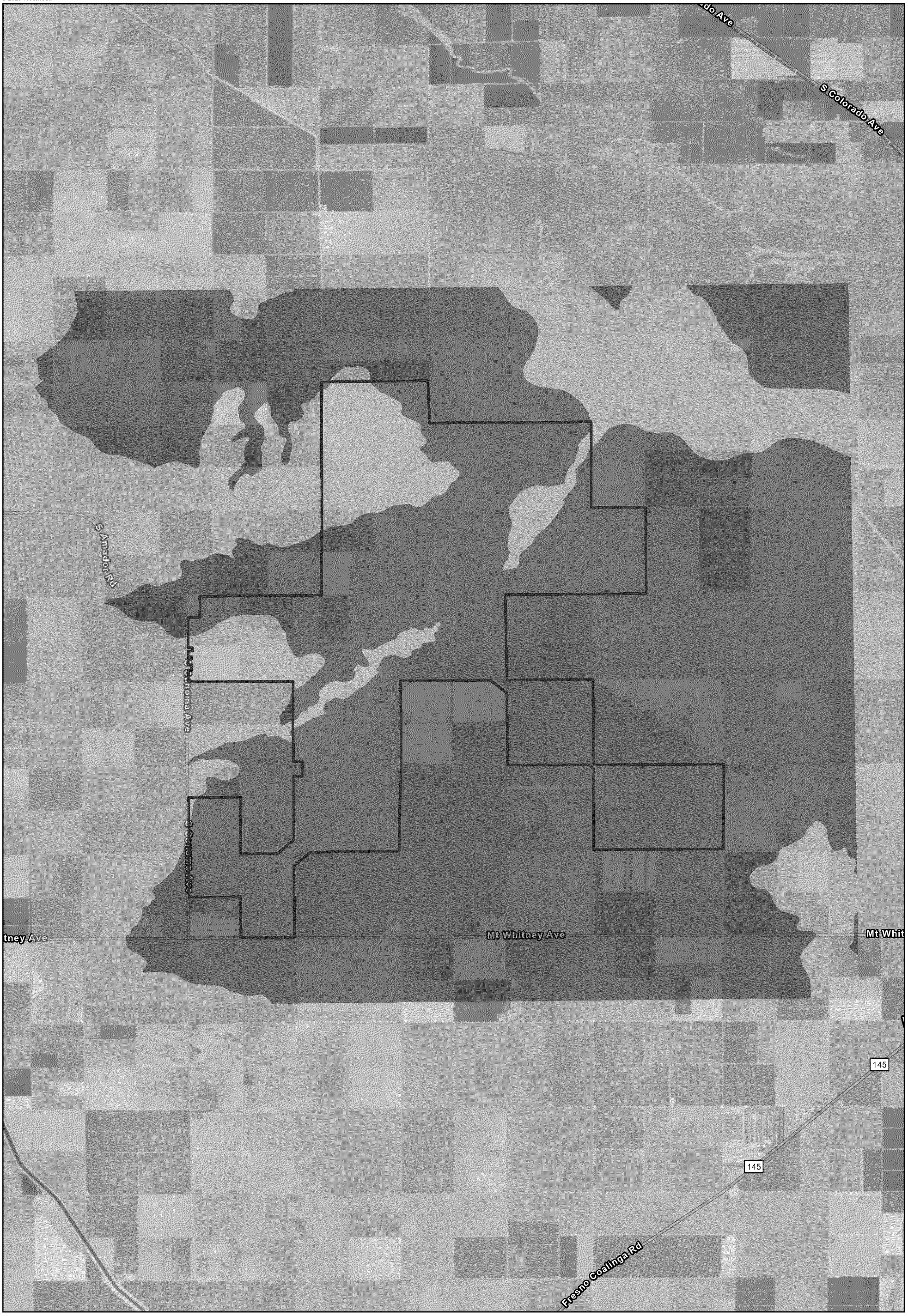
Darden Clean Energy Project

Fresno County. CA

Exhibit 2: Base Hydrologic Map

April 13, 2023

N:\0037938.00_GIS_Data_SHP\SWMR Exhibits\Darden Solar Project\Darden Solar Project.aprx
Soils Map - Soil Map | 4/13/2023 8:55 AM | KMZangel



Data Source(s): Westwood (2023); Esri WMS Basemap Imagery (Accessed 2023); USGS (2023); FEMA (2023); USDA (2023)

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Legend

- Property Boundary
- County Boundary

Hydrologic Soils Group

- A
- B
- C
- D
- W

Darden Clean Energy Project

Fresno County, CA

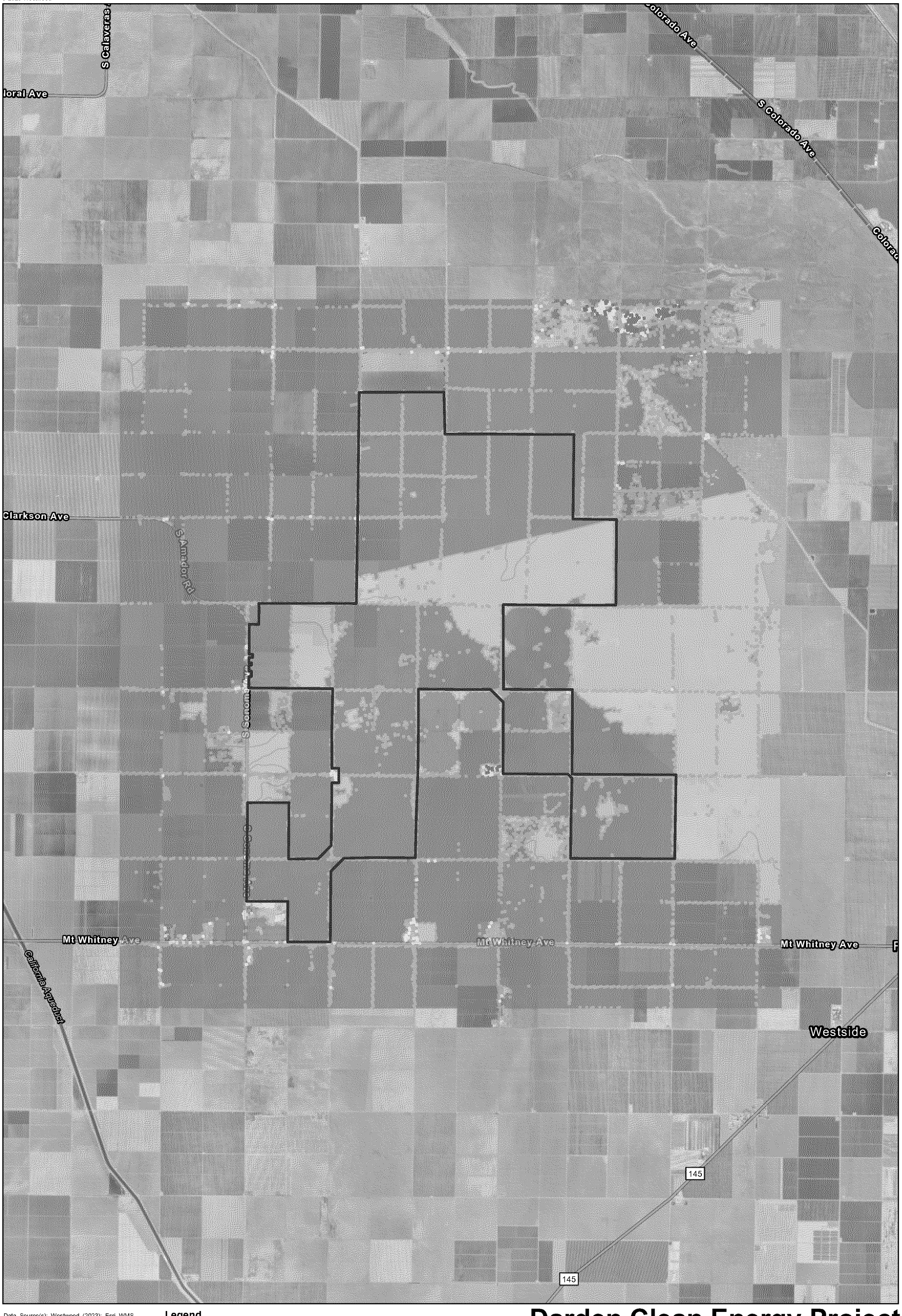
N

0 4,000 US Feet

Exhibit 3: Soils Map

April 13, 2023

N:\0037938.00_GIS_Data_SHP\SWMR Exhibits\Darden Solar Project\Darden Solar Project.aprx
Landcover Map - Landcover Map | 4/13/2023 8:56 AM | KMZangel



Data Source(s): Westwood (2023); Esri WMS Basemap Imagery (Accessed 2023); USGS (2023); FEMA (2023); USDA (2023)

Legend

- Property Boundary
- County Boundary
- Layer
- Landcover
- Barren
- Cultivated
- Developed
- Fallow
- Woods
- Grassland/Pasture
- Shrubland
- Water
- Wetland

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Darden Clean Energy Project

Fresno County, CA

N

0 1 Miles

Exhibit 4: Landcover Map

April 13, 2023

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR (900)
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT (STO)
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROWS
- DRAINAGE AREA LABEL (1)

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REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 1700' 3400' 5100'

IP Darden

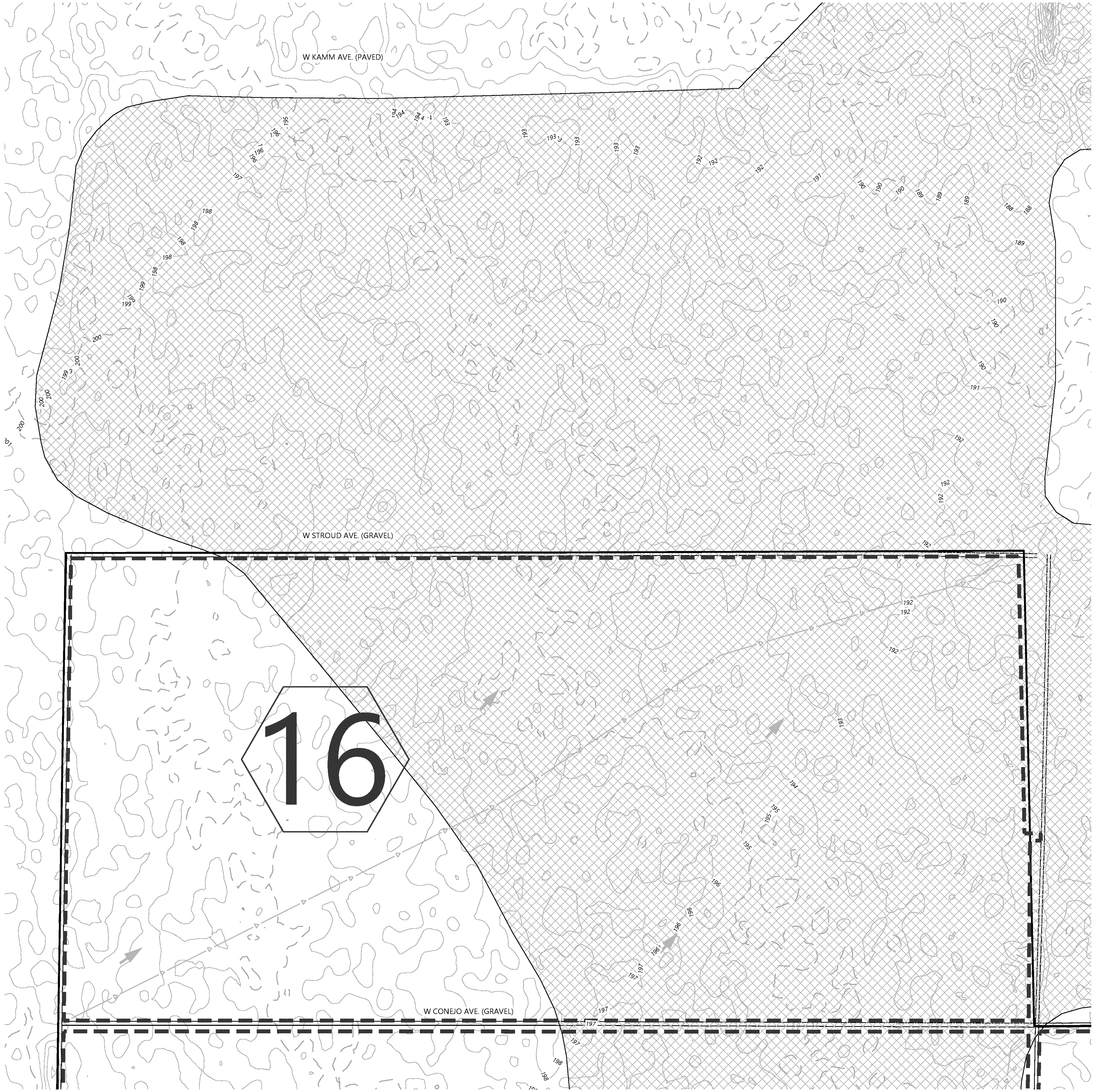
Fresno County, CA

Overall Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5



SEE SHEET 5B

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
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0' 300' 600' 900'

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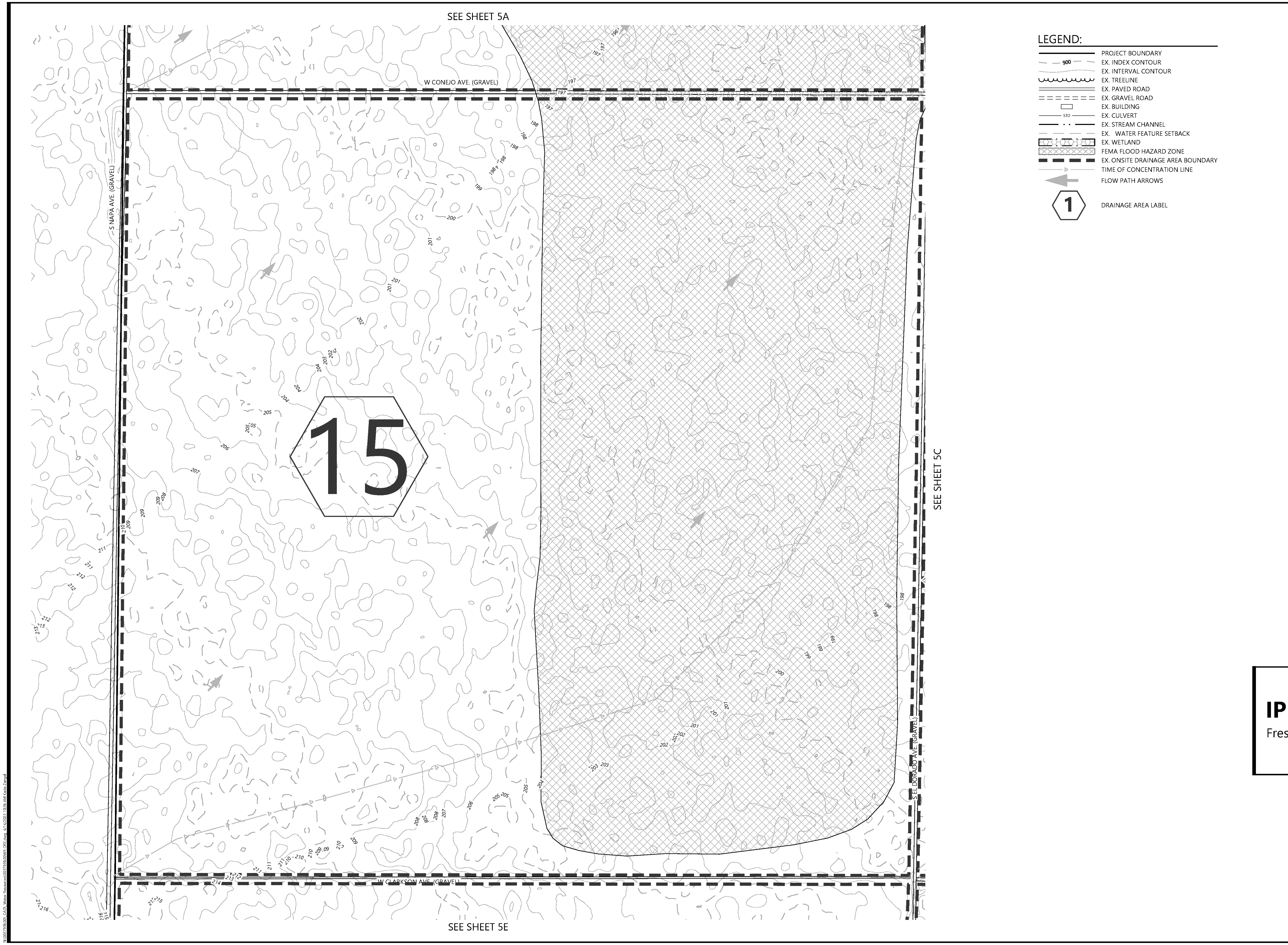
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5A



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IP Darden

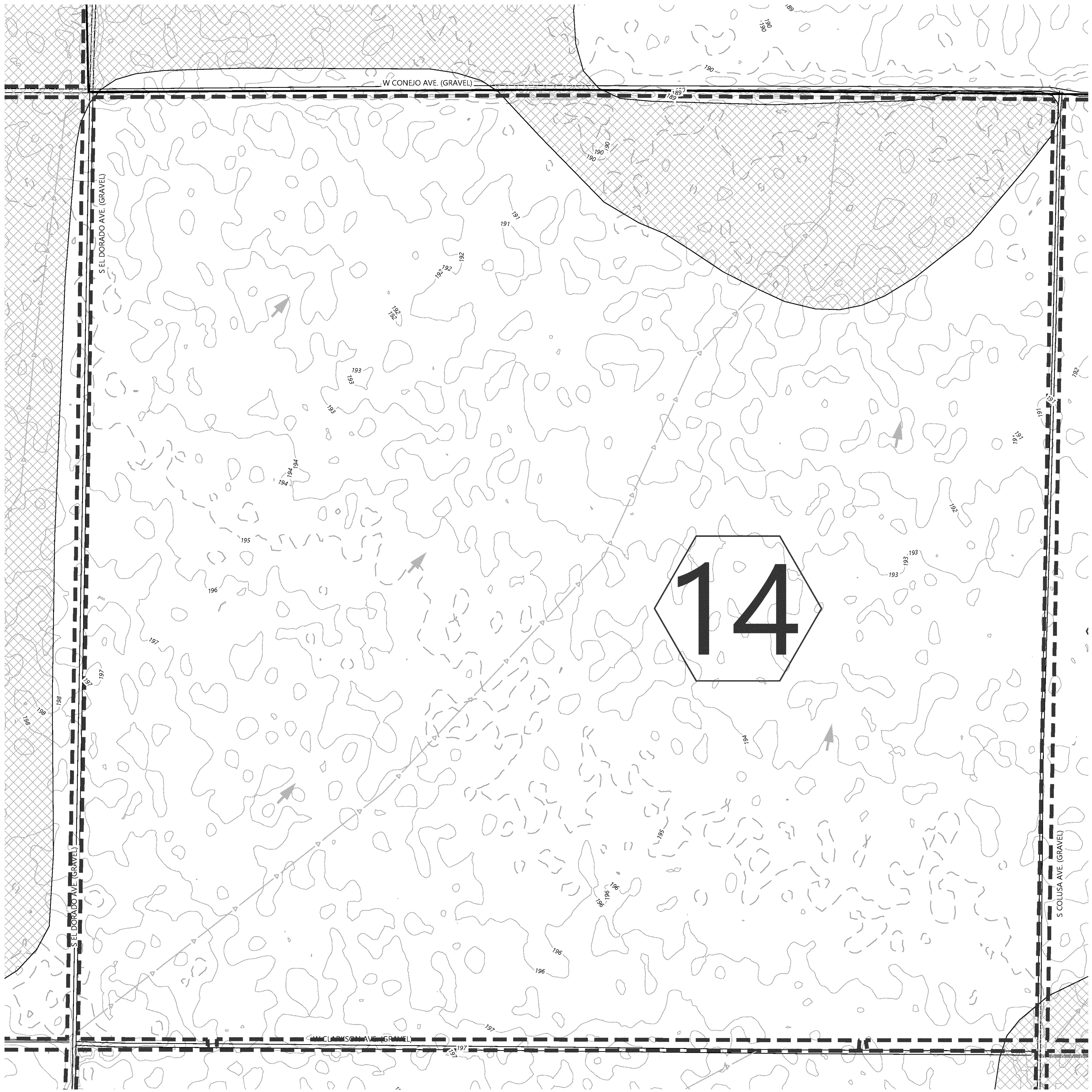
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

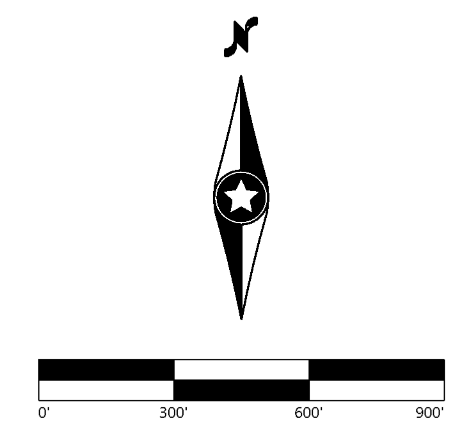
REV:

SHEET: 5B



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR (900)
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT (STO)
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROWS
- DRAINAGE AREA LABEL (1)



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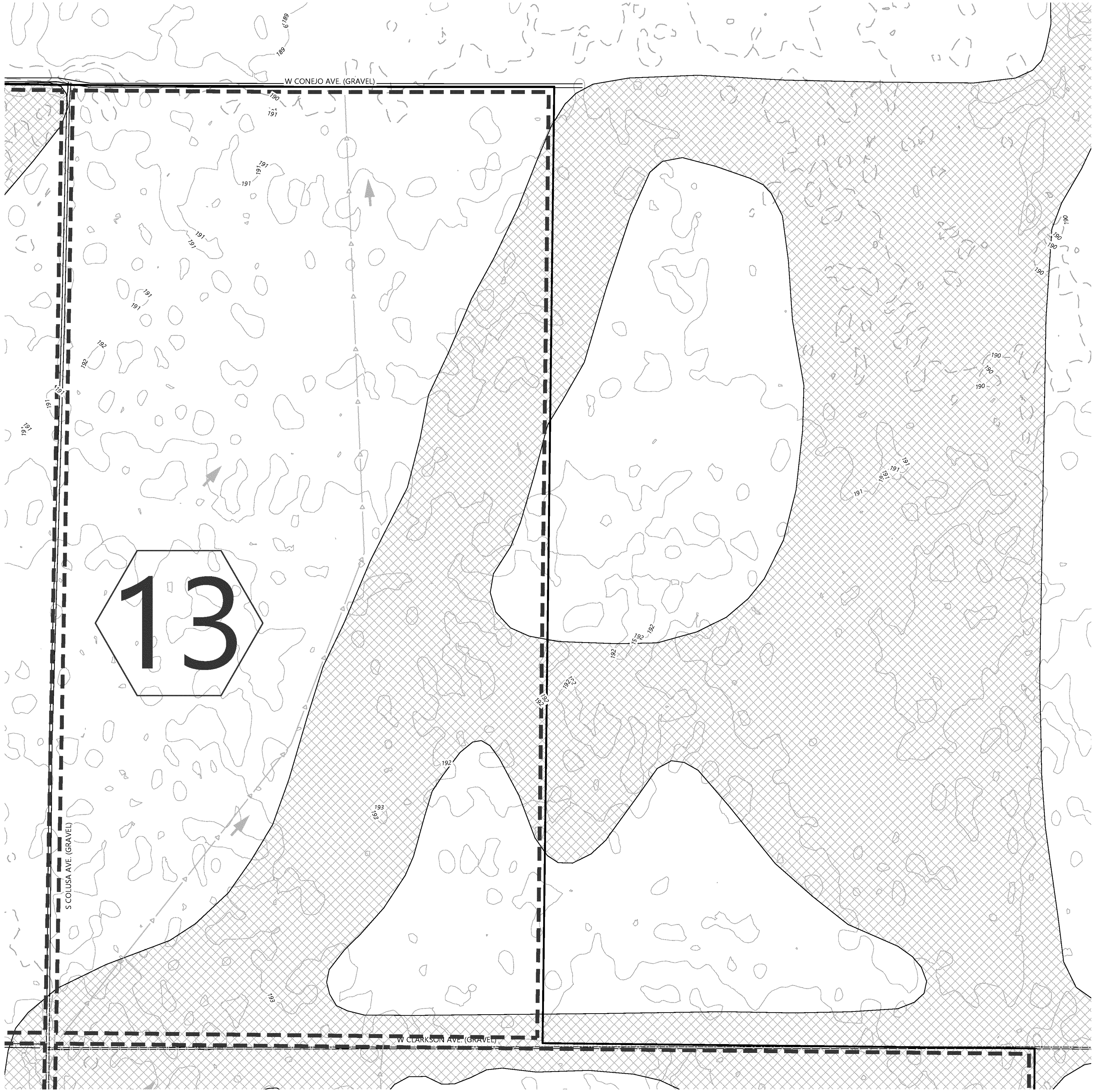
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5C



SEE SHEET 5C

SEE SHEET 5G

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR (900)
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
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- (1) DRAINAGE AREA LABEL

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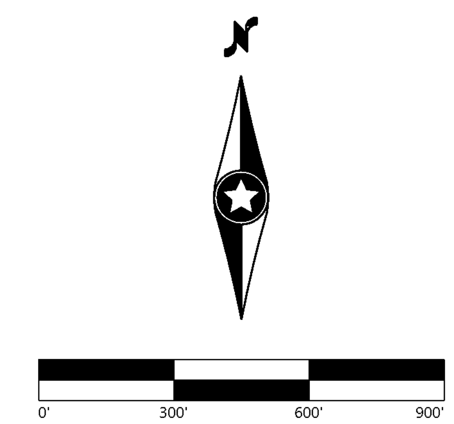


IP Darden

Fresno County, CA

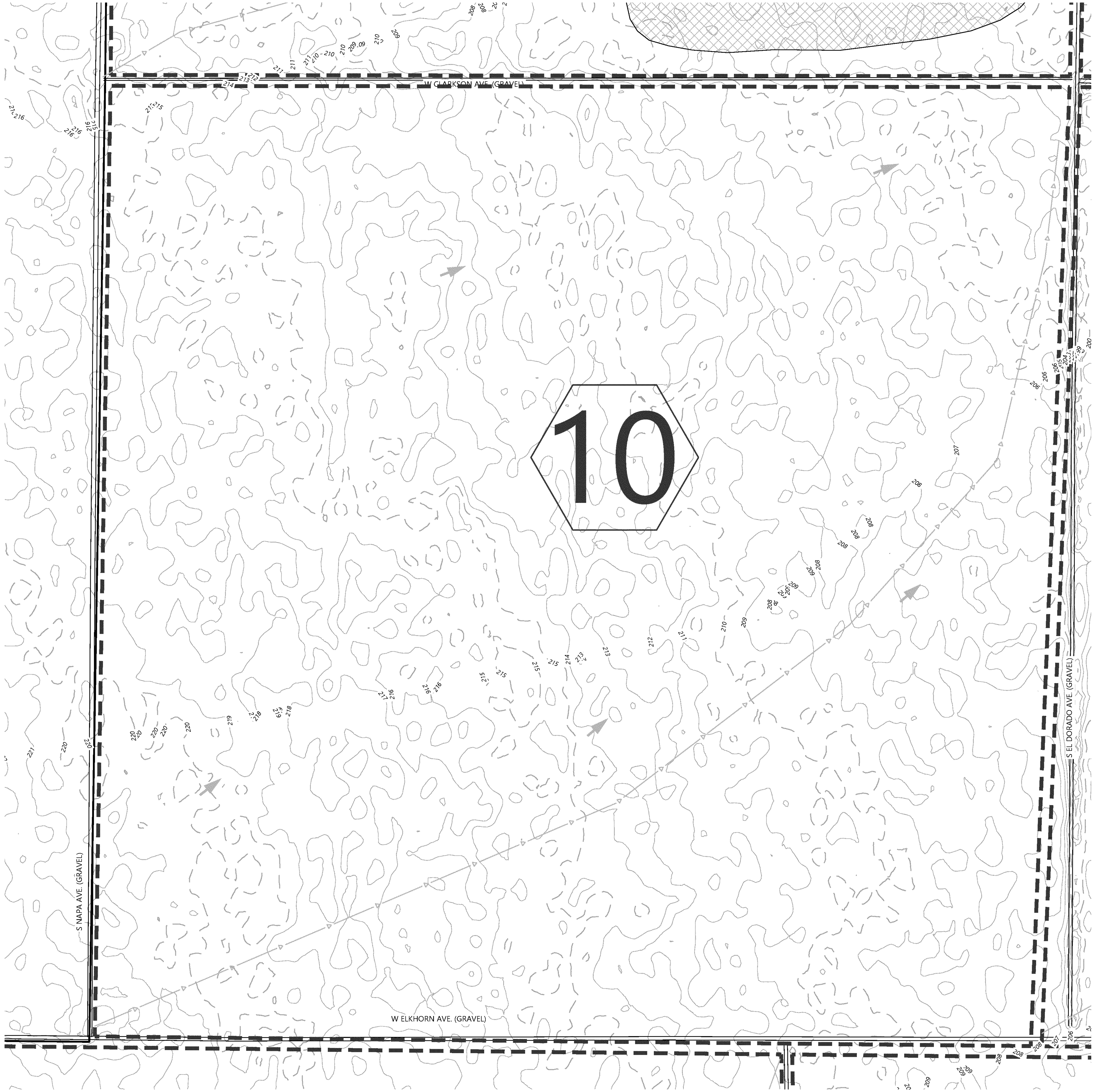
Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5D

SEE SHEET 5B



SEE SHEET 5F
SEE SHEET 5I

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
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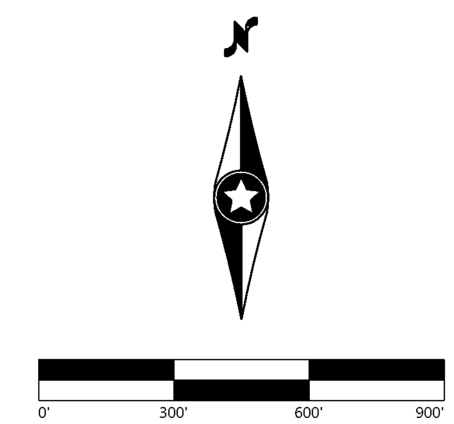

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

SHEET: 5E

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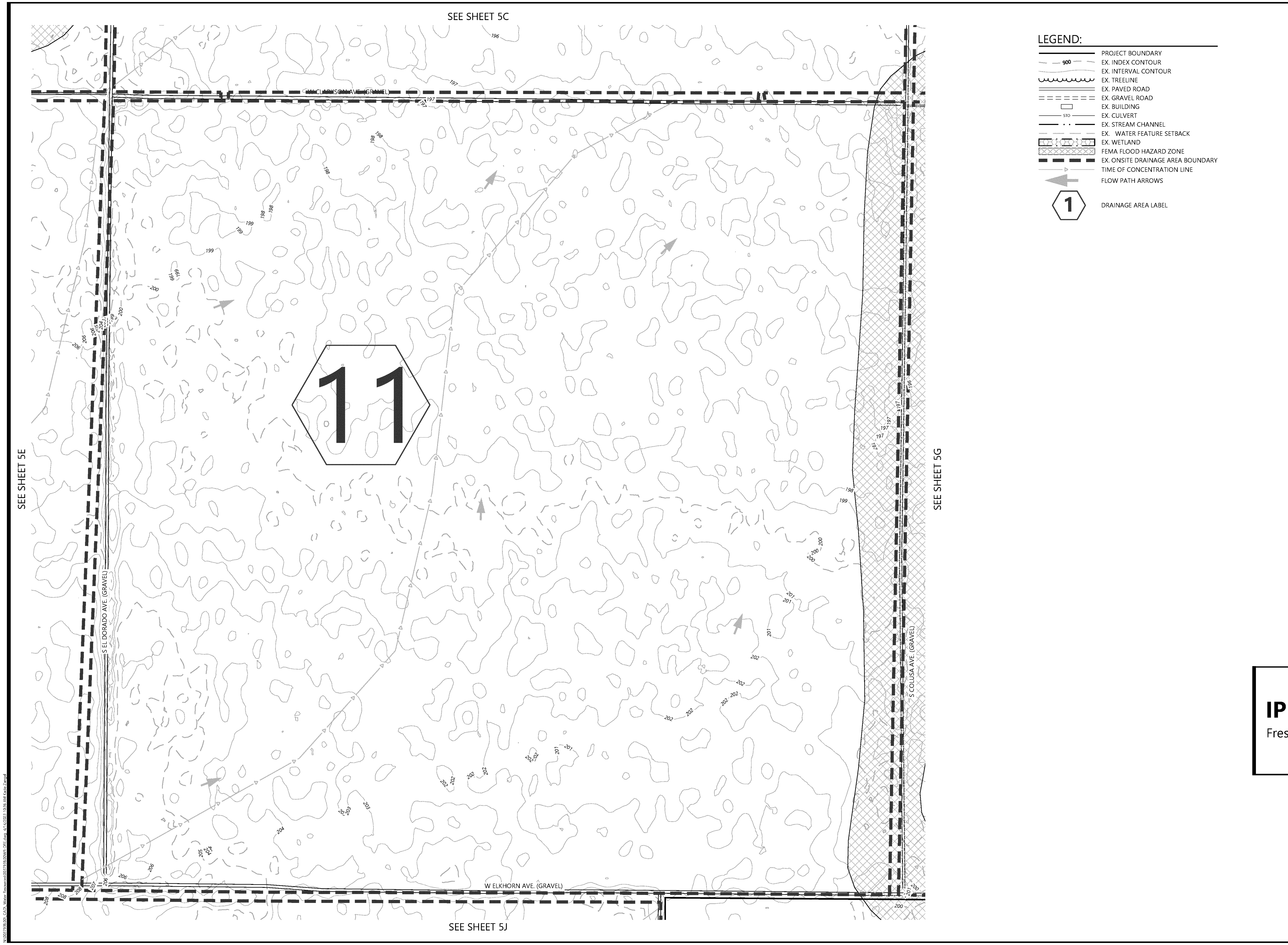

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Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

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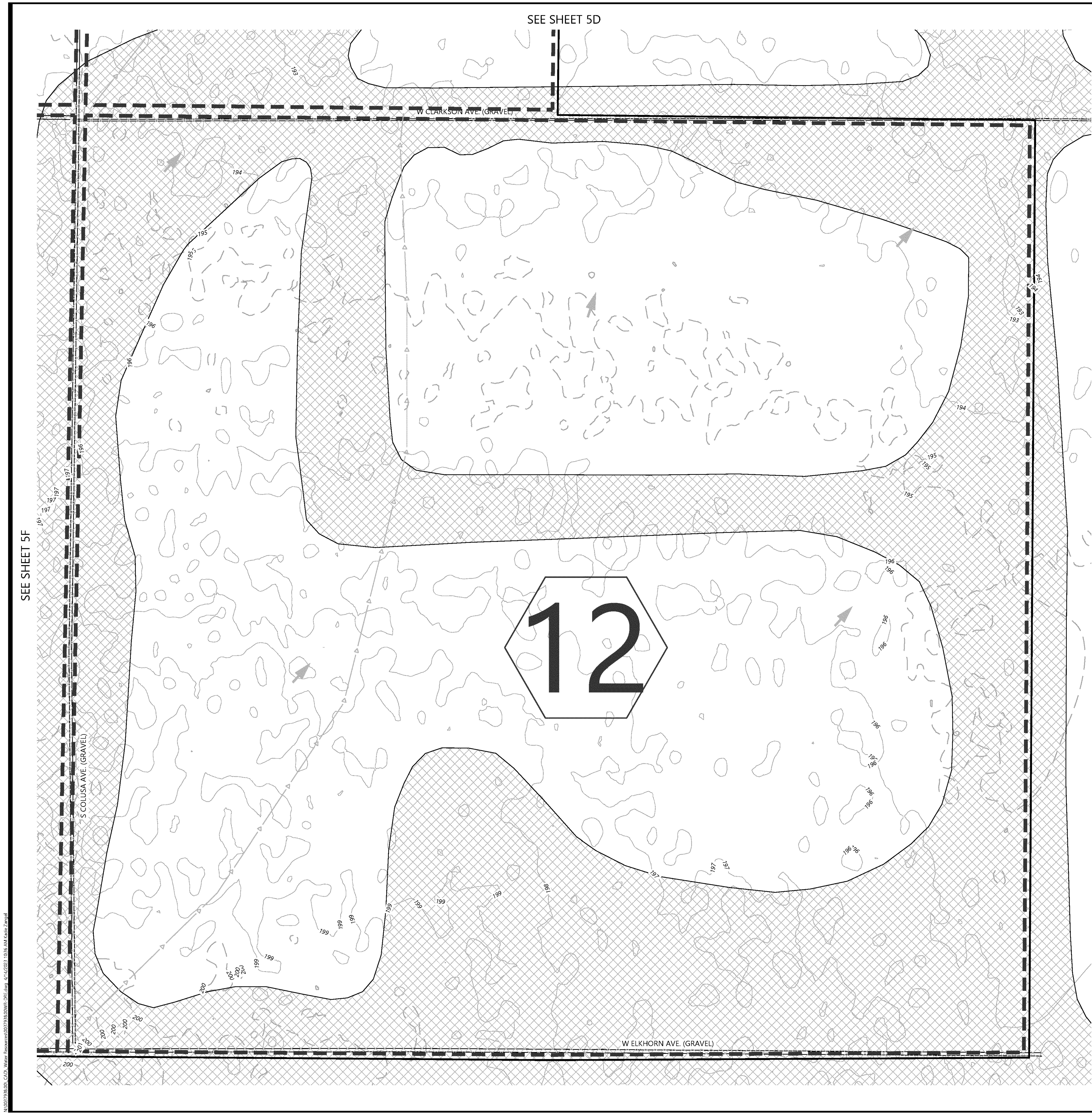

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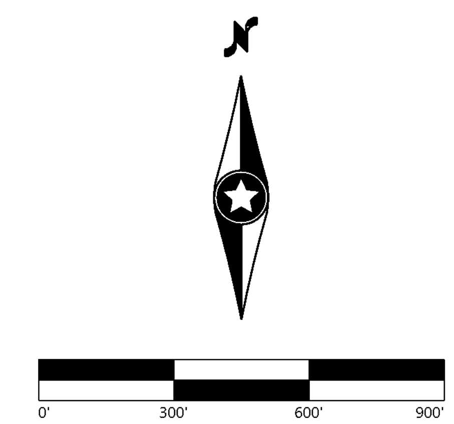

IP Darden

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Existing Drainage Map

DATE: 04/14/2023

REV:

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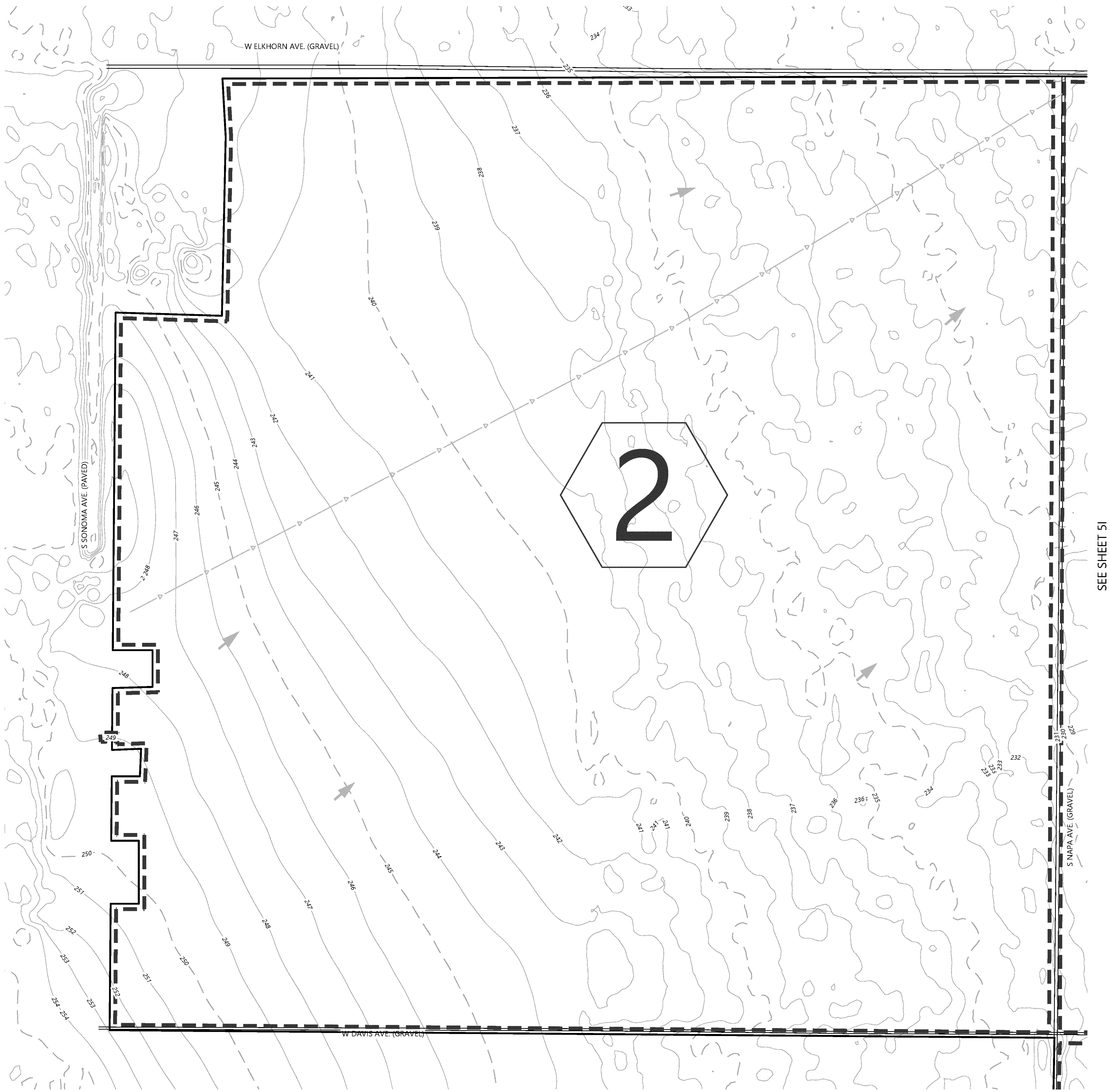

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0' 300' 600' 900'

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

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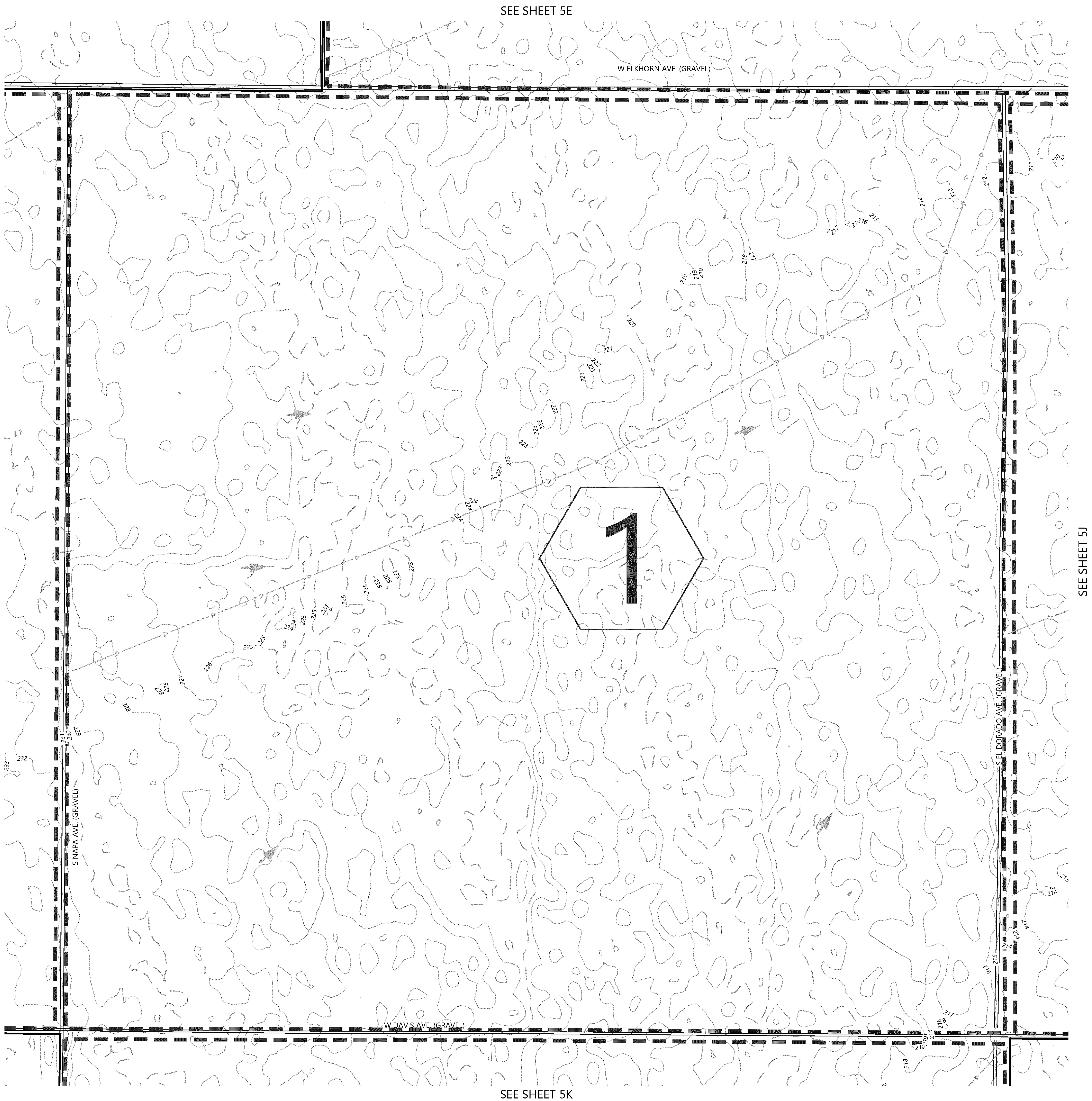

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0' 300' 600' 900'

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5I

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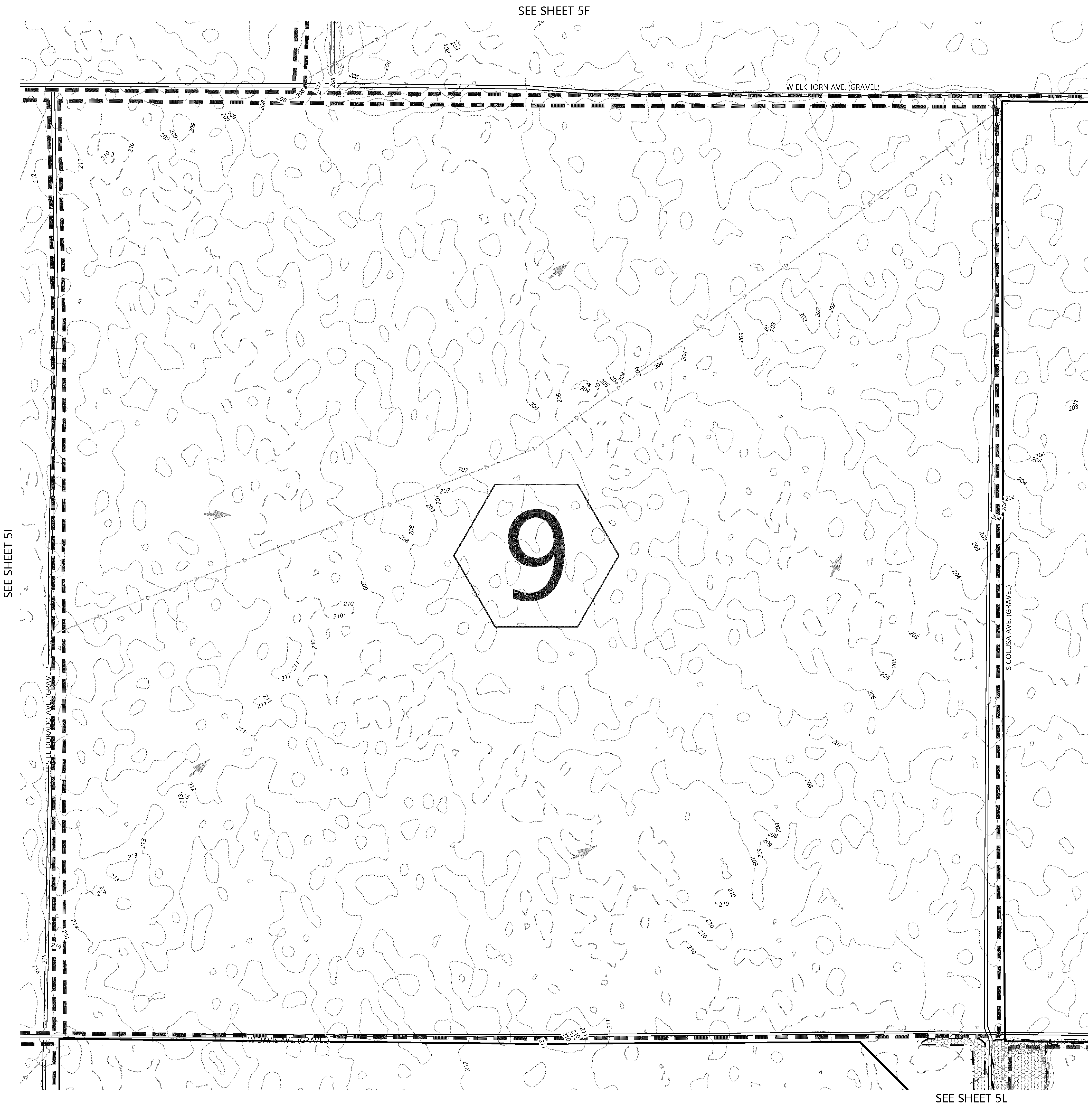

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0' 300' 600' 900'

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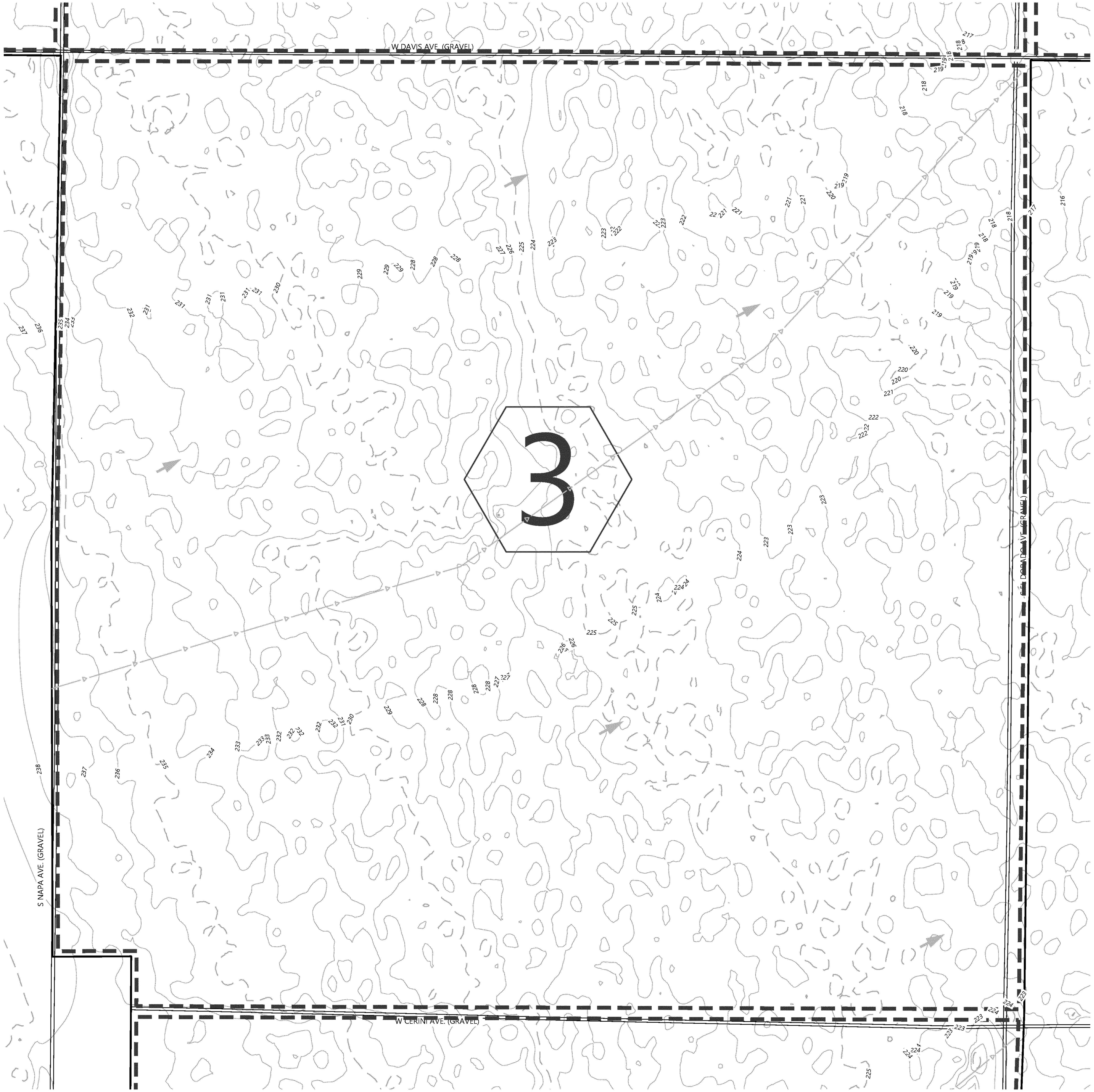
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5J



LEGEND:

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- EX. INTERVAL CONTOUR
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0' 300' 600' 900'

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

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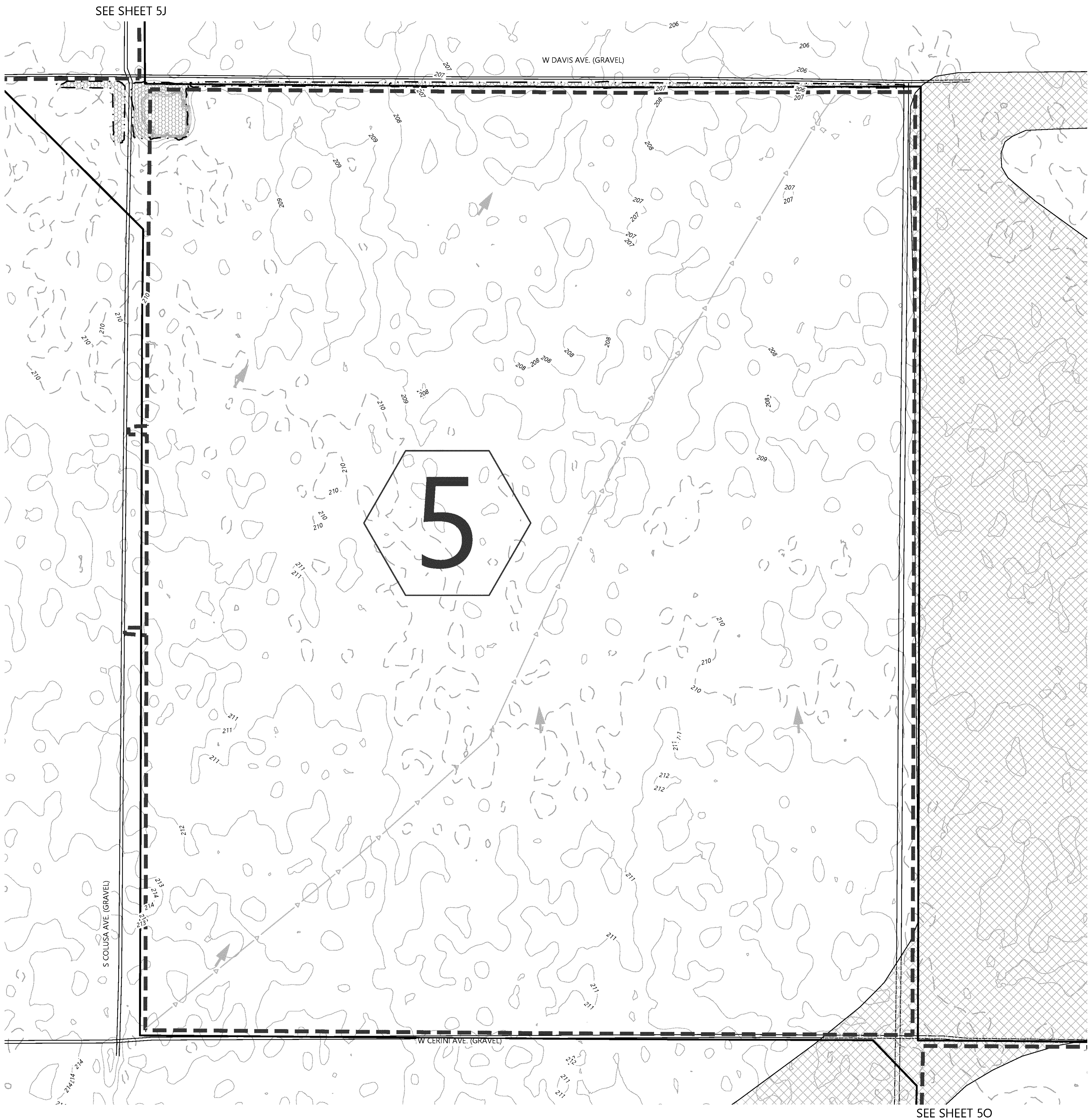

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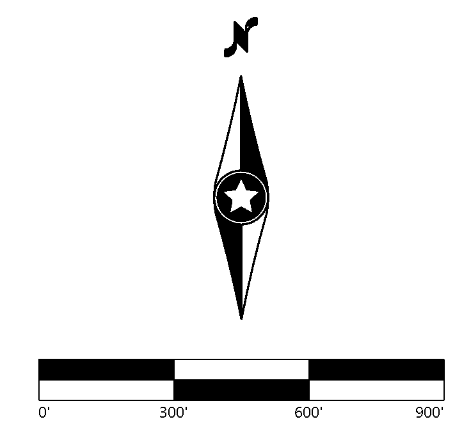

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

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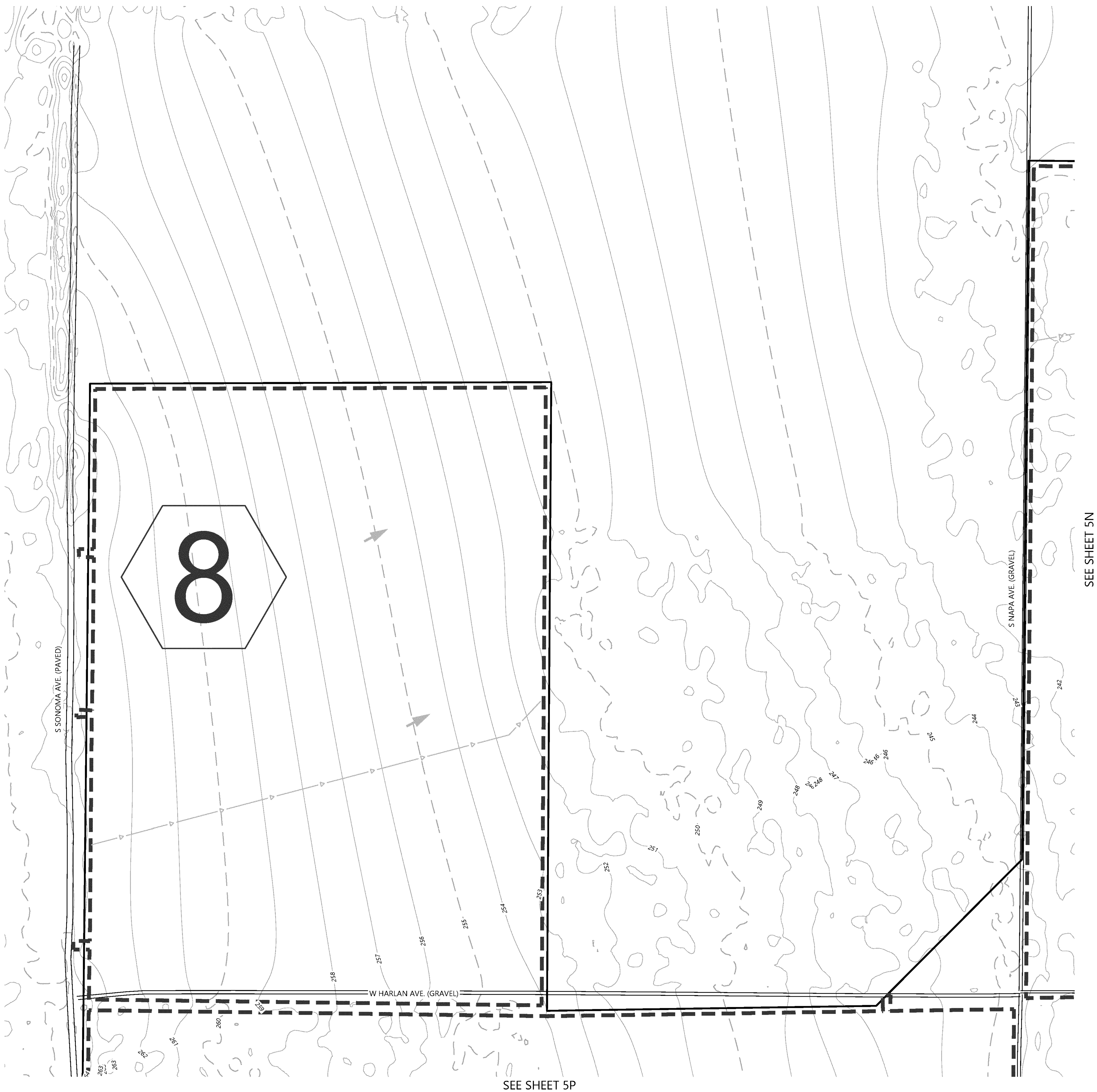
SHEET: 5L



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- EX. BUILDING
- EX. CULVERT (STO)
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROWS
- (1) DRAINAGE AREA LABEL

0' 300' 600' 900'

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IP Darden

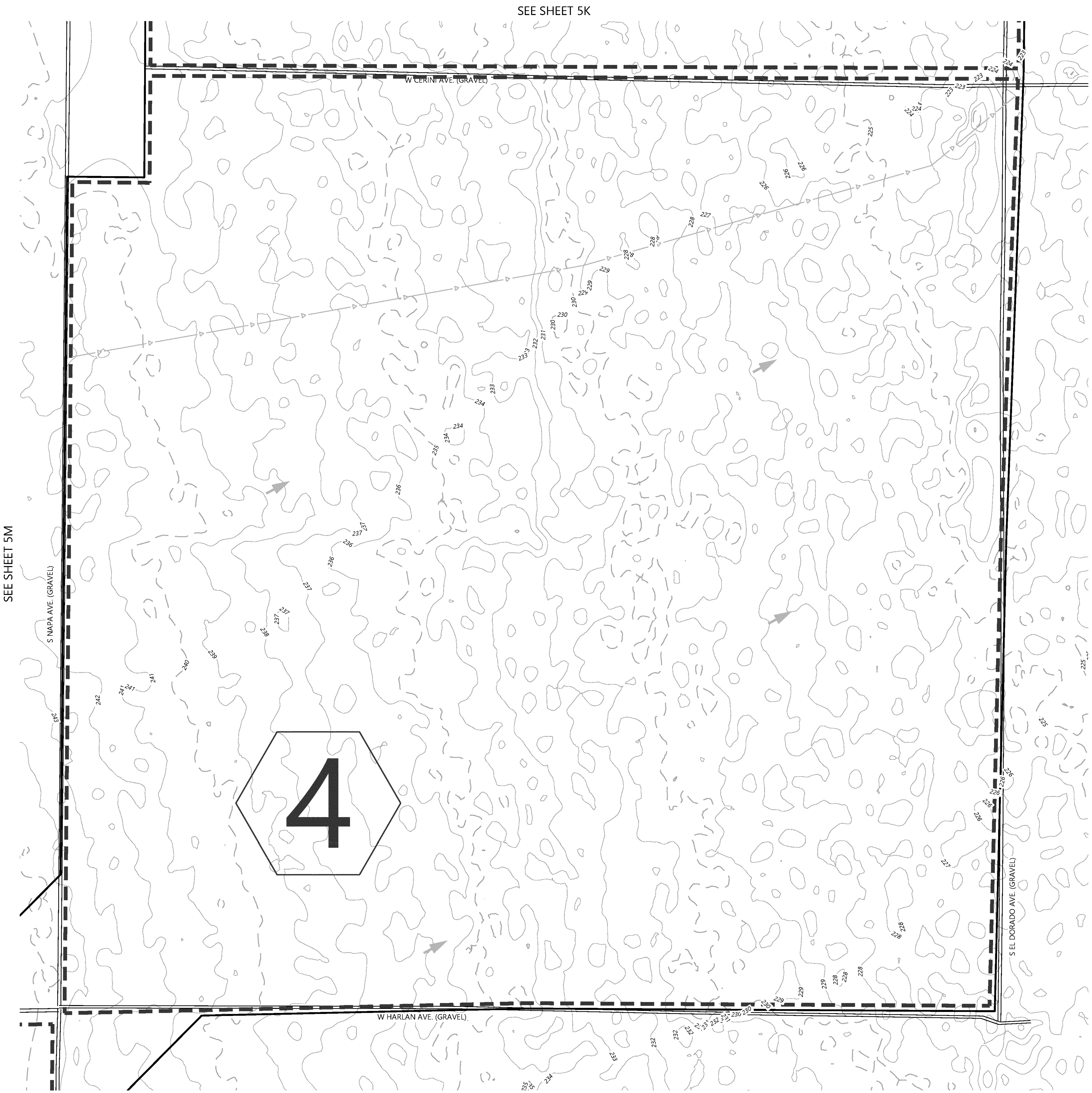
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5M



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- PROJECT BOUNDARY
- EX. INDEX CONTOUR (900)
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#	DATE	COMMENT	BY	CHK	APR
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0' 300' 600' 900'

IP Darden

Fresno County, CA

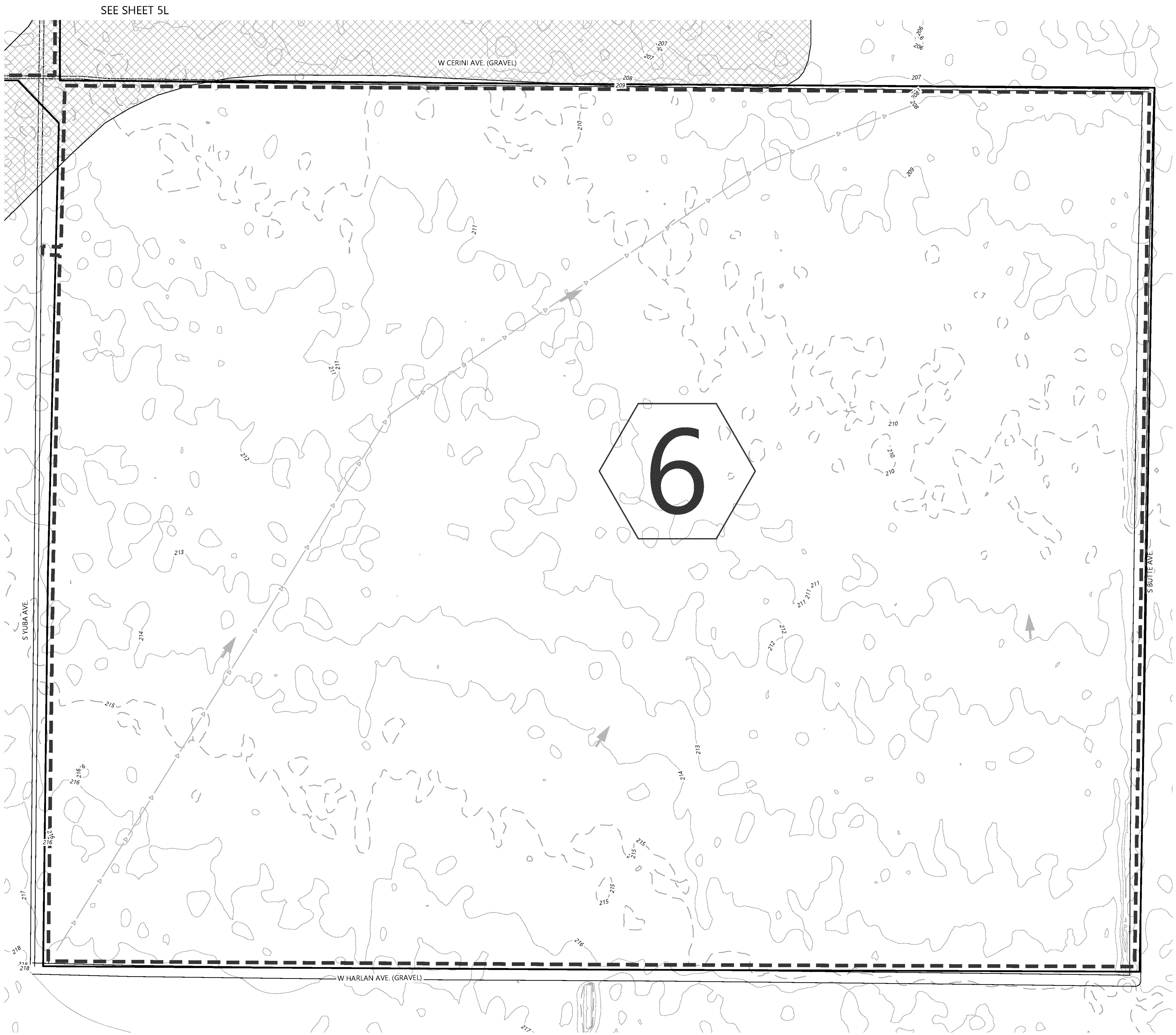
Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5N

DCEP0002270



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROWS
- 1 DRAINAGE AREA LABEL

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PREPARED FOR:

IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 300' 600' 900'

IP Darden

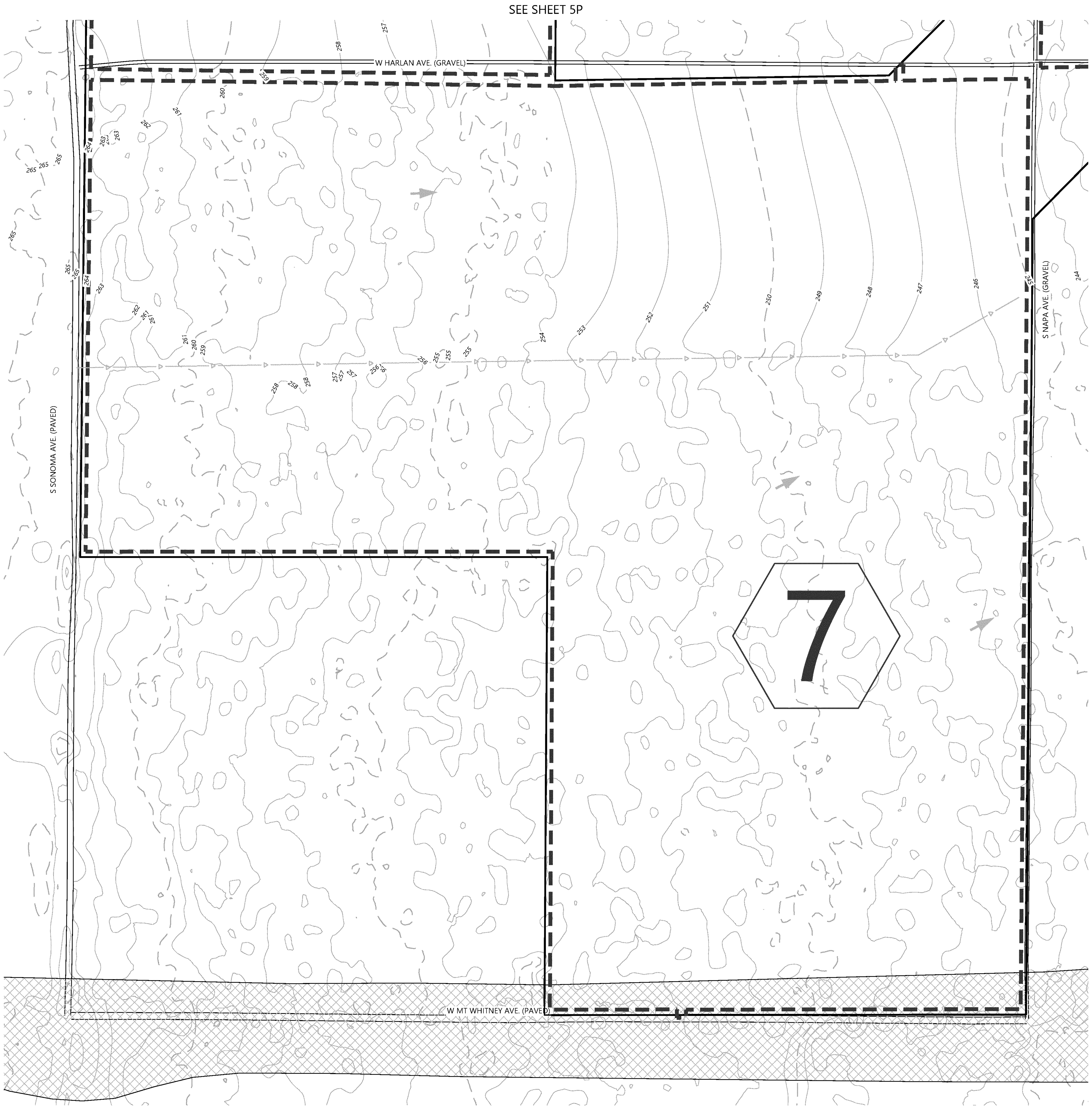
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5O



