DOCKETED	
Docket Number:	23-OPT-02
Project Title:	Darden Clean Energy Project
TN #:	261662
Document Title:	Preliminary Stormwater Management Report
Description:	Preliminary stormwater management report. Although the pertinent information was included in Section 5.13 Water Resources of the original application materials, the CEC requested these documents be docketed.
Filer:	Becky Moores
Organization:	Intersect Power
Submitter Role:	Applicant
Submission Date:	2/7/2025 5:48:58 PM
Docketed Date:	2/10/2025

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:

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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.

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

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Exhibits

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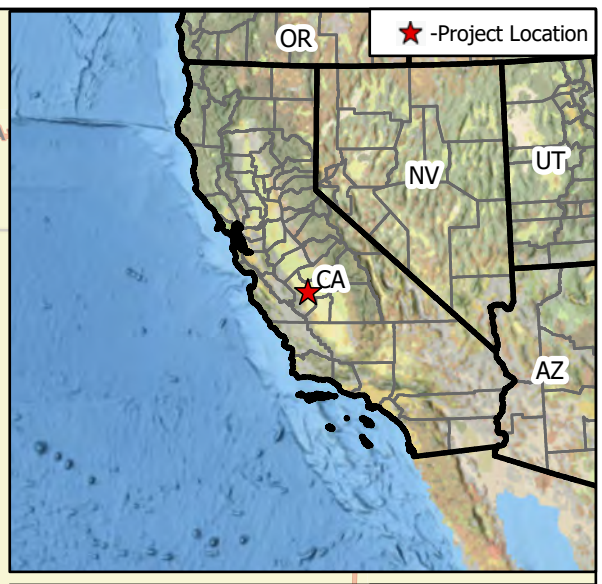

Data Source(s): Westwood (2023); Esri WMS Basemap Imagery (Accessed 2023); USGS (2023); FEMA (2023); USDA (2023)

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

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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
- County Boundary
- HUC-12 Boundary
- NHD Flowlines

N

0 4,000 Feet

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Exhibit 2: Base Hydrologic Map

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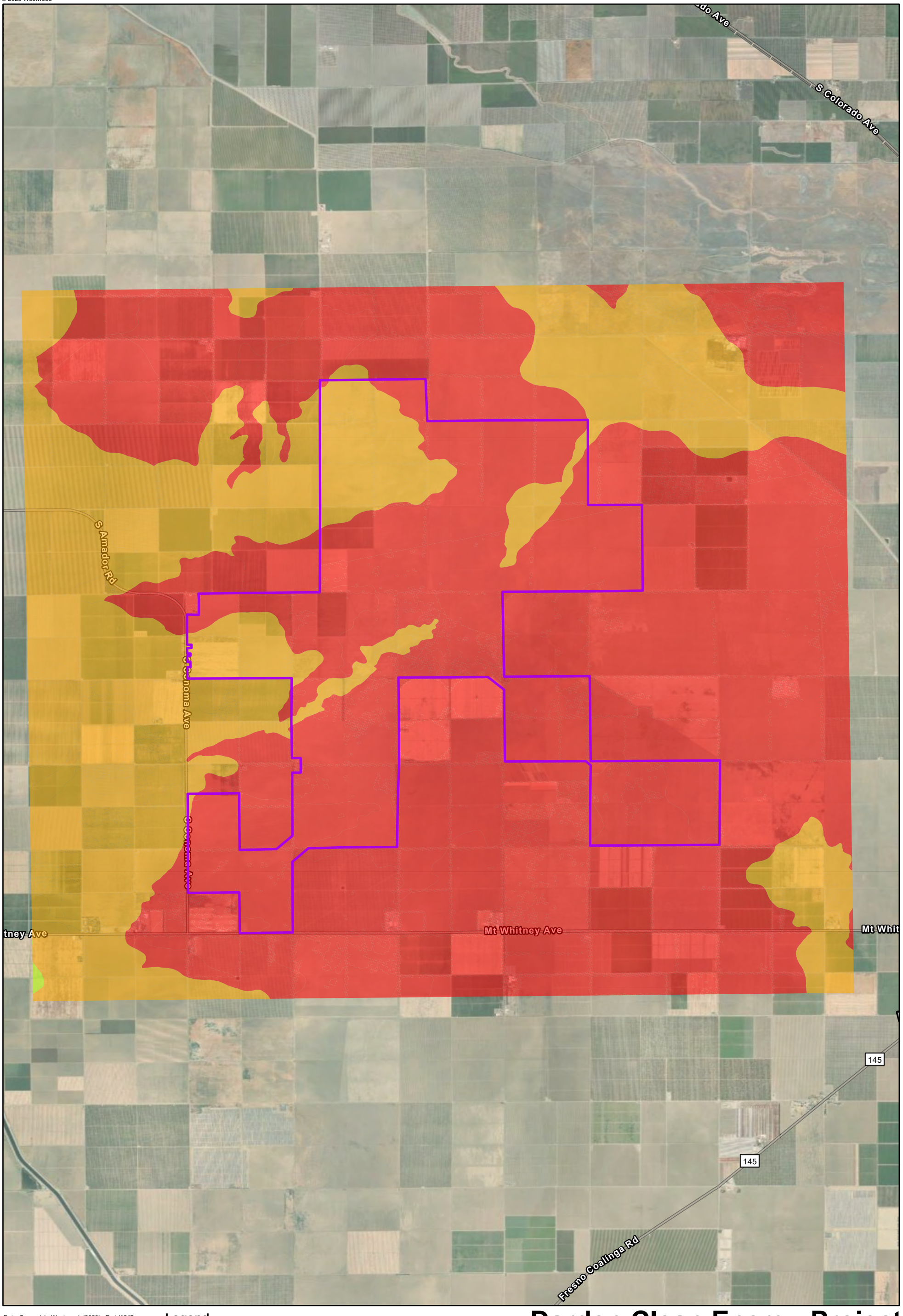

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Legend

- Property Boundary
- County Boundary

Hydrologic Soils Group

- A
- B
- C
- D
- W

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Exhibit 3: Soils Map

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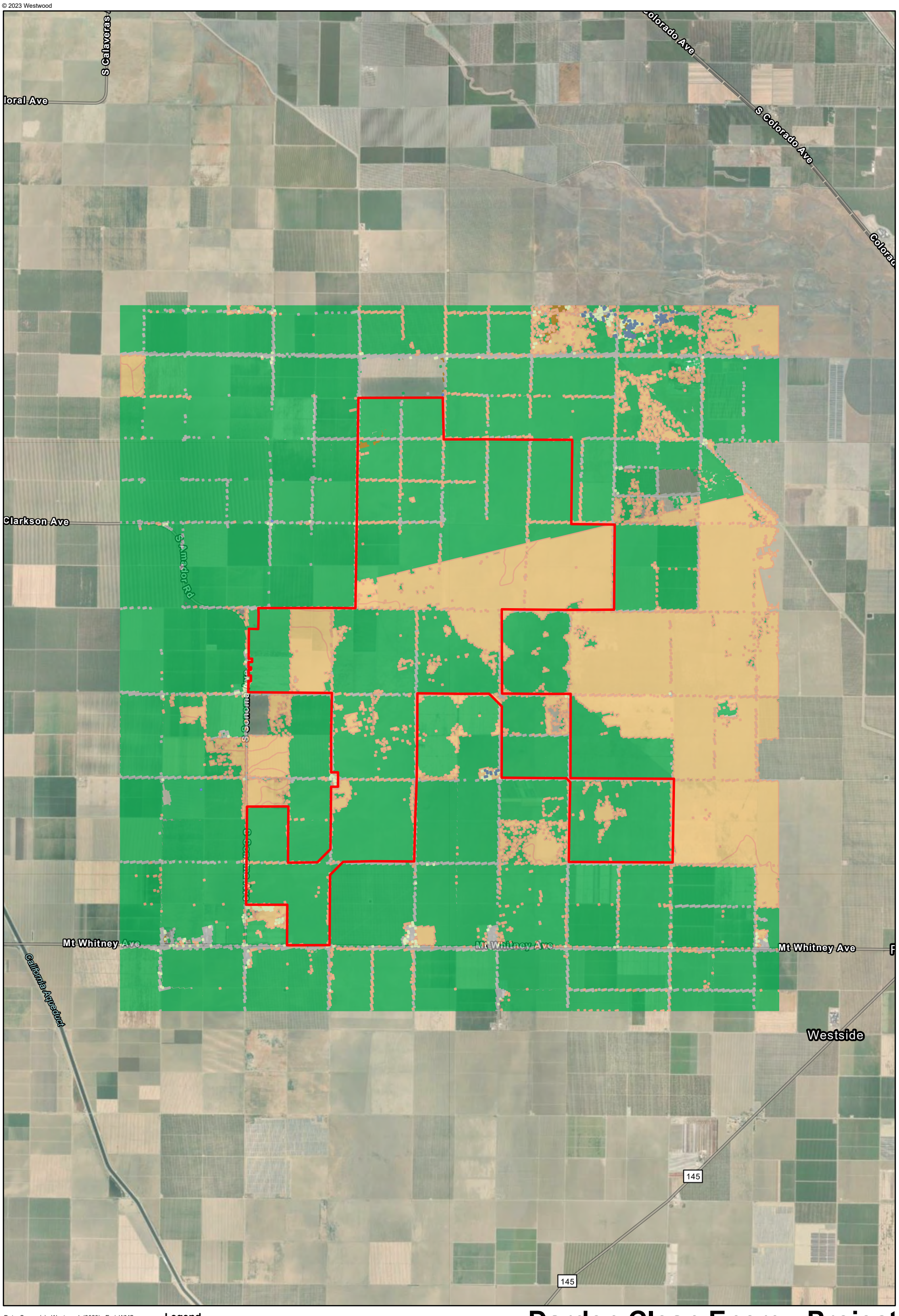

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Legend

- 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

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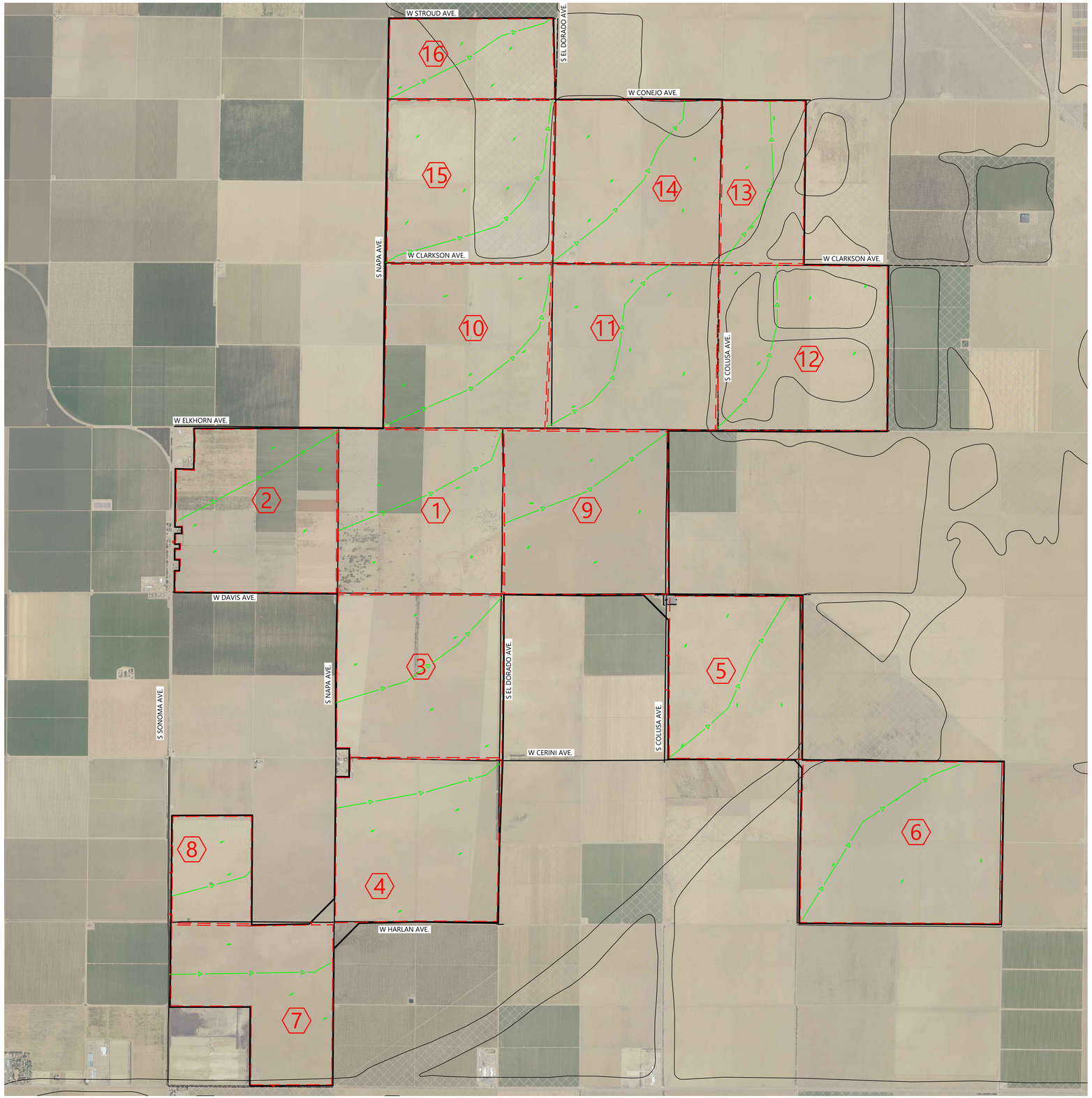
Exhibit 4: Landcover Map

April 13, 2023



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

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IP DARDEN I, LLC

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0' 1700' 3400' 5100'

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Fresno County, CA

Overall Existing Drainage Map

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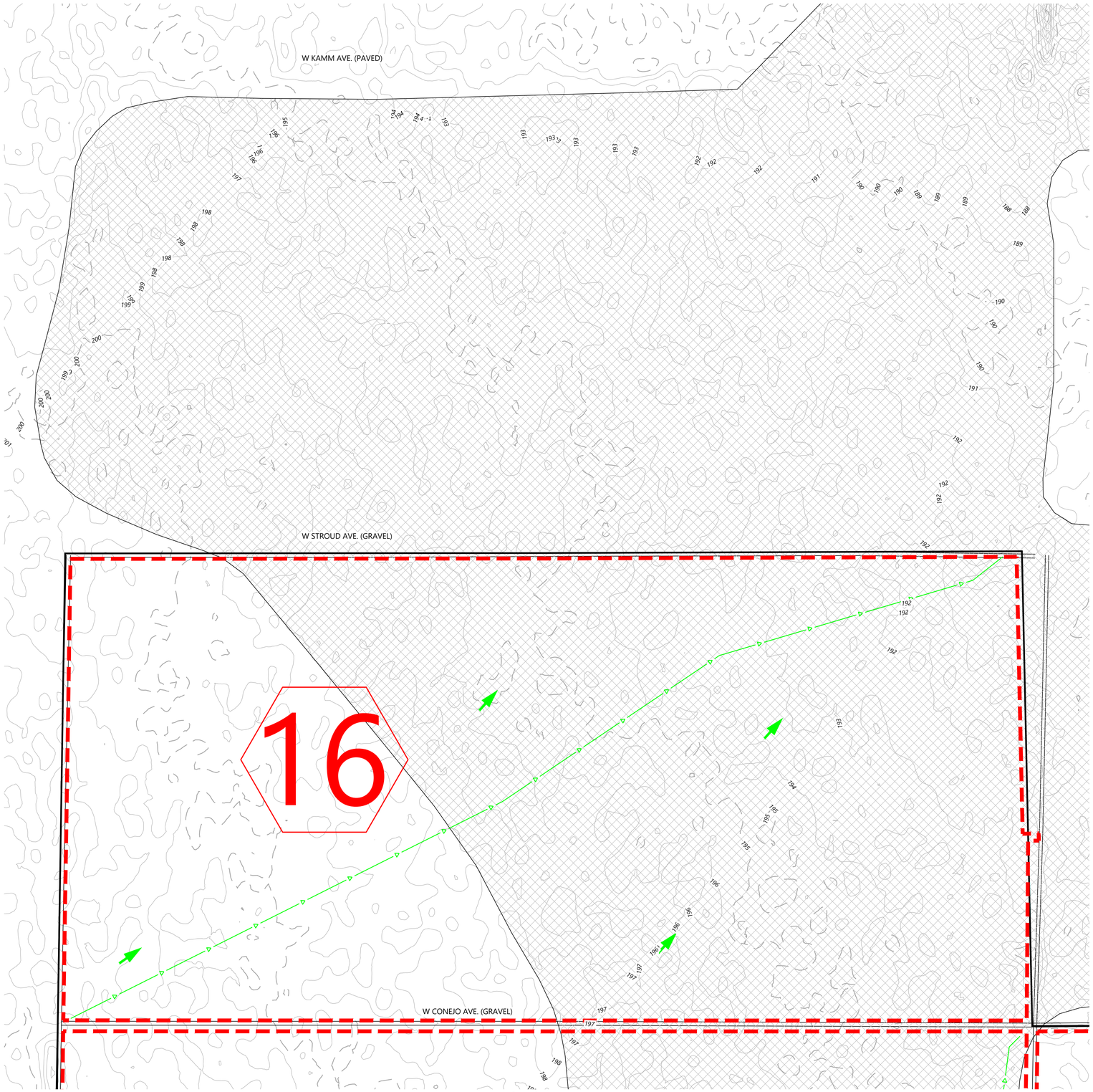

