DEFINITIONS

DCW – Dry Creek watershed

DEM – Digital elevation model.

GSA – GeoSystems Analysis, Inc.

Geodatabase – A collection of geographic data, including maps, created, viewed, and processed in a geographic information system (GIS).

Harmonic mean – An average calculated as the reciprocal of the arithmetic mean of the reciprocals of the values being averaged.

HEC-HMS – U.S. Army Corps of Engineers Hydrologic Engineering Center’s Hydrologic Modeling System. Software used to simulate precipitation and runoff in watersheds.

HEC-RAS – U.S. Army Corps of Engineers Hydrologic Engineering Center's River Analysis System. Software used to model water flow, sediment bed and transport, temperature, and water quality in watersheds.

Hydrograph – A plot showing water flow rate over time in a stream or other channel.

Inundation area – An area of land subject to flooding

LiDAR - Light Detection and Ranging. A remote sensing method using laser light to measure distances to the Earth.

MAA – Multiple Accounts Analysis. A tool for assessing the impacts from a list of alternatives by describing and measuring those impacts.

Managed aquifer recharge – Intentional recharge of water into aquifers.

Reservoir routing – A mathematical method for determining the peak flow of a hydrograph as water enters a reservoir.

Saturated hydraulic conductivity – A measure of the speed or ease at which water moves through the pores between soil particles when that soil is holding its maximum amount of water.

USGS – U.S. Geological Survey

Vadose zone – The portion of ground between the earth surface and the groundwater table.

Watershed delineation – Identification of a watershed’s boundaries.

WRI – Wood Rodgers, Inc.

WSE – water stage elevation. The water surface elevation in a stream above the elevation of the streambed.

MEMORANDUM

December 13, 2021

TO: Michael Brinton, Stanislaus County Public Works (SPCW)
Dhyan Gilton, SCPW

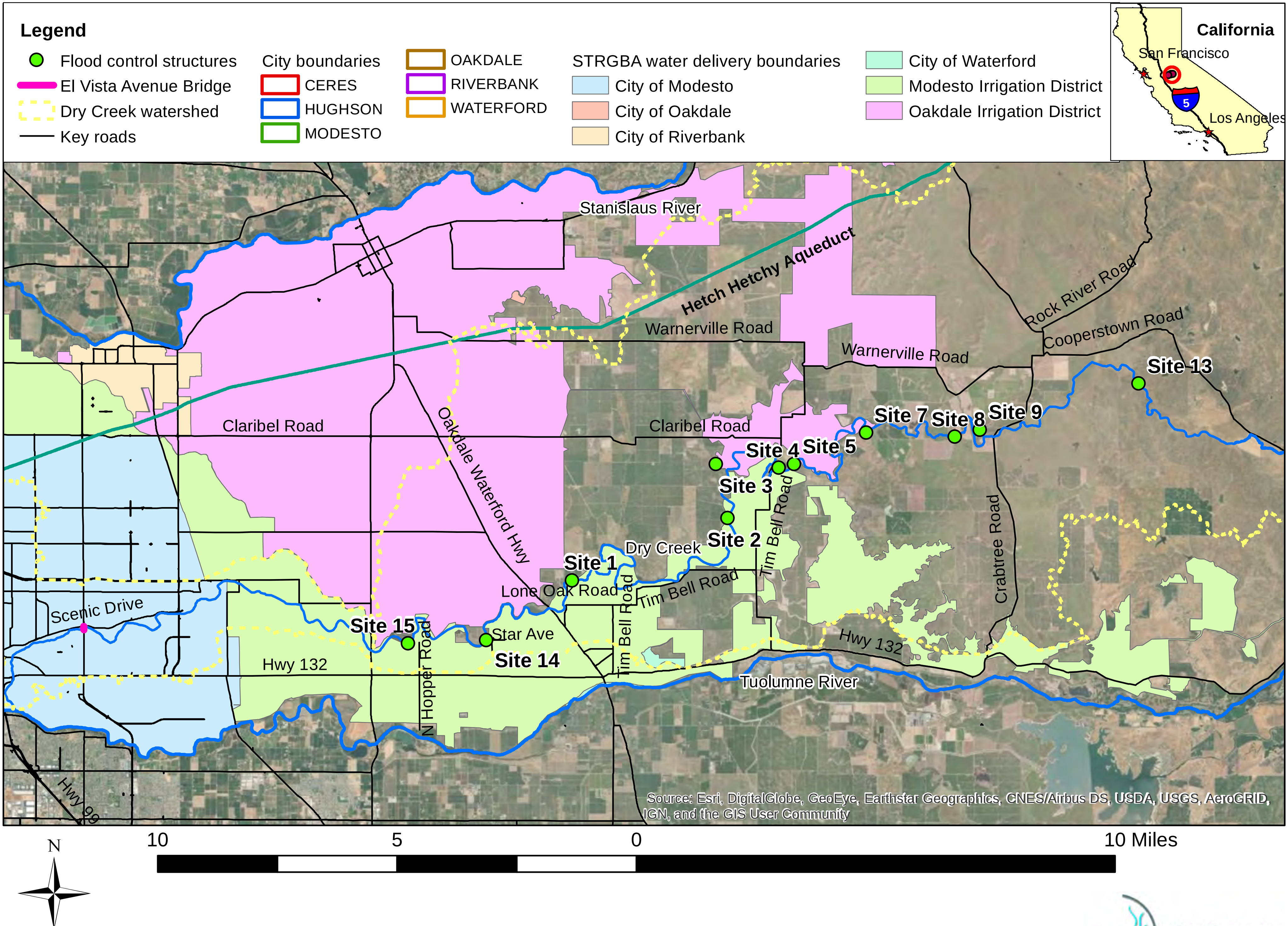
FROM: Jason Keller, GSA

CC: Frederic Clark, SCPW
Mike Milczarek, GSA
John Lambie, E-PUR, LLC
David Mueller, Wood Rogers, Inc.
Jonathan Kors, Wood Roger, Inc.

RE: Technical Memorandum 1 – Phase II Dry Creek Watershed Stormwater Management and Groundwater Recharge Multiple Account Analysis Results

1.0 INTRODUCTION

In conjunction with Stanislaus County, the GeoSystems Analysis, Inc. (GSA) Team developed key criteria for evaluating and comparing potential stormwater management sites identified in the Phase I Evaluation of Stormwater Management and Groundwater Recharge Projects in the Dry Creek Watershed (GSA, 2020a, 2020b). Fifteen (15) potential flood control and stormwater capture sites within the Dry Creek Watershed (DCW) were identified in the Phase I study, which were later reduced to eleven potential sites based on additional information. The locations of the eleven potential flood control structures are shown in Figure 1. To evaluate the relative advantages and disadvantages of the different potential stormwater control sites, technical, economic, environmental, and social/cultural factors for each site was applied into a Multiple Account Analysis (MAA) evaluation matrix (Mendoza and Martins, 2006). The purpose of the MAA was to use the various criteria in a methodical fashion to rank the overall attributes of each potential site. This memo presents MAA key criteria, weighting factor values, and MAA evaluation results for the DCW potential flood control and stormwater capture sites.



GSA GeoSystems Analysis, Inc. Innovative Solutions

Figure 1. Flood control structure locations and El Vista Avenue Bridge

2.0 MULTIPLE ACCOUNT ANALYSIS MATRIX

The MAA methodology considers a series of principal criteria (accounts) with a weighting value. Each account has different influence factors or sub-criteria (sub-accounts), which also have their own weighting value. Finally, for each sub-account, there are different indicator criteria with their own weighting values. The MAA process is subjective given that the weighting values and accounts are provided based on the experience and professional criteria of the GSA team.

The comprehensive MAA evaluation matrix, incorporating technical, economic, environmental, social and cultural criteria is presented in Table 1. The description of each criterion and its scoring is provided in Section 4.0. Each site was analyzed, and a score value from -3 to +3 was assigned to each indicator criterion (Table 2). The values assigned for the indicators, sub-accounts, and accounts were then multiplied to obtain a total weighting value per account, and the account values were then added to obtain the total value per site alternative. The site alternative with the highest value can then be considered the best option. Additional information on the MAA methodology can be found in GSA (2020b) and Mendoza and Martins (2006).

Table 1. Evaluation criteria matrix

Account	Account Weight	Sub-Account	Sub-Account Weight	Indicator	Indicator Weight
Technical	**0.5**	Managed Aquifer Recharge Suitability	0.5	Soil permeability	2
				Offsite opportunities	2
				Vadose zone permeability	5
				Depth to groundwater	4
				Volumes captured	4
		Flood Control Suitability	0.5	Flood protection	4
Economic	**0.2**	Cost	1	Capital cost	3
				Constructability/Feasibility	5
				Operation costs	3
Environmental	**0.1**	Wildlife/Habitat	0.33	Habitat improvement/maintenance	4
		Water Quality	0.33	Dilution contaminants	4
		Regulatory	0.33	Permitting/regulated	4
Social and Cultural	**0.2**	Social	0.7	Reduced flood risk to DACs	4
				Increased water availability	4
				Potential impact to landowners	5
		Cultural	0.3	Impacts to cultural resources	4
				Visual impacts	3

DAC – Disadvantaged Communities

Table 2. Indicator score values

Score Value	Description
3	Good
2	Moderately Good
1	Slightly Good
0	Neutral
-1	Slightly Poor
-2	Moderately Poor
-3	Poor

3.0 SURFACE WATER ANALYSES

Wood Rodgers, Inc. (WRI) developed a HEC-HMS hydrologic model in January 2020 to serve as the basis for comparing potential stormwater control/ground water recharge sites within the DCW. This effort was documented in GSA (2020a). To support the model development WRI collected existing data within the DCW and developed a project geodatabase containing site topography, soils data, land use data, precipitation data, and canals and storm drain linework. In addition, WRI obtained topographic digital elevation models (DEM) from the United States Geological Survey (USGS), National Elevation Data, and DEMs generated from LiDAR data from the California Department of Water Resources Central Valley Floodplain Evaluation and Delineation Program (CVFED) to create a hydrologically accurate DEM for the purposes of watershed delineation.

In Phase 1 of the project the HEC-HMS model was calibrated against a January 2017 storm event, and design storm hydrographs ranging from a 2-year to a 50-year frequency were constructed using the HEC-HMS model (GSA, 2020a). Additionally, the HEC-HMS model was used to determine preliminary reductions in peak flow values (and corresponding maximum storage) at each of the sites using one-dimensional reservoir routing (GSA, 2020a).

For the MAA, WRI used the same HEC-HMS model framework and built a two-dimensional (2D) HEC-RAS model. The 2D HEC-RAS model used the existing condition flow hydrographs from the HEC-HMS model to estimate the existing and proposed condition hydraulic characteristics for the entire DCW reach, allowing for a much more robust comparison of hydraulic characteristics from existing and proposed conditions for each potential site. The 2D HEC-RAS model was used with a focus on the flow, stage (head), and inundation area to assess the potential flood control project sites against the criteria in the MAA. Detailed topographic data were used at each potential project site to conceptualize earthen dams that could provide flood protection. The available height/elevation of those practical structures was used at each site individually to model the flow and stage effects on a range of return frequency storm ranging from 5-year to 100-year with 96-hour duration. For the purposes of the MAA evaluation, the results from the 25 year, 96-hour storm event were used unless otherwise described.

Examples of the 2D HEC-RAS model predicted 25-year storm event inundation area and maximum flood depth with and without the potential flood control structure is presented in Appendix B for Sites 2, 4, 5, and 15. Each project provides reduced flood risk downstream and temporarily increases the maximum flood depth and inundation area upstream from the control structure.

4.0 MULTIPLE ACCOUNTS ANALYSIS

4.1 Technical Criteria

Technical criteria account for 50% of the total weight of the MAA; 25% for Managed Aquifer Recharge Suitability and 25% for Flood Control Suitability.

4.1.1 Managed Aquifer Recharge Suitability

Five indicator criteria that affect the feasibility of Managed Aquifer Recharge projects were evaluated for each site as discussed below.

Soil

The soil indicator represents the permeability of near surface soils (0 to 6.5 ft below ground surface) for infiltration of project retained stormwater. The soil indicator ranking was determined from the weighted harmonic mean saturated hydraulic conductivity (K_{sat}) for soils within the 2D HEC-RAS model predicted 25-year storm event inundation area for each site. U.S. Natural Resources Conservation Service estimated K_{sat} values for each soil unit (GSA, 2020a) were applied in the analysis. Multiple soil units exist in the 25-year storm event inundation area, therefore the harmonic mean K_{sat} weighting was based on the area and depth of each soil unit within the inundation area. Table 3 presents the mean K_{sat} values for each site and the indicator score.