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROWS
- 1 DRAINAGE AREA LABEL

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PREPARED FOR:

IP DARDEN I, LLC

REVISIONS:

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0' 300' 600' 900'

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5P

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
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- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
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0' 1700' 3400' 5100'

IP Darden

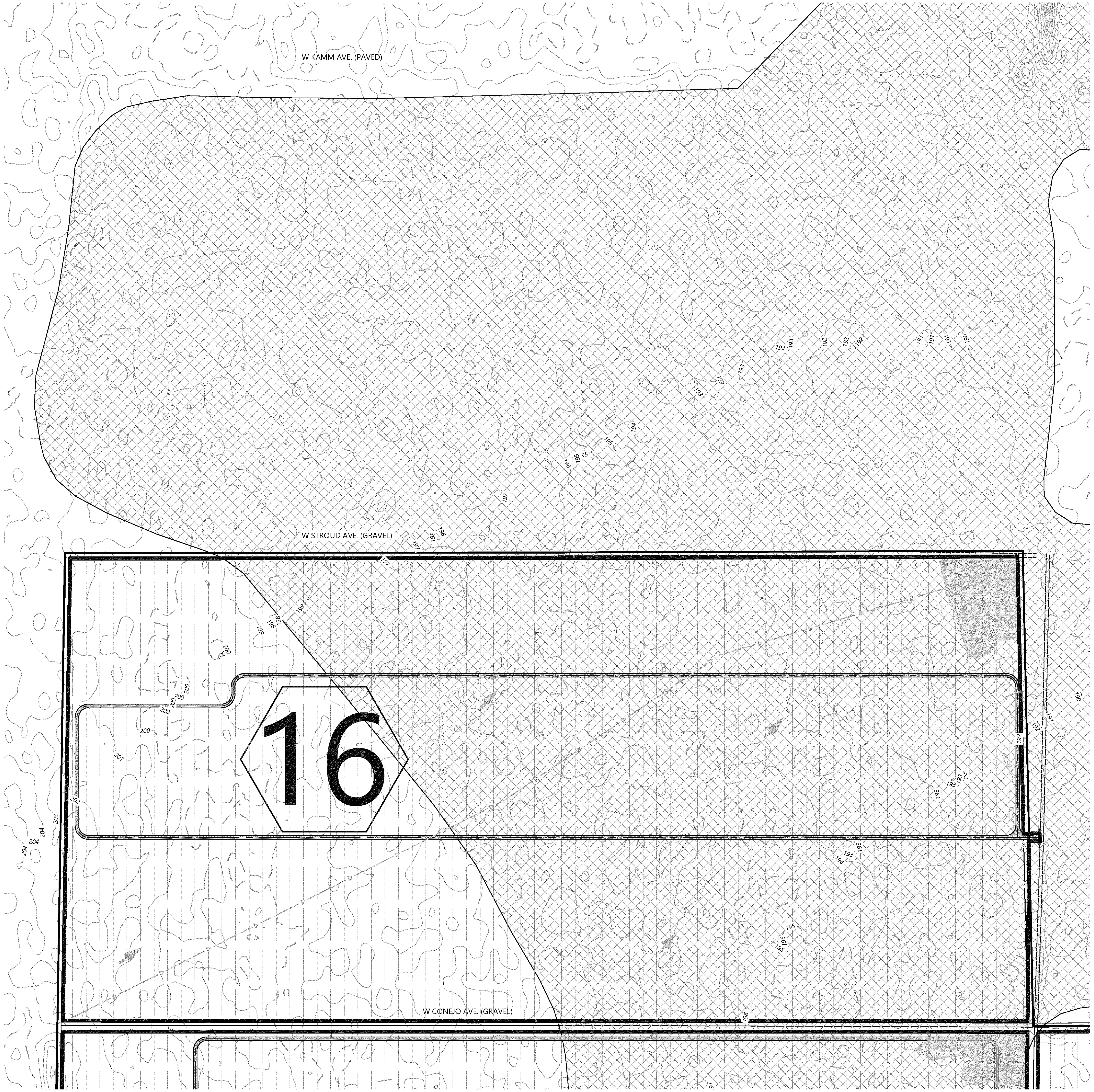
Fresno County, CA

Overall Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5



SEE SHEET 6B

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL

0' 300' 600' 900'

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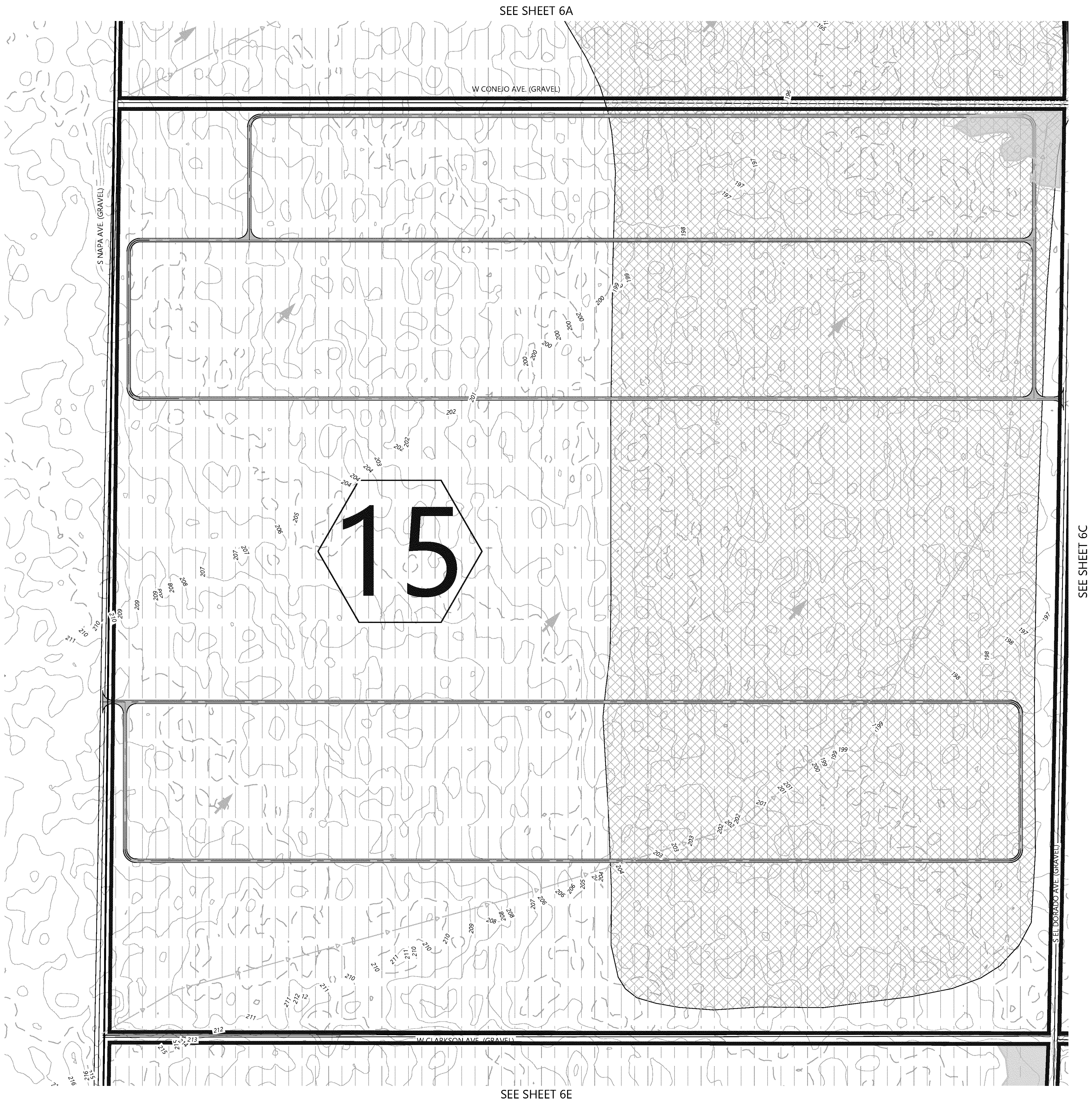
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6A



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL

0' 300' 600' 900'

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#	DATE	COMMENT	BY	CHK	APR

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Fresno County, CA

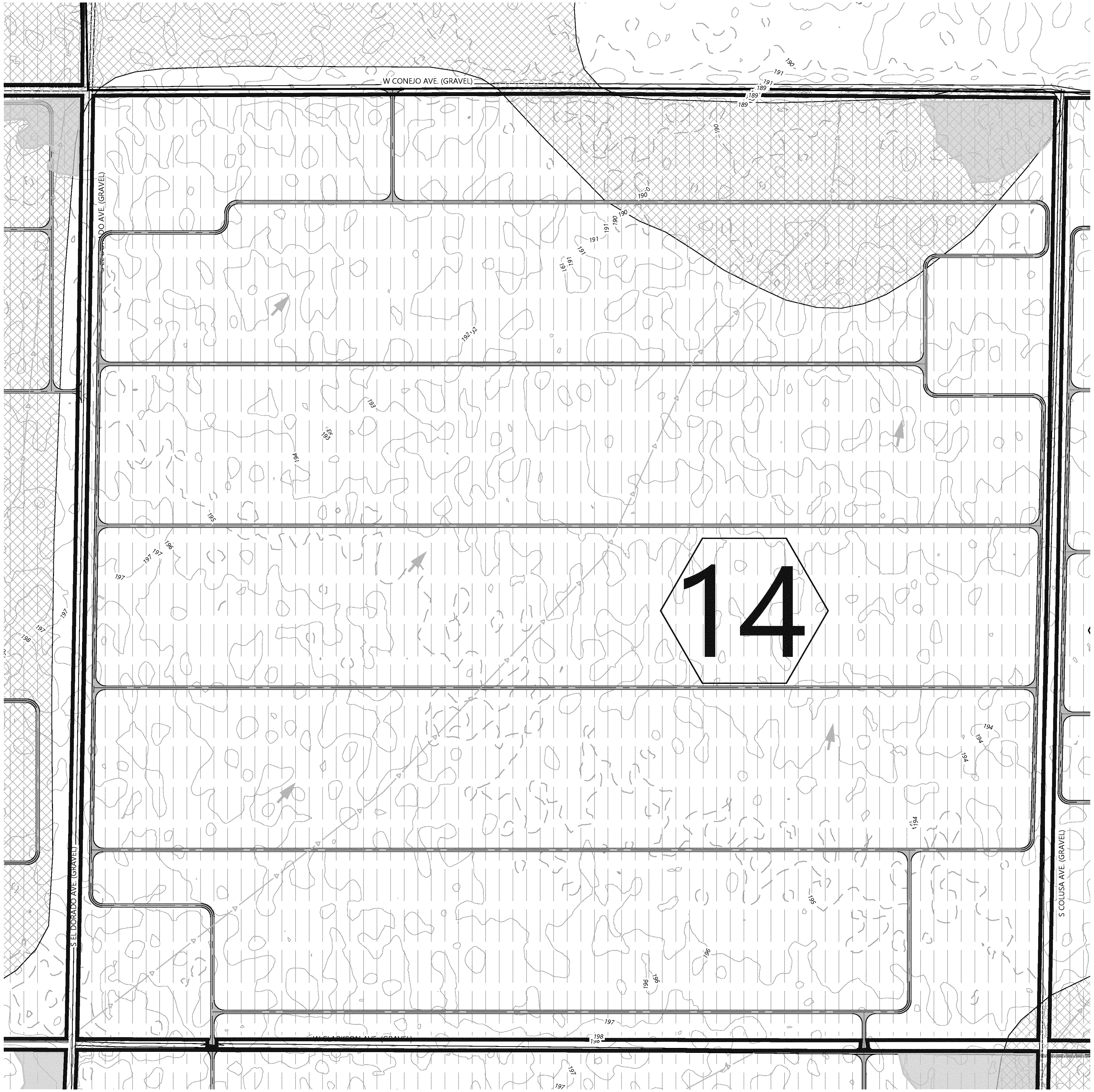
Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6B

SEE SHEET 6B



SEE SHEET 6D

SEE SHEET 6F

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- (1) DRAINAGE AREA LABEL

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0' 300' 600' 900'

IP Darden

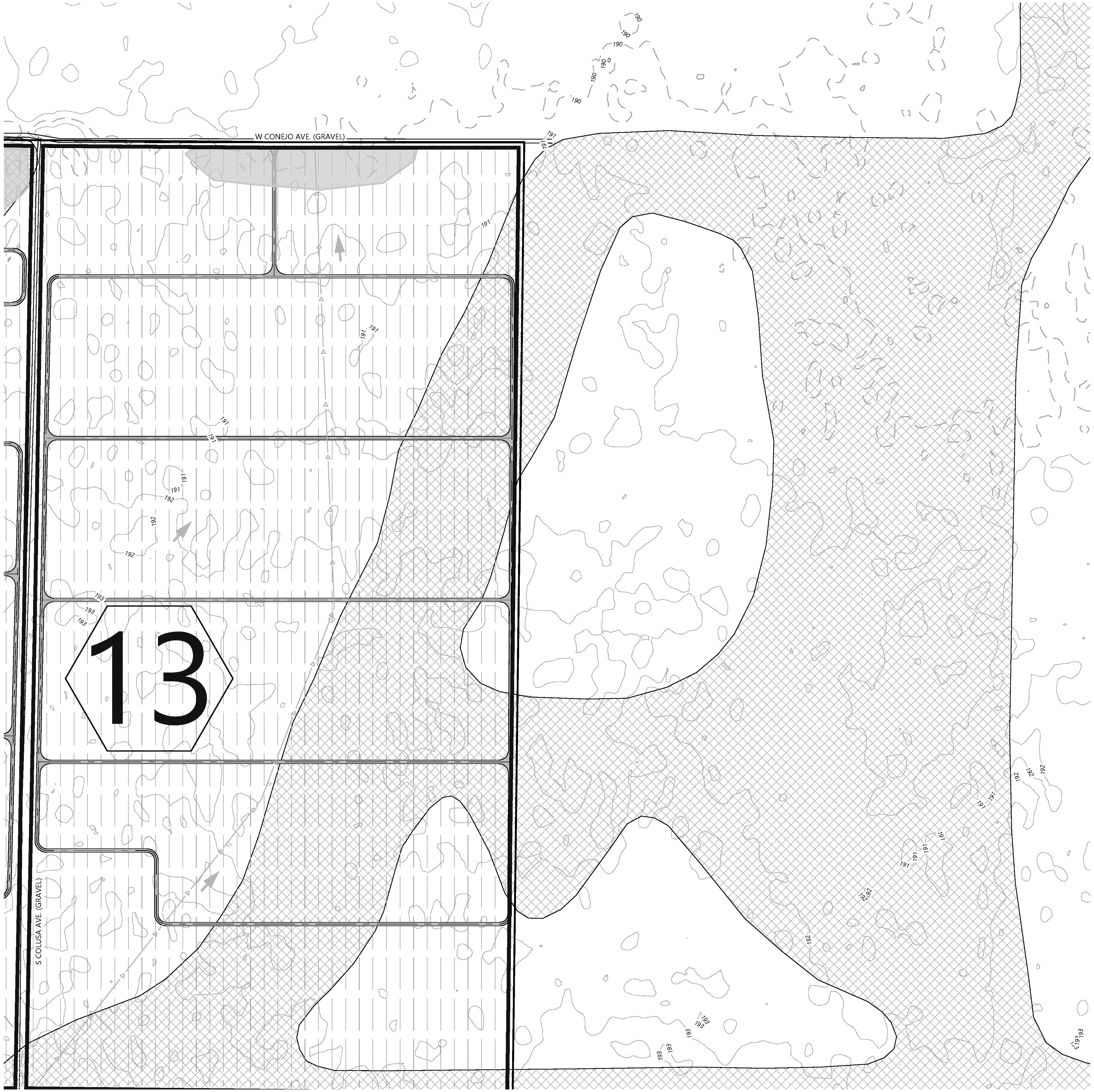
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6C



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL

0' 300.0001' 600.0002' 900.0002'

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#	DATE	COMMENT	BY	CHK	APR

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Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

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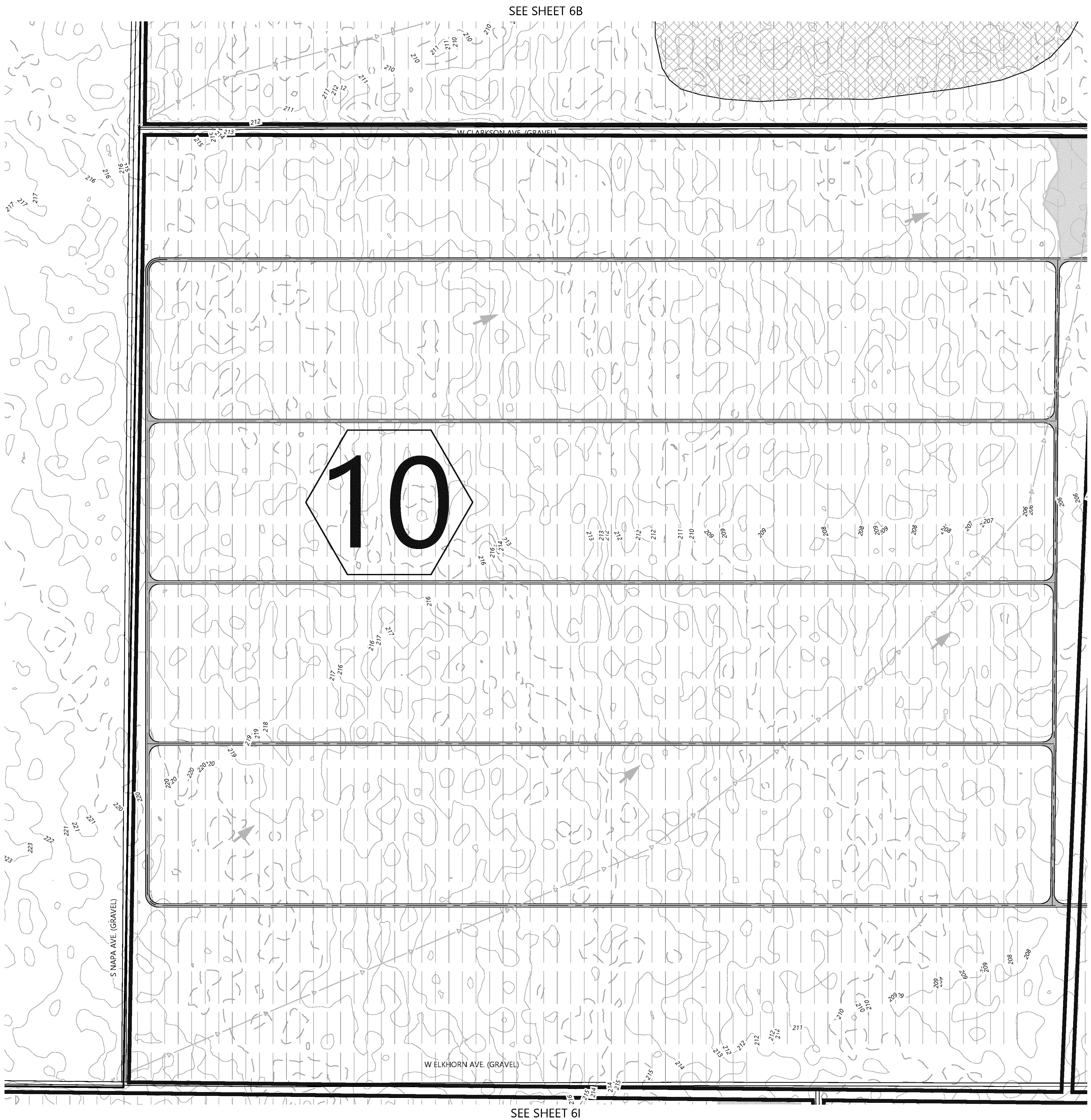

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
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- DRAINAGE AREA LABEL

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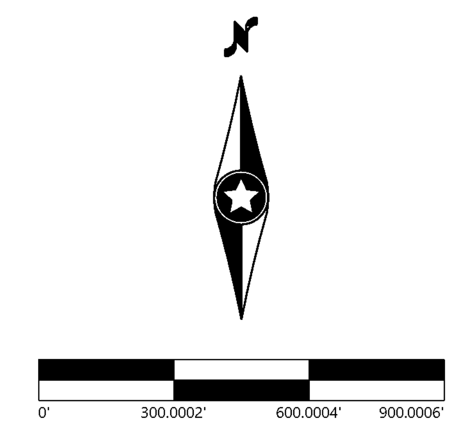

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Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

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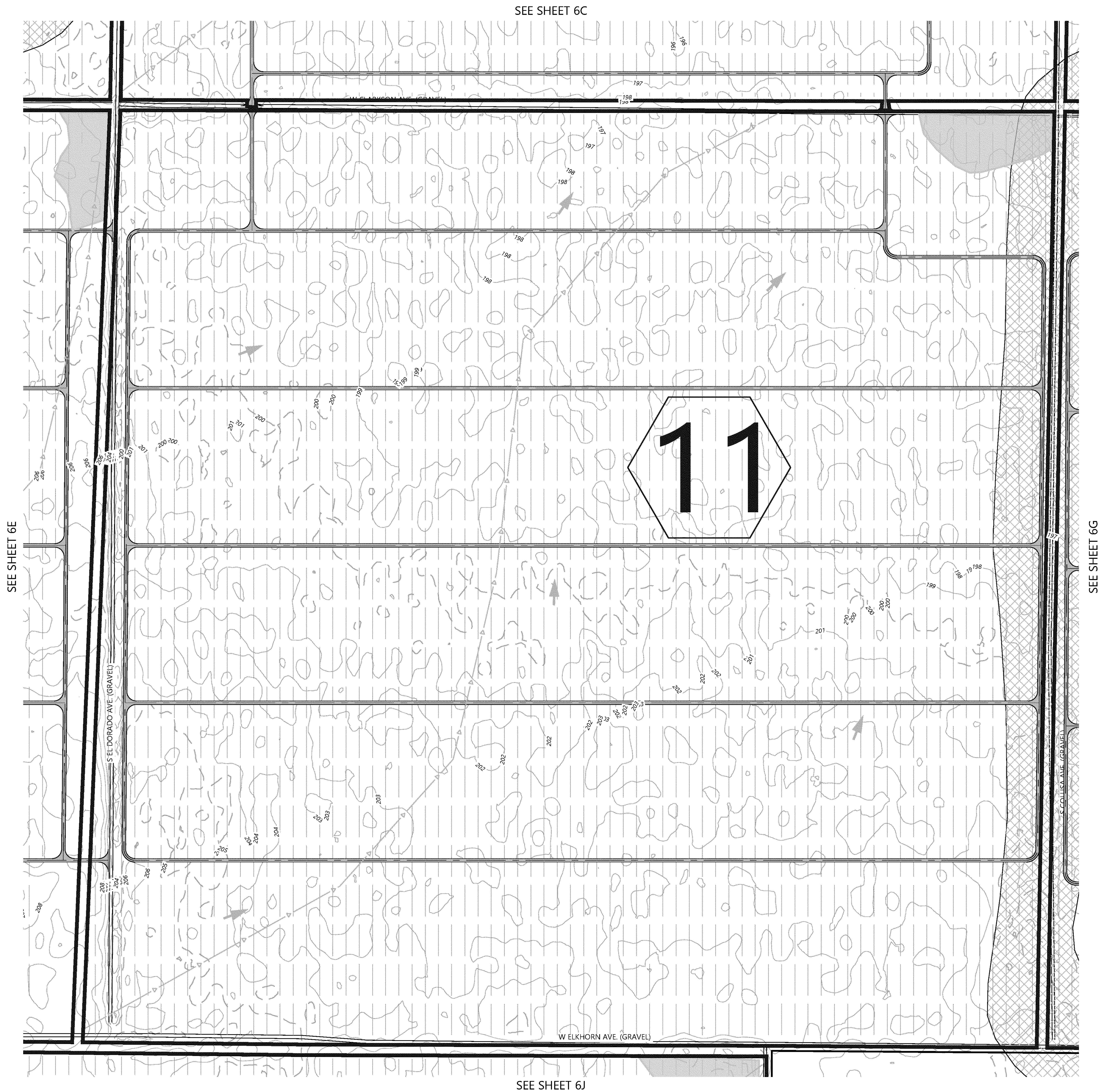

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL

0' 300' 600' 900'

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#	DATE	COMMENT	BY	CHK	APR

IP Darden

Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

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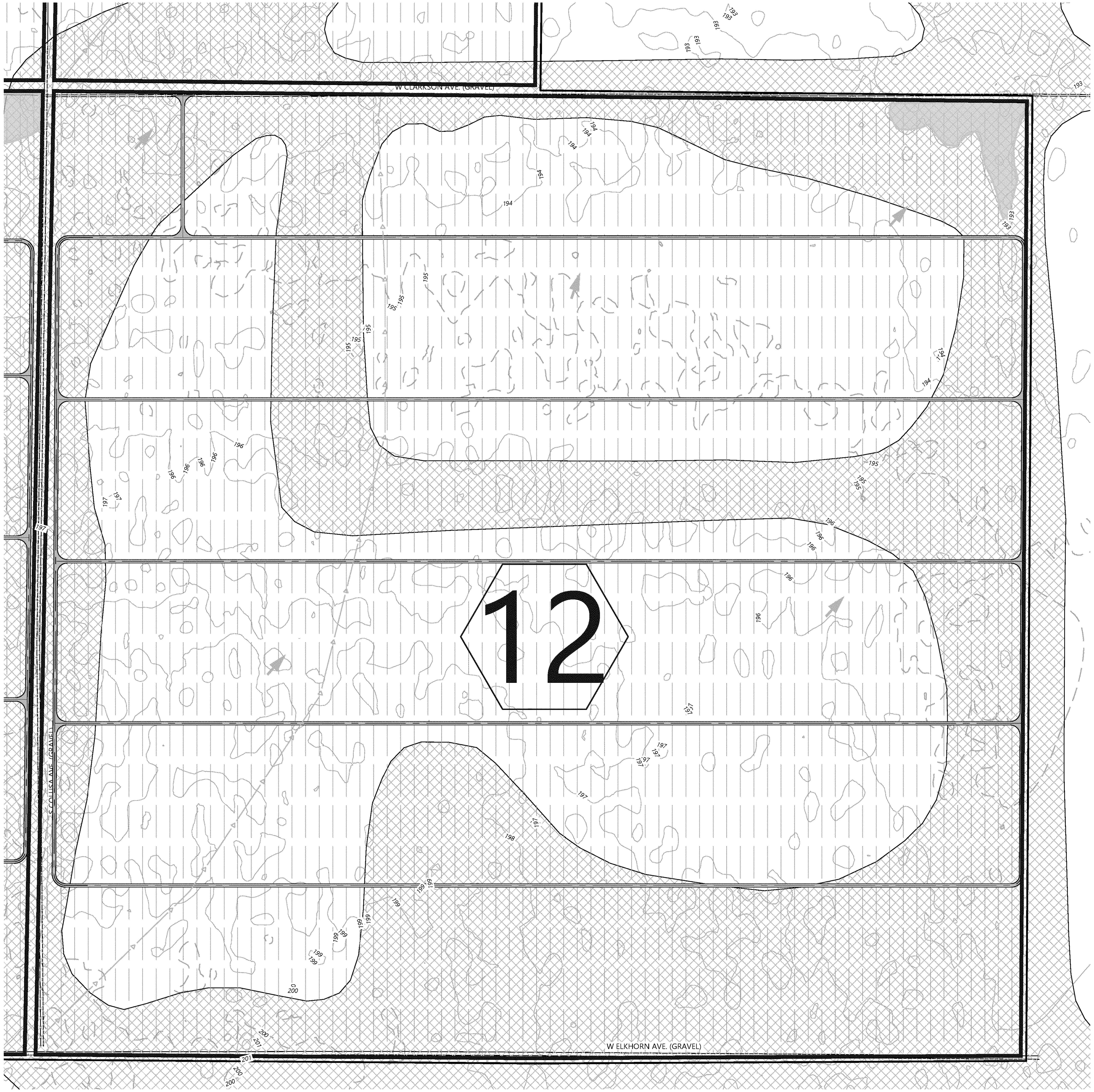
SEE SHEET 6D

SEE SHEET 6F



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL

0' 300' 600' 900'

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IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

IP Darden

Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

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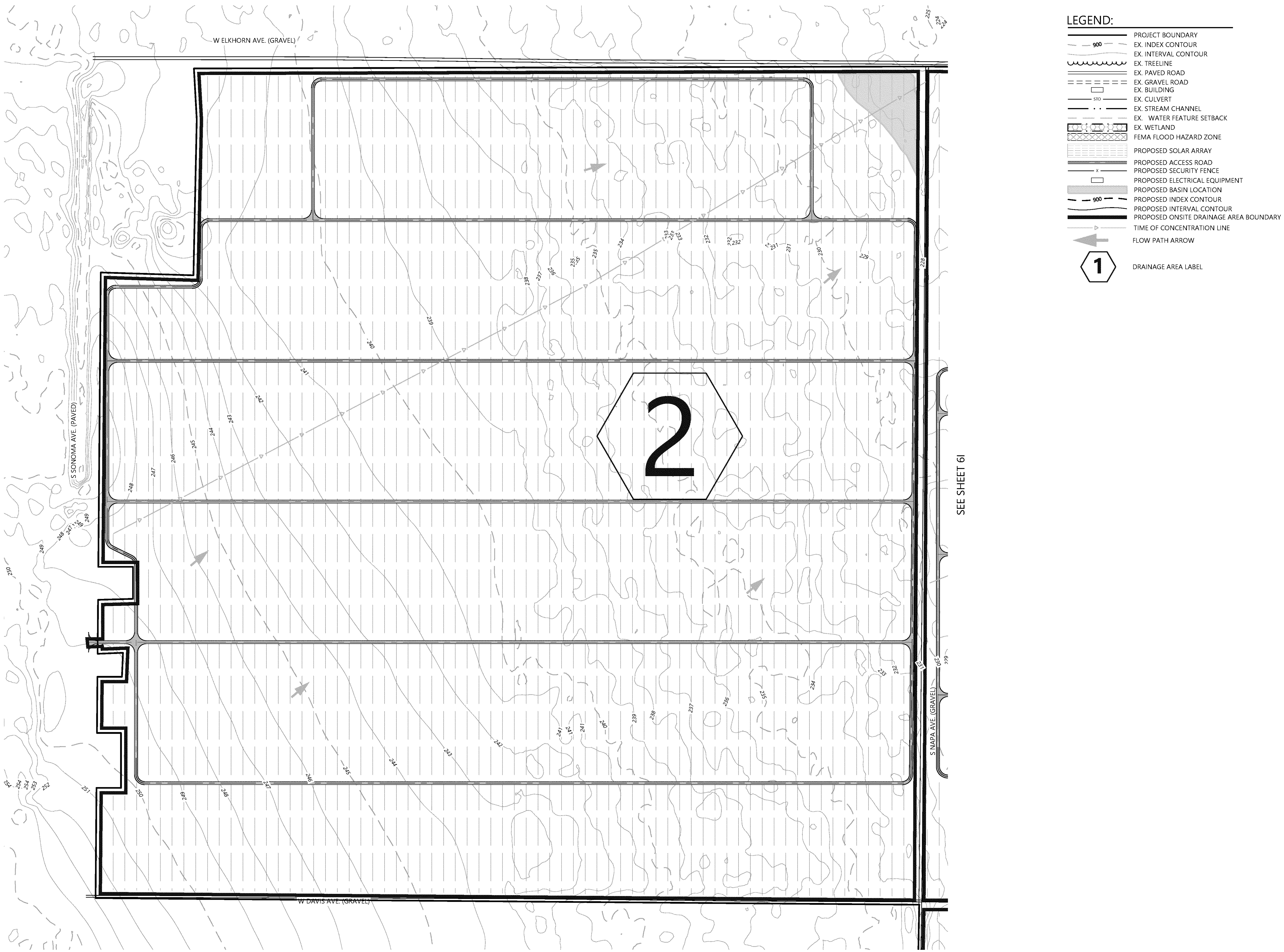

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PREPARED FOR:

IP DARDEN I, LLC

REVISIONS:

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IP Darden

Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

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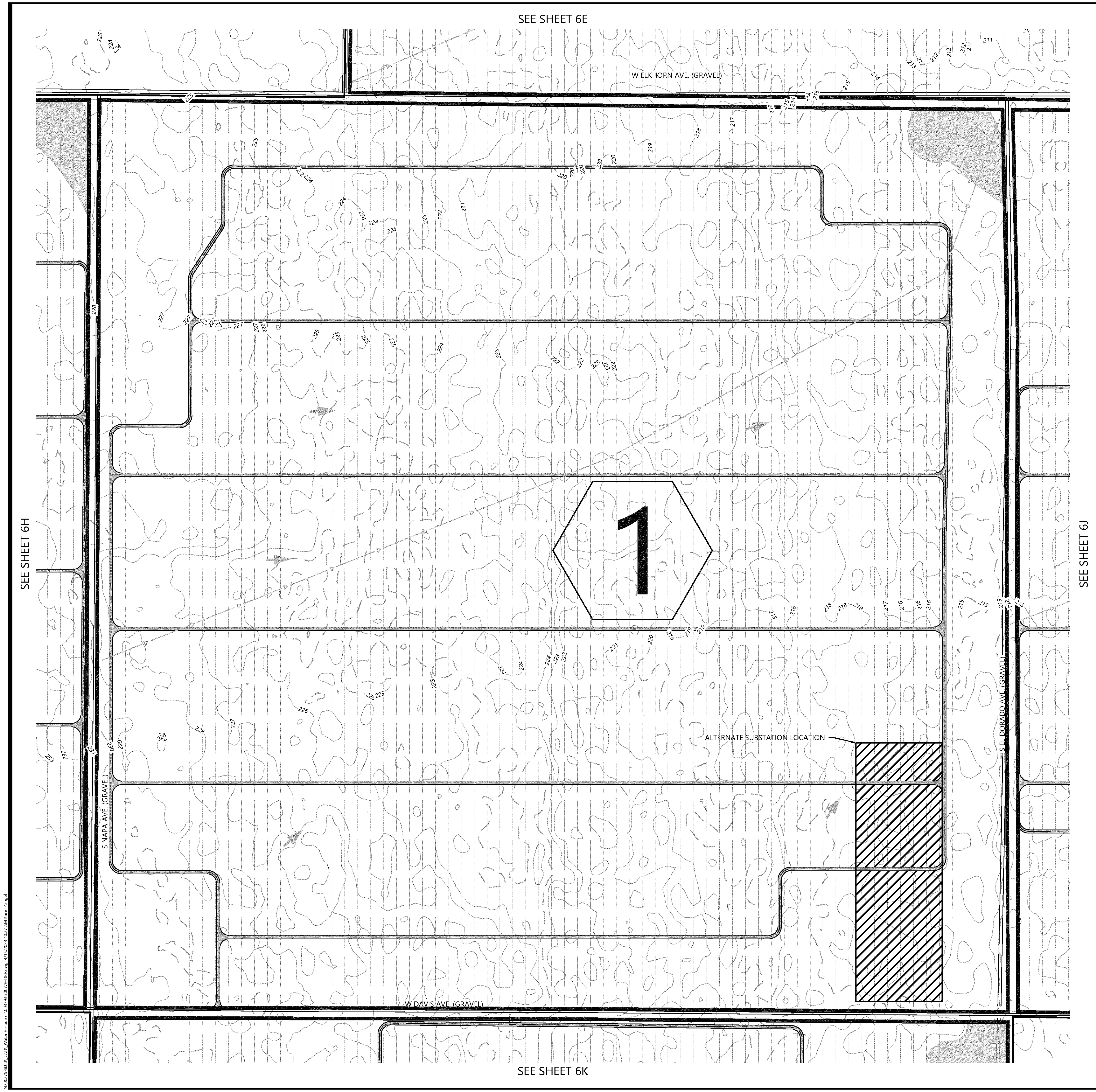

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR (900)
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT (STO)
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE (X)
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR (900)
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL (1)

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IP DARDEN I, LLC

REVISIONS:

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-	-	-	-	-	-
-	-	-	-	-	-

0' 300' 600' 900'

IP Darden

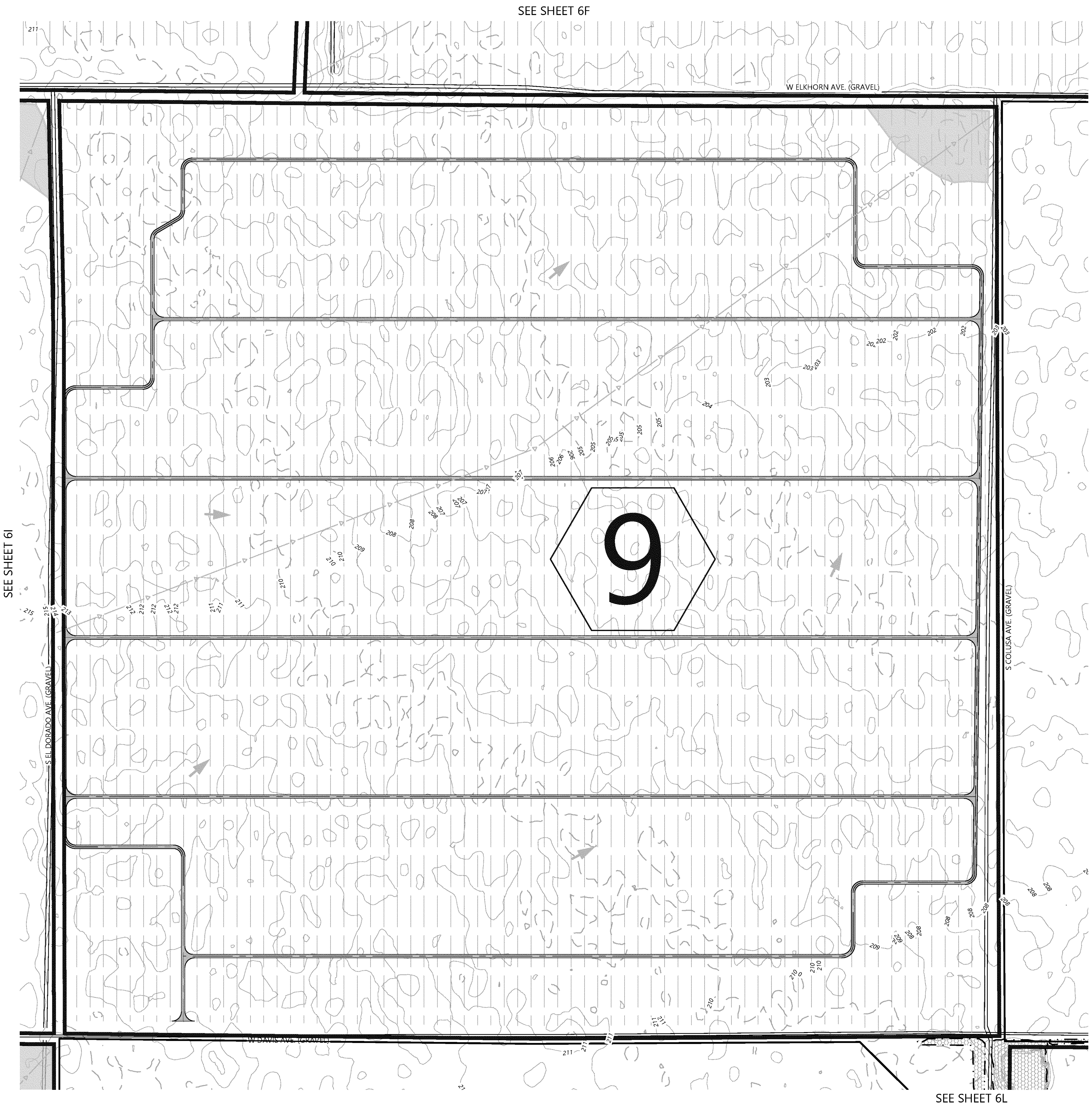
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6I



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
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- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- 1 DRAINAGE AREA LABEL

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IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 300' 600' 900'

IP Darden

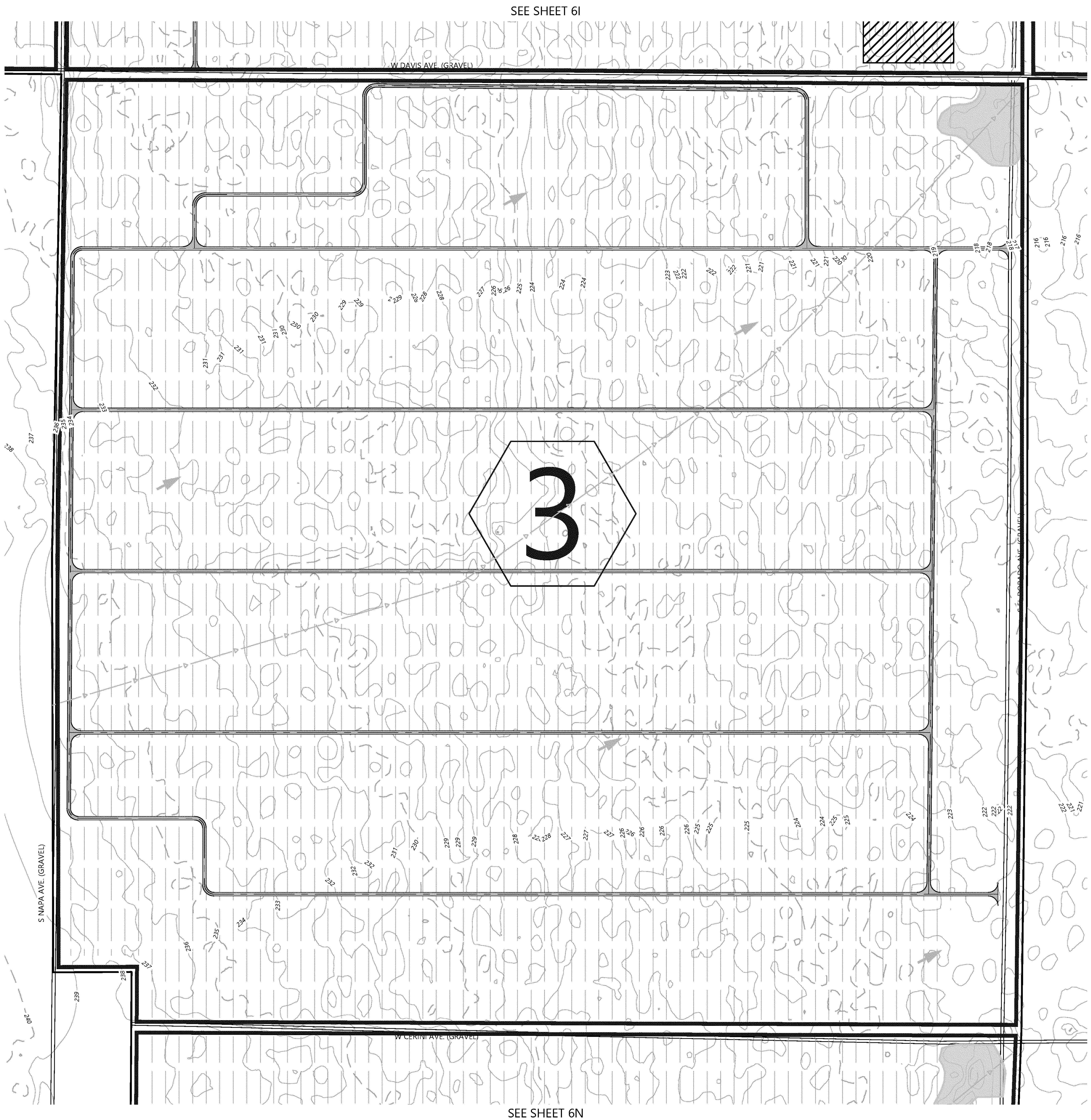
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6J



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
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- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
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IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 300' 600' 900'

IP Darden

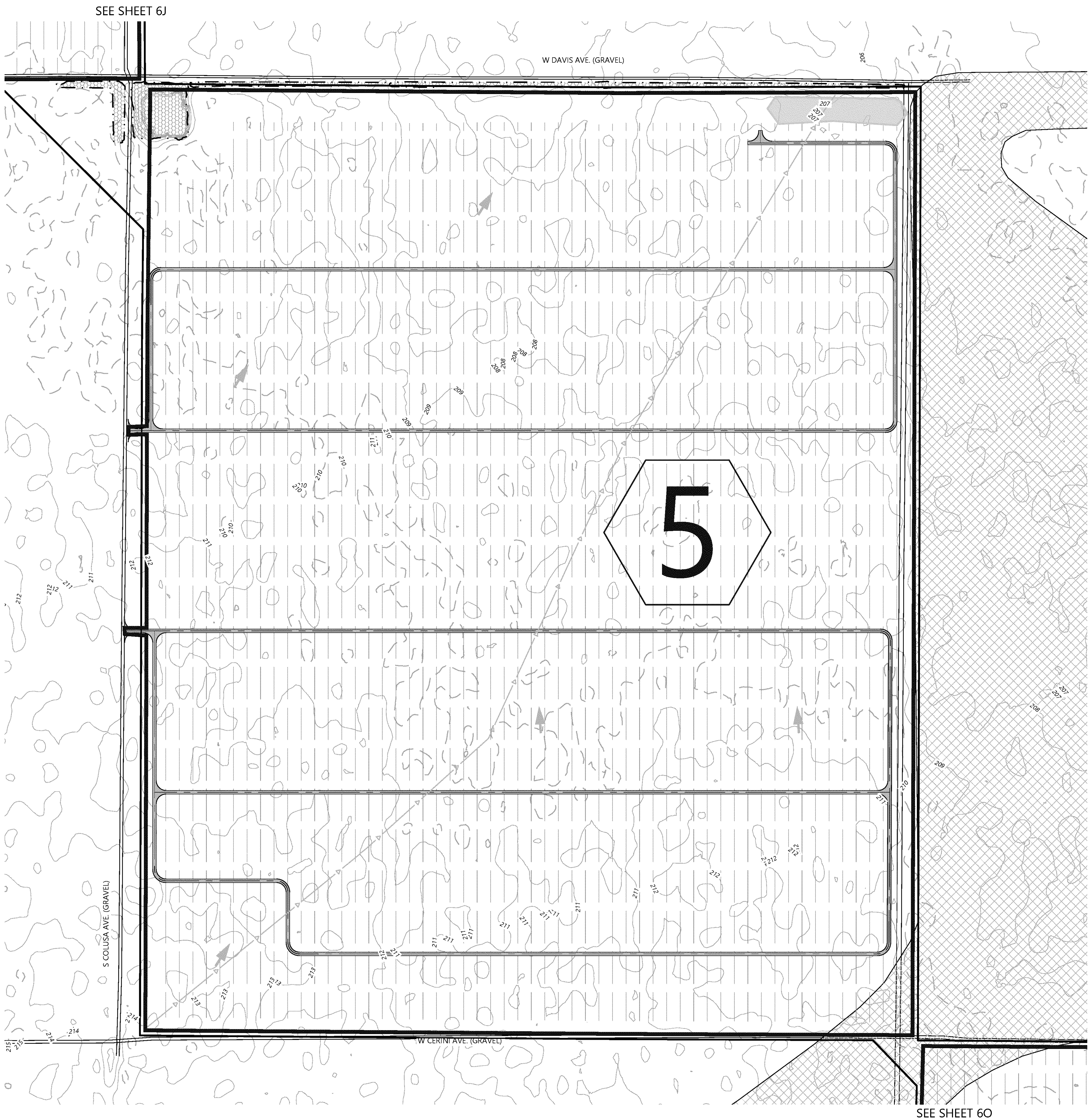
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6K



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
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- FEMA FLOOD HAZARD ZONE
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IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 300' 600' 900'

IP Darden

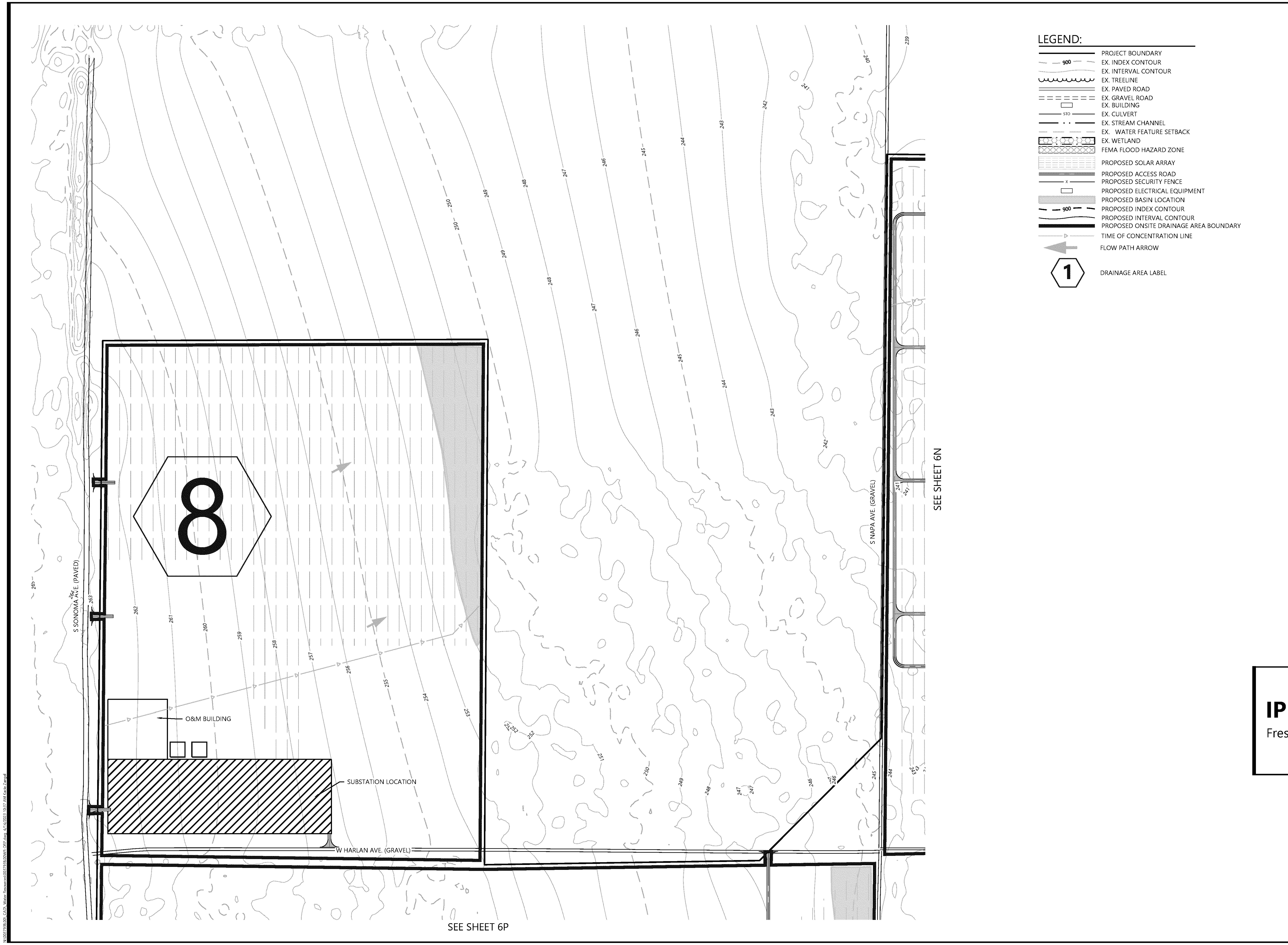
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6L



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#	DATE	COMMENT	BY	CHK	APR

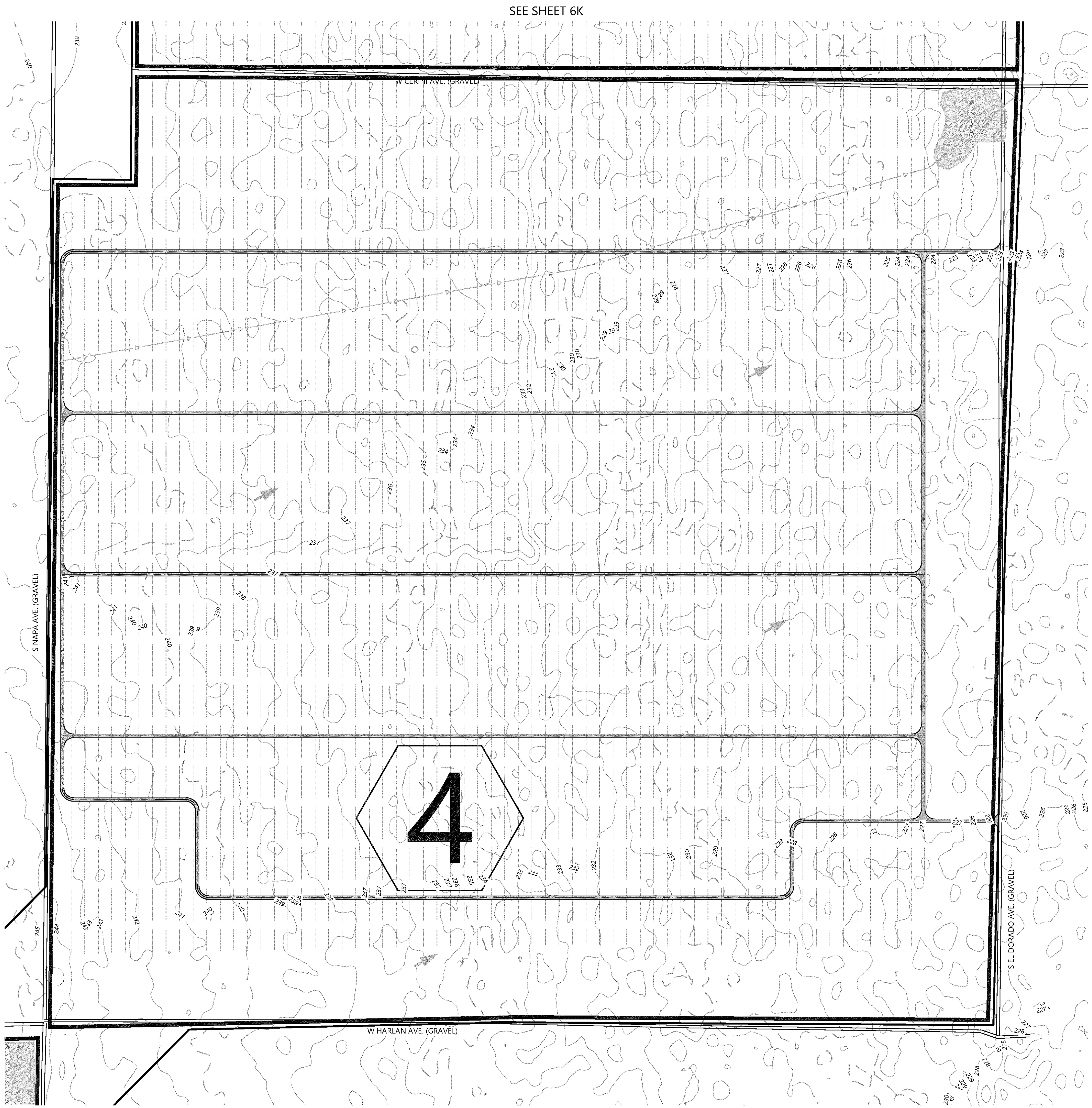
IP Darden
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6M



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR (900)
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT (STO)
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR (900)
- PROPOSED INTERVAL CONTOUR
- PROPOSED ONSITE DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION LINE
- FLOW PATH ARROW
- DRAINAGE AREA LABEL (1)

Westwood

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.

PREPARED FOR:

IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 300' 600' 900'

IP Darden

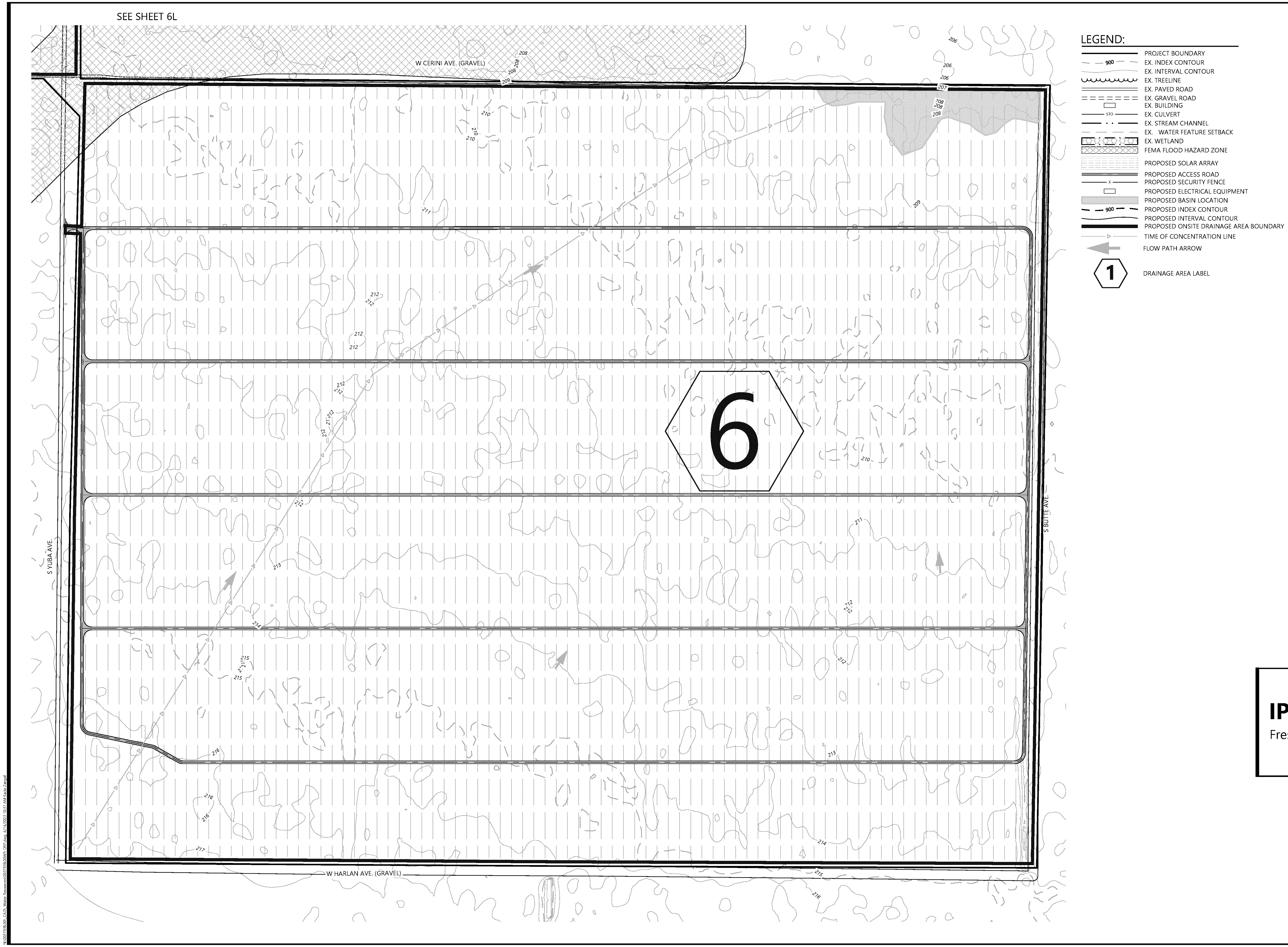
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6N



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IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

IP Darden

Fresno County, CA

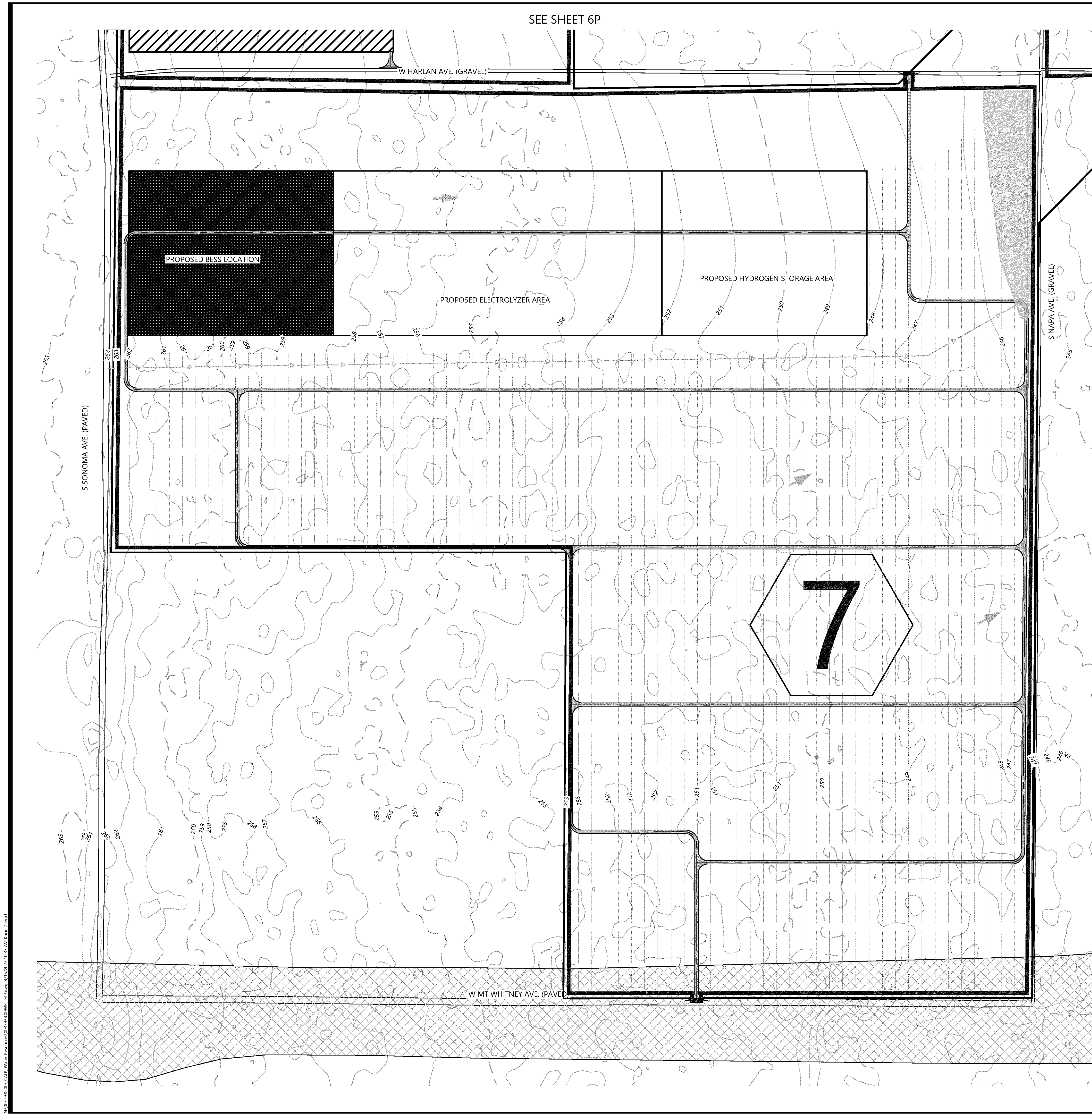
Proposed Drainage Map

DATE: 04/14/2023

REV:

SHEET: 6O

DCEP0002288



LEGEND:
PROJECT BOUNDARY
EX. INDEX CONTOUR
EX. INTERVAL CONTOUR
EX. TREELINE
EX. PAVED ROAD
EX. GRAVEL ROAD
EX. BUILDING
EX. CULVERT
EX. STREAM CHANNEL
EX. WATER FEATURE SETBACK
EX. WETLAND
FEMA FLOOD HAZARD ZONE
PROPOSED SOLAR ARRAY
PROPOSED ACCESS ROAD
PROPOSED SECURITY FENCE
PROPOSED ELECTRICAL EQUIPMENT
PROPOSED BASIN LOCATION
PROPOSED INDEX CONTOUR
PROPOSED INTERVAL CONTOUR
PROPOSED ONSITE DRAINAGE AREA BOUNDARY
TIME OF CONCENTRATION LINE
FLOW PATH ARROW
1 DRAINAGE AREA LABEL

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Minnetonka, MN 55343
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PREPARED FOR:

IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 300' 600' 900'

IP Darden
Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023
REV:
SHEET: 6P

Appendix A

Rational Method Runoff Calculations

Runoff Rate Calculation Summary Table

Area	Total Acres	Gravel (ac)	Impervious (ac)	Desert Landscape (ac)	Existing Runoff Rate (cfs)	Proposed Runoff Rate (cfs)
1	635.5	17.5	1.27	616.73	40.48	37.04
2	599.5	17.5	1.20	580.80	38.19	34.93
3	634.1	17.2	1.27	615.63	40.39	36.96
4	621	14.8	1.24	604.96	39.56	36.22
5	508.5	12.8	1.02	494.68	32.39	29.65
6	766.7	17.9	1.53	747.27	48.84	44.73
7	460.3	40.12	0.92	419.26	29.32	26.47
8	200	18	4.10	177.90	12.74	11.76
9	630	18.3	1.26	610.44	40.13	36.71
10	633	15.3	1.27	616.43	40.32	36.92
11	653.5	16	1.31	636.19	41.63	38.12
12	658.1	16.1	1.32	640.68	41.92	38.38
13	315.8	9.7	0.63	305.47	20.12	18.39
14	635.2	19.1	1.27	614.83	40.46	37.00
15	634.8	13.8	1.27	619.73	40.44	37.05
16	309.6	5.6	0.62	303.38	19.72	18.08
Total	8895.60	269.72	21.49	8604.39	566.65	518.42

Appendix B

Basin Storage Calculations

Drainage Area Storage Analysis										
Drainage Area #	(GL) Captured Gravel (acres)	(GA) Captured Gravel Area (SF)	(Gi) Gravel Coefficient	Beam Area (ac)	(BA) Beam Area (SF)	Impervious Coefficient	Substation Area and BESS Area	(OA) O&M Area	(Cw) Composit Coefficient	**(Vr) Volume Required (CF)**
			0.35			1.00			Cw=(GA*Gi+BA*Bi+SA*Si +OA*Oi)/(GA+BA+SA+OA)	**Vr=.5*(Cw)*(GA+BA+SA+OA)**
1	17.5	762,300.0	0.35	1.27	55,364.76	1.00			0.39	**163,533**
2	17.5	762,300.0	0.35	1.20	52,228.44	1.00			0.39	**162,906**
3	17.2	749,232.0	0.35	1.27	55,242.79	1.00			0.39	**160,895**
4	14.8	644,688.0	0.35	1.24	54,101.52	1.00			0.40	**139,758**
5	7.4	322,344.0	0.35	1.02	44,300.52	1.00			0.43	**73,329**
6	17.9	779,724.0	0.35	1.53	66,794.90	1.00			0.40	**169,304**
7	13.3	579,348.0	0.35	0.92	40,101.34	1.00	753,476.00	158,831.00	0.18	**306,351**
8	5.5	239,580.0	0.35	0.40	17,424.00	1.00	1,120,352.00		0.07	**275,471**
9	18.3	797,148.0	0.35	1.26	54,885.60	1.00			0.39	**170,407**
10	15.3	666,468.0	0.35	1.27	55,146.96	1.00			0.40	**144,323**
11	16.0	696,960.0	0.35	1.31	56,932.92	1.00			0.40	**150,779**
12	16.1	701,316.0	0.35	1.32	57,333.67	1.00			0.40	**151,730**
13	9.7	422,532.0	0.35	0.63	27,512.50	1.00			0.39	**90,009**
14	19.1	831,996.0	0.35	1.27	55,338.62	1.00			0.39	**177,467**
15	5.5	239,580.0	0.35	1.27	55,303.78	1.00			0.47	**58,977**
16	8.3	361,548.0	0.35	0.62	26,972.35	1.00			0.40	**77,704**

Table 1		
Added Impervious	**Square Feet**	**Runoff Coefficient**
20' Wide Gravel Road	9,801,000	0.35
Substation Gravel Area	1,873,828	0.35
Beam Area	774,932	1.00
O&M Storage Building	158,831	1.00
Total Area	**12,608,591**	
Composite Coefficient	**0.40**	
Permanent Volume Required	**2,509,976**	**Cubic Feet Required**

Basin Volume Calculations

Basin	Required Volume (af)	Aws (ac)	Ab (acre)	Dw (ft)	Provided Volume (af)
1	3.75	4.2	2.7	1.5	6.29
2	3.74	3.5	2.1	1.5	4.64
3	3.69	3.2	1.9	1.5	4.07
4	3.21	2.8	1.7	1.5	3.44
5	1.68	2.3	1.5	1.5	2.76
6	3.89	7.2	3.5	1.5	11.65
7	7.03	5.9	2.1	1.5	7.10
8	6.32	10.8	1.3	1.5	9.56
9	3.91	4.6	2.1	1.5	5.77
10	3.31	3.5	1.5	1.5	3.81
11	3.46	4.5	3.3	1.5	7.61
12	3.48	4.3	2	1.5	5.30
13	2.07	5.1	1.1	1.5	4.50
14	4.07	5.3	2	1.5	6.30
15	1.35	3	0.49	1.5	2.11
16	1.78	3.9	0.8	1.5	3.13
Total	56.77				88.04

V_s = Retention basin storage capacity in acre feet or cubic feet.