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Existing Drainage Map

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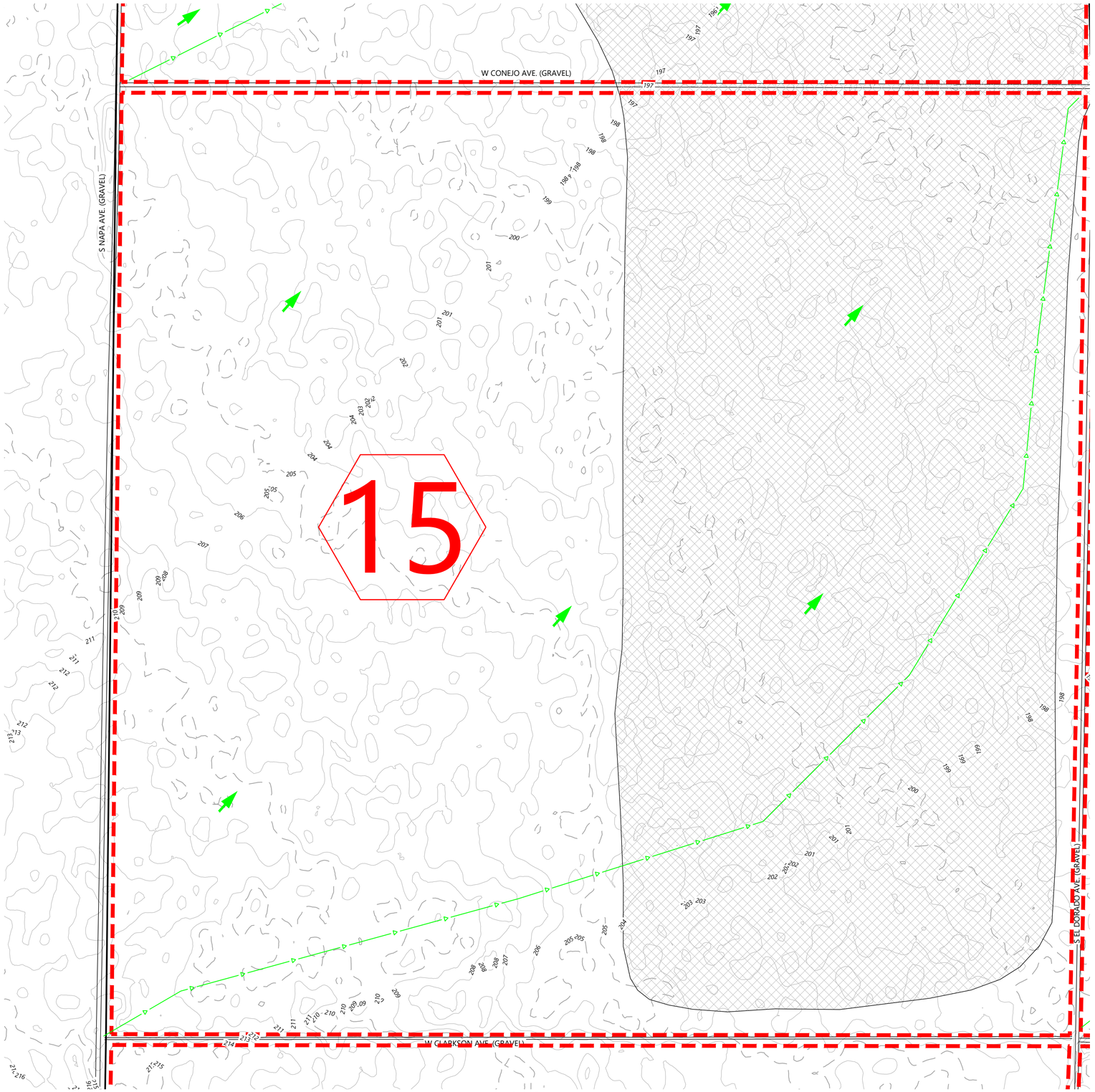

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Existing Drainage Map

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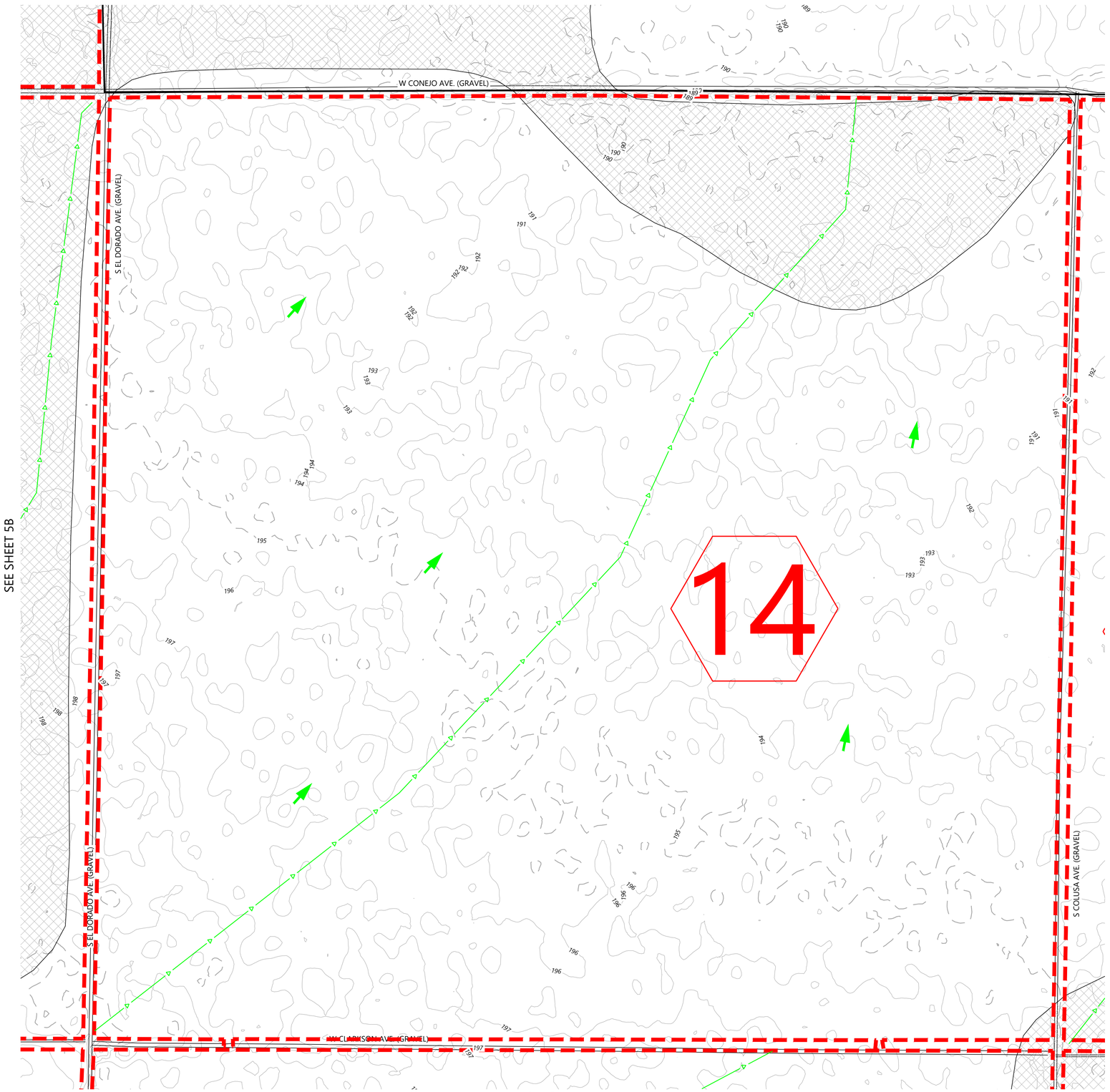

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Existing Drainage Map

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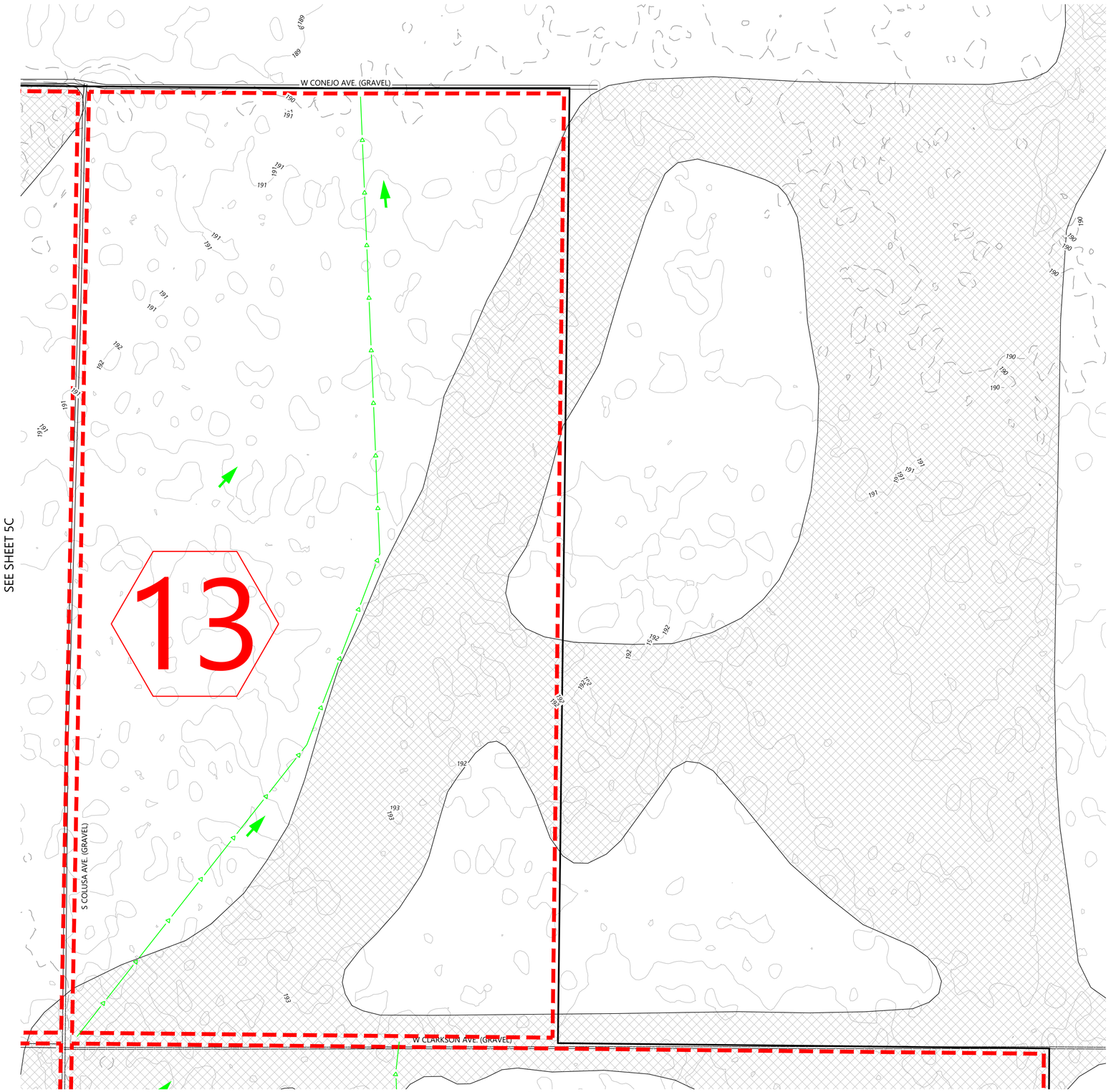

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Existing Drainage Map

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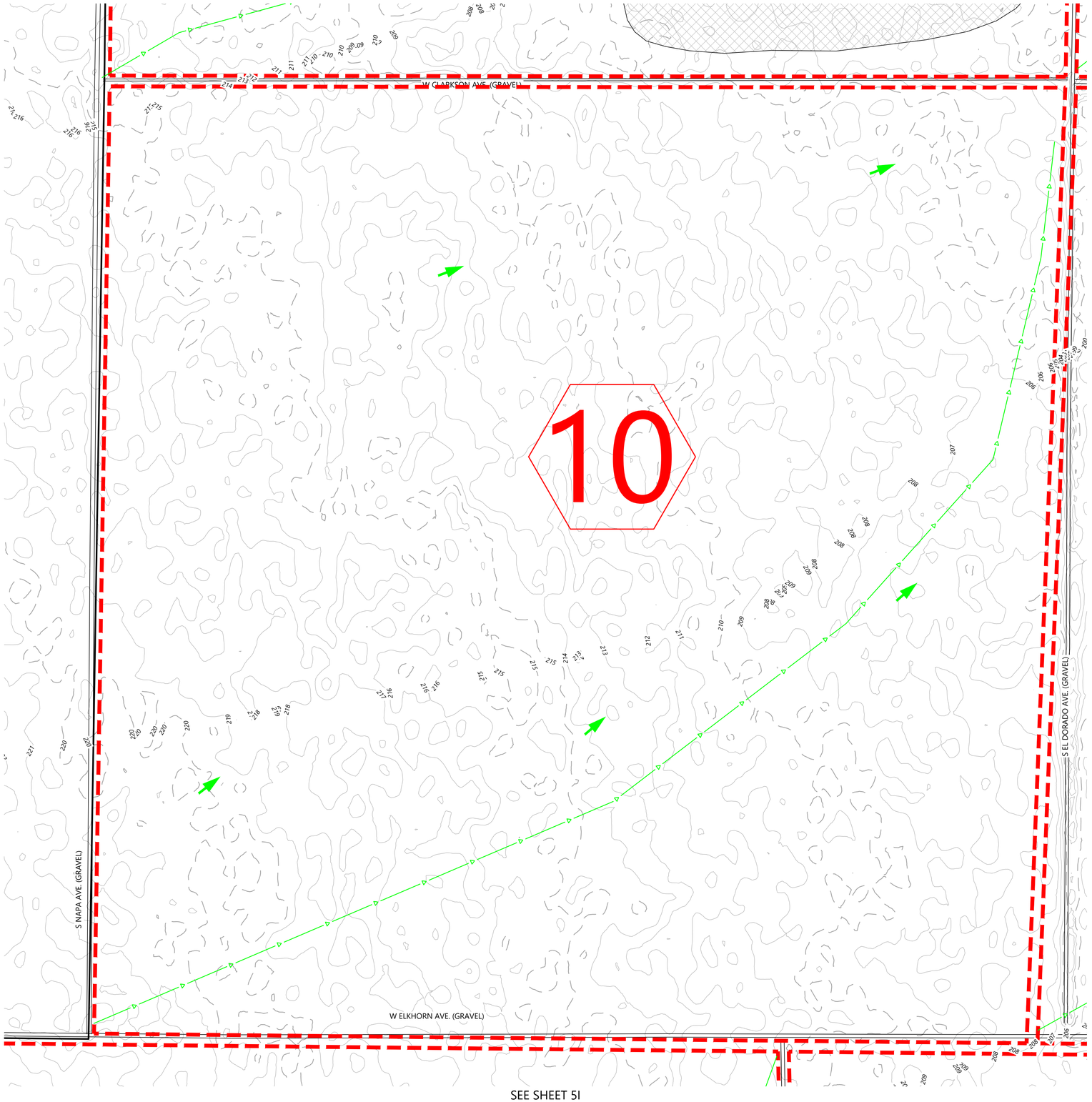