Table 3. 25-year storm event inundation area weighted harmonic mean saturated hydraulic conductivity and site score

Site	Weighted Harmonic Mean Saturated Hydraulic Conductivity (ft/day)	Indicator Score[1]
1	0.281	3
2	0.120	0
3	0.109	0
4	0.116	0
5	0.120	0
7	0.153	1
8	0.127	0
9	0.068	-1
13	0.113	0
14	0.175	1
15	0.186	1

[1]3=> 0.25 ft/day; 2=0.20-0.25 ft/day; 1=0.15-0.20 ft/day; 0=0.10-0.15 ft/day; -1=0.05-0.10 ft/day; -2=0.01-0.05 ft/day; -3=<0.01 ft/day

Offsite Opportunities

The offsite opportunities indicator represents the potential for retained stormwater to be recharged at locations outside of the DCW channel/flood inundation area. The offsite opportunity indicator was determined from the proximity of the predicted 25-year storm event inundation area to existing water conveyance infrastructure or existing off-channel water storage infrastructure. These existing facilities may be accessible from the project site and increase potential recharge opportunities. This assessment was qualitative, using visual inspection of canal networks relative to the predicted 25-year storm event inundation area. Table 4 presents the offsite indicator score applied in the MAA for each site. Note that LF Brichetto Farming, LLC has an existing off-site recharge facility and riparian water rights that should be considered in further design evaluations.

Table 4. Offsite opportunities site score

Site	Indicator Score
1	3
2	2
3	2
4	1
5	2
7	0
8	-2
9	-2
13	-2
14	3
15	3

Vadose zone permeability

The vadose zone permeability indicator represents the permeability of vadose zone sediments for percolating infiltrated detained stormwater. The vadose zone permeability indicator was determined from the surficial geologic unit weighted harmonic mean vertical saturated hydraulic conductivity (K_{sat-v}) for geologic units within the 2D HEC-RAS model predicted 25-year storm event inundation area. The distribution of surficial geologic units and geologic unit estimated K_{sat-v} values were acquired from GSA (2000a). Multiple geologic units exist in the 25-year inundation storm event inundation area; therefore, the harmonic mean K_{sat-v} weighting was based on the area of each geologic unit within the inundation area. Table 5 presents the mean K_{sat-v} for each site and the indicator score.

Table 5. 25-year storm event inundation area weighted harmonic mean vertical saturated hydraulic conductivity and site score

Site	Weighted Harmonic Mean Vertical Saturated Hydraulic Conductivity (ft/day)	Indicator Score[1]
1	0.71	-2
2	1.03	0
3	1.83	3
4	1.73	2
5	1.99	3
7	1.02	0
8	0.83	-1
9	1.36	1
13	0.31	-3
14	0.78	-1
15	0.98	-1

[1]3=> 1.75 ft/day; 2=1.50-1.75 ft/day; 1=1.25-1.50 ft/day; 0=1.00-1.50 ft/day; -1=0.75-1.00 ft/day; -2=0.50-0.75 ft/day; -3=<0.50 ft/day

Depth to Groundwater

The depth to groundwater indicator represents available vadose zone thickness for storage of detained and infiltrated stormwater. The mean depth to groundwater within the 2D HEC-RAS model predicted 25-year storm event inundation area was calculated from the 2015 groundwater depths provided in GSA (2020a). Table 6 presents the mean groundwater depth for each site and the resulting indicator score.

Table 6. 25-year event inundation area mean depth to groundwater and project scoring

Site	Mean Groundwater Depth (ft below ground surface)	Indicator Score[1]
1	74.5	1
2	81.6	2
3	89.7	2
4	69.5	0
5	66.9	0
7	90.0	3
8	90.0	3
9	90.0	3
13	90.0	3
14	67.3	0
15	62.8	0

[1]3=>90 ft; 2=80-90 ft; 1=70-80 ft; 0=60-70 ft; -1=50-60 ft; -2=40-50 ft; -3<40 ft

Volumes Captured

The volumes captured indicator represents the estimated flood control structure maximum volume of water from the 2D HEC-RAS model predicted detention depths and areas during the 25-year storm event. Table 7 presents the predicted 25-year storm event water detained at each site and the indicator score.

Table 7. 25-year storm event water captured and project scoring

Site	25 Year Storm Event Water Captured (acre-ft)	Indicator Score[1]
1	5,905	0
2	10,845	3
3	1,133	-3
4	6,433	1
5	7,264	1
7	3,472	-1
8	6,794	1
9	2,657	-2
13	2,385	-2
14	8,287	2
15	11,310	3

[1]3=>9000 acre-ft; 2=7500-9000 acre-ft; 1=6000-7500 acre-ft; 0=4500-6000 acre-ft; -1=3000-4500 acre-ft; -2=1500-3000 acre-ft; -3<1500 acre-ft

4.1.2 Flood Control Suitability

Flood Protection

The flood protection indicator was based on the 2D HEC-RAS model predicted reduction in water stage elevation (WSE) at the El Vista Avenue bridge with and without each proposed flood control structure for the 10-, 25-, 50-, and 100-year storm events. The sum of the WSE decrease with the flood control structure for all four storm events was applied in the MAA scoring analysis. Table 8 presents the 10-, 25-, 50-, and 100-year storm event model predicted WSE reduction with the flood control structure, total WSE reduction for all four storm events and the indicator score.

Table 8. Dry Creek flood control structure model predicted water surface elevation reduction at El Vista Avenue bridge for 10-, 25-, 50-, and 100-year storm event and project scoring

Site	Water Surface Elevation Reduction at El Vista Bridge (ft)					Indicator Score[1]
	10 Year Storm Event	25 Year Storm Event	50 Year Storm Event	100 Year Storm Event	Sum	
1	0.5	0.5	0.5	0.6	2.1	-2
2	4.2	4.5	4.5	4.5	17.7	3
3	0.3	0.2	0.2	0.2	0.9	-3
4	2.6	2.6	2.4	2.7	10.2	2
5	2.8	2.8	2.6	1.6	9.7	1
7	1.9	1.8	2.0	2.3	8.0	1
8	2.6	2.6	2.4	1.9	9.4	1
9	1.0	0.6	0.7	0.7	3.0	-2
13	1.0	0.7	0.8	1.0	3.5	-2
14	2.1	0.3	0.1	0.0	2.5	-2
15	3.8	4.1	4.3	4.4	16.6	3

[1]3=>12 ft; 2=10-12 ft; 1=8-10 ft; 0=6-8 ft; -1=4-6 ft; -2=2-4 ft; -3<2 ft

4.2 Economic Criteria

Economic criteria account for 20% of the total MAA to include weights for capital costs, constructability/feasibility and operations cost as discussed below.

4.2.1 Capital Costs

Capital costs for construction of the project were estimated by WRI based on the following components. Preliminary detention structure designs are provided in Appendix A.

- Land acquisition costs: Assumed to be land acquisition within the 2D HEC-RAS model predicted 25-year storm event inundation area and detention structure footprint assuming a unit price of $25,000/acre and a 25% contingency.

- Environmental mitigation costs: Assumed to be 7% of construction costs with a 50% contingency.
- Construction costs: Includes costs for mobilization and demobilization, stormwater pollution prevention plan preparation and implementation, fill and material import quantities, and structure cutoff wall length. Construction costs assumed a 50% contingency.
- Design costs: Assumed to be 8% of land acquisition, environmental, and construction costs with a 50% contingency.
- Construction management costs: Assumed to be 6% of land acquisition, environmental, and constructions costs with a 50% contingency.

Table 9 presents the estimated capital costs for each site and indicator score.

Table 9. Estimated project capitol cost and project scoring

Site	Capital Cost	Indicator Score[1]
1	$28,646,800.00	1
2	$31,212,200.00	0
3	$7,624,800.00	3
4	$20,912,500.00	1
5	$18,002,300.00	2
7	$40,586,200.00	-1
8	$36,311,300.00	0
9	$14,519,900.00	2
13	$29,730,900.00	1
14	$39,089,600.00	0
15	$47,920,200.00	-1

[1]3=<$10M; 2=$10M-$20M; 1=$20M-$30M; 0=$30M-$40M; -1=$40M-$50M; -2=$50M-$60M; -3>$60M

4.2.2 Operations Costs

Project operation costs were estimated by WRI to be 1% of the construction costs amortized over 30 years. Table 10 presents the estimated operation costs for each site and indicator score.

Table 10. Estimated project operations and maintenance cost and project scoring

Site	Operation Cost	Indicator Score[1]
1	$1,192,000.00	2
2	$968,500.00	2
3	$246,200.00	3
4	$1,343,000.00	1
5	$1,343,000.00	1
7	$4,708,200.00	-2
8	$3,507,500.00	-1
9	$740,200.00	2
13	$3,433,100.00	-1
14	$1,842,100.00	1
15	$2,311,300.00	0

[1]3=<0.25M; 2=0.25M-1.25M; 1=1.25M-2.25M; 0=2.25M-3.25M; -1=3.25M-4.25M; -2=4.25M-5.25M; -3>5.25M

4.2.3 Constructability/Feasibility

The constructability/feasibility indicator represents potential fatal flaw impediments to construction based on number of impacted landowners. The land parcels and landowners within the 2D HEC-RAS model predicted 25-year storm event inundation area was provided by Stanislaus County and the total number of unique landowners was tallied and applied in the scoring. Table 11 presents the number of landowners within the 25-year storm event inundation area for each site and the indicator score applied in the MAA.

Table 11. Number of landowners within the 25-year event inundation area and project scoring

Site	Number of Landowners	Indicator Score[1]
1	33	-2
2	22	0
3	7	3
4	13	2
5	12	2
7	13	2
8	14	2
9	7	3
13	4	3
14	48	-3
15	61	-3

[1]3=<10; 2=10-15; 1=15-20; 0=20-25; -1=25-30; -2=30-35; -3>35

4.3 Environmental Criteria

Environmental criteria account for 10% of the total MAA to include weights for wildlife habitat, water quality and regulatory impediments as discussed below.

4.3.1 Wildlife/Habitat

Improvement of habitat for native wildlife (e.g., aquatic species, birds) and/or habitat maintenance (e.g., control of non-native vegetation species) was not considered in this phase of the analysis; however, thus sub-account remained in the MAA for potential future consideration. All sites were given an indicator score of 0.

4.3.2 Water Quality

The water quality indicator represents the potential dilution of nitrate within the groundwater from recharge of detained stormwater. Mean groundwater nitrate concentrations from wells within 0.5 miles of the 2D HEC-RAS model predicted 25-year storm event inundation area were acquired from the California State Water Resources Control Board's Groundwater Ambient Monitoring and Assessment Program Groundwater Information System (GSA, 2020a). Inundation areas with greater mean nitrate concentration received a higher score due to the potential for infiltrated surface water to reduce the elevated nitrate concentrations. Table 12 presents the 2019 through 2021 mean groundwater nitrate concentration from groundwater samples within 0.5 miles of the 25-year storm event inundation area for each site and the indicator score applied in the MAA.

Table 12. Mean groundwater nitrate concentration of 2019 through 2021 samples within 0.5 miles of the 25-year event inundation area and score

Site	Groundwater Mean Nitrate Concentration (mg/l)	Indicator Score[1]
1	2.1	0
2	1.8	0
3	1.7	0
4	2.2	0
5	2.2	0
7	3.0	1
8	3.0	1
9	3.0	1
13	1.7	0
14	2.5	0
15	2.8	0

[1]3=>10 mg/l; 2=5.0-10.0 mg/l; 1=3.0-5.0 mg/l; 0=1.0-3.0 mg/l; -1=<1.0 mg/l

4.3.3 Regulatory

The regulatory indicator was evaluated against three recognized permitting issues related to construction of a flood control structure: 1) Jurisdictional dam permit approval from the California Division of Safety of Dams (DOSD), 2) Section 404 of the Clean Water Act permit for in-water work from the U.S. Army Corps of Engineers (USACE), and 3) California Environmental Quality Act (CEQA) thresholds for compliance and level of effort. Each issue or criterion was evaluated independently. A project received a +1 score for each regulatory permit condition deemed to be statutorily excluded and each required permit was given a -1 scoring to arrive at the weighting on Subaccount.

Each type of project site under consideration will require an individual permit approval from DOSD given their height (i.e., greater than 6 feet) and their volumetric hold. Each project site was evaluated for 404-permit requirements based upon whether it fits within a standing Nationwide Permit (NWP) 43 the USACE for stormwater management. NWP 43 exists to enable stormwater management projects that result in less than a 1/2 acre loss of streambed. Thus, the in-water footprint size of each project site was evaluated by measurement of the bank-to-bank ordinary high-water mark multiplied by the linear width of the preliminary embankment design (Appendix A) placed in the streambed. Sites with embankments less than 1/2 acre received a +1 score and sites with an embankment greater than 1/2 acre received a -1 score because the larger embankments would have to file for an individual project 404 permit. It is anticipated that each project would need file for a 404-permit approval but at sites with footprints less than 1/2 acre that conform to NWP 43 would greatly reduce the time, effort, and cost to obtain construction approval from USACE.

Each project site was evaluated for CEQA regulatory approval requirements. At a minimum it was judged that barring a Categorical Exemption, that each project would need to prepare information and submit for a CEQA Mitigated Negative Declaration. A Negative Declaration means that the identified environmental disruptions such as a flow alteration to the natural hydrograph could be mitigated in project construction and operation. However, there is a Categorical Exemption in CEQA potentially available for Emergency Projects that prevent or mitigate an emergency condition such as flood control potential (Section 15269.(c)). It is uncertain as to what constitutes an "emergency condition", but for the purposes of the MAA, it was assumed that if a project could reduce the large flood risk of a 25-year event to below that of a 5-year event then a Categorical Exemption might apply, and the project could proceed more rapidly to approval and construction. The actual threshold conditions for CEQA Categorical Exemptions may be found to be different by Stanislaus County Planning or other oversight entities on CEQA compliance. Table 13 presents the resulting indicator score applied in the MAA.