C = Composite runoff coefficient (Dimensionless)

A = Drainage area in acres or square feet

The basin design capacity shall be calculated using the pyramidal frustum volume equation below.

$$V = \frac{\left[A_B + A_{WS} + (A_B * A_{WS})^{\frac{1}{2}}\right] * D_W}{3}$$

Where,

V = Basin design capacity in cubic feet

A_{WS} = Area of water surface in square feet

A_B = Area of bottom in Square feet

D_W = Average depth of water in feet not including freeboard depth

Appendix C

Atas 14 Rainfall Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Helm, California, USA*
Latitude: 36.4935°, Longitude: -120.1758°
Elevation: m/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	**0.067** (0.059-0.077)	**0.084** (0.074-0.097)	**0.109** (0.096-0.125)	**0.130** (0.113-0.151)	**0.162** (0.135-0.196)	**0.188** (0.153-0.233)	**0.217** (0.172-0.277)	**0.248** (0.190-0.328)	**0.295** (0.215-0.409)	**0.335** (0.234-0.483)
10-min	**0.096** (0.085-0.110)	**0.121** (0.107-0.139)	**0.156** (0.137-0.180)	**0.187** (0.163-0.217)	**0.232** (0.194-0.281)	**0.270** (0.220-0.334)	**0.311** (0.246-0.397)	**0.356** (0.272-0.470)	**0.423** (0.308-0.586)	**0.480** (0.335-0.692)
15-min	**0.116** (0.103-0.133)	**0.146** (0.129-0.168)	**0.189** (0.166-0.217)	**0.226** (0.197-0.262)	**0.281** (0.235-0.339)	**0.326** (0.266-0.404)	**0.376** (0.297-0.480)	**0.431** (0.330-0.568)	**0.511** (0.373-0.709)	**0.580** (0.406-0.837)
30-min	**0.159** (0.140-0.182)	**0.200** (0.176-0.229)	**0.258** (0.227-0.297)	**0.309** (0.269-0.358)	**0.383** (0.320-0.463)	**0.445** (0.363-0.552)	**0.513** (0.406-0.655)	**0.588** (0.450-0.776)	**0.698** (0.509-0.968)	**0.792** (0.554-1.14)
60-min	**0.222** (0.196-0.254)	**0.280** (0.246-0.320)	**0.361** (0.317-0.415)	**0.432** (0.375-0.501)	**0.536** (0.448-0.648)	**0.622** (0.507-0.772)	**0.717** (0.568-0.916)	**0.822** (0.629-1.09)	**0.976** (0.711-1.35)	**1.11** (0.774-1.60)
2-hr	**0.325** (0.287-0.371)	**0.401** (0.354-0.460)	**0.510** (0.448-0.586)	**0.605** (0.527-0.703)	**0.746** (0.624-0.902)	**0.864** (0.704-1.07)	**0.992** (0.785-1.27)	**1.14** (0.868-1.50)	**1.34** (0.979-1.86)	**1.52** (1.06-2.20)
3-hr	**0.398** (0.352-0.456)	**0.491** (0.433-0.563)	**0.623** (0.548-0.716)	**0.739** (0.643-0.858)	**0.909** (0.759-1.10)	**1.05** (0.856-1.30)	**1.21** (0.954-1.54)	**1.38** (1.05-1.82)	**1.63** (1.19-2.26)	**1.84** (1.29-2.65)
6-hr	**0.541** (0.477-0.619)	**0.673** (0.594-0.771)	**0.858** (0.754-0.987)	**1.02** (0.887-1.18)	**1.25** (1.05-1.51)	**1.44** (1.18-1.79)	**1.65** (1.31-2.11)	**1.88** (1.44-2.48)	**2.21** (1.61-3.06)	**2.48** (1.73-3.58)
12-hr	**0.691** (0.611-0.791)	**0.892** (0.787-1.02)	**1.17** (1.02-1.34)	**1.39** (1.21-1.62)	**1.72** (1.43-2.07)	**1.97** (1.61-2.44)	**2.24** (1.77-2.86)	**2.52** (1.93-3.33)	**2.92** (2.13-4.05)	**3.25** (2.27-4.69)
24-hr	**0.868** (0.785-0.981)	**1.16** (1.05-1.31)	**1.55** (1.39-1.76)	**1.87** (1.67-2.13)	**2.30** (1.99-2.73)	**2.64** (2.23-3.20)	**2.99** (2.46-3.71)	**3.36** (2.69-4.29)	**3.86** (2.96-5.15)	**4.26** (3.15-5.88)
2-day	**1.05** (0.949-1.19)	**1.41** (1.28-1.60)	**1.90** (1.71-2.15)	**2.30** (2.05-2.63)	**2.84** (2.45-3.37)	**3.27** (2.76-3.96)	**3.71** (3.05-4.60)	**4.17** (3.33-5.32)	**4.80** (3.68-6.40)	**5.30** (3.92-7.31)
3-day	**1.17** (1.06-1.32)	**1.57** (1.42-1.78)	**2.11** (1.90-2.39)	**2.56** (2.28-2.92)	**3.18** (2.74-3.76)	**3.66** (3.09-4.43)	**4.16** (3.42-5.16)	**4.68** (3.75-5.98)	**5.41** (4.15-7.21)	**5.99** (4.43-8.27)
4-day	**1.26** (1.14-1.43)	**1.69** (1.53-1.91)	**2.27** (2.04-2.57)	**2.75** (2.45-3.14)	**3.42** (2.95-4.05)	**3.95** (3.33-4.77)	**4.50** (3.70-5.58)	**5.07** (4.06-6.48)	**5.88** (4.50-7.83)	**6.52** (4.82-9.00)
7-day	**1.48** (1.34-1.67)	**1.95** (1.76-2.20)	**2.59** (2.33-2.94)	**3.13** (2.80-3.58)	**3.91** (3.37-4.62)	**4.52** (3.82-5.47)	**5.17** (4.26-6.41)	**5.86** (4.69-7.48)	**6.84** (5.24-9.11)	**7.62** (5.64-10.5)
10-day	**1.58** (1.43-1.79)	**2.06** (1.86-2.33)	**2.72** (2.45-3.09)	**3.29** (2.94-3.77)	**4.11** (3.55-4.87)	**4.77** (4.03-5.77)	**5.47** (4.50-6.79)	**6.22** (4.97-7.95)	**7.30** (5.59-9.72)	**8.16** (6.04-11.3)
20-day	**1.90** (1.72-2.15)	**2.47** (2.23-2.80)	**3.28** (2.95-3.72)	**3.98** (3.55-4.55)	**4.99** (4.30-5.91)	**5.82** (4.91-7.04)	**6.70** (5.51-8.31)	**7.66** (6.12-9.77)	**9.02** (6.91-12.0)	**10.1** (7.49-14.0)
30-day	**2.23** (2.01-2.52)	**2.91** (2.62-3.29)	**3.87** (3.48-4.39)	**4.70** (4.19-5.37)	**5.91** (5.10-6.99)	**6.90** (5.82-8.34)	**7.94** (6.54-9.85)	**9.07** (7.25-11.6)	**10.7** (8.18-14.2)	**12.0** (8.86-16.5)
45-day	**2.70** (2.44-3.05)	**3.55** (3.20-4.01)	**4.74** (4.26-5.37)	**5.76** (5.14-6.59)	**7.25** (6.25-8.58)	**8.46** (7.14-10.2)	**9.74** (8.01-12.1)	**11.1** (8.88-14.2)	**13.0** (9.99-17.4)	**14.6** (10.8-20.1)
60-day	**3.14** (2.84-3.55)	**4.14** (3.73-4.68)	**5.53** (4.98-6.27)	**6.73** (6.01-7.70)	**8.45** (7.29-10.0)	**9.85** (8.31-11.9)	**11.3** (9.31-14.0)	**12.9** (10.3-16.4)	**15.1** (11.5-20.1)	**16.8** (12.4-23.2)

[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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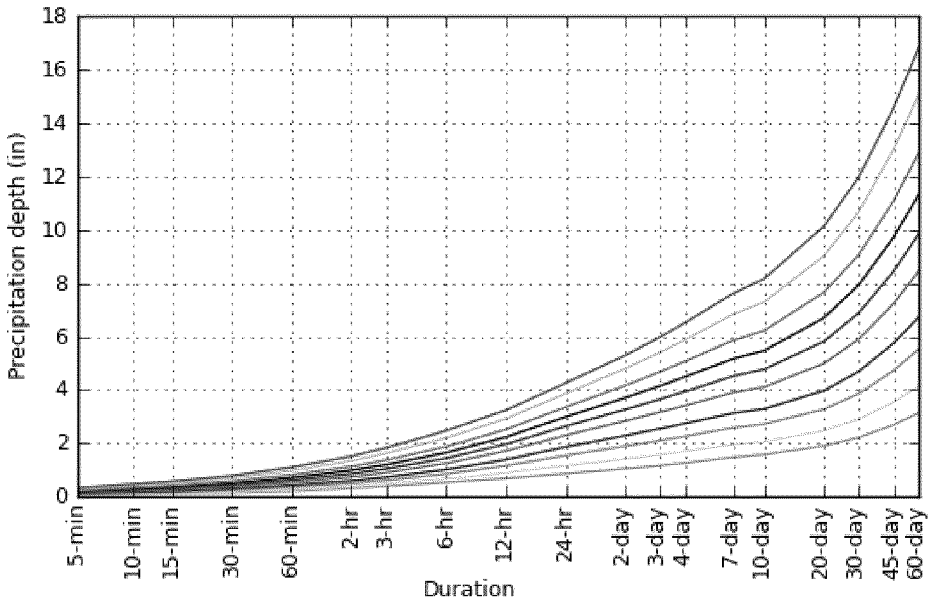
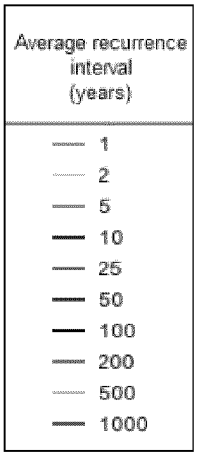
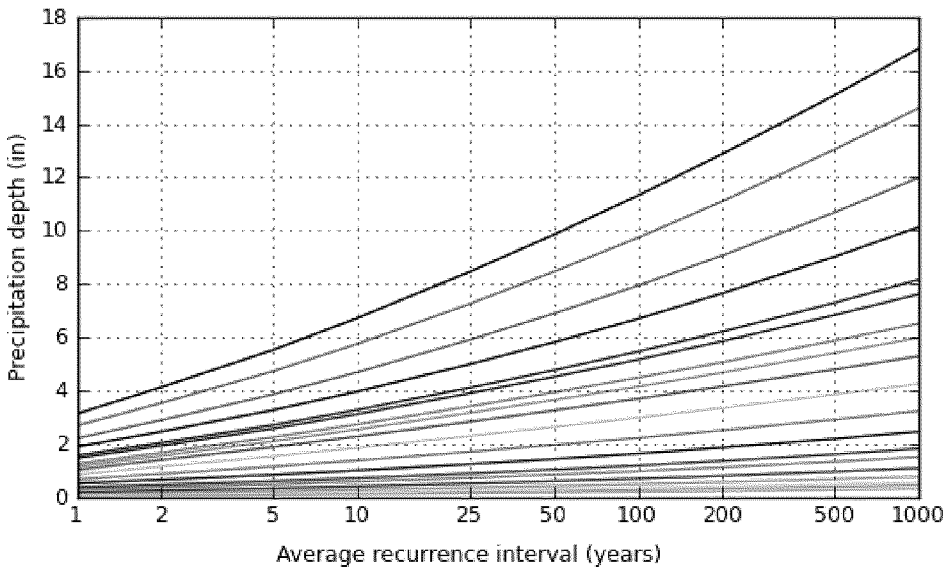
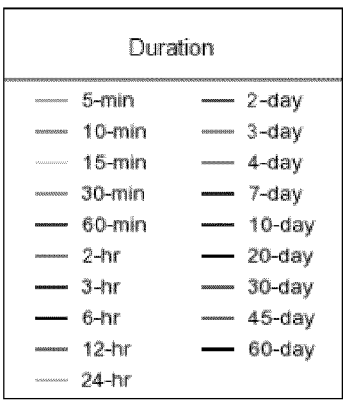
PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 36.4935°, Longitude: -120.1758°









NOAA Atlas 14, Volume 6, Version 2

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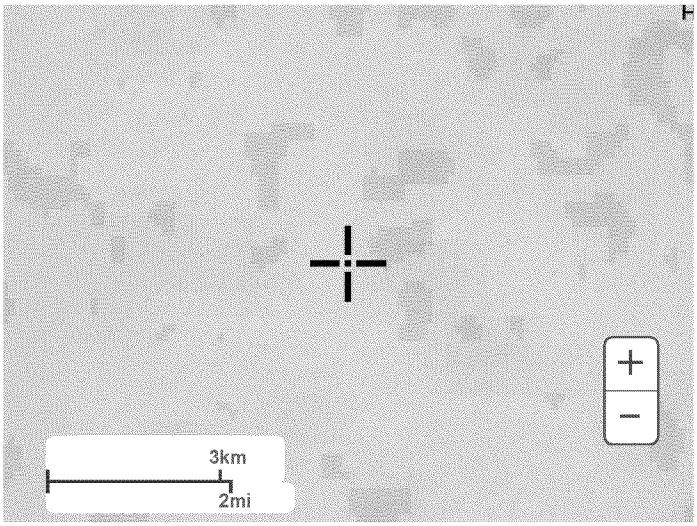
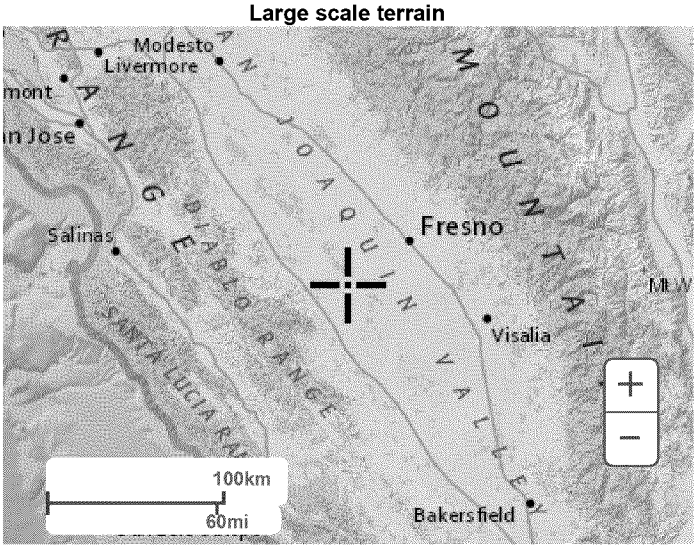
Maps & aerials

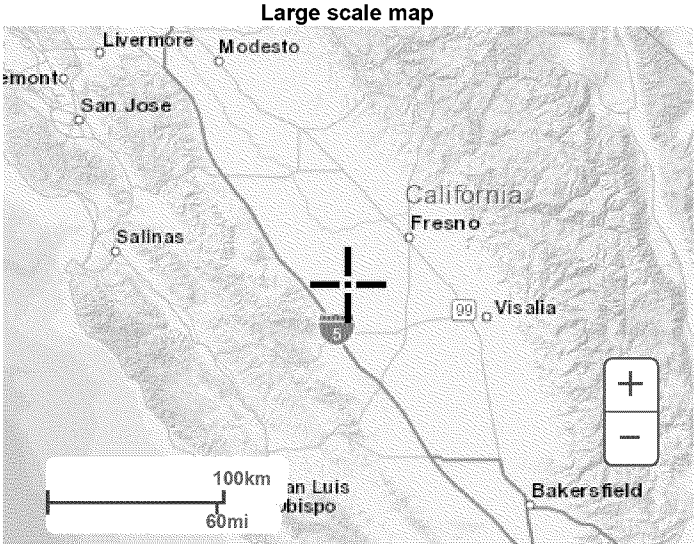
Small scale terrain



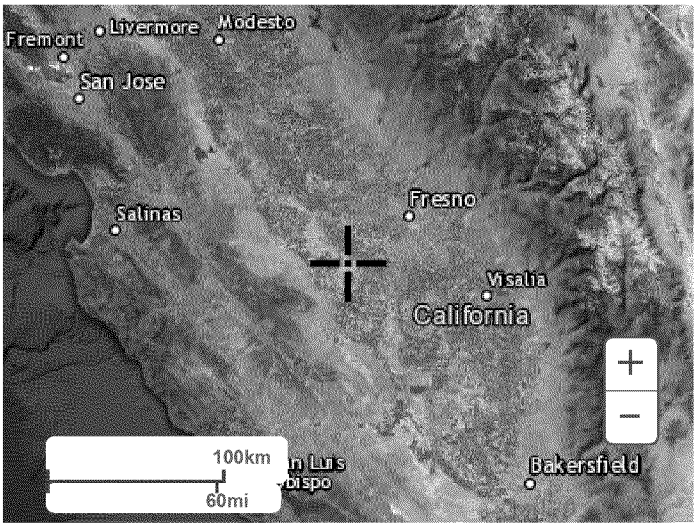
Large scale terrain



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

Appendix D

Partial Fresno County Improvement Standards Manual Table

Chart for obtaining "C" in rational drainage formula Q=CiA, for Rural Areas.
C normally falls between .30 & .55, .55 to .75 is high, above .75 is extreme and below .30 is low. Add partial factors for relief, soil, cover and storage to obtain total C factor:

Example:		
	Flat terrain	.08 to .12
	Clay soil	.11 to .15
	No cover	.15 to .19
	Normal storage	.06 to .11
	C=	.40 to .57

DESIGNATION OF WATERSHED CHARACTERISTICS	DESCRIPTION AND RANGE OF RUNOFF PRODUCING CHARACTERISTICS			
Relief	.30 to .38 Steep rugged terrain-average slopes above 40%.	.22 to .30 Hilly to mountainous terrain-average slopes between 15 and 40%.	.12 to .22 Rolling to hilly terrain-average slopes from 6 to 15%.	.08 to .12 Flat to mildy rolling terrain-average slopes less than 6%.
Soil	.15 to .19 No effective soil cover-either rock or thin soil mantle of poor to negligible infiltration capacity.	.11 to .15 Slow to take up water-clay or other soil with fair to poor infiltration capacity.	.06 to .11 Normal-permeable soils of good depth with good to fair infiltration capacity.	.04 to .06 Soils of good to excellent infiltration capacity-sands, loamy sands, and other loose open soils.
Vegetal Cover	.15 to .19 No effective plant cover-bare to very sparce cover.	.11 to .15 Fair to sparve cover-clean cultivated crops or poor natural, vegitation-less than 20% of drainage area under good cover.	.06 to .11 Good to fair cover-not more than 50% of area in clean cultivated crops or poor natural vegitation-between 20 & 65% in good grassland, woodland or equivalent cover.	.04 to .06 Good to excellent cover-65 to 85% of area in good grassland, woodland or equivalant cover.
Surface Storage	.15 to .19 Negligible-surface depression few and shallow-drainage ways steep and narrow-no ponds or marshes.	.11 to .15 Low- only fair amount of surface depression storage well defined system of small drainage ways-no ponds or marshes.	.06 to .11 Normal-fair to considerable surface depression storage-having a drainage system similar to that of prairie lands-small amount of lakes, ponds, and marshes	.04 to .06 High-large amount of surface depression storage drainage system not sharply defined-large flood plain storage or a large number of lakes, ponds or

From: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
Sent: 12/11/2024 11:21:48 PM
To: Becky Moores [becky.moores@intersectpower.com]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
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Subject: Re: Darden Clean Energy Project (23-OPT-02) - currently proposed BIO mitigation measures

Hi Becky,

Thank you for accommodating our request, we also received the 4 SHWA files and appreciate you being able to provide.

Talk soon,

Ann

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, December 11, 2024 9:17 AM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Will Lutkewitte <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
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We plan to work this into our data response package as well so a clean version will be docketed for public availability.

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Thanks for all the coordination to date and it has been great working with you and Will as a PM on the Darden project!

Ann

Ann Crisp
Biological Resources Unit Supervisor
Siting and Environmental Branch
Siting, Transmission and Environmental Protection Division
916-352-0543

California Energy Commission
Website: www.energy.ca.gov

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Sent: Wednesday, December 4, 2024 7:09 PM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Cc: Will Lutkewitte <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
Subject: Re: Darden Clean Energy Project (23-OPT-02) - currently proposed BIO mitigation measures

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application. Staff needs to develop a final list of COCs for the DEIR and this would help in integrating the applicant's mitigation measure with any proposed conditions of certification.

Thanks!

Ann

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From: Worrall, Lisa@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=E4BBC7048B38485084BDB03FB494B25B-WORRALL, LI]
Sent: 12/11/2024 11:21:35 PM
To: Becky Moores [becky.moores@intersectpower.com]; Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
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Subject: RE: Darden Clean Energy Project (23-OPT-02) - Option 2

Great. Thanks.

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, December 11, 2024 3:17 PM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Cc: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
Subject: Re: Darden Clean Energy Project (23-OPT-02) - Option 2

Ann and Lisa,

I'm working through my review of all the responses now but we intend to make updates to all responses to remove both hydrogen and option 2.
We plan to get everything docketed by end of day Friday.

Thank you,

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(e) becky.moores@intersectpower.com

On Mon, Dec 9, 2024 at 2:52 PM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

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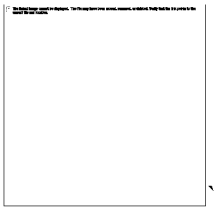

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Sent: 12/10/2024 4:37:26 PM
To: Becky Moores [becky.moores@intersectpower.com]
CC: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]; Will Lutkewitte [will.lutkewitte@intersectpower.com]; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]
Subject: RE: Darden Clean Energy Project (23-OPT-02) - Option 2

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From: Becky Moores <becky.moores@intersectpower.com>
Sent: Tuesday, December 10, 2024 8:36 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
Subject: Re: Darden Clean Energy Project (23-OPT-02) - Option 2

Hi Lisa,

No, the number of backup generators would not change. Up to 3 would still be required for the project's substation.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Tue, Dec 10, 2024 at 9:34 AM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Hi Becky,
>
> Our AQ staff were wondering if the removal of Option 2 would change the number of backup generators. We understand there would be three backup generators.
>
> Thanks,
>
> Lisa

From: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Sent: Monday, December 9, 2024 1:53 PM
To: Becky Moores <becky.moores@intersectpower.com>
Cc: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
Subject: Darden Clean Energy Project (23-OPT-02) - Option 2

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Biological Resources Unit Supervisor

Siting and Environmental Branch

Siting, Transmission and Environmental Protection Division

916-352-0543

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From: Becky Moores [becky.moores@intersectpower.com]
Sent: 12/11/2024 11:17:25 PM
To: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
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To: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
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Subject: Re: Darden Clean Energy Project (23-OPT-02) - currently proposed BIO mitigation measures
Attachments: Darden Application Mitigation Measures_Dec 2024.pdf; Darden Application Mitigation Measures_Dec 2024_Tracked.pdf

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Attached are a list of the mitigation measures included in our application materials. There is a clean and tracked version. Changes from our initial submittal include adjustments to burrowing owl measures based on data responses and the official listing, and removal of references to hydrogen which included removing two mitigation measures that were focused on aspects related to the hydrogen facility alone (noise and water).

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Darden Clean Energy Project Mitigation Measures

December 2024

The following mitigation measures were included in application materials submitted with the Darden Project's Opt-in Certification application package including the original submittal and data request responses, as well as updates due to the removal of the hydrogen facility from the Project.

AQ-1 Voluntary Emission Reduction Agreement

The Applicant shall enter into a voluntary emissions reduction agreement (VERA) with the SJVAPCD to offset the NOX emissions above the 10 tons per year threshold. The VERA is a mechanism for the Applicant to fund programs to reduce NOX emissions in the SJVAB. The Applicant shall coordinate with SJVAPCD to ensure VERA funds are used for programs near the Project site to the extent feasible. The VERA shall be submitted and approved by the SJVAPCD prior to beginning construction activities.

If available and as feasible, electric equipment could be incorporated into the off-road equipment fleet to reduce NOX emissions that must be offset with the required VERA. In order to reduce the NOX emissions that must be offset with the required VERA, the Applicant shall provide commitment to available electric equipment to the CEC and the SJVAPCD prior to the issuance of a permit to construct and quantify the emissions reductions from the electric equipment. Documentation of the equipment operating on-site, shall be maintained on-site at all times during construction and decommissioning activities.

AQ-2 Fugitive Dust Control Plan

Prior to construction and decommissioning activities, the Applicant shall prepare a Fugitive Dust Control Plan. At a minimum, the Fugitive Dust Control Plan shall include the following: Control fugitive dust on-site during construction and decommissioning with a minimum of one watering across the site daily with the use of chemical stabilizers during construction activities. Additional water/chemical treatments shall occur as needed based on daily site conditions and ground disturbance activities. Roads and other areas that experience high traffic volumes may be stabilized with water and/or chemicals up to four times a day. The method of monitoring site conditions for additional dust control needs shall be detailed in the plan. Chemical stabilizers shall be used for long-term fugitive dust control on-site. Specific stabilizers proposed for use and their location shall be included in the fugitive dust control plan for the project and records of watering and stabilizer application shall be kept. PM10 reduction quantifications from this measure are to be applied prior to the finalization of a voluntary emissions reduction agreement.

BIO-1 Construction Worker Environmental Awareness Training and Education Program

Prior to any activity on-site and for the duration of construction activities, all personnel at the Project area (including laydown areas and/or transmission routes) shall attend a Worker Environmental Awareness Program (WEAP) developed and presented by the Qualified Biologist

or authorized designee. New personnel shall receive WEAP training on the first day of work and prior to commencing work on the site. Any employee responsible for the O&M or decommissioning of the Project facilities shall also attend an O&M-specific WEAP training.

1. The program shall include information on the life history of the San Joaquin kit fox, Swainson's hawk, burrowing owl, American badger, San Joaquin coachwhip, and nesting birds as well as other wildlife and plant species that may be encountered during construction activities.
2. The program shall also discuss the legal protection status of each species, the definition of "take" under the Federal Endangered Species Act and California Endangered Species Act, measures the project proponent is implementing to protect the species, reporting requirements, specific measures that each worker shall employ to avoid take of wildlife species, and penalties for violation of the Federal Endangered Species Act or California Endangered Species Act.
3. The program shall include the contact information for the project biologist and on-site environmental compliance manager.
4. The program shall provide information on how and where to bring injured animals for treatment in the case any animals are injured the Project area.
5. An acknowledgement form signed by each worker indicating that WEAP training has been completed shall be kept on record.
6. A sticker shall be placed on hard hats indicating that the worker has completed the WEAP training. Construction workers shall not be permitted to operate equipment within the construction areas unless they have attended the WEAP training and are wearing hard hats with the required sticker.
7. A copy of the training transcript and/or training video, as well as a list of the names of all personnel who attended the WEAP training and copies of the signed acknowledgement forms will be made available upon agency request.

BIO-2 Construction Best Management Practices

The following best management practices shall be implemented during construction:

- Designation of a 15 mile per hour speed limit in all construction areas.
- All vehicles and equipment shall be parked on pavement, existing roads, and previously disturbed areas, and clearing of vegetation for vehicle access shall be avoided to the greatest extent feasible.
- The number of access routes, number and size of staging areas, and the total area of the activity shall be limited to the minimum necessary to achieve the goal of the project.
- Designation of equipment washout and fueling areas to be located within the limits of grading at a minimum of 100 feet from any sensitive resources as identified by a Qualified Biologist. Washout areas shall be designed to fully contain polluted water and materials for subsequent removal from the site.
- Drip pans shall be placed under all stationary vehicles and mechanical equipment that show signs of leaking or discharging lubricants or other fluids.

- All carrion shall be removed from the Project site prior to and during construction.
- All trash, including carrion, shall be placed in sealed containers and shall be removed from the project site a minimum of once per week.
- No pets are permitted on the Project site during construction.

BIO-3 Preconstruction Surveys for Special-Status Species

Preconstruction surveys for burrowing species shall be conducted by a Qualified Biologist for the presence of San Joaquin kit fox, American badger, and burrowing owl prior to commencement of construction activities in all areas with potential to support these species. This survey shall be conducted no more than 30 days prior to ground disturbing activities without prior agency approval. The surveys shall be conducted in areas of suitable habitat for each species. Surveys shall conform to USFWS guidelines for San Joaquin kit fox, CDFW guidelines for burrowing owl, and to industry standards for American badger.

Where special-status species habitat (e.g., burrows or nest trees and vegetation) are known to occur and there is a potential for significant impacts, Qualified Biologist shall monitor construction activities to ensure that impacts to special-status species are avoided and minimized.

BIO-4 Measures for San Joaquin Kit Fox

In areas of the Project site where San Joaquin kit fox potentially occur (the utility switchyard location), the following measures shall be implemented by a Qualified Biologist:

- Pre-construction surveys for San Joaquin kit fox no more than 30 days prior to ground disturbance
- Construction activity monitoring
- San Joaquin kit fox dens are not expected to occur in project work areas. If San Joaquin kit fox occurs in the Project site, work within 500 feet of the animal shall be halted until the animal leaves the area, as determined by the Qualified Biologist.

BIO-5 Measures for Burrowing Owl

Superseded, refer to BIO-11 Burrowing Owl Management Plan.

BIO-6 Measures for American Badger

- Preconstruction surveys for American badger shall be conducted by a Qualified Biologist no more than 30 days prior to ground disturbance.
- If potential American badger dens are observed and avoidance is feasible, buffer distances of 50 feet for occupied dens and 250-foot, no-disturbance buffers for natal dens shall be established by the Qualified Biologist prior to construction activities.
- If avoidance of the potential American badger dens is not feasible, the following measures are recommended to minimize potential adverse effects to the American badger:

- If a Qualified Biologist determines that potential dens are inactive, the biologist shall excavate these dens by hand with a shovel and collapse them to prevent American badgers from re-using them during construction.
- If the Qualified Biologist determines that potential dens may be active, biologist shall conduct remote camera monitoring of the burrow for a period of three consecutive days to confirm occupancy status. If the Qualified Biologist determines that a burrow is an active natal burrow, avoidance buffers shall be established to demarcate no-work areas that shall be maintained until the burrow is no longer an active natal burrow. Burrows that are determined to be non-natal or are active outside of the breeding season shall implement passive eviction procedures through the installation of one-way doors, and the use of remote camera monitoring to document no activity for 3 consecutive days. Dens that are determined to be unoccupied or have become inactive following passive eviction or at the end of breeding season shall be hand-excavated with a shovel and collapsed to prevent re-use during construction.

BIO-7 Pre-construction Surveys for Nesting Birds and Common Raptors

If construction is scheduled to commence during the non-breeding season (September 1 to January 31), no pre-construction surveys or additional measures for nesting birds or other raptors would be required. Prior to ground disturbing and vegetation removal activities that are initiated during the breeding season (February 1 to August 31), a Qualified Wildlife Biologist shall conduct pre-construction surveys of all potential nesting habitats within the Project area. The raptor survey shall focus on potential nest sites (e.g., owl boxes, large trees, windrows, and shrubs) within 500 feet of the site for common raptors. Nesting bird surveys shall be conducted within 14 days of the start of ground-disturbing or vegetation removal activities. Surveys need not be conducted for the entire Project area at one time and may be conducted in phases consistent with construction activity schedules. The surveying biologist must be qualified to determine the status and stage of nesting by migratory birds and all locally breeding raptor species without causing intrusive disturbance.

BIO-8 Nest Buffers

If active nests are found, a suitable no-work buffer shall be established around active nests. Buffers shall be determined by the Qualified Biologist and be established based on the species and nest location, to allow for known species' behavior and environmental factors (e.g., line of sight to nest) when establishing avoidance buffers. Standard buffers are typically 200-500 feet for common raptors and 30-50 feet for most common passerines. No access into buffer areas shall be allowed until a Qualified Biologist has determined that the nestlings have fledged and are no longer reliant on the nest or the nest has become otherwise inactive (e.g., depredation). Encroachment into the buffer may occur at the discretion of a Qualified Biologist and with the appropriate biological monitoring; however, for State-listed species, CDFW shall be consulted for approval of buffer encroachment or reduction.

BIO-9 Swainson's Hawk Conservation Strategy

The Applicant shall prepare a Swainson's Hawk Conservation Strategy to be implemented during Project construction and operations. The goals of the conservation strategy will be to avoid and minimize direct impacts to individuals present within the Project vicinity, and manage nesting and foraging habitat within the Project site to benefit the Swainson's hawk through implementation of both short-term and long-term conservation strategies during Project construction and operation, including specific methodologies, location of specific mitigation and management actions, success criteria, and evaluation of success criteria. The Swainson's Hawk Conservation Strategy will include the items described below.

Short-Term Conservation Strategy

Short term conservation measures are intended to address potential impacts to nesting and temporary loss of foraging habitat during the Project's construction phase, and will include a discussion of:

1. Nesting habitat
    a. Preservation of nest trees
    b. Temporary construction buffers
    c. Temporary nest structure establishment
    d. Establishment of new nest trees
2. Foraging habitat
    a. Habitat restoration

Long-Term Conservation Strategy

Long-term conservation measures are intended to address potential cumulative impacts and promote Swainson's hawk population stability and growth, as well as address potential impacts to nesting Swainson's hawks during some O&M phase activities, and will include a discussion of:

1. Implementation of a Vegetation Management Plan
2. Monitoring and management of nest tree plantings and artificial nest structures
3. Implementation of Swainson's hawk management research program

Success Criteria and Evaluation

1. Short-term conservation strategy success criteria
2. Long-term conservation strategy success criteria
3. Success criteria evaluation

BIO-10 Vegetation Management Plan

Revegetation and Vegetation Management Goals and Objectives

Revegetation and vegetation management of the Project site will occur during the Project construction and operation phases. Revegetation will account for on-site constraints including a lack of irrigation, saline soils, and poor drainage conditions. The Project will facilitate a Before-After- Control-Impact (BACI) research design to test the efficacy of multiple vegetation management regimes on the establishment of Swainson's hawk foraging habitat with the goal of achieving the following success criteria:

- Establish permanent, regenerative vegetative cover that will:
    - Represent high-quality foraging habitat for Swainson's hawks (i.e., appropriate vegetative structure that maintains a sufficient prey base).
    - Provide suitable floral resources for native pollinators.
    - Prevent and control noxious weed infestations.
    - Allows for safe and efficient O&M Project activities.

Additional benefits of a vegetation management plan that achieves these primary goals would be reduced fire risk through management of fuel loads, erosion control, stormwater runoff control, and water quality control during the Project's operational phase.

Preparation of a Vegetation Management Plan

The Applicant shall prepare a Vegetation Management Plan to be implemented during construction and operations Project phases. The plan shall be developed to address the goals and objectives outlined above and will contain the following sections and information:

1. Purpose of the plan
2. List and discussion of target species
3. Prevention methods
    a. Specifications for completing preconstruction weed survey
    b. Discussion of control methods including preconstruction, construction, and O&M methods
    c. Vehicle inspections and cleaning during construction
    d. Weed free materials
    e. Preliminary seeding
4. Weed control methods
    a. Mechanical and manual controls
    b. Chemical controls
    c. Grazing controls
5. Revegetation Implementation Plan
    a. Site preparation methods
        i. Soil testing
        ii. Methods

        iii. Timing
    b. Seed Pallet
6. Planting Methods and Guidelines
    a. Seeding
    b. Tree container planting
7. Vegetation Maintenance and Long-Term Management
8. Preliminary Monitoring Plan
    a. Study Design
        i. Vegetation Sampling
        ii. Soils/Phytoremediation
        iii. Wildlife Sampling
9. Success Criteria
10. Adaptive Management
11. Post Decommissioning Revegetation Plan

BIO-11 Burrowing Owl Management Plan

The Applicant shall prepare a Burrowing Owl Management Plan that will address the following topics to fully minimize and mitigate potential impacts to the species. The management plan will include the following:

1. Burrowing owl existing conditions, including site conditions and burrowing owl observations
2. Management Strategy
    a. Qualified Biologist
    b. Pre-construction surveys
    c. Determination of occupancy
    d. Nesting deterrence
    e. Construction monitoring
    f. Burrow avoidance and activity buffers
    g. Sound or visual barriers
    h. Passive relocations and exclusion, including installation of artificial burrows if necessary
    i. Burrow excavation
3. Reporting
4. Mitigation
5. Operations and Maintenance Measures

BIO-12 Operations and Maintenance Biological Resources Management Plan

The Applicant shall prepare an Operations and Maintenance Biological Resources Management Plan to be implemented during Project operations that incorporates elements of final Project layout and design and baseline conditions. The plan will address the following topics to avoid and minimize potential impacts to sensitive biological resources including San Joaquin kit fox, American badger, and Swainson's hawk, including from vehicle use; solar panel, facility, and equipment maintenance and repair; and vegetation management activities; among other operations activities. The management plan will be prepared prior to initiation of Project operations and will include the following:

1. Existing conditions, including sensitive biological resources
2. Management Strategy
    a. Worker Environmental Awareness Program
    b. Avoidance and minimization measures
    c. Surveys
    d. Monitoring
3. Reporting

The plan will be reviewed and updated every 5 years to incorporate changed conditions and adaptive management, as needed.

CUL-1 Designated Cultural Resources Specialist

The Applicant shall retain a designated Cultural Resources Specialist (CRS) who will be available to carry out mitigation measures related to cultural resources for the Project. The CRS shall meet or exceed the Secretary of the Interior's Professional Qualifications Standards for archaeology (National Park Service 1983). The CRS shall be qualified in site detection, evaluation of deposit significance, consultation with regulatory agencies, and plan site evaluation and mitigation activities.

CUL-2 Collection of Darden-ISO-CJ-68

Prior to the start of construction, Darden-ISO-CJ-68 shall be collected under the direction of the CRS. A Native American representative shall also be contacted to participate in the collection of the find. Once collected, Darden-ISO-CJ-68 shall be sketched and photographed. The isolate shall be collected and final disposition will be determined by the lead agency and any Native American tribes who choose to consult on the Project.

CUL-3 Archaeological Monitoring and Discovery Plan

Prior to the start of permitted ground disturbing activities, an Archaeological Monitoring and Discovery Plan shall be prepared by the CRS. The monitoring plan shall include a description of the monitoring methodology, including when monitoring will be required, the authority of the monitor to halt construction should a discovery be made, contact information should a discovery

be made, definition of site types typically present within the area, define the types of resources that would require that work be halted or redirected, provide the protocols for unanticipated discoveries (e.g., who to call and next steps for documentation and coordination), methodology for establishing an Environmentally Sensitive Area (ESA) should one be required, review and approval protocols (e.g., define review periods for agencies and stakeholders), and dispute resolution.

CUL-4 Worker Environmental Awareness Program (WEAP)

Prior to the start of ground disturbance, the construction crew shall participate in on-site training on the proper procedures to follow if cultural resources are uncovered during the Project excavations, site preparation, or other related activities. This Worker Environmental Awareness Program shall include a comprehensive discussion of applicable laws and penalties under the law, samples or visuals of artifacts that might be found in the vicinity of the Project site, a discussion of what such artifacts may look like when partially buried or wholly buried and then freshly exposed, a discussion of what prehistoric and historic-period archaeological deposits look like at the surface and when exposed during construction, instruction that employees are to halt work in the vicinity of a discovery (within 50 feet) and requirements for working within 50 feet of an ESA. This information shall be provided in an informational brochure that outlines reporting procedures in the event of a discovery and shall be provided to all individuals working on-site.

CUL-5 Archaeological Monitoring

Archaeological monitor(s) working under the direction of the CRS shall be on-site during permitted ground disturbing activities described herein that occur within the moderate to high sensitivity locations identified in Figure 5.1-2. Activities that shall require an archaeological monitor include mass grading that exposes previously undisturbed soils (approximately 18 inches below ground surface based on previous agricultural practices), and open trench excavation with mechanical equipment. Activities that do not expose soil profiles, such as pile driving, ditch witch trenching, and the use of hand tools, will not require monitoring unless they occur within 50 feet of an ESA.

During monitoring, the monitors shall examine the work areas for the presence of prehistoric artifacts (e.g., chipped stone tools and production debris, stone milling tools, ceramics), historic-period debris (e.g., metal, glass, ceramics), and/or soil discoloration that might indicate the presence of a cultural midden. Each monitor shall maintain a daily log documenting ground disturbing activity, work locations, description, and provenience of any archaeological discoveries (if any), and any necessary action items for monitoring.

The archaeological monitor shall have the authority to halt and redirect work in the event of a discovery. If archaeological resources are encountered during ground-disturbing activities, work in the immediate area shall be halted and/or redirected, and the find evaluated for listing in the CRHR. Should an unanticipated resource be found as CRHR eligible and avoidance is infeasible, additional analysis (e.g., testing) may be necessary to determine if project impacts would be significant.

Archaeological monitoring may be reduced or terminated at the discretion of the CRS in consultation with the lead agency, as warranted by conditions such as encountering bedrock, the presence of fill soil, or negative findings during initial ground disturbance. If monitoring is reduced to spot-checking, spot-checking shall occur when ground-disturbance moves to a new location or when ground disturbance will extend to depths not previously excavated (unless those depths are within bedrock).

CUL-6 Unanticipated Discovery of Cultural Resources

In the event archaeological resources are unexpectedly encountered during ground-disturbing activities, work within 50 feet of the find shall halt and the project CRS be contacted immediately to evaluate the resource. If the resource is determined by the CRS to be prehistoric, then a Native American representative shall also be contacted to participate in the evaluation of the resource. If the CRS and/or Native American representative determines it to be appropriate, archaeological testing for CRHR eligibility shall be completed. If the resource proves to be eligible for the CRHR and significant impacts to the resource cannot be avoided via Project redesign, the CRS shall prepare a data recovery plan tailored to the physical nature and characteristics of the resource, per the requirements of the CCR Guidelines Section 15126.4(b)(3)(C). The data recovery plan shall identify data recovery excavation methods, measurable objectives, and data thresholds to reduce any significant impacts to cultural resources related to the resource. Pursuant to the data recovery plan, the CRS and Native American representative, as appropriate, shall recover and document the scientifically consequential information that justifies the resource's significance. The lead agency shall review and approve the treatment plan and archaeological testing as appropriate, and the resulting documentation shall be submitted to the regional repository of the CHRIS, per CCR Guidelines Section 15126.4(b)(3)(C).

CUL-7 Human Remains

No human remains are known to be present within the Project site. However, the discovery of human remains is always a possibility during ground-disturbing activities. If human remains are found, the State of California Health and Safety Code Section 7050.5 states that no further disturbance shall occur until the County Coroner has made a determination of origin and disposition pursuant to Public Resources Code Section 5097.98. In the event of an unanticipated discovery of human remains, the County Coroner must be notified immediately. If the human remains are determined to be of Native American origin, the Coroner will notify the NAHC, which will determine and notify a Most Likely Descendant (MLD). The MLD has 48 hours from being granted site access to make recommendations for the disposition of the remains. If the MLD does not make recommendations within 48 hours, the landowner shall reinter the remains in an area of the property secure from subsequent disturbance.

PAL-1 Paleontological Resources Specialist

Prior to the start of construction, the Project Applicant shall submit the name and resume of an individual to the CEC for review and approval as the Project's Paleontological Resources Specialist. The PRS shall be an individual with a degree in paleontology or geology and at least

three years of paleontological resource mitigation and field experience in California, including at least one year of leading paleontological resource mitigation and field activities. The PRS shall be responsible for directing all paleontological mitigation efforts for the Project.

PAL-2 Paleontological Worker Environmental Awareness Program

The PRS or their designee shall conduct a paleontological Worker Environmental Awareness Program (WEAP) training for construction personnel regarding the appearance of fossils and the procedures for notifying paleontological staff should fossils be discovered by construction personnel.

PAL-3 Paleontological Monitoring

Full-time paleontological monitoring shall be conducted during trenching, excavation, grading, and drilling (if borehole is 2 feet or more in diameter) when ground disturbing depths exceed 18 inches, within previously undisturbed sediments with high paleontological sensitivity (i.e., Quaternary older alluvium) to mitigate for potential impacts to currently unknown paleontological resources. Full-time paleontological monitoring shall also be conducted during trenching, excavation, grading, and drilling (if borehole is 2 feet or more in diameter) activities reaching deeper than 5 feet below current grade in sediments assigned a low paleontological sensitivity from 0 to 5 feet and high paleontological sensitivity below 5 feet (i.e., Quaternary basin deposits and Quaternary fan deposits). Pile driving and drilling for boreholes less than 2 feet in diameter do not require paleontological monitoring as the data required to accompany scientifically valuable paleontological resources cannot be collected under the conditions of typical drilling and pile driving activity.

Monitoring shall be conducted by a paleontological monitor with experience with collection and salvage of paleontological resources and who meets the minimum standards of the Society of Vertebrate Paleontology (2010) for a Paleontological Resources Monitor. The PRS in coordination with the CEC may recommend that monitoring be reduced in frequency or ceased entirely based on geologic observations.

In the event of the discovery of a previously unknown paleontological resource by the paleontological monitor or construction personnel, all construction activity within 50 feet of the find shall cease, and the PRS shall evaluate the find. If the fossil(s) is (are) not scientifically significant, then construction activity may resume. If it is determined that the fossil(s) is (are) scientifically significant, Mitigation Measure PAL-4 shall be enacted.

PAL-4 Paleontological Resource Salvage and Curation

If a paleontological resource is determined to be potentially scientifically significant, the paleontological monitor shall salvage (i.e., excavate and recover) the fossil to protect it from damage/destruction. Typically, fossils can be safely salvaged quickly by a single paleontological monitor with minimal disruption to construction activity. In some cases, larger fossils (such as complete skeletons or large mammal fossils) require more extensive excavation and longer salvage periods. Bulk matrix sampling may be necessary to recover small invertebrates or microvertebrates from within paleontologically sensitive deposits. After the fossil(s) is (are) salvaged, construction activity may resume.

Fossils shall be identified to the lowest (i.e., most-specific) possible taxonomic level, prepared to a curation-ready condition, and curated in a scientific institution with a permanent paleontological collection along with all pertinent field notes, photos, data, and maps. Fossils of undetermined significance at the time of collection may also warrant curation at the discretion of the PRS.

PAL-5 Paleontological Mitigation Report

Upon completion of ground-disturbing activities (or laboratory preparation and curation of fossils, if necessary), the PRS shall prepare a final report describing the results of the paleontological monitoring efforts. The report shall include a summary of the field and laboratory methods employed; an overview of Project geology; and, if fossils were discovered, an analysis of the fossils, including physical description, taxonomic identification, and scientific significance. The report shall be submitted to the CEC and, if fossil curation is required, the designated scientific institution.

PH-1 Minimize Personnel and Public Exposure to Valley Fever

Prior to site preparation, grading activities, or ground disturbance, the Applicant shall prepare a Fugitive Dust Control Plan for the Project. The Fugitive Dust Control Plan shall include the following at a minimum:

- Equipment, vehicles, and other items shall be cleaned thoroughly of dust before they are moved off-site to other work locations.
- Wherever possible, grading, and trenching work shall be phased so that earth-moving equipment works well ahead or down-wind of workers on the ground.
- The area immediately behind grading or trenching equipment shall be sprayed with water before ground workers move into the area.
- If a water truck runs out of water before dust is dampened sufficiently, ground workers exposed to dust are to leave the area until a full truck resumes water spraying.
- All heavy-duty earth-moving vehicles shall be closed-cab and equipped with a High Efficiency Particulate Arrestance (HEPA) filtered air system.
- N95 respirators shall be provided to onsite workers for the duration of the construction period.
- Workers shall receive training to recognize the symptoms of Valley Fever and shall be instructed to promptly report suspected symptoms of work-related Valley Fever to a supervisor. Evidence of training shall be provided to the Fresno County Planning and Community Development Department within 24 hours of the training session.
- A Valley Fever informational handout shall be provided to all on-site construction personnel. The handout shall provide, at a minimum, information regarding the symptoms, health effects, preventative measures, and treatment.

SOC-1 Emergency Service Agreement

In coordination with Fresno County, the Applicant would prepare an agreement to support emergency services personnel in the Project area to minimize Project demand on local sheriff, fire, and EMS providers and maintain their ability to respond to other emergencies. The agreement would allow for adequate training and coordination with local fire and law enforcement responders to become familiar with the risks and procedures needed to respond to potential emergencies associated with Project facilities. The Applicant would also develop and implement a private security system with which local law enforcement could integrate and coordinate response and deterrent measures.

TRA-1 Construction Traffic Carpool and Trip Reduction Plan

Prior to the start of construction, the Applicant shall submit a Construction Traffic Carpool and Trip Reduction Plan for review and approval by CEC, which shall include, but not be limited to:

- Feasible methods that encourage or provide ridesharing opportunities for construction workers.
- Feasible methods to reduce VMT by both construction employees and construction-related truck trips, such as encouraging hiring of local construction workers.
- Use of rail transport for specialized equipment that may originate from ports or other long distances to reduce VMT associated with vehicle delivery to the Project site, if feasible.
- Define potential methods to coordinate with adjacent solar project developers where Project construction may overlap to potentially provide group ridesharing opportunities for construction workers.
- Means for local hiring practices of operations workers and local procurement of maintenance supplies in efforts to reduce VMT of operations and maintenance trips.

VIS-1 Surface Treatment Plan

To reduce potential significant impacts associated with color contrast and glare for components of the Project, the applicant will prepare and implement a Surface Treatment Plan for new above-ground structural elements associated with the solar facility, step-up substation, BESS, and gen-tie line. The Surface Treatment Plan will require that the finishes on all new transmission and other structures with metal surfaces shall be non-reflective, and new conductors shall be non-specular. The Surface Treatment Plan will also address non-steel structural elements associated with Project components, such as buildings and storage tanks. Colors will be selected according to their ability to reduce the aesthetic impact associated with contrast with the surrounding landscape. Color finishes will be flat and non-reflective. The Surface Treatment Plan will include an evaluation of the final location of the step-up substation and BESS to evaluate structure finishes and color in the appropriate landscape context.

VIS-2 Utility Switchyard Surface Treatment Plan

To reduce potential significant impacts associated with contrast and glare for components of the utility switchyard, the applicant will prepare and implement a Utility Switchyard Surface

Treatment Plan. The Utility Switchyard Surface Treatment Plan will require that the finishes on all new transmission and other structures with metal surfaces shall be non-reflective, new conductors shall be non-specular, and the plan will be prepared consistent with PG&E's surface treatment standards.

Darden Clean Energy Project Mitigation Measures

The following mitigation measures were included in application materials submitted with the Darden Project's Opt-in Certification application package including the original submittal and data request responses, as well as updates due to the removal of the hydrogen facility from the Project.

AQ-1 Voluntary Emission Reduction Agreement

The Applicant shall enter into a voluntary emissions reduction agreement (VERA) with the SJVAPCD to offset the NOX emissions above the 10 tons per year threshold. The VERA is a mechanism for the Applicant to fund programs to reduce NOX emissions in the SJVAB. The Applicant shall coordinate with SJVAPCD to ensure VERA funds are used for programs near the Project site to the extent feasible. The VERA shall be submitted and approved by the SJVAPCD prior to beginning construction activities.

If available and as feasible, electric equipment could be incorporated into the off-road equipment fleet to reduce NOX emissions that must be offset with the required VERA. In order to reduce the NOX emissions that must be offset with the required VERA, the Applicant shall provide commitment to available electric equipment to the CEC and the SJVAPCD prior to the issuance of a permit to construct and quantify the emissions reductions from the electric equipment. Documentation of the equipment operating on-site, shall be maintained on-site at all times during construction and decommissioning activities.

AQ-2 Fugitive Dust Control Plan

Prior to construction and decommissioning activities, the Applicant shall prepare a Fugitive Dust Control Plan. At a minimum, the Fugitive Dust Control Plan shall include the following: Control fugitive dust on-site during construction and decommissioning with a minimum of one watering across the site daily with the use of chemical stabilizers during construction activities. Additional water/chemical treatments shall occur as needed based on daily site conditions and ground disturbance activities. Roads and other areas that experience high traffic volumes may be stabilized with water and/or chemicals up to four times a day. The method of monitoring site conditions for additional dust control needs shall be detailed in the plan. Chemical stabilizers shall be used for long-term fugitive dust control on-site. Specific stabilizers proposed for use and their location shall be included in the fugitive dust control plan for the project and records of watering and stabilizer application shall be kept. PM10 reduction quantifications from this measure are to be applied prior to the finalization of a voluntary emissions reduction agreement.

BIO-1 Construction Worker Environmental Awareness Training and Education Program

Prior to any activity on-site and for the duration of construction activities, all personnel at the Project area (including laydown areas and/or transmission routes) shall attend a Worker Environmental Awareness Program (WEAP) developed and presented by the Qualified Biologist

or authorized designee. New personnel shall receive WEAP training on the first day of work and prior to commencing work on the site. Any employee responsible for the O&M or decommissioning of the Project facilities shall also attend an O&M-specific WEAP training.

1. The program shall include information on the life history of the San Joaquin kit fox, Swainson's hawk, burrowing owl, American badger, San Joaquin coachwhip, and nesting birds as well as other wildlife and plant species that may be encountered during construction activities.
2. The program shall also discuss the legal protection status of each species, the definition of "take" under the Federal Endangered Species Act and California Endangered Species Act, measures the project proponent is implementing to protect the species, reporting requirements, specific measures that each worker shall employ to avoid take of wildlife species, and penalties for violation of the Federal Endangered Species Act or California Endangered Species Act.
3. The program shall include the contact information for the project biologist and on-site environmental compliance manager.
4. The program shall provide information on how and where to bring injured animals for treatment in the case any animals are injured the Project area.
5. An acknowledgement form signed by each worker indicating that WEAP training has been completed shall be kept on record.
6. A sticker shall be placed on hard hats indicating that the worker has completed the WEAP training. Construction workers shall not be permitted to operate equipment within the construction areas unless they have attended the WEAP training and are wearing hard hats with the required sticker.
7. A copy of the training transcript and/or training video, as well as a list of the names of all personnel who attended the WEAP training and copies of the signed acknowledgement forms will be made available upon agency request.

BIO-2 Construction Best Management Practices

The following best management practices shall be implemented during construction:

- Designation of a 15 mile per hour speed limit in all construction areas.
- All vehicles and equipment shall be parked on pavement, existing roads, and previously disturbed areas, and clearing of vegetation for vehicle access shall be avoided to the greatest extent feasible.
- The number of access routes, number and size of staging areas, and the total area of the activity shall be limited to the minimum necessary to achieve the goal of the project.
- Designation of equipment washout and fueling areas to be located within the limits of grading at a minimum of 100 feet from any sensitive resources as identified by a Qualified Biologist. Washout areas shall be designed to fully contain polluted water and materials for subsequent removal from the site.
- Drip pans shall be placed under all stationary vehicles and mechanical equipment that show signs of leaking or discharging lubricants or other fluids.

- All carrion shall be removed from the Project site prior to and during construction.
- All trash, including carrion, shall be placed in sealed containers and shall be removed from the project site a minimum of once per week.
- No pets are permitted on the Project site during construction.

BIO-3 Preconstruction Surveys for Special-Status Species

Preconstruction surveys for burrowing species shall be conducted by a Qualified Biologist for the presence of San Joaquin kit fox, American badger, and burrowing owl prior to commencement of construction activities in all areas with potential to support these species. This survey shall be conducted no more than 30 days prior to ground disturbing activities without prior agency approval. The surveys shall be conducted in areas of suitable habitat for each species. Surveys shall conform to USFWS guidelines for San Joaquin kit fox, CDFW guidelines for burrowing owl, and to industry standards for American badger.

Where special-status species habitat (e.g., burrows or nest trees and vegetation) are known to occur and there is a potential for significant impacts, Qualified Biologist shall monitor construction activities to ensure that impacts to special-status species are avoided and minimized.

BIO-4 Measures for San Joaquin Kit Fox

In areas of the Project site where San Joaquin kit fox potentially occur (the utility switchyard location), the following measures shall be implemented by a Qualified Biologist:

- Pre-construction surveys for San Joaquin kit fox no more than 30 days prior to ground disturbance
- Construction activity monitoring
- San Joaquin kit fox dens are not expected to occur in project work areas. If San Joaquin kit fox occurs in the Project site, work within 500 feet of the animal shall be halted until the animal leaves the area, as determined by the Qualified Biologist.

BIO-5 Measures for Burrowing Owl

Superseded, refer to BIO-11 Burrowing Owl Management Plan.

~~If suitable burrows for burrowing owls are found during preconstruction surveys on the Project site; burrowing owl occupancy shall be determined through up to three additional focused surveys on potential burrows during the morning and/or evening survey windows as defined in the Staff Report on Burrowing Owl Mitigation (Appendix B in CDFG 2012). If the burrows are determined to be unoccupied, they shall be hand excavated by a Qualified Biologist in the same manner as described under B-1(g) in CDFG (2012). If occupied burrowing owl burrows are confirmed prior to construction, the avoidance measures described below shall be implemented.~~

~~Occupied burrows shall not be disturbed during the nesting season (February 1 through August 31) unless a Qualified Biologist verifies, through noninvasive methods, that either (1) the birds have not begun egg-laying and incubation, (2) a previously active nest has failed and re-nesting is highly unlikely, or (3) all juveniles from the occupied burrow are foraging independently and~~

~~capable of independent survival. Owls present after February 1 shall be assumed to be nesting unless evidence indicates otherwise. Nest-protection buffers described below shall remain in effect until August 31 or, based upon monitoring evidence, until the nest has failed, or all juvenile owls are foraging independently as determined by a Qualified Biologist.~~

~~Site-specific, no-disturbance buffer zones shall be established and maintained between Project activities and occupied burrows, using the distances recommended in the CDFW guidelines (CDFG 2012). Typical avoidance buffer distances for burrowing owl range from 100 meters (330 feet) to 250 meters (825 feet) depending on project activity, line of sight and local topography, during the breeding season (February 1 to August 31). During the non-breeding (winter) season (September 1 to January 31), typical avoidance buffers range from 50 meters (165 feet) to 100 meters (330 feet) from the burrow. Depending on the level of disturbance, a smaller buffer may be established in consultation with CDFW.~~

~~The appropriateness of using reduced buffer distances or burrow-specific buffer distances shall be established on a case-by-case basis by a Qualified Biologist who may consult with CDFW, and shall depend on existing conditions (e.g., vegetation/topographic screening and current disturbance regimes). If necessary, buffer distances shall be carefully reassessed and relaxed or modified, based on construction schedule and activities (e.g., increased or intensified construction activities), by a Qualified Biologist who may consult with CDFW. The buffer zones shall be clearly delineated by highly visible orange construction fencing (or similar), which shall be maintained in good condition through construction of the Project or until construction activities are no longer occurring in the vicinity of the burrow.~~

~~If burrowing owl burrow avoidance is infeasible during the non-breeding season or during the breeding season (February 1 through August 31) where burrows can be shown as conclusively not an active nesting burrow, a Qualified Biologist may passively relocate burrowing owls found within construction areas. Prior to passively relocating burrowing owls, a Burrowing Owl Exclusion Plan shall be prepared by a Qualified Biologist in accordance with Appendix E of the Staff Report on Burrowing Owl Mitigation (CDFG 2012).~~

~~The biologist shall accomplish such relocations using one-way burrow doors installed and left in place for at least three nights so owls exiting their burrows will not be able to re-enter. Then, immediately before the start of construction activities, the biologists shall remove all doors and excavate the burrows to ensure that no animals are present in the burrow. The excavated burrows shall then be backfilled. To prevent evicted owls from occupying other burrows in the impact area, the biologist shall, before eviction occurs, (1) install one-way doors and backfill all potentially suitable burrows within the impact area, and (2) install one-way doors in all suitable burrows located within approximately 50 feet of the active burrow, then remove them once the displaced owls have settled elsewhere. When temporary or permanent burrow-exclusion methods are implemented, the following steps shall be taken:~~

~~Prior to excavation, a Qualified Biologist shall verify that evicted owls have access to multiple, unoccupied, alternative burrows, located nearby (within 250 feet) and outside of the projected disturbance zone. If no suitable alternative natural burrows are available for the owls, then, for each owl that is evicted, two artificial burrows shall be installed in suitable nearby habitat areas, per the Users Guide to Installation of Artificial Burrows for Burrowing Owls (Johnson et al. 2010) referenced in CDFG 2012. The artificial burrow design and installation shall be described in the~~

~~Burrowing Owl Exclusion Plan per Appendix E of the Staff Report on Burrowing Owl Mitigation (CDFG 2012).~~

~~Passive relocation of burrowing owls shall be limited in areas adjacent to Project activities that have a sustained or low-level disturbance regime; this approach shall allow burrowing owls that are tolerant of Project activities to occupy quality, suitable nesting and refuge burrows. The use of passive relocation techniques in a given area shall be determined by a Qualified Biologist based on existing and future conditions (e.g., time of year, vegetation/topographic screening, and disturbance regimes).~~

BIO-6 Measures for American Badger

- Preconstruction surveys for American badger shall be conducted by a Qualified Biologist no more than 30 days prior to ground disturbance.
- If potential American badger dens are observed and avoidance is feasible, buffer distances of 50 feet for occupied dens and 250-foot, no-disturbance buffers for natal dens shall be established by the Qualified Biologist prior to construction activities.
- If avoidance of the potential American badger dens is not feasible, the following measures are recommended to minimize potential adverse effects to the American badger:
    - If a Qualified Biologist determines that potential dens are inactive, the biologist shall excavate these dens by hand with a shovel and collapse them to prevent American badgers from re-using them during construction.
    - If the Qualified Biologist determines that potential dens may be active, biologist shall conduct remote camera monitoring of the burrow for a period of three consecutive days to confirm occupancy status. If the Qualified Biologist determines that a burrow is an active natal burrow, avoidance buffers shall be established to demarcate no-work areas that shall be maintained until the burrow is no longer an active natal burrow. Burrows that are determined to be non-natal or are active outside of the breeding season shall implement passive eviction procedures through the installation of one-way doors, and the use of remote camera monitoring to document no activity for 3 consecutive days. Dens that are determined to be unoccupied or have become inactive following passive eviction or at the end of breeding season shall be hand-excavated with a shovel and collapsed to prevent re-use during construction.

BIO-7 Pre-construction Surveys for Nesting Birds and Common Raptors

If construction is scheduled to commence during the non-breeding season (September 1 to January 31), no pre-construction surveys or additional measures for nesting birds or other raptors would be required. Prior to ground disturbing and vegetation removal activities that are initiated during the breeding season (February 1 to August 31), a Qualified Wildlife Biologist shall conduct pre-construction surveys of all potential nesting habitats within the Project area. The raptor survey shall focus on potential nest sites (e.g., owl boxes, large trees, windrows, and shrubs) within 500 feet of the site for common raptors. Nesting bird surveys shall be conducted

within 14 days of the start of ground-disturbing or vegetation removal activities. Surveys need not be conducted for the entire Project area at one time and may be conducted in phases consistent with construction activity schedules. The surveying biologist must be qualified to determine the status and stage of nesting by migratory birds and all locally breeding raptor species without causing intrusive disturbance.

BIO-8 Nest Buffers

If active nests are found, a suitable no-work buffer shall be established around active nests. Buffers shall be determined by the Qualified Biologist and be established based on the species and nest location, to allow for known species' behavior and environmental factors (e.g., line of sight to nest) when establishing avoidance buffers. Standard buffers are typically 200-500 feet for common raptors and 30-50 feet for most common passerines. No access into buffer areas shall be allowed until a Qualified Biologist has determined that the nestlings have fledged and are no longer reliant on the nest or the nest has become otherwise inactive (e.g., depredation). Encroachment into the buffer may occur at the discretion of a Qualified Biologist and with the appropriate biological monitoring; however, for State-listed species, CDFW shall be consulted for approval of buffer encroachment or reduction.

BIO-9 Swainson's Hawk Conservation Strategy

The Applicant shall prepare a Swainson's Hawk Conservation Strategy to be implemented during Project construction and operations. The goals of the conservation strategy will be to avoid and minimize direct impacts to individuals present within the Project vicinity, and manage nesting and foraging habitat within the Project site to benefit the Swainson's hawk through implementation of both short-term and long-term conservation strategies during Project construction and operation, including specific methodologies, location of specific mitigation and management actions, success criteria, and evaluation of success criteria. The Swainson's Hawk Conservation Strategy will include the items described below.

Short-Term Conservation Strategy

Short term conservation measures are intended to address potential impacts to nesting and temporary loss of foraging habitat during the Project's construction phase, and will include a discussion of:

1. Nesting habitat
    a. Preservation of nest trees
    b. Temporary construction buffers
    c. Temporary nest structure establishment
    d. Establishment of new nest trees
2. Foraging habitat
    a. Habitat restoration

Long-Term Conservation Strategy

Long-term conservation measures are intended to address potential cumulative impacts and promote Swainson's hawk population stability and growth, as well as address potential impacts to nesting Swainson's hawks during some O&M phase activities, and will include a discussion of:

1. Implementation of a Vegetation Management Plan
2. Monitoring and management of nest tree plantings and artificial nest structures
3. Implementation of Swainson's hawk management research program

Success Criteria and Evaluation

1. Short-term conservation strategy success criteria
2. Long-term conservation strategy success criteria
3. Success criteria evaluation

BIO-10 Vegetation Management Plan

Revegetation and Vegetation Management Goals and Objectives

Revegetation and vegetation management of the Project site will occur during the Project construction and operation phases. Revegetation will account for on-site constraints including a lack

of irrigation, saline soils, and poor drainage conditions. The Project will facilitate a Before-After-Control-Impact (BACI) research design to test the efficacy of multiple vegetation management regimes on the establishment of Swainson's hawk foraging habitat with the goal of achieving the following success criteria:

- Establish permanent, regenerative vegetative cover that will:
    - Represent high-quality foraging habitat for Swainson's hawks (i.e., appropriate vegetative structure that maintains a sufficient prey base).
    - Provide suitable floral resources for native pollinators.
    - Prevent and control noxious weed infestations.
    - Allows for safe and efficient O&M Project activities.

Additional benefits of a vegetation management plan that achieves these primary goals would be reduced fire risk through management of fuel loads, erosion control, stormwater runoff control, and water quality control during the Project's operational phase.

Preparation of a Vegetation Management Plan

The Applicant shall prepare a Vegetation Management Plan to be implemented during construction and operations Project phases. The plan shall be developed to address the goals and objectives outlined above and will contain the following sections and information:

1. Purpose of the plan

2. List and discussion of target species
3. Prevention methods
    a. Specifications for completing preconstruction weed survey
    b. Discussion of control methods including preconstruction, construction, and O&M methods
    c. Vehicle inspections and cleaning during construction
    d. Weed free materials
    e. Preliminary seeding
4. Weed control methods
    a. Mechanical and manual controls
    b. Chemical controls
    c. Grazing controls
5. Revegetation Implementation Plan
    a. Site preparation methods
        i. Soil testing
        ii. Methods
        iii. Timing
    b. Seed Pallet
6. Planting Methods and Guidelines
    a. Seeding
    b. Tree container planting
7. Vegetation Maintenance and Long-Term Management
8. Preliminary Monitoring Plan
    a. Study Design
        i. Vegetation Sampling
        ii. Soils/Phytoremediation
        iii. Wildlife Sampling
9. Success Criteria
10. Adaptive Management
11. Post Decommissioning Revegetation Plan

BIO-11 Burrowing Owl Management Plan

The Applicant shall prepare a Burrowing Owl Management Plan that will address the following topics to fully minimize and mitigate potential impacts to the species~~, particularly in the case that it becomes a candidate species under the California Endangered Species Act (CESA)~~. The management plan will include the following:

1. Burrowing owl existing conditions, including site conditions and burrowing owl observations
2. Management Strategy
    a. Qualified Biologist
    b. Pre-construction surveys
    c. Determination of occupancy
    ~~a.~~d. Nesting deterrence
    ~~b.~~e. Construction monitoring
    f. Burrow avoidance and activity buffers
    ~~c.~~g. Sound or visual barriers
    ~~Burrow avoidance and buffers~~
    ~~d.~~h. Passive relocations and exclusion, including installation of artificial burrows if necessary
    ~~e.~~i. Burrow excavation
3. Reporting
4. Mitigation
~~4.~~5. Operations and Maintenance Measures

BIO-12 Operations and Maintenance Biological Resources Management Plan

The Applicant shall prepare an Operations and Maintenance Biological Resources Management Plan to be implemented during Project operations that incorporates elements of final Project layout and design and baseline conditions. The plan will address the following topics to avoid and minimize potential impacts to sensitive biological resources including San Joaquin kit fox, American badger, and Swainson's hawk, including from vehicle use; solar panel, facility, and equipment maintenance and repair; and vegetation management activities; among other operations activities. The management plan will be prepared prior to initiation of Project operations and will include the following:

1. Existing conditions, including sensitive biological resources
2. Management Strategy
    a. Worker Environmental Awareness Program
    b. Avoidance and minimization measures
    c. Surveys
    d. Monitoring
3. Reporting

The plan will be reviewed and updated every 5 years to incorporate changed conditions and adaptive management, as needed.

CUL-1 Designated Cultural Resources Specialist

The Applicant shall retain a designated Cultural Resources Specialist (CRS) who will be available to carry out mitigation measures related to cultural resources for the Project. The CRS shall meet or exceed the Secretary of the Interior's Professional Qualifications Standards for archaeology (National Park Service 1983). The CRS shall be qualified in site detection, evaluation of deposit significance, consultation with regulatory agencies, and plan site evaluation and mitigation activities.

CUL-2 Collection of Darden-ISO-CJ-68

Prior to the start of construction, Darden-ISO-CJ-68 shall be collected under the direction of the CRS. A Native American representative shall also be contacted to participate in the collection of the find. Once collected, Darden-ISO-CJ-68 shall be sketched and photographed. The isolate shall be collected and final disposition will be determined by the lead agency and any Native American tribes who choose to consult on the Project.

CUL-3 Archaeological Monitoring and Discovery Plan

Prior to the start of permitted ground disturbing activities, an Archaeological Monitoring and Discovery Plan shall be prepared by the CRS. The monitoring plan shall include a description of the monitoring methodology, including when monitoring will be required, the authority of the monitor to halt construction should a discovery be made, contact information should a discovery be made, definition of site types typically present within the area, define the types of resources that would require that work be halted or redirected, provide the protocols for unanticipated discoveries (e.g., who to call and next steps for documentation and coordination), methodology for establishing an Environmentally Sensitive Area (ESA) should one be required, review and approval protocols (e.g., define review periods for agencies and stakeholders), and dispute resolution.

CUL-4 Worker Environmental Awareness Program (WEAP)

Prior to the start of ground disturbance, the construction crew shall participate in on-site training on the proper procedures to follow if cultural resources are uncovered during the Project excavations, site preparation, or other related activities. This Worker Environmental Awareness Program shall include a comprehensive discussion of applicable laws and penalties under the law, samples or visuals of artifacts that might be found in the vicinity of the Project site, a discussion of what such artifacts may look like when partially buried or wholly buried and then freshly exposed, a discussion of what prehistoric and historic-period archaeological deposits look like at the surface and when exposed during construction, instruction that employees are to halt work in the vicinity of a discovery (within 50 feet) and requirements for working within 50 feet of an ESA. This information shall be provided in an informational brochure that outlines reporting procedures in the event of a discovery and shall be provided to all individuals working on-site.

CUL-5 Archaeological Monitoring

Archaeological monitor(s) working under the direction of the CRS shall be on-site during permitted ground disturbing activities described herein that occur within the moderate to high sensitivity locations identified in Figure 5.1-2. Activities that shall require an archaeological monitor include mass grading that exposes previously undisturbed soils (approximately 18 inches below ground surface based on previous agricultural practices), and open trench excavation with mechanical equipment. Activities that do not expose soil profiles, such as pile driving, ditch witch trenching, and the use of hand tools, will not require monitoring unless they occur within 50 feet of an ESA.

During monitoring, the monitors shall examine the work areas for the presence of prehistoric artifacts (e.g., chipped stone tools and production debris, stone milling tools, ceramics), historic-period debris (e.g., metal, glass, ceramics), and/or soil discoloration that might indicate the presence of a cultural midden. Each monitor shall maintain a daily log documenting ground disturbing activity, work locations, description, and provenience of any archaeological discoveries (if any), and any necessary action items for monitoring.

The archaeological monitor shall have the authority to halt and redirect work in the event of a discovery. If archaeological resources are encountered during ground-disturbing activities, work in the immediate area shall be halted and/or redirected, and the find evaluated for listing in the CRHR. Should an unanticipated resource be found as CRHR eligible and avoidance is infeasible, additional analysis (e.g., testing) may be necessary to determine if project impacts would be significant.

Archaeological monitoring may be reduced or terminated at the discretion of the CRS in consultation with the lead agency, as warranted by conditions such as encountering bedrock, the presence of fill soil, or negative findings during initial ground disturbance. If monitoring is reduced to spot-checking, spot-checking shall occur when ground-disturbance moves to a new location or when ground disturbance will extend to depths not previously excavated (unless those depths are within bedrock).

CUL-6 Unanticipated Discovery of Cultural Resources

In the event archaeological resources are unexpectedly encountered during ground-disturbing activities, work within 50 feet of the find shall halt and the project CRS be contacted immediately to evaluate the resource. If the resource is determined by the CRS to be prehistoric, then a Native American representative shall also be contacted to participate in the evaluation of the resource. If the CRS and/or Native American representative determines it to be appropriate, archaeological testing for CRHR eligibility shall be completed. If the resource proves to be eligible for the CRHR and significant impacts to the resource cannot be avoided via Project redesign, the CRS shall prepare a data recovery plan tailored to the physical nature and characteristics of the resource, per the requirements of the CCR Guidelines Section 15126.4(b)(3)(C). The data recovery plan shall identify data recovery excavation methods, measurable objectives, and data thresholds to reduce any significant impacts to cultural resources related to the resource. Pursuant to the data recovery plan, the CRS and Native American representative, as appropriate, shall recover and document the scientifically

consequential information that justifies the resource's significance. The lead agency shall review and approve the treatment plan and archaeological testing as appropriate, and the resulting documentation shall be submitted to the regional repository of the CHRIS, per CCR Guidelines Section 15126.4(b)(3)(C).

CUL-7 Human Remains

No human remains are known to be present within the Project site. However, the discovery of human remains is always a possibility during ground-disturbing activities. If human remains are found, the State of California Health and Safety Code Section 7050.5 states that no further disturbance shall occur until the County Coroner has made a determination of origin and disposition pursuant to Public Resources Code Section 5097.98. In the event of an unanticipated discovery of human remains, the County Coroner must be notified immediately. If the human remains are determined to be of Native American origin, the Coroner will notify the NAHC, which will determine and notify a Most Likely Descendant (MLD). The MLD has 48 hours from being granted site access to make recommendations for the disposition of the remains. If the MLD does not make recommendations within 48 hours, the landowner shall reinter the remains in an area of the property secure from subsequent disturbance.

~~NOI-1 Green Hydrogen Facility Noise Analysis and Design Requirements~~

~~During final engineering, when the precise locations and design details of the green hydrogen facility are finalized, a qualified acoustician shall conduct a quantitative analysis of the operational noise levels from such sources to determine if the noise generating equipment from the green hydrogen facility would result in an exceedance of Fresno County's applicable exterior noise level standards. If the green hydrogen facility would not exceed established thresholds, no noise reduction measures would be necessary. However, if it is determined that the green hydrogen facility could potentially result in exceedance of the County's exterior noise standards, the Applicant shall be required to implement additional feasible measures to minimize noise generated at the green hydrogen facility. Such additional measures to reduce noise generation equipment impacts may include, but are not limited to, setbacks, barriers, and other shielding techniques. The additional measures must reduce noise levels below Fresno County's applicable exterior nighttime noise standards. A qualified acoustician shall prepare a report to demonstrate the additional measures would be consistent with Fresno County's exterior noise standards for CEC review and approval. The CEC shall verify these additional measures are included on the final site plan prior to issuing construction permits/approvals for the green hydrogen facility.~~

PAL-1 Paleontological Resources Specialist

Prior to the start of construction, the Project Applicant shall submit the name and resume of an individual to the CEC for review and approval as the Project's Paleontological Resources Specialist. The PRS shall be an individual with a degree in paleontology or geology and at least three years of paleontological resource mitigation and field experience in California, including at least one year of leading paleontological resource mitigation and field activities. The PRS shall be responsible for directing all paleontological mitigation efforts for the Project.

PAL-2 Paleontological Worker Environmental Awareness Program

The PRS or their designee shall conduct a paleontological Worker Environmental Awareness Program (WEAP) training for construction personnel regarding the appearance of fossils and the procedures for notifying paleontological staff should fossils be discovered by construction personnel.