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Existing Drainage Map

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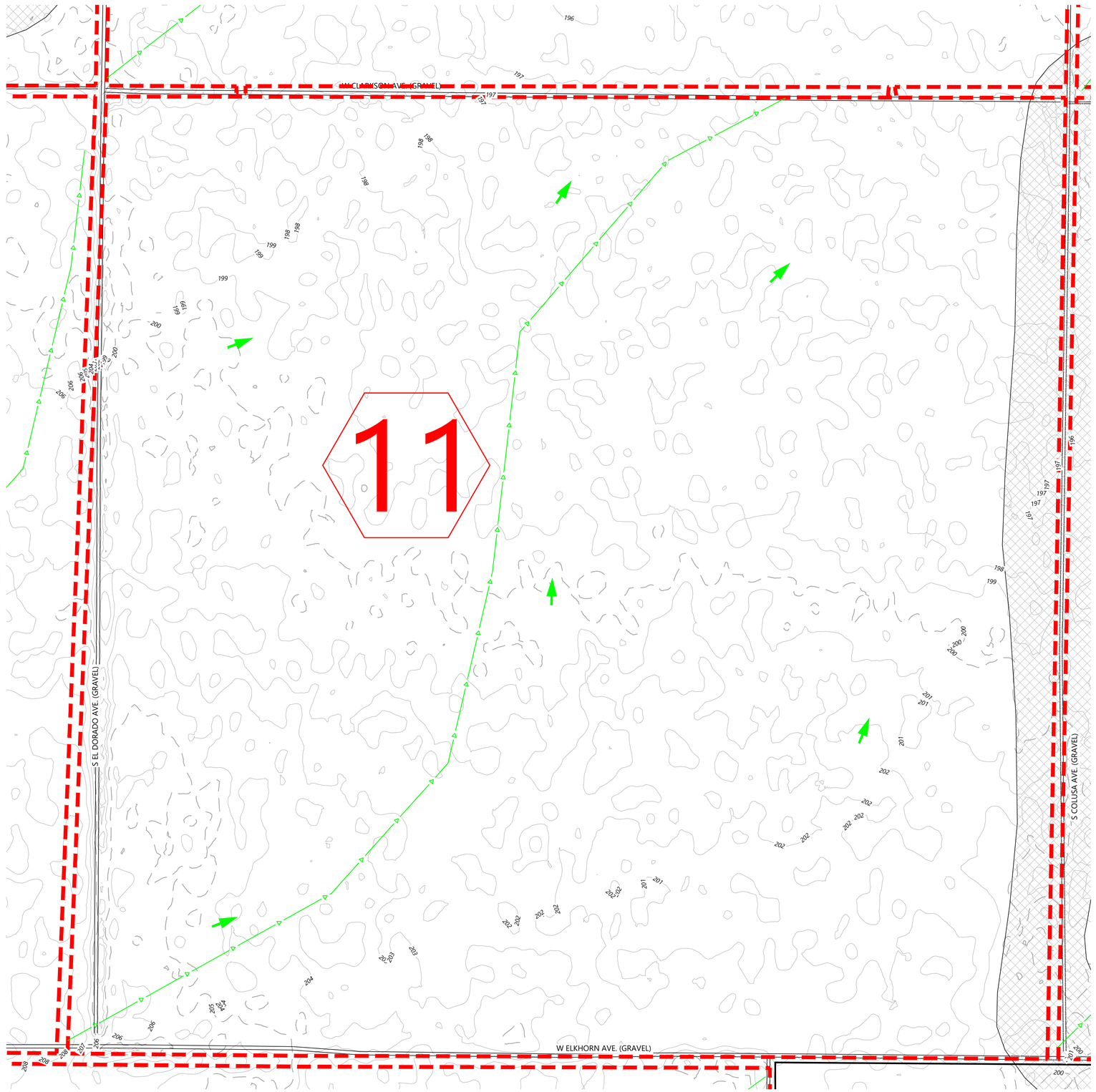

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- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
- EX. CULVERT
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
- FEMA FLOOD HAZARD ZONE
- EX. ONSITE DRAINAGE AREA BOUNDARY
-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

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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

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5F

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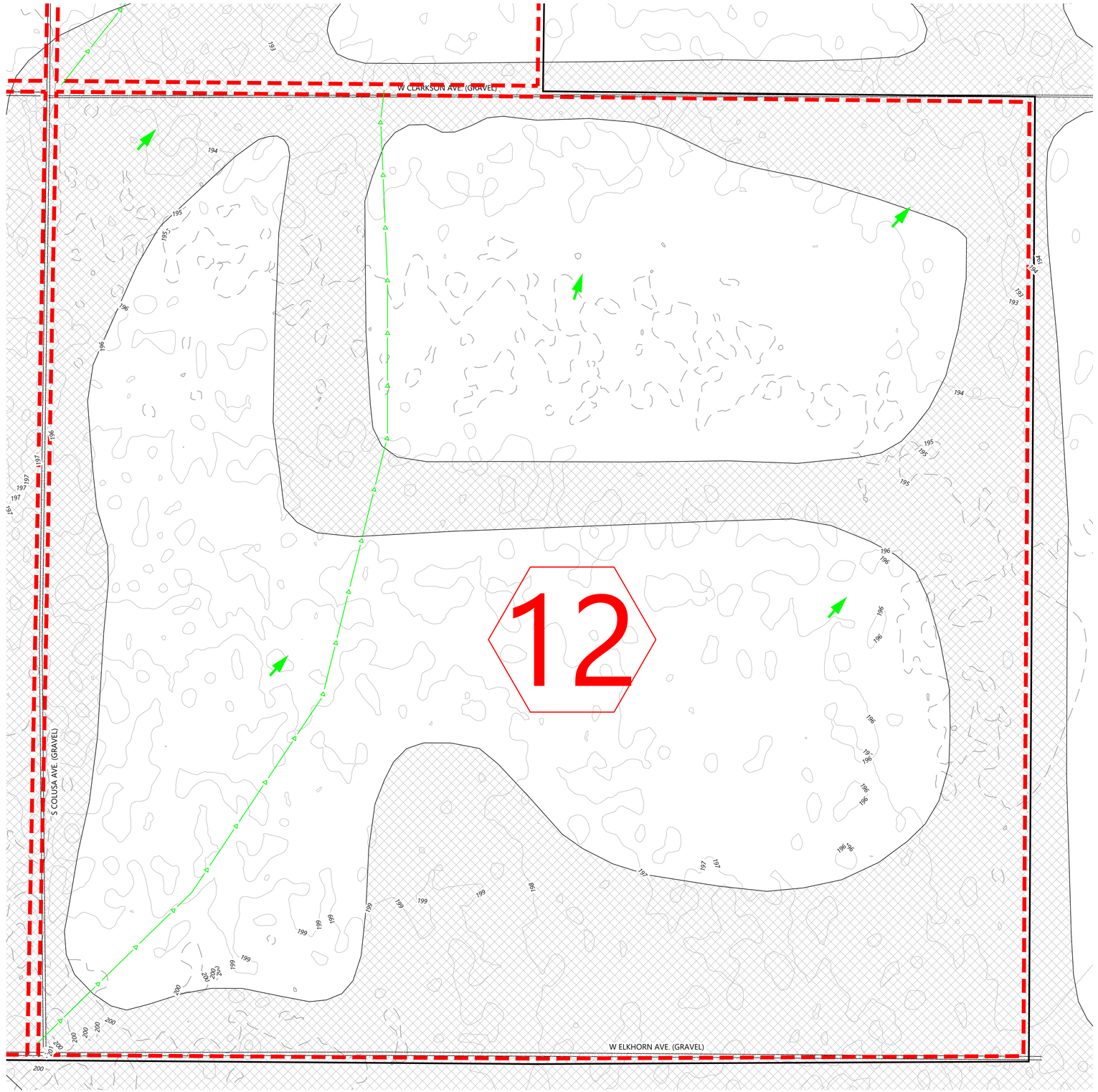

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
- EX. BUILDING
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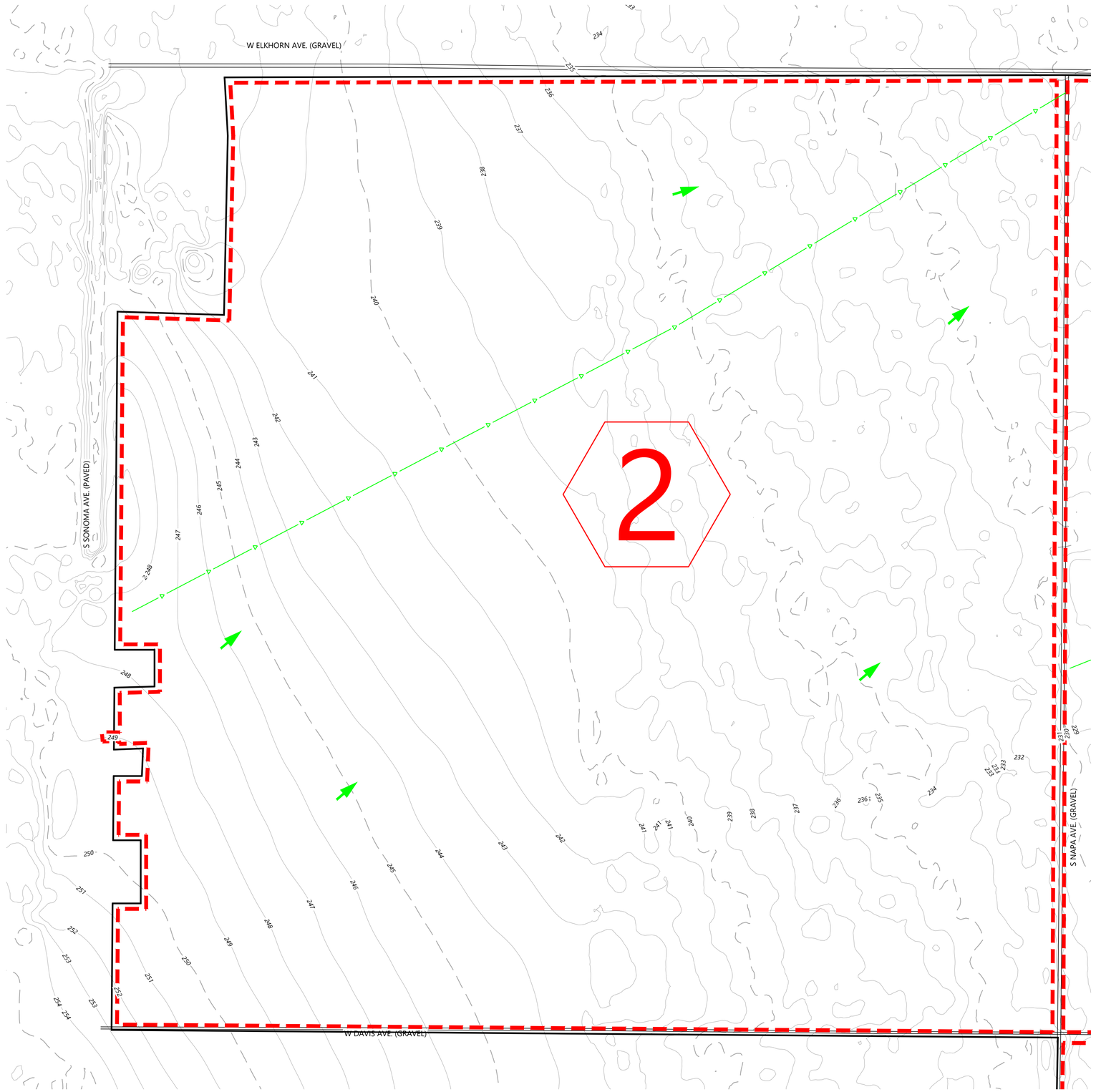
0' 300' 600' 900'

IP Darden
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023
REV:
SHEET: 5G



LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
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0' 300' 600' 900'

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5H

SEE SHEET 5E

W ELKHORN AVE. (GRAVEL)

SEE SHEET 5H

SEE SHEET 5J

S NAPA AVE. (GRAVEL)

S EL DORADO AVE. (GRAVEL)

W DAVIS AVE. (GRAVEL)

SEE SHEET 5K

1

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
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IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5I

SEE SHEET 5F

W ELKHORN AVE. (GRAVEL)

S EL DORADO AVE. (GRAVEL)

S COLUSA AVE. (GRAVEL)

W DAVIS AVE. (GRAVEL)

SEE SHEET 5I

SEE SHEET 5L

9

LEGEND:

- PROJECT BOUNDARY
- 900 EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
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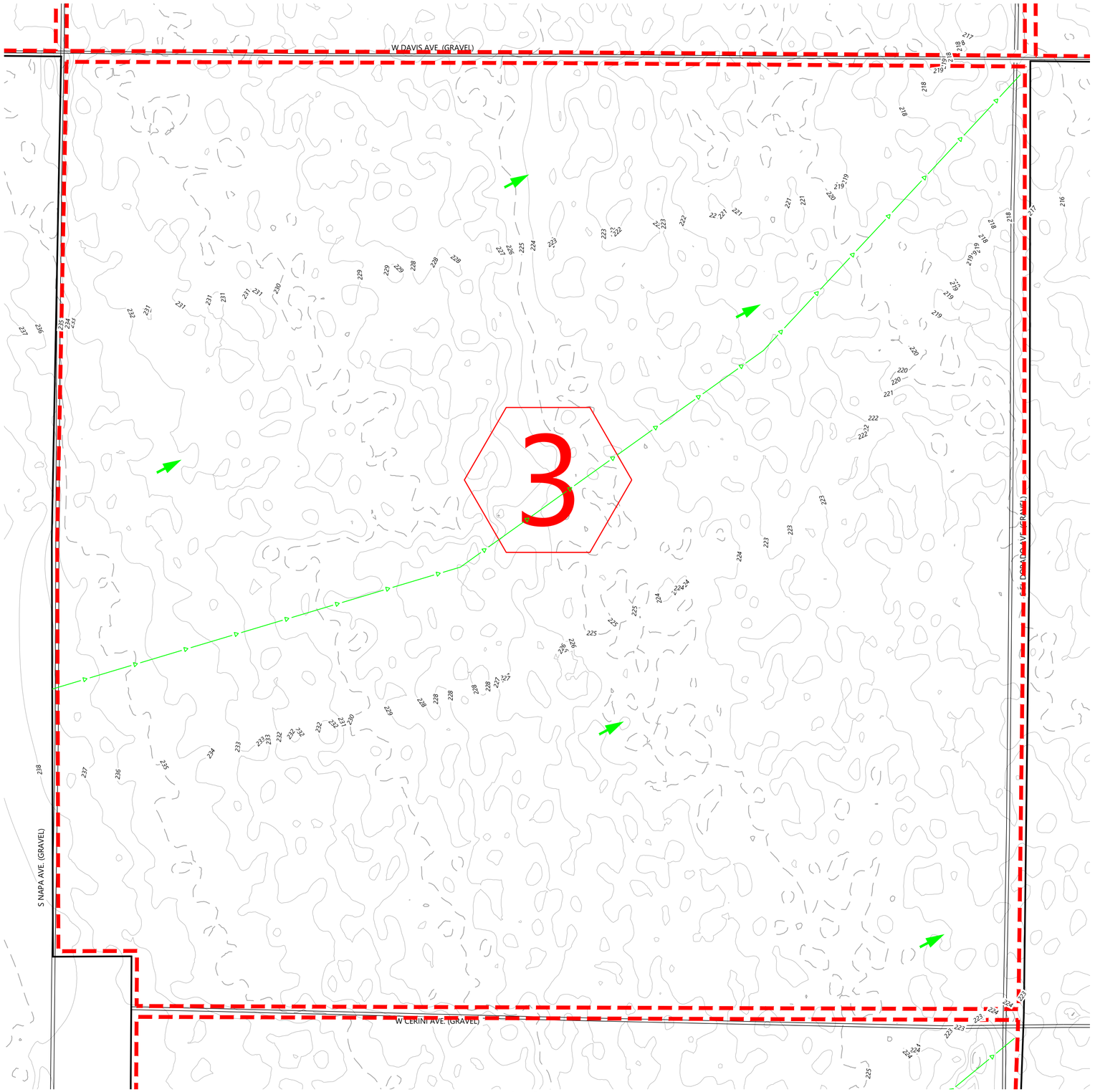
Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5J