Table 13. In-channel embankment area, embankment height, flood risk reduction, and regulatory score

Site	In-Channel Embankment Area (acres)	Embankment Height (ft)	Reduce Flood Risk for 25 Year Storm Event to Below 5 Year Storm Event (ft)	Indicator Score
1	0.43	33	No	-1
2	0.53	45	Yes	-1
3	0.33	31	No	-1
4	0.47	47	No	-1
5	1.05	48	No	-3
7	2.33	46	No	-3
8	0.39	42	No	-1
9	0.70	24	No	-3
13	0.89	52	No	-3
14	0.85	28	No	-3
15	0.44	41	Yes	1

4.4 Social and Cultural Criteria

Social and cultural criteria account for 20% of the total MAA to include weights for reduced flood risk to DACs, increased water availability, potential impacts to landowners, impacts to cultural resources and visual impacts as discussed below.

4.4.1 Reduced Flood Risk to Disadvantaged Communities

The reduced flood risk to disadvantaged communities indicator represents the reduction in flood risk to below a 5-year storm event with the presence of a flood control project. Regional flood control studies indicate that localized flooding in disadvantaged community areas occurs when the Tuolumne River flows exceed 9,000 cfs and the DCW receives a 5-year or greater storm event (GSA, 2020a). This criterion was assessed using the 2D HEC-RAS model predicted difference in maximum WSE at the El Vista Avenue bridge crossing for a 5-year storm event without the control structure present (current conditions) versus a 25-year storm event with the control structure present. Table 14 presents the model predicted WSE at El Vista Avenue bridge, difference in WSE, and the indicator score applied in the MAA.

Table 14. Model predicted water surface elevation at El Vista Avenue bridge for a 5- and 25-year storm event with and without a control structure and project scoring

Site	Water Surface Elevation at El Vista Bridge for 5 Year Storm Event and No Project (ft)	Water Surface Elevation at El Vista Bridge for 25 Year Storm Event with Project (ft)	Difference in Water Surface Elevation (ft)	Indicator Score[1]
1	73.6	76.6	-3.0	-2
2	73.6	72.6	1.0	3
3	73.6	76.8	-3.3	-3
4	73.6	74.5	-0.9	2
5	73.6	74.3	-0.7	2
7	73.6	75.2	-1.6	0
8	73.6	74.5	-0.9	2
9	73.6	76.4	-2.8	-2
13	73.6	76.3	-2.7	-2
14	73.6	76.7	-3.1	-3
15	73.6	72.9	0.6	3

[1]3=>-0.5 ft; 2=-0.5 to -1.0 ft; 1=-1.0 to -1.5 ft; 0=-1.5 to -2.0 ft; -1=-2.0 to -2.5 ft; -2=-2.5 to -3.0 ft; -3<-3.0 ft

4.4.2 Increased Water Availability

The increased water availability indicator represents increased groundwater storage that may be available to water users. This indicator was evaluated from the estimated detained water that could infiltrate for a 25-year storm event. The infiltration volume estimate was calculated by summing the product of the 2D HEC-RAS model predicted inundation area and the inundation area harmonic mean soil K_{sat} for each day that inundation was predicted to occur. Table 15 presents the predicted potential infiltration volume for a 25-year storm event and the indicator score applied in the MAA.

Table 15. Predicted infiltration of detained stormwater for the 25-year storm event

Site	Potential Recharge (acre-ft)	Indicator Score[1]
1	732	3
2	423	1
3	76	-3
4	178	-2
5	201	-1
7	227	-1
8	218	-1
9	98	-3
13	74	-3
14	589	2
15	746	3

[1]3=>600 acre-ft; 2=500-600 acre-ft; 1=400-500 acre-ft; 0=300-400 acre-ft; -1=200-300 acre-ft; -2=100-200 acre-ft; -3<100 acre-ft

4.4.3 Potential Impacts to Landowners

This indicator represents potential impacted cropped land due to inundation of the land during the 25-year storm event with a control structure present. This was assessed using the 2D HEC-RAS model predicted difference in inundation area for a 25-year storm event without the control structure present (current conditions) versus with the control structure present. The cropped land areas compiled by GSA (2020a) and residing within the model predicted increased inundation area were applied in the MAA score. Table 16 presents the increased inundated crop area and the indicator score applied in the MAA.

The model predicted 25-year storm event inundation area and maximum flood depth with and without the potential flood control structure for Sites 2, 4, 5, and 15 (Appendix B, Table 16) indicate a moderate increase of inundation area upstream from the control structure for Sites 4, 5, and 15. A large increase in inundation area for Site 2 is predicted (Appendix B, Table 16), predominately occurring adjacent to Cashman Creek, a tributary of Dry Creek.

Table 16. Increased inundated crop area within the 25-year storm event inundation area with project versus without project and project scoring

Site	Increased Inundated Crop Area for 25 Year Storm Event with Project Versus without Project (acres)	Indicator Score[1]
1	19	2
2	232	-3
3	53	1
4	86	0
5	93	0
7	46	1
8	100	0
9	111	0
13	0	3
14	34	2
15	74	1

[1]3=0 acres; 2=0-40 acres; 1=40-80 acres; 0=80-120 acres; -1=120-160 acres; -2=160-200 acres; -3>200 acres

4.4.4 Impacts to Cultural Resources

Impacts to cultural resources were not evaluated in this phase of the analysis; however, the sub-account remained in the MAA for potential future consideration. All sites were given an indicator score of 0.

4.4.5 Visual Impacts

The visual impacts indicator represents changes to the scenic attributes of the landscape due to the construction of the flood control structure. This indicator was evaluated based on the length of the constructed flood control structure (Appendix A), assuming a longer structure may result in greater visual impacts. Table 17 presents the flood control structure length and the indicator score applied in the MAA.

Table 17. Flood control structure length and project scoring

Site	Structure Length (ft)	Indicator Score[1]
1	1,250	1
2	590	2
3	235	3
4	3,070	-3
5	415	3
7	1,670	0
8	1,540	0
9	3,300	-3
13	2,800	-2
14	1,490	1
15	1,400	1

[1]3=<500 ft; 2=500-1,000 ft; 1=1,000-1,500 ft; 0=1,500-2,000 ft; -1=2,000-2,500 ft; -2=2,500-3,000 ft; -3>3,000 ft

4.5 Total Matrix Score

The MAA account and total matrix score for each alternative analyzed are presented in Table 18 and Figure 2. The total matrix score is greatest for Site 2 (1.24), which also had the greatest Technical score (2.21) and a moderately low Economic score (0.55). Site 15 had the second largest total score (1.09), due in part to a high Technical score (2.09) and a low Economic score (-1.64). Site 5 and Site 4 had the third (0.95) and fourth (0.92) largest scores, respectively. All other site alternatives had a Matrix score of 0.52 or less.

Table 18. Account and total matrix score

Account	Score										
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 7	Site 8	Site 9	Site 13	Site 14	Site 15
Technical	-0.82	2.21	-1.06	1.47	1.18	0.79	0.71	-0.91	-1.44	-0.68	2.09
Economic	-0.09	0.55	3.00	1.45	1.73	0.09	0.64	2.45	1.36	-1.09	-1.64
Environmental	-0.33	-0.33	-0.33	-0.33	-1.00	-0.67	0.00	-0.67	-1.00	-1.00	0.33
Social/Cultural	0.88	0.31	-0.64	-0.39	0.60	0.05	0.22	-1.46	-0.53	0.45	1.69
Total[1]	**-0.29**	**1.24**	**-0.09**	**0.92**	**0.95**	**0.36**	**0.52**	**-0.32**	**-0.65**	**-0.57**	**1.09**

1 – Total Matrix Score = (Technical Score × 0.5) + (Economic Score × 0.2) + (Environmental Score × 0.1) + (Social and Cultural Score × 0.2)

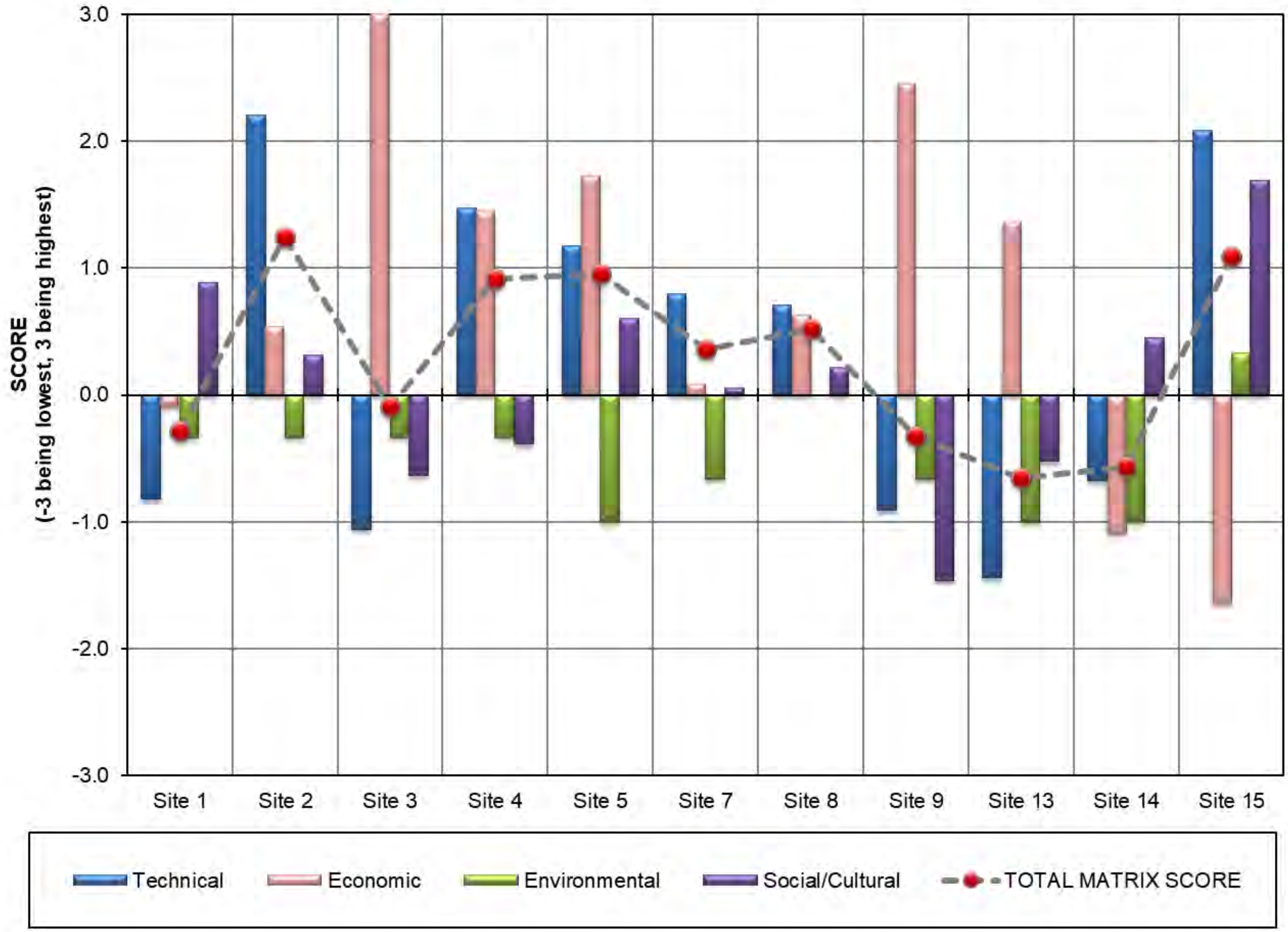


Figure 2. Multiple Accounts Analysis results

5.0 CONCLUSIONS

A comprehensive MAA evaluation was completed for eleven potential flood control structures on Dry Creek. The evaluation incorporated technical, economic, environmental, and social and cultural criteria and was supported by 2D HEC-RAS model predicted inundation area, capture volume and water surface elevations at each site for a range of return frequency storm ranging from 5-year to 100-year. The total matrix score was greatest for Site 2 (1.24), followed by Site 15 (1.09), Site 5 (0.95), and Site 4 (0.92). All other site alternatives had a Matrix score of 0.52 or less.

The MAA results indicate that Sites 2, 15, and 5 should be further evaluated to optimize the designs. Additionally, Site 4 may also be included in the additional evaluation due to the small difference between the Site 5 and Site 4 scores (0.95 versus 0.92).

6.0 REFERENCES

GSA – See GeoSystems Analysis, Inc.