PAL-3 Paleontological Monitoring

Full-time paleontological monitoring shall be conducted during trenching, excavation, grading, and drilling (if borehole is 2 feet or more in diameter) when ground disturbing depths exceed 18 inches, within previously undisturbed sediments with high paleontological sensitivity (i.e., Quaternary older alluvium) to mitigate for potential impacts to currently unknown paleontological resources. Full-time paleontological monitoring shall also be conducted during trenching, excavation, grading, and drilling (if borehole is 2 feet or more in diameter) activities reaching deeper than 5 feet below current grade in sediments assigned a low paleontological sensitivity from 0 to 5 feet and high paleontological sensitivity below 5 feet (i.e., Quaternary basin deposits and Quaternary fan deposits). Pile driving and drilling for boreholes less than 2 feet in diameter do not require paleontological monitoring as the data required to accompany scientifically valuable paleontological resources cannot be collected under the conditions of typical drilling and pile driving activity.

Monitoring shall be conducted by a paleontological monitor with experience with collection and salvage of paleontological resources and who meets the minimum standards of the Society of Vertebrate Paleontology (2010) for a Paleontological Resources Monitor. The PRS in coordination with the CEC may recommend that monitoring be reduced in frequency or ceased entirely based on geologic observations.

In the event of the discovery of a previously unknown paleontological resource by the paleontological monitor or construction personnel, all construction activity within 50 feet of the find shall cease, and the PRS shall evaluate the find. If the fossil(s) is (are) not scientifically significant, then construction activity may resume. If it is determined that the fossil(s) is (are) scientifically significant, Mitigation Measure PAL-4 shall be enacted.

PAL-4 Paleontological Resource Salvage and Curation

If a paleontological resource is determined to be potentially scientifically significant, the paleontological monitor shall salvage (i.e., excavate and recover) the fossil to protect it from damage/destruction. Typically, fossils can be safely salvaged quickly by a single paleontological monitor with minimal disruption to construction activity. In some cases, larger fossils (such as complete skeletons or large mammal fossils) require more extensive excavation and longer salvage periods. Bulk matrix sampling may be necessary to recover small invertebrates or microvertebrates from within paleontologically sensitive deposits. After the fossil(s) is (are) salvaged, construction activity may resume.

Fossils shall be identified to the lowest (i.e., most-specific) possible taxonomic level, prepared to a curation-ready condition, and curated in a scientific institution with a permanent paleontological collection along with all pertinent field notes, photos, data, and maps. Fossils of

undetermined significance at the time of collection may also warrant curation at the discretion of the PRS.

PAL-5 Paleontological Mitigation Report

Upon completion of ground-disturbing activities (or laboratory preparation and curation of fossils, if necessary), the PRS shall prepare a final report describing the results of the paleontological monitoring efforts. The report shall include a summary of the field and laboratory methods employed; an overview of Project geology; and, if fossils were discovered, an analysis of the fossils, including physical description, taxonomic identification, and scientific significance. The report shall be submitted to the CEC and, if fossil curation is required, the designated scientific institution.

PH-1 Minimize Personnel and Public Exposure to Valley Fever

Prior to site preparation, grading activities, or ground disturbance, the Applicant shall prepare a Fugitive Dust Control Plan for the Project. The Fugitive Dust Control Plan shall include the following at a minimum:

- Equipment, vehicles, and other items shall be cleaned thoroughly of dust before they are moved off-site to other work locations.
- Wherever possible, grading, and trenching work shall be phased so that earth-moving equipment works well ahead or down-wind of workers on the ground.
- The area immediately behind grading or trenching equipment shall be sprayed with water before ground workers move into the area.
- If a water truck runs out of water before dust is dampened sufficiently, ground workers exposed to dust are to leave the area until a full truck resumes water spraying.
- All heavy-duty earth-moving vehicles shall be closed-cab and equipped with a High Efficiency Particulate Arrestance (HEPA) filtered air system.
- N95 respirators shall be provided to onsite workers for the duration of the construction period.
- Workers shall receive training to recognize the symptoms of Valley Fever and shall be instructed to promptly report suspected symptoms of work-related Valley Fever to a supervisor. Evidence of training shall be provided to the Fresno County Planning and Community Development Department within 24 hours of the training session.
- A Valley Fever informational handout shall be provided to all on-site construction personnel. The handout shall provide, at a minimum, information regarding the symptoms, health effects, preventative measures, and treatment.

SOC-1 Emergency Service Agreement

In coordination with Fresno County, the Applicant would prepare an agreement to support emergency services personnel in the Project area to minimize Project demand on local sheriff, fire, and EMS providers and maintain their ability to respond to other emergencies. The agreement would allow for adequate training and coordination with local fire and law

enforcement responders to become familiar with the risks and procedures needed to respond to potential emergencies associated with Project facilities. The Applicant would also develop and implement a private security system with which local law enforcement could integrate and coordinate response and deterrent measures.

TRA-1 Construction Traffic Carpool and Trip Reduction Plan

Prior to the start of construction, the Applicant shall submit a Construction Traffic Carpool and Trip Reduction Plan for review and approval by CEC, which shall include, but not be limited to:

- Feasible methods that encourage or provide ridesharing opportunities for construction workers.
- Feasible methods to reduce VMT by both construction employees and construction-related truck trips, such as encouraging hiring of local construction workers.
- Use of rail transport for specialized equipment that may originate from ports or other long distances to reduce VMT associated with vehicle delivery to the Project site, if feasible.
- Define potential methods to coordinate with adjacent solar project developers where Project construction may overlap to potentially provide group ridesharing opportunities for construction workers.
- Means for local hiring practices of operations workers and local procurement of maintenance supplies in efforts to reduce VMT of operations and maintenance trips.

VIS-1 Surface Treatment Plan

To reduce potential significant impacts associated with color contrast and glare for components of the Project, the applicant will prepare and implement a Surface Treatment Plan for new above-ground structural elements associated with the solar facility, step-up substation, BESS, and gen-tie line~~, and green hydrogen facility~~. The Surface Treatment Plan will require that the finishes on all new transmission and other structures with metal surfaces shall be non-reflective, and new conductors shall be non-specular. The Surface Treatment Plan will also address non-steel structural elements associated with Project components, such as buildings and storage tanks. Colors will be selected according to their ability to reduce the aesthetic impact associated with contrast with the surrounding landscape. Color finishes will be flat and non-reflective. The Surface Treatment Plan will include an evaluation of the final location of the step-up substation and~~,~~ BESS~~, and green hydrogen facility~~ to evaluate structure finishes and color in the appropriate landscape context.

VIS-2 Utility Switchyard Surface Treatment Plan

To reduce potential significant impacts associated with contrast and glare for components of the utility switchyard, the applicant will prepare and implement a Utility Switchyard Surface Treatment Plan. The Utility Switchyard Surface Treatment Plan will require that the finishes on all new transmission and other structures with metal surfaces shall be non-reflective, new conductors shall be non-specular, and the plan will be prepared consistent with PG&E's surface treatment standards.

WAT-1 Water Supply Contingency Plan

A Water Supply Contingency Plan (WSCP) shall be developed and implemented for the Project to define how the Project's year-round and long-term water demands will be consistently met, and to identify management and monitoring activities to support sustainable water supply development for the Project. The WSCP shall include:

- Definition of the water supply sources, including the associated approvals and regulatory requirements; a Water Supply Assessment (WSA) for the Project may be included in the WSCP to satisfy this item.
- A comprehensive accounting of all water supply (in AFY) to be obtained from landowners that have agreed to sell surplus water supplies to Project companies and those that have agreed to sell land with attached water rights. Landowner information will remain confidential and will be shared only with the CEQA Lead Agency, as needed to demonstrate supply availability.
- A Monitoring and Reporting Plan (MRP) to document the accumulation and use of banked water through aquifer storage and recovery (ASR). The MRP shall also define the methods and approach necessary to provide accounting of banked water contributed to storage and removed from storage throughout the year.

The WSCP shall be subject to review and approval by the California Energy Commission, Westland Water District Groundwater Sustainability Agency (GSA), and the County of Fresno GSA-Westside prior to the start of Project construction.

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 12/13/2024 6:54:24 PM
To: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
CC: Evelyn Langsdale [elangsdale@rinconconsultants.com]; Record, Jacquelyn@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=80a752975c1d44efbd17fb602595a1e7-Leyva, Jacq]; Ding, Yifan@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=49ee78637b0648578196965a7385b6f2-6d1c78d5-11]; Hughes, Joseph@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=7dd5e80572b644209e9607ba7bdcb630-Hughes, Jos]; Qian, Wenjun@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4421be8df5f40ec851d73affcbff913-Qian, Wenju]; Will Lutkewitte [will.lutkewitte@intersectpower.com]; Michael Stewart [mstewart@rinconconsultants.com]; Heather Dubois [hdubois@rinconconsultants.com]; Brenda Eells [beells@rinconconsultants.com]
Subject: Re: 23-OPT-02 Darden Clean Energy Project - Air Quality Meeting Summary
Attachments: Darden Operational Emissions Breakdown.pdf

CEC Team,

A supplemental application was submitted to SJVAPCD on December 3. That information will be submitted with our data request response set today.

On the November 25th call with Intersect, CEC, and Rincon, CEC staff mentioned they were having trouble pulling out the daily operational emissions from the existing data files. The attached Operational Emissions Breakdown has been prepared to provide a crosswalk of where emissions were pulled from for construction and operations. The information in the attached was originally provided in Appendix N of the Opt-In Application and is publicly available. The text in red in the attached has been added for informational purposes and does not provide new or updated information.

Thank you,

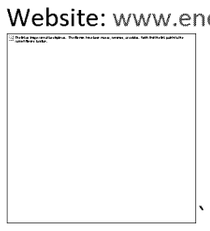
Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Wed, Nov 27, 2024 at 9:12 AM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

> Hi Becky,
>
> The notes look accurate to the AQ team. Please let us know when you have submitted the permit application to SJVAPCD so we can coordinate with the air district to get the permit conditions to add to our conditions.
>
> Thanks,
>
> Ann
>
> **Ann Crisp**
> Senior Environmental Planner
> Siting and Environmental Branch

Siting, Transmission and Environmental Protection Division
1-916-352-0543

California Energy Commission
Website: www.energy.ca.gov



From: Evelyn Langsdale <elangsdale@rinconconsultants.com>
Sent: Monday, November 25, 2024 5:39 PM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Record, Jacquelyn@Energy <Jacquelyn.Record@energy.ca.gov>; Ding, Yifan@Energy <Yifan.Ding@Energy.ca.gov>; Hughes, Joseph@Energy <Joseph.Hughes@energy.ca.gov>; Qian, Wenjun@Energy <Wenjun.Qian@energy.ca.gov>
Cc: Becky Moores <becky.moores@intersectpower.com>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Michael Stewart <mstewart@rinconconsultants.com>; Heather Dubois <hdubois@rinconconsultants.com>; Brenda Eells <beells@rinconconsultants.com>
Subject: 23-OPT-02 Darden Clean Energy Project - Air Quality Meeting Summary

Good evening,

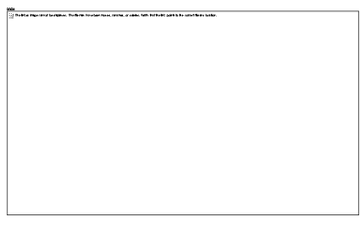
Thank you all for the productive call today. Please find below a summary of our notes from this afternoon's meeting regarding the AQ/GHG supplemental data requests.

- CEC noted that it has been difficult to break out the daily operational emissions from the existing files. Rincon confirmed they can break out the daily operational emissions and provide to CEC.
- CEC asked about the locations of the LPG generators. Intersect confirmed that up to 3 LPG generators will be at either the Option 1 or Option 2 project substation location. Precise locations within the substation footprint will be determined as design evolves; however, it can be assumed the LPG generators at the Option 1 and Option 2 locations will be in the same approximate locations as previously analyzed.
- CEC stated they need permit conditions from SJVAPCD to complete their analysis. Intersect clarified that SJVAPCD will not be issuing a permit and suggested a follow up call with CEC, Intersect, and SJVAPCD to discuss further, if needed. Rincon will reach out to SJVAPCD to confirm what kind (if any) permit is needed from SJVAPCD now that the diesel generators have been removed.
- CEC indicated that if Rincon can show original modeling was conservative (e.g., emissions comparison), then redoing air dispersion modeling can be avoided.
- CEC confirmed they are amenable to a qualitative approach to avoid full CalEEMod remodeling. Rincon noted they will have limited updates to the tables identified in SUP DR AQ-4 given this approach. Rincon will present stationary source emission reductions, and construction and other operational emissions from the removal of the green hydrogen facility will generally be treated qualitatively.
- CEC requested the data request responses state and re-confirm the assumptions that were made during modeling (e.g., conservative locations chosen for generators).

Best,
Evelyn

Evelyn Langsdale, Senior Environmental Planner
(She/Her/Hers)

925-231-5696 Direct
elangsdale@rinconconsultants.com



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Darden Renewable Energy Project
CalEEMod
Summary splits

The following provides the cells in the support tables that the summary rows pull from. For Example for row 11 there are no AQ emmissions associated with Area Sources and GHG is pulled from rows 138 and 141 respectively for Columns P through U.

Row

Operational Emissions, Solar Facility

		$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e					
	Category	MT CO_2e										
9	Off-Road	AQ- Columns C-M; GHG Colums P-U; 63-65,74-76,85-87,96-98										
10	Mobile	AQ- Columns C-M; GHG Colums P-U; Rows 66-68,77-79,88-90,99-101										
11	Energy	GHG Colums P-U, Rows 138,141										
12	Area Source	AQ- Columns C-M, Rows 128 columns I and J										
13	Water											
14	Solid Waste	GHG Colums P-U - Driectly from CalEEMod, PDF Page 306 of Opt-In Application Appendix N, Table 4.5.1 "Government Office Building"										
15	Refrig.	GHG Colums P-U, Rows 159,161										
16	**Total**	**Sum - Rows 9-15**										

Operational Emissions Hydrogen Facility (all) (Hydrogen facility O&M as part of overall O&M Building)

		$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e					
	Category	MT CO_2e										
21	Off-Road	AQ- Columns C-M, Rows C108:C110; GHG Colums P-U, Rows 108-110										
22	Mobile	AQ- Columns C-M ; GHG Colums P-U; Rows 111-113										
23	Energy	GHG Colums P-U; Rows 139										
24	Area Source											
25	Water											
26	Solid Waste	AQ- Columns C-M ; GHG Colums P-U; Rows 124										
27	Refrig.	GHG Colums P-U; Rows 111-113										
28	Stationary Sources	AQ- Columns C-M ; GHG Colums P-U; Rows 153										
29	**Total**	**Sum - Rows 21-28**										

Darden Renewable Energy Project
CalEEMod
Summary splits

Operational Emissions Hydrogen Facility (separate facility) (O&M Separate facility)

		$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e					
	Category	MT CO_2e										
35	Off-Road											
36	Mobile											
37	Energy	GHG Colums P-U; Rows 137										
38	Area Source	AQ- Columns C-M (TOG); Rows I129:J129										
39	Water											
40	Solid Waste	GHG Colums P-U - Driectly from CalEEMod, PDF Page 306 of Opt-In Application Appendix N, Table 4.5.1 "General Office Building"										
41	Refrig.	GHG Colums P-U; Rows 158										
42	Stationary Sources											
43	**Total**	**Sum - Rows 35-42**										

Darden Renewable Energy Project
CalEEMod
Annual Operational

Operational Emissions Solar Facility

Row	Category	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
		tons/year										
9	Off-Road	0.37	0.3	2.76	4.9	0.02	0.095	0.03	0.125	0.085	0.005	0.09
10	Mobile	0.03	0.03	0.03	0.18	0	0	0.04	0.04	0	0.02	0.02
11	Energy											
12	Area Source	0.057545	0	0	0	0	0	0	0	0	0	0
13	Water											
14	Solid Waste											
15	Refrig.											
16	**Total**	**0.457544638**	**0.33**	**2.79**	**5.08**	**0.02**	**0.095**	**0.07**	**0.165**	**0.085**	**0.025**	**0.11**

Operational Emissions Hydrogen Facility (all)

Row	Category	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
		tons/year										
21	Off-Road	0	0	0	0	0	0	0	0	0	0	0
22	Mobile	0.045	0.045	0.05	0.3	0.005	0.005	0.07	0.07	0.005	0.015	0.015
23	Energy											
24	Area Source											
25	Water											
26	Solid Waste	0.001	0.001	0.001	0.013	0.000	0.000	0.002	0.002	0.000	0.000	0.001
27	Refrig.											
28	Stationary Sources	0.725	0.66	1.85	1.68	0.003	0.097	0	0.097	0.097	0	0.097
29	**Total**	**0.77081**	**0.70575**	**1.90093**	**1.99308**	**0.00803**	**0.102015**	**0.07195**	**0.16898**	**0.102015**	**0.01548**	**0.11251**

Darden Renewable Energy Project
CalEEMod
Annual Operational

Operational Emissions Hydrogen Facility (separate facility)

	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
Category	tons/year										
Off-Road											
Mobile											
Energy											
Area Source	0.045952										
Water											
Solid Waste											
Refrig.											
Stationary Sources											
Total	**0.04595178**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Darden Renewable Energy Project
CalEEMod
Annual Operational

Road and Fence Repair

(Emissions taken from Section 3.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 287 of Appendix N - Volume 1 of the Opt-In Application)

	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
Category	tons/year										
Off-Road	0.01	0.01	0.07	0.1	0.005	0.005		0.005	0.005		0.005
Dust							0	0		0	0
On-Site Truck	0	0	0	0	0	0	0	0	0	0	0
Worker	0.005	0.005	0.005	0.005	0	0	0.005	0.005	0	0.005	0.005
Vendor	0	0	0	0	0	0	0	0	0	0	0
Hauling	0	0	0	0	0	0	0	0	0	0	0
Total	**0.015**	**0.015**	**0.075**	**0.105**	**0.005**	**0.005**	**0.005**	**0.01**	**0.005**	**0.005**	**0.01**

Road Reconditioning

(Emissions taken from Section 3.3 Of theCalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 288 of Appendix N - Volume 1 of the Opt-In Application)

	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
Category	tons/year										
Off-Road	0.08	0.06	0.49	0.69	< 0.005	0.02		0.02	0.02		0.02
Dust							0.03	0.03		0.005	0.005
On-Site Truck	0	0	0	0	0	0	0	0	0	0	0
Worker	0.005	0.005	0.005	0.005	0	0	0.005	0.005	0	0.005	0.005
Vendor	0	0	0	0	0	0	0	0	0	0	0
Hauling	0	0	0	0	0	0	0	0	0	0	0
Total	**0.085**	**0.065**	**0.495**	**0.695**	**0**	**0.02**	**0.035**	**0.055**	**0.02**	**0.01**	**0.03**

Darden Renewable Energy Project
CalEEMod
Annual Operational

Solar Panel Washing

(Emissions taken from Section 3.5 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 290 of Appendix N - Volume 1 of the Opt-In Application)

	Category	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
		tons/year										
85	Off-Road	0.05	0.04	0.26	0.37	0.005	0.01		0.01	0.01		0.01
86	Dust	0	0	0	0	0	0	0	0	0	0	0
87	On-Site Truck											
88	Worker	0.01	0.01	0.01	0.07	0	0	0.01	0.01	0	0.005	0.005
89	Vendor	0	0	0	0	0	0	0	0	0	0	0
90	Hauling	0	0	0	0	0	0	0	0	0	0	0
91	**Total**	**0.06**	**0.05**	**0.27**	**0.44**	**0.005**	**0.01**	**0.01**	**0.02**	**0.01**	**0.005**	**0.015**

Landscape Management

(Emissions taken from Section 3.9 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 293 of Appendix N - Volume 1 of the Opt-In Application)

	Category	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
		tons/year										
96	Off-Road	0.23	0.19	1.94	3.74	0.01	0.06		0.06	0.05		0.05
97	Dust	0	0	0	0	0	0	0	0	0	0	0
98	On-Site Truck											
99	Worker	0.01	0.01	0.01	0.1	0	0	0.02	0.02	0	0.005	0.005
100	Vendor	0	0	0	0	0	0	0	0	0	0	0
101	Hauling	0	0	0	0	0	0	0	0	0	0	0
102	**Total**	**0.24**	**0.2**	**1.95**	**3.84**	**0.01**	**0.06**	**0.02**	**0.08**	**0.05**	**0.005**	**0.055**

Darden Renewable Energy Project
CalEEMod
Annual Operational

Hydrogen Facility

(Emissions taken from Section 3.11 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 2295 of Appendix N - Volume 1 of the Opt-In Application)

	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
Category	tons/year										
Off-Road	0	0	0	0	0	0		0	0		0
Dust	0	0	0	0	0	0	0	0	0	0	0
On-Site Truck											
Worker	0.04	0.04	0.02	0.29	0	0	0.06	0.06	0	0.01	0.01
Vendor	0	0	0	0	0	0	0	0	0	0	0
Hauling	0.005	0.005	0.03	0.01	0.005	0.005	0.01	0.01	0.005	0.005	0.005
Total	**0.045**	**0.045**	**0.05**	**0.3**	**0.005**	**0.005**	**0.07**	**0.07**	**0.005**	**0.015**	**0.015**

Additonal Calcs

Hydrolizer Waste

(Emissions taken from Section 4.1.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 297 of Appendix N - Volume 1 of the Opt-In Application. Represents mobile emissions to transport waste)

days/yr	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
Category	lbs/day										
1	0.27	0.25	0.31	4.36	0.01	0.005	0.65	0.66	0.005	0.16	0.17
6	1.62	1.5	1.86	26.16	0.06	0.03	3.9	3.96	0.03	0.96	1.02
tons/yr	0.00081	0.00075	0.00093	0.01308	0.00003	0.000015	0.00195	0.00198	0.000015	0.00048	0.00051

(Area Emissions taken from Section 4.3.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 302 of Appendix N - Volume 1 of the Opt-In Application)

Area Source ROG

			SQFT	% Total	ROG - CP	ROG - AC
		PV	10,400	0.002623	0.05744	0.000105
Consumer Products	21.9	HF	8,000	0.002018	0.044184	0.001767
Arch Coating	0.04	BESS	3,946,800	0.99536	N/A	N/A

Darden Renewable Energy Project
CalEEMod
Annual Operational

Stationary Source (Hydrogen Facility)

(Emissions taken from Section 4.8.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 309 of Appendix N - Volume 1 of the Opt-In Application)

	hrs/yr	TOG	ROG	NOx	CO	SO2	Exhaust PM10	Fugitive PM10	PM10 Total	Exhaust PM2.5	Fugitive PM2.5	PM2.5 Total
	Category	lbs/day (0.5 hrs/day)										
150	1/2 hr;day	7.25	6.6	18.5	16.8	0.03	0.97	0	0.97	0.97	0	0.97
151	1 hr /day	14.5	13.2	37	33.6	0.06	1.94	0	1.94	1.94	0	1.94
152	100 hrs/yr	1450	1320	3700	3360	6	194	0	194	194	0	194
153	**tons/year**	**0.725**	**0.66**	**1.85**	**1.68**	**0.003**	**0.097**	**0**	**0.097**	**0.097**	**0**	**0.097**

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Operational Emissions Solar Facility

Row	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
							MT CO_2e
9	Off-Road	783.3	783.3	0.04	0.02	0	786.4
10	Mobile	32.79	32.79	0.02	0.02	0.06	33.31
11	Energy	0	0	0	0	0	0
12	Area Source						
13	Water						
14	Solid Waste	13.3	0	13.3	1.33	0	46.5
15	Refrig.	0	0	0	0	17,415	17,415
16	**Total**	**829**	**816**	**13**	**1**	**17,415**	**18,281**

Operational Emissions Hydrogen Facility (all)

Row	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
							MT CO_2e
21	Off-Road	0	0	0	0	0	0
22	Mobile	78.7	78.7	0.01	0.01	0.1	80.9
23	Energy	0	0	0	0	0	141951.29
24	Area Source						
25	Water						
26	Solid Waste	2	2	0	0	0	2
27	Refrig.						
28	Stationary Sources	306	306	0	0	0	307
29	**Total**	**387**	**387**	**0**	**0**	**0**	**142,342**

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Operational Emissions Hydrogen Facility (separate facility)

	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
				MT CO_2e			
35	Off-Road						
36	Mobile						
37	Energy	CalEEMod	0	0	0	0	0
38	Area Source						
39	Water						
40	Solid Waste	0.66	0	0.66	0.07	0	2.32
41	Refrig.	0	0	0	0	0.005	0.005
42	Stationary Sources						
43	**Total**	**1**	**0**	**1**	**0**	**0**	**2**

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Road and Fence Repair

(Emissions taken from Section 3.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 287 of Appendix N - Volume 1 of the Opt-In Application)

		$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
	Category						MT CO_2e
63	Off-Road	29.3	29.3	0.005	0.005		29.4
64	Dust						
65	On-Site Truck	0	0	0	0	0	0
66	Worker	0.73	0.73	0.005	0.005	0.005	0.74
67	Vendor	0	0	0	0	0	0
68	Hauling	0	0	0	0	0	0
69	**Total**	**30.03**	**30.03**	**0.01**	**0.01**	**0.005**	**30.14**

Road Reconditioning

(Emissions taken from Section 3.3 Of theCalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 288 of Appendix N - Volume 1 of the Opt-In Application)

		$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
	Category						MT CO_2e
74	Off-Road	128	128	0.01	0.005		129
75	Dust						
76	On-Site Truck	0	0	0	0	0	0
77	Worker	0.56	0.56	0.005	0.005	0.005	0.57
78	Vendor	0	0	0	0	0	0
79	Hauling	0	0	0	0	0	0
80	**Total**	**128.56**	**128.56**	**0.015**	**0.01**	**0.005**	**129.57**

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Solar Panel Washing

(Emissions taken from Section 3.5 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 290 of Appendix N - Volume 1 of the Opt-In Application)

	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
							MT CO_2e
85	Off-Road	110	110	0.005	0.005		111
86	Dust	0	0	0	0	0	0
87	On-Site Truck						
88	Worker	12.5	12.5	0.005	0.005	0.02	12.7
89	Vendor	0	0	0	0	0	0
90	Hauling	0	0	0	0	0	0
91	**Total**	**122.5**	**122.5**	**0.01**	**0.01**	**0.02**	**123.7**

Landscape Management

(Emissions taken from Section 3.9 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 293 of Appendix N - Volume 1 of the Opt-In Application)

	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
94							
95							MT CO_2e
96	Off-Road	516	516	0.02	0.005		517
97	Dust	0	0	0	0	0	0
98	On-Site Truck						
99	Worker	19	19	0.005	0.005	0.03	19.3
100	Vendor	0	0	0	0	0	0
101	Hauling	0	0	0	0	0	0
102	**Total**	**535**	**535**	**0.025**	**0.01**	**0.03**	**536.3**

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Hydrogen Facility

(Emissions taken from Section 3.11 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 2295 of Appendix N - Volume 1 of the Opt-In Application)

	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
		MT CO_2e					
108	Off-Road	0	0	0	0		0
109	Dust	0	0	0	0	0	0
110	On-Site Truck						
111	Worker	53.1	53.1	0.005	0.005	0.08	54
112	Vendor	0	0	0	0	0	0
113	Hauling	25.6	25.6	0.005	0.005	0.02	26.9
114	**Total**	**78.7**	**78.7**	**0.01**	**0.01**	**0.1**	**80.9**

Additonal Calcs

Hydrolizer Waste

(Emissions taken from Section 4.1.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 297 of Appendix N - Volume 1 of the Opt-In Application. Represents mobile emissions to transport waste)

	days	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
	Category	lbs/day					
122	1	734	734	0.02	0.02	2.57	743
123	6	4404	4404	0.12	0.12	15.42	4458
124	MT/yr	1.997619	1.997619	5.44E-05	5.44E-05	0.006994	2.0221131

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Energy (Emissions taken from Section 4.2.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 299 of Appendix N - Volume 1 of the Opt-In Application)

	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e					
		MT CO_2e										
137	General Office Building	CalEEMod emissions not used because the facilitiy is							Powered Onsite		Hydrogen O&M	
138	Government Office Building	CalEEMod emissions not used because the facilitiy is							Powered from onsite		Solar Facility	
139	Other Non-Asphalt Surfaces[1]						141,951.29				Hydrogen Facility	
140		140	140	0.02	0.005		142					
141	Refrigerated Warehouse-No Rail	CalEEMod emissions not used because the facilitiy is							Powered from Onsite		Solar Facility	

Note: The 142 MT CO2e was based on a usage of 1,515 MWH per year. Subsequent to the calculations the MWH/year was revised to 1,515480 MWH per year. GHG emissions were scaled to account for the increase in electrical consumption from the grid. (142*1515480)/1516 = 141,951.29 MT CO2e

Stationary Source (Hydrogen Facility) (Emissions taken from Section 4.8.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 309 of Appendix N - Volume 1 of the Opt-In Application)

	Category	$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e
		lbs/day					
150	1/2 hr;day	3377	3377	0.14	0.03	0	3389
151	1 hr /day	6754	6754	0.28	0.06	0	6778
152	100 hrs/yr	675400	675400	28	6	0	677800
153	**tons/year**	306.356	306.356	0.012701	0.002722	0	307.44466

Darden Renewable Energy Project
CalEEMod
Operational - GHG

Refrigerant

(Emissions taken from Section 4.6.1 Of the CalEEMod Modeling Files "Darden Custom Operational Report, 9/10/2023", starting on PDF page 306 of Appendix N - Volume 1 of the Opt-In Application)

		$NBCO_2$	CO_2T	CH_4	N_2O	R	CO_2e					
	Category	MT CO_2e										
158	General Office Building					0.005	0.005					Hydrogen O&M
159	Government Office Building					0.06	0.06					Solar Facility
160	Other Non-Asphalt Surfaces											Hydrogen Facility
161	Refrigerated Warehouse-No Rail					17415	17415					Solar Facility

From: Marisa Mitchell [marisa@intersectpower.com]
Sent: 10/18/2024 11:57:08 PM
To: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
CC: Will Lutkewitte [will.lutkewitte@intersectpower.com]; Becky Moores [becky.moores@intersectpower.com]; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]
Subject: Re: Darden Clean Energy Project (23-OPT-02) - clarification

Ann, here is our explanation:

We originally proposed a green hydrogen generator in a novel configuration with the Darden project to produce economically attractive hydrogen in coordination with ARCHES. We explained to State Agencies and the Governor's office that this novel configuration would require a change in law. We pursued a change in law via SB 1018, but ran into headwinds caused by the State's Budget shortfall. ARCHES is responsible for matching economic supply with conveyance and demand, and we want to support that effort with economic hydrogen supply. We are considering how best to proceed with the change in law strategy. In the meantime, Darden is viable as a standalone solar and battery storage project which will significantly advance California's ability to meet its near term decarbonization and renewable energy goals. We have identified another potentially feasible location in the San Joaquin Valley to site green hydrogen in coordination with ARCHES, but the timing for that project would be later than that of Darden.

Marisa Mitchell
Head of Environmental and Permitting
INTERSECT POWER
415.846.0730
marisa@intersectpower.com
www.linkedin.com/in/marisa-n-mitchell

On Fri, Oct 18, 2024 at 2:45 PM Marisa Mitchell <marisa@intersectpower.com> wrote:

> Thanks, Ann. I'll get back to you ASAP. Just getting internal signoffs since it involves media.
>
> Marisa Mitchell
> Head of Environmental and Permitting
> INTERSECT POWER
> 415.846.0730
> marisa@intersectpower.com
> www.linkedin.com/in/marisa-n-mitchell
>
> On Thu, Oct 17, 2024 at 3:55 PM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:
>
> > Hi Marisa,
> >
> > Thanks for hosting an informative site visit today. We had a request from the media for clarification on the reason explained in yesterday's meeting for removing the green hydrogen part of project from the Darden project. The audio

during this portion was unclear and the staff writer couldn't understand what was said. Could you please send a brief explanation why it was removed?

Thanks!

Ann

Ann Crisp
Senior Environmental Planner
Siting and Environmental Branch
Siting, Transmission and Environmental Protection Division
1-916-352-0543

California Energy Commission
Website: www.energy.ca.gov

From: Chang, Kaycee@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=DD3D2FC8670840BDA4ACDC455903E787-CHANG, KAYC]
Sent: 12/27/2024 6:58:21 PM
To: Becky Moores [becky.moores@intersectpower.com]
CC: Will Lutkewitte [will.lutkewitte@intersectpower.com]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]
Subject: Additional Information for the Biology Section - 23-OPT-02 Darden

Hello Becky and Will,

While I'm waiting to hear back from our air quality team who are out for the holidays for the other request, additional information related to biology for the Darden project would be helpful, please:

BIOLOGY

BIO staff had a general question on when you planned to conduct the baseline surveys for the revegetation plan? Marisa had mentioned during the site visit that you were working with River Partners to develop a planting list and seed mix. In the interest of time, is that something in your most recent submittal or in another location aside from information in Appendix V?

BACI: as described in locations throughout Appendix V, TN 253021, pdf page 116 describes goals such as providing suitable floral resources for native pollinators, and represents high-quality forage habitat for Swainson's, among other vegetative goals fundamental to the reveg plan. Specifically, section 6.1.3 pdf page 136 discusses wildlife sampling in treatment and control plots. Can the applicant elaborate location of "control plots" and starting date of data collection?

If/when did you plan to submit ongoing BUOW survey work? Staff is unclear when those would be submitted, pursuant to TN 260650, updated Burrowing owl management plan, which states that “non-breeding season BUOW surveys will be conducted at the Project site November 2024 through January 2025.”

Once you respond to this email with the information, we will docket the response as a record of conversation to get the information into the docket log. Please let me know if you have any questions.

Thank you,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
CEQA Project Management
Siting and Environmental Branch
Siting, Transmission, and Environmental Protection Division
1-916-232-6319

California Energy Commission
Website: www.energy.ca.gov

Book time to meet with me

From: Chang, Kaycee@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=DD3D2FC8670840BDA4ACDC455903E787-CHANG, KAYC]
Sent: 12/27/2024 10:08:33 PM
To: Becky Moores [becky.moores@intersectpower.com]
CC: will.lutkewitte@intersectpower.com; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]; Evelyn Langsdale [elangsdale@rinconconsultants.com]; Michael Stewart [mstewart@rinconconsultants.com]
Subject: Re: Additional Information for the Air Quality Section - 23-OPT-02 Darden

Hi Becky,

Thank you for your questions and for the email chain. Per our air quality team, they wanted confirmation from the applicant that the worst-case air quality and public health impacts modeled previously were due to the deleted generators. Without the detailed spreadsheet calculation for the previous modeling, staff could not tell whether the worst-case impacts were due to the larger engines. The applicant only provided unitized results previously. Staff would like to see the spreadsheet so that staff can confirm that the previously modeled results are conservative and no new modeling is needed. This is consistent with what was discussed during previous meeting with the applicant:

• CEC indicated that if Rincon can show original modeling was conservative (e.g., emissions comparison), then redoing air dispersion modeling can be avoided.

I hope this helps and look forward to hearing back.

Thank you and happy new year,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
Siting, Transmission, and Environmental Protection Division
Book time to meet with me

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, December 20, 2024 3:27 PM
To: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>
Cc: will.lutkewitte@intersectpower.com <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>; Evelyn Langsdale <elangsdale@rinconconsultants.com>; Michael Stewart <mstewart@rinconconsultants.com>
Subject: Re: Additional Information for the Air Quality Section - 23-OPT-02 Darden

Hello Kaycee,

I confirmed with our environmental consultant that the information you are requesting are items that we previously agreed on during a call with CEC air quality SME's as not being necessary, including an update to the technical analysis to address AAQA and HRA impacts due to the removal of the diesel generators. Our understanding from the call on 11/25 was that a demonstration of drastic reductions in emissions due to the removal of the diesel generators would be sufficient to determine that the already less than significant impacts

would remain so, and would only improve, which is what we provided with the supplemental response set. I have attached an email chain with a summary of topics discussed during that 11/25 call.

If we are misunderstanding your ask, can you please clarify what information the air quality team still needs?

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Thu, Dec 19, 2024 at 2:41 PM Becky Moores <becky.moores@intersectpower.com> wrote:

Hello Kaycee,

We will review these requests and get started on gathering information for a response.

Thank you,

Becky Moores
Director, Environmental & Permitting
INTERSECT POWER
(c) 303.919.6735
(e) becky.moores@intersectpower.com

On Thu, Dec 19, 2024 at 2:29 PM Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov> wrote:

Hello Becky and Will,

Nice to e-meet you - I'm Kaycee, supervisor of our CEQA Project Management team, working with Lisa Worrall and Ann Crisp. Lisa will be out for the remainder of the year, so I'm helping out with maintaining our open lines of communication. Additional information related to air quality for the Darden project would be helpful:

AIR QUALITY

The applicant has proposed a change to utilize three LPG generators, remove the green hydrogen facility, and discontinue Option 2 during the operational phase. Staff requires additional information to confirm that these changes would result in lower air quality and public health impacts than previously analyzed.

DR AQ-1. Please provide a copy of the spreadsheet that was used to calculate the project impacts (shown in Tables 7 and 8 in Data Request Response Set 3 [TN 255906]) for different pollutants and averaging periods based on estimated emission rates and AERMOD results using unitized emission rates. Please provide a summary table showing air quality impacts for the deleted and remaining emergency generators. Please confirm whether the worst-case project impacts shown in Tables 7 and 8 in Data Request Response Set 3 were due to the deleted emergency generators.

DR AQ-2. Please provide a summary table showing public health risks for the deleted and remaining emergency generators. Please confirm whether the worst-case public health risks shown in TN 252975 were due to the deleted emergency generators.

Once you respond to this email with the information, we will docket the response as a record of conversation to get the information into the docket log. Please let me know if you have any questions.

Thank you,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
CEQA Project Management
Siting and Environmental Branch
Siting, Transmission, and Environmental Protection Division
1-916-232-6319

California Energy Commission
Website: www.energy.ca.gov

Book time to meet with me

From: Crisp, Ann@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=B89C4DE7ECE742679D19E1E3EE713DC2-CRISP, ANN@]
Sent: 12/13/2024 8:45:03 PM
To: Becky Moores [becky.moores@intersectpower.com]
CC: Evelyn Langsdale [elangsdale@rinconconsultants.com]; Record, Jacquelyn@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=80a752975c1d44efbd17fb602595a1e7-Leyva, Jacq]; Ding, Yifan@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=49ee78637b0648578196965a7385b6f2-6d1c78d5-11]; Hughes, Joseph@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=7dd5e80572b644209e9607ba7bdcb630-Hughes, Jos]; Qian, Wenjun@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4421be8df5f40ec851d73affcbff913-Qian, Wenju]; Will Lutkewitte [will.lutkewitte@intersectpower.com]; Michael Stewart [mstewart@rinconconsultants.com]; Heather Dubois [hdubois@rinconconsultants.com]; Brenda Eells [beells@rinconconsultants.com]
Subject: Re: 23-OPT-02 Darden Clean Energy Project - Air Quality Meeting Summary

Thank you Becky - I am looping in Lisa.

Ann

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, December 13, 2024 10:54 AM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Cc: Evelyn Langsdale <elangsdale@rinconconsultants.com>; Record, Jacquelyn@Energy <Jacquelyn.Record@energy.ca.gov>; Ding, Yifan@Energy <Yifan.Ding@Energy.ca.gov>; Hughes, Joseph@Energy <Joseph.Hughes@energy.ca.gov>; Qian, Wenjun@Energy <Wenjun.Qian@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Michael Stewart <mstewart@rinconconsultants.com>; Heather Dubois <hdubois@rinconconsultants.com>; Brenda Eells <beells@rinconconsultants.com>
Subject: Re: 23-OPT-02 Darden Clean Energy Project - Air Quality Meeting Summary

CEC Team,

A supplemental application was submitted to SJVAPCD on December 3. That information will be submitted with our data request response set today.

On the November 25th call with Intersect, CEC, and Rincon, CEC staff mentioned they were having trouble pulling out the daily operational emissions from the existing data files. The attached Operational Emissions Breakdown has been prepared to provide a crosswalk of where emissions were pulled from for construction and operations. The information in the attached was originally provided in Appendix N of the Opt-In Application and is publicly available. The text in red in the attached has been added for informational purposes and does not provide new or updated information.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Wed, Nov 27, 2024 at 9:12 AM Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov> wrote:

Hi Becky,

The notes look accurate to the AQ team. Please let us know when you have submitted the permit application to SJVAPCD so we can coordinate with the air district to get the permit conditions to add to our conditions.

Thanks,

Ann

Ann Crisp
Senior Environmental Planner
Siting and Environmental Branch
Siting, Transmission and Environmental Protection Division
1-916-352-0543

California Energy Commission
Website: www.energy.ca.gov

From: Evelyn Langsdale <elangsdale@rinconconsultants.com>
Sent: Monday, November 25, 2024 5:39 PM
To: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Record, Jacquelyn@Energy <Jacquelyn.Record@energy.ca.gov>; Ding, Yifan@Energy <Yifan.Ding@Energy.ca.gov>; Hughes, Joseph@Energy <Joseph.Hughes@energy.ca.gov>; Qian, Wenjun@Energy <Wenjun.Qian@energy.ca.gov>
Cc: Becky Moores <becky.moores@intersectpower.com>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Michael Stewart <mstewart@rinconconsultants.com>; Heather Dubois <hdubois@rinconconsultants.com>; Brenda Eells <beells@rinconconsultants.com>
Subject: 23-OPT-02 Darden Clean Energy Project - Air Quality Meeting Summary

Good evening,

Thank you all for the productive call today. Please find below a summary of our notes from this afternoon's meeting regarding the AQ/GHG supplemental data requests.

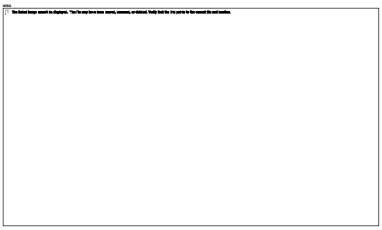
- CEC noted that it has been difficult to break out the daily operational emissions from the existing files. Rincon confirmed they can break out the daily operational emissions and provide to CEC.
- CEC asked about the locations of the LPG generators. Intersect confirmed that up to 3 LPG generators will be at either the Option 1 or Option 2 project substation location. Precise locations within the substation footprint will be determined as design evolves; however, it can be assumed the LPG generators at the Option 1 and Option 2 locations will be in the same approximate locations as previously analyzed.

- CEC stated they need permit conditions from SJVAPCD to complete their analysis. Intersect clarified that SJVAPCD will not be issuing a permit and suggested a follow up call with CEC, Intersect, and SJVAPCD to discuss further, if needed. Rincon will reach out to SJVAPCD to confirm what kind (if any) permit is needed from SJVAPCD now that the diesel generators have been removed.
- CEC indicated that if Rincon can show original modeling was conservative (e.g., emissions comparison), then redoing air dispersion modeling can be avoided.
- CEC confirmed they are amenable to a qualitative approach to avoid full CalEEMod remodeling. Rincon noted they will have limited updates to the tables identified in SUP DR AQ-4 given this approach. Rincon will present stationary source emission reductions, and construction and other operational emissions from the removal of the green hydrogen facility will generally be treated qualitatively.
- CEC requested the data request responses state and re-confirm the assumptions that were made during modeling (e.g., conservative locations chosen for generators).

Best,
Evelyn

Evelyn Langsdale, Senior Environmental Planner
(She/Her/Hers)

925-231-5696 Direct
elangsdale@rinconconsultants.com



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From: Worrall, Lisa@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=E4BBC7048B38485084BDB03FB494B25B-WORRALL, LI]
Sent: 1/3/2025 10:53:21 PM
To: Becky Moores [becky.moores@intersectpower.com]
CC: Chang, Kaycee@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd3d2fc8670840bda4acdc455903e787-Chang, Kayc]; Will Lutkewitte [will.lutkewitte@intersectpower.com]; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]; Watson, Carol@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=84e32d50c7dc47d89812b468a50090ed-Watson, Car]
Subject: RE: Additional Information for the Biology Section - 23-OPT-02 Darden

Thanks Becky. Our bio staff will review your responses and let you know if we have any follow up questions.

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, January 3, 2025 2:45 PM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Subject: Re: Additional Information for the Biology Section - 23-OPT-02 Darden

Thanks, Lisa, that sounds good. See responses below.

BIO staff had a general question on when you planned to conduct the baseline surveys for the revegetation plan? Marisa had mentioned during the site visit that you were working with River Partners to develop a planting list and seed mix. In the interest of time, is that something in your most recent submittal or in another location aside from information in Appendix V?
Seed mixes are still being evaluated and a planting list is not available at this time.
Additional baseline studies have not been conducted. Baseline vegetation and land use data can be found in the following:

- Response to Data Request REV 1 DR BIO-1 response set #6
- Response to Data Request DR BIO-12 in response set #4
- Biological Resources Assessment (Appendix Q): Section 3.2, Appendix Q-5, and Appendix Q-11

BACI: as described in locations throughout Appendix V, TN 253021, pdf page 116 describes goals such as providing suitable floral resources for native pollinators, and represents high-quality forage habitat for Swainson's, among other vegetative goals fundamental to the reveg plan. Specifically, section 6.1.3 pdf page 136 discusses wildlife sampling in treatment and control plots. Can the applicant elaborate location of "control plots" and starting date of data collection?
Intersect is actively working with Cornell University to develop the scientific study for the project area. Specifics, including control plots and data collection schedules, have not been finalized at this time.

If/when did you plan to submit ongoing BUOW survey work? Staff is unclear when those would be submitted, pursuant to TN 260650, updated Burrowing owl management plan, which states that "non-breeding season BUOW surveys will be conducted at the Project site November 2024 through January 2025."
Non-breeding season BUOW surveys will continue through January 2025 and results are not available at this time.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Thu, Jan 2, 2025 at 5:31 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

Hi Becky,

We could take an email response, but if there are some responses that staff need to reference in their analysis, that is when we will want to capture that information in the docket and add it to our reference list.

I think we can start with your responses to staff's questions and then go from there as to what, if anything in your response we need to include in the docket.

I hope that works for you.

Thanks,

Lisa

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Thursday, January 2, 2025 4:19 PM
To: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>
Cc: Will Lutkewitte <will.lutkewitte@intersectpower.com>; Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>
Subject: Re: Additional Information for the Biology Section - 23-OPT-02 Darden

Hello Kaycee and Lisa,

We have not had emailed conversations docketed in the past. Would it be better to have a phone call to avoid that, given the responses to these questions will be fairly simple with no substantive information.

Thank you,

Becky Moores

INTERSECT POWER

(e) becky.moores@intersectpower.com

On Fri, Dec 27, 2024 at 11:58 AM Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov> wrote:

Hello Becky and Will,

While I'm waiting to hear back from our air quality team who are out for the holidays for the other request, additional information related to biology for the Darden project would be helpful, please:

BIOLOGY

BIO staff had a general question on when you planned to conduct the baseline surveys for the revegetation plan? Marisa had mentioned during the site visit that you were working with River Partners to develop a planting list and seed mix. In the interest of time, is that something in your most recent submittal or in another location aside from information in Appendix V?

BACI: as described in locations throughout Appendix V, TN 253021, pdf page 116 describes goals such as providing suitable floral resources for native pollinators, and represents high-quality forage habitat for Swainson's, among other vegetative goals fundamental to the reveg plan. Specifically, section 6.1.3 pdf page 136 discusses wildlife sampling in treatment and control plots. Can the applicant elaborate location of "control plots" and starting date of data collection?

If/when did you plan to submit ongoing BUOW survey work? Staff is unclear when those would be submitted, pursuant to TN 260650, updated Burrowing owl management plan, which states that "non-breeding season BUOW surveys will be conducted at the Project site November 2024 through January 2025."

Once you respond to this email with the information, we will docket the response as a record of conversation to get the information into the docket log. Please let me know if you have any questions.

Thank you,

Kaycee

Kaycee Chang (she, her, hers)
Supervisor
CEQA Project Management
Siting and Environmental Branch
Siting, Transmission, and Environmental Protection Division
1-916-232-6319

California Energy Commission
Website: www.energy.ca.gov

Book time to meet with me

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/10/2025 3:46:28 PM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Chang, Kaycee@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd3d2fc8670840bda4acdc455903e787-Chang, Kayc]; Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]; Abulaban, Abdel-Karim@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c1ff1d38281a4068b2708271d22c0d94-Abulaban, A]; Watson, Carol@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=84e32d50c7dc47d89812b468a50090ed-Watson, Car]; Ackerman, James@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=3cc35de240cf4253af9cc7d3d2cbb643-Ackerman, J]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Lisa,

Before I can confirm a meeting time and so I can determine who needs to be on the call I need a specific list of questions, your initial email made a lot of statements and it's unclear if there are questions around those statements or just stating previous information. Please be aware that we have not completed a final hydrology study at this time and precise details on final detention basin sizing and locations are not available. Any additional information we can provide will be typical design information and assumptions from the preliminary hydrology report.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Thu, Jan 9, 2025 at 4:52 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Yes. I think that would be a good idea.
>
> Bio has one more question:
>
> A description of the predicted frequency that standing water would occur, and the length of time to percolate. For example, is standing water expected on site most years during rainy season? Or only during a 100 year storm? What about standing water during a 5 year storm, an event more likely to occur during the project's lifetime than the modeled 100 year storm.

These are our available dates and times through the next week:

Tue Jan 14: 1:30-2pm

Wed Jan 15: 9-11am, 1-2:30pm

Thurs Jan 16: 9-10am, 10:30-11am, 1:30-2:30pm

Fri Jan 17: 9am-12pm

Let me know when you can meet.

Thanks,

Lisa

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Thursday, January 9, 2025 3:24 PM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>
Subject: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Hello Lisa,

Would it be possible to get more clearly stated questions and/or the concern that your teams are trying to address to aid in responding with the appropriate information during a call?

Thank you,

Becky Moores

INTERSECT POWER

(e) becky.moores@intersectpower.com

On Thu, Jan 9, 2025 at 3:51 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Hi Becky,
>
> Our water resources and bio staff have some questions for you in response to the Preliminary Stormwater Report and 2D hydraulic analysis report.
>
> The water resources section of the application, the preliminary stormwater plan and 2D hydraulic analysis report state that the detention basins will be strategically placed around the project site and that they will be designed to Fresno County and State requirements.
>
> The applicant has run the calculations for estimating the volumes of stormwater produced during a 100-year rain event and appears to have considered the minimum 1' freeboard from 100-year HWL to top of the berm.
>
> The depths and surface areas of the detention basins are also provided in Table 5.13-13 of the application. However, no details or schematics are provided on the actual design.
>
> The figure of the drainage areas and detention basin locations (Sheet 5 of the Preliminary Stormwater Plan) infer that the detention ponds will be bermed on the northern and eastern boundaries of the northeast corner of each drainage area and open to the interior.
>
> The length of these berms is not identified.

If the berms extend along the entire northern and eastern boundaries of each drainage area, the detention basin may be adequate. If not, stormwater runoff may not be controlled and could flow off-site.

Bio staff are also interested in the berms as they may prove preferred habitat for owls, as well.

Our staff would be happy to meet with you to discuss these matters.

Thanks,

Lisa Worrall

Senior Environmental Planner

California Energy Commission

Siting, Transmission and Environmental Protection Division

715 P Street, MS-40, Sacramento, CA 95814

Direct: (916) 661-8367

Email: lisa.worrall@energy.ca.gov

From: Worrall, Lisa@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=E4BBC7048B38485084BDB03FB494B25B-WORRALL, LI]
Sent: 1/11/2025 12:51:27 AM
To: Becky Moores [becky.moores@intersectpower.com]
CC: Hughes, Joseph@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=7dd5e80572b644209e9607ba7bdcb630-Hughes, Jos]; Fooks, Brett@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=870df74143964b71ada0039bf13c5a9a-Fooks, Bret]; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Edirisuriya, Sudath@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a5d6cd74e9024972b122d8344f69b3a8-Edirisuriya]; Will Lutkewitte [will.lutkewitte@intersectpower.com]; Daniel Yanchus [daniel@intersectpower.com]
Subject: RE: FW: Darden- Discrepancy with electric grid interconnection description with California ISO description

Thanks Becky. We will review this and let you know if we have any follow questions.

Lisa

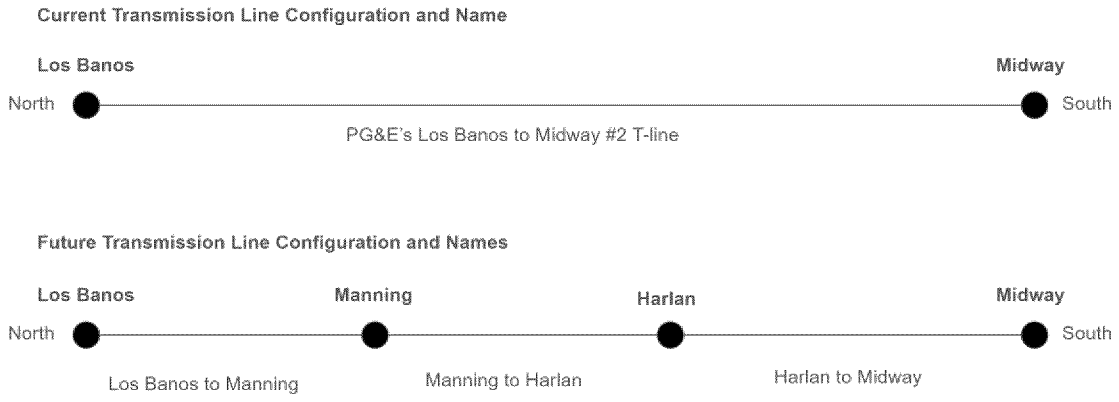
From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, January 10, 2025 4:35 PM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Hughes, Joseph@Energy <Joseph.Hughes@energy.ca.gov>; Fooks, Brett@Energy <Brett.Fooks@energy.ca.gov>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Edirisuriya, Sudath@Energy <sudath.edirisuriya@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>; Daniel Yanchus <daniel@intersectpower.com>
Subject: Re: FW: Darden- Discrepancy with electric grid interconnection description with California ISO description

Hi Lisa,

Here is clarification on our interconnection, let us know if you have any follow-up questions. Thank you

- Intersect is currently working with PG&E's Transmission Planning and Protections teams to confirm Harlan's (Darden's 500kV utility switchyard) ability to achieve its In-Service Date prior to the completion of the Manning substation. PG&E's Transmission Planning Team has been conducting a study that is progressing well, with initial results confirming our ability to achieve ISD before Manning. The results are tracking to be finalized within a month or so.
- Once the study has been completed, we will work with PG&E and CAISO to memorialize the re-sequencing of Harlan/Darden ISD ahead of Manning.
- Darden achieving Full Capacity Deliverability Status, or FCDS, is not a requirement for the project to come online.
- Transmission line names are based on the substation nodes that they connect. Despite the new line names, in this case it's the same line that's being segmented by the new nodes looping into it. Regardless of whether Manning or Harlan achieves ISD first, there is no change to the alignment or location of either substation's loop-in point, it's just a name change to the transmission line.
    - Currently, there is one long stretch of transmission line from Los Banos substation at the north end to Midway in the South. If Manning were to be installed prior to Harlan (Darden's switching station), then the Los Banos to Midway line would be divided into two segments and renamed: North segment is Los Banos to Manning, and then continuing south it would now be called Manning to Midway.

- If Harlan comes online prior to Manning, the existing line would instead be renamed Los Banos to Harlan in the north, and Harlan to Midway in the south.
- Once both Harlan and Manning are installed, the original Los Banos to Midway T-line will be divided into 3 segments with the following names: Los Banos to Manning, Manning to Harlan, Harlan to Los Banos

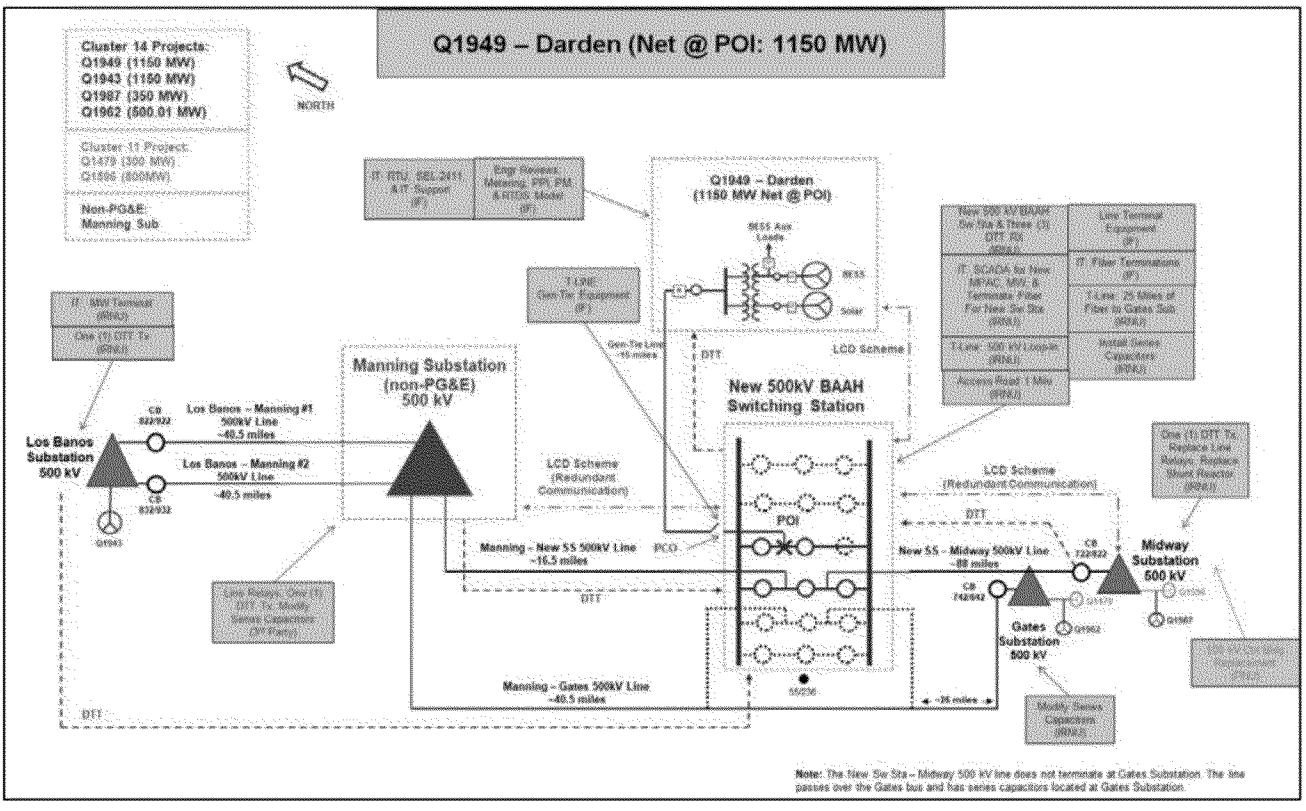


Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Thu, Jan 9, 2025 at 9:51 AM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Good morning Becky,
>
> I received this notification from our transmission staff. Below is the single line diagram for Darden from California ISO.
>
> Please see Sudath's email below and advise.
>
> Thanks very much,
>
> Lisa

Figure 1-2: Proposed Single-Line Diagram



From: Edirisuriya, Sudath@Energy <sudath.edirisuriya@energy.ca.gov>
Sent: Thursday, January 9, 2025 8:44 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Subject: FW: Darden- Discrepancy with electric grid interconnection description with California ISO description

Our transmission staff has highlighted a discrepancy with how the opt-in application describes project interconnection with the grid versus the California ISO proposed single-line diagram for Cluster 14 for Darden interconnection to the grid. The application states that the PG&E utility switchyard will connect to the existing transmission system by rerouting and looping in and out the existing Los Banos-Midway No. 2 500 kV Transmission Line into the facility. However, the one-line diagram of the Ca ISO study shows that Darden must connect to the Manning Substation via a transmission line to achieve Full Capacity Deliverability Status. (The application submitted by the applicant to the California ISO expects the project to have a full

deliverability status. Therefore, the applicant should satisfy the Transmission Planning Process (TPP) requirement, which the California ISO interconnection study has suggested).

According to the California ISO study's one-line diagram, our transmission staff suggests that the line connecting the Darden project switchyard would be the loop in and out of the Manning-Midway 500 kV transmission line.

- With this difference in interconnection line name, we need to know how it would change the alignment and location of the loop in line or just the transmission line name.

- Staff would like to know whether the Manning substation should be constructed and completed before interconnecting the Darden project to the grid. Additionally, we would like to know if the transmission line Los Banos—Manning must be rerouted before interconnecting the Darden project.

Please advise. Thanks kindly,

Sudath

From: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Sent: Wednesday, January 8, 2025 2:31 PM
To: Edirisuriya, Sudath@Energy <sudath.edirisuriya@energy.ca.gov>
Subject: Darden- Discrepancy with electric grid interconnection description with California ISO description

Hi Sudath, Can you review this email and make any necessary additions or edits. Thanks. Lisa

Hi Becky,

Our transmission staff has brought up a discrepancy with the way the opt in application describes how the project is interconnecting to the electric grid versus what the California ISO proposed single line diagram for Cluster 14 for Darden shows. As you know, the application states that the PG&E utility switchyard will connect to the existing transmission system by rerouting and looping in the existing Los Banos-Midway No. 2 500 kV Transmission Line into the

facility. However, the single line diagram shows that to achieve Full Capacity Deliverability Status, Darden would need to connect to the Manning Substation via a transmission line. Our transmission staff says that the transmission line would be referred to as the Los Banos-Manning 500 kV transmission line.

With this difference in interconnection, we need to know how it would change the alignment and location of the loop in line or just the transmission line name.

Also, with this different interconnection, the manning substation and transmission line to Los Banos Substation would need to be operational before Darden to connect to the electric grid.

Please advise. Thanks kindly,

Lisa Worrall

Senior Environmental Planner

California Energy Commission

Siting, Transmission and Environmental Protection Division

715 P Street, MS-40, Sacramento, CA 95814

Direct: (916) 661-8367

Email: lisa.worrall@energy.ca.gov

From: Watson, Carol@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=84E32D50C7DC47D89812B468A50090ED-WATSON, CAR]
Sent: 1/10/2025 5:49:22 PM
To: Nelson, Matthew J [matthew_nelson@fws.gov]
Subject: FW: Darden draft solar plan

Happy New Year!

To keep you up to speed, here's what I've been up to with the migratory birds division.

Best,
Carol

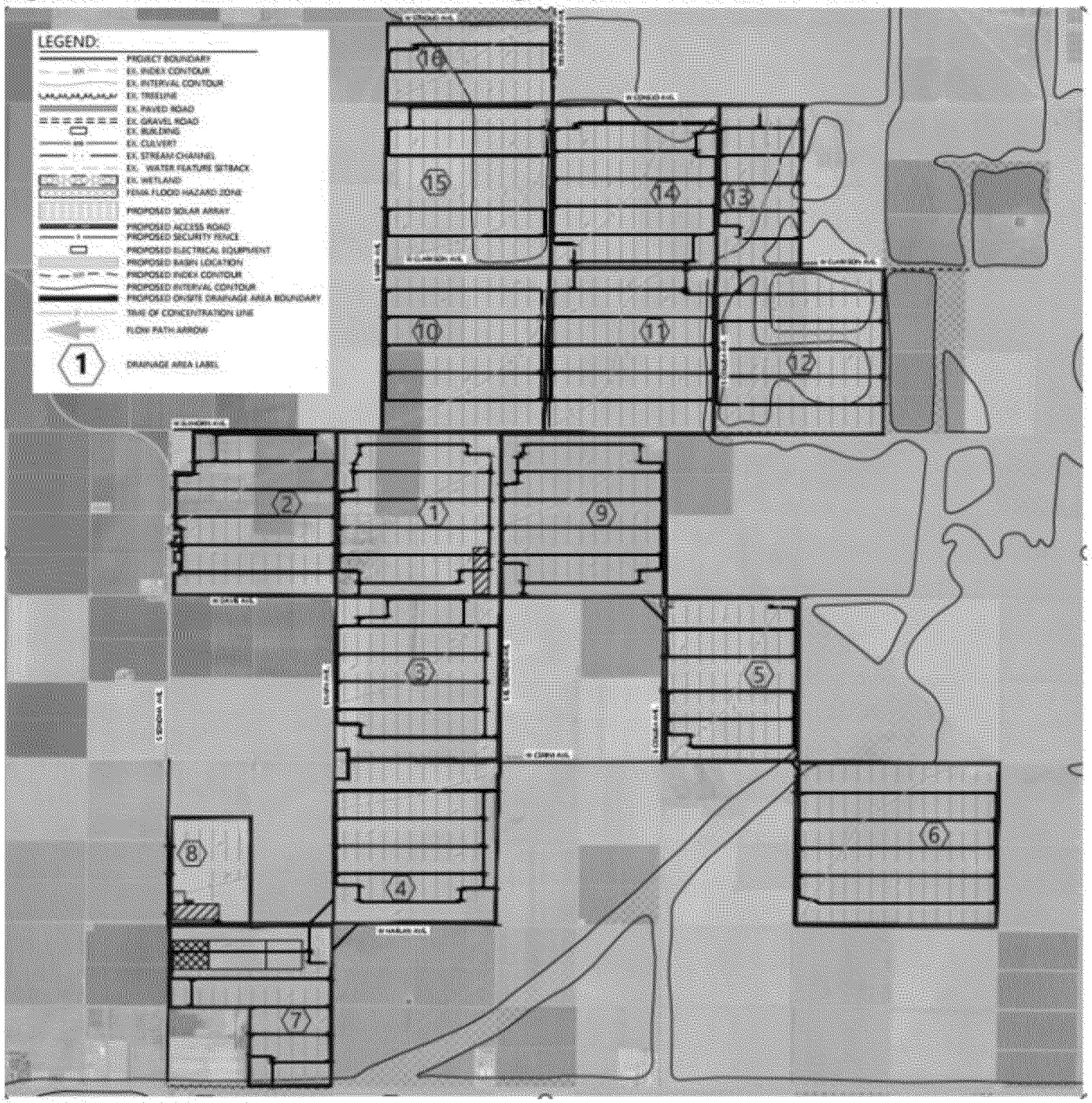
From: Watson, Carol@Energy
Sent: Friday, January 10, 2025 9:48 AM
To: Tom Dietsch (Thomas_Dietsch@fws.gov) <Thomas_Dietsch@fws.gov>
Cc: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Subject: RE: Darden draft solar plan

Hi, Tom,

Something I need to mention. There will be 16 detention ponds with standing water at a frequency that is yet to be determined. But the surface area of the 16 ponds averages 4.63 acres. So not only will there be the attractant of the panels' polarization, but there could be actual standing water across the site. As I mentioned, the applicant has yet to provide data on how often that is projected to occur, or the time to percolate.

Here's a map of the 16 detention ponds. Let me know if you have any questions, and where you are at with review of my draft Avian Solar Conservation Plan. Thanks!

Figure 4 DR WATER-19 Preliminary Drainage Map with Detention Basins



Source: IP Darden I LLC, 2023 (pg. 36)

From: Watson, Carol@Energy
Sent: Monday, January 6, 2025 12:31 PM
To: Tom Dietsch (Thomas_Dietsch@fws.gov) <Thomas_Dietsch@fws.gov>
Subject: Darden draft solar plan

Here's the Avian Conservation draft plan for your consideration and edits, thanks!

other ideas:

Feel free to put forth ideas on a reduced project footprint such as a permanent buffer (200 plus feet or more?) around nest trees for SWHA or BUOW

Eliminating/opening rows for foraging

Best,
Carol

Carol Watson
Staff Biologist
Siting, Transmission & Environmental Protection Division
California Energy Commission
715 P Street
Sacramento, CA 95814
Cell: #702.370.1019

From: Watson, Carol@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=84E32D50C7DC47D89812B468A50090ED-WATSON, CAR]
Sent: 1/6/2025 8:31:04 PM
To: Tom Dietsch (Thomas_Dietsch@fws.gov) [Thomas_Dietsch@fws.gov]
Subject: Darden draft solar plan
Attachments: AVIAN SOLAR CONSERVATION PLAN.docx

Here's the Avian Conservation draft plan for your consideration and edits, thanks!

other ideas:

Feel free to put forth ideas on a reduced project footprint such as a permanent buffer (200 plus feet or more?) around nest trees for SWHA or BUOW

Eliminating/opening rows for foraging

Best,
Carol

Carol Watson
Staff Biologist
Siting, Transmission & Environmental Protection Division
California Energy Commission
715 P Street
Sacramento, CA 95814
Cell: #702.370.1019

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/8/2025 10:26:10 PM
To: Chang, Kaycee@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd3d2fc8670840bda4acdc455903e787-Chang, Kayc]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: will.lutkewitte@intersectpower.com; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Evelyn Langsdale [elangsdale@rinconconsultants.com]; Michael Stewart [mstewart@rinconconsultants.com]
Subject: Re: Additional Information for the Air Quality Section - 23-OPT-02 Darden
Attachments: Darden_Supp AQ DR Responses_01.08.2025.docx

CEC Team,

Please find the attached response to the additional air quality questions. After your review, if there are no additional comments we can submit this to the docket. If there are follow-up questions or clarifications needed we can update the document and docket when finalized.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Fri, Dec 27, 2024 at 3:08 PM Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov> wrote:

Hi Becky,

Thank you for your questions and for the email chain. Per our air quality team, they wanted confirmation from the applicant that the worst-case air quality and public health impacts modeled previously were due to the deleted generators. Without the detailed spreadsheet calculation for the previous modeling, staff could not tell whether the worst-case impacts were due to the larger engines. The applicant only provided unitized results previously. Staff would like to see the spreadsheet so that staff can confirm that the previously modeled results are conservative and no new modeling is needed. This is consistent with what was discussed during previous meeting with the applicant:

• CEC indicated that if Rincon can show original modeling was conservative (e.g., emissions comparison), then redoing air dispersion modeling can be avoided.

I hope this helps and look forward to hearing back.

Thank you and happy new year,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
Siting, Transmission, and Environmental Protection Division

Book time to meet with me

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, December 20, 2024 3:27 PM
To: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>
Cc: will.lutkewitte@intersectpower.com <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>; Evelyn Langsdale <elangsdale@rinconconsultants.com>; Michael Stewart <mstewart@rinconconsultants.com>
Subject: Re: Additional Information for the Air Quality Section - 23-OPT-02 Darden

Hello Kaycee,

I confirmed with our environmental consultant that the information you are requesting are items that we previously agreed on during a call with CEC air quality SME's as not being necessary, including an update to the technical analysis to address AAQA and HRA impacts due to the removal of the diesel generators. Our understanding from the call on 11/25 was that a demonstration of drastic reductions in emissions due to the removal of the diesel generators would be sufficient to determine that the already less than significant impacts would remain so, and would only improve, which is what we provided with the supplemental response set. I have attached an email chain with a summary of topics discussed during that 11/25 call.

If we are misunderstanding your ask, can you please clarify what information the air quality team still needs?

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Thu, Dec 19, 2024 at 2:41 PM Becky Moores <becky.moores@intersectpower.com> wrote:

Hello Kaycee,

We will review these requests and get started on gathering information for a response.

Thank you,

Becky Moores
Director, Environmental & Permitting
INTERSECT POWER
(c) 303.919.6735
(e) becky.moores@intersectpower.com

On Thu, Dec 19, 2024 at 2:29 PM Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov> wrote:

Hello Becky and Will,

Nice to e-meet you - I'm Kaycee, supervisor of our CEQA Project Management team, working with Lisa Worrall and Ann Crisp. Lisa will be out for the remainder of the year, so I'm helping out with maintaining our open lines of communication. Additional information related to air quality for the Darden project would be helpful:

AIR QUALITY

The applicant has proposed a change to utilize three LPG generators, remove the green hydrogen facility, and discontinue Option 2 during the operational phase. Staff requires additional information to confirm that these changes would result in lower air quality and public health impacts than previously analyzed.

DR AQ-1. Please provide a copy of the spreadsheet that was used to calculate the project impacts (shown in Tables 7 and 8 in Data Request Response Set 3 [TN 255906]) for different pollutants and averaging periods based on estimated emission rates and AERMOD results using unitized emission rates. Please provide a summary table showing air quality impacts for the deleted and remaining emergency generators. Please confirm whether the worst-case project impacts shown in Tables 7 and 8 in Data Request Response Set 3 were due to the deleted emergency generators.

DR AQ-2. Please provide a summary table showing public health risks for the deleted and remaining emergency generators. Please confirm whether the worst-case public health risks shown in TN 252975 were due to the deleted emergency generators.

Once you respond to this email with the information, we will docket the response as a record of conversation to get the information into the docket log. Please let me know if you have any questions.

Thank you,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
CEQA Project Management
Siting and Environmental Branch
Siting, Transmission, and Environmental Protection Division
1-916-232-6319

California Energy Commission
Website: www.energy.ca.gov

Book time to meet with me

DR AQ-1. Please provide a copy of the spreadsheet that was used to calculate the project impacts (shown in Tables 7 and 8 in Data Request Response Set 3 [TN 255906]) for different pollutants and averaging periods based on estimated emission rates and AERMOD results using unitized emission rates. Please provide a summary table showing air quality impacts for the deleted and remaining emergency generators. Please confirm whether the worst-case project impacts shown in Tables 7 and 8 in Data Request Response Set 3 were due to the deleted emergency generators.