SEE SHEET 5I



SEE SHEET 5N

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
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IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5K

SEE SHEET 5J

W DAVIS AVE. (GRAVEL)

S COLUSA AVE. (GRAVEL)

W CERINI AVE. (GRAVEL)

SEE SHEET 5O

5

LEGEND:

- PROJECT BOUNDARY
- 900 EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
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Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

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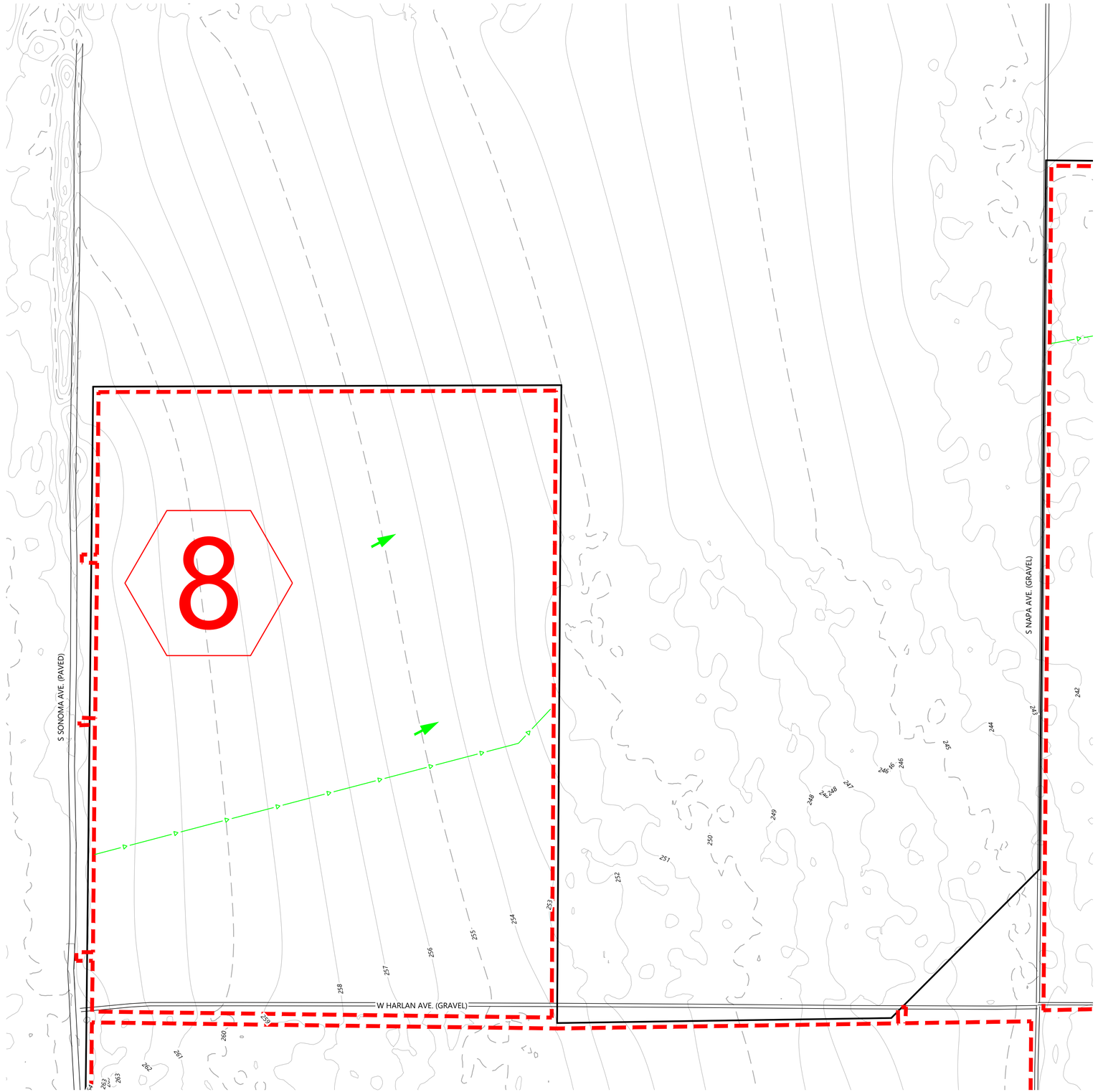

LEGEND:

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- EX. INDEX CONTOUR
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Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5M

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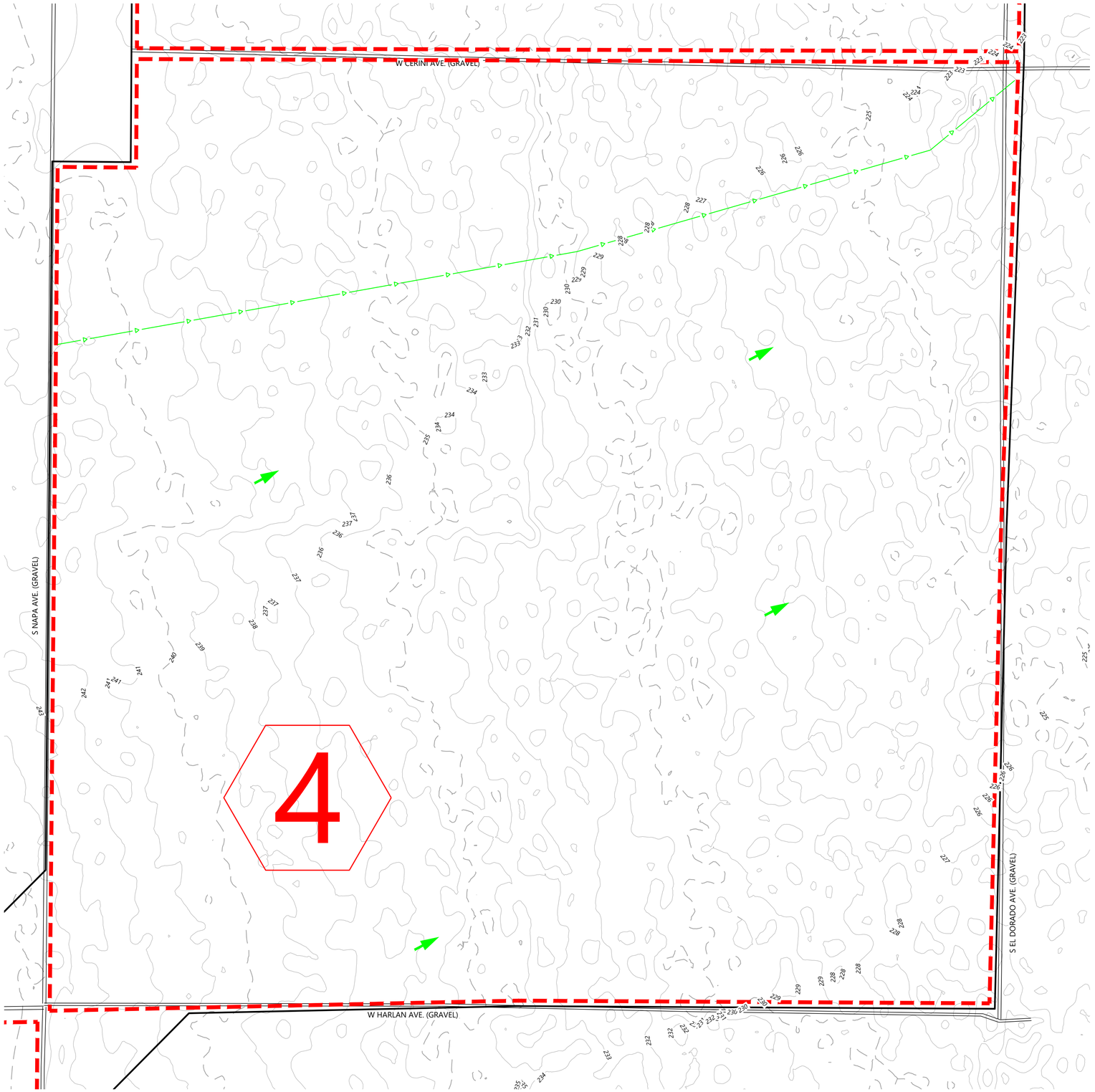

SEE SHEET 5M

LEGEND:

- PROJECT BOUNDARY
- 900 EX. INDEX CONTOUR
- EX. INTERVAL CONTOUR
- EX. TREELINE
- EX. PAVED ROAD
- EX. GRAVEL ROAD
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#	DATE	COMMENT	BY	CHK	APR

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Fresno County, CA

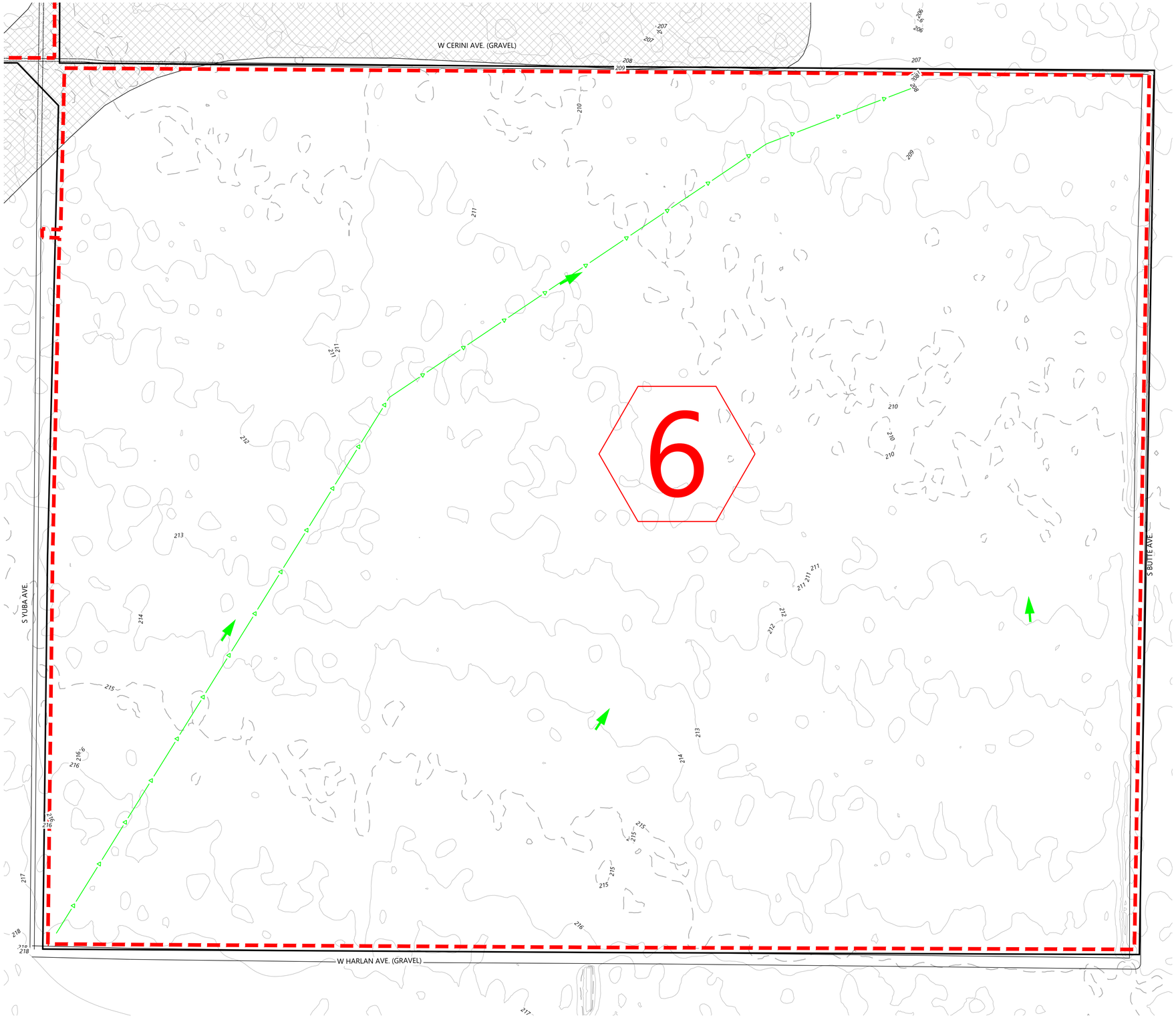
Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5N

SEE SHEET 5L



LEGEND:

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REVISIONS:

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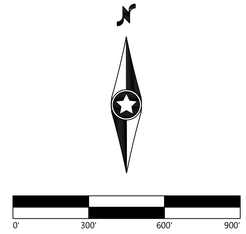

IP Darden

Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

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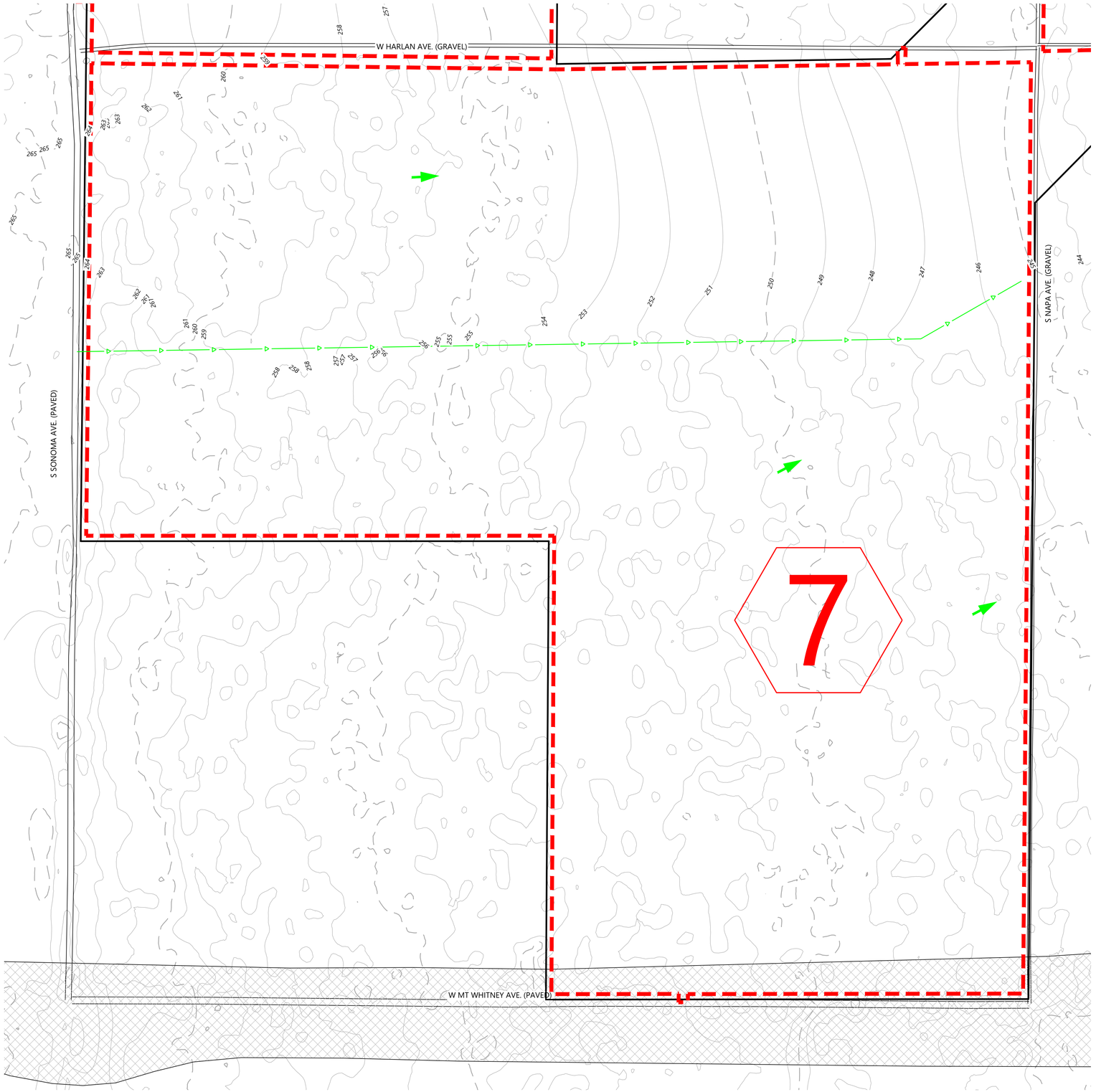
SEE SHEET 5P