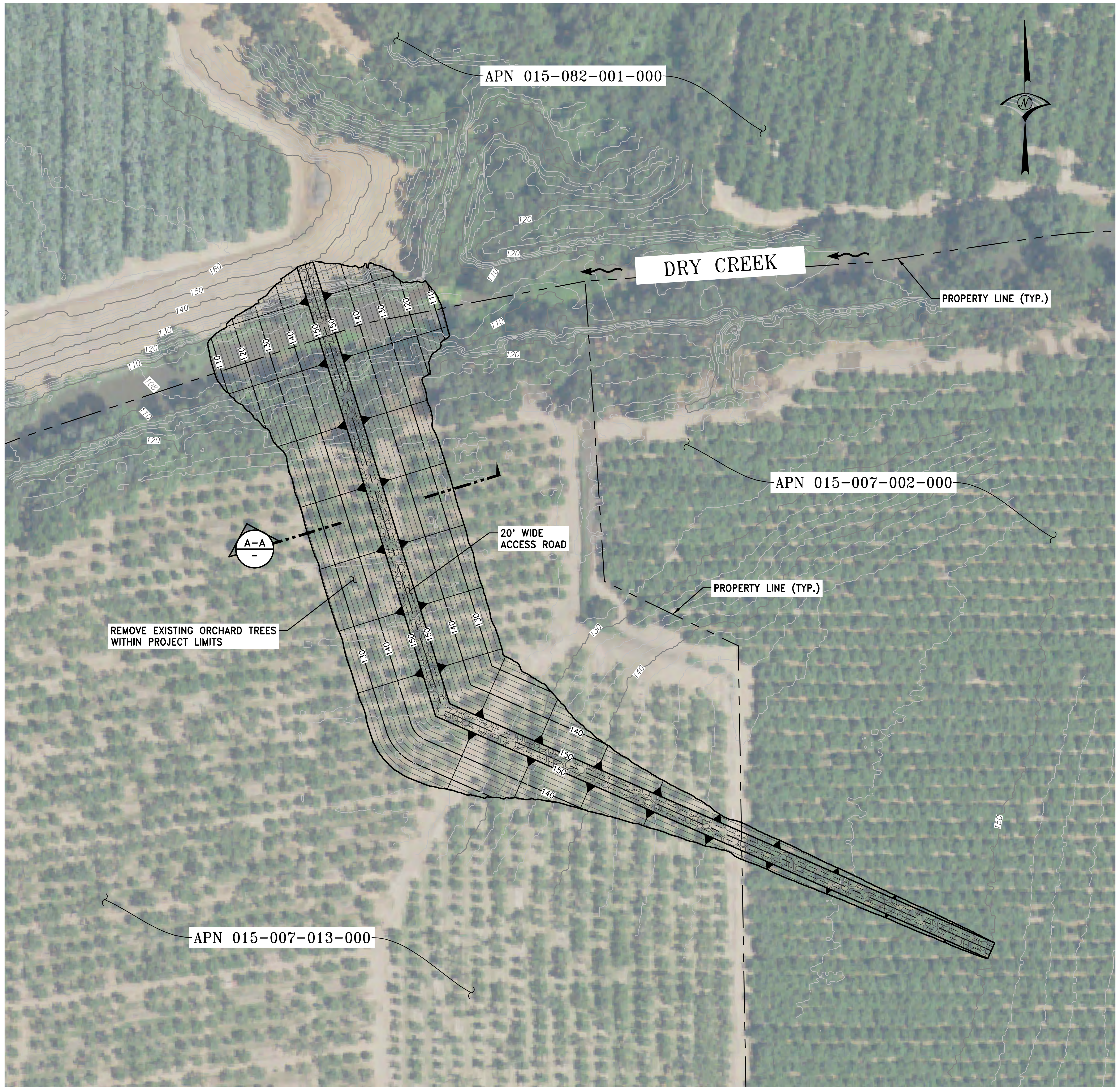
GeoSystems Analysis, Inc. 2020a. Evaluation of Stormwater Management and Groundwater Recharge Projects in the Dry Creek Watershed of Stanislaus County. Prepared for Stanislaus County Public Works, March 12, 2020.

GeoSystems Analysis, Inc. 2020b. Technical Memorandum 2 – Dry Creek Watershed Stormwater Management and Groundwater Recharge Multiple Account Analysis. Prepared for Stanislaus County Public Works, April 23, 2020.

Mendoza, G.A. and H. Martins, 2006. Multi-criteria decision analysis in natural resource management: A critical review of methods and new modelling paradigms. Forest Ecology and Management. 230 (2006), pg. 1-22.

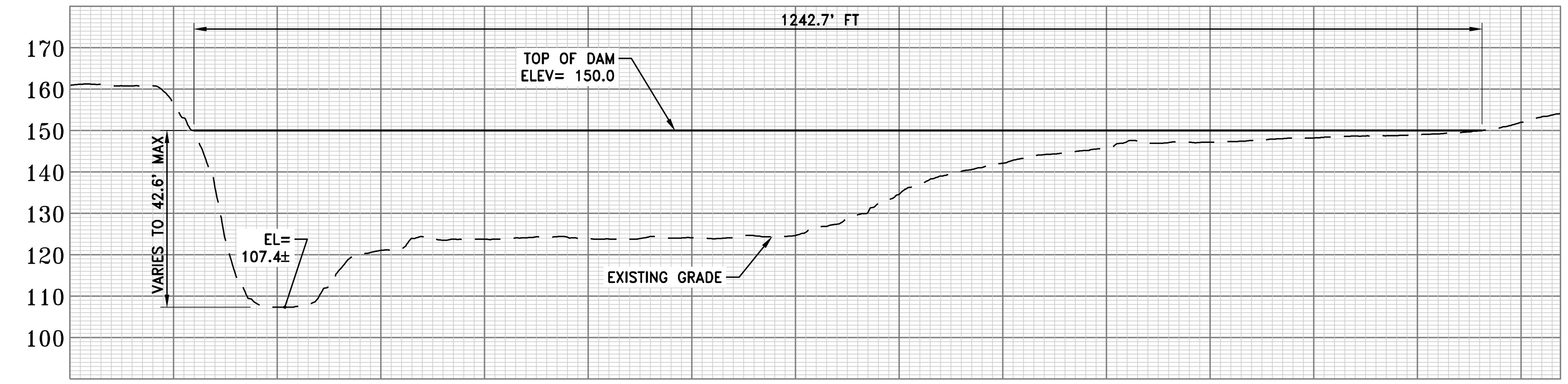
Appendix A

Flood Control Structure Preliminary Design



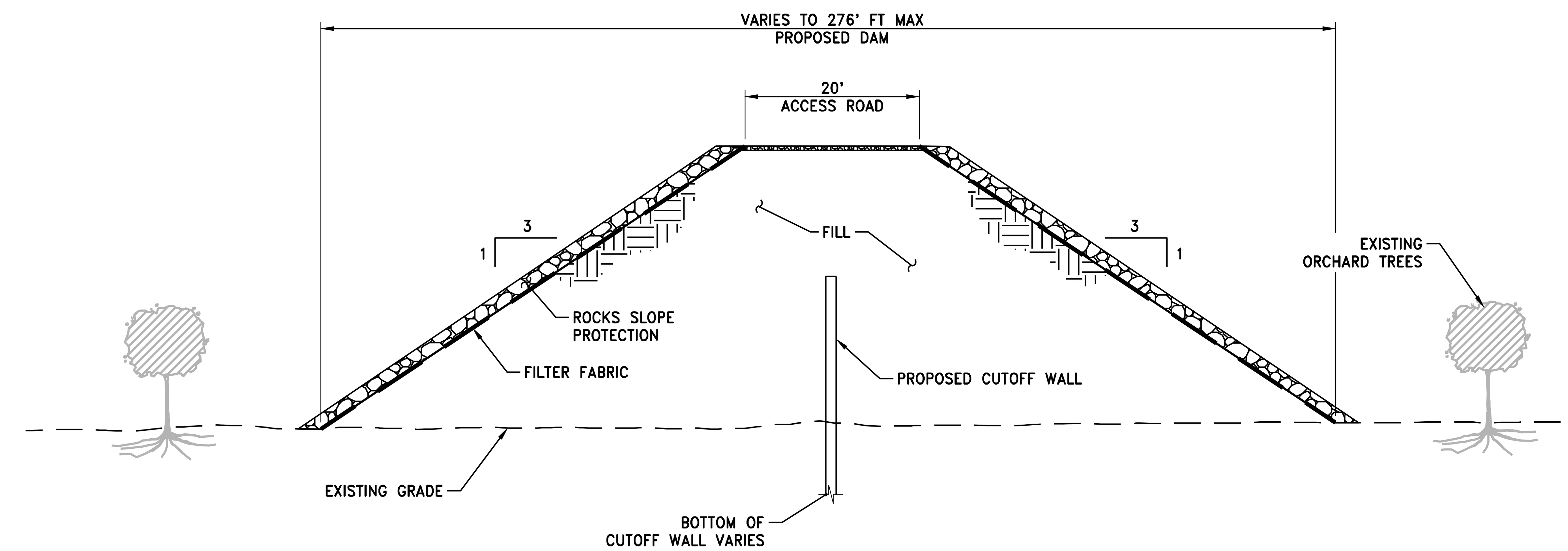
SITE 1 - PLAN VIEW

SCALE: 1"=80'



SITE 1 - PROFILE VIEW

SCALE: HORZ-1"=100'
VERT-1"=25'



A-A
SITE 1 -TYPICAL SECTION

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:
DRAWN BY:
CHECKED BY:
IN CHARGE:
DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED
APPROVED

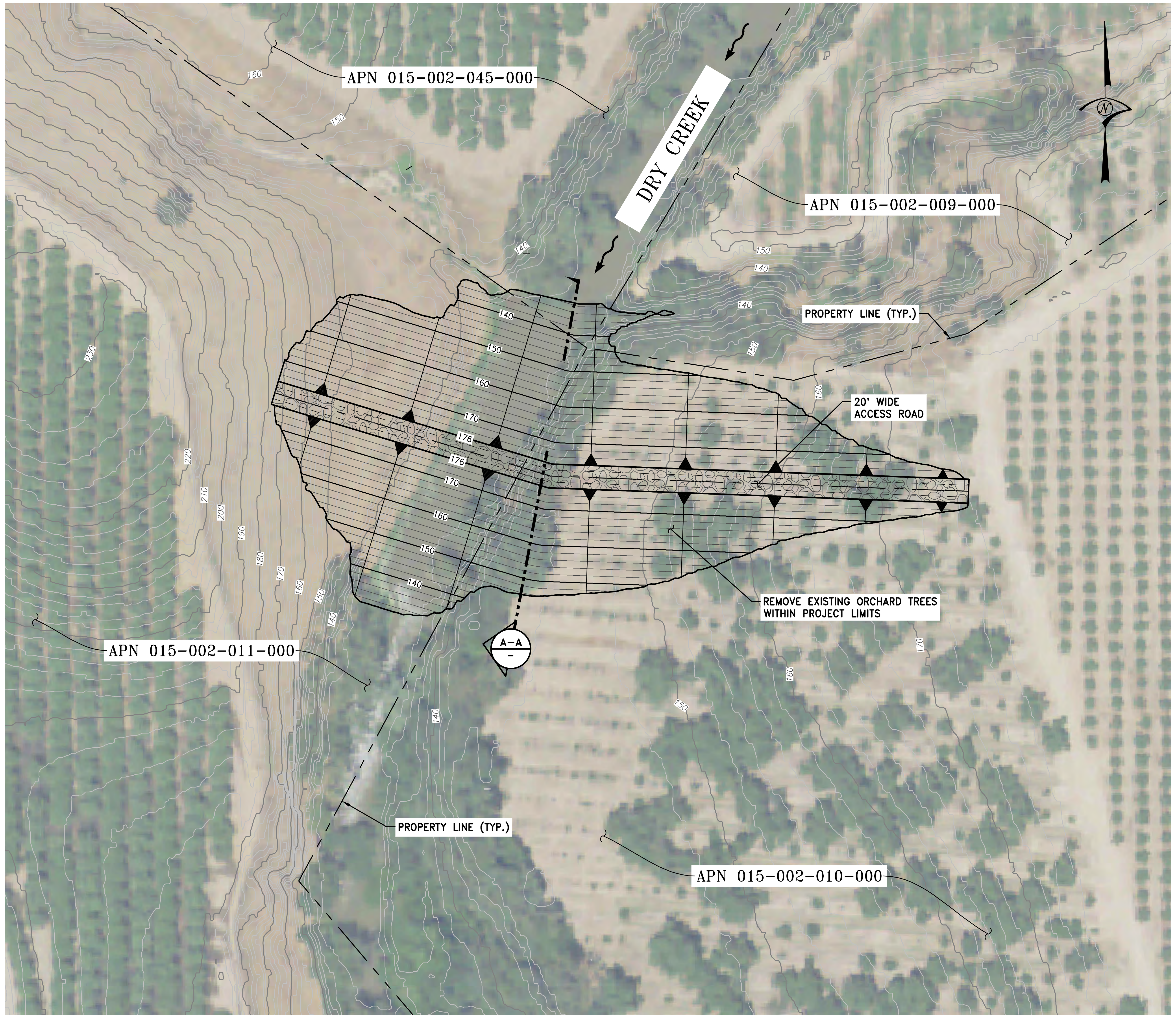
GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT
AND GROUNDWATER RECHARGE PROJECT