Response:

The spreadsheet that was used to calculate project impacts as shown in Tables 7 and 8 in Data Request Response Set 3 was provided as Appendix E2 to Data Response Set 3. Specifically, it begins in Appendix E, Volume 3 (TN 255910), page 36 and continues through Appendix E, Volume 4 (TN 255909).

Tables 7 and 8 in Data Request Response Set 3 provided conservative worst-case project impacts for two LPG generators, two diesel fire pump engines and two diesel emergency generator sets, and did not result in an exceedance of AAQA thresholds. The spreadsheet provided in Appendix E2 demonstrates that diesel engines/generators are the primary contributors to the maximum air pollutant concentrations at each receptor. The updated project includes three LPG generators and no diesel engines/generators. Therefore, with removal of the diesel engines/generators, air pollutant concentrations would be significantly reduced.

The table below summarizes the original and updated equipment lists and corresponding emissions. As shown in the table, removal of the diesel engines/generators and the addition of one LPG generator results in a minimum 31% reduction in hourly emissions rates and minimum 20% reduction in annual emission rates. Therefore, since original project impacts were below AAQA thresholds and the updated project results in a decrease in air pollutant concentrations, the updated project would remain below AAQA thresholds.

Equipment	NOx (lb/hr)	(lb/yr)	VOC (lb/hr)	(lb/yr)	CO (lb/hr)	(lb/yr)	SOx (lb/hr)	(lb/yr)	PM (lb/hr)	(lb/yr)
Power Solutions Int'l (PSI) 8800CAC (LPG) Emerg. Generator Set	0.578	57.8	0.404	40.4	1.155	115.5	0.0	0.0	0.0	0.0
CAT C18 Fire Pump Engine (Diesel)	6.741	674.1	0.355	35.5	6.149	614.9	0.005	0.5	0.355	35.5
CAT C18 Emergency Generator Set (Diesel)	5.375	207.0	0.585	35.9	9.224	627.2	2.311	56.2	0.078	7.8
Original Project Maximum Emissions (2 LPG Generators, 2 Diesel Fire Pump Engines, 2 Diesel Emergency Generators)	6.741	996.6	0.585	152.2	9.224	1473.2	2.311	56.7	0.355	43.3
Updated Project Maximum Emissions (3 LPG Generators)	0.578	173.3	0.404	121.3	1.155	346.6	0.0	0.0	0.0	0.0
Difference in Emissions	-6.2	-823.4	-0.2	-30.9	-8.1	-1126.7	-2.3	-56.7	-0.4	-43.3
Percent Difference	-91%	-83%	-31%	-20%	-87%	-76%	-100%	-100%	-100%	-100%
Note: Hourly emissions were based on a single engine being tested at a time for one hour, as committed by the Applicant. Annual emissions are the sum of total anticipated annual emissions from all the engines. Please refer to Appendix A in Data Request Response Set 3 for more details regarding emissions methodology.										

DR AQ-2. Please provide a summary table showing public health risks for the deleted and remaining emergency generators. Please confirm whether the worst-case public health risks shown in TN 252975 were due to the deleted emergency generators.

Response:

The health risk assessment results were provided in Section 4.2 Health Risk Assessment of the San Joaquin Valley Air Pollution Control District Preliminary Draft Permit Application, which was provided as Appendix A to CEC Data Response Set 3. According to Section 4.2 of the Preliminary Draft Permit Application Package (Appendix A of Data Response Set 3), Table 13, maximum individual residential cancer risk was 0.13 in one million.

The public health risks shown in application section 5.8 Public Health (TN 252975) provided conservative worst-case project impacts for two LPG generators, two diesel fire pump engines and two diesel emergency generator sets and did not result in an exceedance of public health risk thresholds. Diesel particulate matter is widely understood to be a highly carcinogenic toxic air contaminant, and to be a key driver of potential health risk impacts. As demonstrated in the table presented in the response to DR AQ-1 above, diesel particulate matter is no longer emitted with the removal of the diesel emergency engines/generators. Therefore, with removal of the diesel engines/generators, public health risks would be significantly reduced.

The table below summarizes the original and estimated updated maximum cancer health risk. As shown in the table, removal of the diesel engines/generators and the addition of one LPG generator is estimated to result in a 98% reduction to public health risk. Therefore, since original project impacts were below public health risk thresholds and the updated project results in a decrease in public health risk, the updated project would remain below public health thresholds.

Maximum Cancer Health Risk	Cases Per Million
Original Project Maximum Emissions (2 LPG Generators, 2 Diesel Fire Pump Engines, 2 Diesel Emergency Generators)	0.13
Updated Project Maximum Emissions (3 LPG Generators)	0.002
Percent Difference	-98%

From: Worrall, Lisa@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=E4BBC7048B38485084BDB03FB494B25B-WORRALL, LI]
Sent: 1/8/2025 11:18:29 PM
To: Becky Moores [becky.moores@intersectpower.com]; Chang, Kaycee@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd3d2fc8670840bda4acdc455903e787-Chang, Kayc]
CC: will.lutkewitte@intersectpower.com; Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Evelyn Langsdale [elangsdale@rinconconsultants.com]; Michael Stewart [mstewart@rinconconsultants.com]
Subject: RE: Additional Information for the Air Quality Section - 23-OPT-02 Darden

Hi Becky,

The AQ staff have reviewed the responses and agree they are complete. Please go ahead and docket it.

Thanks,

Lisa

From: Worrall, Lisa@Energy
Sent: Wednesday, January 8, 2025 2:50 PM
To: Becky Moores <becky.moores@intersectpower.com>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>
Cc: will.lutkewitte@intersectpower.com; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Evelyn Langsdale <elangsdale@rinconconsultants.com>; Michael Stewart <mstewart@rinconconsultants.com>
Subject: RE: Additional Information for the Air Quality Section - 23-OPT-02 Darden

Thanks Becky. I have forwarded your responses to the AQ team and requested the review them and confirm that the response are complete. Once I hear back from them, I will let you know and you can docket them.

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, January 8, 2025 2:26 PM
To: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: will.lutkewitte@intersectpower.com; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Evelyn Langsdale <elangsdale@rinconconsultants.com>; Michael Stewart <mstewart@rinconconsultants.com>
Subject: Re: Additional Information for the Air Quality Section - 23-OPT-02 Darden

CEC Team,

Please find the attached response to the additional air quality questions. After your review, if there are no additional comments we can submit this to the docket. If there are follow-up questions or clarifications needed we can update the document and docket when finalized.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Fri, Dec 27, 2024 at 3:08 PM Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov> wrote:

Hi Becky,

Thank you for your questions and for the email chain. Per our air quality team, they wanted confirmation from the applicant that the worst-case air quality and public health impacts modeled previously were due to the deleted generators. Without the detailed spreadsheet calculation for the previous modeling, staff could not tell whether the worst-case impacts were due to the larger engines. The applicant only provided unitized results previously. Staff would like to see the spreadsheet so that staff can confirm that the previously modeled results are conservative and no new modeling is needed. This is consistent with what was discussed during previous meeting with the applicant:

• CEC indicated that if Rincon can show original modeling was conservative (e.g., emissions comparison), then redoing air dispersion modeling can be avoided.

I hope this helps and look forward to hearing back.

Thank you and happy new year,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
Siting, Transmission, and Environmental Protection Division

Book time to meet with me

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, December 20, 2024 3:27 PM
To: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>
Cc: will.lutkewitte@intersectpower.com <will.lutkewitte@intersectpower.com>; Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>; Evelyn Langsdale <elangsdale@rinconconsultants.com>; Michael Stewart <mstewart@rinconconsultants.com>
Subject: Re: Additional Information for the Air Quality Section - 23-OPT-02 Darden

Hello Kaycee,

I confirmed with our environmental consultant that the information you are requesting are items that we previously agreed on during a call with CEC air quality SME's as not being necessary, including an update to the technical analysis to address AAQA and HRA impacts due to the removal of the diesel generators. Our understanding from the call on 11/25 was that a demonstration of drastic reductions in emissions due to the removal of the diesel generators would be sufficient to determine that the already less than significant impacts would remain so, and would only improve, which is what we provided with the supplemental response set. I have attached an email chain with a summary of topics discussed during that 11/25 call.

If we are misunderstanding your ask, can you please clarify what information the air quality team still needs?

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Thu, Dec 19, 2024 at 2:41 PM Becky Moores <becky.moores@intersectpower.com> wrote:

Hello Kaycee,

We will review these requests and get started on gathering information for a response.

Thank you,

Becky Moores
Director, Environmental & Permitting
INTERSECT POWER
(c) 303.919.6735
(e) becky.moores@intersectpower.com

On Thu, Dec 19, 2024 at 2:29 PM Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov> wrote:

Hello Becky and Will,

Nice to e-meet you - I'm Kaycee, supervisor of our CEQA Project Management team, working with Lisa Worrall and Ann Crisp. Lisa will be out for the remainder of the year, so I'm helping out with maintaining our open lines of communication. Additional information related to air quality for the Darden project would be helpful:

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DR AQ-2. Please provide a summary table showing public health risks for the deleted and remaining emergency generators. Please confirm whether the worst-case public health risks shown in TN 252975 were due to the deleted emergency generators.

Once you respond to this email with the information, we will docket the response as a record of conversation to get the information into the docket log. Please let me know if you have any questions.

Thank you,
Kaycee

Kaycee Chang (she, her, hers)
Supervisor
CEQA Project Management
Siting and Environmental Branch
Siting, Transmission, and Environmental Protection Division
1-916-232-6319

California Energy Commission
Website: www.energy.ca.gov

Book time to meet with me

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/7/2025 12:36:09 AM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Record, Jacquelyn@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=80a752975c1d44efbd17fb602595a1e7-Leyva, Jacq]; Qian, Wenjun@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4421be8df5f40ec851d73affcbff913-Qian, Wenju]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Darden- Request to docket draft ATC for AQ staff use

Hello Lisa,

I'm going to forward you an email from Ann in November that stated the CEC was working directly with the SJVAPCD to get the general conditions directly from the air district. Let me know if we can assist with those communications at all.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Mon, Jan 6, 2025 at 2:28 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Hi Becky,
>
> Happy New Year to you and your team. I hope you had a happy holidays.
>
> Our AQ staff is requesting that you docket the draft ATC for the Darden LPG engines as they have referenced the Draft ATC conditions in their AQ analysis, and have no other way to include this as a reference.
>
> Thanks kindly,
>
> Lisa Worrall
>
> Senior Environmental Planner
>
> California Energy Commission

Siting, Transmission and Environmental Protection Division

715 P Street, MS-40, Sacramento, CA 95814

Direct: (916) 661-8367

Email: lisa.worrall@energy.ca.gov

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/7/2025 12:38:54 AM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Will Lutkewitte [will.lutkewitte@intersectpower.com]; Qian, Wenjun@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4421be8df5f40ec851d73affcbff913-Qian, Wenju]; Record, Jacquelyn@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=80a752975c1d44efbd17fb602595a1e7-Leyva, Jacq]
Subject: Fwd: Darden Clean Energy Project (23-OPT-2) - SUP-DR-AQ-3 clarification

Hi Lisa,

For your reference, please see the email below regarding your team's outreach to the SJVAPCD.

Best,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

---------- Forwarded message ---------
From: **Crisp, Ann@Energy** <Ann.Crisp@energy.ca.gov>
Date: Tue, Nov 26, 2024 at 10:41 AM
Subject: Darden Clean Energy Project (23-OPT-2) - SUP-DR-AQ-3 clarification
To: Becky Moores <becky.moores@intersectpower.com>
Cc: Will Lutkewitte <will.lutkewitte@intersectpower.com>, Knight, Eric@Energy <Eric.Knight@energy.ca.gov>, Hughes, Joseph@Energy <Joseph.Hughes@energy.ca.gov>, Qian, Wenjun@Energy <Wenjun.Qian@energy.ca.gov>, Record, Jacquelyn@Energy <Jacquelyn.Record@energy.ca.gov>, Ding, Yifan@Energy <Yifan.Ding@energy.ca.gov>

Hi Becky,

Thanks for meeting yesterday and providing the meeting notes....just wanted to provide clarification on SUP DR-AQ-3 and let you know that AQ staff spoke with Zeferino yesterday, an engineer at the San Joaquin Valley Air Pollution Control District (SJVAPCD), regarding your project. He confirmed the following:

- **Permit Conditions:** The proposed engines - which are rated at 262 bhp and using LPG - would have standard permit conditions associated with engines of this size and fuel type. Zeferino mentioned these conditions are fairly boilerplate. If you submit your permit application to him, he can provide these conditions to the CEC within the next week or two.

- **BACT Analysis Thresholds:** As long as the engines do not emit over 2 lbs/day of any criteria pollutant (except CO), a full Best Available Control Technology (BACT) analysis would not be required. Based on the information you provided to the air district your engines do not exceed this threshold.

Zeferino also noted that he has not yet heard from you regarding the project change. Currently, his analysis includes six engines, with only two of the 262 bhp engines accounted for, not three. It would be helpful to

confirm the updated project details with SJVAPCD directly to ensure the most accurate permit conditions are applied.

To clarify, in response to SUP DR-AQ-3, we need to receive the information that would have been provided to the air district, but for CEC's in lieu authority. We also want confirmation that the applicant sends that same information to the air district. For the purposes of the CEC's jurisdiction and in lieu authority as set forth in Public Resources Code section 25545.1(b)(1), any state or local air quality permit that would have been issued by the SJVAPCD would instead be incorporated into the CEC's certification for this project.

Please let me know once you've submitted your application to SJVAPCD or if you have any questions about this process.

Thanks!

Ann

Ann Crisp

Senior Environmental Planner
Siting and Environmental Branch
Siting, Transmission and Environmental Protection Division
1-916-352-0543

California Energy Commission
Website: www.energy.ca.gov

From: Mtunga, Tawanda [tmtunga@fresnocountyca.gov]
Sent: 1/8/2025 11:45:41 PM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Chang, Kaycee@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd3d2fc8670840bda4acdc455903e787-Chang, Kayc]
Subject: RE: Project Status Request for Darden Clean Energy Project - Docket Number 23-OPT-02

Thank you very much Lisa. I will let you know if we have any follow up questions.

Tawanda Mtunga | **Principal Planner**
Department of Public Works and Planning
Development Services and Capital Projects Division
2220 Tulare St. 6th Floor Fresno, CA 93721
Main Office: (559) 600-4022 Direct: (559) 600-4256 Cell Phone: (559) 826-9265
Your input matters! Customer Service Survey

From: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Sent: Wednesday, January 08, 2025 3:14 PM
To: Mtunga, Tawanda <tmtunga@fresnocountyca.gov>
Cc: Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>
Subject: RE: Project Status Request for Darden Clean Energy Project - Docket Number 23-OPT-02

Hello Tawanda,

Our staff are preparing their analysis for the Darden Clean Energy Project. We will be including a Draft EIR as part of our Staff Analysis. We are working to publish mid-February 2025.

By the way, I recommend you sign up to the project subscription, if you haven't done so already. You will receive automatic email notifications any time something is uploaded to the docket. You can sign up on the project website: https://www.energy.ca.gov/powerplant/solar-photovoltaic-pv/darden-clean-energy-project

Take care,

Lisa

Lisa Worrall
Senior Environmental Planner
California Energy Commission
Siting, Transmission and Environmental Protection Division
715 P Street, MS-40, Sacramento, CA 95814
Direct: (916) 661-8367
Email: lisa.worrall@energy.ca.gov

From: Mtunga, Tawanda <tmtunga@fresnocountyca.gov>
Sent: Wednesday, January 8, 2025 9:41 AM
To: Energy - STEP Siting <STEPsiting@energy.ca.gov>; Energy - Public Advisor's Office <publicadvisor@energy.ca.gov>
Subject: Project Status Request for Darden Clean Energy Project - Docket Number 23-OPT-02

Good morning,

My name is Tawanda Mtunga, and I serve as a Principal Planner for Fresno County. I am contacting you to request an update on the status of an Opt-in project. The Docket Number I have is 23-OPT-02, and the project is titled the Darden Clean Energy Project. Fresno County seeks to obtain information regarding the current status of the project, particularly concerning its progress in the Environmental Impact Report process. We understand that the project may still be in the Draft Environmental Impact Report phase, but we would appreciate your confirmation on this matter. Thank you in advance.

Tawanda Mtunga| Principal Planner
Department of Public Works and Planning

Development Services and Capital Projects Division
2220 Tulare St. 6th Floor Fresno, CA 93721
Main Office: (559) 600-4022 Direct: (559) 600-4256 Cell Phone: (559) 826-9265

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From: Dietsch, Thomas V [thomas_dietsch@fws.gov]
Sent: 1/13/2025 5:10:35 PM
To: Watson, Carol@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=84e32d50c7dc47d89812b468a50090ed-Watson, Car]
CC: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
Subject: Re: [EXTERNAL] RE: Darden draft solar plan

Hi Carol,

I sent the measure to my supervisor, Thomas Leeman, last Wednesday to see if he had any additional comments. I'll try to get our comments back to you later today or tomorrow.

The detention basins add an extra level of concern. Do you know if they will be treating the water in the basins or if anything other than natural runoff will go in them?

Thanks, Tom

****
Thomas Dietsch, PhD
Migratory Bird Biologist
US Fish and Wildlife Service, Region 8
Carlsbad Fish and Wildlife Office
2177 Salk Ave, Suite 250
Carlsbad, CA 92008
~~(760) 431-9440 Ext. 214~~
Email is preferred: thomas_dietsch@fws.gov
****

From: Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Sent: Friday, January 10, 2025 9:48 AM
To: Dietsch, Thomas V <thomas_dietsch@fws.gov>
Cc: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Subject: [EXTERNAL] RE: Darden draft solar plan

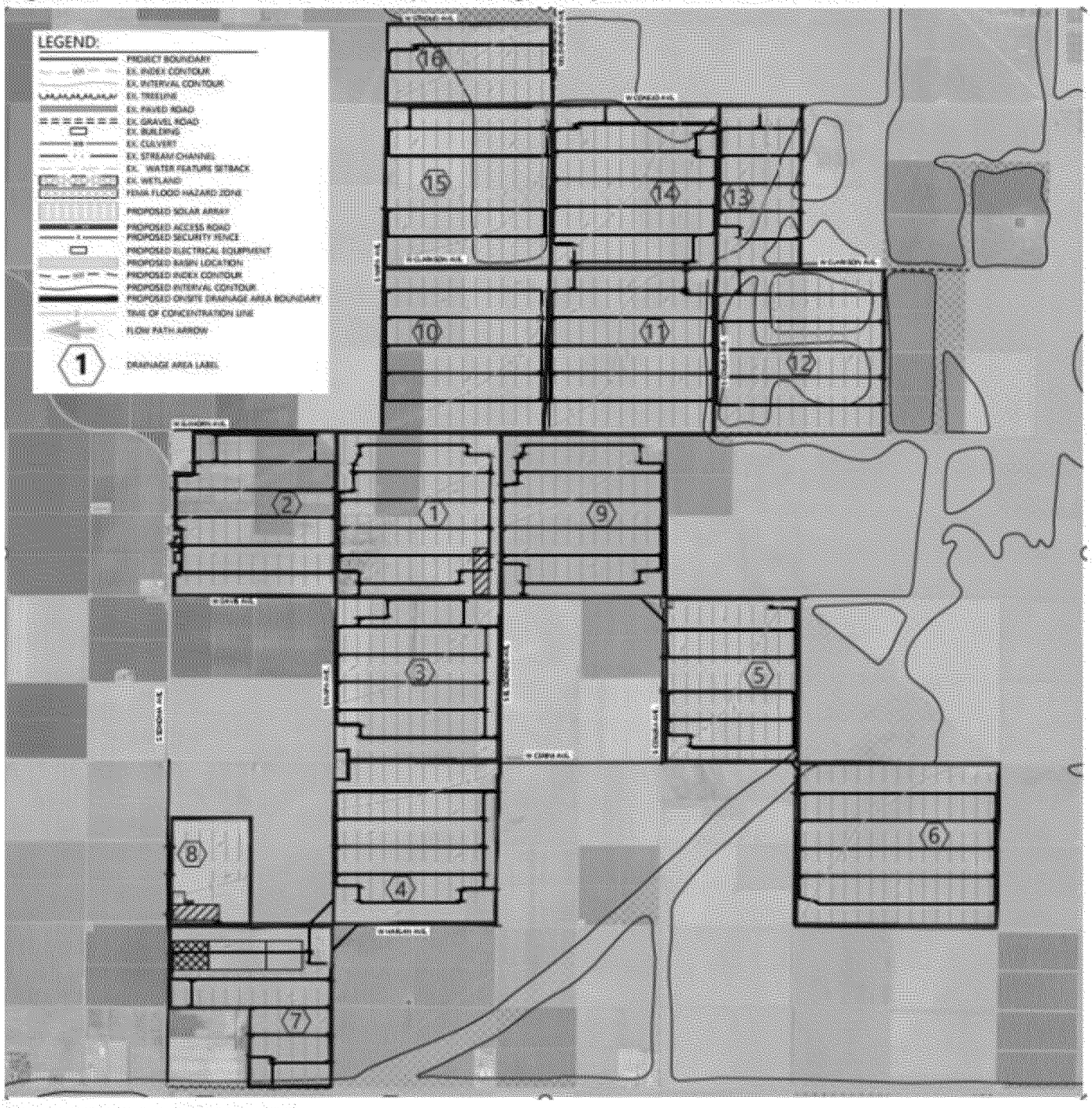
Hi, Tom,

Something I need to mention. There will be 16 detention ponds with standing water at a frequency that is yet to be determined. But the surface area of the 16 ponds averages 4.63 acres. So not only will there be the attractant of the panels'

polarization, but there could be actual standing water across the site. As I mentioned, the applicant has yet to provide data on how often that is projected to occur, or the time to percolate.

Here's a map of the 16 detention ponds. Let me know if you have any questions, and where you are at with review of my draft Avian Solar Conservation Plan. Thanks!

Figure 4 DR WATER-19 Preliminary Drainage Map with Detention Basins



Source: IP Darden I LLC, 2023 (pg. 36)

From: Watson, Carol@Energy
Sent: Monday, January 6, 2025 12:31 PM
To: Tom Dietsch (Thomas_Dietsch@fws.gov) <Thomas_Dietsch@fws.gov>
Subject: Darden draft solar plan

Here's the Avian Conservation draft plan for your consideration and edits, thanks!

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Feel free to put forth ideas on a reduced project footprint such as a permanent buffer (200 plus feet or more?) around nest trees for SWHA or BUOW

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Best,
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Carol Watson
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California Energy Commission
715 P Street
Sacramento, CA 95814
Cell: #702.370.1019

From: Watson, Carol@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=84E32D50C7DC47D89812B468A50090ED-WATSON, CAR]
Sent: 1/14/2025 7:00:12 PM
To: Dietsch, Thomas V [thomas_dietsch@fws.gov]
CC: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
Subject: RE: [EXTERNAL] RE: Darden draft solar plan

Hi, Tom,
Thanks for the references. I'll send an invite separately.
Carol

From: Dietsch, Thomas V <thomas_dietsch@fws.gov>
Sent: Tuesday, January 14, 2025 10:32 AM
To: Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Cc: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Subject: Re: [EXTERNAL] RE: Darden draft solar plan

Hi Carol,

Here are the recent references that I mentioned on our last call. You might also look at the mortality monitoring reports for the Blythe PV project which are on the CEC docket for the project. If I recall any other papers, I'll send them your way.

I'll send our comments on the conservation measure shortly. Can we schedule a call to discuss? I'm open tomorrow (Wed 1/15) after 3pm or most of the day on Friday (minus 12-1pm).

Thanks, Tom

****
Thomas Dietsch, PhD
Migratory Bird Biologist
US Fish and Wildlife Service, Region 8
Carlsbad Fish and Wildlife Office
2177 Salk Ave, Suite 250
Carlsbad, CA 92008
~~(760) 431-9440 Ext. 214~~
Email is preferred: thomas_dietsch@fws.gov
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From: Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Sent: Monday, January 13, 2025 10:54 AM
To: Dietsch, Thomas V <thomas_dietsch@fws.gov>

Cc: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Subject: RE: [EXTERNAL] RE: Darden draft solar plan

Thank you for the update. I believe that the basins are to be unlined and therefore, untreated.

Best,

carol

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Sent: Monday, January 13, 2025 9:11 AM
To: Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Cc: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
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To: Dietsch, Thomas V <thomas_dietsch@fws.gov>
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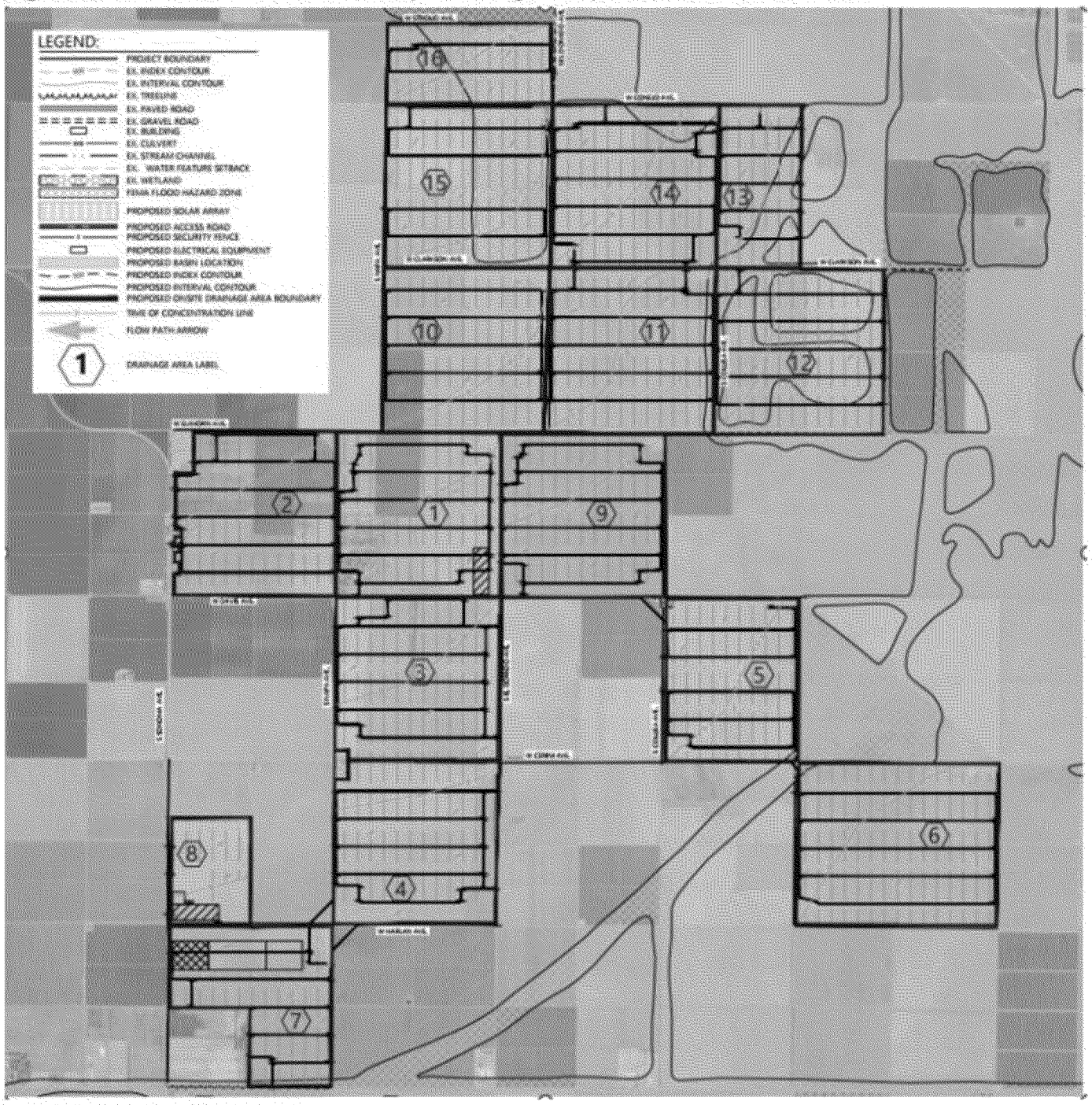

Source: IP Darden I LLC, 2023 (pg. 36)

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Siting, Transmission & Environmental Protection Division

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Cell: #702.370.1019

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To: Watson, Carol@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=84e32d50c7dc47d89812b468a50090ed-Watson, Car]
CC: Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]
Subject: Re: [EXTERNAL] RE: Darden draft solar plan
Attachments: Kosciuch et al. 2020 solar fatality summary.pdf; Kosciuch etal 2021 birds & solar.pdf; Conkling et al_2023_Wildlife fatalities at RE facilities in southern CA.pdf; Vander Zanden etal 2024 The geographic extent of bird populations affected by renewable-energy.pdf

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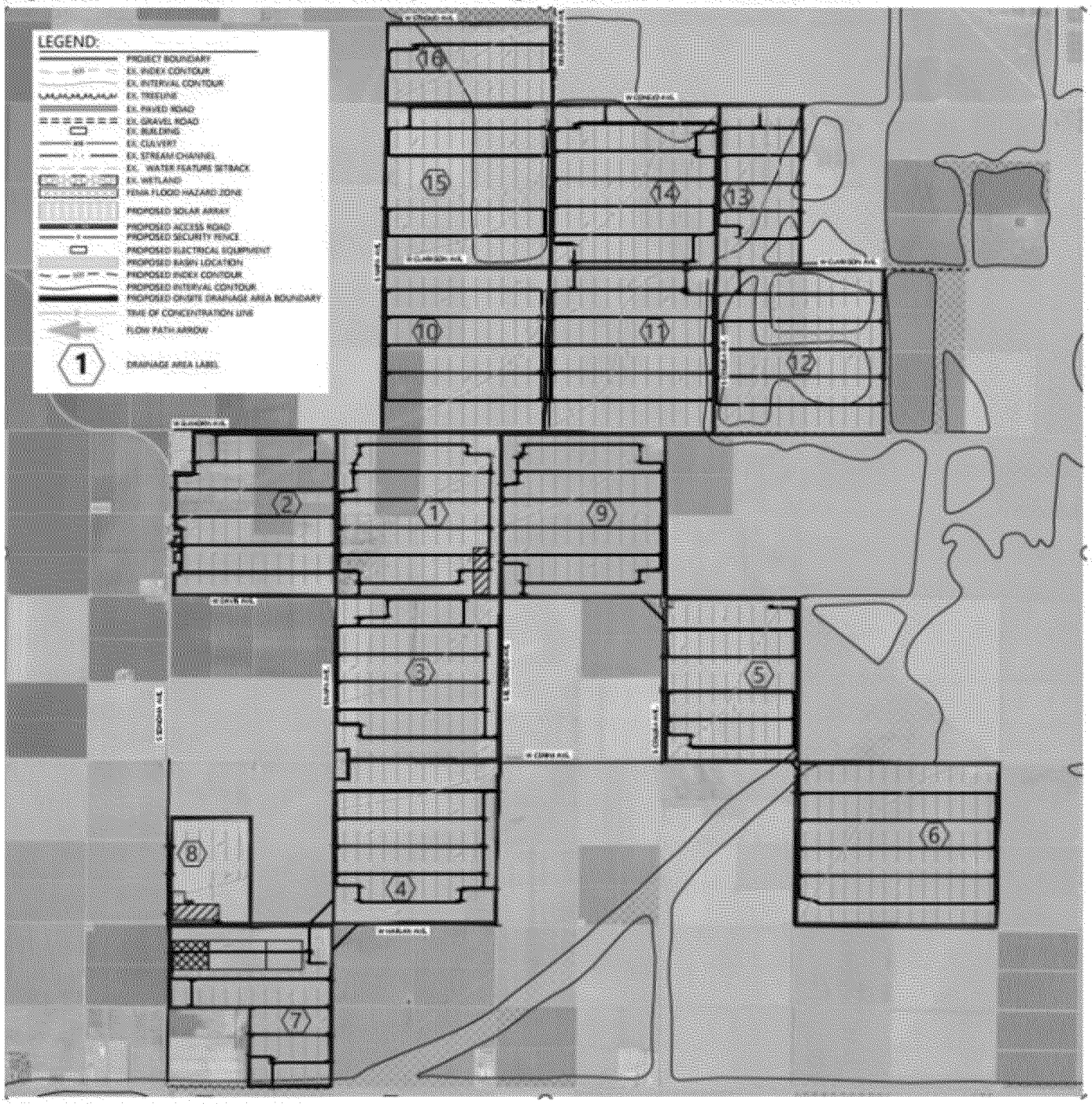

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Carol Watson
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PLOS ONE

RESEARCH ARTICLE

A summary of bird mortality at photovoltaic utility scale solar facilities in the Southwestern U.S.

Karl Kosciuch*, Daniel Riser-Espinoza, Michael Gerringer, Wallace Erickson

Western EcoSystems Technology, Inc., Cheyenne, Wyoming, United States of America

These authors contributed equally to this work.
* kkosciuch@west-inc.com

OPEN ACCESS

Citation: Kosciuch K, Riser-Espinoza D, Gerringer M, Erickson W (2020) A summary of bird mortality at photovoltaic utility scale solar facilities in the Southwestern U.S.. PLoS ONE 15(4): e0232034. https://doi.org/10.1371/journal.pone.0232034

Editor: Jinbao Zhang, Stanford University, UNITED STATES

Received: February 9, 2020

Accepted: April 6, 2020

Published: April 24, 2020

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Funding: Funding for this research was provided by First Solar; NextEra Energy, Inc.; Duke Energy, and Clearway Energy Group, LLC, and the funders provided support in the form of salaries for KK, DR-E, MG, and WE, who all work for Western EcoSystems Technology, Inc. The specific roles of these authors are articulated in the 'author contributions' section. The funders did not have any additional role in study design, data collection

Abstract

Recent trends in renewable energy development in the United States (U.S.) show that new installed capacity of utility-scale solar energy has exceeded 30% of total installed capacity of all sources per year since 2013. Photovoltaic solar energy provides benefits in that no emissions are produced; however, there are potential impacts from photovoltaic solar development on birds that include habitat loss and potential for collision mortality. Only 2 papers in the peer-reviewed literature present fatality information from fatality monitoring studies at a photovoltaic utility-scale solar energy facility; however, more data exists in unpublished reports. To provide a more comprehensive overview of bird mortality patterns, we synthesized results from fatality monitoring studies at 10 photovoltaic solar facilities across 13 site-years in California and Nevada. We found variability in the distribution of avian orders and species among and within Bird Conservation Regions, and found that water-obligate birds, which rely on water for take-off and landing, occurred at 90% (9/10) of site-years in the Sonoran and Mojave Deserts Bird Conservation Region. We found that a cause of mortality could not be determined for approximately 61% of intact carcasses, and that approximately 54% of all carcasses were feather spots, introducing uncertainty into the interpretation of the fatality estimates. The average annual fatality estimate we calculated for photovoltaic solar (high-end estimate of 2.49 birds per megawatt per year) is lower than that reported by another study (9.9 birds per megawatt per year) that included one photovoltaic facility. Our results provide a summary of fatalities in bird conservation regions where the facilities are located, but expanding our conclusions to new regions is limited by the location of facilities with fatality monitoring data.

Introduction

Recent trends in renewable energy development in the United States (U.S.) show that new installed capacity of utility-scale solar energy (USSE) has exceeded 30% of total installed capacity of all energy sources per year since 2013 [1]. The development trend is predicted to continue, with USSE capacity increasing 6 times more than wind energy capacity between 2020

and analysis, decision to publish, or preparation of the manuscript.

Competing interests: Funding for this research was provided by First Solar; NextEra Energy, Inc.; Duke Energy, and Clearway Energy Group, LLC, and the funders provided support in the form of salaries for KK, DR-E, MG, and WE, who all work for Western EcoSystems Technology, Inc. This does not alter our adherence to all PLOS ONE policies on sharing data and materials.

and 2050. The prevalent technology of USSE development projects more than 1 megawatt (MW) that deliver energy to the electric transmission grid is expected to be photovoltaic [2]. Photovoltaic (PV) technology uses semiconductor cells to convert solar energy into electricity, and cells are assembled on panels that facilitate installation at energy facilities. Other types of technology, such as concentrating solar power, which uses reflected sunlight to generate thermal energy, is less common in the U.S., and development trends have moved from concentrating solar power to PV facilities [3].

The lack of carbon dioxide emissions generated from PV solar energy is a benefit to reducing the impact of climate change, which has been identified as the single largest threat to wildlife, including birds [4]. As with all forms of development, there are potential impacts from PV USSE development on birds, including habitat loss and potential for collision mortality [5]. Current PV technology requires approximately 1.5–3 hectares of land per MW of production, and vegetation is often removed in regions such as deserts in the southwestern U.S. [6]. However, the benefits of site restoration to pollinators and other wildlife has been recently recognized [7], and developers in some regions of the U.S. are moving towards ecologically-based site restoration and low impact site restoration [8]. Compared to impacts from wind energy development, direct impacts to birds from PV solar development are not well studied [5]. Only 1 paper in the peer-reviewed literature presents fatality information from a monitoring study at a PV solar facility in South Africa [9]. Other authors have summarized the potential effects of solar energy development [5] or have predicted the cumulative effects on birds from a projected solar buildout in the U.S. using PV and concentrated solar technology [6]. However, a current summary of bird fatalities at PV USSE facilities is generally lacking.

Given the rapid expansion of PV USSE, it is important to summarize the impacts to birds given their susceptibility to collide with anthropogenic structures so that the potential impacts of future PV USSE development can be evaluated [5,9]. Based on the comparatively sparse data available in the peer-reviewed literature, generalizations of direct impacts of PV USSE to birds are currently limited. For example, the unexpected detection of stranded, injured, or deceased water-associated birds (i.e., species that rely on water for foraging, reproduction, and/or roosting, such as herons and egrets [Pelecaniformes]) and water-obligate birds (i.e., species that cannot take flight from land, such as loons [Gaviiformes] and grebes [Podicipediformes]) at a PV USSE facility in the southwestern U.S. [5,10] led some researchers to propose that these groups of birds mistook a PV solar USSE for water (lake effect hypothesis) [10]. However, the extent of mortality of water-associated and water-obligate birds is unknown; indicating evidence supporting the lake effect hypothesis is in its infancy. Given the limited peer-reviewed papers available, it is unknown if the pattern of water-obligate birds at PV solar facilities is unique to one facility or widespread among facilities.

A potential source of information to enhance the understanding of bird fatality patterns at PV USSE facilities is the gray literature. Several fatality monitoring reports have been prepared voluntarily or to meet conditions included in the facility permit, and these reports contain important information that should be synthesized by presenting the information in one location. Similar gray literature has been synthesized to provide an understanding of bird mortality at wind projects [11,12]. Based on the relatively limited information on direct impacts to birds from PV USSE facilities, our objective involved searching the primary and gray literature to identify fatality studies in the U.S. that could be synthesized to provide inference into broader scale patterns in the region or regions represented by available studies. Specifically, we were interested in species composition and fatality estimates and how patterns varied spatially and temporally among facilities. Further, we compared fatality estimates from PV USSE reports we summarized to fatality estimates calculated by Walston et al. [6], whose analysis included multiple types of solar technology, including concentrating solar power.

Methods

Literature search

We used several sources of information to obtain studies on bird fatality rates at PV USSE. First, we conducted an internet-based search for studies on avian mortality at solar facilities in a manner similar to that of Walston et al. [6]. We used Google [13] and Web of Science [14] to search the term "solar energy" in various combinations with bird, avian, death, fatality, monitoring, mortality, and report. As fatality monitoring reports at PV USSE could also be available outside of the peer-reviewed literature, we obtained studies on standardized surveys for avian mortality at PV USSE from state and federal agencies, and from solar energy developers and operators. We excluded any studies of residential PV or studies of concentrated solar power or solar trough technologies.

Data review

Guided by the study objectives, we examined each study to identify data that were appropriate for analysis. First, studies needed to use standardized fatality monitoring for a full year in the solar field. At a minimum, standardized monitoring must include searches for evidence of bird fatalities at regularly spaced intervals of time (although not necessarily consistent year round) at a fixed sample of the solar field at a PV USSE facility. Studies could include results from other infrastructure associated with PV USSE facilities (e.g., overhead lines, fences, generation-tie lines). Given that features such as power lines and fences are ubiquitous on the landscape, we only included data collected in the solar field since it represents the unique anthropogenic defining PV USSE facilities. For sites with multiple full study years, each year was treated as a separate study and is indicated by year in the analyses. Thus, we refer to each study as a site-year. We created acronyms for each site and site-year by Bird Conservation Region (BCR [15]), and distinguish among site-years when necessary (e.g., the first of two years of study at 1 site in BCR 33, Sonoran and Mojave Deserts, has acronym SMD1-1). BCRs are an appropriate rubric to group site-years because they were developed to aggregate ecologically similar regions in North America with similar bird communities, habitats, and resource management issues.

Carcass-level information, including species and date of discovery, was necessary for species and group composition and arrival phenology analyses. As not all birds die because of collision with infrastructure, studies could contain results for birds that were found alive (e.g., stranded, injured, dehydrated) in addition to carcasses. Thus, to capture all birds found with a single term, we refer to any discovery, regardless if the bird was alive, injured or deceased, as a detection. All detections found in the solar field, whether during standardized searches or incidentally, were included in species composition and phenology analyses. Authors of the original reports provided species determinations for detections, and we did not attempt to reclassify species or species groups. To understand the phenology of detection occurrence over the year, detections were assigned to Julian calendar days (1–365) and aggregated by week. We assigned seasons based on typical season dates used in monitoring reports from the southwestern U.S.: winter (November 1 –February 28/29), spring (March 1 –May 31), summer (June 1 –August 31), and fall (September 1 –October 31).

Suspected cause of death is generally provided in fatality monitoring studies and could include collision with PV panels, overhead lines, or other infrastructure (e.g., buildings, fence lines), electrocution, predation, or an unknown cause [10]. Carcass condition was assigned by study authors using a variety of terms (e.g., whole-intact carcass, partial carcass, dead-fresh, dead-semi fresh) commonly used in fatality monitoring studies (e.g., U.S. Fish and Wildlife Service [16], Warren Hicks et al. [17]). We reclassified detections into 3 consistent categories based on the designations

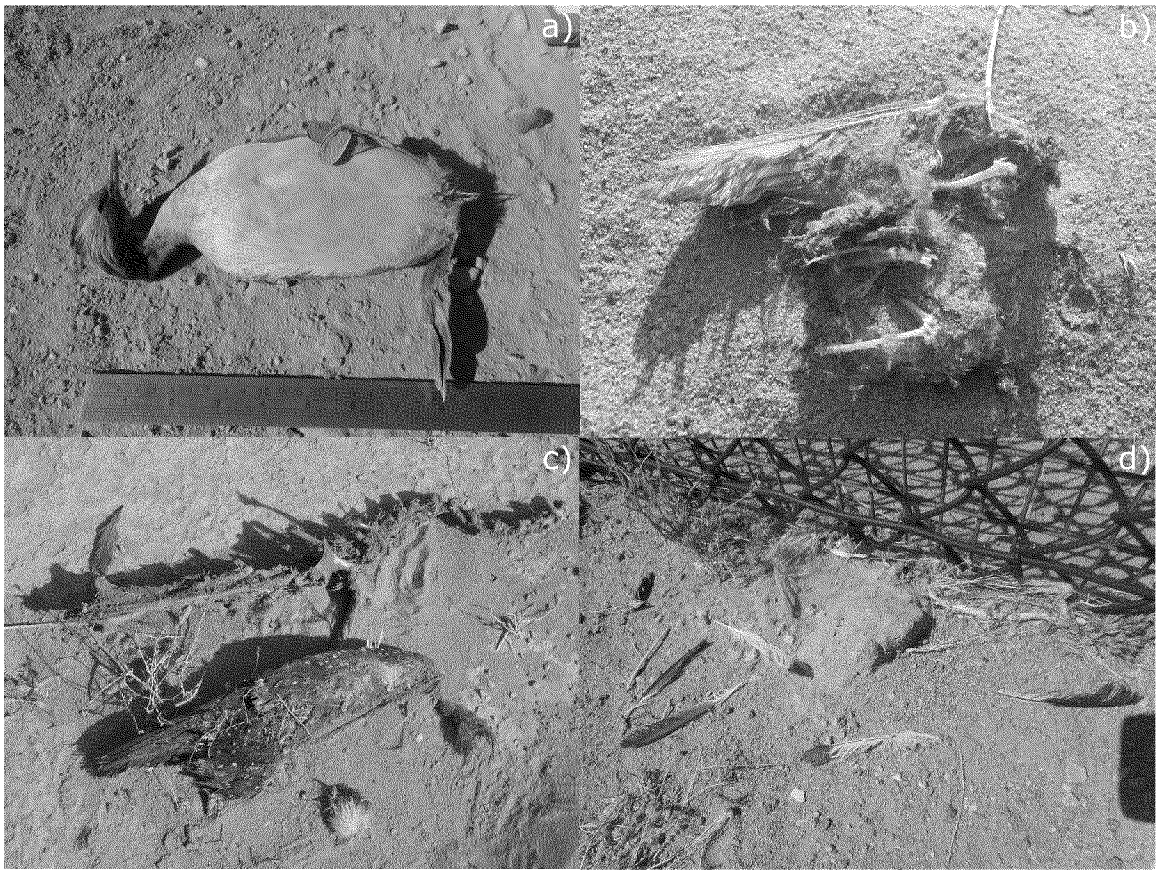

Fig 1. Examples of an intact carcass (a), partial carcass (b, c), and feather spot (d) found at PV USSE facilities in the Southwestern U.S.

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in the reports: partial (less than intact carcasses, with some bone or tissue present), feather spot (at least 5 tail feathers, or 2 primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within 5 meters of each other [18]), and intact carcass or live find (Fig 1).

If fatality estimates were reported, the estimates were only used in our analyses if accompanied by a measure of variation (e.g., variance, standard deviation, or confidence interval) and if the estimates included adjustments for searcher efficiency and carcass persistence bias using a peer-reviewed fatality estimator (e.g., Huso [19]). To provide a comparison among site-years, we standardized fatality estimates, if not done so in the original study, by dividing the total fatality estimate by the nameplate capacity to calculate bird fatalities/MW/year. As there is also interest in understanding estimates in the context of land use and the potential contribution of background mortality (mortality not due to collision infrastructure [11]), we digitized the solar field for all sites from publicly available aerial imagery of facilities, and calculated the total area (in hectares) occupied by the solar field using ArcGIS [20]. We then divided the total fatality estimate by the measured hectares to obtain bird fatalities/hectare/year. To compare variability in estimates, we calculated a standardized confidence interval half-width as

$$0.5 * \frac{\text{upper confidence bound} - \text{lower confidence bound}}{\text{estimate}} \quad (1)$$

to serve as an analog for coefficient of variation.

Bird group categories

We used taxonomic order [21] or created groups based on a trait of interest (e.g., associated with water) to aggregate birds for analysis. Bird groups developed for this review are diurnal raptors, including eagles, hawks, kites, harriers, falcons, and vultures (Accipitriformes, Cathartiformes Falconiformes); and water-associated and water-obligate birds. We define water-associated birds (hereafter, water associates) based on life history traits, and include any species that relies primarily upon aquatic habitats for the purposes of foraging, reproduction, and/or roosting and could be present in the study areas based upon their known range. Water associates can walk on and take off from land. Given this definition, water associates include most species of ducks, geese, and swans (Anseriformes); pelicans, herons, ibises, bitterns, and allies (Pelecaniformes); coots and rails (Gruiformes); plovers, sandpipers, gulls, and allies (Charadriiformes); and osprey (*Pandion haliaetus*; Accipitriformes). We distinguish water-obligate birds (hereafter, water obligates), which rely on water for landing or take off, from water associates because of the importance of water obligates to the foundation of the lake-effect hypothesis. Water obligates include loons, grebes, cormorants (Suliformes), and diving ducks (Anseriformes), such as ruddy duck (*Oxyura jamaicensis*). S1 Appendix notes species that are considered water associates and water obligates.

In fatality monitoring reports, detections were identified with varying levels of resolution by the study authors, based on the condition of the detection, experience of the observer, and the degree to which the detection could be examined. The resolution of species identification in each site-year affected how detections were treated in the analyses. When detections could not be identified to individual species, but identified to a species group (e.g., unidentified duck), those detections were included in summaries by taxonomic order, as well as if a water associate or water obligate. Detections that could not be identified to a species group (e.g., unidentified large bird) were pooled into an "unidentified" category when comparing composition of different taxonomic orders, and aggregated in the category of "other birds" in analyses focused on water associates and water obligates.

Fatality estimates

For each study included in the data summary of estimates, mathematical models known as estimators were used by the study authors to adjust the number of detections observed based on biases in the searchers' abilities to find carcasses and scavenging/removal of the carcasses that might occur between searches. Searcher efficiency is a measure of how well an observer was able to find detections present in search plots, typically presented as a proportion of carcasses found to those available to be found during the trial. In the studies summarized, researchers placed trial bird carcasses to represent fatalities prior to actual searches to measure how many of the trials were found. To account for possible effects of bird size, small birds (100 grams or less on average), medium birds (101–999 grams on average), and large birds (1000 grams or greater on average) were used, with some studies using only small and large birds. Further, season was often included as a variable in analysis. Because observer detection is typically not perfect, searcher efficiency rates vary between 0 and 1.

Researchers measured how long a carcass persisted by conducting carcass persistence trials, during which they placed trial bird carcasses at the facility and checked on the status of the trial carcasses at varying intervals until the carcass vanished (assumed taken by a scavenger) or is not detectable due to weathering or decomposition or when the trial time period was over. The same size classes and seasonal estimates were included in carcass persistence analysis. Using estimates of searcher efficiency and carcass persistence, and the number of detections found during standardized searches, researchers estimated fatalities at each facility using a

variation of the general underlying model:

$$F = \frac{c}{r * p * a} \quad (2)$$

where F is the total number of fatalities, C is the number of detections found and included in fatality estimation, r is the probability a carcass is available to be found on regular searches, p is the probability of detecting a carcass (given it is available), and a is the proportion of solar field surveyed [19,22].

Species, taxonomic order or group composition (i.e., the proportion of detections by species or group) is an important metric to understand how frequently species or groups occur in the detection dataset. However, species composition using the raw detection data could bias estimates because detection probability (i.e., probability a carcass is available to be found on a search, and detected by a searcher) differed between small, medium, and large carcasses. Generally, probability of detection tends to increase with carcass size. To properly account for detection probability among species, we calculated adjusted composition by dividing the detection counts by the product of searcher efficiency and carcass persistence probability (i.e., detection probability; as in Huso [19]). When detection bias estimates were reported, we calculated site-year specific adjusted composition, accounting for size class, season (as reported in each report), and year when applicable. Some studies did not distinguish between medium and large birds, in which case we used the large bird detection probability for medium-sized birds. When detection probability estimates were not reported for a site-year (4 site-years), we calculated adjusted composition using the average detection probability (by size class) based on all site-years with detection probabilities reported. Thus, the adjusted composition is a better representation of species composition than that calculated from raw detections.

Comparison of fatality estimates with other studies

Walston et al. [6] produced a range of capacity-weighted average mortality rate estimates for Southern California and the United States, and based on fatality monitoring data from 3 studies in Southern California. These studies included 2 concentrating solar facilities, Solar One and Ivanpah Solar Electric Generating System, and one PV solar facility, California Valley Solar Ranch. Walston et al. [6] calculated a range of estimates from mortality attributable to the facility (2.7 birds/MW/year), mortality from unknown causes (7.3 birds/MW/year) and total mortality (9.9 birds/MW/year) at USSE facilities. When extrapolated to the built and planned solar capacity in the study area (6 gigawatts [GW]), the result was an estimated 16,200–59,400 bird fatalities/year. A new estimate of average annual per MW bird mortality for southern California was calculated using the PV solar (only) dataset presented in our study. In addition, we also extrapolated avian fatalities to all of California and Nevada, using updated solar buildout statistics from Walston et al. [8].

Results

Studies of bird fatality at PV solar facilities

We identified useable data that met our inclusion criteria from 13 site-years occurring between November 2013 and September 2018 at 10 PV USSE facilities located in southern California in Imperial, Riverside, San Bernardino, and San Luis Obispo counties, and Nevada in Clark and Mineral counties (Fig 2; S2 Appendix). Facilities were located in the following BCRs: Sonoran and Mojave Deserts (SMD; BCR 33), Coastal California (CC; BCR 32), and Great Basin (GB; BCR 9). BCR 33 covers southeastern California and southern Nevada and adjoins the Sonoran Desert. The region is arid and dominated by cacti (Caryophyllales), slow-growing grasses

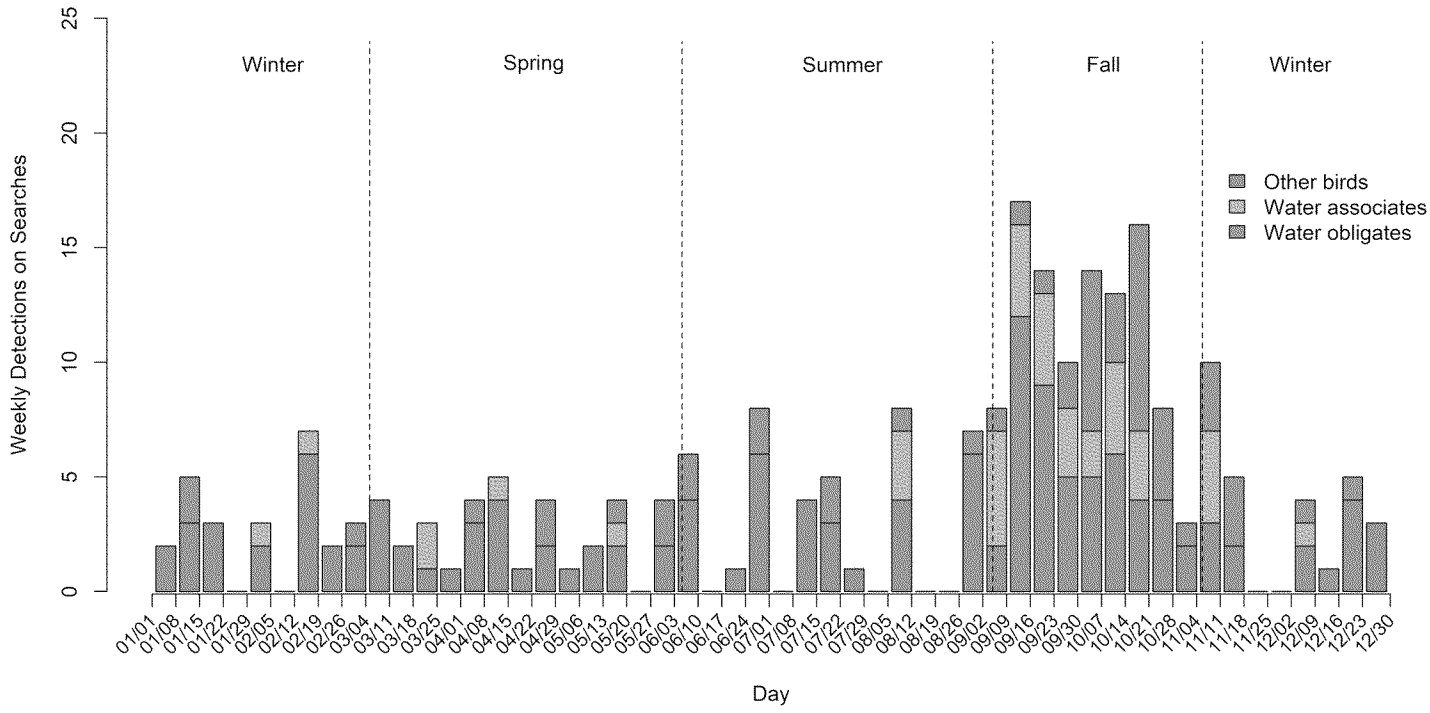

Fig 2. Phenology of avian detections found during standardized monitoring in the photovoltaic solar field at 7 sites from January 1, 2013, to September 1, 2018 in the Sonoran and Mojave Deserts and Great Basin Bird Conservation Regions. Water associates are species that rely on water for foraging, reproduction, and/or roosting; water obligates are species that cannot take flight from land; other birds are species not falling into either of those categories.

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(Poales), creosote bush (*Larrea tridentata*), and other desert shrubs. Waterbodies are relatively limited, and important bird resources include the Colorado River and the Salton Sea. BCR 32 extends from the coast of California inland to the foothills of the Sierra Nevada Mountains. Inland, the climate is hot and dry during summer, and the vegetation consists of mixed chaparral and remnant grasslands. BCR 9 is a relatively large area stretching from central Nevada north to southern British Columbia, Canada. The BCR is in the rain shadow of the Cascade Mountain Range, creating a dry climate with grasslands, sagebrush (Asterales), and shrub-steppe habitat in and lowlands, with piñon-juniper (*Pinus-Juniperus* spp.) woodlands and open ponderosa pine (*P. ponderosa*) forests at higher elevations.

Survey methods were relatively similar among the sites (S3 and S4 Appendices); however, project size varied from a nameplate capacity of 20 MW (SMD4) to 550 MW (SMD3 and CC2).

Characterizing species and temporal patterns for bird fatalities at PV solar facilities

Across the 13 site-years in our dataset with a complete year of monitoring in the PV solar field, there were 669 avian detections. The data included detections of 86 identifiable species, representing 17 distinct taxonomic orders. The number of detections (unadjusted for detection probability) by site-year ranged from 6 (SMD5-1) to 274 (CC1-2). The total number of detections by species across all studies ranged from 1 (38 different identifiable species) to 145 (mourning dove [*Zenaida macroura*]; S1 Appendix). Songbirds (Passeriformes) and pigeons and doves (Columbiformes) had the highest number of detections (243 and 183, respectively), whereas hummingbirds (Apodiformes), woodpeckers (Piciformes), and cormorants had the fewest (2 in each taxonomic order).

Table 1. Adjusted composition by taxonomic order (or group) by Bird Conservation Region (BCR) provided in fatality monitoring reports from January 1, 2013, to September 1, 2018. Data are presented by site-year so that SMD1-1 is the first year report for site SMD1 and SMD1-2 is the second year report for site SMD1.

	Sonoran and Mojave Deserts BCR										Great Basin BCR	Coastal California BCR		
Taxonomic Order Name or Group[a]	SMD1-1	SMD1-2	SMD2-1	SMD3-1	SMD3-2	SMD4-1	SMD5-1	SMD5-2	SMD6-1	SMD7-1	GB1-1	CC1-2	CC2-1	Total
Cormorants and allies (Suliformes)	0	0	0.64	0.53	0	0	0	0	0	0	0	0	0	0.09
Cuckoos (Cuculiformes)	7.38	2.17	3.18	0	0	0	0	0	0	0	0	0	5.85	0.68
Doves and pigeons (Columbiformes)	0	3.47	39.51	3.73	5.22	59.85	0	0.91	0	0	0	31.50	17.54	17.20
Ducks and geese (Anseriformes)	0	2.17	1.91	12.29	11.22	0	0	1.44	0	0	0	0	0	3.07
Falcons and allies (Falconiformes)	0	0	2.12	0	0	3.98	0	0	0	0	0	0	0	0.24
Grebes (Podicipediformes)	0	0.81	0	16.01	14.74	4.12	0	1.13	0	64.32	0	0.25	0	3.92
Grouse and allies (Galliformes)	0	2.17	0	1.05	0.77	6.30	0	0	0	0	0	0	17.53	0.79
Raptors (Accipitriformes)	0	0	0.64	0.81	0	2.27	0	0.53	20.07	13.85	5.80	0	0	0.76
Loons (Gaviiformes)	3.30	1.63	0	2.10	1.20	0	0	0	3.76	0	0	0	0	0.59
Nightjars (Caprimulgiformes)	31.36	0	2.15	0	4.82	0	21.55	0	0	0	0	0	0	1.52
Owls (Strigiformes)	0	0	5.31	0	0	4.12	0	0	0	0	0	1.25	0	0.95
Pelicans and allies (Pelecaniformes)	0	0	3.18	0	2.77	0	0	0	0	0	0	0	0	0.68
Rails and allies (Gruiformes)	0	0	4.88	14.62	17.68	0	12.47	3.49	0	0	0	0.5	0	4.79
Shorebirds and gulls (Charadriiformes)	0	0	2.15	1.29	3.72	0	0	0	0	0	0	0	0	0.82
Songbirds (Passeriformes)	57.96	79.15	2.15	34.68	26.07	14.97	65.98	83.20	25.39	21.83	91.78	64.98	35.45	54.71
Hummingbirds (Apodiformes)	0	1.93	0	1.46	0	0	0	0	0	0	0	0	0	0.31
Unidentified	0	6.51	32.20	10.42	11.78	4.39	0	7.56	50.78	0	2.42	1.52	23.63	8.58
Woodpeckers (Piciformes)	0	0	0	1.00	0	0	0	1.75	0	0	0	0	0	0.29
Water associates[a]	0	2.17	7.86	18.44	25.16	0	12.47	1.96	0	0	0	0	0	6.28
Water obligates[a]	3.30	2.44	4.88	28.40	26.18	4.12	0	4.63	3.76	64.32	0	0.75	0	7.75

[a] Water associates are species that rely on water for foraging, reproduction, and/or roosting; water obligates are species that cannot take flight from land. Water-associates and water obligates (gray shaded rows) are groups composed of species from Orders and are not additive with Orders in the table. Water associates and water obligates do not contain the same species and are mutually exclusive.

https://doi.org/10.1371/journal.pone.0232034.t001

One taxonomic order was found during all site-years, songbirds (Table 1). Doves and pigeons were also relatively widely represented, occurring at 62% (8 of 13) of site-years overall and at 60% (6 of 10) of site-years in the SMD BCR (Table 1). Water associates were not as widely distributed across site-years as water obligates; water associates occurred at 47% (6 of 13) of site-years, water obligates occurred at 77% (10 of 13) site-years. Water associates only occurred in site-years in the SMD BCR, whereas water obligates occurred in one of three site-years outside of the SMD BCR. Within the SMD BCR, water associates occurred at 57% (5 of 7) of facilities, and water obligates occurred at 100% (7 of 7) of facilities. Of identified species, there were no species common to all site-years; the most widely represented species was mourning dove, occurring at 62% (8 of 13) of site-years, including 60% (6 of 10) of site-years

in the SMD BCR (S1 Appendix). The most common Passeriformes were western meadowlark (*Sturnella neglecta*), found at 54% (7 of 13) of site-years, and horned lark (*Eremophila alpestris*), found at 46% (6 of 13) of site-years; other species were found at 5 or fewer site-years. Of water obligates, only American coot (*Fulica americana*) and pied-billed grebe (*Podilymbus podiceps*) were found at a site-year outside of the SMD BCR (S1 Appendix). Among water obligates within the SMD BCR, common loon (*Gavia immer*) was found at 50% (5 of 10) of site-years; American coot and eared grebe (*P. nigricollis*) were each found at 40% (4 of 10) of site-years; other water obligates were found at fewer than 40% of site-years (S1 Appendix).

Adjusted composition of songbirds was the highest percentage of all detections (54.71%) and the highest percentage of detections at 69.23% (9 of 13) of site-years (Table 1). Doves and pigeons were the next most highly represented taxonomic order, with adjusted composition of 17.20%, and the highest percentage of detections at 15.38% (2 of 13) of site-years. Although water associates and water obligates did not occur consistently across sites-years, resulting in a lower overall percentage of detections (6.28% and 7.75%, respectively), several site-years in the SMD BCR contributed more to the adjusted composition for water associates and water obligates across all site-years. Water associates composed 7.86%, 18.44%, 25.16%, and 12.47% of detections at SMD2-1, SMD3-1, SMD3-2, and SMD5-1, respectively; water obligates composed 28.4%, 26.18%, and 64.32% of detections at SMD3-1, SMD3-2, and SMD7-1, respectively. Overall, water associates composed 10.54% and water obligates had an adjusted composition of 12.62% in the SMD BCR, whereas these groups were absent from site-years in the GB BCR, and water obligates composed 0.75% in the CC BCR. Adjusted composition was higher for water associates and water obligates the closer the site was to the Salton Sea (Fig 2). The furthest sites from the Salton Sea showed almost no contribution of water associates and water obligates to be adjusted composition: GB1-1 (none), CC1-2 (0.75% water obligates), CC2-1 (none).

Identifiable species were most highly represented in adjusted composition by mourning dove (12.92%), horned lark (11.93%), house finch (*Haemorhous mexicanus*; 8.41%), and western meadowlark (7.78%; S1 Appendix). The high adjusted composition of mourning dove was driven by 3 site-years in the SMD and CC BCRs: SMD2-1, SMD4-1, and CC1-2. The water-obligate birds with the highest adjusted composition was American coot, representing 2.87% overall, and American coot was represented in higher percentages at 4 SMD BCR projects: SMD2-1 (4.25%), SMD3-1 (7.32%), SMD3-2 (9.47%), and SMD5-2 (3.49%). Eared grebe was reported in 4 site-years in the SMD BCR, although adjusted composition was less than 3% at all but 1 of those site-years. At SMD7-1, eared grebe composed 64.32% of all detections; however, there were only 7 total detections in the solar field for that site-year.

Timing of detections was included in all datasets except SMD2-1. The phenology of detections varied by season within the desert and non-desert ecoregions (Figs 3 and 4). For the SMD and GB BCRs, detections were found in all months of the year, and detections of water obligates were found in all months except February. Detections of water associates were found in all months except January, June, and July. The highest concentration of all birds, and water-associated and water-obligate bird detections in particular, was from September through early November at PV USSE facilities in the SMD and GB BCRs (Fig 3). In the CC BCR, the highest concentration of fatalities occurred between late September and early January, with only 2 water-obligate detections (September and January; Fig 4).

We summarized detections by day and week to attempt to capture variability in search schedules between studies for different site-years. The maximum number of detections by day and site-year for the CC BCR was 13 (CC1-2), and for the SMD BCRs the maximum number of detections in a single day was 5 (SMD3-1). The maximum number of detections by week—the most common search interval during the spring and fall survey periods in the dataset–and

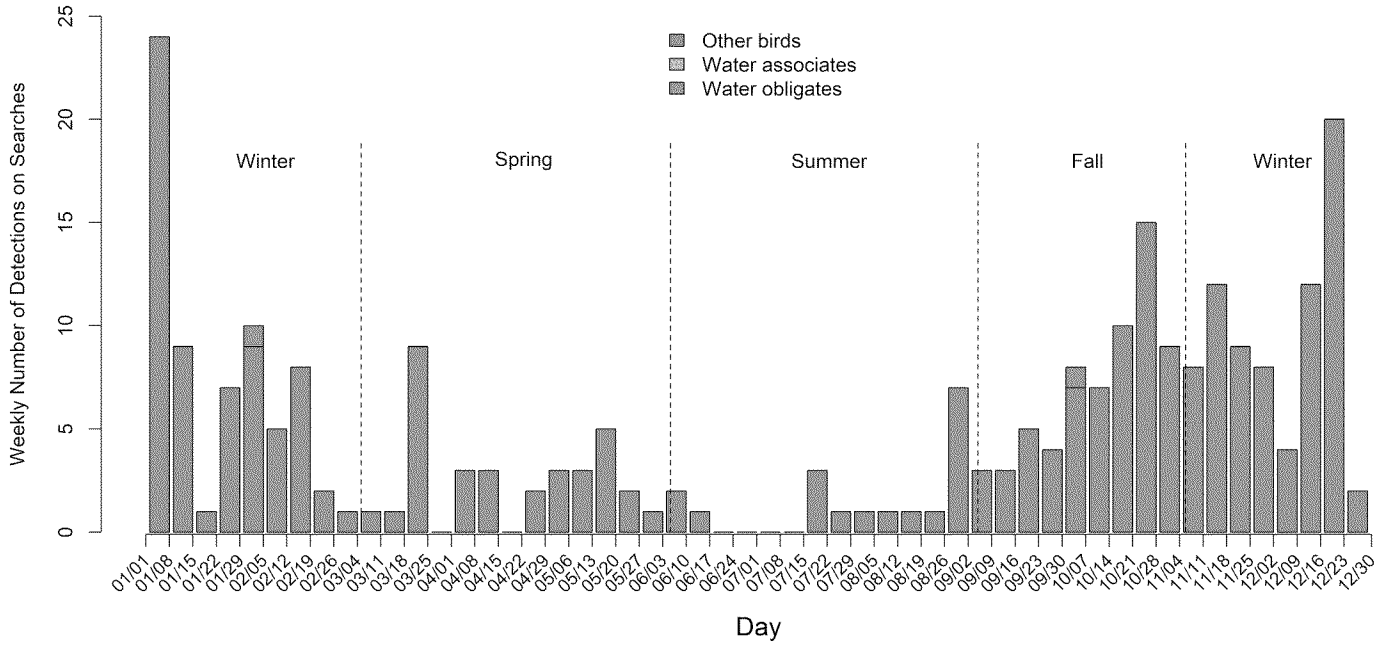

Fig 3. Phenology of avian detections found during standardized monitoring from January 1, 2013, to September 1, 2018 in the photovoltaic solar field at 2 sites in the Coastal California Bird Conservation Region. Water associates are species that rely on water for foraging, reproduction, and/or roosting; water obligates are species that cannot take flight from land; other birds are birds not falling into either of those categories.

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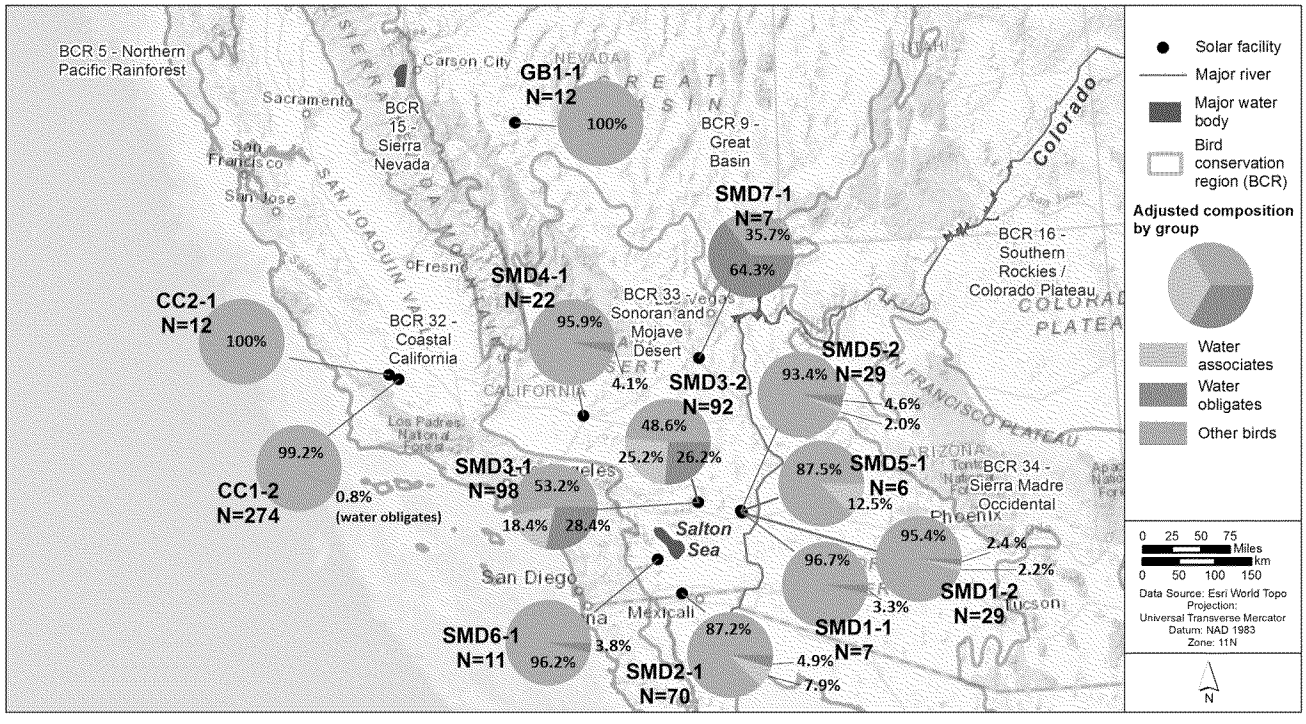

Fig 4. Adjusted composition of water obligates, water associates, and other birds for 13 fatality monitoring site-years at photovoltaic solar facilities in California and Nevada from January 1, 2013, to September 1, 2018. Water associates are species that rely on water for foraging, reproduction, and/or roosting; water obligates are species that cannot take flight from land; other birds are birds not falling into either of those categories. N = total number of detections for each site-year (e.g., CC2-1) represented on the map.

https://doi.org/10.1371/journal.pone.0232034.g004

site-year was larger, with 23 for the CC BCR (CC1-2) and 9 for the SMD BCRs (SMD3-1 and SMD3-2).