LEGEND:

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IP DARDEN I, LLC

REVISIONS:

#	DATE	COMMENT	BY	CHK	APR
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0' 300' 600' 900'

IP Darden

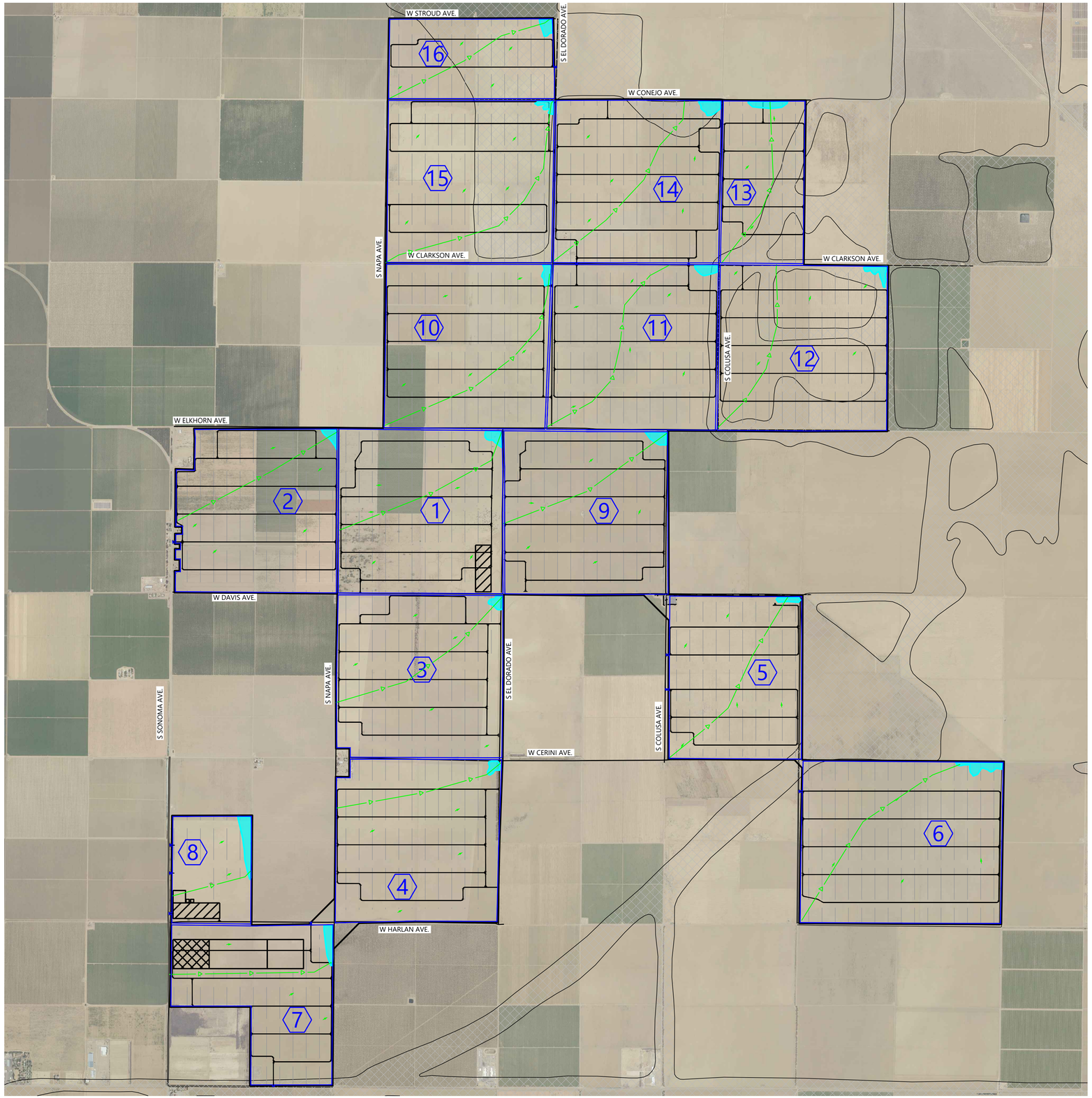
Fresno County, CA

Existing Drainage Map

DATE: 04/14/2023

REV:

SHEET: 5P



LEGEND:

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- PROPOSED SECURITY FENCE
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
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REVISIONS:

#	DATE	COMMENT	BY	CHK	APR

0' 1700' 3400' 5100'

IP Darden

Fresno County, CA

Overall Proposed Drainage Map

DATE: 04/14/2023

REV:

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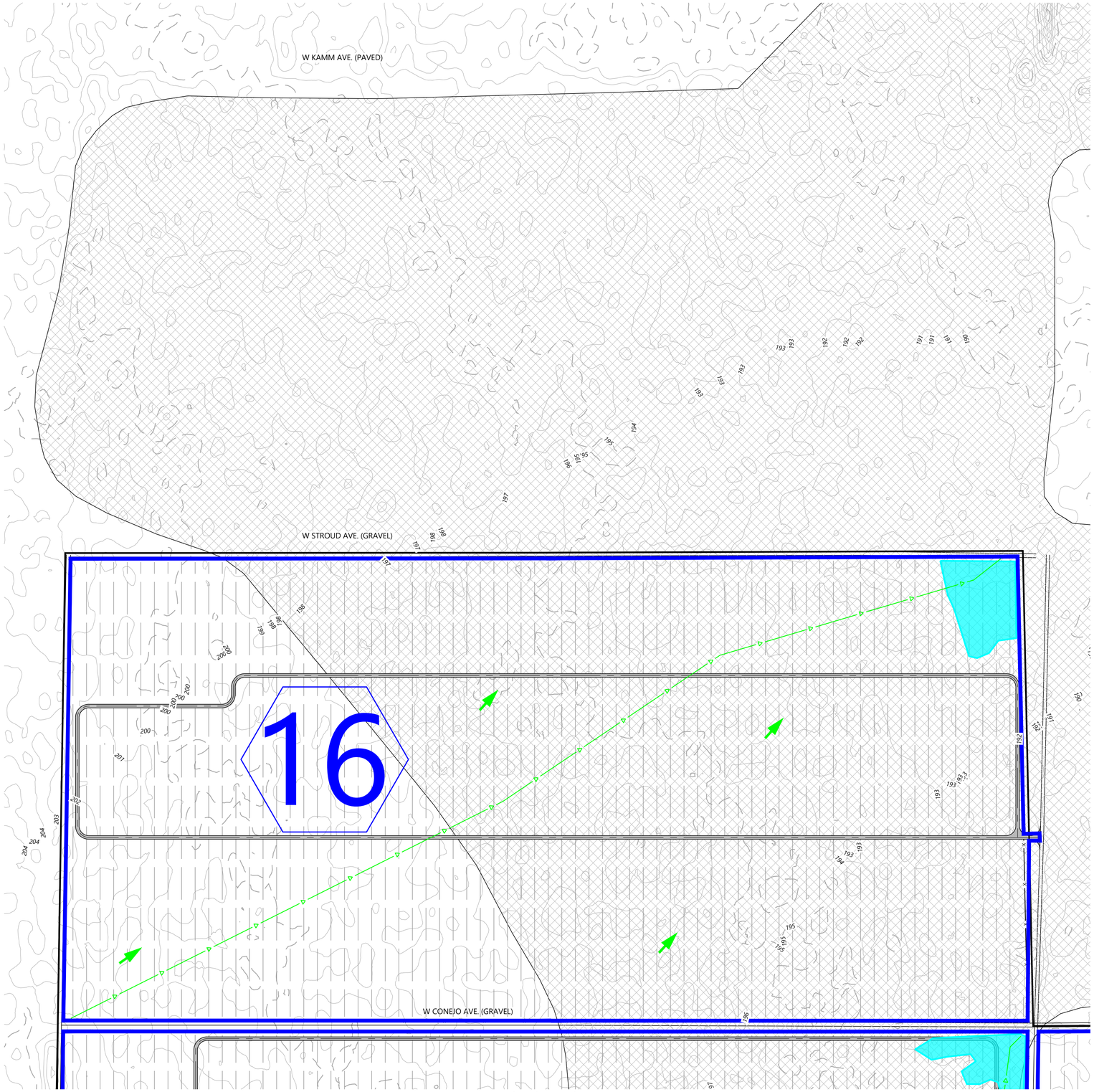

LEGEND:

- PROJECT BOUNDARY
- EX. INDEX CONTOUR
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- PROPOSED INDEX CONTOUR
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IP Darden

Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

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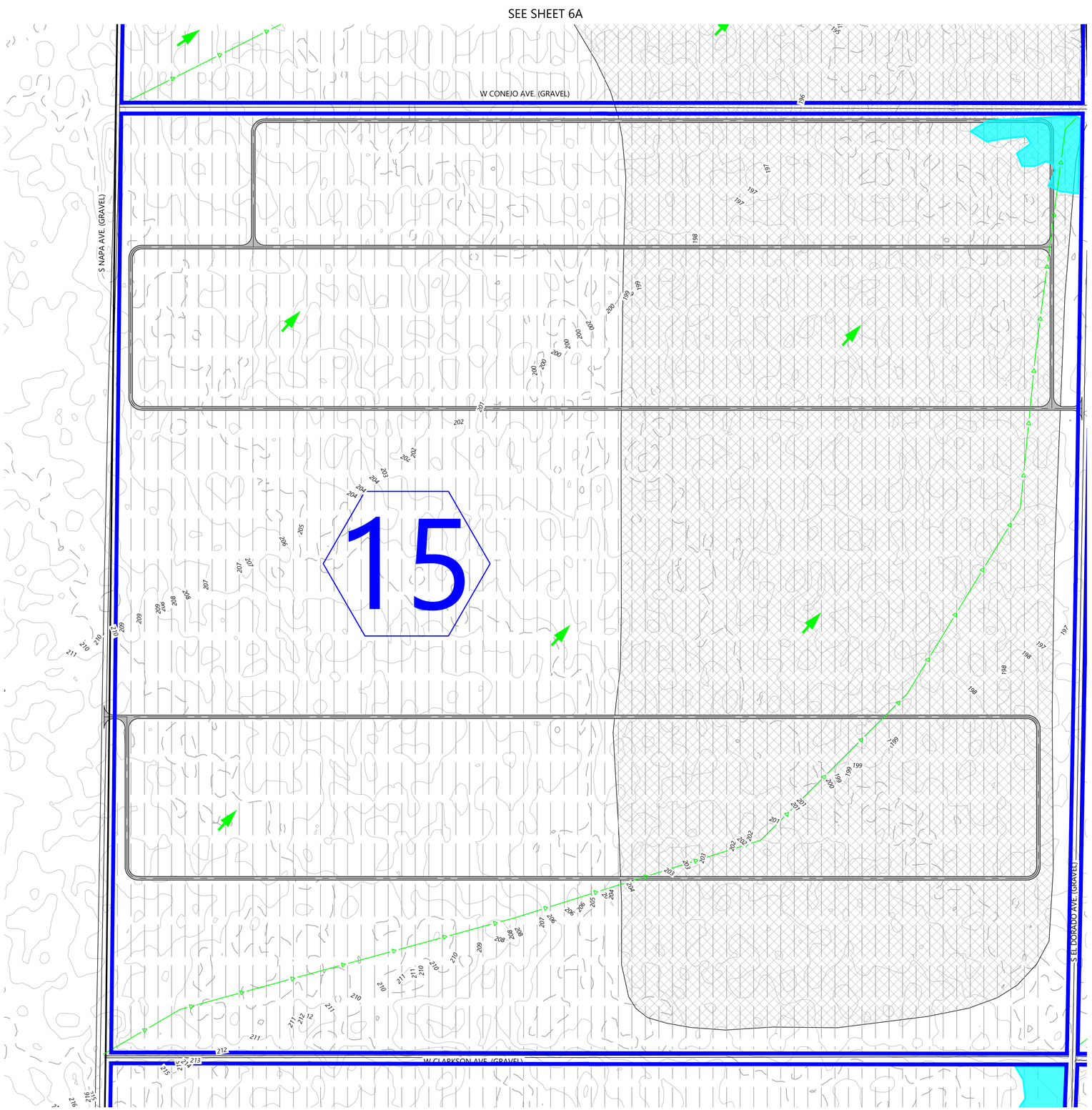

LEGEND:

- PROJECT BOUNDARY
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- EX. BUILDING
- EX. CULVERT (STO)
- EX. STREAM CHANNEL
- EX. WATER FEATURE SETBACK
- EX. WETLAND
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- PROPOSED SOLAR ARRAY
- PROPOSED ACCESS ROAD
- PROPOSED SECURITY FENCE (X)
- PROPOSED ELECTRICAL EQUIPMENT
- PROPOSED BASIN LOCATION
- PROPOSED INDEX CONTOUR (900)
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IP Darden
Fresno County, CA

Proposed Drainage Map

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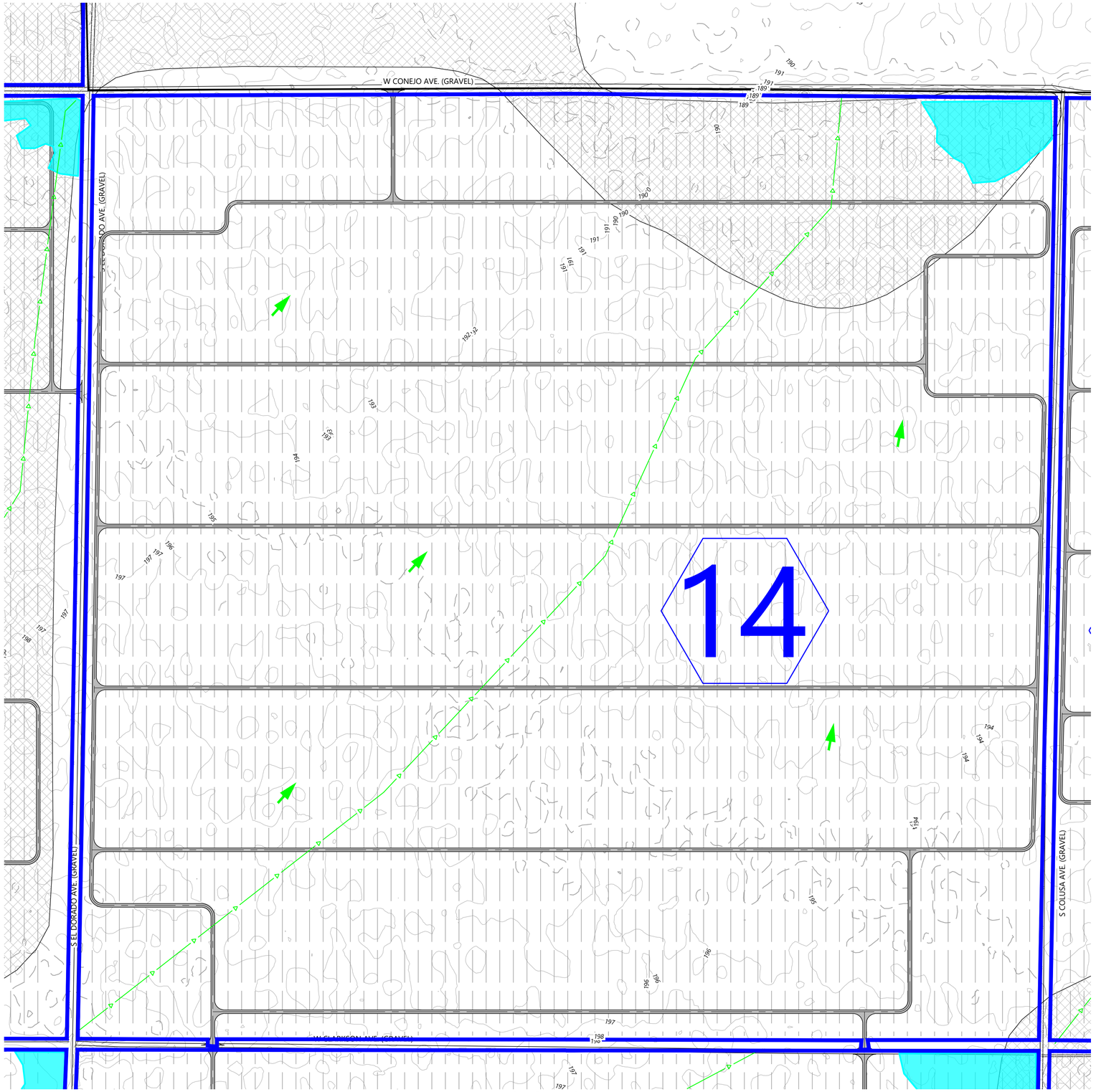