SITE 1 DAM

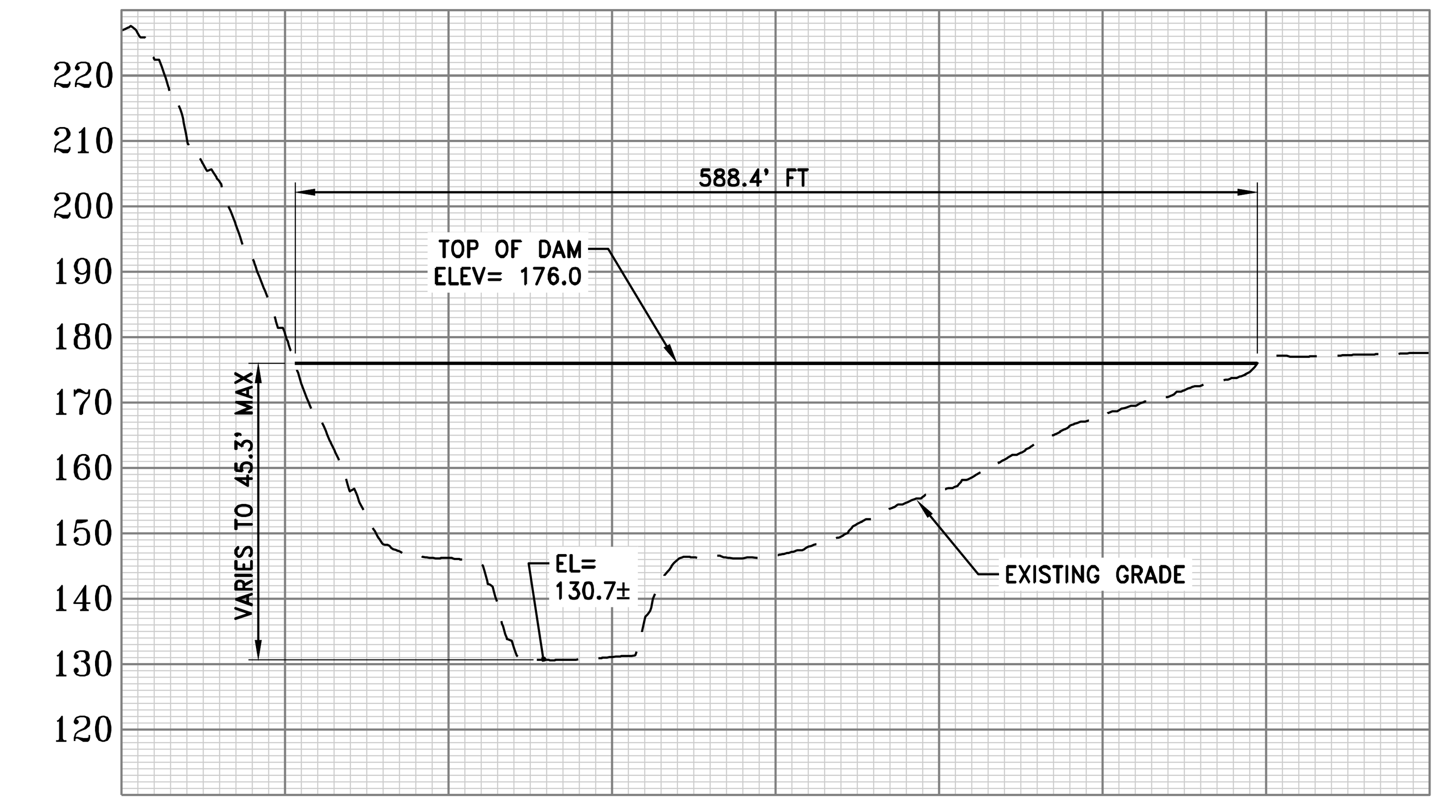
DRAWING NO. SHEET

z:\3000-s\3772_GSA\377201_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-01_SITE-01_DC-SMG.dwg 9/10/2021 4:48 PM Jenny Priest



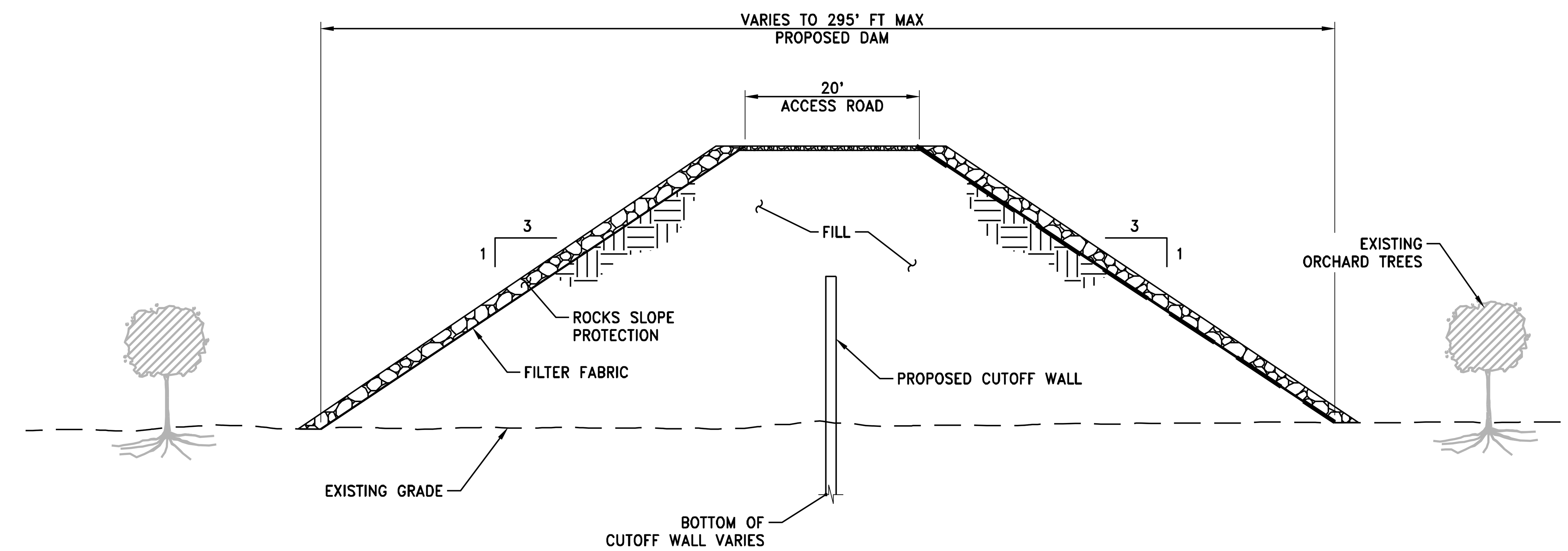
SITE 2 - PLAN VIEW

SCALE: 1"=60'



SITE 2 - PROFILE VIEW

SCALE: HORZ-1"=100'
VERT-1"=25'



A-A SITE 2 -TYPICAL SECTION

SCALE: NOT TO SCALE

LEGEND:

- PROPOSED ACCESS ROAD
- PROPOSED ROCK SLOPE PROTECTION
- EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:
DRAWN BY:
CHECKED BY:
IN CHARGE:
DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED
APPROVED

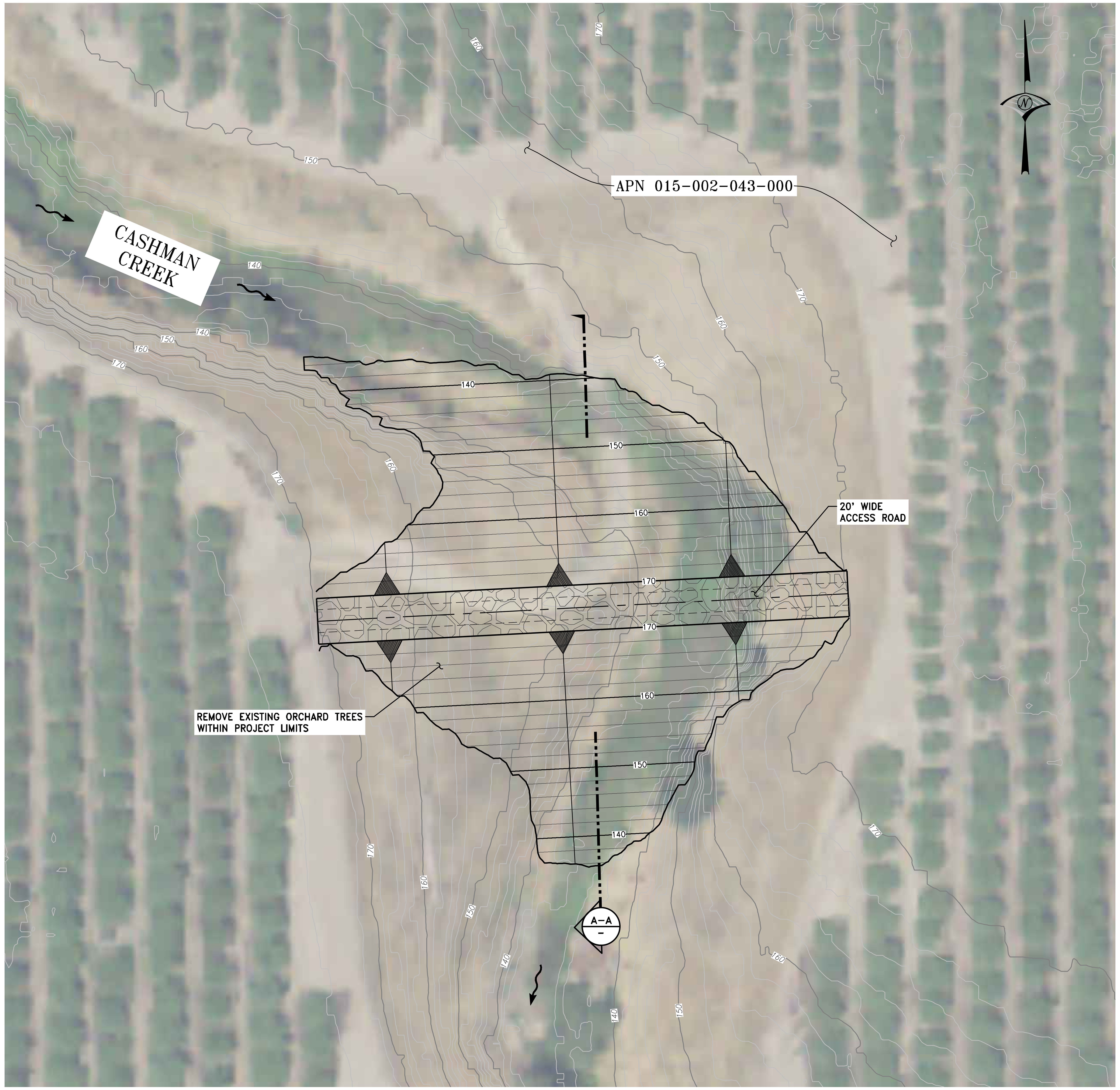
GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 2 DAM

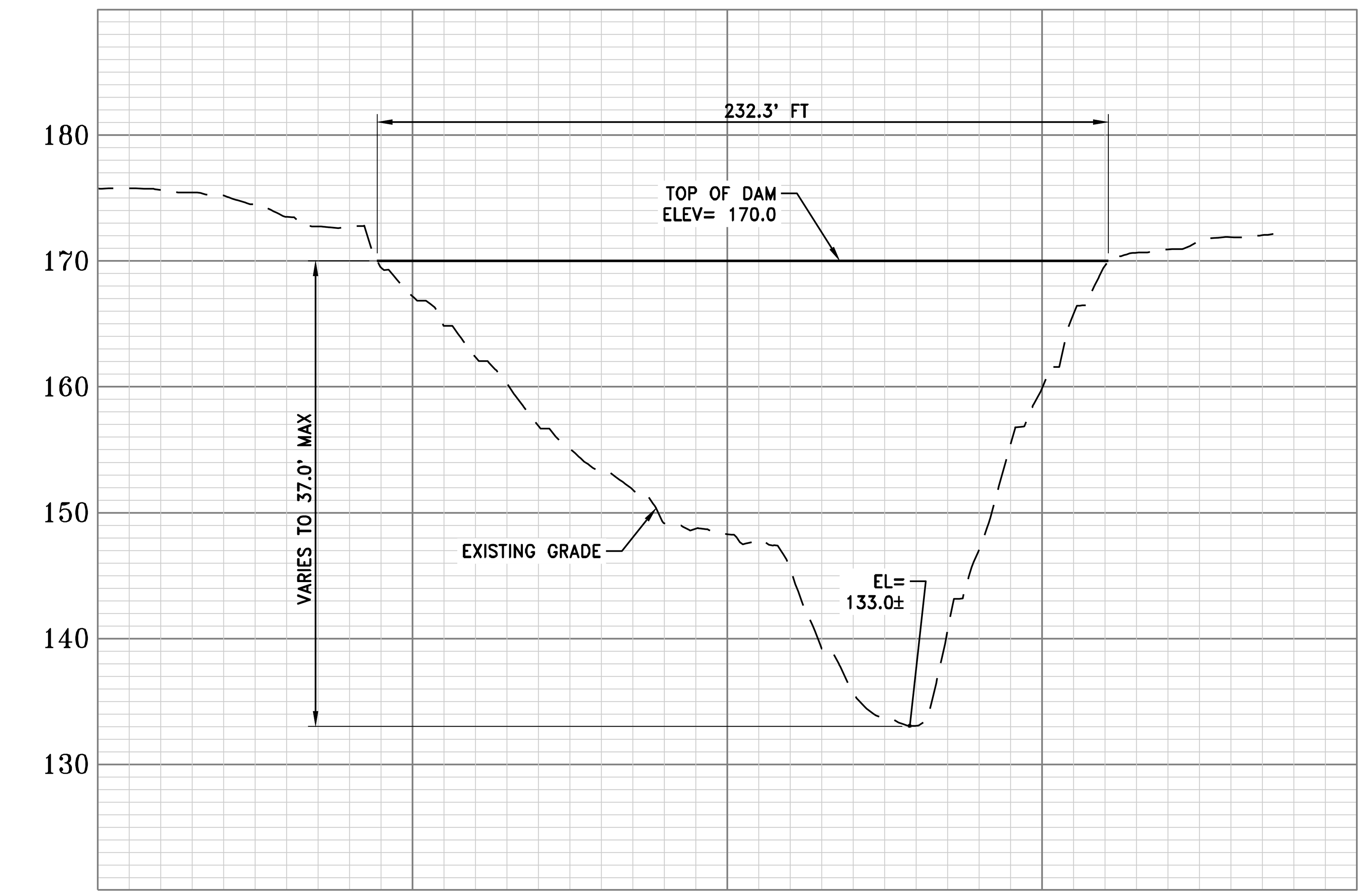
DRAWING NO.
SHEET

J:\3000-s\3772_GSA\3772001_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-02_SITE-02_DC-SMG.dwg 9/10/2021 4:46 PM Jenny Priest