Characterizing carcass condition and suspected cause of death for bird fatalities at PV solar facilities

Carcass condition and suspected cause of death data were present for all detections except those from SMD2-1 (all detections) and 11 detections from SMD6-1 that were missing suspected cause data. Of the 599 avian detections with carcass condition data, feather spots had the highest overall adjusted composition (53.79%), and were the majority of detections for 5 of the taxonomic orders reported (Table 2). Partial carcass was the second most highly represented condition (31.65%), and composed the majority of detections for all taxonomic orders where feather spots were not the most highly represented category. Intact carcasses and live finds made up 14.56% of all detections, and were not more than 46% of detections for any single taxonomic order. Less than 1% of detections (8 of 599) were found alive.

There were 96 detections discovered as intact carcasses with suspected cause of death recorded, representing 9 taxonomic orders (Table 3). The overall majority (61% adjusted composition) of intact carcasses and the majority within each taxonomic order represented were recorded with unknown or indeterminable cause of death based on field evaluation. When suspected cause of death was determinable, collision with a panel or other solar infrastructure composed the highest percentage of carcasses with a known cause of death for all taxonomic orders.

Characterizing avian fatality estimates at PV solar facilities

Annual all bird fatality estimates adjusted for detection probability and search effort were available for 11 of the 13 site-years (unavailable for CC2-1 and SMD2-1). Fatality estimates

Table 2. Adjusted composition by taxonomic order and carcass condition for detections provided in fatality monitoring reports ranging from January 1, 2013, to September 1, 2018.

Common Order Name	Intact Carcass or Live Find[a]	Partial Carcass	Feather Spot
Cormorants and allies (Suliformes)	0	100	0
Cuckoos (Cuculiformes)	20.49	58.06	21.45
Doves and pigeons (Columbiformes)	5.42	10.00	84.58
Ducks and geese (Anseriformes)	13.25	72.52	14.23
Falcons and allies (Falconiformes)	0	0	100
Grebes (Podicipediformes)	17.63	63.37	19.00
Grouse and allies (Galliformes)	0	34.68	65.32
Raptors (Accipitriformes)	45.73	41.85	12.43
Loons (Gaviiformes)	35.16	64.84	0
Nightjars (Caprimulgiformes)	26.83	73.17	0
Owls (Strigiformes)	0	13.07	86.93
Pelicans and allies (Pelecaniformes)	0	100	0
Rails and allies (Gruiformes)	25.05	61.13	13.82
Shorebirds and gulls (Charadriiformes)	0	100	0
Songbirds (Passeriformes)	17.31	24.18	58.51
Hummingbirds (Apodiformes)	0	68.6	31.4
Unidentified	0	57.51	42.49
Woodpeckers (Piciformes)	0	76.78	23.22
Overall	14.56	31.65	53.79

[a]Live find includes birds that were injured or stranded but unharmed in the PV solar array.

https://doi.org/10.1371/journal.pone.0232034.t002

Table 3. Adjusted composition of intact carcasses or live finds by suspected cause of death for detections provided in fatality monitoring reports ranging from January 1, 2013, to September 1, 2018.

Common Order Name	Collision–PV Panel[a]	Collision-Line	Collision-Other	Electrocution	Predation	Unknown
Cuckoos (Cuculiformes)	0.00	0.00	0.00	0.00	0.00	100.00
Doves and pigeons (Columbiformes)	5.77	0.00	31.75	0.00	0.00	62.48
Ducks and geese (Anseriformes)	14.05	0.00	0.00	0.00	0.00	85.95
Grebes (Podicipediformes)	7.16	0.00	0.00	0.00	0.00	92.84
Raptors (Accipitriformes)	0.00	0.00	0.00	0.00	0.00	100.00
Loons (Gaviiformes)	0.00	0.00	0.00	0.00	0.00	100.00
Nightjars (Caprimulgiformes)	50.00	0.00	0.00	0.00	0.00	50.00
Rails and allies (Gruiformes)	27.15	0.00	0.00	0.00	0.00	72.85
Songbirds (Passeriformes)	15.75	16.15	10.88	1.94	1.93	53.35
Overall	15.82	11.36	9.47	1.36	1.36	60.63

[a] PV = photovoltaic

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were standardized relative to the nameplate MW capacity of each PV USSE facility, a common metric used in the analysis of avian fatalities from energy generation sources, especially wind energy. Estimates ranged from 0.08 birds/MW/year (0.031 birds/hectare/year; SMD7-1) to 9.26 birds/MW/year (5.170 birds/hectare/year; CC1-2), with a mean of 2.49 birds/MW/year (1.088 birds/hectare/year; Table 4). Excluding CC1-2, which could be considered an outlier in the dataset as 42.70% of the detections were unknown-cause mourning dove feather spots and

Table 4. Annual all bird fatality estimates, adjusted for detection probability and search effort, per megawatt nameplate capacity and per hectare (with confidence intervals), for 11 fatality monitoring studies at photovoltaic solar facilities in California and Nevada from January 1, 2013, to September 1, 2018.

Project Acronym	Year	Megawatts	Array Area (Hectares)	Technology	Analysis Detections	Fatalities/Megawatt (Confidence Interval[a])	Fatalities/Hectare (Confidence Interval)
CC1-2	2013–2014	250	448	tracker	150	9.26 (7.56–11.86)	5.170 (4.223–6.625)
GB1-1	2017–2018	50	140	tracker	14	5.72 (1.52–14.68)	2.037 (0.541–5.227)
SMD1-1	2016–2017	235	681	tracker	2	0.20 (0.01–0.46)	0.062 (0.003–0.157)
SMD1-2	2017–2018	235	681	tracker	18	2.08 (0.94–2.90)	0.719 (0.326–0.999)
SMD3-1	2015–2016	550	1,206	fixed	74	1.05 (0.88–1.56)	0.480 (0.402–0.713)
SMD3-2	2016–2017	550	1,206	fixed	74	1.92 (1.47–2.57)	0.874 (0.671–1.173)
SMD4-1	2017–2018	20	51	tracker	22	2.55 (1.40–4.95)	1.000 (0.549–1.942)
SMD5-1	2016–2017	250	727	tracker	3	0.23 (0.04–0.49)	0.078 (0.015–0.169)
SMD5-2	2017–2018	250	727	tracker	20	2.99 (1.17–6.32)	1.028 (0.403–2.174)
SMD6-1	2017–2018	50	138	tracker	11	1.36 (0.74–3.54)	0.494 (0.269–1.286)
SMD7-1	2016–2017	250	635	tracker	7	0.08 (0.03–0.22)	0.031 (0.011–0.085)

[a]All confidence intervals are 90% confidence intervals, with the exception of SMD6-1, which presented a 95% confidence interval.

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the estimate was more than 1.5 times higher than the next highest estimate, the average annual fatality rate was 1.82 birds/MW (0.680 birds/hectare/year). Confidence intervals were presented in the report for each site-year when an estimate was presented, and all confidence intervals were 90% confidence intervals, with the exception of SMD6-1 (95% confidence interval). Site-years showed a comparatively wide range of variability, even when standardized by the magnitude of the estimate. As an analog to coefficient of variation (standard deviation/estimate), the standardized confidence interval half-width varied from 0.23 (CC1-2) to 1.25 (SMD1-1). Thus, the upper/lower ends of the confidence intervals were generally separated from the estimate by a distance between 0.23 and 1.25 times the estimate itself.

There was a strong positive correlation between nameplate MW capacity and solar field area (Pearson's Correlation Coefficient, $\rho = 0.97$, $p < 0.001$), so we used nameplate MW capacity as the metric for facility size. Annual per MW fatality estimates showed a relatively weak, slightly negative relationship with facility size (slope = -0.003, $p = 0.55$, $R^2 = 0.04$; Fig 5). CC1-2 was an outlier, but excluding these data did not appreciably change the overall relationship between fatality rate and facility size.

The dataset was dominated by site-years in the SMD BCR, which showed variability in annual fatality rates between 0.08 and 2.99 birds/MW/year (Fig 6). Annual fatality rate estimates in the CC and GB BCRs, represented by 1 site-year each, were higher than the SMD BCR estimates. However, the estimate associated with GB1-1 had the widest 90% confidence

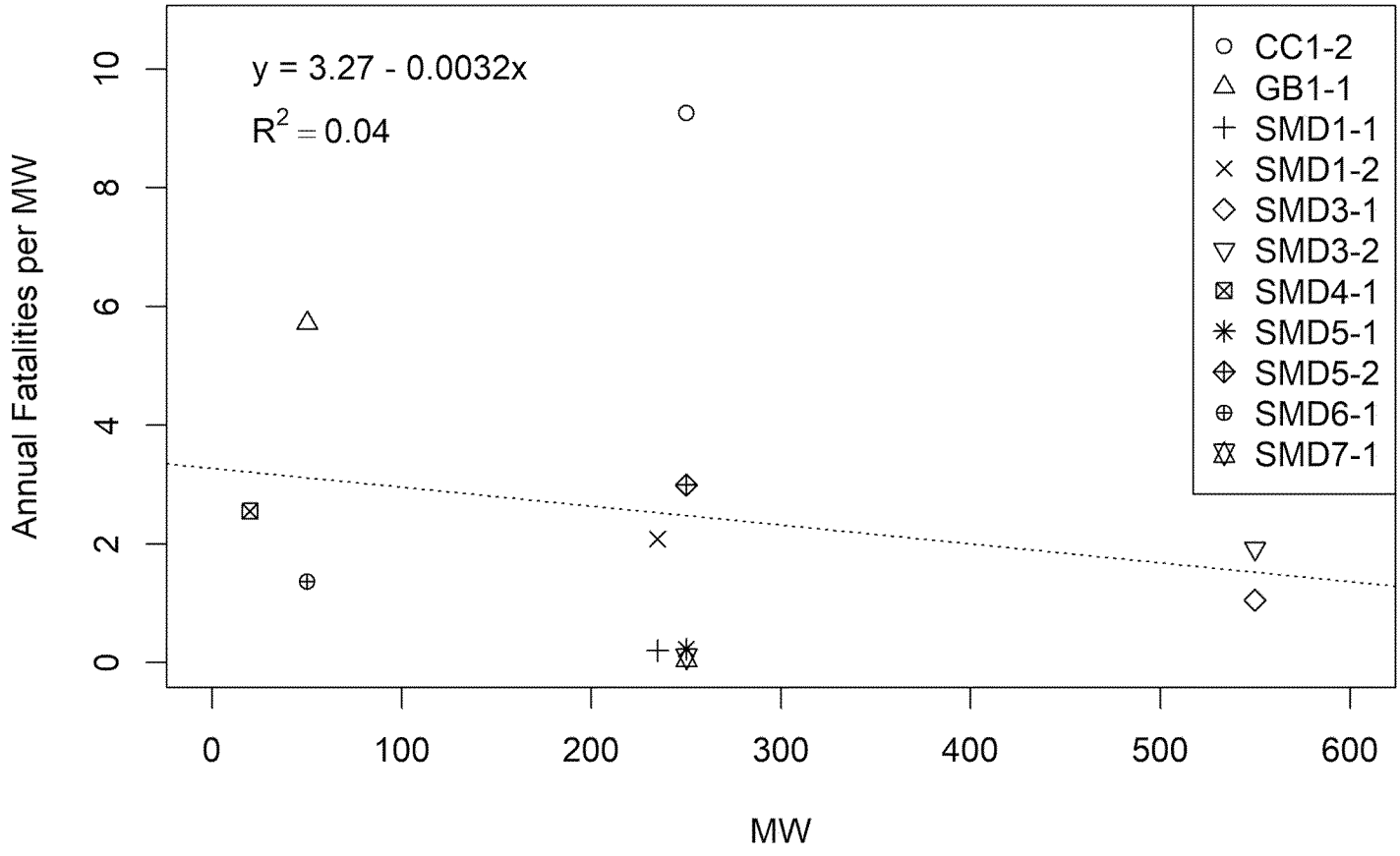

Fig 5. Annual all bird fatality estimates, adjusted for detection probability and search effort, per megawatt (MW; nameplate capacity), by nameplate capacity, from January 1, 2013, to September 1, 2018.

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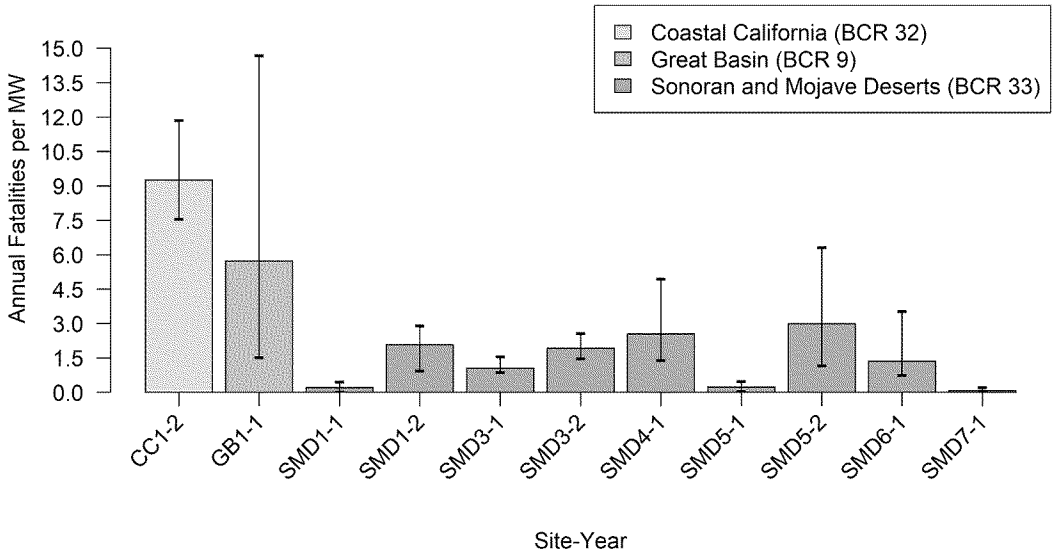

Fig 6. Annual all bird fatality estimates, adjusted for detection probability and search effort, per megawatt (nameplate capacity) by Bird Conservation Region, from January 1, 2013, to September 1, 2018. Vertical bars show 90% confidence interval around estimates for each study except SMD6-1, which only reported a 95% confidence interval.

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interval of any site-year, extending below several estimates from the SMD BCR, and above the upper confidence bound of the estimates from CC1-2.

Comparison of fatality estimates with other studies

Based on the dataset assembled for this manuscript, we updated the solar fatality estimate from Walston et al. [6] to reflect a larger dataset of estimates derived from systematic monitoring studies at PV USSE facilities that compose 9.7% of current and planned solar buildout in California and Nevada. We calculated the average annual fatality estimate of known and unknown cause per MW at PV USSE facilities in desert BCRs to be 1.82 birds/MW/year. Using the 6-GW capacity cited in Walston et al. [6], and assuming predominantly PV development, the result is an estimate of 10,920 fatalities/year in southern California, compared to Walston et al.'s [6] known and unknown cause estimate of 59,400 fatalities/year in southern California. Including the estimate from CC1-2 raises the average fatality rate to 2.49 birds/MW/year, or 14,940 bird fatalities/ year in Southern California. We also took updated estimates of USSE development in California (14.562 GW) and Nevada (2.458 GW) from Walston et al. [8] to derive an updated range of known and unknown cause estimates for all of California and Nevada: 30,976 (excluding CC1-2) to 42,193 (including CC1-2) bird fatalities per year.

Discussion

Our study provided 4 main findings. First, we found variability in the distribution of taxonomic orders and species among and within BCRs; however, 3 species (mourning dove, horned lark, and western meadowlark) were consistently found among site-years, with adjusted composition greater than 5% over all site-years. Second, a phenology pattern emerged where most detections occurred in fall in the SMD BCR, with a pattern of higher detections occurring through winter in the CC BCR. Third, we found that most detections were of feather spots, and that most detections were attributed to an unknown cause of fatality. Last, we found that annual fatality rates never exceeded 2.99 fatalities/MW/year (1.03 fatalities/hectare/year)

in the SMD BCR, were highest in the CC BCR where the rate was 9.26 fatalities/MW/year (5.17 fatalities/hectare/year), and that fatality rates did not correlate with nameplate capacity. Overall, the fatality rate we calculated for PV USSE using known and unknown cause fatalities was lower than that calculated by Walston et al. [6], who used multiple types of USSE development to generate an average annual fatality rate per MW. Taken together, our results offer important insight into the patterns of bird mortality at PV USSE facilities that will assist interested stakeholders in understanding the effects of an energy technology that is becoming more common on the landscape.

Species composition and variation among PV solar facilities

We found variability in the species composition among site-years among and within a BCR. Songbirds occurred in all site-years, which is consistent with patterns at other anthropogenic features where songbirds were widely represented in fatality studies (e.g., Erickson et al. [11], Longcore et al. [23]). The species detected in the most site-years included mourning dove, western meadowlark, and horned lark. These 3 species, along with house finch, also had the highest adjusted composition across the dataset. Mourning dove, western meadowlark, and horned lark share several traits, including that these species are primarily ground dwelling, inhabit landscapes with relatively low-growing vegetation, and have comparatively large populations in the U.S. in regions where the studies occurred [24]. Mourning dove and house finch share a trait in that they associate with anthropogenic structures [24]. According to the Partners in Flight Bird Population Database [25], there are an estimated 12.8 million mourning doves, 13.8 million western meadowlarks, 16.09 million horned larks, and 14.2 million house finches in the 3 BCRs represented by site-years. Thus, the overall most common species found as detections are generally abundant in the regions where the studies occurred and the species share behavioral traits in that they move at or near ground level or associate with anthropogenic structures. It is possible that PV USSE facilities provide structure and an environmental microclimate that attracts birds and other species, but none of the studies we reviewed compared mortality data to live bird count data, so it is unknown if mortality at PV USSE facilities is associated with increased localized use.

We found that water associates were not as widely distributed among site-years as water obligates, and that water obligates occurred at 9 of 10 site-years in the SMD BCR and at 1 of 3 site-years in the CC and GB BCRs. Mortality of water associates and water obligates is known from other anthropogenic features, including wind turbines [26], communication towers [23,27], and buildings [28]. However, wind turbines, communication towers, and buildings represent comparatively tall, vertical hazards to migrating individuals, whereas PV solar panels at the sites are generally within 3 meters of the ground. The collision of water obligates with relatively low-lying PV panels raised questions by Kagan et al. [10] about the causal mechanism for occurrence (e.g., lake-effect hypothesis). None of the studies included in our summary provided hypotheses for the occurrence of water obligates, nor did the studies collect data to investigate potential causal mechanisms such as the amount of polarized light reflected by the PV panels or behavioral responses of water obligates to PV panels. Thus, none of the studies provide insight into the causal mechanism responsible for the presence of water obligates at PV USSE in the SMD BCR, and we avoid speculating about possible causes given the relative lack of important information (e.g., how water obligates perceive polarized light reflected from PV solar panels). Rather, we focus our review on summarizing the spatial and temporal patterns of occurrence.

The Salton Sea and Gulf of California serve as stop-over and winter habitat for hundreds of thousands of water associates and water obligates [29]. For example, the majority of the eared

grebe population in the U.S. winters in the Gulf of California [29]. Thus, at a broad scale among BCRs, the concentration of water obligates in the SMD BCR at the Salton Sea is a plausible explanation for the variability in occurrence as concentrations of water obligates at similar stop-over areas are not known in the CC or GB BCRs near the sites. However, finer resolution spatial exposure data are needed to begin to understand variability among site-years within the SMD BCRs. Therefore, variation among BCRs appears associated with an abundance of migratory and over-wintering water obligates at the Salton Sea and the proximity of the sites to the Salton Sea, but we cannot readily interpret the variation among site-years within the SMD BCR given the absence of local exposure data at each site. An important limitation of our study and interpretation of the broad scale patterns of water-obligate bird occurrence is that our results are not predictive outside of the vicinity of the sites included. Our statements should not be interpreted as evidence there will be water-obligate bird mortality at PV USSE facilities developed in areas with concentrations of migrating or overwintering water obligates because the causal mechanism for fatality risk is unknown. Rather, additional fatality data collected can be evaluated to determine if results from a site align with, or fall outside of the pattern evident in our summary.

Phenology

Peak number of detections per survey period was highest in fall in the Sonoran and Mojave Deserts and GB BCRs and highest in fall and winter in the CC BCR. The phenology of detections mirrors patterns found at other anthropogenic features (e.g., buildings), and coincides with higher abundance of birds following the breeding season [30]. The peak in detections in the fall season at site-years in the SMD and GB BCRs is likely influenced by an increase in the number of water associates and water obligates during the fall season. Although all bird detections tend to increase at the beginning of the fall period in September, detections of water associates and water obligates continued to increase until the end of October, whereas detections of other birds declined steadily throughout the fall. Waterfowl, loons, and grebes are all known to move in comparatively large numbers in fall when weather conditions are favorable for migration [31,32,33]. Eared grebes stage at the Great Salt Lake in Utah, and synchronize migration with upwards of 100,000 to 200,000 birds departing simultaneously en route to the Gulf of California [34]. Thus, the increase in water associates and water obligates during fall is likely explained by migratory movements to the wintering grounds.

Unlike mortality events of migratory birds at comparatively tall anthropogenic structures where hundreds of whole-intact carcasses have been found in a single night at a single communication tower or building [26], the highest number of carcasses detected in a site-year single visit was 13. Comparatively large-scale mortality events at communication towers or buildings are generally associated with lighting and nights with relatively low cloud ceilings [35,36]. In addition, no comparatively large downing events of water obligates were documented at any site-year, although relatively large downing events of eared and western (*Aechmophorus occidentalis*) grebes have been documented during poor weather, or associated with other factors such as wet parking lots [37]. Thus, the absence of large-scale mortality events of nocturnal migrants at PV USSE is likely best explained by the low stature of PV panels and the general lack of lighting.

Carcass type, condition, and uncertainty

The majority of detections in the site-years were feather spots, and a cause of mortality could not be attributed for most detections, in contrast to patterns at comparatively tall structures where cause is typically attributed to collision (e.g., Erickson et al. [26], Loss et al. [28]). Feather

spots could occur from a number of sources, including background mortality (e.g., mortality from predation [11]). At CC1-2, where the majority of detections were mourning doves, a prey species, fatality monitoring was conducted at reference plots outside of the solar facility. Reference plots equal in size to sample units within the facility (referred to as "tracker units") at CC1-2 were searched concurrently with sample units in the solar field. The resulting adjusted fatality rate of 1.73 birds/tracker unit/year converts to an annual reference plot fatality rate of 6.92 birds/MW/year (based on the approximate MW to tracker unit ratio of 0.25 MW per tracker unit at the facility). All detections found in reference plots at CC1-2 were feather spots, primarily composed of Columbiformes (45%), supporting the idea that some proportion of the detections in the solar field at CC1-2 could be predation related, but the proportion cannot be conclusively stated because fatality events were not observed. At SMD3, Kagan et al. (2014) estimated from opportunistic necropsies 31% of the carcasses examined were likely impact trauma (e.g., collision with a solar panel or overhead line), 24% likely predation, with most of the remaining carcasses of unknown cause. Thus, when considering impacts to birds in general from anthropogenic structures, it is important to distinguish the certainty in cause for building and tower mortality, where intact carcasses are found below the structures, from PV USSE, where the majority of the detections are feather spots or partial carcasses found throughout the PV array field.

Comparison of fatality estimates with other studies

We calculated an average annual fatality estimate for known and unknown cause per MW at PV USSE (2.49 fatalities/MW/year, upper estimate) that was less than that provided by Walston et al. [6] (9.9 fatalities/MW/year), and the difference is driven by 3 factors. First, Walston et al. [6] included data from the California Solar One and Ivanpah Solar Electric Generating System (Ivanpah) where the concentrating solar flux has been shown to singe migratory birds in fall and spring, and singeing does not occur at PV USSE [38]. Second, the fatality estimates Walston et al. [6] used in their analysis included all infrastructure monitored (e.g., overhead lines, generation tie-lines, fences), not just the solar field. Third, the only PV USSE facility included in Walston et al. [6] is CC1-2 in our study, which had an average annual fatality estimate 5.1 times higher than the average among the other 12 site-years, possibly due to the contribution of background mortality of mourning doves. Therefore, the average annual fatality estimate produced by Walston et al. [6] contains a mixture of solar technologies, was not limited to the PV solar field, and includes one PV facility with the highest annual fatality estimate among site-years. Thus, our average annual fatality estimate (2.49 birds/MW/year) reflects current PV USSE development. However, as CC1-2 is included in our analysis, an average annual fatality estimate of 1.82 birds/MW/year might be a more accurate representation at PV USSE facilities in the BCRs where the studies occurred.

Even our conservative average annual fatality estimate (2.49 birds/MW/year) of known and unknown detections was approximately 75% less than the known and unknown cause average annual fatality estimate from Walston et al. [6] based on a 6-GW capacity in southern California. Furthermore, our conservative average annual fatality estimate for the entirety of California and Nevada, based on updated capacity, was 29% less than the average annual fatality estimate by Walston et al. [6] for southern California alone. However, our conclusions from an expanded dataset align with Walston et al. [6] in that avian mortality at PV USSE was lower than other sources of anthropogenic bird mortality (e.g., Loss et al. [28]). The conclusions we reached are relevant for regions within the BCRs represented by our dataset, in particular the SMD BCR where most of the site-years occurred. Given that mortality risk is not well understood in different habitat contexts, we do not recommend extrapolating the average annual

fatality estimates we calculated out to the current and projected buildout of the U.S., or to other BCRs with markedly different habitats (e.g., BCR 19, Central Mixed Grass Prairie).

Conclusions

There are consistent patterns in several aspects of our analysis that could provide insight into potential patterns of bird mortality at PV USSE outside of the BCRs where the studies occurred; however, a primary limitation of our study in reaching broader generalizations is that 77% (10 of 13) of site-years occurred in the SMD BCR. Four patterns that could provide broader inference to other regions are: 1) the most widely occurring species among site-years have populations in the millions in the BCRs where studies occurred, and 3 of the top 4 species detected are ground-dwelling birds; 2) most detections occurred in fall; 3) there was no evidence of a comparatively large-scale fatality events of nocturnal migrating passerines or migrating water associates or water obligates; 4) most detections were of unknown cause feather spots. As none of the studies investigated the potential causal mechanism responsible for the occurrence of water obligates, generalizations are limited to mortality patterns in the SMD BCR where water obligates were found at 90% of site-years and 100% of PV USSE facilities. Proximity to a stop-over site for hundreds of thousands of water associates and water obligates could be a contributing factor to the variability among BCRs. The overall average annual fatality estimate can be generalized to the habitats in the BCRs where the studies occurred with more inference from the SMD BCR; however, generalizing the average annual fatality estimate in BCRs where studies did not occur is not appropriate. The intent of our summary was to provide an understanding of overarching patterns in bird mortality at PV USSE and we feel providing management recommendations is outside of the scope of our summary. Instead, we suggest that if fatality monitoring is conducted in areas outside of the regions where the studies occurred that researches evaluate their fatality patterns against our summary. In order to predict whether water-associated and water-obligate birds will occur at PV USSE outside of the SMD BCR, studies investigating the underlying causal mechanisms are needed. Further, a summary or additional studies of the potential contribution of background mortality to PV USSE fatality estimates could be considered to determine if suitable information exists to untangle facility-related from background mortality.

Supporting information

S1 Appendix. Adjusted composition and total detections of species by site year and Bird Conservation Region (BCR) provided in fatality monitoring reports ranging from January 1, 2013, to September 1, 2018. Data are presented by site-year so that SMD1-1 is the first year report for site SMD1 and SMD1-2 is the second year report for site SMD1.
(DOCX)

S2 Appendix. Photovoltaic solar facility studies included in the dataset, with acronym and citation.
(DOCX)

S3 Appendix. Physical attributes and study information for photovoltaic solar facility studies included in the dataset.
(DOCX)

S4 Appendix. Study attributes for photovoltaic solar facility studies included in the dataset.
(DOCX)

S5 Appendix. Detection bias estimates for photovoltaic solar facility studies included in the dataset.
(DOCX)

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Aquatic Habitat Bird Occurrences at Photovoltaic Solar Energy Development in Southern California, USA

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Abstract: The development of photovoltaic (PV) utility-scale solar energy (USSE) in the desert Southwest has the potential to negatively affect birds through collision mortality. Based on early patterns in fatality monitoring data, the lake effect hypothesis (LEH) was developed and suggested that birds misinterpret PV solar panels for water. As the LEH was only recently defined and inference beyond bird mortality is limited, our research objective was to examine the species composition, abundance, and distribution of live and dead aquatic habitat birds at five PV solar facilities and paired reference areas in southern California. Further, we collected data from a small regional lake as an indicator of the potential aquatic habitat bird community that could occur at our study sites. Using an ordination analysis, we found the lake grouped away from the other study sites. Although the bird community (live and dead) at the solar facilities contained aquatic habitat species, Chao's diversity was higher, and standardized use was more than an order of magnitude higher at the lake. Finally, we did not observe aquatic habitat bird fatalities in the desert/scrub and grassland reference areas. Thus, the idea of a "lake effect" in which aquatic habitat birds perceive a PV USSE facility as a waterbody and are broadly attracted is likely a nuanced process as a PV solar facility is unlikely to provide a signal of a lake to all aquatic habitat birds at all times.

Keywords: photovoltaic solar; birds; fatality; lake effect; attraction; development

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1. Introduction

The development of photovoltaic (PV) utility-scale solar energy (USSE) in the desert Southwest of the United States of America (USA.) was thought to have the potential to negatively affect birds through habitat loss, habitat fragmentation, and collision mortality with infrastructure, similar to other forms of energy development [1]. Although bird mortality was anticipated, the discovery of stranded or dead waterbirds was not expected as PV USSE facilities do not contain water-settling ponds as are found with other types of energy development, such as oil and gas production [2]. In a summary of bird carcasses that were opportunistically obtained from three USSE solar facilities (two concentrating solar power and one PV) in California, U.S., Kagan et al. [3] determined that 48% (27/56) of identifiable remains found at the Desert Sunlight PV USSE facility (hereafter Desert Sunlight) in California, U.S., were of aquatic habitat birds that foraged in water. The carcasses from Desert Sunlight included species that rely on water for takeoff and landing (e.g., family Gaviidae) and those that use water for some aspect of their life history (e.g., family Charadriidae); these groups are defined by Kosciuch et al. [4] as water obligates and water associates, respectively.

The detection of water-obligate and water-associate bird carcasses raised questions about the causal mechanisms responsible for the species' occurrence because PV solar panels are typically within 4 m (m) of the ground and do not represent a vertical hazard in the airspace similar to other forms of anthropogenic development, such as buildings [5], communication towers [6], and wind turbines [7,8]. Further, Desert Sunlight is located in

a desert ecosystem that lacks many permanent large waterbodies. In their report, Kagan et al. [3] stated that the solar panels might be "reminiscent" of bodies of water because some species of aquatic habitat birds (a broad group of birds including water associates and water obligates) should not occur on the ground in a desert environment. An article formalized the idea as "lake effect", concluding that birds mistake a reflective PV USSE facility for a waterbody [9]. The outcome of a "lake effect" at PV USSE facilities could include negative effects on aquatic habitat birds if the causal mechanism occurs broadly across PV USSE facilities and bird species.

The lake effect hypothesis (LEH), which posits that aquatic habitat birds are attracted to PV solar facilities, was used to explain the occurrence of aquatic habitat bird carcasses at PV USSE facilities; however, no data existed at the time to understand how birds perceive PV USSE facilities, nor were alternative hypotheses proposed. Further, as the LEH was developed based on one PV USSE facility, it was unknown whether the occurrence of aquatic habitat birds was unique to Desert Sunlight or whether the pattern was widespread among PV USSE facilities in southern California, U.S. In a summary of 13 studies at 10 PV USSE facilities in the Southwestern U.S., Kosciuch et al. [4] determined that carcasses of water-obligate birds were documented in 90% (9/10) of studies in the Sonoran and Mojave Desert (SMD) Bird Conservation Region (BCR), the region where Desert Sunlight is located. However, Kosciuch et al. [4] found that water obligates were detected in only one of three studies outside the SMD BCR. Thus, uncertainty remains in how broadly the LEH can be applied and whether the LEH applies to all aquatic habitat birds or is limited to specific species.

As the LEH was only recently defined and inference beyond bird mortality is limited, our research objective was to examine the species composition, abundance, and distribution of live and dead aquatic habitat birds at five PV solar facilities and paired reference areas in southern California. Further, we collected data from a small regional lake as an indicator of the potential aquatic habitat bird community that could occur at our study sites. Including live bird surveys in our study was an important advancement in investigating the LEH because the risk profile differs among aquatic habitat birds. For example, species that forage over water (e.g., tree swallow (*Tachycineta bicolor*)) are at lower collision risk and are less likely to be represented in fatality data even if they were attracted to the facility than species that land on water (e.g., western grebe (*Aechmophorus occidentalis*)). It is unknown how the aquatic habitat bird diversity and abundance at PV USSE facilities compares with that at a regional waterbody; thus, our objective was to understand whether a local lake could provide context for our findings at the PV study sites. Our final objective was to determine whether there was support for the alternative hypothesis that exhausted or sick aquatic birds landed broadly on the landscape and died, but were only detected at PV USSE facilities because researchers did not search outside the facilities (e.g., [4]). Searching for aquatic habitat bird carcasses in reference areas outside the PV solar sites would allow us to determine whether there was support for an alternative hypothesis that posits mortality was not predicated on birds being attracted to the PV solar facility.

2. Materials and Methods

Our study was conducted in 2018 and 2019 at PV USSE facilities and paired reference areas in southern California, USA. (Figure 1), during the fall migration period in each year. Kosciuch et al. [4] demonstrated that aquatic habitat bird fatalities peak in fall between 2 September and 11 November in the Southwestern USA Thus, as our study was intended to understand aquatic habitat bird responses to PV solar facilities, we conducted monitoring at our study sites from 18 September to 1 November 2018 and 23 September to 1 November 2019. We monitored each study site for a 2-week focal period within the fall migration period, alternating between live bird surveys and fatality surveys. During each week, three fatality surveys and two point count surveys were conducted for a total of six fatality surveys and four point count surveys per study site. Slight variations in survey frequency occurred due to weather and scheduling logistics.

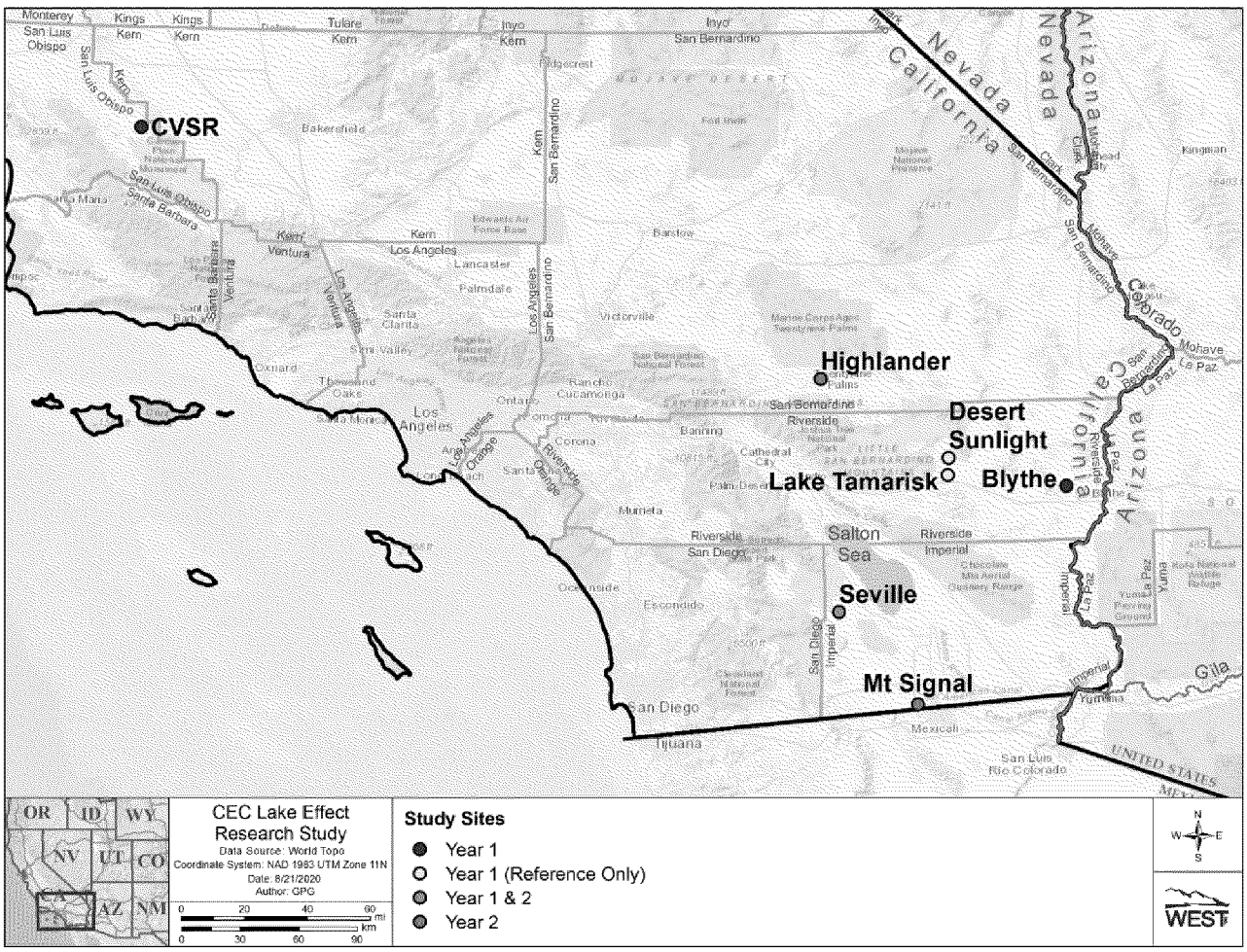

Figure 1. Study site locations in California, USA, 2018–2019.

2.1. Study Sites

In 2018, our PV USSE study sites included the Blythe Solar Energy Center (Blythe; 235 megawatts (MW)) located in Riverside County, California; California Valley Solar Ranch (CVSR; 250 MW) located in San Luis Obispo County, California; and Seville 1 and Seville 2 Solar (treated as one site called Seville; 50 MW) located in Imperial County, California. A matched pairs design was implemented by selecting a paired reference area for each study site using the criteria of being at least 1 km (km) from an operational PV USSE facility and composed of similar vegetation communities as found within the facility prior to construction [10]. We selected reference areas that did not contain a solar facility and had limited anthropogenic features that could result in aquatic habitat bird mortality.

In addition, we monitored two reference areas in 2018 that were not paired with a PV USSE facility, the desert habitat outside of Desert Sunlight (hereafter Reference A) in Riverside County, California, and Lake Tamarisk in Riverside County. Reference A was selected as it is near Desert Sunlight, where 94 water-associate and water-obligate bird carcasses and injuries were detected during the first 2 years of fatality monitoring [4]. We selected Lake Tamarisk, an approximately 5.5 ha artificial lake located approximately 6.4 km away from the nearest PV USSE facility, as an indicator of the species composition and abundance of birds at a waterbody local to our study sites. In 2019, our PV USSE study sites included one studied in 2018 (Seville) and two new sites that included Highlander II (Highlander; 10 MW) in San Bernardino County, California, and Mt. Signal 3 (Mt. Signal; 328 MW) in Imperial County, California. The same criteria were used to select reference areas in 2019. Given the agricultural landscape in the Imperial Valley, it was challenging to locate reference areas without anthropogenic features. Thus, our reference area for Mt.

Signal contained anthropogenic features; however, these features were present at the solar site prior to development. Data were not collected at Reference A or Lake Tamarisk in 2019. We assigned each site to one of three general habitat classes based on dominant vegetation on the surrounding landscape: grassland, desert/scrub, and agriculture. Blythe, Seville, Mt. Signal, and Highlander were desert/scrub; Mt. Signal was agriculture; and CVSR was grassland. Lake Tamarisk is an artificial lake, and we did not include it in one of the three habitat categories, but it occurs in a desert/scrub habitat.

To understand whether there was a relationship between the amount of water on the landscape and the occurrence of aquatic habitat bird mortality, we used the 2016 National Land Cover Database (NLCD) [11,12] to calculate the hectares of land cover types based on NLCD classification. For each area, we generated the minimum convex polygon (MCP) around all surveyed areas (facility and reference, where applicable). Next, we calculated the amount of area within a 5 km buffer of each MCP occupied by each represented 2016 NLCD land cover type and the percentage of the total area with the 5 km buffer occupied by each land cover type. Only three NLCD land cover types associated with aquatic habitats were represented across the seven sites in our study: emergent herbaceous wetlands, open water, and wood wetlands (Table 1). Mt. Signal, the agricultural site, had the greatest amount (609 ha) and proportion of area occupied (2.23%) by aquatic habitat land cover types within the 5 km buffered MCP. Blythe, in a desert/scrub habitat, had the least representation of aquatic habitat land cover types (0.09 ha, 0.001%). The land cover data also confirmed Lake Tamarisk is a relatively isolated waterbody, being the only aquatic habitat (6.3 ha, 0.08%) within the 5 km buffered MCP around the lake survey points.

2.2. Fixed-Point Count Surveys

The objective of fixed-point count surveys was to collect data to evaluate patterns of live aquatic habitat bird use at the PV USSE study sites and reference areas. We established and surveyed 10 min fixed-point count locations (with a survey defined as one complete 10 min observation period at an individual 10 min point location) within each solar facility and at the reference areas [13]. Point count locations were determined by randomly sampling coordinates within facility boundaries and polygons defining accessible public or private land for reference areas. At Mt. Signal, point count locations were selected along roads adjacent to reference areas due to land access limitations. The number of point count locations was based on PV solar facility size and varied among study sites (Supplementary Material Table S1). In addition, in 2019 we added one 60 min fixed long-sit point count at each study site to increase the likelihood of observing aquatic habitat bird behavior, such as approaching the PV solar facility (with a survey defined as one complete 60 min observation period at an individual 60 min long-sit point location). The long-sit point count was situated such that the surveyor was able to observe birds flying over the solar facility and the surrounding habitat. In 2018 and 2019, 10 min point count locations were surveyed four times each (thus, a total of 40 observation minutes per location) during the study period. Long-sit point count sites were surveyed in 2019 only and were surveyed two times each (thus, a total of 120 observation minutes per location) during the study period. During both 10 and 60 min counts, we limited observations for small birds to within a 100 m radius from an observer; no limit was imposed (i.e., unlimited distance) for observations of large birds (e.g., family Podicipedidae). The number of 10 min points surveyed per day varied dependent on the study site, but typically ranged between 10 and 15 points surveyed per day. Surveys for all 10 min point count locations typically commenced 30 min before sunrise and were conducted no later than 4 h after sunrise. Long-sit point counts were conducted once during the sunrise period (between 30 min prior and no more than 4 h after sunrise) and once during the mid-day or evening period (within 6 h of sunset) to capture temporal differences in flight patterns.

Table 1. Total area (hectares) and percent of area occupied by open water or aquatic habitat types (2016 NLCD) within 5 km of the minimum convex polygon enclosing all survey areas at sites monitored, 2018–2019.

Aquatic Habitat Type (2016 NLCD)	Desert/Scrub										Grassland		Agricultural		Total	
	Blythe		Highlander II		Seville		Reference A		Lake Tamarisk		CVSR		Mt. Signal 3			
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
Barren Land	2929.50	16.59	8898.36	60.88	14,977.13	95.63	1811.56	10.95	52.43	0.64	556.29	3.25	2885.69	10.58	14,977.13	27.43%
Cultivated Crops	117.40	0.66		0.00	118.28	0.76	-	0.00	-	0.00	161.68	0.95	12,124.00	44.46	118.28	10.70%
Deciduous Forest	-	0.00	0.90	0.01	-	0.00	-	0.00	-	0.00	-	0.00	0.54	0.00	-	0.00%
Developed, High Intensity	17.04	0.10	25.83	0.18	0.63	0.00	27.44	0.17	3.51	0.04	0.84	0.00	91.35	0.33	0.63	0.14%
Developed, Low Intensity	300.37	1.70	290.43	1.99	29.18	0.19	632.00	3.82	91.96	1.12	11.44	0.07	1157.39	4.24	29.18	2.15%
Developed, Medium Intensity	71.73	0.41	80.55	0.55	82.25	0.53	198.59	1.20	32.44	0.40	1.39	0.01	540.68	1.98	82.25	0.86%
Developed, Open Space	1107.89	6.27	1591.03	10.89	99.80	0.64	625.56	3.78	98.89	1.21	2013.04	11.77	1612.27	5.91	99.80	6.11%
Emergent Herbaceous Wetlands	-	0.00	-	0.00	0.72	0.00	-	0.00	-	0.00	12.58	0.07	88.19	0.32	0.72	0.09
Evergreen Forest	-	0.00	0.09	0.00	-	0.00	-	0.00	-	0.00	-	0.00	2.70	0.01	-	0.00
Hay/Pasture	11.97	0.07	2.07	0.01	8.63	0.06	-	0.00	9.00	0.11	0.36	0.00	1398.05	5.13	8.63	1.22
Herbaceous	715.57	4.05	44.62	0.31	0.18	0.00	154.85	0.94	17.59	0.21	13,541.04	79.15	20.33	0.07	0.18	12.38
Open Water	0.09	0.00	24.91	0.17	0.63	0.00	3.15	0.02	6.30	0.08	0.09	0.00	45.46	0.17	0.63	0.07
Shrub/Scrub	12,389.26	70.15	3654.09	25.00	329.55	2.10	13,089.43	79.13	7894.04	96.20	808.78	4.73	1324.14	4.86	329.55	33.73
Unclassified	-	0.00	-	0.00	-	0.00	-	0.00	-	0.00		0.00	5506.45	20.19		4.70
Woody Wetlands	-	0.00	2.70	0.02	14.62	0.09	-	0.00	-	0.00		0.00	474.59	1.74	14.62	0.42
Total	17,660.82	100.00	14,615.57	100.00	15,661.60	100.00	16,542.57	100.00	8206.15	100.00	17,107.52	100.00	27,271.83	100.00	15,661.60	100.00

CVSR = California Valley Solar Ranch, NLCD = National Land Cover Database, Reference A = desert habitat outside of Desert Sunlight.

2.3. Fatality Surveys

The objective of fatality surveys was to collect data to understand the distribution of aquatic habitat bird carcasses inside and outside of PV USSE facilities. We used distance sampling [14–16] to search for carcasses and feather spots (hereafter "detections") of birds in facility and reference areas. Distance sampling is well suited to PV USSE facilities, especially when vegetation is low or nonexistent and other visual barriers are absent, as it allows for efficient sampling of large areas. The design of PV USSE facilities is also amenable to distance sampling, in that a surveyor can walk perpendicular to PV panel rows and look down each row for potential detections. For each facility study site, a viewshed (maximum distance to search during distance sampling surveys) was established based on the length of the typical panel row at the facility. For reference areas, the viewshed was always 100 m, with the exception of CVSR, where the viewshed was 50 m due to visibility limitations associated with vegetation density. Cumulatively, we sampled approximately 546 ha of the PV USSE facilities and 1038 ha of the reference areas; the area sampled varied by facility and was based on the field schedule and facility size (Supplementary Material Table S2).

Biologists completed fatality surveys consistent with established protocols for monitoring at PV solar facilities [16]. Within the PV USSE facilities, biologists surveyed arrays of PV solar panels on foot, traveling approximately 0.9 m/s. Sampled arrays were surveyed from roads bordering the north or south edge of the solar panel array. Biologists walked perpendicular (east or west) to the edge of the solar array and scanned between each row for potential mortalities. During the survey, the biologist scanned out to the maximum viewshed specific to the study site. Surveys in the paired reference areas were conducted to mimic surveys in the solar arrays. Thus, the surveyor walked 0.9 m/s along an east–west transect and scanned north or south into the reference area, in the same manner used when scanning between solar panel rows. Due to safety restrictions, biologists were not able to access interior sections of the solar arrays or the reference areas at the Mt. Signal study site. Survey methodology was unaffected, but data collection had to be completed from a distance, aided as best as possible by high-powered optics (10× binoculars and a 60× spotting scope).

During fatality monitoring, not all carcasses are detected by searchers due to observers failing to see a carcass, or a carcass being removed between searches. Thus, searcher efficiency and carcass persistence are measured to adjust for detection bias in fatality studies [16]. Given that carcass persistence times were typically at least 1–2 days for even the smallest trial birds at other solar projects [17–21], we did not measure carcass persistence because we assumed that most fatalities would persist through the average search interval (48 h). Searcher efficiency trials were deployed in facility and reference areas to measure potential differences in the detectability of carcasses between areas within study sites.

2.4. Searcher Efficiency Trials

We conducted searcher efficiency trials to calculate the probability that a carcass present in a search area is detected. Searcher efficiency trials are typically conducted with actual bird carcasses; however, given logistical constraints associated with travel between study sites, we used a variety of surrogates to mimic species that could occur at each study site, including Dokken waterfowl trainers (Dokken Dog Supply Inc., Northfield, Minnesota) and characteristically appropriate birds obtained from craft stores similar to passerines typically encountered as detections at PV USSE facilities. Surrogates were chosen to represent small (average weight $\leq$ 100 g) and large (average weight > 100 g) bird species typically or expected to be encountered. Whenever possible, surrogates were modified by hand to better resemble actual detections. Modifications included color modification to better represent the local species and the attachment of feathers to the body of the surrogate to represent a fatality posture. Trials were administered prior to surveys by a biologist not otherwise involved with the day's fatality surveys. The biologist conducting fatality surveys was unaware of the time or location of surrogate deployments, or of the number of

surrogates being dropped [22]. All biologists participating in fatality surveys were tested multiple times throughout each study period.

2.5. Data Analysis

We defined habitat associations for all birds detected during our study similar to other studies on bird communities [23,24]. To provide a consistent and reproducible categorization of habitat association, we used the "Habitat" information under the "Life History" tab on the Cornell Lab of Ornithology's All About Birds website [25]. We considered aquatic habitat species those that associate with lakes and ponds, marshes, rivers and streams, and shorelines. The species classified as aquatic habitat species in this study were consistent with species classified as water associates and water obligates in Kosciuch et al. [4].

We calculated a metric of use for each aquatic habitat species by site and facility or reference area. We did not calculate density estimates because our dataset included flying individuals and rarely included perched individuals. We acknowledge that detection could have differed among species, but we assumed similar detection for an aquatic habitat species between the PV solar sites and reference areas because we were focused on birds in flight above the solar panels and vegetation. For each species, we summed the count of birds by point and visit (including flyovers), averaging over all points within a survey, and then averaging across all surveys (four surveys at each site in each year of study). We then averaged over sites within a habitat category (desert, grassland, or agriculture) and calculated relative frequencies of point count observations of aquatic habitat species in facility and reference areas within each ecoregion. Relative frequencies were calculated as the averaged use value for each aquatic habitat species divided by the sum of use values for facility and reference areas, respectively. Furthermore, we calculated species richness and Chao's estimator of richness (S_{chao1}) [26,27] (using the "vegan" package in R [28]) to assess the bird communities across the sampled sites. Species richness was calculated as the number of unique identifiable aquatic habitat species by site and facility or reference area. We also used counts of aquatic habitat species to test the null hypothesis that aquatic habitat birds would occur as frequently at the PV solar site as the paired reference area by performing a Cochran–Mantel–Haenszel test (significance level $\alpha = 0.10$) on the aquatic habitat bird count data. We tabulated the counts of aquatic and nonaquatic habitat birds into bins by facility or reference and habitat category (desert, agriculture, or grassland). We visualized the live aquatic habitat bird community using unconstrained ordination based on latent variable models with the boral (Bayesian ordination and regression analysis) package in R to determine whether any of the PV facility sites grouped with the lake [29,30].

For fatality surveys, detections were summarized by project and facility/reference area. Searcher efficiency (i.e., probability of detecting a carcass, assuming it was available to be detected) was calculated for each facility and reference area. Searcher efficiency was modeled, and fatalities were estimated using a distance sampling [31] approach commonly applied during postconstruction monitoring at utility scale PV USSE facilities in the U.S. (e.g., [16,19,20]). To generate standardized metric of fatalities, we calculated a fatality index for each site and paired facility and reference area where detections occurred. The fatality index (f) was the sum of detections (c) divided by the product of average searcher efficiency (p) within each site and facility or reference area and the total area surveyed in each area (a; i.e., $f = \frac{c}{p*a}$) and used to compare the relative number of aquatic habitat bird fatalities in the facility and paired reference areas.

3. Results

In 2018, we completed 234 point count surveys at 3 PV USSE facilities, 229 point count surveys at 3 paired reference areas, 88 at Reference A, and 18 at Lake Tamarisk. In 2019, we completed 172 point count surveys at 3 solar facilities and 216 point count surveys at 3 paired reference areas; we completed 12 long-sit point counts (4 surveys per long-sit point count location at each study site in 2019). Over the 2 study periods at all study sites, we observed 4128 aquatic habitat birds of 26 species during point counts (Table 2). During long-sit point counts, we observed 299 aquatic habitat birds, representing 7 species.

Table 2. Counts of aquatic habitat birds during 10 min point count surveys at 5 photovoltaic solar facilities and paired reference areas, 1 lake, and 1 unpaired reference area, 2018–2019, in southern California, U.S. Data are counts of live birds from point counts (counts of bird carcasses from fatality surveys).

Species Name	Habitat and Study Site [1]												
	Desert/Scrub							Grassland			Agricultural		Total
	B-F	B-R	H-F	H-R	S-F	S-R	RA-R	LT-R	CVSR-F	CVSR-R	Mt. S-F	Mt. S-R	
American coot *Fulica americana*	0	0	0	0	0	0	0	1686	0	0	0 (1)	0 (1)	1686 (2)
white-faced ibis *Plegadis chihi*	0	0	0	0	0	0	0	0	0 (1)	0	300	565 (1)	865 (2)
cattle egret *Bubulcus ibis*	0	0	0	0	0	0	0	0	0	0	315	14 (1)	329 (1)
red-winged blackbird *Agelaius phoeniceus*	0	0	0	0	0	0	0	0	0	0	80 (1)	240	320 (1)
mallard *Anas platyrhynchos*	0	0	0	0	0 (1)	0	0	264	0	0	0	0	264 (1)
ring-necked duck *Aythya collaris*	0	0	0	0	0	0	0	241	0	0	0	0	241
ruddy duck *Oxyura jamaicensis*	0	0	0	0	0	0	0	119	0	0	0	0	119
black-crowned night-heron *Nycticorax nycticorax*	0	1	0	0	0	0	0	60	0	0	0	0	61
tree swallow *Tachycineta bicolor*	4	6	0	0	23	13	0	0	0	5	0	3	54
pied-billed grebe *Podilymbus podiceps*	0	0	0	0	0	0	0	53	0	0	0	0	53
great egret *Ardea alba*	0	0	1	0	0	4	0	6	0	0	6 (1)	31 (1)	48 (2)
northern rough-winged swallow *Stelgidopteryx serripennis*	1	5	0	0	5	2	0	0	0	0	0	0	13
double-crested cormorant *Phalacrocorax auritus*	0	0	0	0	0	0	0	0	0	0	13	0	13
American wigeon *Mareca americana*	0	0	0	0	0	0	0	12	0	0	0	0	12
yellow-headed blackbird *Xanthocephalus xanthocephalus*	0	0	1	10	0	0	0	1	0	0	0	0	12

Table 2. *Cont.*

Species Name	Habitat and Study Site [1]												Total
	Desert/Scrub								Grassland		Agricultural		
	B-F	B-R	H-F	H-R	S-F	S-R	RA-R	LT-R	CVSR-F	CVSR-R	Mt. S-F	Mt. S-R	
northern shoveler *Spatula clypeata*	0	0	0	0	0	0	0	9	0	0	0	0	9
cliff swallow *Petrochelidon pyrrhonota*	0	0	0	0	2	5	0	0	0	0	0	0	7
belted kingfisher *Megaceryle alcyon*	0	0	0	0	0	0	0	5	0	0	0	1	6
great blue heron *Ardea herodias*	0	0	1	0	0	0	0	0	0	0	0 (1)	4 (1)	5 (2)
marsh wren *Cistothorus palustris*	0	0	0	0	0	0	0	4	0	0	0	0	4
American avocet *Recurvirostra americana*	0	0	0	0	0	0	0	2	0	0	0	0	2
lesser yellowlegs *Tringa flavipes*	0	0	0	0	0	0	0	1	0	0	0	0	1
osprey *Pandion haliaetus*	0	0	0	1	0	0	0	0	0	0	0	0	1
California gull *Larus californicus*	0	0	0	0	0	0	0	0	0	0	0	1	1
green heron *Butorides virescens*	0	0	0	0	0	0	0	0	0	0	1	0	1
greater yellowlegs *Tringa melanoleuca*	0	0	0	0	0	0	0	0	0	0	0	1	1
blue-winged teal *Spatula discors*	0 (1)	0	0	0	0	0	0	0	0	0	0	0	0 (1)
common loon *Gavia immer*	0	0	0	0	0 (1)	0	0	0	0	0	0	0	0 (1)
western grebe *Aechmophorus occidentalis*	0	0	0	0	0	0	0	0	0	0	0	0 (1)	0 (1)
sora *Porzana carolina*	0	0	0	0	0	0	0	0	0	0	0 (1)	0	0 (1)
Total	5 (1)	12	3	11	30 (2)	24	0	2463	0 (1)	5	715 (5)	860 (6)	4128 (15)

[1] B = Blythe Solar Energy Center, H = Highlander II, S = Seville 1 and 2, RA = Reference A (desert habitat outside of Desert Sunlight), LT = Lake Tamarisk, CVSR = California Valley Solar Ranch, Mt. S = Mt. Signal 3; F = Solar Facility, R = Reference.

3.1. Species Richness and Community Association of Live Aquatic Habitat Birds at Photovoltaic Solar and Reference Areas

We examined patterns in the relative frequency of occurrence to determine whether aquatic habitat birds occurred more frequently at the PV solar site than at the paired reference area. For the sites in the desert/scrub habitat, we found that of the 8 aquatic habitat species observed during point counts, 4 species (50%) occurred more frequently in the reference areas than in the solar facilities. For the site in the agricultural habitat, we found that of the 11 aquatic habitat species observed during point counts, 6 species (55%) occurred more frequently in the reference areas than in the solar facility. Aquatic habitat birds were not observed during point counts at the solar facility area in the grassland ecoregion, and only a single species was observed in the reference area (tree swallow (*Tachycineta bicolor*)). We found no statistically significant difference ($\chi^2 = 0.0297$, $p = 0.8633$) in the distribution of aquatic habitat birds between facility and reference areas, accounting for habitat. The test result is consistent with the qualitative analysis of relative frequencies of aquatic habitat birds by habitat in that aquatic habitat bird species did not appear in higher relative frequency in facility areas compared with reference areas.

We examined patterns in species diversity and use to determine how the aquatic habitat bird community at PV solar facilities compares with a regional lake. Using Chao's [26,27] estimator, richness was estimated for live aquatic habitat birds to be highest at the lake (14.5, SD = 1.28; Table 3), which was 20.8% higher than the strata with the next highest richness estimate (agriculture reference, 12, SDE = 4.48; Table 3). The remaining strata where aquatic habitat birds were observed during point counts (agriculture facility, desert facility, desert reference, and grassland reference) had richness estimates between 1 and 7 for aquatic habitat species. However, 90% confidence intervals generally overlapped between all strata, and it was not clear whether there were any statistically significant differences in Chao's estimate between any two strata (Table 3). Among the strata with bird fatality detections, there was a high degree of variability (Table 4). The agriculture reference area had the highest Chao's estimate (21, SD = 13.46; Table 4), followed in rank by agriculture facility, desert facility, and grassland facility (no aquatic habitat birds were found during fatality monitoring in the grassland or desert reference areas). However, due to the small number of aquatic habitat birds detected during fatality monitoring, the standard deviation was large relative to richness estimates. The percent coefficient of variation (100 × estimate/standard deviation) was between 64% and 71% for the strata with more than one aquatic habitat bird fatality, and 90% confidence intervals were wide compared with the live bird data and largely overlapping for all strata (Table 4). We also qualitatively compared the mean avian use and fatality index of aquatic habitat birds within each stratum to account for differences in use, fatality rate, and effort associated with each site (Figure 2). The results were consistent, if not more pronounced than the comparison of species richness, with the lake showing an order of magnitude higher use by aquatic habitat species (10 observations/point/visit) compared with the next highest site, agriculture facility (0.75 observation/point/visit; Figure 3).

Table 3. Species richness and Chao's estimator of richness for aquatic habitat birds observed during live bird counts in 3 habitat regions and a lake. Birds unidentifiable to species were excluded from species richness calculations.

	Reference-Lake	Facility-Desert	Reference-Desert	Facility-Agriculture	Reference-Agriculture	Facility-Grassland	Reference-Grassland
Species richness	14	6	7	6	9	0	1
Chao's estimator	14.5	7.5	8	6	12	NA	1
Standard deviation	1.28	2.54	2.24	0.46	4.48	NA	0
90% Confidence interval	14.05–19.20	6.22–16.16	7.11–16.04	6–NA	9.51–26.81	NA	NA

NA = not applicable.

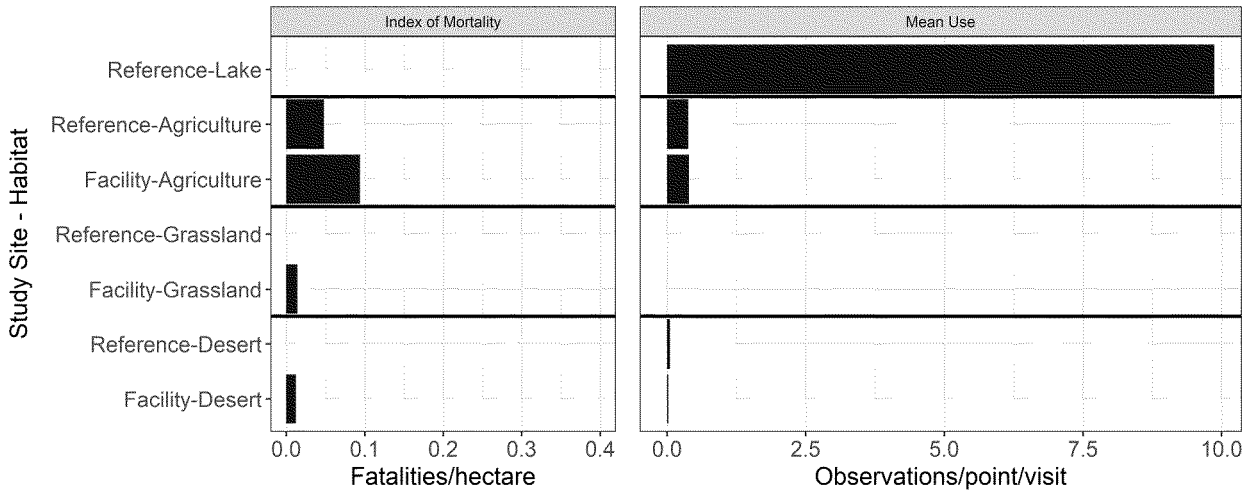

Figure 2. Index of mortality (found fatalities per hectare of area searched, adjusted for searcher efficiency) and mean use (live birds counted per point per survey visit) of aquatic habitat birds found at the facility and reference survey areas in 3 habitat regions and a lake (no fatality surveys occurred at the lake).

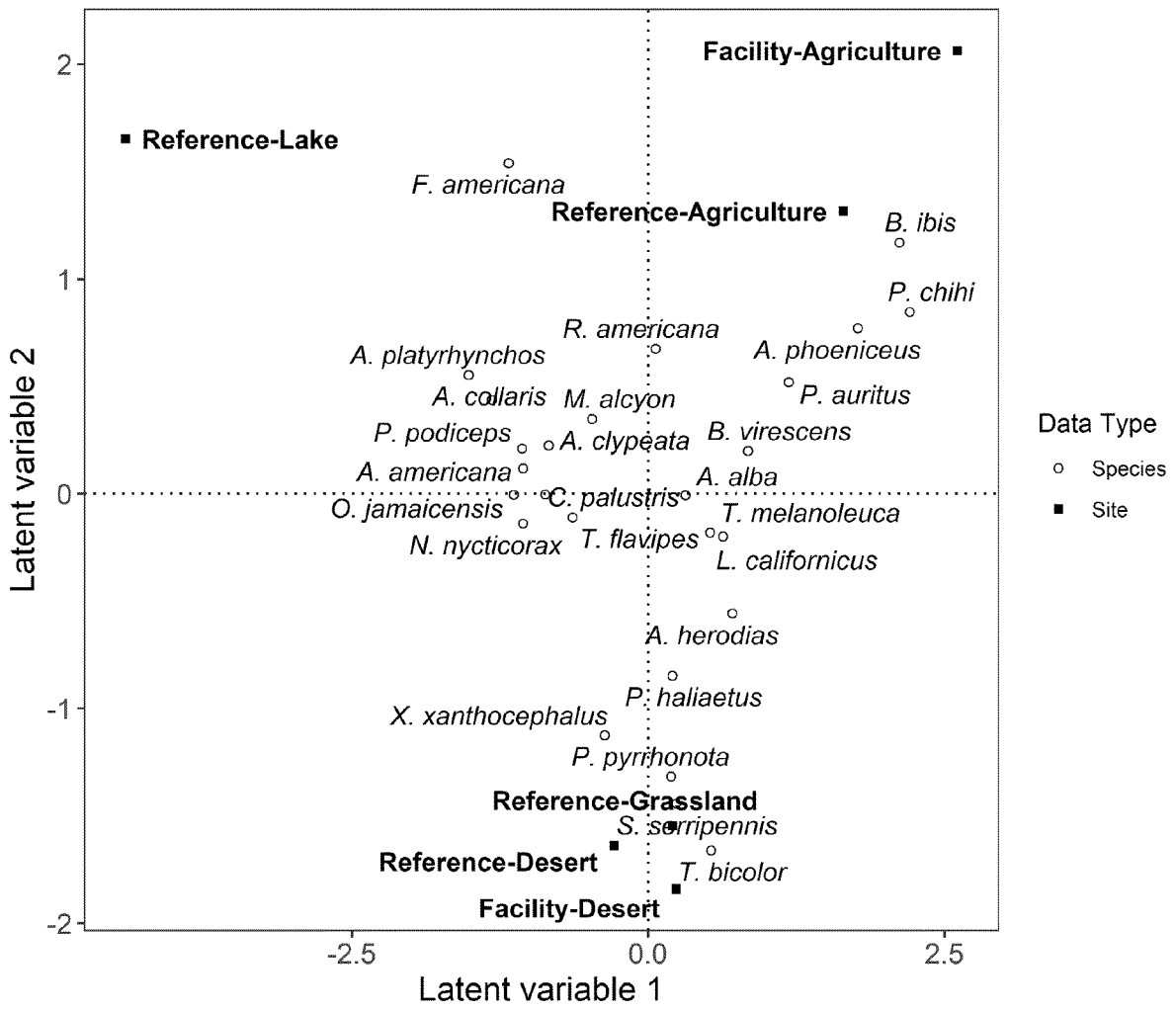

Figure 3. Ordination of aquatic habitat species observed during point count surveys and facility or reference areas in 3 habitat regions based on 2 latent variables in a Bayesian ordination and regression analysis. No aquatic habitat birds were observed in the facility-grassland stratum.

Table 4. Species richness and Chao's estimator of richness for aquatic habitat birds detected as fatalities at facility and reference survey areas in 3 habitat regions. Birds unidentifiable to species were excluded from species richness calculations.

	Facility-Desert	Reference-Desert	Facility-Agriculture	Reference-Agriculture	Facility-Grassland	Reference-Grassland
Species richness	3	0	5	6	1	0
Chao's estimator	6	NA	15	21	1	NA
Standard deviation	4.29	NA	10.04	13.46	0	NA
90% Confidence interval	3.53–20.00	NA	7.53–44.49	10.24–59.09	NA	NA

NA = not applicable.

Ordination of live bird data supported the separation of study sites into three groupings (Figure 3). The lake grouped away from all other combinations of habitat and facility/reference. The desert facility and reference areas grouped with the grassland reference area, and the agricultural areas grouped together. Heron, egret, and blackbird species also tended to group closer to the agricultural site, whereas grebes, coots (*Fulica* spp.), and ducks tended to group towards the lake and desert/grassland cluster to a lesser extent.

3.2. Mortality of Aquatic Habitat Birds at Photovoltaic Solar and Reference Areas

During the 2018 field season, we deployed 201 searcher efficiency trials across the sites (90 large bird trials and 111 small bird trials), including 87 trials in facility areas and 114 trials in reference areas (Supplementary Material Table S3). In 2019, we deployed 144 trials (78 large bird trials and 66 small bird trials), including 70 trials in facility areas and 74 trials in reference areas. No trials were placed at Blythe facility areas, which had an existing bias trial dataset resulting from over 2 years of standardized fatality monitoring (95 m row lengths), and Reference A given the proximity and similarity to Blythe reference areas. Furthermore, no trials could be placed in any area at the Mt. Signal site due to access restrictions. The ground conditions (e.g., amount of visible bare ground, presence of rubble or vegetation, typical vegetation height, and density when present) at Mt. Signal were more similar to Seville (facility and reference areas) than any other site monitored during the study. Thus, we assumed the probability of detection in the facility and reference areas of Mt. Signal would be comparable to Seville, and modeled searcher efficiency for Mt. Signal using the 2019 Seville data.

Searcher efficiency varied by study site and whether trials were in the facility or reference area. The best-fit model for 2018 facility areas was a half-normal detection function and included a covariate for study site (i.e., systematic differences in search efficiency by facility) for both small and large birds (Supplementary Material Table S4). The top model for reference areas in 2018 did not include any covariates (i.e., no systematic differences in search efficiency by facility) and was a half-normal detection function for large birds and a hazard detection function for small birds. In 2019, the best-fit model for facility areas included study site and was a uniform detection function for small birds, while the large bird model for facility did not include any covariates and used a half-normal detection function. In the reference areas, both small birds and large birds used an exponential detection function and included study site as a covariate.

Within the facility area and reference area of each study site, respectively, searcher efficiency was generally lower for small birds compared with large birds in each year (Figure 4). In 2018, average searcher efficiency in the facility areas ranged between 0.38 (SE = 0.03) and 0.69 (SE = 0.09) for small birds, and between 0.53 (SE = 0.03) and 1.0 (SE = 0) for large birds; average searcher efficiency in the reference areas ranged between 0.31 (SE = 0.12) and 0.41 (SE = 0.10) for small birds, and between 0.74 (SE = 0.14) and 0.92 for large birds. In 2019, average searcher efficiency in the facility areas ranged between 0.38 (SE = 0.12) and 0.72 (SE = 0.12) for small birds, and between 0.93 (SE = 0.05) and 0.98 (SE = 0.03) for large birds; average searcher efficiency in the reference areas ranged between

0.30 (SE = 0.10) and 0.76 (SE = 0.11) for small birds, and between 0.54 (SE = 0.11) and 0.75 (SE = 0.10) for large birds.

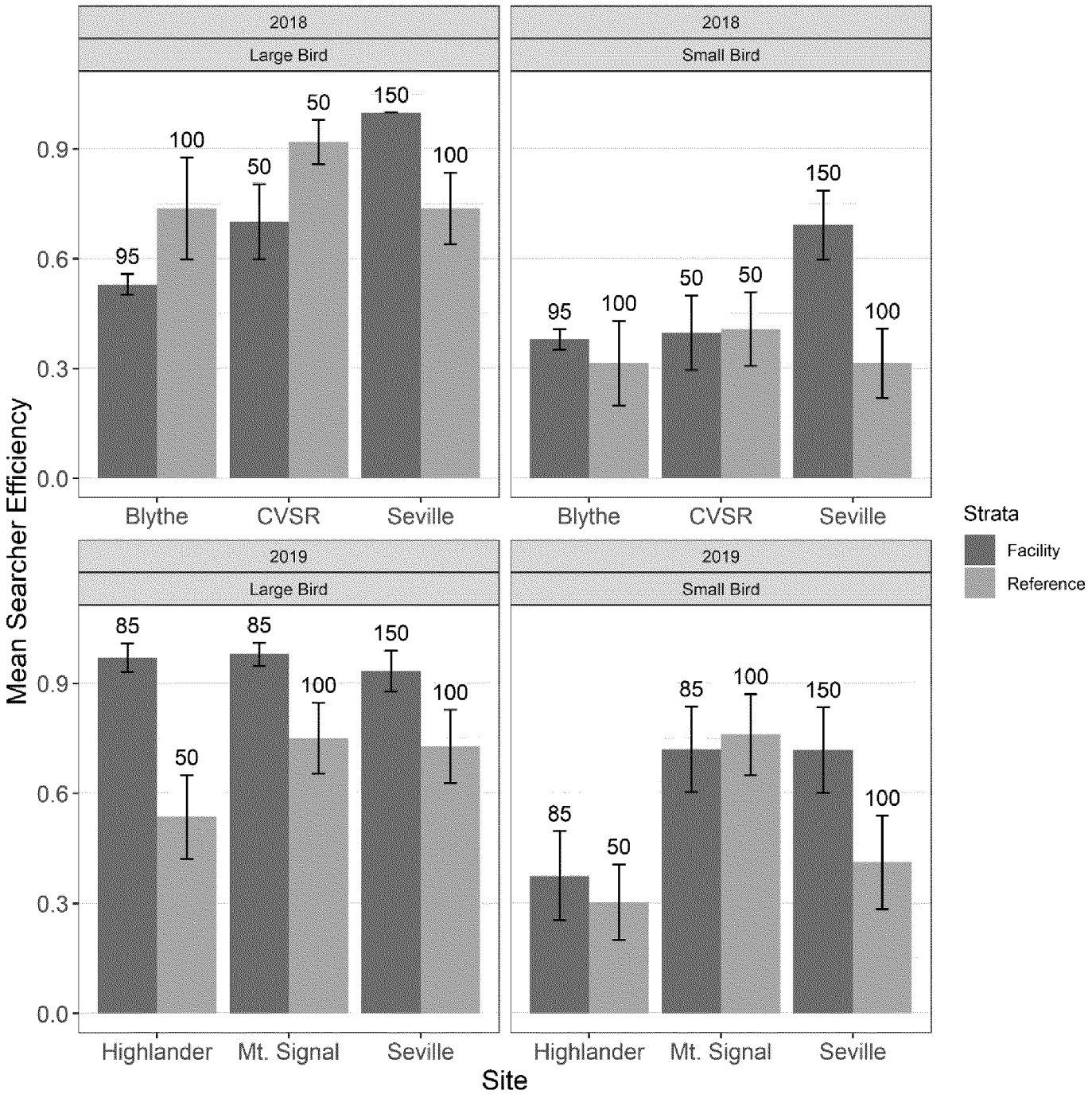

Figure 4. Mean searcher efficiency by bird size category and study site used to calculate the index of mortality. Viewshed sampling distance (in meters) is indicated above each column. Error bars show mean +/- one standard error.