LEGEND:

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- EX. INDEX CONTOUR
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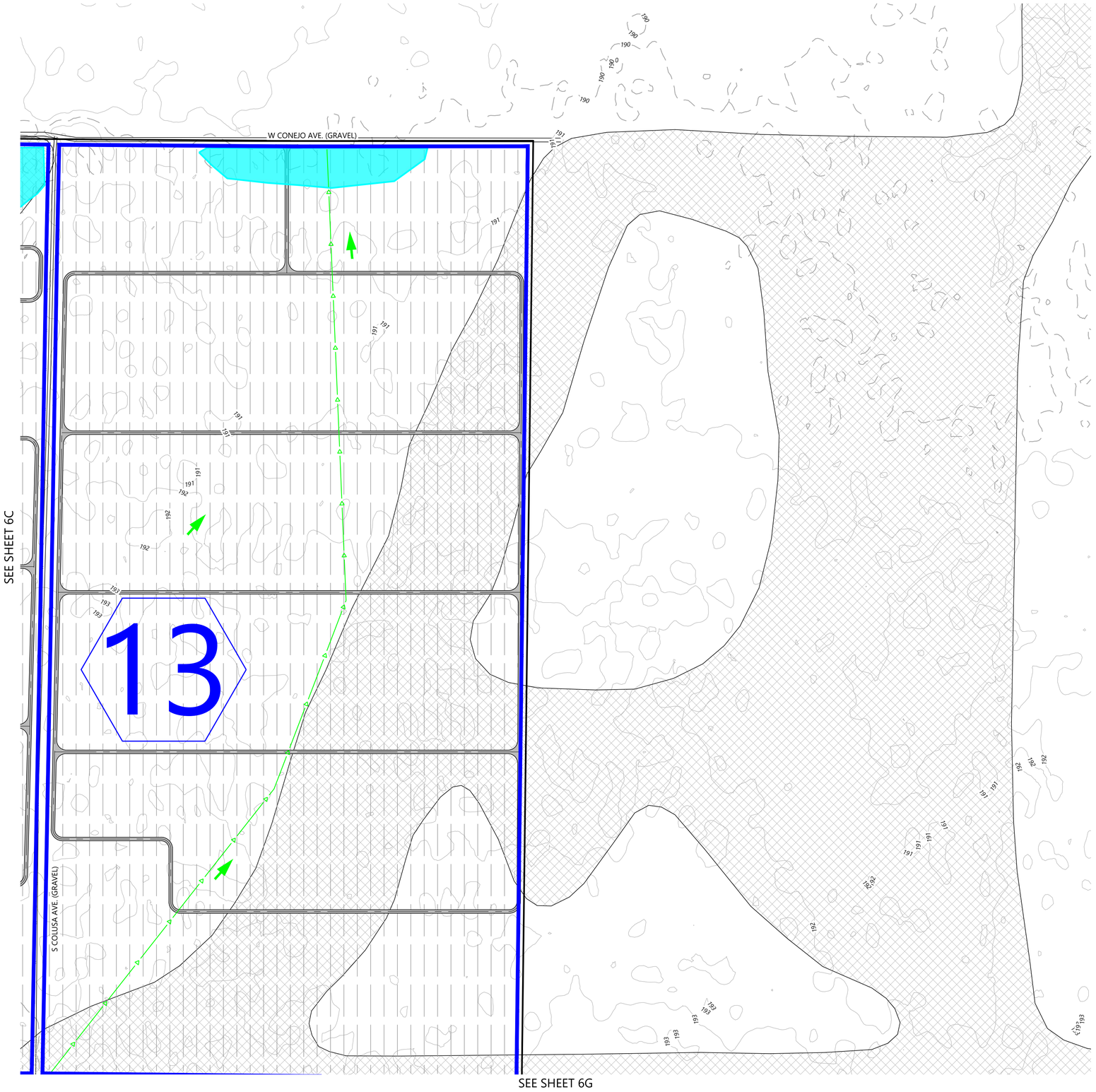

LEGEND:

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0' 300.0001' 600.0002' 900.0002'

IP Darden

Fresno County, CA

Proposed Drainage Map

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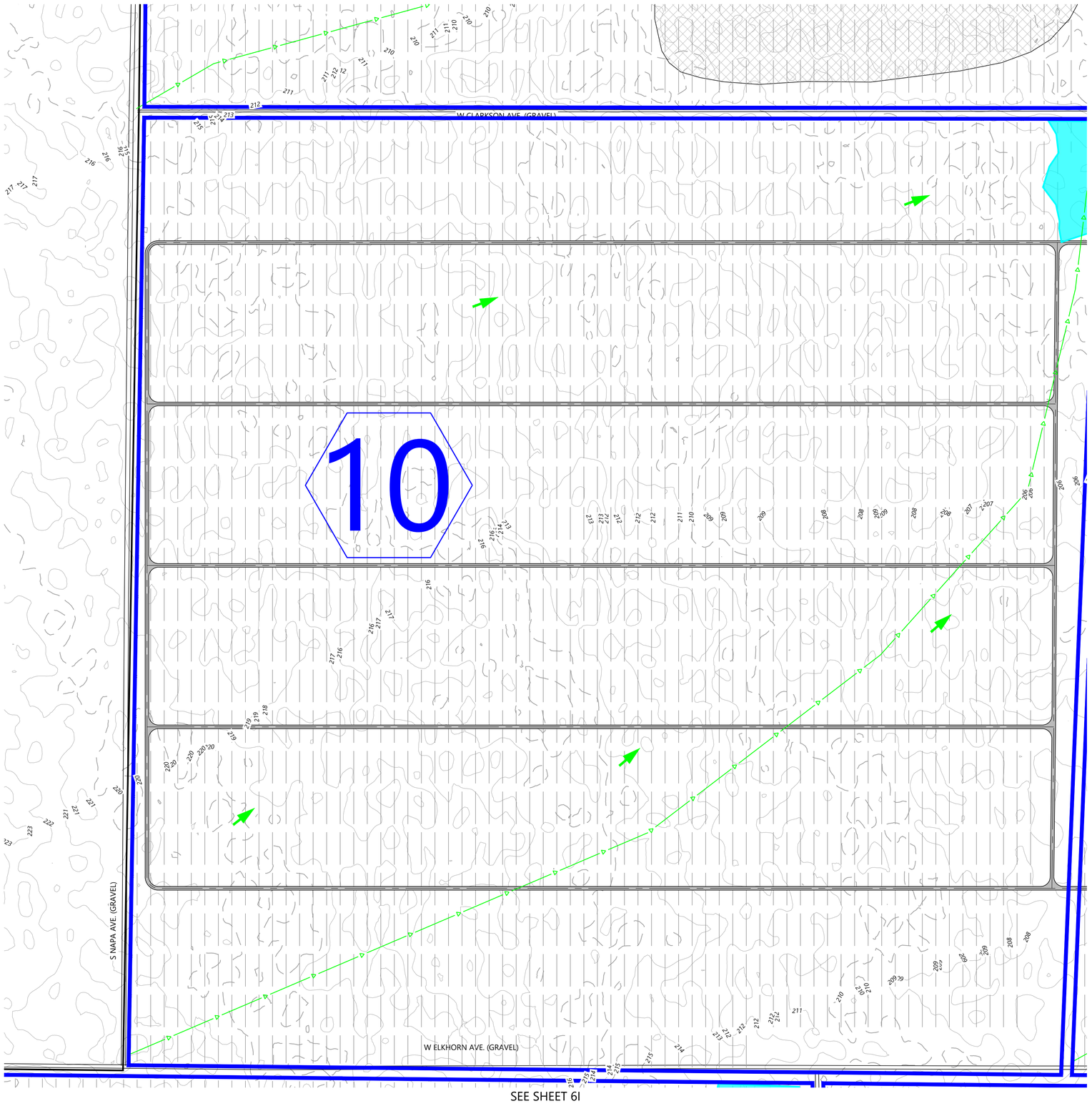

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0' 300.0002' 600.0004' 900.0006'

IP Darden

Fresno County, CA

Proposed Drainage Map

DATE: 04/14/2023

REV:

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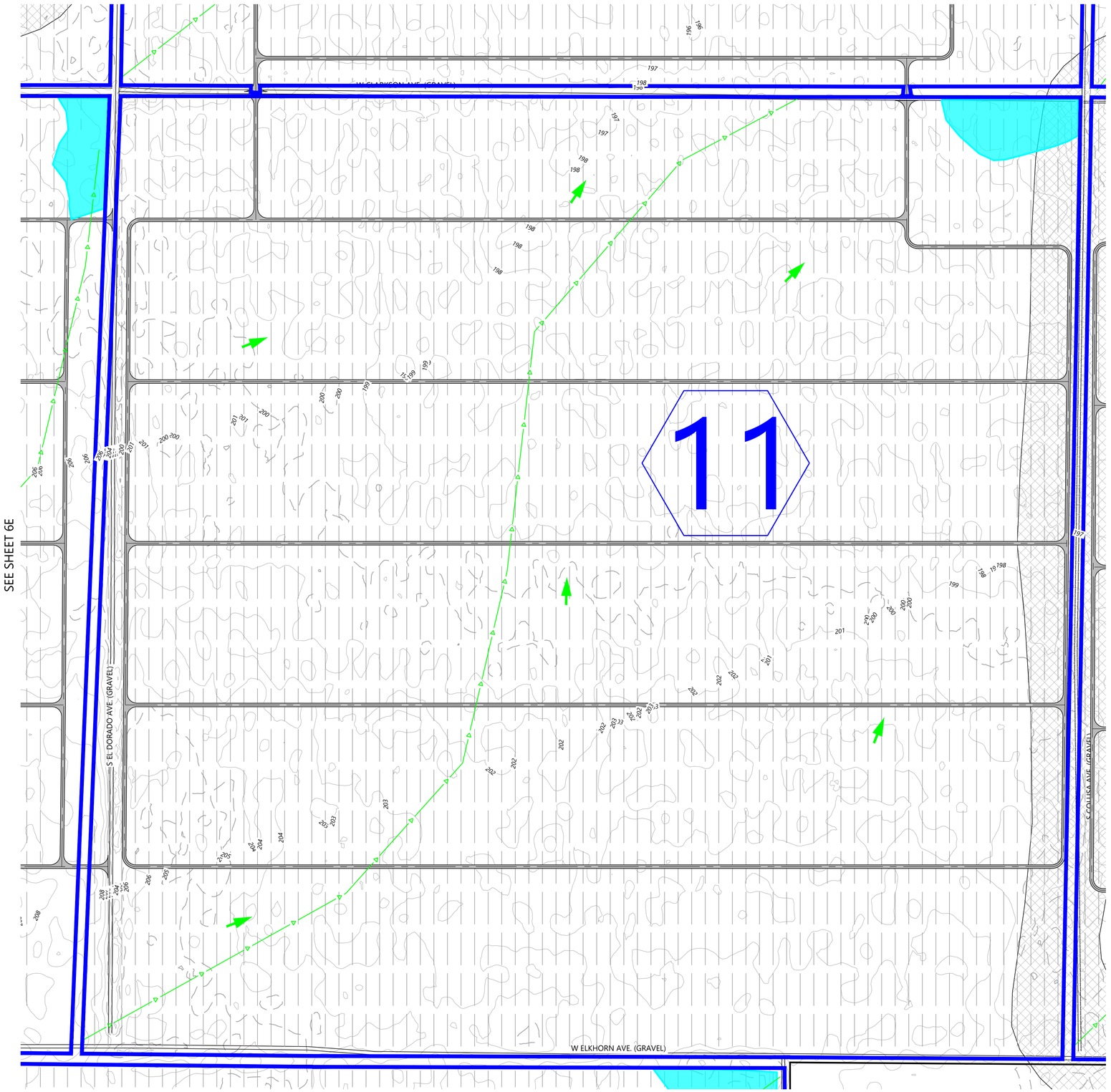
SEE SHEET 6C



SEE SHEET 6E

SEE SHEET 6G

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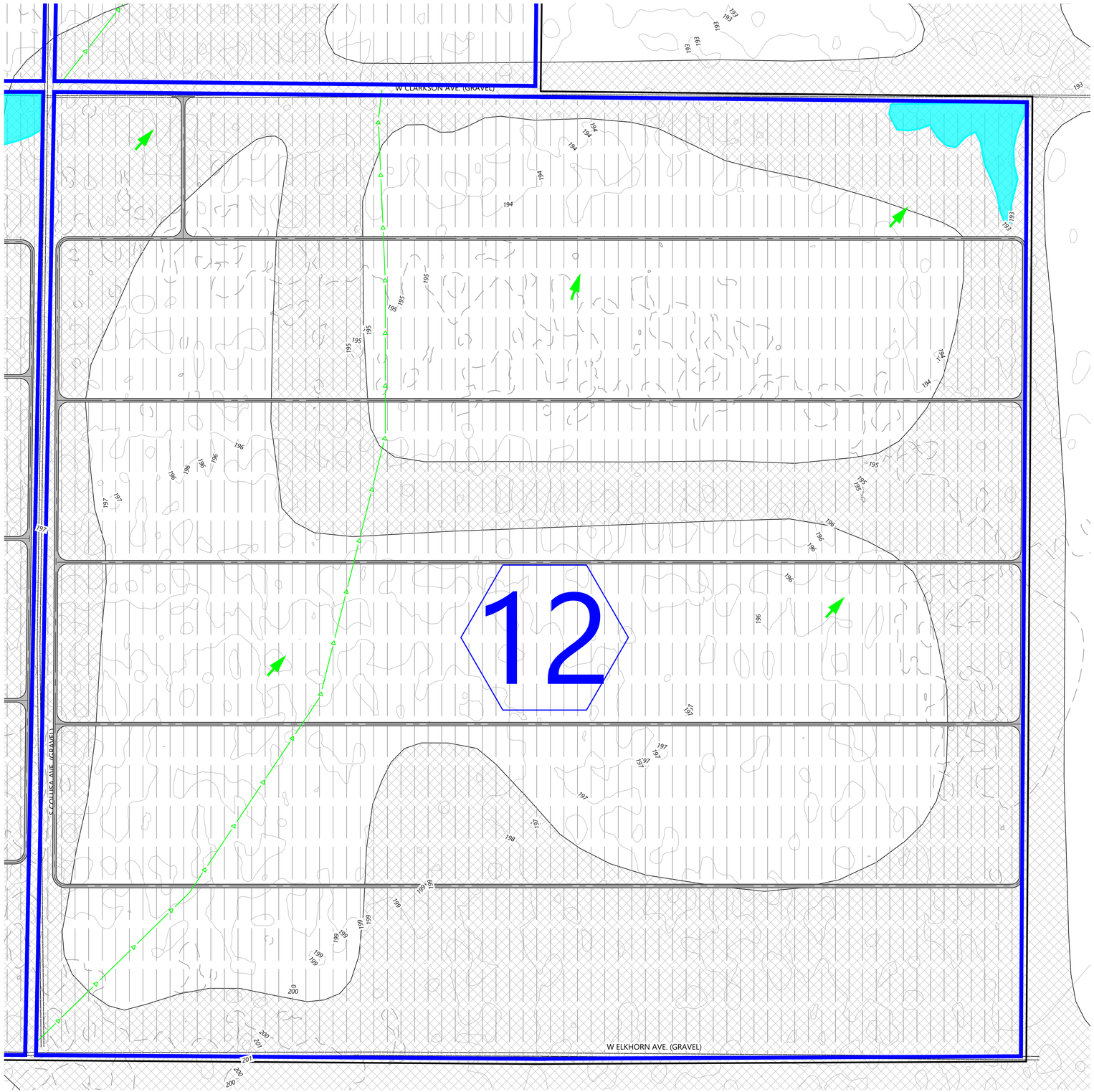

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SEE SHEET 6E

W ELKHORN AVE. (GRAVEL)

SEE SHEET 6H

SEE SHEET 6J

S NAPA AVE. (GRAVEL)

S ELDORADO AVE. (GRAVEL)

W DAVIS AVE. (GRAVEL)