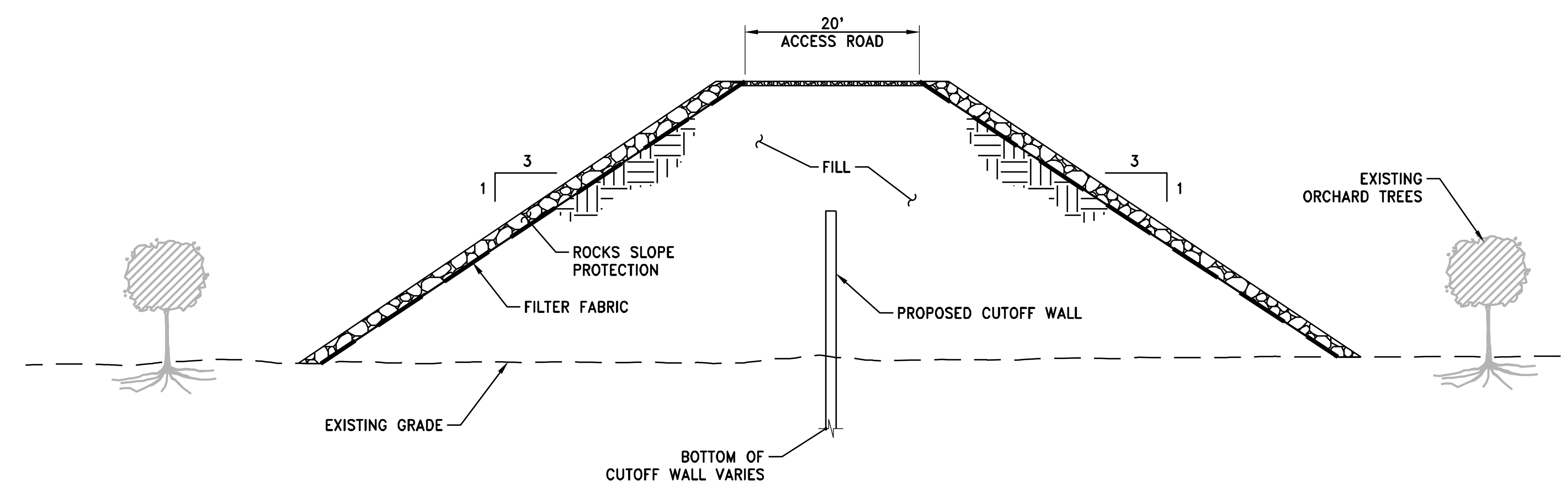
SITE 3 - PLAN VIEW

SCALE: 1"=30'



SITE 3 - PROFILE VIEW

SCALE: HORZ-1"=40'
VERT-1"=10'



A-A **SITE 3 -TYPICAL SECTION**

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:

DRAWN BY:

CHECKED BY:

IN CHARGE:

DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED

APPROVED

GEOSYSTEMS ANALYSIS, INC

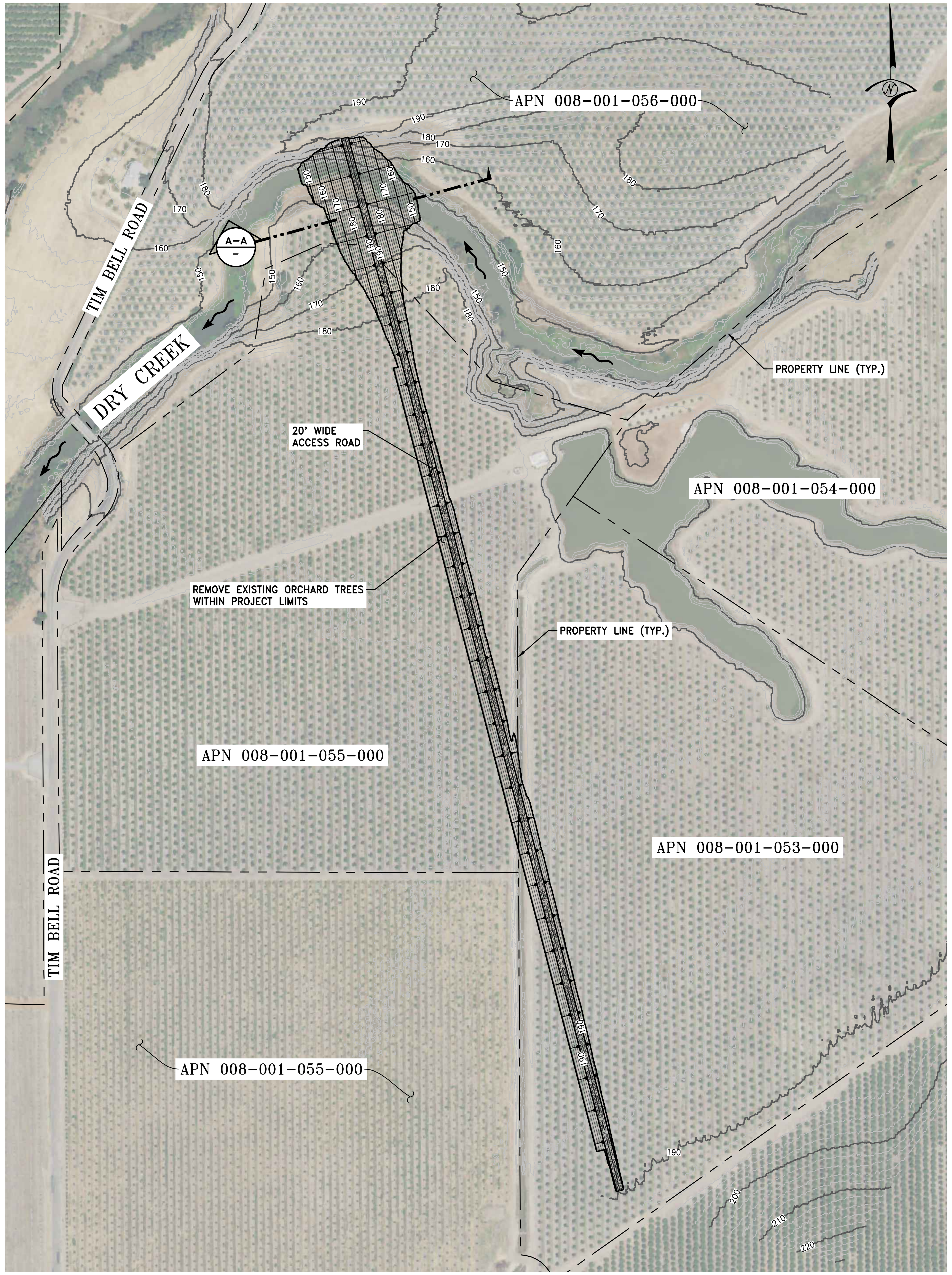
DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 3 DAM

DRAWING NO.

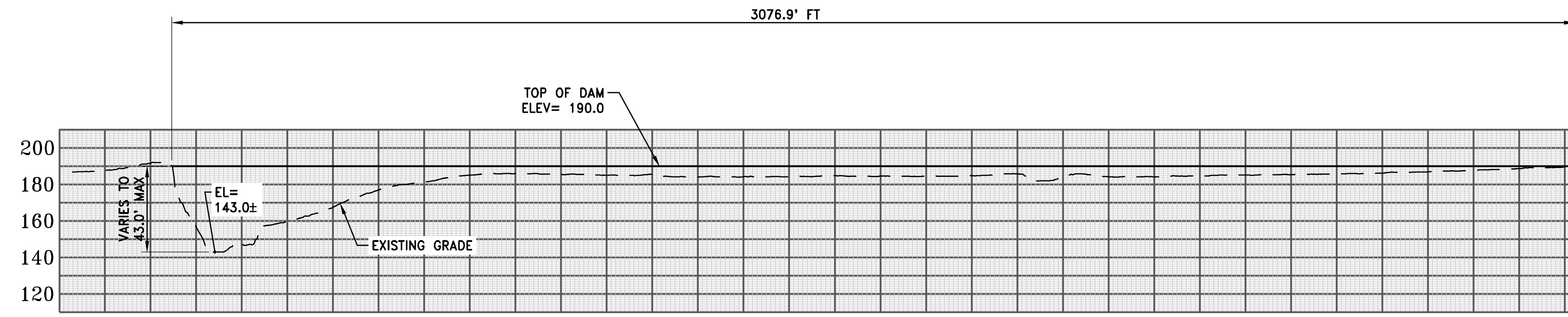
SHEET

J:\3000-s\3772_GSA\3772001_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-03_SITE-03_DC-SMG.dwg 9/10/2021 7:23 PM Jenny Priest



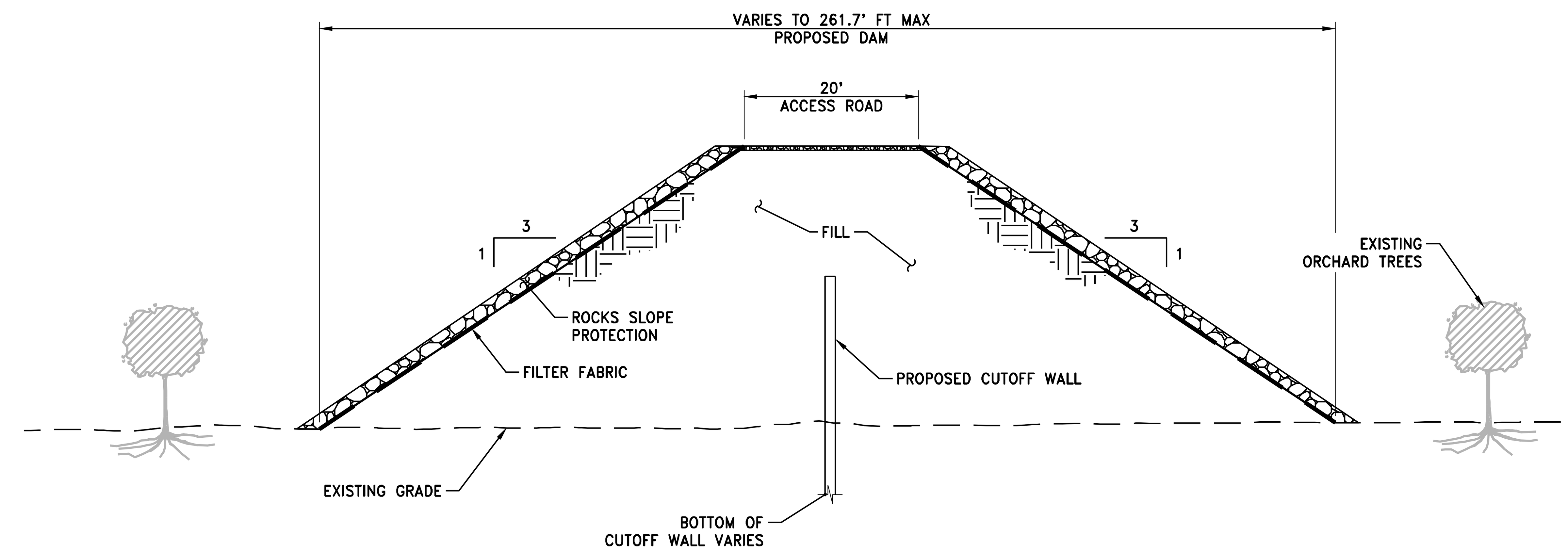
SITE 4 - PLAN VIEW

SCALE: 1"=200'



SITE 4 - PROFILE VIEW

SCALE: HORZ-1"=200'
VERT-1"=50'



A-A
SITE 4 -TYPICAL SECTION

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:

DRAWN BY:

CHECKED BY:

IN CHARGE:

DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED

APPROVED

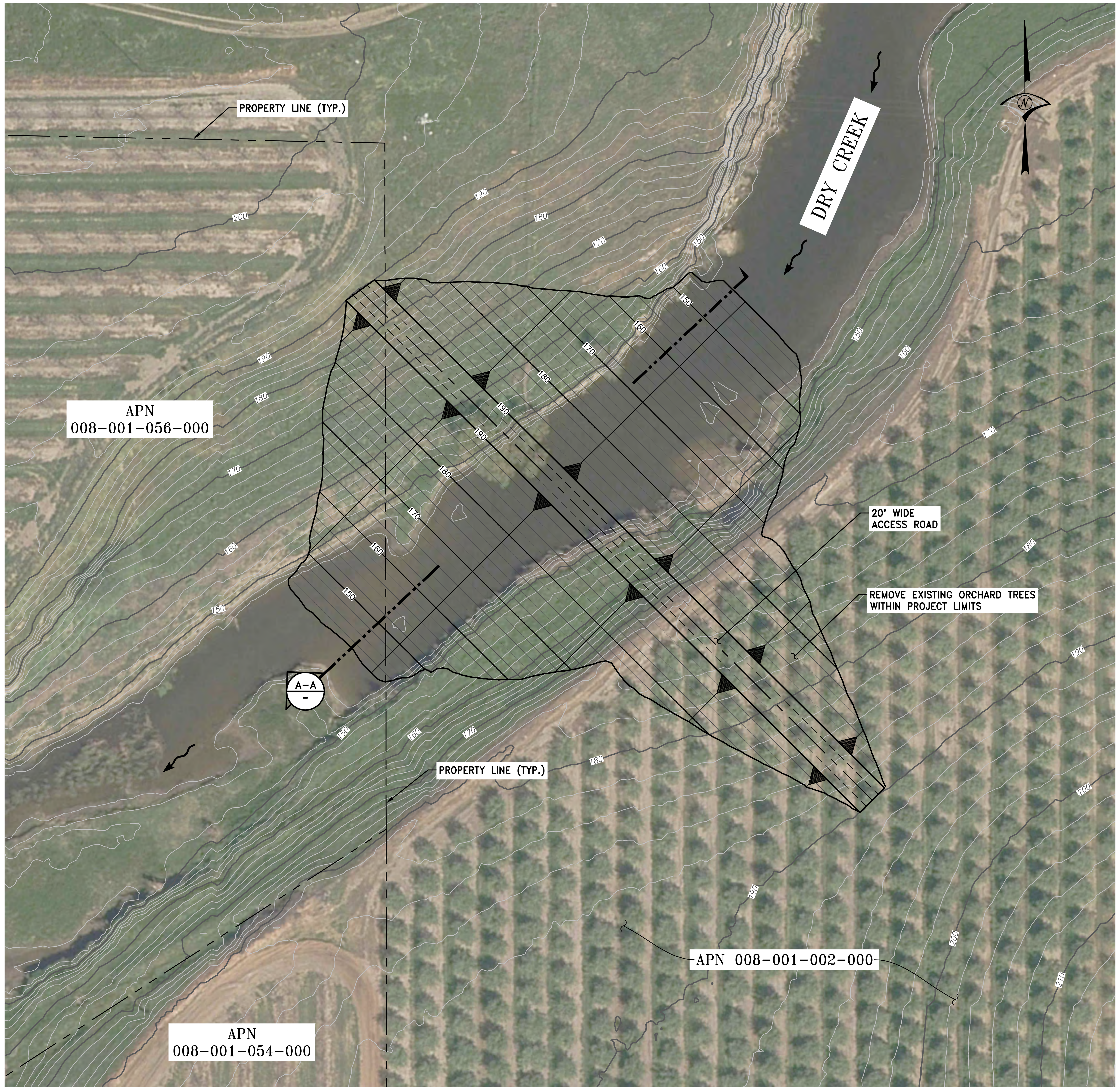
GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 4 DAM

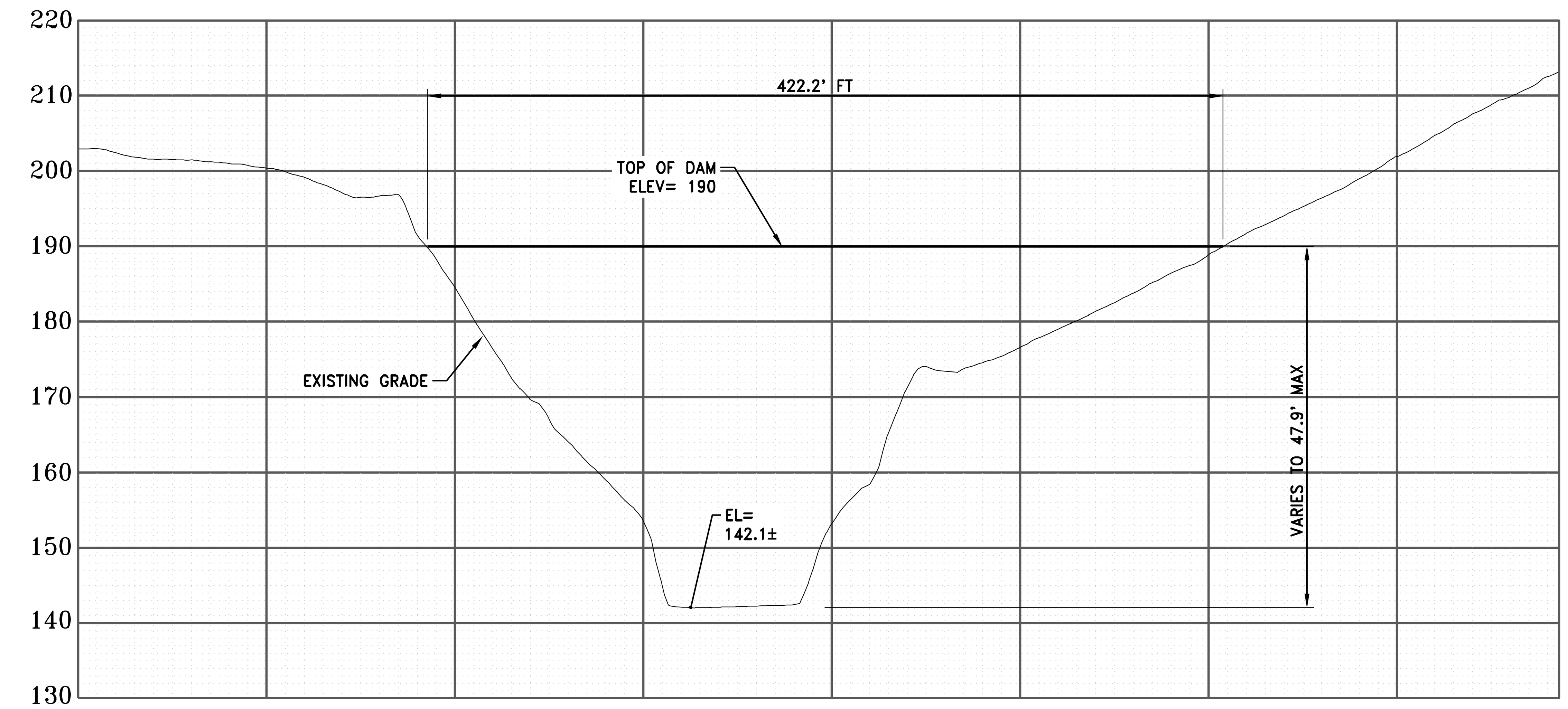
DRAWING NO.

SHEET



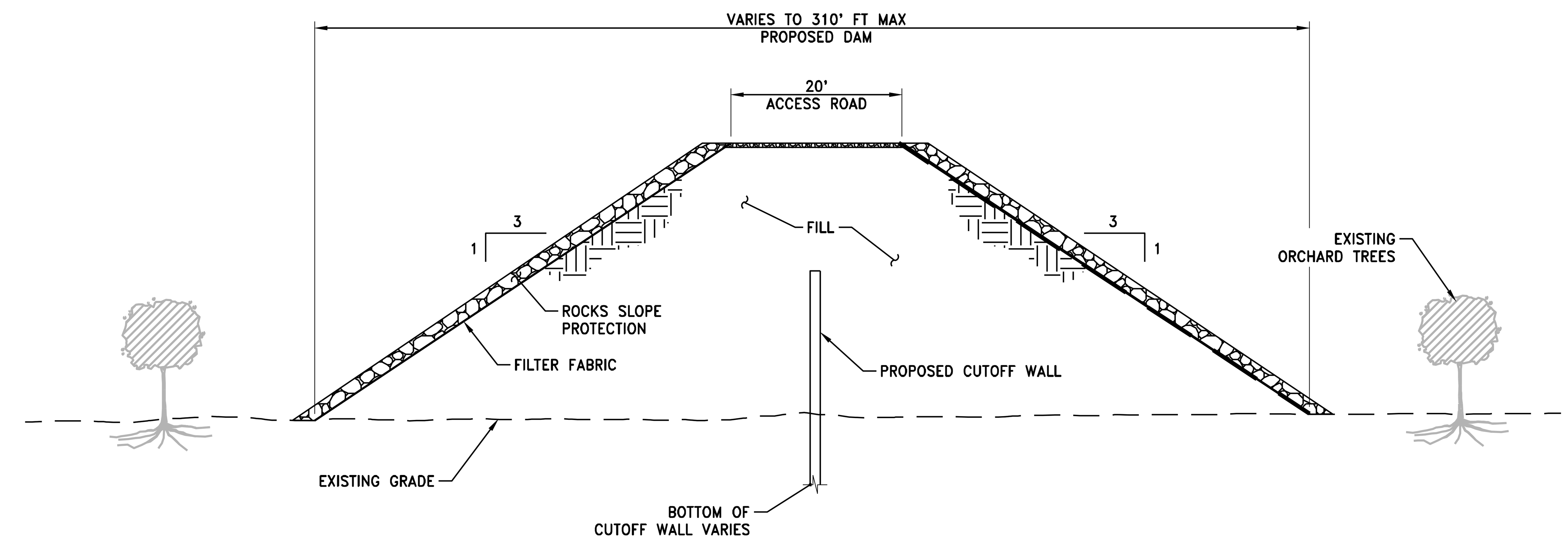
SITE 5 - PLAN VIEW

SCALE: 1"=40'



SITE 5 - PROFILE VIEW

SCALE: HORZ-1"=60'
VERT-1"=15'



A-A SITE 5 -TYPICAL SECTION

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:

DRAWN BY:

CHECKED BY:

IN CHARGE:

DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED

APPROVED

GEOSYSTEMS ANALYSIS, INC

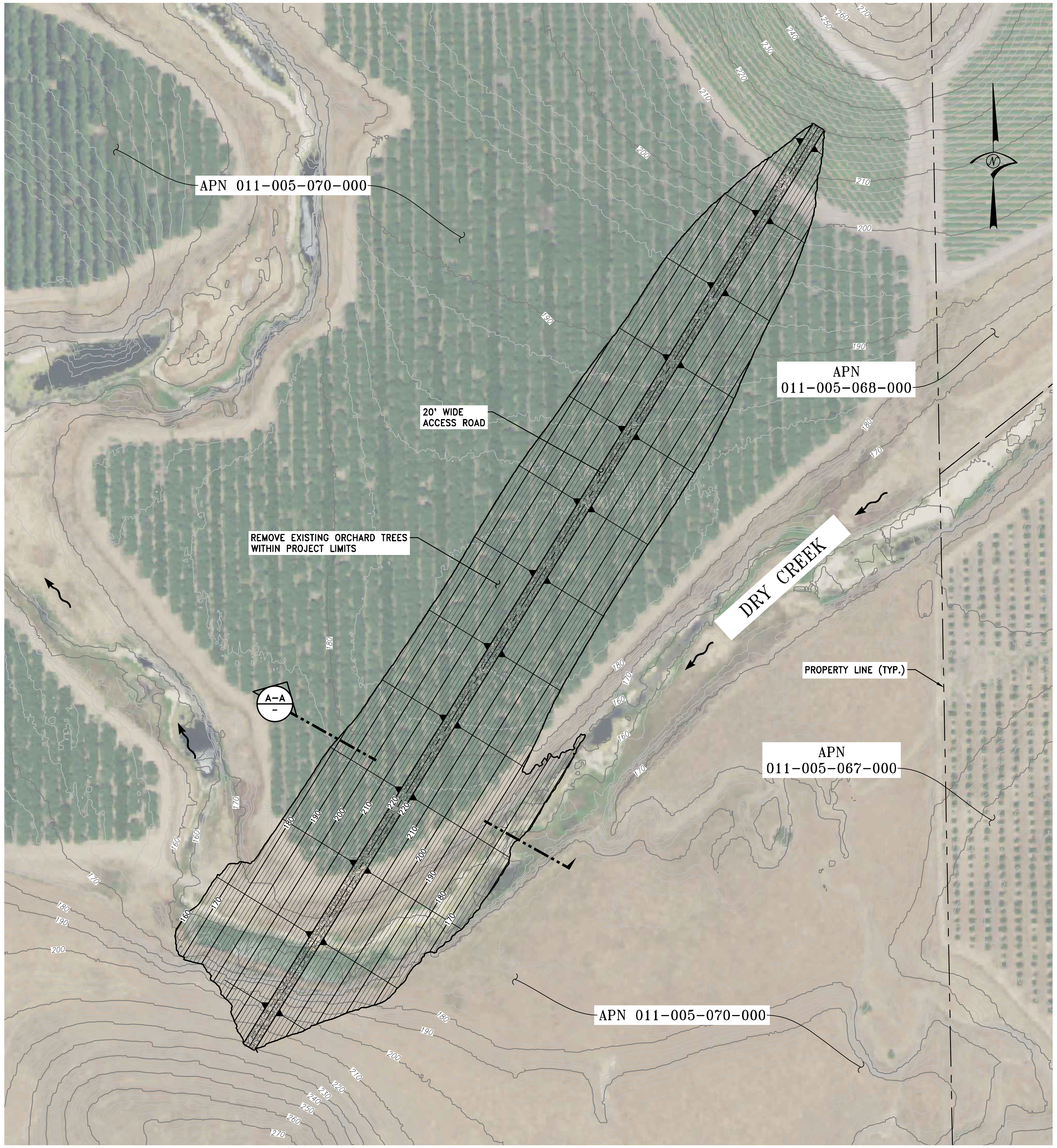
DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 5 DAM

DRAWING NO.