There were 15 detections of aquatic habitat species across all study sites and years of study, ranging from 0 (6 of the 11 combinations of site and facility or reference) to 6 (Mt. Signal reference area). Given the small number of detections relative to total hectares surveyed, the fatality index for aquatic habitat species showed little variability within the 2-week study periods at each study site, ranging from 0 (grassland reference) to 0.09 fatalities/ha/study period (agriculture facility; Figure 2). Thus, fatalities were not

distinctly higher in the reference or facility areas of any site, accounting for differences in searcher efficiency by site and facility or reference area, and different amounts of total area searched.

4. Discussion

The LEH was developed from mortality patterns at PV USSE facilities, and researchers suggested that the PV facility provided a signal of water to aquatic habitat birds [3]. However, data gaps exist in our understanding of the LEH as live bird behavior at PV solar facilities had not been examined, nor had an alternative to the LEH been considered. Further, context for the number of carcasses detected is lacking as aquatic habitat bird mortality had never been evaluated against the bird community at a regional waterbody. We found that live aquatic habitat birds occurred at PV solar facilities, but we did not observe flocks approaching the solar sites exhibiting landing behavior. We found that aquatic habitat bird diversity was lower at PV USSE facilities compared with Lake Tamarisk, and standardized use was more than an order of magnitude higher at Lake Tamarisk than what we found at the PV USSE facilities. We did not locate aquatic habitat bird detections in the desert/scrub and grassland reference areas; thus, we did not find support for the alternative hypothesis that mortality is independent of the PV facility. Taken together, we cannot readily generalize the LEH to all aquatic habitat birds, and fatality risk could be species specific and context dependent.

If aquatic habitat birds are attracted to PV solar facilities across taxa, we would expect to find, in addition to fatality detections, live aquatic habitat birds approaching or perched at the facility. Our results show that aquatic habitat birds were infrequently observed at the desert/scrub and grassland study sites, and we found no evidence of the expression of maladaptive behaviors, such as landing attempts or flocks repeatedly circling a facility. Rather, our observations were of aquatic habitat birds transitioning the facility, and the same species were often observed in the paired reference area. As our study did not include nocturnal sampling using radar or other methods, we would not have detected birds moving outside of our sampling period. Some species of aquatic habitat birds found as detections in this study and in Kosciuch et al. [4] migrate nocturnally (e.g., [32]), and it is possible that aquatic habitat bird exposure at the PV facilities nocturnally was higher than we measured diurnally. However, species resolution is limited with radar, and interpreting patterns in the context of the LEH could be challenging. Thus, our point count results demonstrate limitations in understanding the extent of a potential lake effect when interpreting diurnal patterns of live aquatic habitat bird occurrences at PV solar facilities. Overall, diurnal point count surveys for aquatic habitat birds are unlikely to provide data to predict the number of fatalities of these species.

Mt. Signal, the PV solar facility and paired reference area in the agriculture habitat, differed from our other study sites having higher aquatic habitat bird diversity, use, and detections. Mt. Signal is developed in a landscape that has been altered by irrigation from the Salton Sea, where irrigation and farming have converted the agricultural habitat into a novel ecosystem with a high level of human disturbance and changes to the biota reflected in the bird community [33]. It follows that aquatic habitat bird use was higher in an irrigated landscape compared with a grassland and desert/scrub habitat; however, the mortality patterns at PV solar facilities in agricultural landscapes are poorly studied [4]. The adjusted fatalities/ha was similar between the facility and reference site for Mt. Signal, suggesting that mortality risk is not isolated to the solar facility. Thus, in the agricultural landscape context, it is difficult to untangle attraction (i.e., lake effect) from other sources of mortality (e.g., predation) for some species. Arid landscapes without water in close proximity to PV USSE facilities, such as our desert/scrub study sites, provide more inference into the LEH because possible attraction is obscured in agricultural landscapes, which can be hybrid or novel ecosystems inhabited by aquatic habitat birds.

The premise of the LEH is that PV USSE facilities attract aquatic habitat birds, but the magnitude of attraction has not been suggested, leaving a gap in our understanding of

how aquatic habitat bird abundance and diversity at a PV USSE facility compares with a natural waterbody. No aspect of the LEH limits the number of live or dead aquatic habitat birds that could occur at a PV solar facility, and the expression of maladaptive behaviors could lead to exaggerated patterns (e.g., [34]). The major waterbody in the vicinity of the study sites in the desert/scrub and agricultural habitat is the Salton Sea, an approximately 89,000 ha saline lake that is a known stopover location for hundreds of thousands of aquatic habitat birds [35]. As none of our PV USSE sites approached the size of the Salton Sea, we surveyed Lake Tamarisk, a 5.5 ha artificial lake in a desert community, and counted thousands of birds over our sampling period, showing the importance of waterbodies in this arid environment. Lake Tamarisk grouped away from the solar facilities and paired reference areas in the multivariate analysis and had 25–800 times the abundance of aquatic habitat birds compared with the PV USSE sites, including the site in the agricultural habitat where aquatic habitat birds were part of the local bird community. Our surveys at Lake Tamarisk included birds that were foraging or loafing on the lake, which is not possible at a PV USSE facility. Thus, it follows that mean use was higher at Lake Tamarisk than at the PV USSE facilities. However, understanding the regional aquatic habitat bird community at a waterbody is important for research questions related to the magnitude of the LEH and predicting aquatic habitat bird occurrence. Although waterbodies are scarce in the desert/scrub habitat near our study sites, had we surveyed a different lake, the results would likely have differed. However, our sample of one lake in a water-limited environment does not alter our conclusions about context for understanding the potential availability of birds that could occur at PV solar facilities in our study.

Developing alternatives to a hypothesis established through abduction is important so that the original hypothesis is not accepted by default [36,37]. An alternative hypothesis to the LEH is that ill or exhausted birds land randomly on a landscape, including PV USSE facilities. Thus, under a random landing hypothesis, an aquatic habitat bird detection would be equally likely to occur outside of a PV USSE facility as inside a facility. Given that there was no reference area monitoring associated with 9 of 10 PV USSE sites summarized by Kosciuch et al. [4], it is possible that broader patterns of mortality were not detected because of the survey methods used in those studies. The occurrence of water-obligate species, such as loons and grebes, on dry land away from water is maladaptive because these species become stranded and ultimately perish on dry land [38]. Thus, there is no evolutionary context for a common loon (*Gavia immer*, a species detected as a fatality at our Seville study site) to occur in the desert on dry land. The presence of aquatic habitat bird detections found at PV USSE facilities in a desert/scrub habitat provides the most compelling evidence that these individuals were attracted to the facility because fatalities were not found in the paired reference areas. We found no aquatic habitat bird detections in Reference A, which was located outside of Desert Sunlight, the site in Kosciuch et al. [4] that had the highest number (n = 94 detections over 2 full years of monitoring) and proportion of aquatic bird detections among PV arrays among the 10 sites summarized. Thus, if a mechanism other than attraction was responsible for aquatic habitat bird detections at PV solar facilities (e.g., exhaustion and random landing), we would have expected to find aquatic habitat bird detections in Reference A, assuming detections continued in the facility.

We found aquatic habitat bird detections at all PV facilities and in the agricultural site reference area, but not at reference areas in a desert/scrub or grassland habitat. Searcher efficiency was similar at the PV facilities and reference areas with three exceptions where the value at the reference area was approximately half that at the paired PV facility. Large difference in searcher efficiency between PV facility and reference area could limit our conclusions about mortality patterns. However, we searched a larger area at the reference areas and accounted for these differences in the fatality index. Although we did not perform carcass persistence trials as is common for fatality-monitoring studies, our goal was not to produce robust estimates of fatalities as summarized in Kosciuch et al. [4]—rather, it was to have a high likelihood of detecting aquatic habitat species as fatalities, were they to occur. Furthermore, we assumed carcass persistence was similar in facility and reference areas,

and the frequency of searches (<48 h apart) would limit potential bias from different rates of carcass removal by scavengers in either area.

5. Conclusions

The idea of "lake effect" in which birds perceive a PV USSE facility as a waterbody (or the facility creates a lake effect) and are attracted is likely a nuanced process as a PV solar facility is unlikely to provide a signal of a lake to all aquatic habitat birds at all times. The results from our study suggest that some species of aquatic habitat birds could be attracted to PV USSE facilities, and if attraction occurs, it is likely context dependent. The most compelling evidence for attraction is the mortality of water-obligate species (e.g., loons) found at PV USSE facilities in desert environments that lack water, as these species perish on dry land. Untangling mortality at PV solar facilities in landscapes with other anthropogenic features is challenging for many species because of the potential for facility-independent mortality (i.e., background mortality). Data from Lake Tamarisk suggested that mortality at the PV USSE facilities was low compared with the abundance and diversity of birds regionally. However, our sampling methods did not measure nocturnal exposure; thus, if aquatic habitat birds were moving nocturnally, we would have underestimated site-specific exposure. Our study shows that a primary limitation of predicting whether aquatic habitat bird mortality will occur is that the causal mechanism is not understood, which could involve complex interactions of the species and the facility. Thus, understanding potential risk at future PV USSE facilities is currently best informed by the regional context of the facility, as suggested by Kosciuch et al. [4]. However, it is unknown how other landscape contexts outside of our study region and the availability of natural waterbodies will influence aquatic habitat bird behavior at PV USSE facilities.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/d13110524/s1: Table S1: Number of fixed-point locations at solar facilities and reference areas by site, Table S2: Viewshed (meters) used for fatality monitoring with the solar field and in reference areas, and total survey area (hectares) at 5 study sites over 2 years, Table S3: Number of searcher efficiency trials deployed by site, strata type, bird size category, and year, Table S4: Candidate searcher efficiency models, AICc, ΔAIC, and selected models for estimating searcher efficiency for small birds and large birds and fatality transects in the facility and reference areas, by year.

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RESEARCH ARTICLE

Numbers of wildlife fatalities at renewable energy facilities in a targeted development region

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Abstract

Increased interest in renewable energy has fostered development of wind and solar energy facilities globally. However, energy development sometimes has negative environmental impacts, such as wildlife fatalities. Efforts by regional land managers to balance energy potential while minimizing fatality risk currently rely on datasets that are aggregated at continental, but not regional scales, that focus on single species, or that implement meta-analyses that inappropriately use inferential statistics. We compiled and summarized fatality data from 87 reports for solar and wind facilities in the Mojave and Sonoran Deserts region of southern California within the Desert Renewable Energy Conservation Plan area. Our goal was to evaluate potential temporal and guild-specific patterns in fatalities, especially for priority species of conservation concern. We also aimed to provide a perspective on approaches interpreting these types of data, given inherent limitations in how they were collected. Mourning doves (*Zenaida macroura*), Chukar (*Alectoris chukar*) and California Quail (*Callipepla californica*), and passerines (*Passeriformes*), accounted for the most commonly reported fatalities. However, our aggregated count data were derived from raw, uncorrected totals, and thus reflect an absolute minimum number of fatalities for the monitored period. Additionally, patterns in the raw data suggested that many species commonly documented as fatalities (e.g., waterbirds and other nocturnal migrants, bats) are rarely counted during typical pre-construction use surveys. This may explain the more commonly observed mismatch between pre-construction risk assessment and actual fatalities. Our work may serve to guide design of future scientific research to address temporal and spatial patterns in fatalities and to apply rigorous guild-specific survey methodologies to estimate populations at risk from renewable energy development.

Introduction

Increased interest in renewable energy as a tool to address climate change and meet growing demand of the global energy market has fostered rapid development of wind and solar energy

decision to publish, or preparation of the manuscript.

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facilities both in the United States and around the world. As a result, renewable energy development is rapidly expanding to meet increased demand without increasing CO_2 emissions. Since 2009 in the U.S.A., growth rates of installed capacity of utility-scale wind and solar energy exceed 300% and 9400% respectively [1–3].

Renewable energy development often results in some level of negative environmental impact, notably habitat loss and fragmentation, along with fatalities of birds and bats [4–6]. These fatalities are largely believed to be caused by collisions with turbines, photovoltaic panels, and heliostat solar reflectors, or other facility infrastructure (e.g., perimeter fences, gen-tie and associated transmission lines). However, birds may also be killed at solar facilities by unintentional grounding or singeing from the concentrated beams of sunlight at CSP power towers, and both birds and bats have been documented drowned in wastewater evaporation ponds found at concentrated solar power (CSP) facilities or been inadvertently trapped in facility buildings and equipment [7–12]. Consequently, there is substantial interest in finding tools to balance the competing interests of maximizing energy production potential and minimizing fatality risk to both local and migratory wildlife species. To do this though, first, developers and land management agencies need to identify the potential avian and bat species at risk and the numbers of individuals of each species found dead at these facilities.

Current research to describe impacts of renewable energy on wildlife often focuses either on single species or taxa (e.g., [13–15]) or on meta-analyses that summarize and analyze fatality estimates generated across a suite of individual environmental reports or datasets [7, 10, 16, 17]. Alternatively, they may rely on pre-construction risk assessment use surveys to estimate fatality risk at a given location [18, 19]. However, there are limitations to inference from these approaches [12]. For example, these assessments are biased towards facilities with publicly available data or where authors have sole access to confidential reports. In fact, none of these published meta-analyses that summarized data from environmental reports from wind or solar facilities have either systematically or randomly sampled the facilities that were included in analyses. As a consequence, even the most complete compendia [e.g., 7, 16] omit many reports that are not publicly available and, thus, the level of inference of their analyses is constrained. Similarly, the field survey techniques used to generate fatality data often are inconsistent among reports or facilities. As such, use of inferential statistics to estimate pooled fatality rates is problematic [20, 21]. Additionally, pre-construction surveys are often designed to meet state or federal monitoring guidelines or requirements (e.g. Environmental Impact Reviews (EIR) or Statements (EIS)), rather than defined research objectives, and surveys may be limited to focal species groups (e.g. raptors) or be spatially or temporally limited (e.g., breeding season point counts), all factors that can reduce the applicability of pre-construction monitoring data to assess post-construction fatality risk [18, 22]. Finally, meta-analyses often group species into broad categories (e.g., raptors, waterbirds, passerines), may ignore some taxa altogether (e.g., bats) and do not identify individual facilities. This approach is a useful data visualization tool for pooled data, but it can obscure important temporal, spatial, and taxon- or species-specific patterns of substantial interest, especially for threatened or endangered species.

Within the U.S.A., regional land managers and regulators are tasked to use the "best available science" to make permitting and mitigation decisions for renewable energy facilities [23]. However, the substantial limitations of existing studies and reports as outlined above can obscure that science. In particular, existing data on wildlife fatalities at renewable energy facilities within regions are rarely consolidated into a single data repository and may be available only as difficult-to-interpret single-species studies, large meta-analyses, consultant reports, or a widely dispersed set of datasheets reported to multiple agencies by wildlife consultants.

The objective of this study was to address this problem by compiling and summarizing data on fatalities from renewable energy facilities in one region of the U.S.A. that is a focus for

renewable energy development. We evaluated fatality data from parts of the Mojave and Sonoran Deserts of southern California that are within the Desert Renewable Energy Conservation Plan (DRECP) area [24]. Our goals were (1) to quantify numbers of fatalities of birds and bats counted at renewable energy facilities in the vicinity of the DRECP, (2) to examine the dataset to identify potential temporal and taxonomic-specific patterns in fatalities, especially for priority species of conservation concern, and (3) given the variability and inconsistency among strategies and availability of reports, to provide a perspective on interpreting these fatality data and the caveats that might accompany those interpretations. By presenting trends in the raw data, we hope to broadly describe an appropriate frame of reference for inference about numbers of species-specific fatalities at these facilities and to provide a starting point for subsequent studies with robust experimental design that can lead to stronger inference.

Materials and methods

Study area

The DRECP was approved in 2016 by the California Energy Commission (CEC), California Department of Fish and Wildlife (CDFW), Bureau of Land Management (BLM), and U.S. Fish and Wildlife Service (FWS) to identify areas in the region that may be appropriate for utility-scale renewable energy development, to facilitate the application process for renewables, and to manage long-term conservation in the region. Land cover in the Mojave desert is scrub dominated by creosote bush (*Larrea tridentata*), Joshua tree (*Yucca brevifolia*), and number of cactus and succulent plants adapted to desert habitat. Land cover in the Sonoran Desert is typified by cacti, especially saguaro (*Carnegiea gigantea*) and cholla (*Cylindropuntia spp.*), but also includes species found in the Mojave desert. Topography in both habitats is rugged with steep mountains and hillsides punctuated by alluvial flats. The climate in both regions is exceptionally arid, although the Sonoran desert is unique in having two seasonal monsoons [25]. The DRECP is a focus for renewable energy development and there is substantial management interest in understanding potential impacts to wildlife from this development. As such, post-construction monitoring is more regular in the DRECP than in many other regions of the USA, making it a good site for the evaluation we performed here.

Data collection and analyses

We use three methods to obtain data on fatalities at renewable energy facilities within the DRECP boundary for the time period ranging from the first installation of wind turbines in the Tehachapi Pass in the early 1980s through December 2019. First, we used online search engines to search the internet for environmental reports that had been posted online. Second, we searched publicly available document collections and California-specific public databases (e.g., American Wind Wildlife Institute documents library (https://awwic.nacse.org/), California Energy Commission) to identify environmental reports they contained. Finally, we queried databases at federal, state, and county-level agencies for environmental reports not collected in our other searches. We focused especially on gathering unpublished environmental reports, usually by consultants (hereafter, "consultant reports"), containing wildlife survey data from proposed and operational wind and solar energy facilities located within or closely adjacent (<20km) to the DRECP boundary. Many of the reports published prior to 2018 we accessed have also been summarized in a previous review of the effects of renewable energy on birds and bats [12]. We also searched the sources listed above for data available from peer-reviewed published literature that included species-specific fatality totals that were not reported elsewhere.

As part of our third search method outlined above, we included consultant reports provided to FWS and BLM, as well as raw data for fatalities and injured birds found incidentally or during systematic surveys provided in the form of spreadsheets required under Special Purpose Utility Permits (SPUT) issued to energy facilities (hereafter, "SPUT reports"). These permits authorized the electrical utilities to collect and temporarily possess migratory bird carcasses found at facilities. SPUT reports are only required to document avian fatalities, not bats. However, if the authors voluntarily included bat fatalities in their report, we included those numbers in our subsequent data summary. All data were from facilities located on public lands, primarily BLM administered lands.

For each consultant or SPUT report, we documented the facility name, energy source and technology type (e.g., wind, solar photovoltaic (PV), concentrating solar power (CSP) parabolic troughs, CSP power tower) and the construction periods (pre- or post- construction). We also summarized the start and end dates of the surveys, the type of survey data collected (e.g., fatality surveys, incidental reporting), and details of the survey methodologies. Finally, we recorded detections of wildlife fatalities, their date, and, where noted, the type of infrastructure with which the fatality was associated (e.g., sometimes fatalities are associated with buildings, fences, or power lines at facilities, rather than the electrical generating infrastructure itself). Although we collected data on both fatalities and injured birds and bats, our subsequent analyses only included individuals found dead, or who later died as a result of their initial injuries.

In some cases, data were summarized across seasons or annual reporting periods and were thus not suitable for subsequent within-season or period analysis. Some facilities had multiple reports for overlapping periods of time (e.g., we obtained both annual and monthly summary reports for the same year). To avoid double-sampling, we excluded those reports that spanned the shorter monitoring periods. Additionally, sometimes the monitoring dates and associated raw fatality data available in SPUT reports overlapped the time period for a given consultant report. In those cases, we preferred to use the individual observations available in the SPUT data, as they tended to have more precise temporal information than did the consultant reports (i.e., they usually specify the date and location for each individual carcass, whereas the consultant reports typically aggregate data across periods or taxa).

We compiled the numbers of raw "uncorrected" fatalities documented in consultant and SPUT reports into summary tables by energy type (e.g., solar or wind), with fatality totals grouped by species and summed by individual years, across all years monitored, and at each energy facility. These raw fatality totals were not adjusted for factors such as searcher efficiency or carcass persistence that can negatively influence detection probabilities [20] We also calculated the proportion of total fatalities comprised by each species or species group. We summarized these annual fatality totals in an uncorrected manner (e.g., totals were not weighted by search frequency or seasonal differences in survey effort) across all monitoring periods with available data. Our subsequent analyses focused on the uncorrected fatality survey totals for a number of federal and state-listed species of conservation priority (hereafter "focal species"). In the DRECP, these were willow flycatcher (*Empidonax traillii*), least Bell's vireo (*Vireo bellii pusillus*), bank swallow (*Riparia riparia*), western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), Gila woodpecker (*Melanerpes uropygialis*), northern flicker (*Colaptes auratus*), burrowing owl (*Athene cunicularia*), and Swainson's hawk (*Buteo swainsoni*). We also summarized cumulative fatality totals for several focal species groups that can be difficult to differentiate in remains, including rails (*Rallidae*), thrashers (*Mimidae*), and warblers (*Parulidae*). Finally, in addition to fatality summary tables, we summarized data in the SPUT reports by month to evaluate temporal patterns of fatalities. We did not include the consultant reports in

these monthly summaries because those reports only sometimes contained temporal data at the scale needed for this analysis.

While these reports typically are designed to meet guidelines or requirements of state and federal environmental reviews (e.g., environmental impact statements or reviews; EIS or EIR), they seldom implement experimental study designs, thereby restricting the inferences across facilities [12]. For example, most consultant reports with fatality monitoring data calculated an index of fatalities relative to nameplate capacity of a given facility (i.e., fatalities/MW) to standardize rates relative to other locations. However, this metric does not necessarily account for variation in mortality rates resulting from factors such as season, geographic region, turbine characteristics (e.g., rotor-swept area, hub height, blade length), turbine operational status (e.g., curtailment periods, non-operational (broken) turbines, rotations per minute) [26], technology type (e.g., Solar PV, CSP parabolic trough, CSP Power Tower, Wind), or variation in survey efforts (e.g., size of search area, frequency of searches, use of detection dogs versus human searchers whether or not surveys accounted for detection probability). Additionally, adjusted fatality estimates that accounted for survey biases in searcher efficiency or carcass persistence in the landscape were commonly calculated only for broad taxonomic groupings (e.g., passerines, water-associated birds, bats) or size categories (e.g., small birds, medium birds, large birds), rather than for individual species, limiting our ability to compare species-specific fatality estimates among facilities. Furthermore, some facilities in our dataset only reported incidental observations. As such, to gain the broadest inference from all documented fatalities, we ignored corrections for survey bias, and we report raw totals to represent the minimum number of fatalities at a given location. This is because it would be misleading and statistically inappropriate to apply inferential statistics to the cumulative dataset of fatality estimates or likewise to directly interpret data patterns across facilities for data of varying rigor. However, although these minimum totals may not be fully equivalent across facilities due to methodological differences such as sampling duration or survey effort, these pooled data can still provide general information about species detected as fatalities, temporal patterns, and fatalities among types of renewable energy.

Results

We obtained 87 consultant reports and, after excluding duplicated datasets, we evaluated information from 64 reports on fatality surveys at 18 facilities (11 wind, 7 solar) conducted between 1996 and 2019. In these reports there were documented 262 species or species groups and 4757 fatalities that were not listed in SPUT reports. We also considered data in SPUT reports from 10 facilities (3 wind, 7 solar), including 3 (2 solar, 1 wind) for which there were no available consultant reports (Tables 1 and S1 and S2 and Fig 1 and S1 Text). In the SPUT reports (S1 and S2 Tables) there were 3326 documented fatalities from 223 species or species groups. Some, but not all, of these data in SPUT reports were originally mentioned in the consultant reports. Data in these reports are provided in the Supporting Information (S1 and S2 Tables).

Data were collected in all months of the year, but only 76% of the facilities conducted mortality surveys for 12 continuous months (Table 1). Additionally, 33% ($n = 7$) of these facilities conducted surveys in the same month more than once, while 4 other facilities compiled reports for multiple years, but solely documented fatalities discovered incidentally, rather than during systematic surveys. For facilities from which SPUT reports were available, nearly all (90% or 9 facilities and 3326 observations) reported fatalities across multiple years, although these observations included both survey and incidentally found carcasses.

Table 1. Availability of fatality data from unpublished reports or SPUT datasheets by energy facility.

			Report	SPUT
Facility	**Type**	**County**	**Monitoring Dates**	**Monitoring Dates**
Solar				
IMP_1	PV	Imperial	6–10/2016	--
IMP_2	PV	Imperial	10/2014–9/2016	--
RIV_1	PV	Riverside	3-5/2016	1/2016–12/2019
RIV_2	PV	Riverside	8/2011–10/2014	9/2011–12/2019
RIV_3	CSP Trough	Riverside	3/2015–2/2017	3/2015–12/2019
RIV_4	PV	Riverside	--	3/2016–4/2019
SBD_1	PV	San Bernardino	--	4/2014–12/2019
SBD_2	CSP Tower	San Bernardino	11/2013–10/2015	11/2011–7/ 2018
SBD_3	CSP Trough	San Bernardino	10/2013–10/2015, 3/2016	10/2013–12/2019
Wind				
IMP_3	HAT	Imperial	3/2018–3/2019	1/2013–12/2015
KER_1	HAT	Kern	6/2009–5/2010	--
KER_2	HAT	Kern	3/2011–5/2019	--
KER_3	HAT	Kern	3/2013–2/2015	--
KER_4	HAT	Kern	1/2013–1/2017	--
KER_5	HAT	Kern	--	1/2015–12/2015
KER_6	HAT	Kern	6/2009–6/2010, 8/2011–6/2013	1/2017–12/2019
Tehachapi	HAT	Kern	10/1996–5/1998	--
RIV_5	HAT	Riverside	3/2008–3/2009	--
RIV_6	HAT	Riverside	8/1995–8/2000, 8/2009–8/2014	--
San Gorgonio	HAT	Riverside	3/1997–5/1998	--
SD_1	HAT	San Diego	1/2006–1/2007	--

Facilities are codes by county, types are solar photovoltaic (PV), concentrating solar power trough or tower (CSP Trough or Tower), and wind turbines, which were solely horizontal axis turbine (HAT). Data could be available either as a consultant report (Report) or a spreadsheet in a Special Purpose Utility Taking Permit (SPUT). "Monitoring Dates" indicates whether or not that data type was available, and dates are given as month/year.

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Trends in fatalities of birds and bats at DRECP solar facilities

The species most commonly reported as found dead at solar facilities was mourning dove (*Zenaida macroura*; *n* = 355 carcasses; S1 Table). Yellow-rumped (*n* = 256; *Setophaga coronate*) and yellow warblers (*n* = 180; *Setophaga petechia)* were the next most commonly found species. Brown-headed cowbird (*n* = 155; *Molothrus ater*), eared grebe (*n* = 153; *Podiceps nigricollis*), white-crowned sparrow (n = 137; *Zonotrichia leucophrys*), Wilson's warbler (*n* = 133; *Cardellina pusilla*), greater roadrunners (*n* = 126; *Geococcyx californianus*) and American coot (*n* = 124; *Fulica americana*) were the next most common species identified. Considering both SPUT and consultant reports together, passerines accounted for nearly 30% of all reported species and 60% of all uncorrected observations (*n* = 3522 passerines) (S1 Table). However, these data were dominated by a few families (Fig 2), primarily warblers (*n* = 905; *Parulidae*) and sparrows (*n* = 638; *Passerellidae*), blackbirds (*n* = 386; *Icteridae*), and swallows (*n* = 371; *Hirundinidae*). Large numbers of carcasses were reported as being of unknown species (n = 12 76; 22%), including 194 classified only as "unknown bird".

Individual focal species and one focal group (thrashers) were rarely reported found at solar facilities (again considering both types of reports; S1 Table). The most common of these were northern flicker (*n* = 22 carcasses), burrowing owl (*n* = 11), bank swallow (*n* = 9), and Crissal

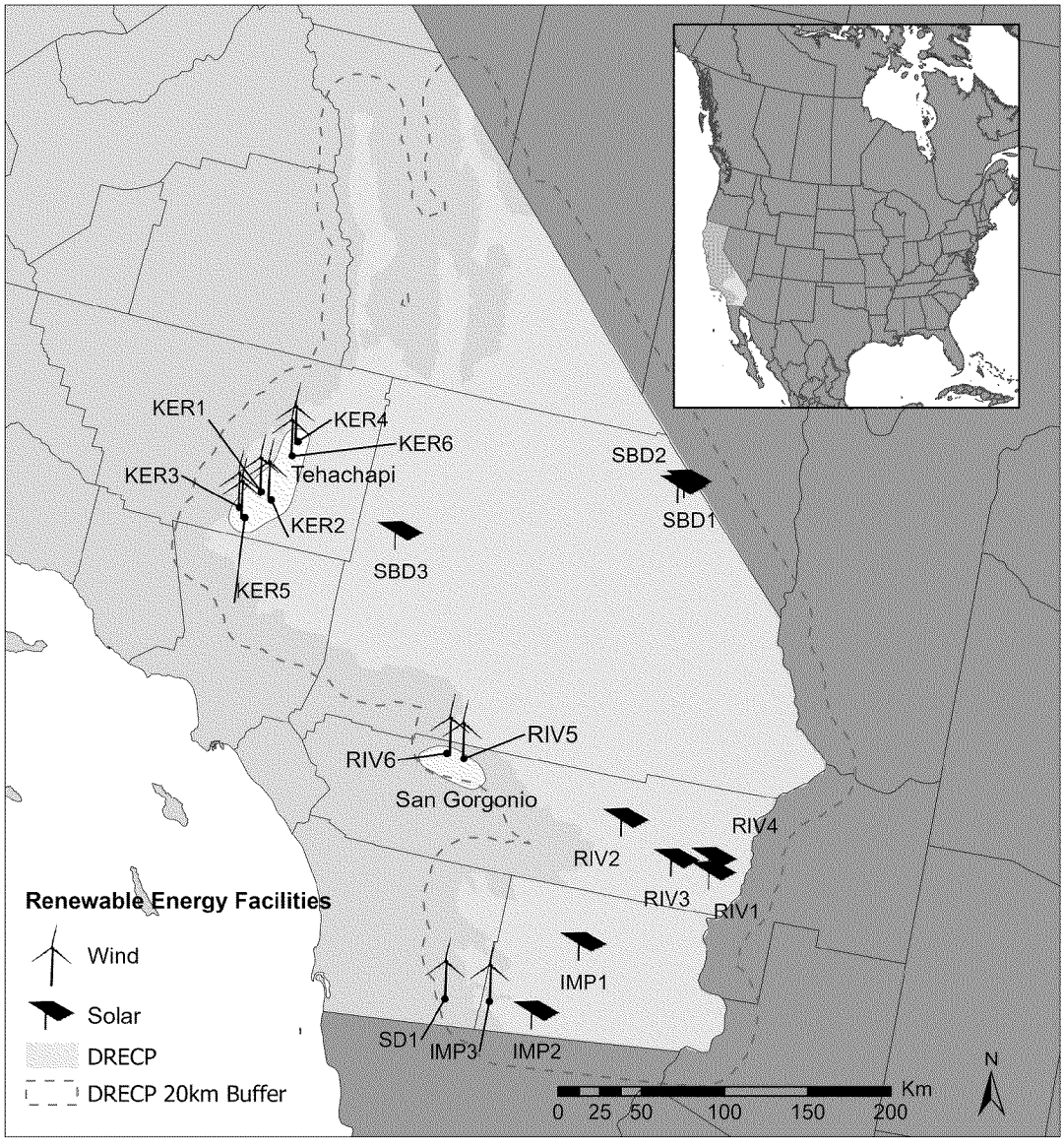

Fig 1. Location of wind and solar facilities used to assess results from fatality surveys at facilities within and in close proximity to the Desert Renewable Energy Conservation Plan Area ("DRECP" in blue) in California, U.S.A. (in yellow). Facilities are given names that show the county in which they are located (e.g., KER1 is in Kern County, SBD1 is in San Bernardino County, RIV1 is in Riverside County, IMP1 is in Imperial County, and SD1 is in San Diego County). Also shown in white are the locations of the Tehachapi and San Gorgonio Wind Resource areas. Basemap made with Natural Earth (www.naturalearthdata.com). DRECP boundary obtained from https://drecp.databasin.org/datasets/b1eb4709a1eb4f6db1dfe7dd5479f6c9/[24].

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thrasher (n = 3; *Toxostoma crissale*). However, there were large numbers of grebes and rails, as noted above, as well as 77 sora (*Porzana carolina*) and 14 common gallinules (*Gallinula galeata*). Likewise, as noted above, warblers were reported in very large numbers; these totals include a large number of unknown warbler species (n = 94), and >15 fatalities of six other warbler species. Interestingly, the warblers and hummingbirds were more commonly found at the single CSP facility, and the waterbirds were more commonly found at the PV and solar trough facilities (Fig 2).

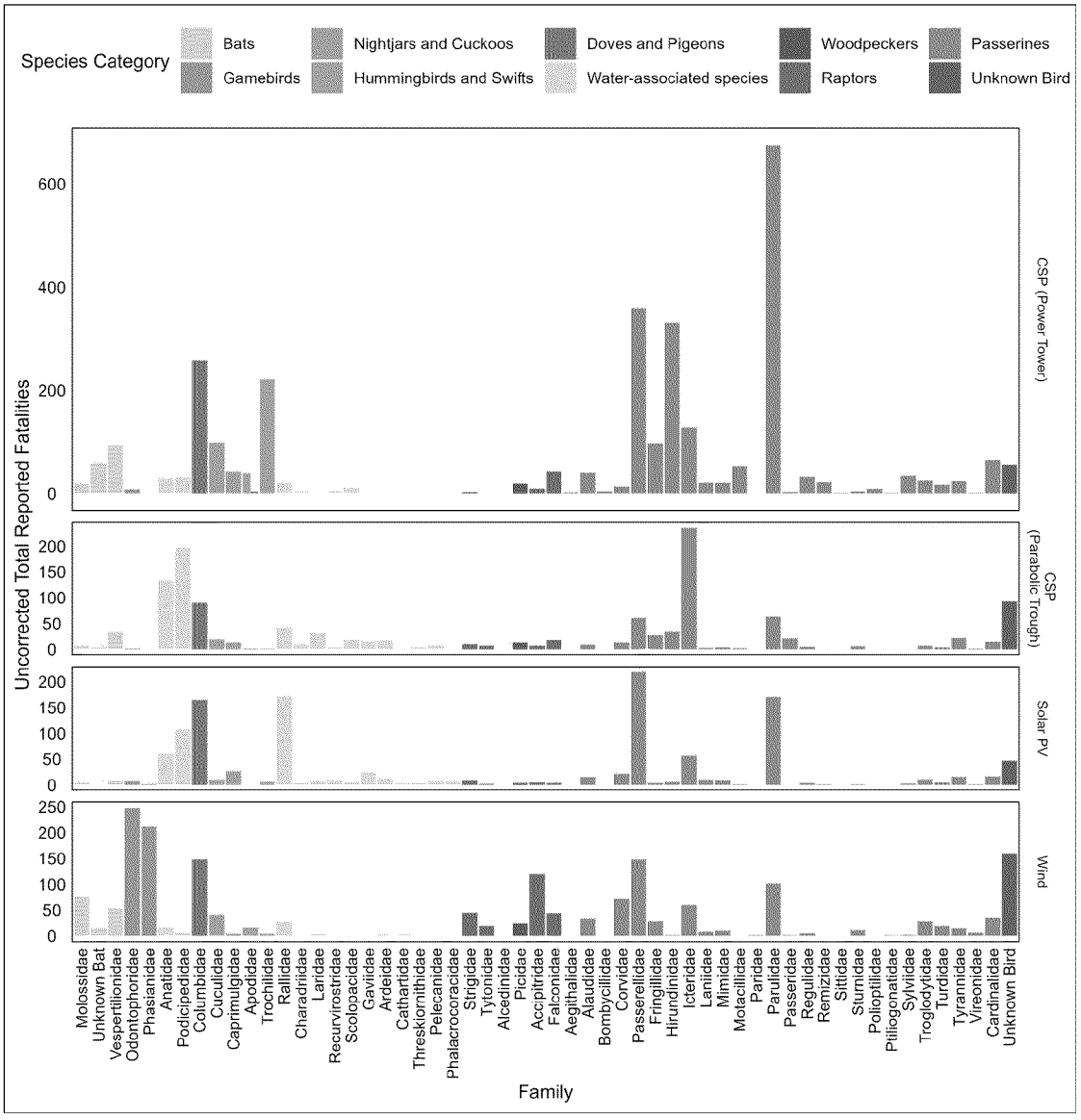

Fig 2. Total raw, uncorrected counts of bird or bat carcasses (n = 8054; grouped by taxonomic family), documented in consultant and SPUT reports from renewable energy facilities in the Desert Renewable Energy Conservation Plan Area. Plots are by facility subtype (e.g., Solar PV, Concentrating Solar Power (CSP) parabolic trough, CSP Power Tower, and Wind). Plot color is indicative of the broad species groups commonly used in meta-analyses (e.g., [7, 16]) that merge multiple Orders and Families.

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Bats were also rarely reported found at solar facilities (n = 149), with Canyon Bats (*Parastrellus hesperus*) accounting for 26% (n = 39) of these carcasses. However, in some cases, reports only documented avian fatalities or did not identify bat fatalities to species. In addition, SPUT reports are only required to document avian fatalities, so these totals reflect a minimum number of bats found at solar facilities.

Trends in fatalities of birds and bats at DRECP wind facilities

California quail (*n* = 236; *Callipepla californica*) and chukar (*n* = 212; *Alectoris chukar*) were the most common species reported dead in both types of reports from wind facilities (S2

Table). At an order level, Passeriformes (n = 725) and Galliformes (n = 460) comprised 58% of documented bird fatalities (n = 2043; Fig 3). Beyond the many carcasses that could not be identified, other common species found dead included mourning dove (n = 89) and red-tailed hawk (n = 79; *Buteo jamaicensis*), western meadowlark (n = 50; *Sturnella neglecta*), rock pigeon (n = 50; *Columba livia*), dark-eyed junco (n = 45; *Junco hyemalis*), and greater roadrunner (n = 41).

Only three focal species and one species from a focal group (i.e., thrashers) were found dead more than twice at wind facilities. These included northern flicker (n = 21), burrowing owl (n = 5), ash-throated flycatcher (n = 3; *Myiarchus cinerascens*), California thrasher (n = 7; *Toxostoma redivivum*). There were no focal rails found dead at wind facilities (Figs 2 and 3). American Coot (n = 25; *Fulica americana*) and Sora (n = 3; *Porzana carolina*) and other water-associated species (n = 34; e.g., Podicipediformes, Anseriformes, Gruiformes, Gaviiformes) accounted for only 3% of total reported fatalities. Among passerine families, sparrows (n = *146*) and warblers (n = 102) were more commonly found at wind facilities than other groups. The most frequently found warblers included yellow-rumped (n = 19), Wilson's (n = 18), and orange-crowned (n = 13; *Leiothlypis celata*) warblers. Additionally, bat fatalities accounted for nearly 7% (n = 142) of the overall documented fatalities at wind facilities, with the most common species including Mexican free-tailed bats (n = 47; *Tadarida brasilensis*) and Hoary bats (n = 37; *Lasiurus cinereus*).

Temporal patterns in fatalities at renewable facilities within the DRECP

Considering only data in SPUT reports, bird and bat fatalities were reported across all months at both wind and solar facilities. However, most incidents occurred during migration periods, especially at solar facilities, with nearly half of fatalities (48%; n = 1580) reported during fall (September-November). That said, temporal patterns varied by Order and broad species groups (Fig 3). For example, migrant waterbirds (e.g., Podicipediformes, Anseriformes, Gruiformes, Gaviiformes) and passerines (Passeriformes) were predominantly found during migration periods, while fatalities of raptors (e.g., Falconiformes, Strigiformes) occurred across all seasons. In contrast, fatalities of Caprimulgiformes primarily occurred during the summer breeding season. For the limited SPUT-reported bat fatalities (n = *33*), most incidents at wind facilities occurred during fall migration involving migratory species (e.g., Mexican Free-tailed bats), whereas incidents at solar facilities were primarily resident bat species (e.g., Canyon bats).

Discussion

The data in these reports are, to our knowledge, the best publicly available dataset to describe species-specific patterns in fatalities at renewable energy facilities within the DRECP. That said, there are several issues regarding study design and data quality that affect inference based on these data (see [12] for documentation of these patterns). As such, these data must be interpreted with caution, with few statistical analyses and from a qualitative perspective. Here we provide a perspective on interpreting them and the caveats that might accompany those interpretations.

The most important caveat is that the aggregated count data we report were not the result of random or systematic sampling of renewable facilities and they were not conducted in a manner that was standardized across all facilities. For example, differences in survey methodologies, (e.g. frequency of survey visits, time of year, size of the search area, use of dogs to search for carcasses) can all influence the number of carcasses found. Likewise, because searcher efficiency and scavenger removal rates for dead birds and bats (to correct raw totals for individuals killed but not detected by searchers on subsequent surveys) were only

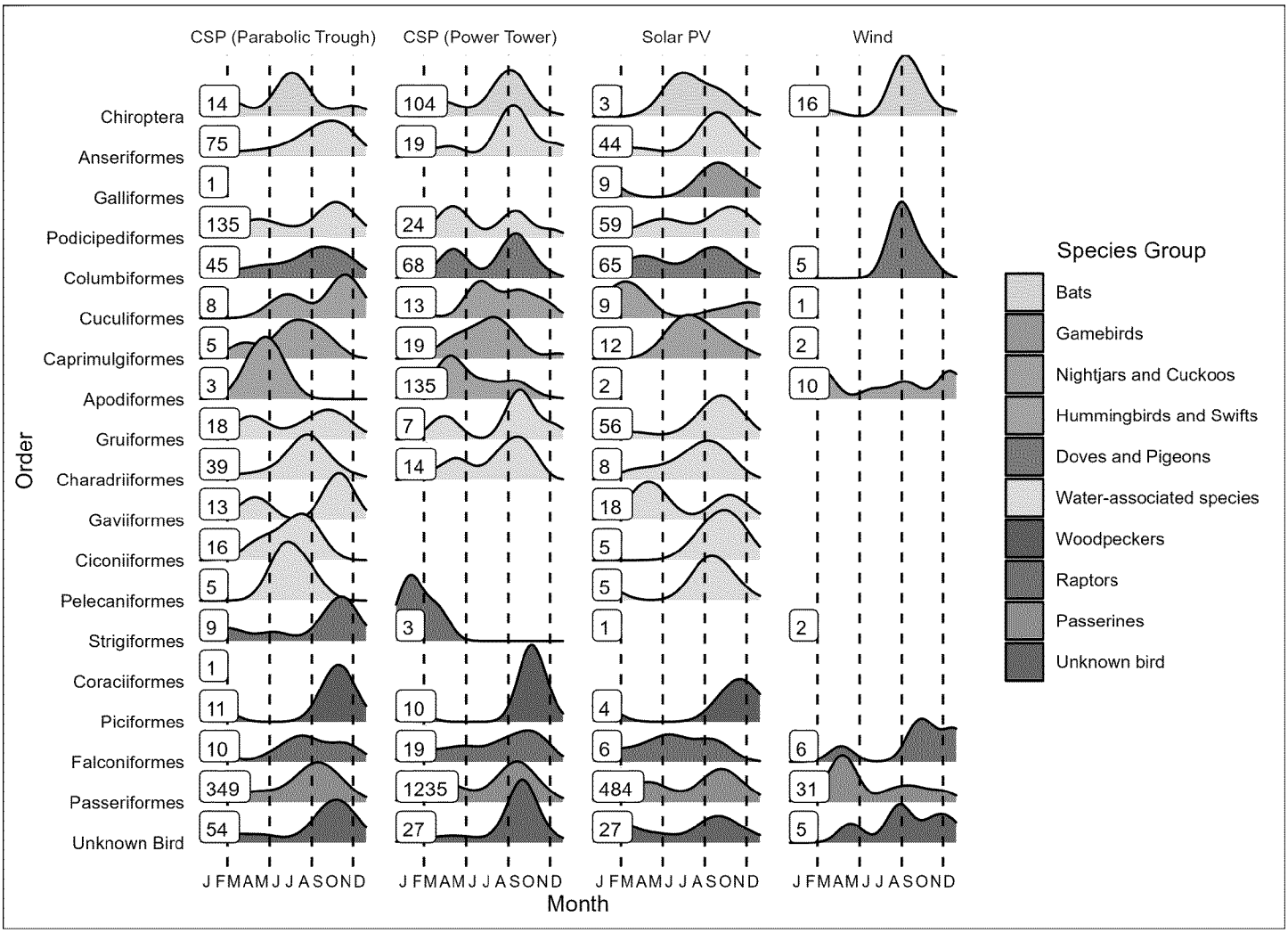

Fig 3. Ridgeplot of the temporal distribution of raw, uncorrected counts of bird or bat carcasses (n = 3304; grouped by taxonomic order), documented in SPUT reports from renewable energy facilities in the Desert Renewable Energy Conservation Plan Area (DRECP). Plots are by month and facility subtype (e.g., Solar PV, Concentrating Solar Power (CSP) parabolic trough, CSP Power Tower, and Wind). Plot color is indicative of the broad species groups commonly used in meta-analyses (e.g., [7, 16]) that merge multiple Orders. Number of reported fatalities is shown with each plot (no plots were generated for ≤ 2 fatalities).

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sometimes estimated, those fatality data are not useful for comparison across all sites [12]. As such, it would be inappropriate to use inferential statistics to analyze aggregated data or to interpret patterns in fatality estimates across facilities [27]. Thus, even straightforward comparison of count data must be done with extreme caution and these totals should be interpreted to reflect *the absolute minimum number* of fatalities at a given location during the monitored time period. Given these caveats, these data can still provide some insight into patterns of species detected as fatalities and about differences among facilities and among technology types. Identification of these patterns also may serve as a starting point for subsequent studies with robust experimental design that can lead to stronger inference.

Waterbirds (e.g., teal (*Anas spp.*), mallard (*Anas platyrhynchos*), grebes (*Podicipedidae*), loons (*Gavia spp.*), phalaropes (*Phalaropus spp.*), ruddy duck (*Oxyura jamaicensis*), spotted sandpiper (*Actitis macularius*)), and forest-nesting warblers (orange-crowned, yellow-rumped, Townsend's (*Setophaga townsendi*), Wilson's) both were common in the list of fatalities (S1

and S2 Tables). However, these taxonomic groups were rarely counted on pre-construction use surveys or point counts for live birds documented in reports we surveyed at solar facilities (S1 Text, TJC unpublished observations). This is notable and suggests the weak relationship between risk assessment pre-construction and actual fatalities post-construction at wind facilities also applies to solar facilities.

Although formal statistical comparison to detect trends would be inappropriate, existing data may provide sufficient insight to guide design of follow-up studies that could explore these patterns and to develop rigorous taxon-specific survey methodologies to estimate populations at risk. While it is possible that there were real biological difference in species present during the two construction phases, at face value, that seems unlikely. In fact, the type and quality of data collected often differs between pre- and post- construction surveys, with pre-construction surveys only rarely incorporating any bias-corrections to account for detection probabilities [12]. Similarly, data often are collected at different spatial and temporal scales, such that pre-construction use surveys monitor a large potential facility site, but post construction surveys focus only on a smaller project footprint or individual facility components (e.g., turbines).

Survey methods at pre-construction sites also may not have been appropriate for the species at risk of fatality (e.g., monthly point counts for cryptic or rare species), or they may have been conducted at the wrong time of year or time of day to detect a given species (i.e., surveying during the nesting season for a species only present during migration, or surveying during the day for a nocturnally migratory species). As such, these surveys can only observe species that are physically present during the defined pre-construction survey period, while carcass searches provide evidence that a species was present at a given location (regardless of whether the observer was present when the fatality occurred). For example, although both waterbirds and warblers are nocturnal migrants [e.g., 28, 29] of the two, only warblers typically stopover in desert habitats that lack bodies of water that are necessary for many waterbirds (e.g., grebes, loons) to initiate flight behaviors. As a result, migration surveys or point counts conducted during daylight hours may be effective to detect warblers but not waterbirds. However, as point counts for live birds are designed to detect vocalizing songbirds during the breeding season, this survey technique may not be as effective during migration and winter months. Use surveys that are effective throughout the year, that detect nocturnally migrating passerines, and that can include replication over multiple years, may be appropriate as follow-ons to the existing work. Furthermore, radar, radio-telemetry arrays, or other similar tools [e.g., 30–32] may provide additional insight into flight patterns and behaviors of migratory species that cross over a proposed solar facility, that may be at risk, or that may not be detected during daytime surveys. All of these factors can cause discrepancies between species and numbers found pre- vs post-construction.

Comparison of fatalities among sites and among renewable energy technologies is difficult with these data of varying quality. That said, there are some patterns that may merit future study that can be gleaned from the cumulative dataset. For example, few waterbirds but many raptors were reported dead at wind facilities, but the opposite pattern was noted at solar facilities (many waterbirds, few raptors) (Fig 2). Also, it is noteworthy that at solar facilities, waterbird fatalities were reported at some PV and CSP solar trough facilities, with causes of death due to collisions with panels, unintentional grounding, or drowning in the wastewater evaporation ponds, but fatalities only rarely reported at the CSP tower facility (i.e., Solar_SBD_2; Tables 1 and S1). The opposite pattern was true for warblers and hummingbirds, with most fatalities detected at the single CSP tower (Fig 2), likely due to feather singeing from the concentrated sunlight beams. Additionally, for most of these species, fatalities occurred primarily during migration periods, highlighting the risk these facilities may pose when located in the

vicinity of major migration flyways, including the Pacific Flyway that includes southern California (Fig 3; also see [33]). It also is noteworthy that greater roadrunners were found in large numbers at both solar and wind facilities, but it is unclear what ecological factors may be increasing fatalities for this species [34]. Finally, it would be valuable to focus future work to see if these patterns hold up more broadly across greater numbers of facilities. If these patterns were also to be observed in robustly designed studies, then it would be possible to evaluate temporal and spatial patterns in fatalities relative to known migration timing, corridors, and landscape features.

A weakness of existing reporting is that often there is insufficient information in publicly available consultant reports to associate species-specific fatalities with the corresponding infrastructure or seasonal timing of deaths (also see [12]). For example, reports typically document fatalities, not only at wind turbines or solar panels, but also in the vicinity of transmission lines, perimeter fences, and evaporation ponds. However, this detail is commonly summarized only for broad taxonomic groups or across the entire monitoring period, an approach which can obscure temporal, spatial, or species-specific patterns in fatalities. Data on the location of fatalities at solar facilities (e.g., at the power block, fence, gen-tie line, road, pond) are often provided with carcass recovery dates in SPUT forms used by consultants. Incorporating this information into species-specific analyses may be a useful tool to examine within-site trends in fatalities. If additional information was provided on when and where carcasses were found, it would allow managers to better understand species-specific differences in causes of death at these facilities. This in turn could guide future efforts to standardize monitoring and improve fatality mitigation practices at facilities and associated infrastructure buildout, such as transmission lines [35]. For example, the large number of Galliform birds that die at wind facilities (Fig 2) is unexpected since these birds tend to fly at relatively low altitudes above ground. Research from other areas suggests ptarmigan, *Lagopus spp*. and other grouse species die from collision with large monopoles, rather than from impact by turbine blades [36]. More detailed information on locations of fatalities of the Galliformes we note here would provide insight into if they may have died in a similar manner.

Finally, our study emphasizes the importance of applying best management practices for study design, utilization, and data aggregation and dissemination of pre- and post-construction monitoring data [12], especially within regions such as the DRECP that have been prioritized for renewable energy buildout. Given that there is a known emphasis on future development in the DRECP, establishing region wide research objectives, standardized survey methodologies, and improving overall data sharing and aggregation would improve our understanding of fatality patterns and provide guidance retarding effective mitigation practices for affected species.

Conclusions

There are many anthropogenic sources of bird and bat mortality [11, 37–39]. As renewable energy becomes increasingly more abundant, there is growing interest in understanding its effects on wildlife. Although it is usually inappropriate to draw statistical inference from studies whose methodology is not standardized, there is still substantial information that can be gained by comparison of data in these studies. Our work highlights both the strengths and weaknesses of this approach and it also identifies a number of species that may prove to be of particular concern to managers because of the frequency with which they are found dead at renewable energy facilities within the DRECP area.

Supporting information

S1 Table. Fatality data obtained from monitoring reports and SPUT datasets from solar energy facilities within the desert renewable energy plan area.
(XLSX)

S2 Table. Fatality data obtained from monitoring reports and SPUT datasets from wind energy facilities within the desert renewable energy plan area.
(XLSX)

S1 Text. All reports included in analyses for fatality surveys and pre-construction use surveys.
(PDF)

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The geographic extent of bird populations affected by renewable-energy development

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Article impact statement: Renewable-energy facilities in California kill birds from broad, but variable, geographic ranges that extend far beyond the state's borders.

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Abstract

Bird populations are declining globally. Wind and solar energy can reduce emissions of fossil fuels that drive anthropogenic climate change, yet renewable-energy production represents a potential threat to bird species. Surveys to assess potential effects at renewable-energy facilities are exclusively local, and the geographic extent encompassed by birds killed at these facilities is largely unknown, which creates challenges for minimizing and mitigating the population-level and cumulative effects of these fatalities. We performed geospatial analyses of stable hydrogen isotope data obtained from feathers of 871 individuals of 24 bird species found dead at solar- and wind-energy facilities in California (USA). Most species had individuals with a mix of origins, ranging from 23% to 98% nonlocal. Mean minimum distances to areas of likely origin for nonlocal individuals were as close as 97 to >1250 km, and these minimum distances were larger for species found at solar-energy facilities in deserts than at wind-energy facilities in grasslands (Cohen's $d = 6.5$). Fatalities were drawn from an estimated 30–100% of species' desingated ranges, and this percentage was significantly smaller for species with large ranges found at wind facilities (Pearson's $r = -0.67$). Temporal patterns in the geographic origin of fatalities suggested that migratory movements and nonmigratory movements, such as dispersal and nomadism, influence exposure to fatality risk for these birds. Our results illustrate the power of using stable isotope data to assess the geographic extent of renewable-energy fatalities on birds. As the buildout of renewable-energy facilities continues, accurate assessment of the geographic footprint of wildlife fatalities can be used to inform compensatory mitigation for their population-level and cumulative effects.

KEYWORDS
immigration, migration, solar energy, stable isotope, wind energy

Extensión geográfica de las poblaciones de aves afectadas por desarrollos de energía renovable

Resumen: Las poblaciones mundiales de aves están en declive. Las energías solar y eólica pueden reducir las emisiones de combustibles fósiles que causan el cambio climático, aunque la producción de energías renovables representa una amenaza potencial para las aves. Los censos para evaluar los efectos potenciales en los centros de energía renovable son exclusivamente locales y se sabe poco sobre la extensión geográfica representada por las aves que mueren en estas instalaciones, lo que plantea obstáculos para mitigar los efectos acumulativos y de nivel poblacional de estas muertes. Realizamos análisis geoespaciales con datos del isótopo de hidrógeno estable obtenido de las plumas de 871 ejemplares de 24 especies de aves que fueron hallados muertos en los centros de energía solar y eólica en California, EE.UU. La mayoría de las especies contó con ejemplares de orígenes mixtos, con un rango del 23% al 98% no local. La media de la distancia mínima a las áreas de probable origen de los ejemplares no locales varía entre los 97 hasta > 1,250 km. Estas distancias mínimas fueron mayores para las especies encontradas en los centros de energía solar situadas en desiertos que para las especies encontradas en los centros de energía eólica localizadas en pastizales (*d* de Cohen = 6.5). Las muertes representan un 30–100% de la extensión de las especies. Este porcentaje fue significativamente menor para las especies con extensiones amplias encontradas en instalaciones eólicas (r de Pearson = –0.67). Los patrones temporales en el origen geográfico de las muertes sugieren que los movimientos migratorios y no migratorios, como la dispersión y el nomadismo, influyen en la exposición de estas aves al riesgo de muerte. Nuestros resultados demuestran la utilidad de los isótopos estables para evaluar el alcance geográfico de las muertes de aves asociadas a energías renovables. Con el progresivo aumento de instalaciones de energía renovable, una evaluación precisa de la huella geográfica de la mortandad de fauna salvaje podrá guiar la mitigación compensatoria de sus efectos acumulativos y de nivel poblacional.

PALABRAS CLAVE
energía eólica, energía solar, inmigración, isótopo estable, migración

INTRODUCTION

Bird abundance has sharply declined globally during the past half century because of anthropogenic pressures (Gaston et al., 2003; Rosenberg et al., 2019; Şekercioğlu et al., 2004), including climate and land-use change (Cahill et al., 2013; Horton et al., 2020; Iknayan & Beissinger, 2018; Newbold, 2018). Renewable energy is a crucial part of strategies to mitigate climate change (Cole et al., 2019; Larson et al., 2021; Socolow, 2020), yet land-use change related to renewable-energy production also has consequences for wildlife (Allison et al., 2019; Marques et al., 2014; Schuster et al., 2015). Besides habitat loss and displacement associated with facility installation (e.g., Smallwood, 2022), estimates are that hundreds of thousands of individual birds die annually at wind- and solar-energy facilities in North America (Erickson et al., 2014; Kosciuch et al., 2020; Loss et al., 2013a; Smallwood, 2013; Walston et al., 2016; Zimmerling et al., 2013).

The primary cause of avian mortality at wind-energy facilities is collision with turbines (Loss et al., 2013a). When it can be determined, collision with infrastructure is the primary cause of death at photovoltaic solar-energy facilities, whereas solar-flux-related mortality is the primary cause of death at concentrating solar-power facilities (Walston et al., 2015). Despite representing a small proportion of fatalities from all anthropogenic sources, wind- and solar-energy development pose an increasing threat to birds because species that are killed at such facilities (e.g., Beston et al., 2016; Erickson et al., 2014; Katzner et al., 2019; Kosciuch et al., 2020) are often different than those affected by other threats, such as window collision (Elmore et al., 2021) or domestic cats (Loss et al., 2013b). Furthermore, energy production from wind and solar is projected to increase 10–50 times during the next few decades (IRENA, 2020; Larson et al., 2021; U.S. Energy Information Administration, 2020), which suggests that fatality risk is likely to expand. Finally, some species may be more demographically vulnerable than others to increased mortality rates from renewable sources of energy (Diffendorfer et al., 2021).

The geographic extent to which renewable-energy facilities affect birds is poorly understood (Katzner et al., 2020). Wildlife interactions with renewable-energy infrastructure result from the spatial location of facilities and the abundance and movement of species at these sites. Without characterizing the geographic origin of fatalities and the spatial scale of affected populations, it is difficult to reduce or mitigate the population-

level and cumulative effects of these fatalities. Although birds are highly vagile, some of the affected species are migratory and others are nonmigratory; yet, existing fatality estimates do not typically differentiate between effects on individuals from local populations versus those affected during migration or dispersal. Furthermore, no studies have evaluated how far away the origin of nonlocal individuals was or from what portion of a species range they originated (Diffendorfer et al., 2021; Loss et al., 2015).

Preconstruction surveys at renewable-energy facilities are meant to characterize the presence and activity of species potentially exposed to the proposed facility, but they often poorly predict the level and species composition of postconstruction fatalities (Ferrer et al., 2012), and thus are not highly useful for identifying possible mitigation options. For example, waterbirds and nocturnal migrant species are typically undetected in preconstruction surveys via diurnal point counts, but they are killed in large numbers at solar-energy facilities in the desert of southern California, USA (Kosciuch et al., 2020). Even for the species that are detected in preconstruction surveys, the geographic extent of affected species is often unknown. If a new facility is predicted to cause a certain number of fatalities, and those fatalities are assumed to all be local rather than equally distributed across the geographic range, the population-level effects of the facilities may be under- or overestimated, which could misdirect permitting or policy decisions.

Characterizing the geographic extent of origin and relative proportion of local versus nonlocal individuals may be useful to identify species and populations at greatest risk from existing or planned facilities and to enable targeted conservation and management decisions designed to minimize or offset fatalities to vulnerable populations (Katzner et al., 2017). One possibility is that nonmigratory species and populations (i.e., local) may be more vulnerable to demographic risk than migrants, presumably because they have year-round exposure to fatalities at renewable-energy facilities. Alternatively, migratory species and populations (i.e., nonlocals) may be more vulnerable to demographic risk, potentially because the threat is novel, and the animals are at higher density during migration and in winter. Relatedly, if many individuals killed are from a small proportion of the range of species with a limited range size, then those fatalities might be expected to have more localized and potentially severe demographic effects than a similar number of fatalities of individuals that originate from widely dispersed parts of the range of a more widespread species. Finally, seasonal variation in the proportion of nonlocal individuals could point to the relative importance of migration, dispersal, or nomadism as factors influencing exposure to fatality risk.

Intrinsic markers (e.g., stable isotopes, genetic markers, trace elements) can retrospectively differentiate residents from migrants and immigrants killed at renewable-energy facilities (Monopoli et al., 2020; Pylant et al., 2016; Vander Zanden et al., 2018a; Voigt et al., 2012; Wieringa et al., 2020). Previous studies that applied these tools to wildlife killed at renewable-energy facilities focused on small numbers of species or one type of renewable energy, limiting the ability to draw generalizations. We expanded on prior efforts and used stable hydrogen isotope (δ^2H) data and assignment models to determine the geographic extent of the origin of 24 bird species of conservation interest killed at wind- and solar-energy facilities in California. We focused on California because feathers from a large number of renewable-energy facilities in the state were available and because the state is a global leader in renewable-energy production (U.S. Energy Information Administration, 2021); contains a variety of ecological communities that may attract birds (U.S. North American Bird Conservation Initiative, 2000); has a diversity of migratory and nonmigratory species affected by renewable energy (Conkling et al., 2020); and is part of a major migratory flyway (U.S. Fish & Wildlife Service, 2017).

We addressed four objectives central to defining the geographic extent over which renewable-energy facilities affect individuals from avian populations: identify whether individuals killed were local or nonlocal in origin; document the distance from which nonlocal individuals originated; determine the proportion of each species' range from which fatalities were drawn and the diversity of geographic origins; and evaluate variability in the proportion of nonlocal birds across the year. Finally, we evaluated our findings in the context of what is known about taxonomic groups and their migration patterns.

METHODS

Use of hydrogen stable isotopes

Hydrogen isotope (δ^2H) values in precipitation vary across North America because of changes in latitude, temperature, and elevation. These variations are transferred through the food web and are incorporated into bird feathers via food and drinking water (Hobson & Wassenaar, 1997; Hobson et al., 2012). Feathers are inert after synthesis, and most birds molt during the breeding season. Therefore, feather samples from carcasses can be used to assess the most probable molting location (and often the breeding origin). The geographic assignment process based on feather δ^2H values lacks the precision of electronic tracking devices, but it can be used to draw broadscale patterns of the most likely region of origin from carcasses (Vander Zanden et al., 2018a).

Sample collection

We collected feather samples from dead birds found at wind- and solar-energy facilities in California. For wind-energy facilities, bird carcasses, found under turbines, were from the Altamont Pass Wind Resource Area in Alameda and Contra Costa Counties, which included approximately 5–30 wind-energy facilities with many different turbine technologies (Figure 1). The actual number of facilities and their ownership has changed through time (Alameda County Community Development Agency & ICF International, 2014; ICF International, 2016). For solar-energy facilities, we collected bird carcasses from six facilities in Riverside and San Bernardino

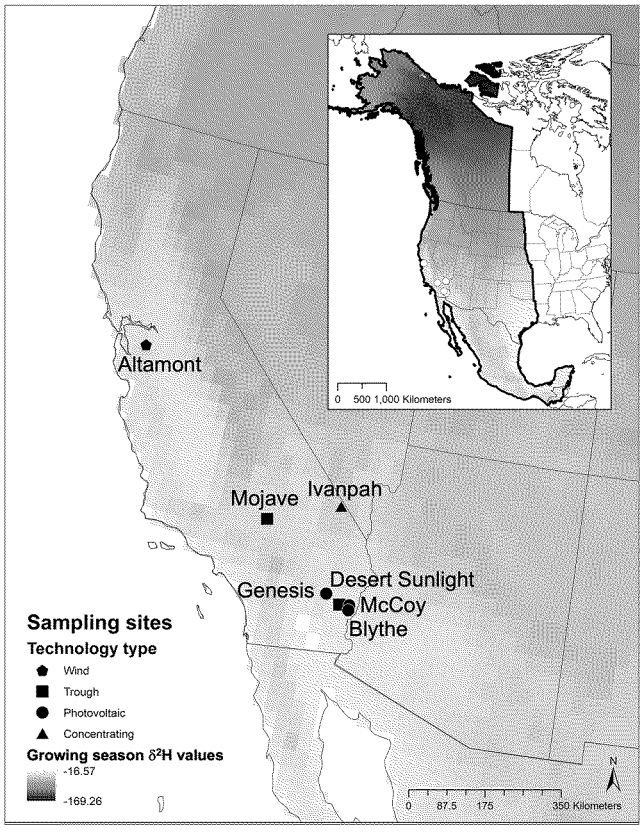

FIGURE 1 Locations where samples were collected from 2007 to 2017 from six solar-energy sites (with three technology types) and 5–30 wind-energy facilities (spread across Altamont Pass Wind Resource Area). The inset contains the growing-season δ^2H values (Bowen et al., 2005), trimmed to the two western flyways (Pacific and Central).

Counties, including Blythe Solar Power Project, Desert Sunlight Solar Farm, Genesis Solar Energy Project, Ivanpah Solar Electric Generating System, McCoy Solar Energy Project, and Mojave Solar Project (Figure 1). Given the opportunistic nature of our collections, we did not have balanced sample sizes to divide the solar or wind facilities by mode of energy generation (for wind, newer or older turbine technologies; for solar, photovoltaic, trough, or concentrating power systems), so they were combined for analyses.

Birds gathered at renewable-energy facilities were collected under facility-specific permits from the US Fish and Wildlife Service. All scientific work with birds was conducted under US Migratory Bird Treaty Act Scientific Collecting Permit MB72348B or its predecessors, California Scientific Collecting Permit SC-011910 or its predecessors, and a large number of other state-specific permits whose numbers are available on request.

Species were selected for analysis with input from an expert panel and based on the species' conservation relevance, taxonomic diversity, and availability of feathers from renewable-energy facilities (as described in Conkling et al., 2020). Bird carcasses were generally found by surveyors or staff incidentally or during fatality monitoring at each site. We used the date of discovery in our analysis of temporal patterns. The condition of the carcasses varied from feather spots, to desiccated parts, to whole carcasses. In many cases, the cause of death could not be determined. Bird carcasses were stored frozen at those facilities for several weeks or months and then transferred to Boise, Idaho, for sample collection and archiving. Samples from Altamont Pass Wind Resource Area prior to 2012 were collected on site and later archived in Boise. We stored feathers in paper envelopes at room temperature until isotopic analyses could be conducted.

The feather type that was analyzed varied by availability, species, body size, and knowledge of molt patterns (Pyle, 1997, 2008) (Appendix S1). Most species molt during the breeding season, though some species molt during migration or the nonbreeding period (Appendix S2). Regardless of molt timing, we evaluated whether the individual was local or nonlocal to the site of collection when the feather was formed. We avoided analysis of singed feathers on carcasses from solar-energy facilities, although limited singeing is unlikely to affect δ^2H values (Vander Zanden et al., 2018b). To assess the isotopic variability within individuals, we analyzed three different feathers from at least six individuals per species (or fewer individuals if our sample size was <6).

Sample analyses

Isotope analyses were performed at the Central Appalachians Stable Isotope Facility (CASIF) at the University of Maryland Center for Environmental Science's Appalachian Laboratory (Frostburg, Maryland). We cleaned samples of the middle section of a feather vane with 1:200 Triton X-100 detergent, followed by a rinse with nanopure water, another rinse with 100% ethanol, and then drying at ambient temperature (Coplen & Qi, 2016). We then measured the δ^2H value of nonexchangeable hydrogen in each sample with a comparative equilibration approach (Wassenaar & Hobson, 2003) in which samples were equilibrated and analyzed alongside international keratin standards (USGS42, USGS43, CBS [caribou hoof standard], and KHS [kudu horn standard]) and an internal keratin standard (porcine keratin [Spectrum Chemical product K3030]). To do this, we placed approximately 0.15 mg of each feather sample or standard into a 3.5×5 mm silver capsule and exposed each sample to ambient air for >72 h to allow for equilibration of exchangeable hydrogen in keratin. We then folded the capsules, loaded them in a 100-position Costech Zero-Blank autosampler, and repeatedly purged the autosampler with dry helium.

Analysis of δ^2H values was performed using a ThermoFinnigan high-temperature conversion elemental analyzer pyrolysis unit interfaced with a ThermoFinnigan Delta V+ isotope ratio mass spectrometer (Thermo Scientific) via a Thermo Scientific ConFlo IV universal continuous flow interface. We normalized all δ^2H data to the Vienna Standard Mean Ocean Water-Standard Light Antarctic Precipitation (VSMOW-SLAP) scale with USGS42, USGS43, CBS , and KHS standards. The δ^2H values of nonexchangeable hydrogen of these standards are −72.9, −44.4, −157.0, and −35.3‰, respectively (Coplen & Qi, 2016; Soto et al., 2017). The long-term δ^2H value of the

internal keratin standard at CASIF is −59.5‰ (SD 2.3). When more than one feather was analyzed from the same individual, we used the mean δ^2H value in the assignment analysis.

We also measured δ^{13}C and δ^{15}N values in feathers from species with the possibility of marine diets that would make the δ^2H values unsuitable for geolocation (Appendix S1). Analysis of δ^{13}C and δ^{15}N values was performed using a Carlo Erba NC2500 elemental analyzer (CE Instruments) interfaced with a ThermoFinnigan Delta V+ isotope ratio mass spectrometer (IRMS). For this analysis, we placed ~1 mg of each feather sample or standard in a 5×9 mm tin capsule, folded it, loaded it into a 50-position Costech Zero-Blank autosampler, and purged the autosampler with dry helium. We normalized the δ^{13}C and δ^{15}N data to the Vienna Pee Dee Belemnite and AIR (atmospheric N_2) scales, respectively, with a two-point normalization curve with internal standards calibrated against USGS40 (δ^{13}C = −26.39‰ and δ^{15}N = −4.52‰) and USGS41 (δ^{13}C = 37.63‰ and δ^{15}N = 47.57‰). The analytical precision of an internal keratin standard was 0.1‰ (SD) for δ^{13}C and δ^{15}N values. When more than one feather was analyzed from the same individual, we used all δ^{13}C and δ^{15}N values to determine whether any were indicative of marine influence.

Geographic assignment process

To rescale precipitation δ^2H values to feather δ^2H values, we used one of two baseline isoscapes plus associated uncertainty isoscapes at a resolution of 0.33 degrees: growing season (Bowen et al., 2005) or mean annual precipitation (Bowen & Revenaugh, 2003) (available from waterisotopes.org). When possible, we selected rescaling equations from previously published linear regressions for each species and used the same precipitation isoscape as the published regression. When species-specific rescaling functions were not available, we used rescaling functions from species or groups that provided the best taxonomic or ecological match to the species of interest (Appendix S3). We trimmed the rescaled isoscapes first to the two western flyways (Pacific and Central, which were approximated in Canada based on provincial boundaries; U.S. Fish & Wildlife Service, 2017) and then to the species' range map (i.e., breeding and wintering range, not including migratory range) (Birdlife International & Handbook of the Birds of the World, 2016). For three species found at solar-energy facilities, the designated range map did not include the fatality sites, which would have precluded the possibility of local individuals. Therefore, we made slight alterations to the procedure for these species (Appendix S1).