ALTERNATE SUBSTATION LOCATION

1

SEE SHEET 6K

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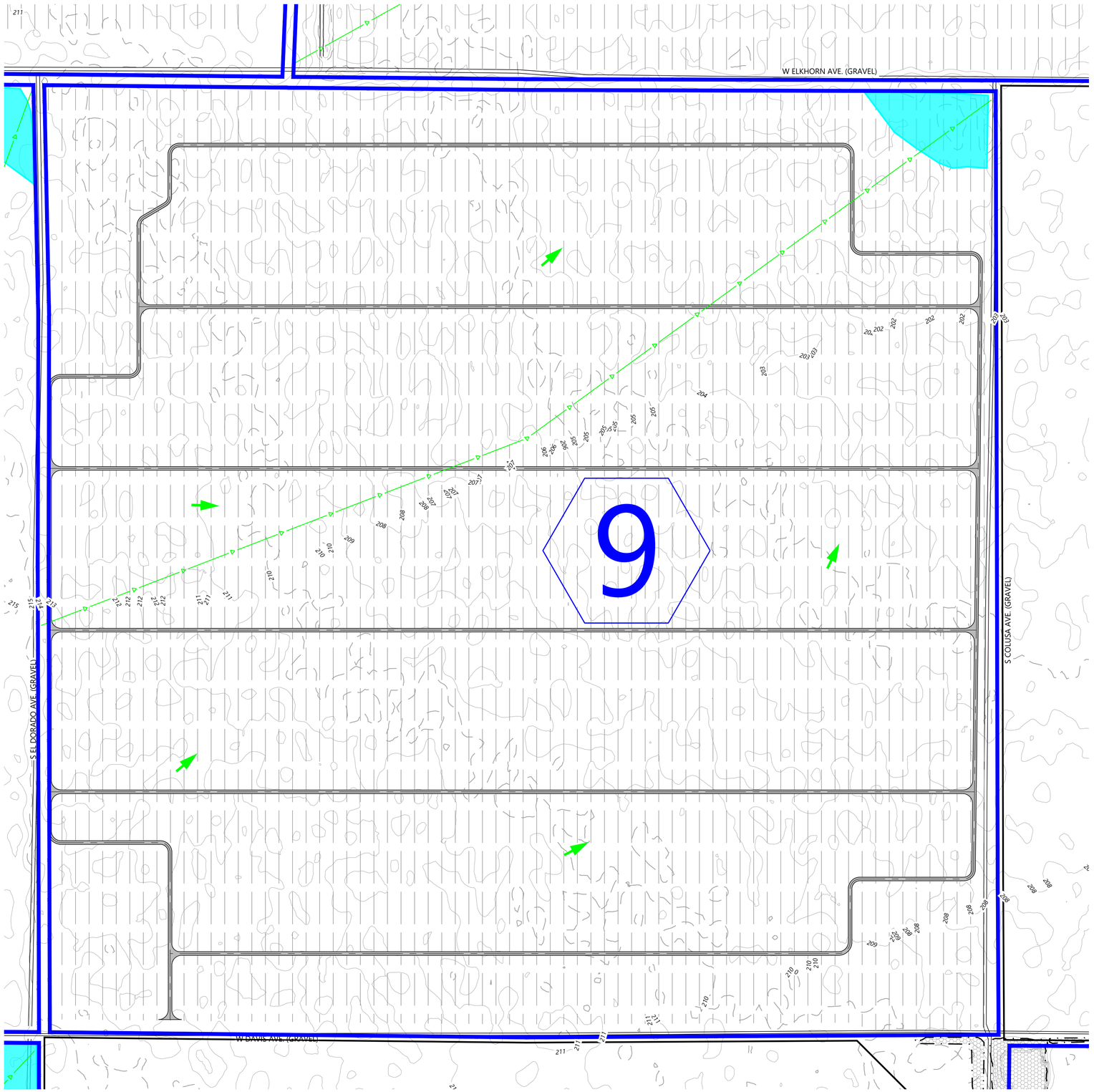

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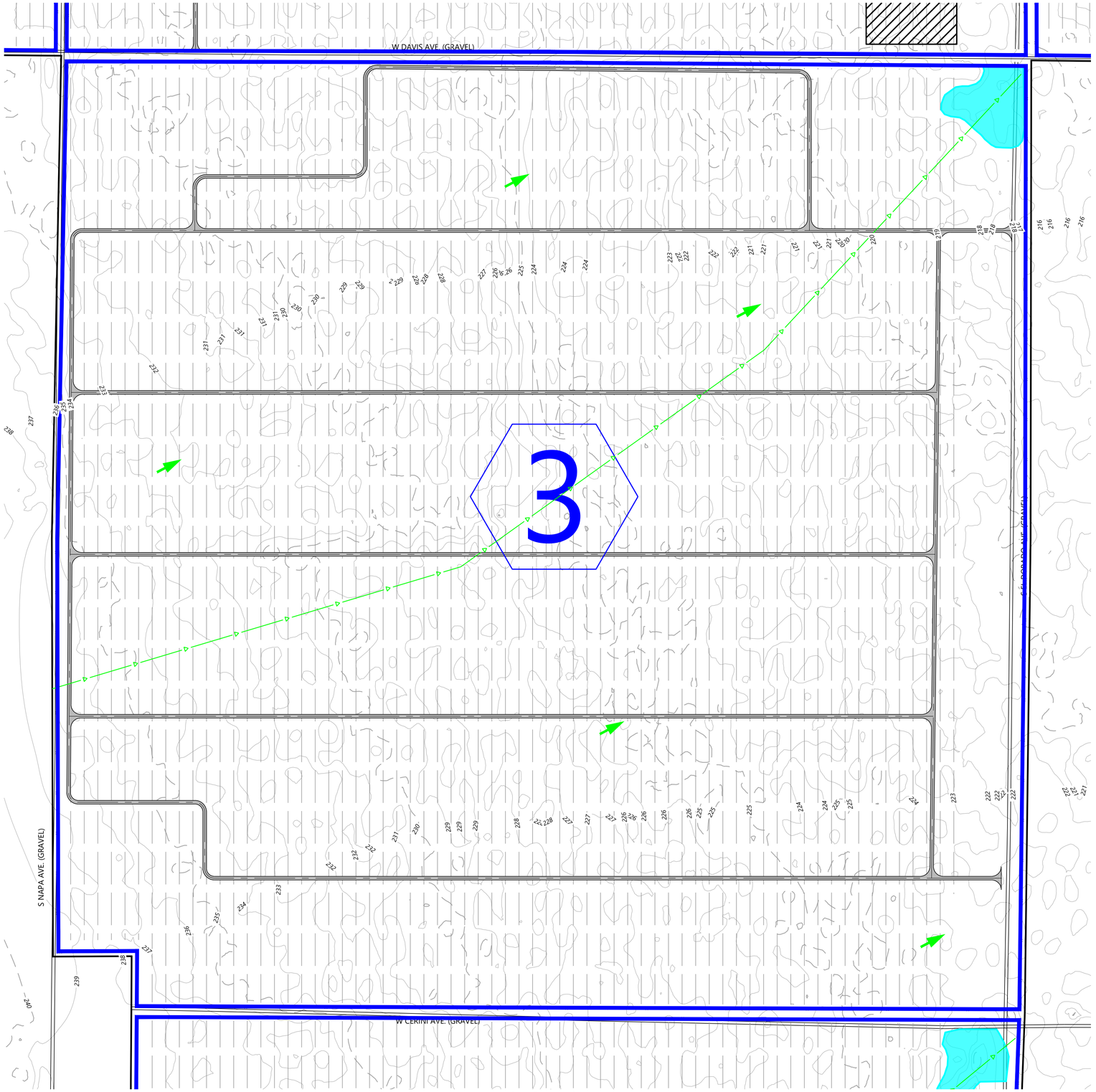

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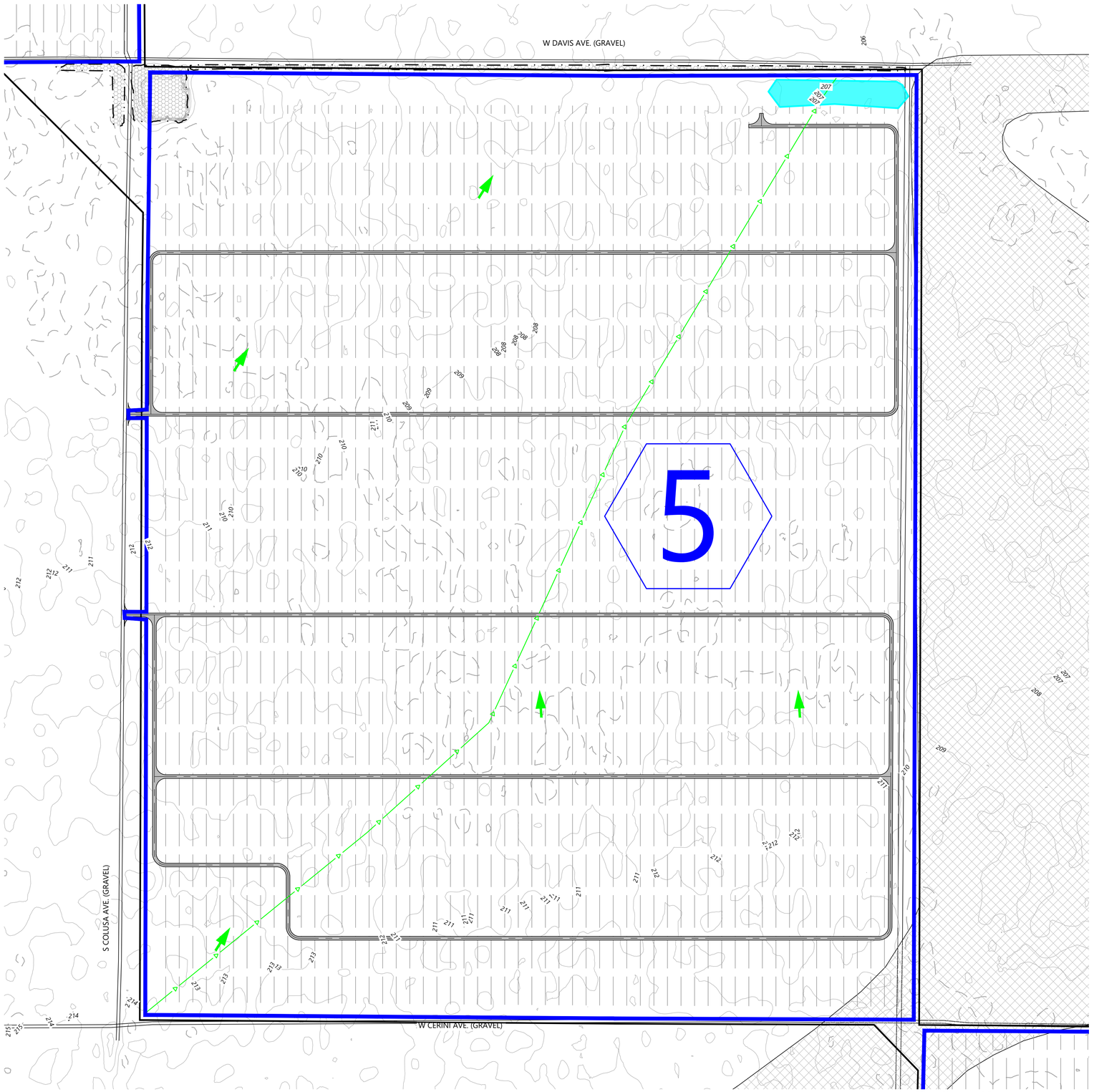

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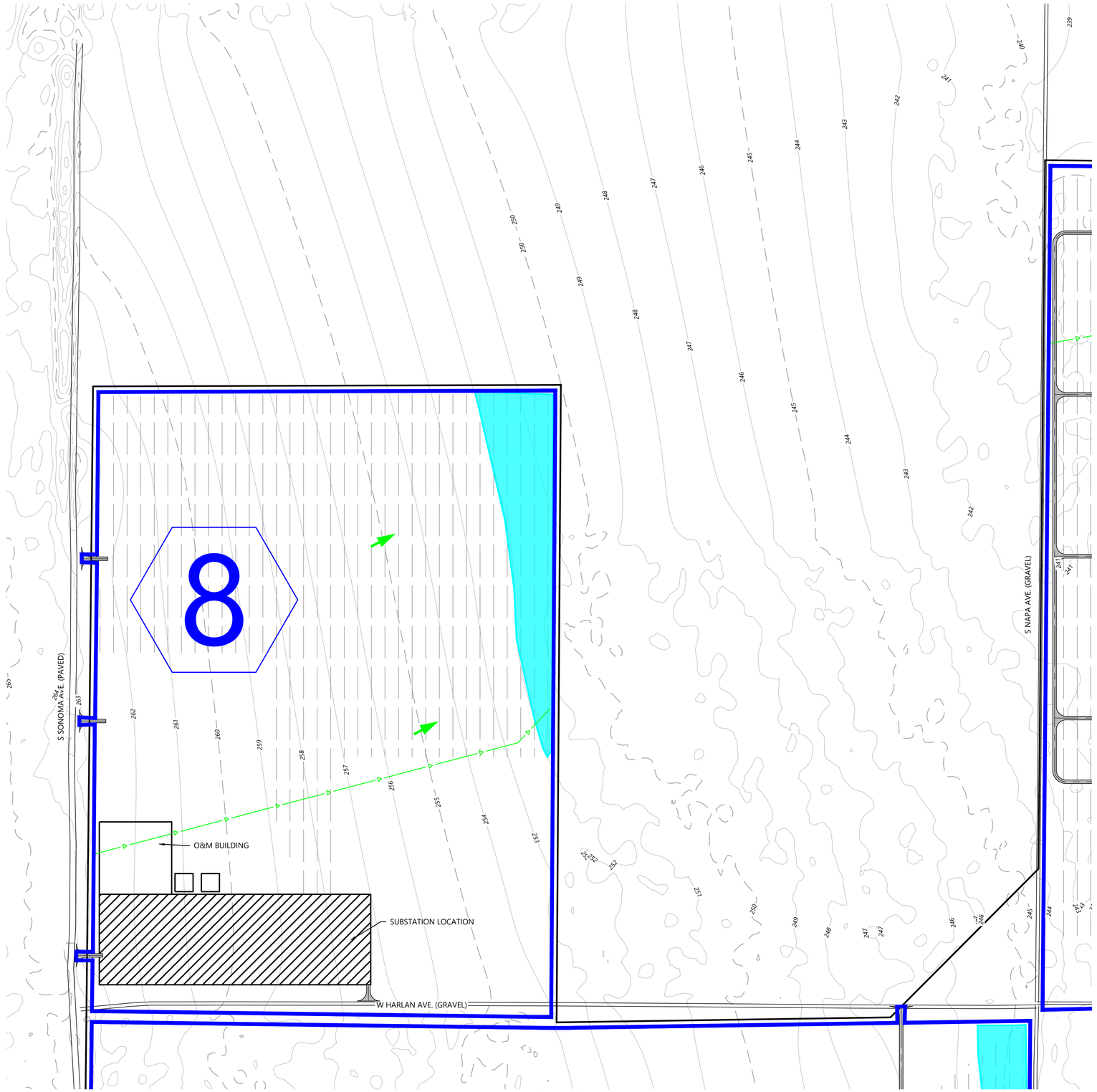