We calculated the posterior probability that a given individual originated from each pixel in its geographic range, given the underlying baseline isoscape, as a normal density function with a resulting raster in which all cells summed to 1 (Vander Zanden et al., 2018a). We included three levels of variance in the calculation of posterior probabilities: variance in precipitation isoscapes, variance within individuals, and analytical variance. We calculated the standard deviation for the relevant precipitation isoscape from the 95% confidence interval raster by dividing the confidence interval value for each pixel by 1.96. We estimated variance within individuals from the data set itself based on a subset of the samples for which three separate feathers of the same individual were analyzed. For each species, we used the mean standard deviation of δ^2H values from three feathers per individual from 2 to 73 individuals as an estimate of individual variance (Appendix S3). Finally, we calculated the analytical standard deviation as the long-term variability in replicates of the internal keratin standard at the CASIF, which was 2.3‰. We assumed that each of these measures of variance was independent, so we calculated a pooled variance, yielding a variance for each pixel of the considered range for each species (Vander Zanden et al., 2018a).

Assignment metrics

To define local versus nonlocal origin status for each individual and to delineate the region of likely origin, we used a 5:1 odds ratio (OR) threshold, which has an expected accuracy of 83% (Vander Zanden et al., 2018a). Pixels with a value that exceeded the threshold were designated the region of likely origin, and if the collection site was included in that region, the individual was categorized as local. A local designation means that the feather isotope value was consistent with having been grown in that pixel, but that designation does not exclude the possibility of many other pixels also meeting the same threshold as potential sites of origin. Nonlocal designations indicate that the pixel of sample collection did not meet the 5:1 OR threshold. We then repeated origin designations for each individual with 2:1 (67% expected accuracy, OR ≥0.33) and 19:1 ORs (95% expected accuracy; OR ≥ 0.05). Finally, we estimated the percentage of all individuals that were nonlocal for each species. The mean estimate was generated from the 5:1 OR threshold, and upper and lower confidence ranges around the percent nonlocal were generated from 2:1 and 19:1 OR thresholds, respectively. Wind and solar nonlocal proportions were compared with a one-way, two-proportions z test.

To understand how far away from renewable-energy facilities nonlocal individuals originated, we calculated the minimum distance to the nearest edge of the likely area of origin (as characterized by the binary surface defined by the 5:1 OR). Minimum distance reflects the nearest edge of a larger distribution of possible origin, and it is a highly conservative estimate of the movement that may have preceded an individual's arrival at the renewable-energy facility. Standard deviation of the mean minimum distance was calculated from all the nonlocal individuals of each species. Wind and solar nonlocal distances were compared with a permutation test to calculate the differences in means with 10,000 random shuffles of the data set without replacement.

To estimate the proportion of each species' range represented by observed fatalities, we used the binary surface created above to calculate the proportion of the species range that was represented by the ratio of the area of likely origin to the species range area (constrained to the western flyways) at the individual and population levels. At the individual level, the binary

surface was defined separately for each individual of a species before calculating the mean catchment area across individuals. At the population level, the binary surfaces were summed to create a single composite surface, and the area was calculated for all pixels with a value ≥1. We used Pearson's correlation tests to examine relationships between the area of the species' ranges and the individual- and population-level catchment metrics. There are some limitations to using proportion of the range as a metric for comparison because isoscape-based assignments tend to be latitudinal bands with limited longitudinal resolution, but it provides an indication of precision of the assignments at the individual level and facilitates useful comparisons across species for understanding the geographic extent of impact at the population level.

We created three summary maps for each species. In the local and nonlocal summary maps, OR prediction surfaces for individuals were summed and divided by the total number of individuals to calculate a mean surface. We repeated this process once for local individuals and once for nonlocal individuals. Although the binary surface was used to categorize individuals as local or nonlocal, the summary surfaces represented the compilation prior to any thresholding. The third map showed the population-level catchment area for the nonlocal individuals of each species (described above).

To summarize the diversity of geographic origins of nonlocal birds, we used a clustering approach in the R package isocat (Campbell et al., 2020). The number of geographic clusters indicates the tendency for individuals of a species to originate from more geographically distinct portions of the range. A similarity index (Schoener's *D*) was used to calculate pairwise comparisons between the normalized posterior probability surfaces of the nonlocal individuals and populate a $n \times n$ symmetric matrix for each species (where n is the number of individuals). Spatial similarity values of 1 indicated complete overlap, whereas values of 0 indicated no overlap. To cluster individuals by similar origins, we used hierarchical clustering applied to each similarity matrix with the package pvclust (Suzuki & Shimodaira, 2006). We used the average method to cluster by correlation distance with 1000 bootstrap replications and cut each dendrogram at height 0.5.

Finally, we evaluated monthly variation in the proportion of local and nonlocal individuals across all species in our data set. We expected that if migratory behavior was the sole driver of presence of nonlocal individuals, the proportion of nonlocal individuals would be low for most of the year and then peak during months when migration occurred. In contrast, if dispersal or nomadism were also important, we expected less month-to-month variation in the proportion of nonlocal individuals. Because we had limited information on month-to-month variation in the sampling effort that generated our sample of bird carcasses, we interpreted with caution monthly variation in counts of bird carcasses and instead focused on monthly proportions of local versus nonlocal individuals. To examine variability in the balance of local versus nonlocals across months, we used a chi-square test. We conducted all analyses and data manipulations in R (R Core Team, 2020).

RESULTS

We obtained 1733 feather samples from 923 individual birds representing 25 species: 410 individuals from 11 species from wind-energy facilities (Appendix S4) and 513 individuals from 18 species from solar-energy facilities (Appendices S5 & S6). The δ^2H values of the 923 individual sample means ranged from 51.4 to −150.7‰ (Appendix S7). After removing 52 individuals because δ^{13}C, δ^{15}N, or δ^{18}O values indicated they were unsuitable for geolocation with δ^2H values (Appendices S1, S8, & S9), we retained 871 feathers from 24 species for geolocation, including 391 individuals from wind-energy facilities and 480 individuals from solar-energy facilities. At wind-energy facilities, these samples represented 322 raptors, 63 passerines, and 6 individuals of species in other guilds, all collected from March 2007 to September 2017 (Appendix S4). From solar-energy facilities, these samples represented 83 individual waterbirds, 12 raptors, 282 passerines, and 103 individuals of species from other guilds, collected from September 2013 to May 2017 (Appendix S5).

For most species, individuals found dead at renewable-energy facilities had a mix of local and nonlocal origin, with the proportion classified as nonlocal ranging from 23% to 98% (Figure 2a,b & Appendices S4 & S5). Only 2 of the 24 species evaluated had 100% local classification (0% nonlocal: white-tailed kite [*Elanus leucurus*], $n = 3$; mourning dove [*Zenaida macroura*], $n = 6$), both found at wind-energy facilities (Figure 2a). Similarly, we classified all individuals as nonlocal in origin for only three species (100% nonlocal: ruddy duck [*Oxyura jamaicensis*], $n = 21$]; red-necked phalarope [*Phalaropus lobatus*], $n = 3$; yellow warbler [*Setophaga petechia*], $n = 34$), all found at solar-energy facilities (Figure 2b). Estimated origins differed among species found at wind- and solar-energy facilities. Wind fatalities had a greater proportion of local individuals (>50% local for 6 of 11 species), whereas solar fatalities had a greater proportion of nonlocal individuals (>50% nonlocal for 16 of 19 species). Overall, the proportion of nonlocal individuals was significantly higher at solar facilities (73%) than at wind facilities (51%) (Cohen's $h = 0.47$, $\chi^2 = 45.7$, df = 1, 95% CI −1.0 to −0.16, $p<0.001$).

Minimum distances to likely regions of origin were also significantly greater for species at solar-energy than wind-energy facilities (Cohen's $d = 6.5$, permutations = 10,000, $p = 0.009$). For the nine species from wind-energy facilities with nonlocal individuals, the mean minimum distance for a species did not exceed 286 km (mean = 182 km [SD 177]) (Figure 2c & Appendix S4). All 18 species from solar-energy facilities for which geographic assignments were conducted had at least some nonlocal individuals, and our models suggested that minimum distances were >400 km for 11 species; some were as far as 1260 km (mean = 657 km [539]) (Figure 2d & Appendix S5).

There was substantial variation in the size of the catchment areas from which fatalities were drawn. The mean individual catchment areas were significantly larger for species with larger geographic ranges at solar facilities ($r = 0.51$, 95% CI 0.07–0.79, $p = 0.03$) (Figure 3b) but not at wind facilities ($r = 0.43$, 95% CI = −0.33 to 0.55, $p = 0.25$) (Figure 3a). The population-level

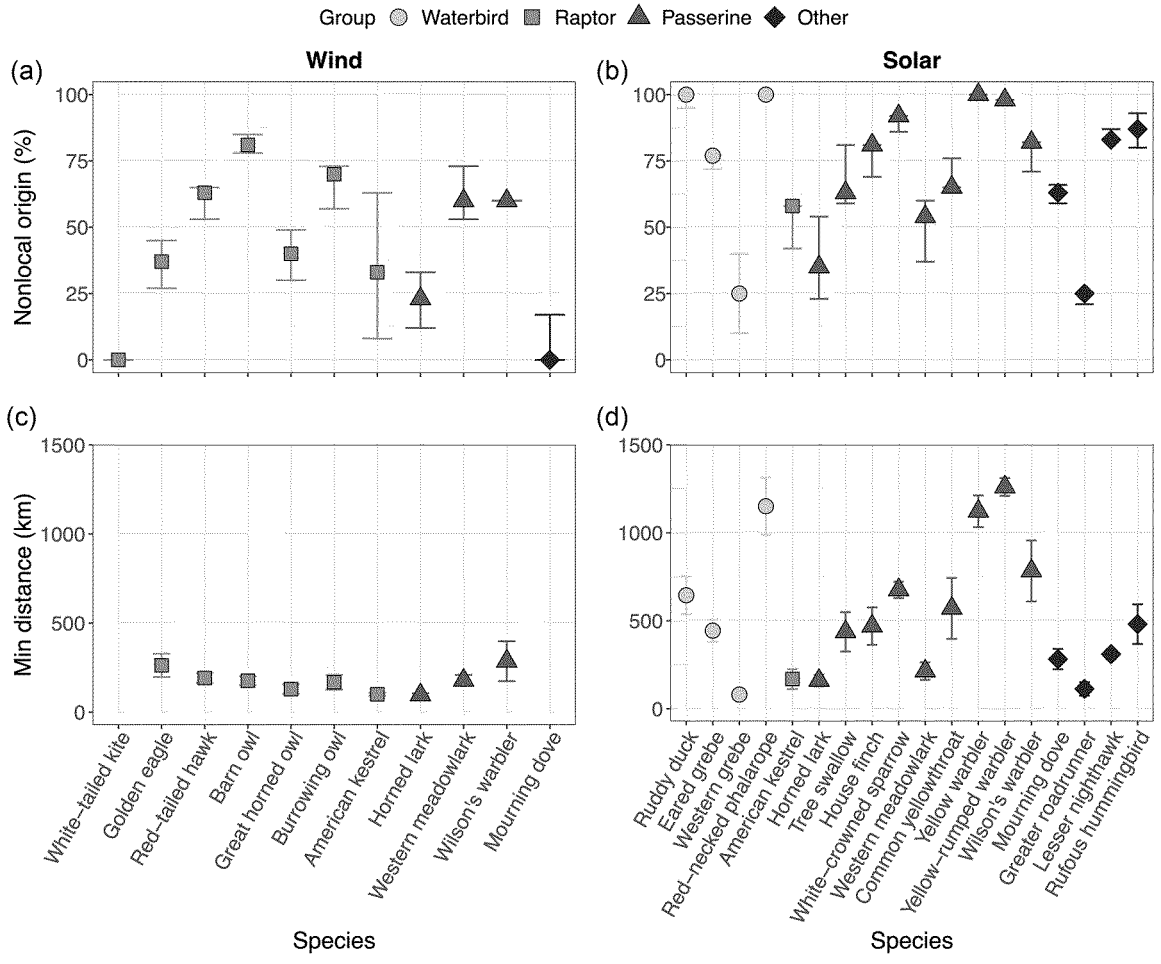

FIGURE 2 Percentage of individuals from each species for which the geographic origin was nonlocal based on feather δ^2H values at (a) wind- and (b) solar-energy facilities (points, percent assigned nonlocal based on 5:1 odds ratio; bar ends, 2:1 and 19:1 odds ratio, respectively) and minimum distance from the carcass location to the likely area of origin of individuals identified as nonlocal based on the stable isotope results at (c) wind and (d) solar fatalities (points, means for each species based on a likely region established with a 5:1 odds ratio; bars, 1 SD). In some cases in (c) and (d), the upper or lower intervals are the same as the value determined through the 5:1 odds ratio. Values with ranges are reported in Appendices S4 and S5.

catchment area, representing the summed surface of all nonlocal individual maps that were restricted to the 5:1 OR threshold, varied from 25% to 100% of the range area (Figure 3c,d). The species range area restricted to the western flyways was significantly negatively correlated with population-level proportion of the range from which fatalities were drawn for wind-energy ($r = -0.67$, 95% CI −0.92 to −0.01 $p = 0.048$) (Figure 3c) but not solar-energy facilities ($r = -0.22$, 95% CI −0.63 to 0.27, $p = 0.37$) (Figure 3d) . Most of the species with nonlocal individuals had population-level catchment areas that exceeded 50% of their considered range, suggesting that the animals that died at renewable-energy facilities could have come from an extensive geographic area across most of the range used by the species (Figure 3c,d).

Taxonomic group and known migration behavior likely influenced how these renewable-energy facilities affected birds. As expected, migratory behavior was influential in determining minimum distances traveled. Passerines—most of which are migratory—found at solar-energy facilities tended to have longer minimum distances traveled than other taxonomic groups; some species originated at minimum distances exceeding 1000 km (mean [SD] = 808 km [542]). For six of the putative longest-distance migrant species (red-necked phalarope, white-crowned sparrow [*Zonotrichia leucophrys*], yellow warbler, yellow-rumped warbler [*Steophaga coronata*], Wilson's warbler [*Cardellina pusilla*], rufous hummingbird [*Selasphorus rufus*]), the proportion of birds classified as nonlocal ranged from 82% to 100%, and mean minimum distances were large (481–1260 km). In contrast, the three nonmigratory species (white-tailed kite, great horned owl [*Bubo virginianus*], greater roadrunner [*Geococcyx californianus*]) had smaller percentages that were classified as nonlocal (0–40%) and smaller mean minimum distances (113–133 km).

Based on hierarchical clustering methods that examine the similarity in origins of nonlocal individuals within a species, the number of geographic clusters ranged from 2 to 7 across all species (Figure 4a,b). Species killed at solar facilities tended to have more geographic clusters, and the mean degree of overlap among individuals of a species was lower when more geographic clusters were identified (Figure 4c,d & Appendix S10).

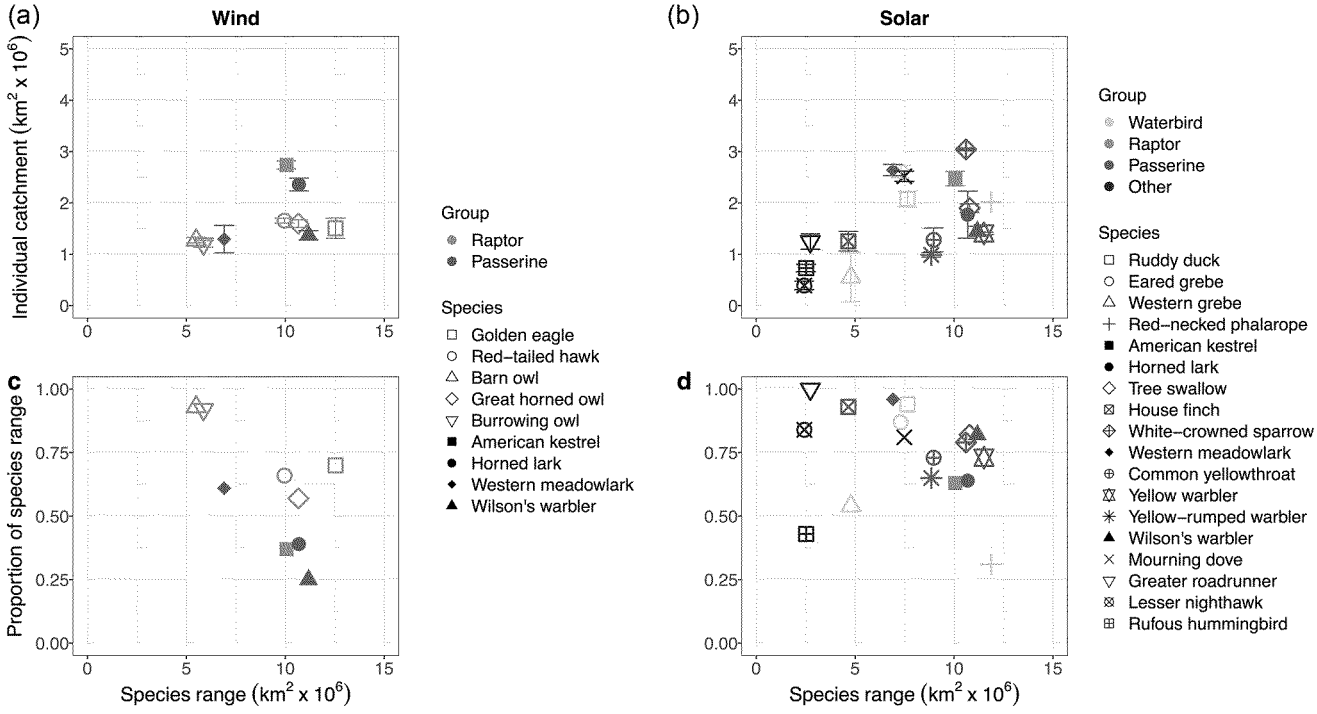

FIGURE 3 Comparison of the size of likely regions of origin (designated with the 5:1 odds ratio threshold) at the individual and population levels for all nonlocal samples of species at wind (a, c: 11 species) and solar (b, d: 18 species) energy facilities in California (USA): (a, b) mean individual catchment area (SE) at the individual level relative to the total species range area and (c, d) proportion of each species' range area at the population level from which all fatalities originated relative to total species range size in the western flyways. Significant correlations are in (b) and (c) (see "Results").

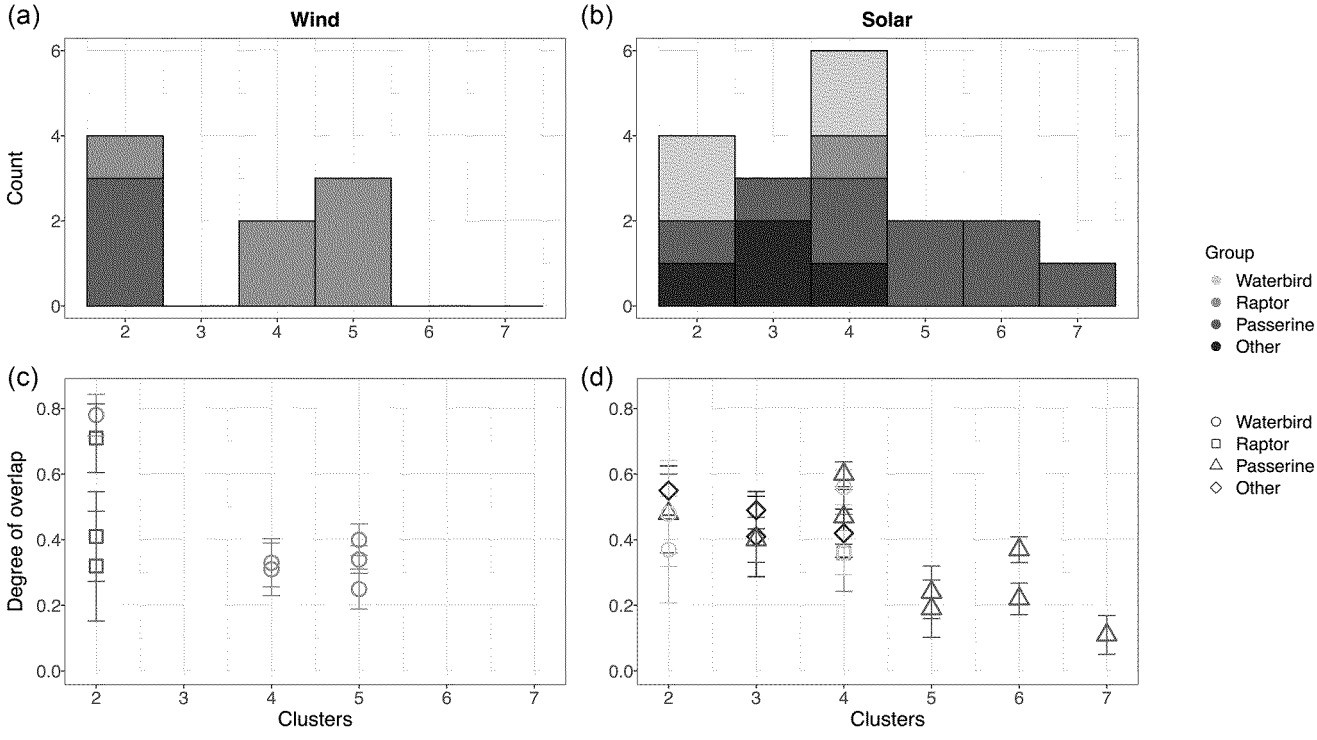

FIGURE 4 Count of species with geographic clusters ranging from 2 to 7 among species found at (a) wind and (b) solar-energy facilities and mean (SE) degree of overlap in pairwise comparisons among individuals of a species (calculated with Schoener's *D*) for species found at (c) wind and (d) solar facilities.

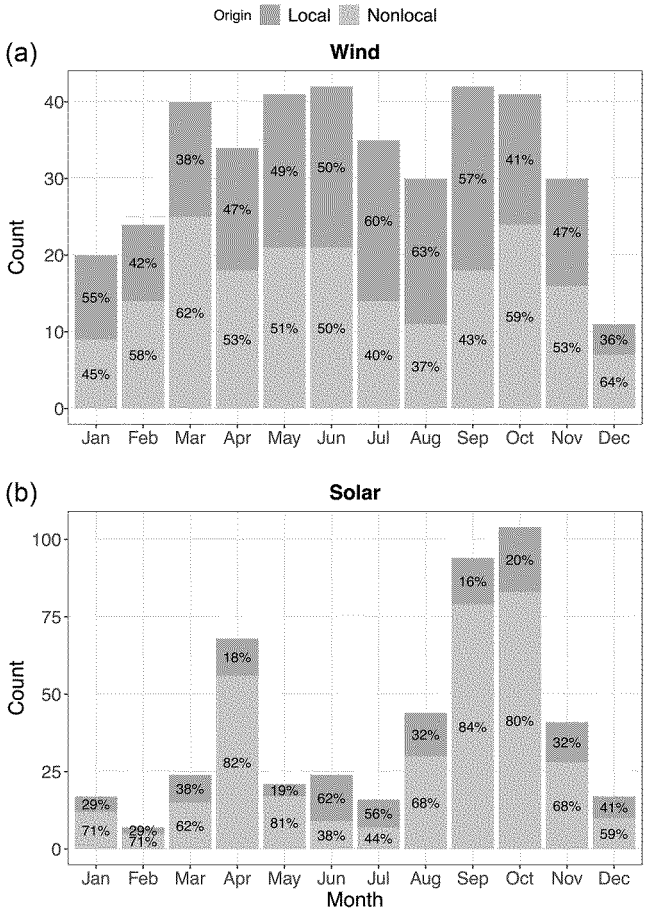

FIGURE 5 Bird fatalities by month from (a) 2007 to 2017 at wind-energy facilities and (b) 2013 to 2017 at solar-energy facilities (percentages in bars, percent local vs. nonlocal). Birds without a known month of collection were not included (15 from wind and three from solar facilities).

In every month of the year, at least one-third of individuals found dead were nonlocal in origin (minimum at wind facilities = 37%, at solar facilities = 38%) (Figure 5). Despite the inconsistency in sampling effort, peaks in proportion of nonlocal individuals during migratory seasons were indicative of an effect of migration on fatality rates. At wind-energy facilities, the highest proportions of nonlocal individuals were detected in March and October, though the difference in the proportion of local versus nonlocal individuals among months was not statistically significant ($\chi^2 = 4.89$, df = 11, $p = 0.94$). At solar-energy facilities, the variation in the proportion of nonlocal birds among months was statistically significant ($\chi^2 = 32.45$, df = 11, $p<0.001$), with the highest proportions of nonlocal birds in April, May, September, and October.

DISCUSSION

Our results illustrate the broad extent and variability in the geographic distribution of birds killed at renewable-energy facilities in California. Although a small number of the affected species were 100% local or nonlocal in origin, most had local and nonlocal individuals, with a higher percentage of nonlocal individuals at solar facilities. Nonlocal individuals may have originated from as near as ~100 to >1250 km from the site at which they died, and the proportion of each species' range from which fatalities could have been drawn varied from 25% to 100%. The diversity of origins (as inferred by the number of geographic clusters) tended to be greater among nonlocal individuals that died at solar- than wind-energy facilities. Additionally, the temporal patterns in fatalities at renewable-energy facilities, including the significant peaks in proportion of fatalities of nonlocal individuals at solar-energy facilities during spring (i.e., March–April) and autumn (i.e., September–October), suggest that migratory species may be particularly vulnerable. Together, these data illustrate the highly variable and, for many of the migratory species, expansive geographic reach of these renewable-energy facilities.

The site-based differences in the geographic origin of fatalities are unlikely to be universal patterns in wind- versus solar-energy facilities, but they may be driven by a combination of site location, landform and land cover, technology type, and characteristics that result in interactions with migratory and nonmigratory species. The solar- and wind-energy facilities were in the Pacific Flyway, an important migration corridor for many bird species that has been the focus of comparatively less research than other North American flyway (Carlisle et al., 2009). Additionally, for the solar facilities in southern California, the nearby Salton Sea is a critical habitat for wintering, migratory, and breeding waterbirds and some migrating Neotropical songbirds (Shuford et al., 2002). Thus, the locations of solar facilities may make them prone to attracting and killing species and individuals engaged in mid- to long-distance migration. Furthermore, many of the species we considered here are migratory. Migrating birds may be at greater risk than nonmigratory individuals due to their increased exposure to anthropogenic threats along the migration route and other threats, such as metabolic exhaustion and adverse weather (Buchan et al., 2022; Hardesty-Moore et al., 2018; Sawyer et al., 2016; Sergio et al., 2019). Although we do not know whether such risks apply in this case, interpreting our results in this context may be informative.

The absolute proportion of individuals with a nonlocal origin was higher at solar-energy facilities (73%) than wind-energy facilities (51%). We were unable to evaluate potential differences in origin among the different types of turbines and solar-energy generation technologies. This is an established problem because inconsistency in survey effort and design is known to limit inference on effects of wildlife fatalities at all types of renewable-energy facilities (Conkling et al., 2021). Despite this, we know of no biases that would have affected our origin assignment. Instead, we suspect that this difference is likely more influenced by the location along the flyway and the habitat in which the facility is sited than by the mode of energy generation. Migrants searching for a stopover site with water in the deserts of Southern California may be at particular risk of fatalities at solar-energy facilities because the reflection of polarized light on solar panels from the sun, moon, or artificial sources is hypothesized to attract insects or create an artificial "lake effect"

that attracts some bird species (Chock et al., 2021). Ten of the 18 species found at solar facilities are not expected to use the habitat in which they died, and all but one of those species were composed of >50% of nonlocal individuals (Appendix S11). In contrast, grassland birds and raptors were commonly killed at the wind-energy facilities, and most of the wind-energy facility species used the habitat in which they were killed (Appendix S11). The wind-energy fatalities in our data set were in habitat that is considered high-quality for raptors (i.e., grasslands with abundant keystone species, such as California ground squirrels [*Otospermophilus beecheyi*] [e.g., Katzner et al., 2017]). Additionally, the flight behavior of foraging raptors when wind currents are ideal for soaring and kiting puts them at the height of rotating blades, increasing the risk of collision (Hoover & Morrison, 2005).

Our samples are the result of field survey efforts that were unbalanced and often temporally inconsistent. Despite the variability in monitoring, the peaks in proportions of nonlocal fatalities during migratory periods corresponded with previously documented patterns. Bird and bat fatalities at renewable-energy facilities across North America have seasonal peaks, though the patterns vary among taxa. Fatalities of migratory tree-roosting bats peak in late summer and fall, coinciding with the autumn migratory period (Arnett et al., 2008; Lloyd et al., 2023). Incidents of fatalities of passerines show two distinct seasonal peaks associated with spring and fall migration in some biomes, whereas fatalities of raptors tend to be more uniform throughout the year (Lloyd et al., 2023). The congruence of our data on timing, migratory behavior, and geography all point to migration as an important risk factor for some of the birds killed at the renewable-energy facilities.

In addition to the significance of migratory behavior to these fatalities, the temporal patterns in fatalities at renewable-energy facilities also suggest that many nonlocal individuals are killed throughout the year, particularly at wind-energy facilities (Figure 5). When considering multiple species together, some migration may happen in nearly all months. In the spring, migration may begin as early as January for some species and end as late as June for others. Fall migration can begin in July for some warblers and end much later in the year for other species, such as ducks and grebes. Furthermore, even if birds are designated as nonlocal when they were not migrating, migration may have been the relevant process that brought them to their area. For example, a nonlocal ruddy duck killed at a solar-energy facility in December could have been overwintering in the nearby Salton Sea or actively migrating. Therefore, an examination of the seasonal patterns by species may be helpful, especially for the species for which it was possible to gather larger sample sizes (Appendices S12 & S13).

For the four species from wind-energy facilities with >60% nonlocals (golden eagles [*Aquila chrysaetos*], red-tailed hawks [*Buteo jamaicensis*], barn owls [*Tyto alba*], burrowing owls [*Athene cunicularia*]), there were slight seasonal peaks, but deaths of nonlocal individuals occurred nearly year-round (Appendix S12). For these species, the data may indicate dispersal or nomadism outside the migratory periods (Houston, 1999; Murphy, 2017; Poessel et al., 2022; van den Brink et al., 2012) because the mean minimum distances we detected were < 275 km for all four species. Alternatively, nonlocal fatalities at solar-energy facilities were very infrequent during June and July for almost all species but lesser nighthawks (*Chordeiles acutipennis*) (Appendix S13). Molt locations of lesser nighthawks are unclear, but many other desert species molt on migration (Pyle, 1997; Pyle et al., 2009), and most of the nonlocal origins of lesser nighthawks are to the south of their breeding grounds in California (Appendix S14). Though migration is likely the overall driver of seasonal peaks, a combination of migration and other dispersal movements may contribute to nonlocal fatalities outside the major migratory periods (March–April and September–October).

The metrics we used to characterize the geographic patterns among species serve to summarize aspects of 871 individual maps of assignment as local or nonlocal among 24 species. However, examining patterns within a species can provide a greater ecological context for these geographic distributions. Two illustrative examples derived from maps of three species highlight this point (Figure 6). First, the separation in the likely areas of origin for local versus nonlocal summary maps corresponded to the diversity in geographic origins. For example, the likely region of origin for American kestrels killed (*Falco sparverius*) at wind facilities was similar between local and nonlocal groups (Figure 6a), and this species had a high degree of overlap among the two identified clusters (Appendix S10). For barn owls, the likely region of local origin was distinct from that of nonlocals (Figure 6b), and this species had a lower degree of overlap among the six identified clusters of nonlocal individuals (Appendix S10).

Second, the patterns revealed by the maps often reflect the documented biology of the species. For example, eared grebes (*Podiceps nigricollis*) stop at hypersaline lakes (primarily Mono Lake, California, and Great Salt Lake, Utah), where the majority of them undergo a complete molt after the breeding season (Cullen et al., 2020; Jehl & Henry, 2010; Storer & Jehl, 1985). Subsequently, they depart for wintering areas in southern California and Mexico. The likely origin of the nonlocal grebes corresponded to much of the breeding area from approximately the latitude of the Great Salt Lake and northward, whereas the likely region of origin of the local individuals included nonbreeding areas to the south of the Great Salt Lake, which includes Mono Lake and the sites where the carcasses were found (Figure 6c). Our results showed that a higher proportion of eared grebes had likely molted at the Great Salt Lake than at Mono Lake, which is consistent with historic population patterns at the two lakes (Roberts et al., 2013). This correspondence indicates there may be instances in which stable isotope data can be used to better understand species-level distributions for species less well known than these grebes.

Another key finding is the large variability in catchment area, especially relative to range size, from which fatalities at California renewable-energy facilities are drawn. For some species, affected individuals originated from a relatively small part of the range, but for other species, they originated from a large portion of the range, and the proportion could not necessarily be predicted using the range size. The demographic relevance of these different geographical patterns likely varies with the life-history strategy of the species at hand. It can be informative to characterize the vulnerability of avian populations, which

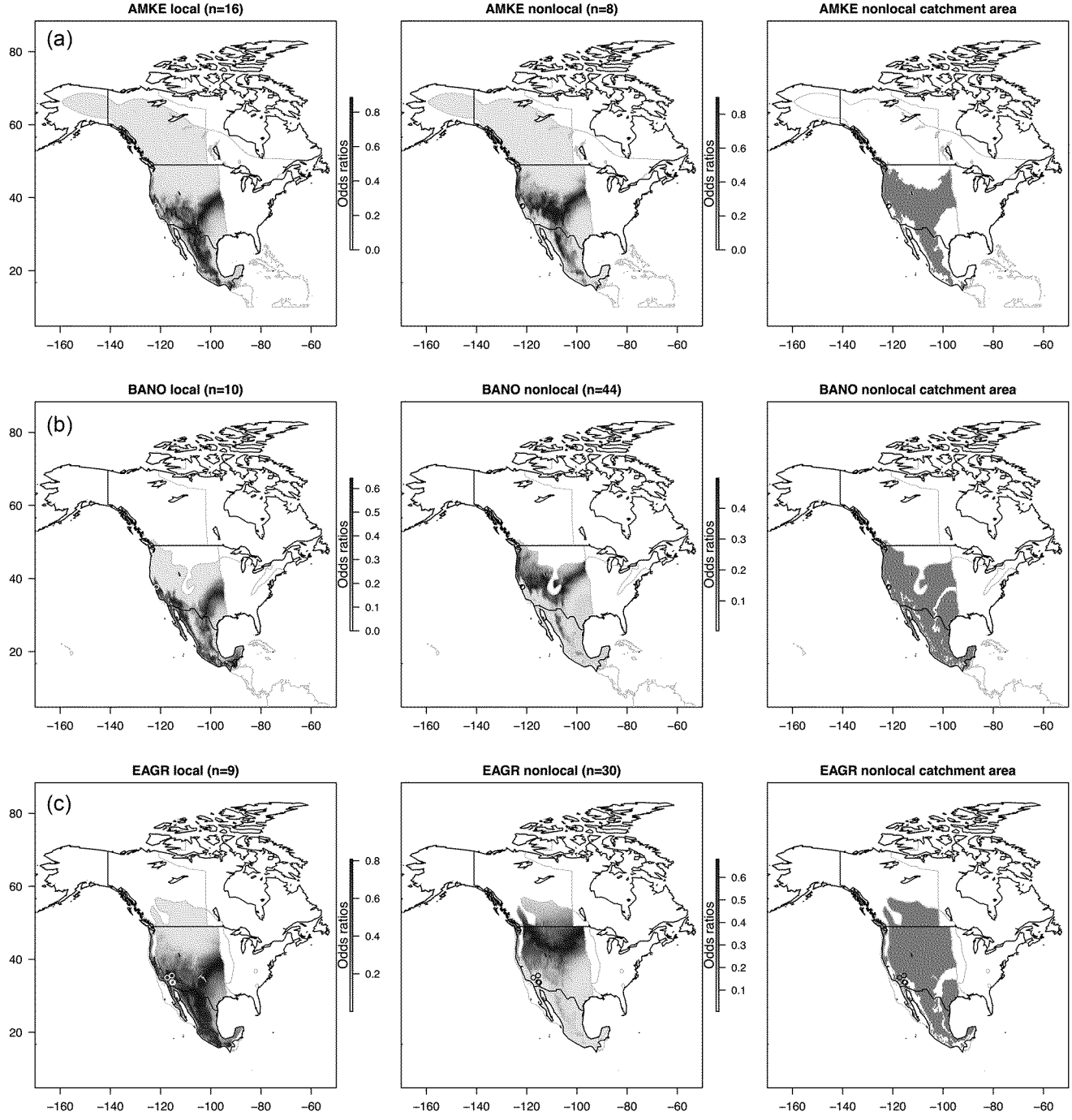

FIGURE 6 Local and nonlocal summary maps (left and middle columns, respectively) for American kestrels (AMKE), barn owls (BANO), and eared grebes (EAGR) indicate mean areas of origin. Posterior probability rasters of likely origin (designated with the 5:1 odds ratio threshold) for all local or nonlocal individuals of a species were summed and divided by the total number of individuals to calculate the mean summary surfaces for each group. The right column shows the population-level catchment area for each species in which all pixels ≥1 were retained after summing all nonlocal binary maps. The ranges were restricted to the two western flyways. Gray lines are species range area and flyway borders.

is not distributed evenly among birds of local and nonlocal origin (Conkling et al., 2022). Consequently, these results are highly relevant to identifying appropriate locations for mitigation actions that most effectively minimize or offset fatalities. For example, this information might be especially useful for species such as rufous hummingbird (*Selasphorus rufus*), for which our results suggest may be locally vulnerable to effects from renewable-energy facilities and well suited to mitigation because the species has a small geographic range, and affected individuals are from a small part of that geographic range.

Stable isotope data permit an unobtrusive exploration of the potential catchment area of wildlife fatalities at renewable-energy facilities, and we expect that applications in future studies will show that most facilities have local and nonlocal effects.

Nevertheless, our data are specific to the species, energy generation type, and sites in California where they were gathered. Additionally, imperfect detection, the focus on carcasses (without sampling individuals that did not die), and the differences in survey methodology among individual energy facilities, only allowed us to draw conclusions about individual animals sampled in our study. Our results imply that regardless of facility type, it is unlikely that preconstruction surveys will provide insight into the far-reaching geography of species vulnerable to collision mortality at renewable-energy facilities. When renewable-energy facilities are sited in known migration flyways, preconstruction surveys are conducted for nonlocal birds (e.g., hawk counts along mountain ridges) (Johnston et al., 2013). However, in settings not recognized as having high occurrence of migratory species, such surveys are not typically conducted. The high potential for nonlocal effects needs to be weighed when predicting effects of future facilities, estimating effects of current facilities, and assessing appropriate locations and mitigation actions that minimize or offset fatalities.

Our results demonstrated that preconstruction surveys are unlikely to effectively characterize the geographic extent of wildlife affected by that renewable-energy facility. They also illustrate that, depending on conservation goals, compensatory mitigation for fatalities from renewable-energy facilities could be structured to target geographic areas that are identified by isotopic analyses so that mitigation is aligned with the effects of the facility. Ultimately, geographic origin information can be combined with population models to predict vulnerability more accurately (Conkling et al., 2022). As the buildout of renewable-energy facilities continues, accurate assessment of the geography of wildlife affected by renewable-energy facilities is, therefore, of substantial significance not only to science to understand effects to wildlife, but also to management seeking to mitigate or account for those effects.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Vander Zanden, H. B., Nelson, D. M., Conkling, T. J., Allison, T. D., Diffendorfer, J. E., Dietsch, T. V., Fesnock, A. L., Loss, S. R., Ortiz, P. A., Paulman, R., Rogers, K. H., Sanzenbacher, P. M., & Katzner, T. E. (2024). The geographic extent of bird populations affected by renewable-energy development. *Conservation Biology*, *38*, e14191. https://doi.org/10.1111/cobi.14191

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/17/2025 10:36:07 PM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Kerr, Steven@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=d0d5a66bed2249fca830918f58b3b921-Kerr, Steve]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Darden-Request for updates to three land use figures
Attachments: Figure 5.2-7a Overview_Existing WA Contracts_01.17.2025.jpg; Land Cover Maps_Overview_01.17.2025.jpg; Figure 5.2-6a Overview_Farmland Mapping_01.17.2025.jpg; Figure 5.2-5a_Overview_Agricultural Uses_01.17.2025.jpg

Hi Lisa,

Updated figures attached. Just in case it is needed, I also included an updated overview land use figure from the mapbook that was provided in Appendix A in response set #6.

Thank you,

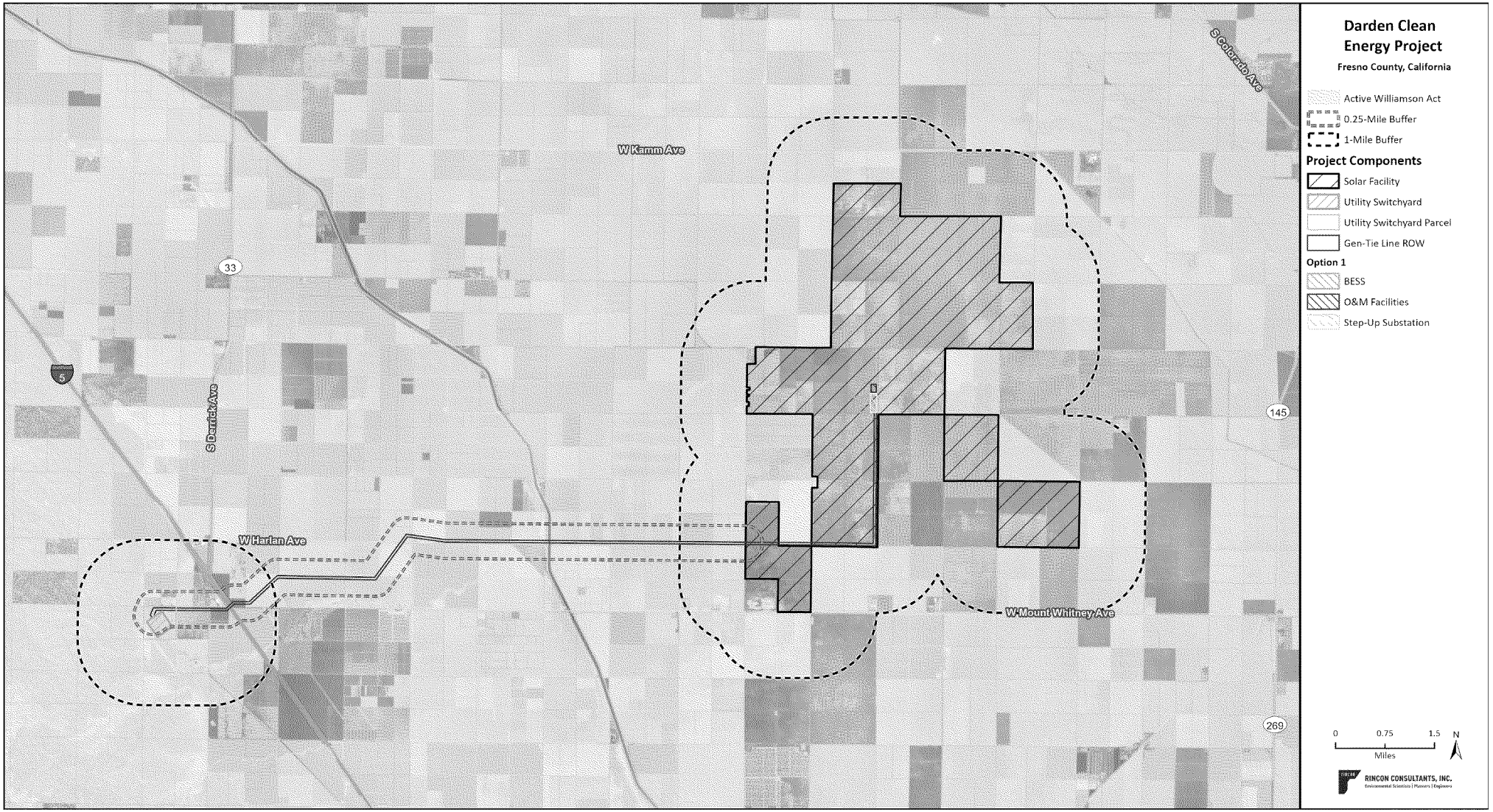
Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Tue, Jan 14, 2025 at 12:20 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

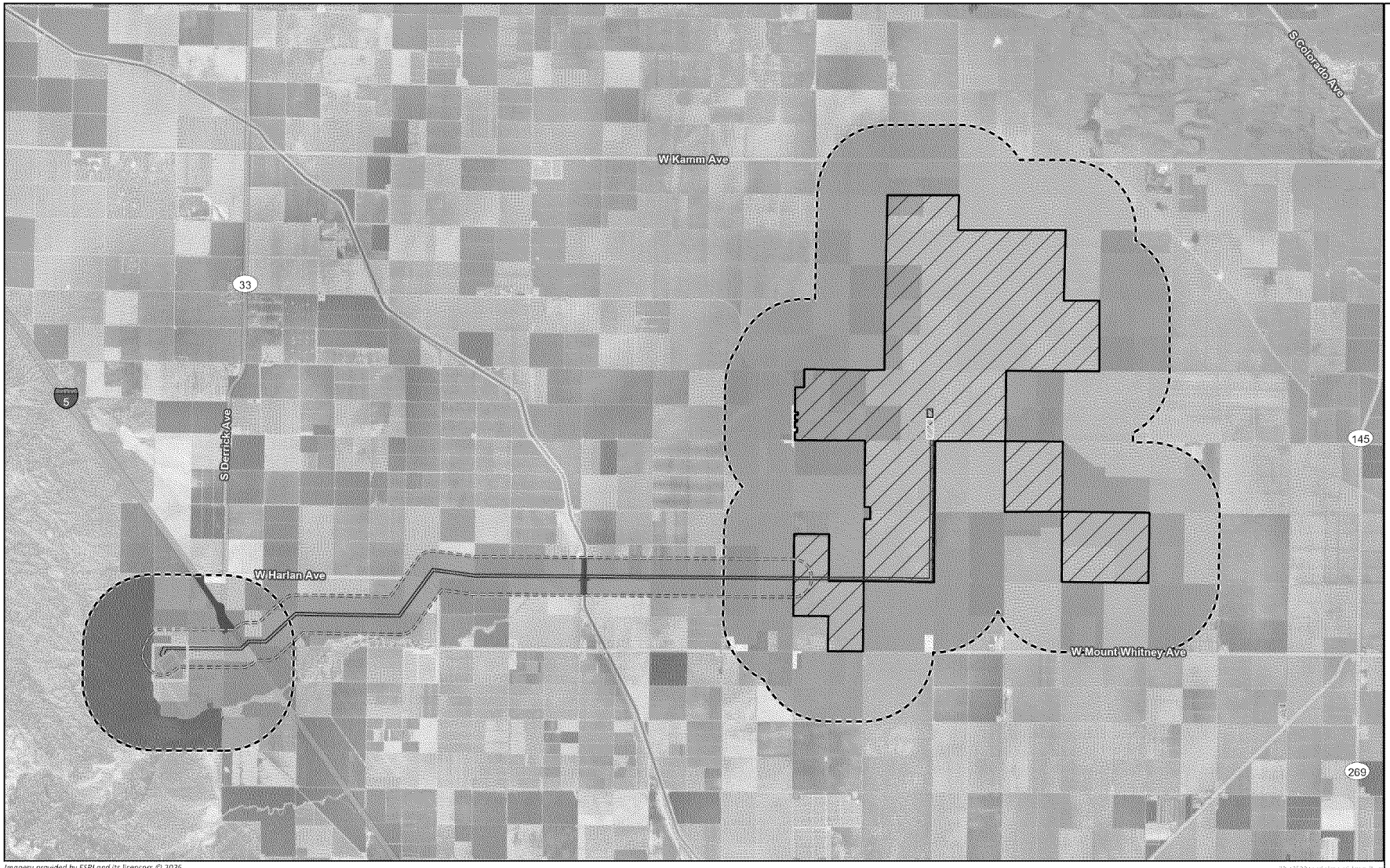
> Hi Becky,
>
> I am hoping we could get an update to the following figures for our land use section to bring it consistent with the current project design.
>
> Figure 5.2-5a Overview of Agricultural Uses Within the Study Area on Pg. 5.2.25 (Land Use TN253034)
> Figure 5.2-6a Overview of Farmland Mapping and Monitoring Program Designations on Pg. 5.2-34 (Land Use TN253034)
> Figure 5.2-7a Overview of Existing Williamson Act Contracts Within the Study Area on Pg. 5.3-43 (Land Use TN253034)
>
> Thanks kindly,
>
> Lisa Worrall
>
> Senior Environmental Planner
>
> California Energy Commission
>
> Siting, Transmission and Environmental Protection Division
>
> 715 P Street, MS-40, Sacramento, CA 95814

Direct: (916) 661-8367

Email: lisa.worrall@energy.ca.gov



Imagery provided by ESRI and its licensors © 2025.



Darden Clean Energy Project

Fresno County, California

- 0.25-Mile Buffer
- 1-Mile Buffer

Important Farmland

- Confined Animal Agriculture
- Grazing Land
- Farmland of Local Importance
- Farmland of Statewide Importance
- Nonagricultural or Natural Vegetation
- Prime Farmland
- Rural Residential Land
- Semi-Agricultural and Rural Commercial Land
- Unique Farmland
- Urban and Built-up Land
- Vacant or Disturbed Land

Project Components

- Solar Facility
- Utility Switchyard
- Utility Switchyard Parcel
- Gen-Tie Line ROW

Option 1

- BESS
- O&M Facilities
- Step-Up Substation

0 0.75 1.5 N

Miles

RINCON CONSULTANTS, INC.

Environmental Scientists | Planners | Engineers

22-13530 Land Use and Agriculture
Fig 3 Important Farmland - OVERVIEW

Darden Clean Energy Project

Fresno County, California

- 0.25-Mile Buffer
- 1-Mile Buffer

Agricultural Uses (CNRA)

- Deciduous Fruits and Nuts
- Field Crops
- Grain and Hay Crop
- Pasture
- Truck Nursery and Berry Crops
- Unclassified
- Vineyard

Project Components

- Solar Facility
- Utility Switchyard
- Utility Switchyard Parcel
- Gen-Tie Line ROW

Option 1

- BESS
- O&M Facilities
- Step-Up Substation

0 0.75 1.5 Miles

N

RINCON CONSULTANTS, INC.
Environmental Scientists | Planners | Engineers

22-12590 | Sec Use and Agriculture
Fig 5 CNRA Crops - OVERVIEW

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/23/2025 6:36:19 PM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Chang, Kaycee@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=dd3d2fc8670840bda4acdc455903e787-Chang, Kayc]; Crisp, Ann@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=b89c4de7ece742679d19e1e3ee713dc2-Crisp, Ann@]; Abulaban, Abdel-Karim@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=c1ff1d38281a4068b2708271d22c0d94-Abulaban, A]; Watson, Carol@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=84e32d50c7dc47d89812b468a50090ed-Watson, Car]; Ackerman, James@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=3cc35de240cf4253af9cc7d3d2cbb643-Ackerman, J]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report
Attachments: Darden_Detention Schematic_2025.01.17.pdf; Stormwater Management Responses 2025-01-23.docx

Hi Lisa,

See attached responses related to stormwater management.

Thank you,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Wed, Jan 15, 2025 at 9:13 AM Becky Moores <becky.moores@intersectpower.com> wrote:

> Lisa - just wanted to let you know we are working on these questions and will get you back responses as soon as possible.
>
> Becky Moores
> INTERSECT POWER
> (e) becky.moores@intersectpower.com
>
> On Mon, Jan 13, 2025 at 6:34 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:
>
> > Hi Becky,
> >
> > Here is bio's question:

A description of the predicted frequency that standing water would occur, and the length of time to percolate. For example, is standing water expected on site most years during rainy season? Or only during a 100 year storm? What about standing water during a 5 year storm, an event more likely to occur during the project's lifetime than the modeled 100 year storm.

Thanks,

Lisa

From: Worrall, Lisa@Energy
Sent: Monday, January 13, 2025 1:22 PM
To: Becky Moores <becky.moores@intersectpower.com>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Subject: RE: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

I was waiting for questions from bio, but in the meanwhile, here are the questions that Water Resources have.

We need to get these resolved so it doesn't affect our document publication timing.

From: Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Sent: Friday, January 10, 2025 9:05 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Subject: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Lisa: I can't speak for BIO, but I suggest the following questions regarding stormwater control.

"The irregular shapes of the detention basins shown in Sheet 5 of the Preliminary Stormwater Plan and the lack of details in the Project Description and the Water Resources sections of the application result in questions concerning stormwater control:

- According to the Water Resources section of the application and the Preliminary Stormwater Plan, the ground surface of the solar facility will be vegetated;
    - Will the detention basins be constructed solely of soil berms that will eventually be vegetated?
- Based on Preliminary Stormwater Plan Sheet 5, detention basins would be located in the northeast corners of each solar facility drainage area based on the general slope of the topography;
    - Will the detention basins be open, or unbermed to the southwest?
    - Will berms only be constructed along the northern and eastern margins of the drainage area northeast corner?
    - What will be the length of the berms?
    - If the berms are not long enough, will drainage area stormwater flow be adequately captured without escape to adjacent areas?
- Both the Water Resources section of the application and the Preliminary Stormwater Plan state that detention basins will capture and treat stormwater.
    - How will the detention basins treat stormwater?
- The Preliminary Stormwater Plan, Stormwater Management Practices section states that the detention basins will be designed with a minimum 1 foot of freeboard from the top of the berm.
    - What design element will ensure this freeboard?
- Would it be possible to get a schematic design drawing of the typical detention basin?"

James Ackerman, PG #6493

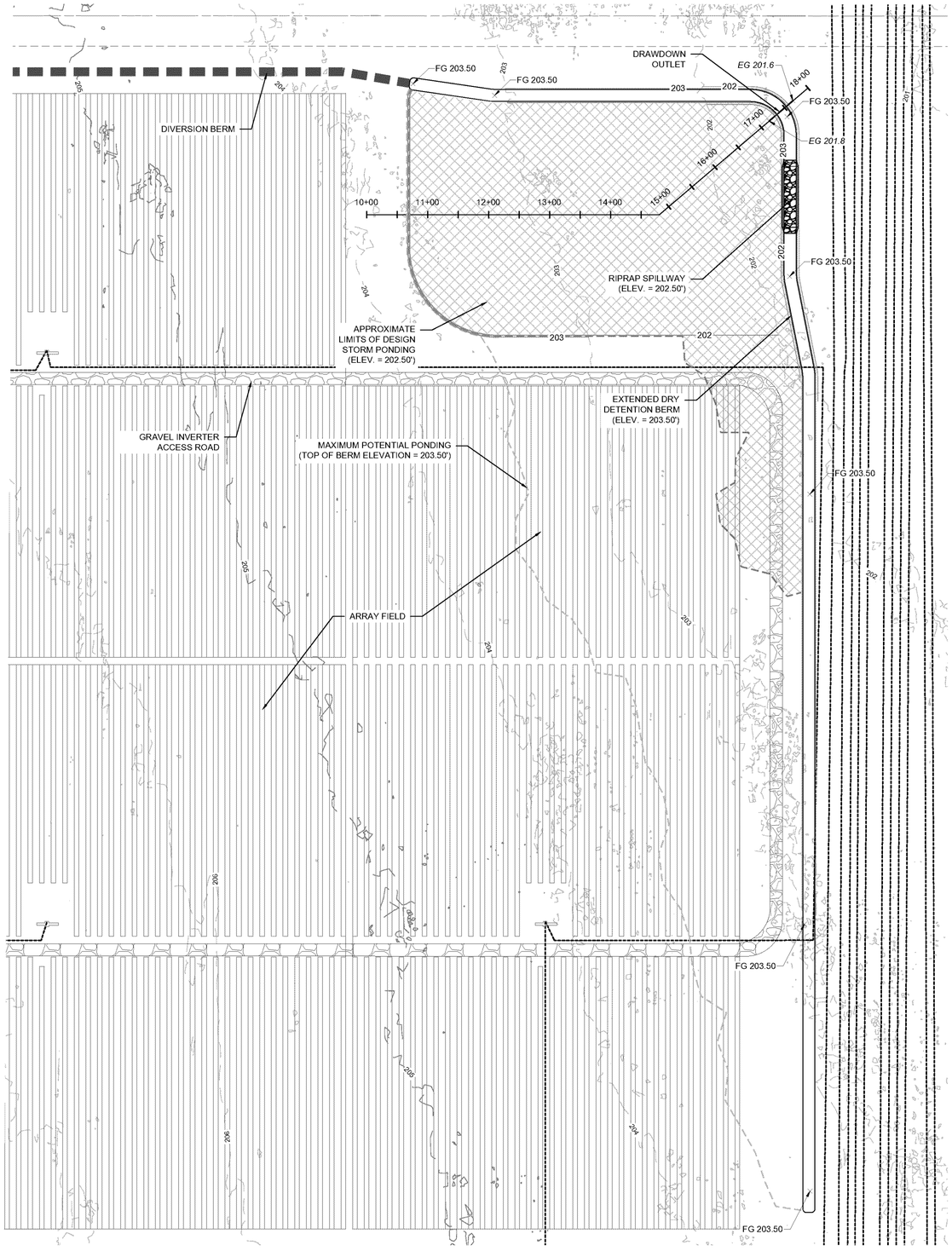
Engineering Geologist

California Energy Commission

Siting, Transmission and Environmental Protection Division

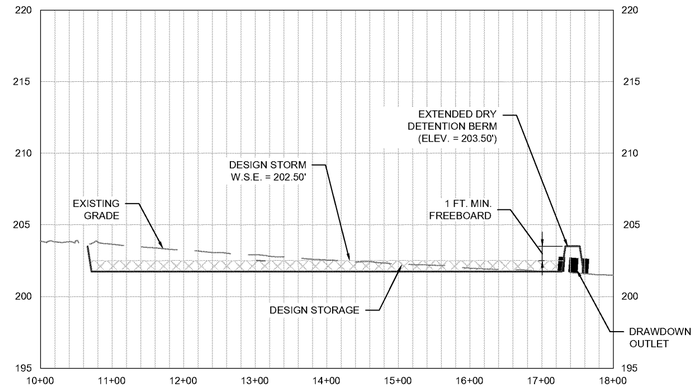
Direct: (530) 878-4966

Email: james.ackerman@energy.ca.gov



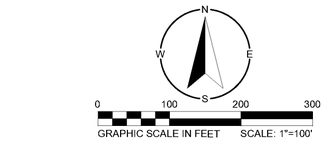
SCHEMATIC EXTENDED DRY DETENTION BASIN - PLAN VIEW

SCALE: 1" = 100'



SCHEMATIC EXTENDED DRY DETENTION BASIN - PROFILE VIEW

SCALE: 1" = 100' (H), 1" = 5' (V)



LEGEND

- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE LINE
- ADJOINER LINE
- ROW — EXISTING RIGHT OF WAY
- EXISTING EASEMENT
- EXISTING ROAD
- GAS — EXISTING GAS/PETROLEUM LINE
- TUG — EXISTING UNDERGROUND TELEPHONE
- O/H — EXISTING OVERHEAD ELECTRIC
- DRILL PADS AND ACCESS EASEMENTS
- PROPOSED DIVERSION BERM

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PRELIMINARY NOT FOR CONSTRUCTION

CLIENT

Intersect Power

PROJECT NAME
DARDEN 1 PV + BESS

SITE LOCATION
FRESNO COUNTY, CA
36.476°, -120.216°

#	DRAWING ISSUE	DATE	DB	CB
0	PRELIMINARY	01/17/25	BT	ML

PROJECT NO.: 24103-01

DRAWING TITLE
SCHEMTATIC DETENTION BASIN DESIGN

DRAWING NUMBER
EXH-1

Stormwater Management

The preliminary stormwater analysis completed for the Darden Project in April 2023 used a conceptual design and thus produced preliminary, conceptual results. Stormwater management across the Project site will be based on the final hydrology study and stormwater management analysis, which will be modeled using the Project's final design and layout. Stormwater management will ensure there is no increase in runoff peak rate post-construction as compared to pre-construction conditions for the 100-year 48-hour storm event.

From CEC Biology Team:

Question 1. *Provide a description of the predicted frequency that standing water would occur, and the length of time to percolate. For example, is standing water expected on site most years during the rainy season? Or only during a 100-year storm? What about standing water during a 5-year storm, an event more likely to occur during the project's lifetime than the modeled 100-year storm.*

Response 1: Project design will mimic the existing conditions with sheet flow and at-grade roads. The site generally has positive drainage that will convey, infiltrate, and evaporate after storms. The soils across the Project site are classified as low infiltration clays (hydrologic soil groups C and D) and heavy or continuous rains could take longer to drain. Revegetation of the site post-construction is anticipated to aid in soil health and the ability for water to infiltrate and evaporate during storm events.

Modeling has not been conducted for a 5-year storm event and that data is not available. The preliminary flood model indicates there will be temporary standing water in the Project area during the 100-year/24-hour and 500-year/24-hour storms that were analyzed, but the results do not have information on how long it would take the water to dissipate. The detention basins will be designed to drain the 100-year stormwater within 48 hours. Smaller storm events would drain more quickly.

From CEC Hydrology Team:

The irregular shapes of the detention basins shown in Sheet 5 of the Preliminary Stormwater Plan and the lack of details in the Project Description and the Water Resources sections of the application result in questions concerning stormwater control:

Question 2: *Will the detention basins be constructed solely of soil berms that will eventually be vegetated? Will any riprap or culverts be used?*

Response 2: Detentions basins may be constructed using a variety of design options to meet stormwater volume requirements and net zero floodplain criteria including flat areas with soil and/or riprap berms and excavated bottom basins with or without soil and/or riprap berms. Options for outflow control include but are not limited to riprap weir outlets, perforated riser pipes with riprap, culverts with floating skimmers, culverts with riprap rings.

Question 3: *Based on Preliminary Stormwater Plan Sheet 5, detention basins would be located in the northeast corners of each solar facility drainage area based on the general slope of the topography. Will the detention basins be open, or unbermed to the southwest?*

Response 3: The basins would be open to the south and west to allow stormwater flows to enter unrestricted.

Question 4: *Will berms only be constructed along the northern and eastern margins of the drainage area northeast corner?*

Response 4: Berms will generally be constructed along the north and east sides of Project sections to divert water toward the basin areas. Placement of berms or other BMPs in other areas, such as within project sections or between solar panel rows may be considered to address areas of high velocity or erosion potential, or to aid in decreasing basin sizing and will be determined based on final modeling results.

Question 5: *What will be the length of the berms?*

Response 5: The detention basin berms will be of sufficient length and height to contain the storage volume and to divert flow into the basin. The final size of the detention basins and berms will be determined based on the final stormwater management study that is not yet complete.

Question 6: *If the berms are not long enough, will drainage area stormwater flow be adequately captured without escape to adjacent areas?*

Response 6: The Project will have detentions basins and berms located and adequately sized to ensure there is no increase in runoff from the Project site post-construction as compared to pre-construction conditions for the 100-year storm event. If final modeling indicates that stormwater flows will not increase post-construction along some boundaries of the Project area and would not result in significant scour or erosion, detention basins and berms would not be needed to control stormwater quantity and water would be allowed to naturally flow across the Project area and off site.

Question 7*: Both the Water Resources section of the application and the Preliminary Stormwater Plan state that detention basins will capture and treat stormwater. How will the detention basins treat stormwater?*

Response 7: Extended detention basins such as those that will be used for the Project are designed to temporarily detain stormwater runoff for some minimum time (typically 48 hours) to allow particles, trash, and associated pollutants to settle while the water is slowly released. Extended detention basins have been shown to be effective at reducing many of the pollutants regulated by the State and Regional Water Boards.

Question 8: *The Preliminary Stormwater Plan, Stormwater Management Practices section states that the detention basins will be designed with a minimum 1 foot of freeboard from the top of the berm. What design element will ensure this freeboard? Would it be possible to get a schematic design drawing of the typical detention basin?*

Response 8: The 1-foot freeboard will be met by adjusting the basin size, berm elevation, and outflow control. These will be modeled using modeling software such as HydroCAD or equivalent. Attached is a schematic showing a concept that could be used which includes a detention basin with a berm, outflow culvert, and berm spillway. Other basin designs and controls could be used in the design, and this concept is subject to change based on final Project layout and stormwater modeling.

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/22/2025 10:00:39 PM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
Subject: Re: FW: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Hi Lisa - yes! These are the responses I am working to finalize with our engineering contractor and get back to you very soon.

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Wed, Jan 22, 2025 at 2:26 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Hi Becky,
>
> I wanted to confirm with you that these items will be addressed in your upcoming submittal to the docket. We want to make sure we don't have any lingering questions as we work to wrap up our analysis.
>
> Thanks,
>
> Lisa
>
> **From:** Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
> **Sent:** Wednesday, January 22, 2025 11:37 AM
> **To:** Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
> **Cc:** Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
> **Subject:** Fw: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report
>
> Hi Lisa,

Can you follow up on this please?

Thanks!

Ann

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, January 15, 2025 8:13 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Subject: Re: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Lisa - just wanted to let you know we are working on these questions and will get you back responses as soon as possible.

Becky Moores

INTERSECT POWER

(e) becky.moores@intersectpower.com

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> Hi Becky,
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A description of the predicted frequency that standing water would occur, and the length of time to percolate. For example, is standing water expected on site most years during rainy season? Or only during a 100 year storm? What about standing water during a 5 year storm, an event more likely to occur during the project's lifetime than the modeled 100 year storm.

Thanks,

Lisa

From: Worrall, Lisa@Energy
Sent: Monday, January 13, 2025 1:22 PM
To: Becky Moores <becky.moores@intersectpower.com>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Subject: RE: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

I was waiting for questions from bio, but in the meanwhile, here are the questions that Water Resources have.

We need to get these resolved so it doesn't affect our document publication timing.

From: Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Sent: Friday, January 10, 2025 9:05 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>
Subject: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Lisa: I can't speak for BIO, but I suggest the following questions regarding stormwater control.

"The irregular shapes of the detention basins shown in Sheet 5 of the Preliminary Stormwater Plan and the lack of details in the Project Description and the Water Resources sections of the application result in questions concerning stormwater control:

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James Ackerman, PG #6493

Engineering Geologist

California Energy Commission

Siting, Transmission and Environmental Protection Division

Direct: (530) 878-4966

Email: james.ackerman@energy.ca.gov

From: Becky Moores [becky.moores@intersectpower.com]
Sent: 1/22/2025 4:43:25 PM
To: Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]
CC: Kerr, Steven@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=d0d5a66bed2249fca830918f58b3b921-Kerr, Steve]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: Re: Darden-Request for updates to three land use figures

We are finalizing responses to the stormwater management that you sent over and hope to submit those today or first thing tomorrow. When you confirm those are complete I can submit these figures and those responses to the docket together.

Thanks,

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Sun, Jan 19, 2025 at 2:12 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Hi Becky,
>
> Can you submit these to the docket. We would love to reference them in our land use section.
>
> Thanks,
>
> Lisa

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Friday, January 17, 2025 2:36 PM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Kerr, Steven@Energy <Steven.Kerr@energy.ca.gov>; Will Lutkewitte <will.lutkewitte@intersectpower.com>
Subject: Re: Darden-Request for updates to three land use figures

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe.

Hi Lisa,

Updated figures attached. Just in case it is needed, I also included an updated overview land use figure from the mapbook that was provided in Appendix A in response set #6.

Thank you,

Becky Moores

INTERSECT POWER

(e) becky.moores@intersectpower.com

On Tue, Jan 14, 2025 at 12:20 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

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>
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> Thanks kindly,
>
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>
> Senior Environmental Planner
>
> California Energy Commission
>
> Siting, Transmission and Environmental Protection Division
>
> 715 P Street, MS-40, Sacramento, CA 95814
>
> Direct: (916) 661-8367

Email: lisa.worrall@energy.ca.gov

From: Worrall, Lisa@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=E4BBC7048B38485084BDB03FB494B25B-WORRALL, LI]
Sent: 1/22/2025 9:26:09 PM
To: Becky Moores [becky.moores@intersectpower.com]
Subject: FW: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Hi Becky,

I wanted to confirm with you that these items will be addressed in your upcoming submittal to the docket. We want to make sure we don't have any lingering questions as we work to wrap up our analysis.

Thanks,

Lisa

From: Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>
Sent: Wednesday, January 22, 2025 11:37 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Subject: Fw: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Hi Lisa,

Can you follow up on this please?

Thanks!

Ann

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, January 15, 2025 8:13 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
Subject: Re: Re: Darden- Questions in response to Preliminary Stormwater Report and 2D hydraulic analysis report

Lisa - just wanted to let you know we are working on these questions and will get you back responses as soon as possible.

Becky Moores
INTERSECT POWER
(e) becky.moores@intersectpower.com

On Mon, Jan 13, 2025 at 6:34 PM Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov> wrote:

> Hi Becky,

Here is bio's question:

A description of the predicted frequency that standing water would occur, and the length of time to percolate. For example, is standing water expected on site most years during rainy season? Or only during a 100 year storm? What about standing water during a 5 year storm, an event more likely to occur during the project's lifetime than the modeled 100 year storm.

Thanks,

Lisa

From: Worrall, Lisa@Energy
Sent: Monday, January 13, 2025 1:22 PM
To: Becky Moores <becky.moores@intersectpower.com>
Cc: Knight, Eric@Energy <Eric.Knight@energy.ca.gov>; Chang, Kaycee@Energy <kaycee.chang@energy.ca.gov>; Crisp, Ann@Energy <Ann.Crisp@energy.ca.gov>; Abulaban, Abdel-Karim@Energy <Abdel-Karim.Abulaban@energy.ca.gov>; Watson, Carol@Energy <Carol.Watson@energy.ca.gov>; Ackerman, James@Energy <james.ackerman@energy.ca.gov>
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Sent: 1/22/2025 4:45:51 PM
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CC: Kerr, Steven@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=d0d5a66bed2249fca830918f58b3b921-Kerr, Steve]; Will Lutkewitte [will.lutkewitte@intersectpower.com]
Subject: RE: Darden-Request for updates to three land use figures

Great. Thanks Becky. Our biologist was following up with me on the stormwater.

From: Becky Moores <becky.moores@intersectpower.com>
Sent: Wednesday, January 22, 2025 8:43 AM
To: Worrall, Lisa@Energy <Lisa.Worrall@energy.ca.gov>
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> California Energy Commission

Siting, Transmission and Environmental Protection Division

715 P Street, MS-40, Sacramento, CA 95814

Direct: (916) 661-8367

Email: lisa.worrall@energy.ca.gov

From: Crisp, Ann@Energy [/O=EXCHANGELABS/OU=EXCHANGE ADMINISTRATIVE GROUP (FYDIBOHF23SPDLT)/CN=RECIPIENTS/CN=B89C4DE7ECE742679D19E1E3EE713DC2-CRISP, ANN@]
Sent: 11/13/2023 6:58:00 PM
To: Vance, Julie@Wildlife [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=6520208b372048588fbfe79308ba3f9c-WildlifeJul]; Bonner, Lawrence(Larry)@Wildlife [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1869dadea1e4452e9802a366a8cd9d2a-WildlifeLaw]; Mulligan, Rhiannon@Wildlife [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=a62a013861764f1e8556eaf023a2cc94-WildlifeRhi]; Tomlinson, Krista@Wildlife [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=0b9c5c6ec182444e9150d634cfda0969-WildlifeKri]
CC: Knight, Eric@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=be42548337f44852a291a9845f226f62-Knight, Eri]; Worrall, Lisa@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=e4bbc7048b38485084bdb03fb494b25b-Worrall, Li]; Babula, Jared@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=6cf386251c7a47f697f411cee0910882-Babula, Jar]; Mayer, Alex@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=1a7ef7ec23eb4292abd2748ce1b69948-ef756fa8-50]; Watson, Carol@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=84e32d50c7dc47d89812b468a50090ed-Watson, Car]; Stroud, Andrea@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=9703ce11dc9547c78c64f22894500b5c-Martine, An]; Hilliard, Jon@Energy [/o=ExchangeLabs/ou=Exchange Administrative Group (FYDIBOHF23SPDLT)/cn=Recipients/cn=27a838bfda534669858cb8cf13dd12a4-Hilliard, J]
Subject: Darden Clean Energy Project (23-OPT-02) - Notice of Receipt of Opt-In Application and Request for CDFW MOU Coordination
Attachments: Darden_Notice of Receipt of Opt In Application_MOU_Agencies.pdf

Hello,

This email serves as notification of receipt of an Opt-in application under Public Resources Code 25519 for the proposed Darden Clean Energy Project (23-OPT-02). This project is proposed in unincorporated Fresno County. The attached letter outlines project information and your responsibilities under AB 205.

Carol Watson and Andrea Stroud will be your technical staff contacts for biological resources. They will reach out to you and include any data requests you have of the applicant in our Data Completeness Letter that will be posted to the proceeding's docket. Jon Hilliard is the supervisor for the Biological Resources Unit

If you have any technical questions, please contact Carol and Andrea. If you have questions about the project in general or about the Opt-in process, please contact me and Lisa Worrall, co-project manager.

This information should be provided within 15 days, per the MOUs, which falls on Saturday November 25, therefore a response by Wednesday November 22 is appreciated.

We appreciate your timely responses and look forward to coordinating with you as the evaluation moves forward.

Thank you,

Ann Crisp
Senior Environmental Planner
Siting, Transmission & Environmental Protection Division
California Energy Commission
715 P Street
Sacramento, CA 95814
Direct: (916) 776-7975
Fax: (916) 651-8868