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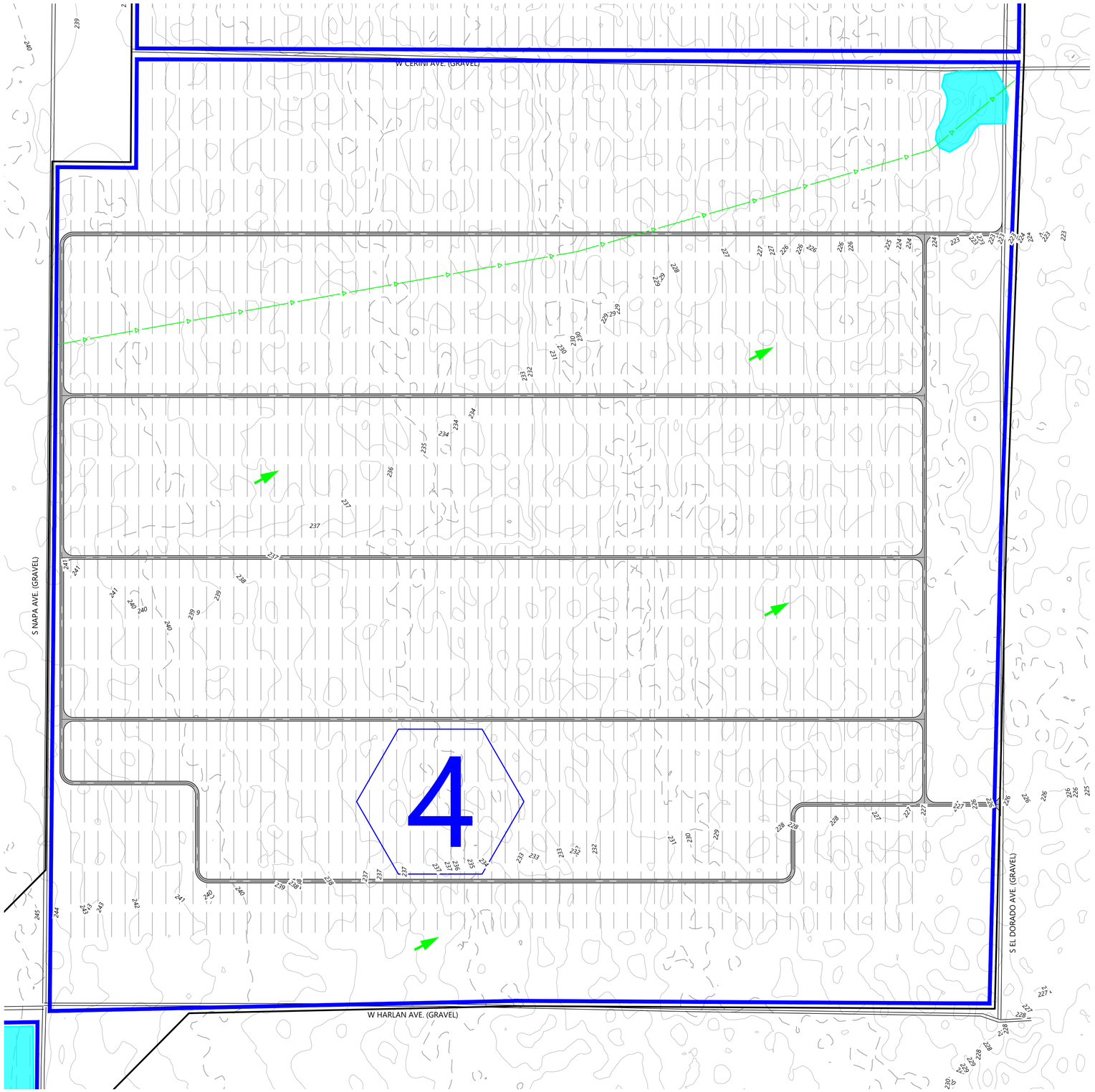

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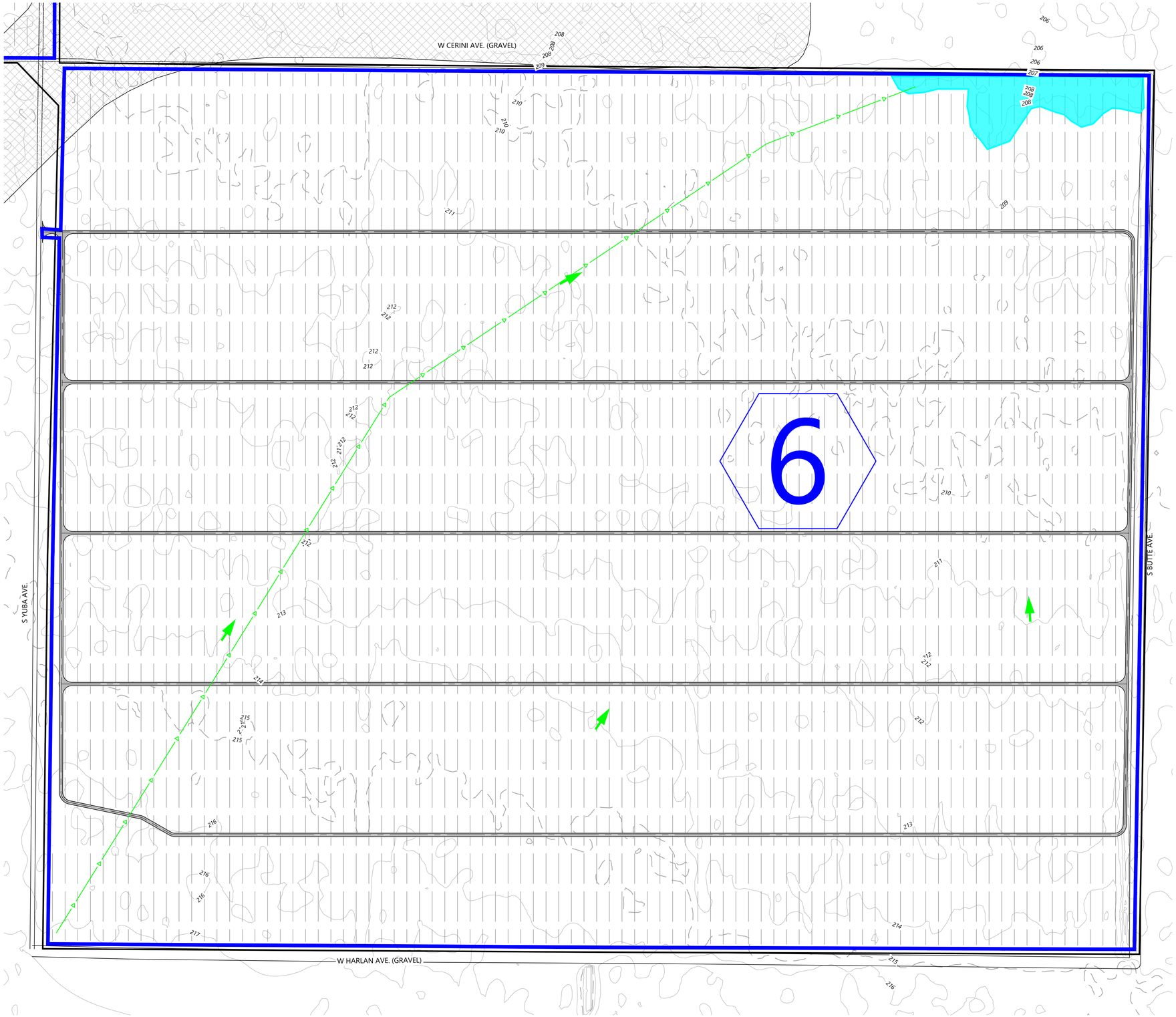

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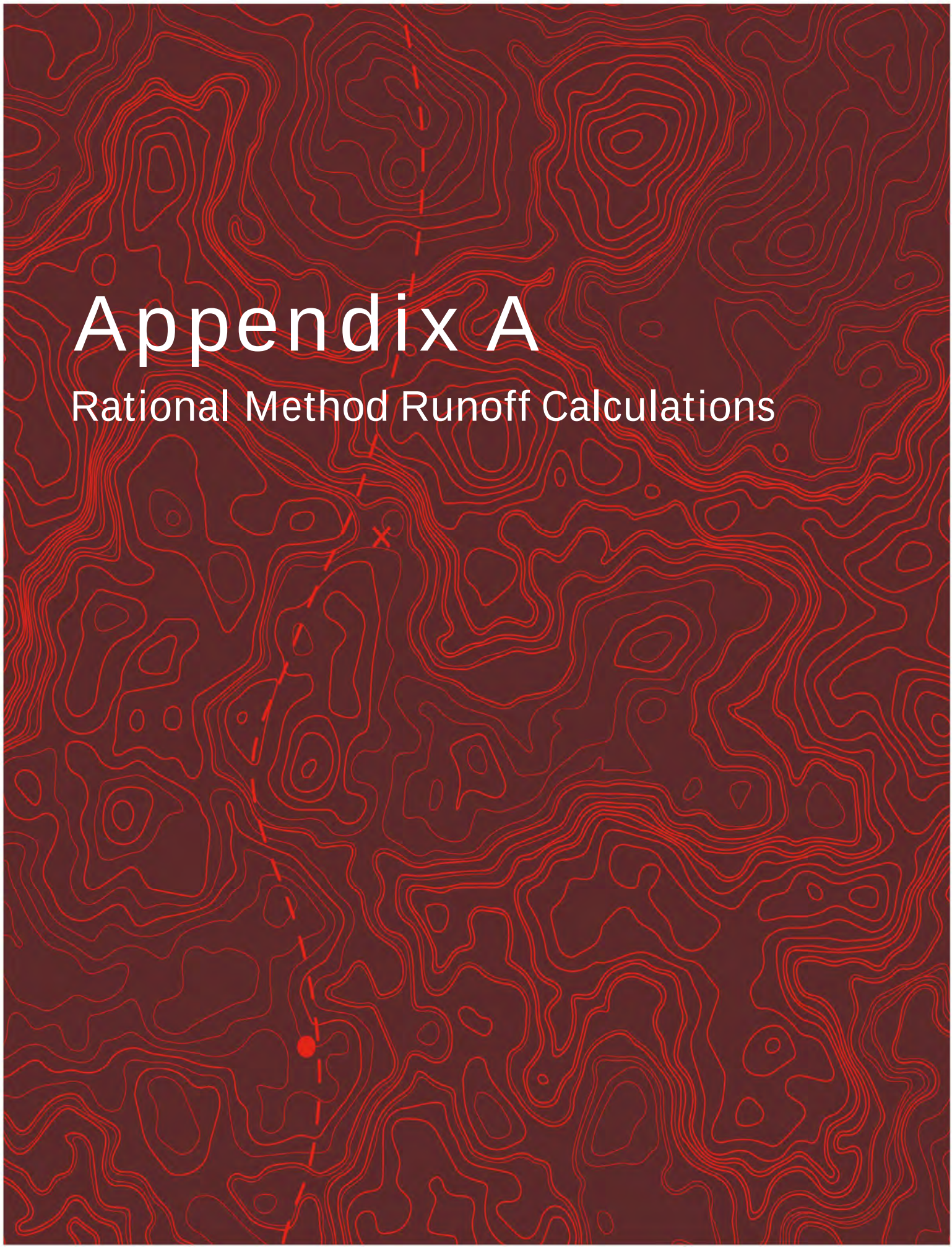
Appendix A

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

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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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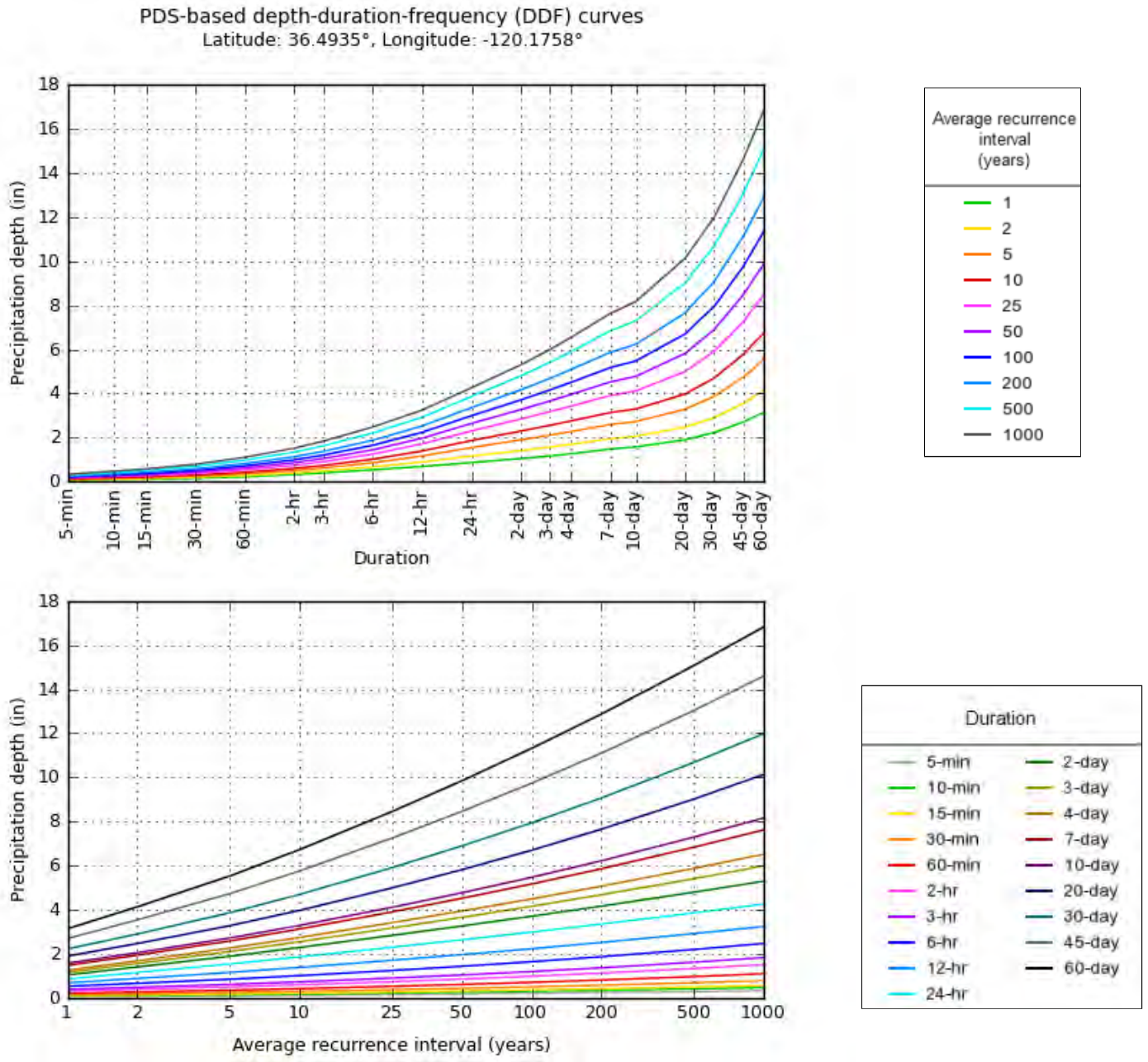
PF graphical



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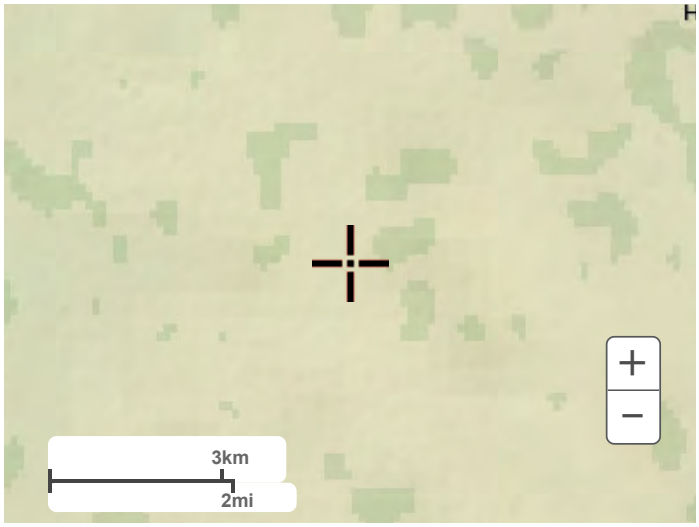
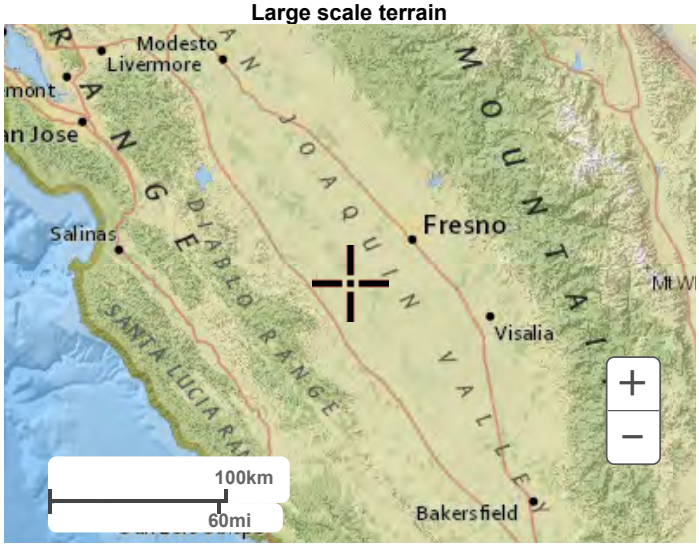
Maps & aerials

Small scale terrain



Large scale terrain



Large scale map

Large scale aerial

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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