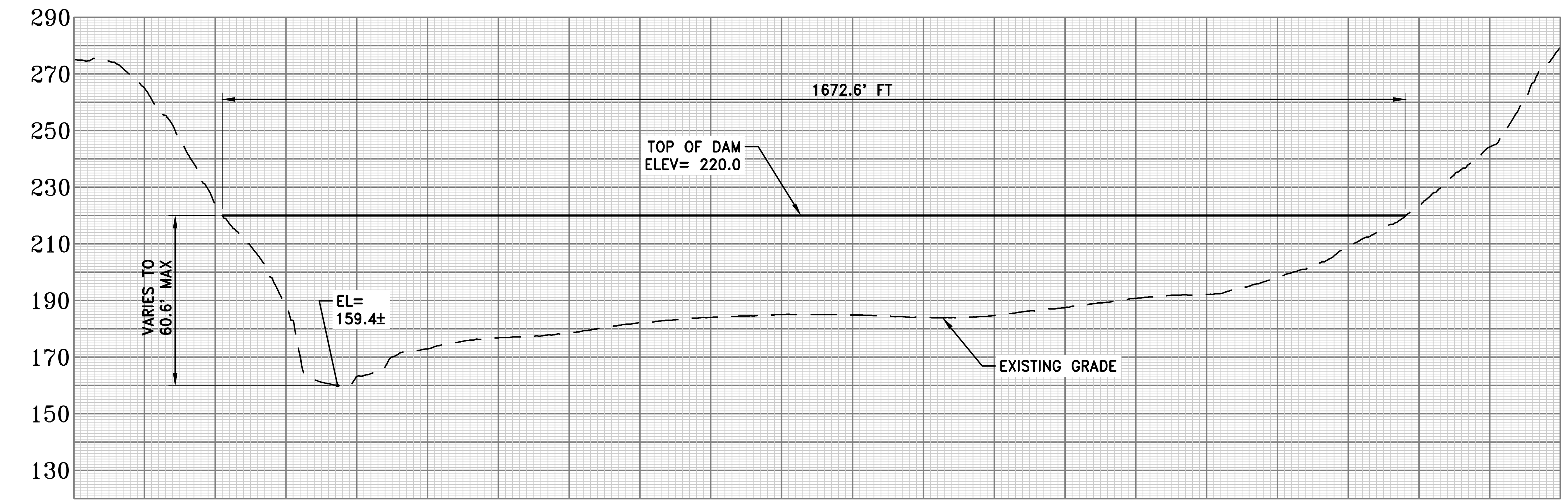
SHEET

z:\3000-s\3772_GSA\3772001_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-11_SITE-05A_DC-SMG.dwg 10/14/2021 10:45 PM Jenny Priest



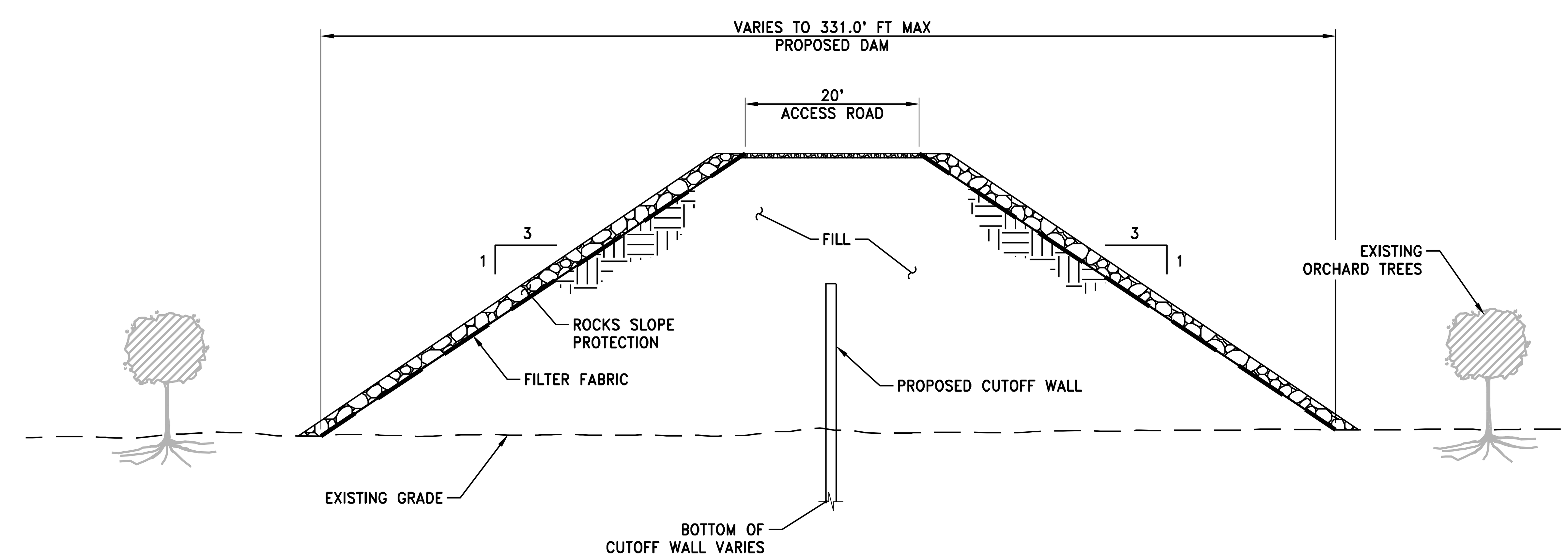
SITE 7 - PLAN VIEW

SCALE: 1"=100'



SITE 7 - PROFILE VIEW

SCALE: HORZ-1"=150'
VERT-1"=35'



A-A SITE 1 -TYPICAL SECTION

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:

DRAWN BY:

CHECKED BY:

IN CHARGE:

DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED

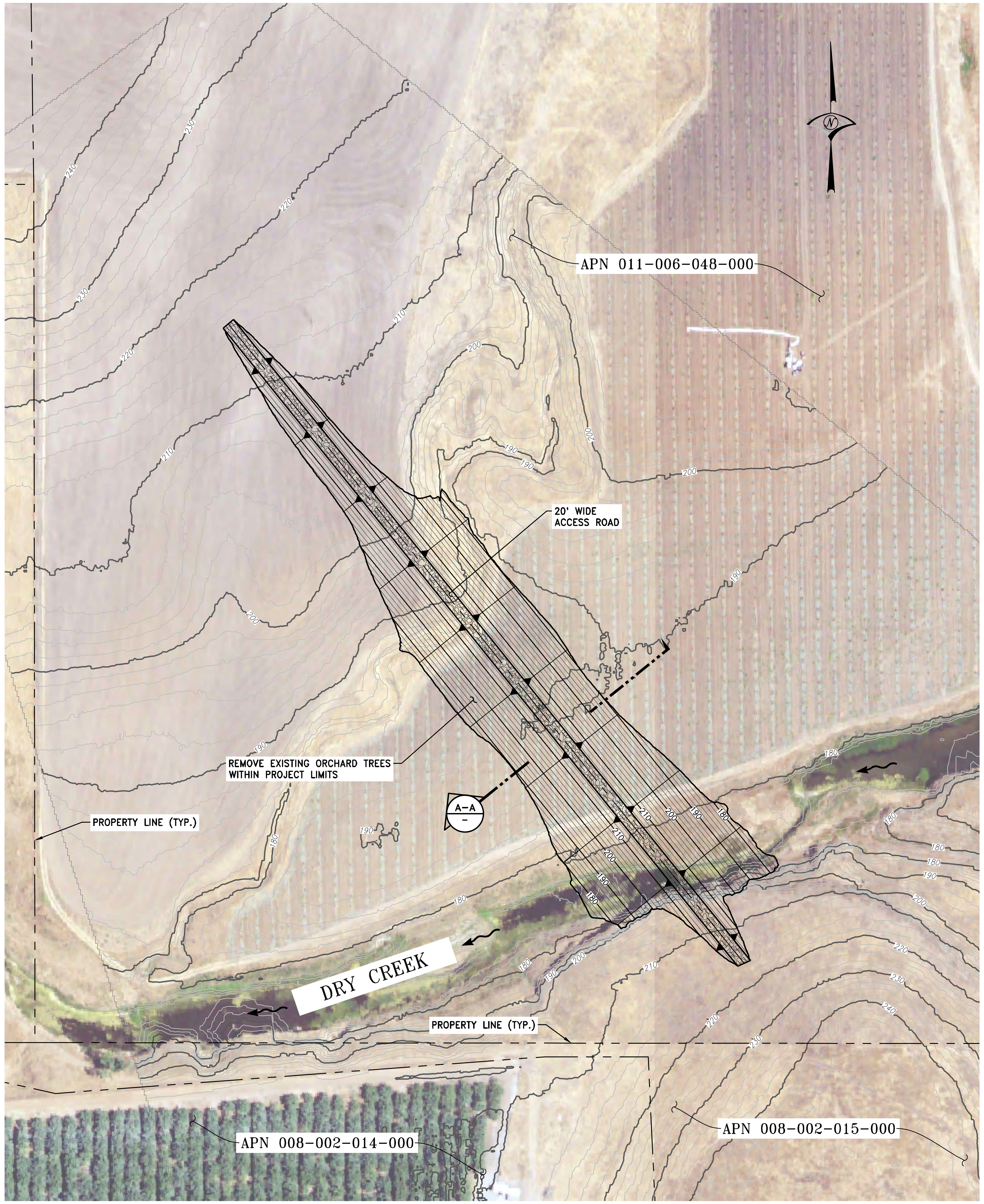
APPROVED

GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

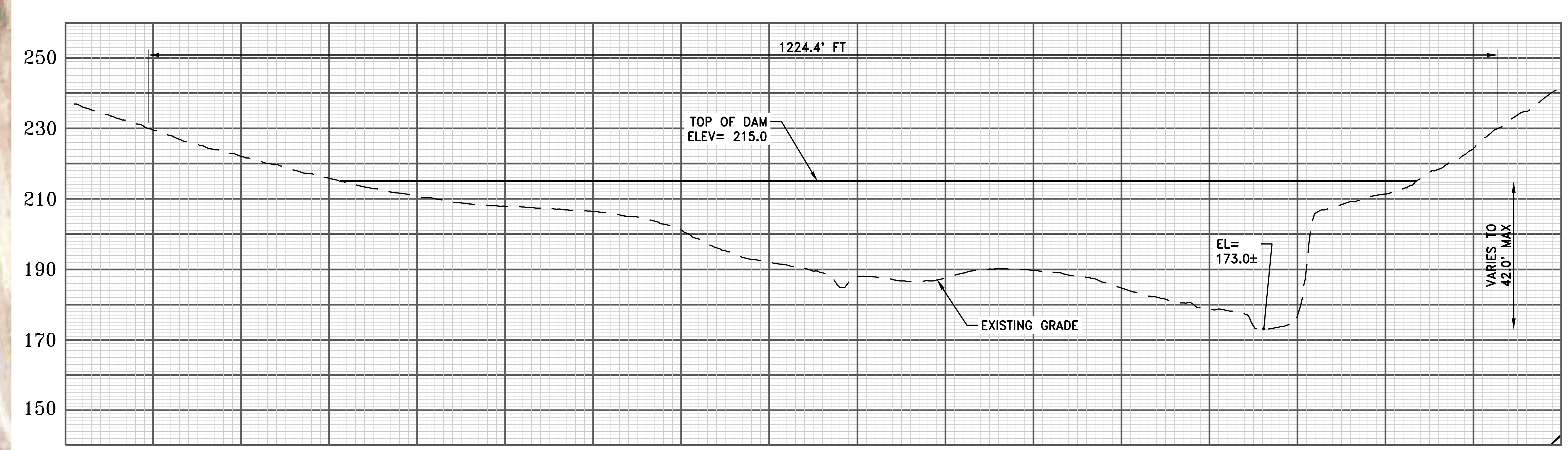
SITE 7 DAM

DRAWING NO. SHEET



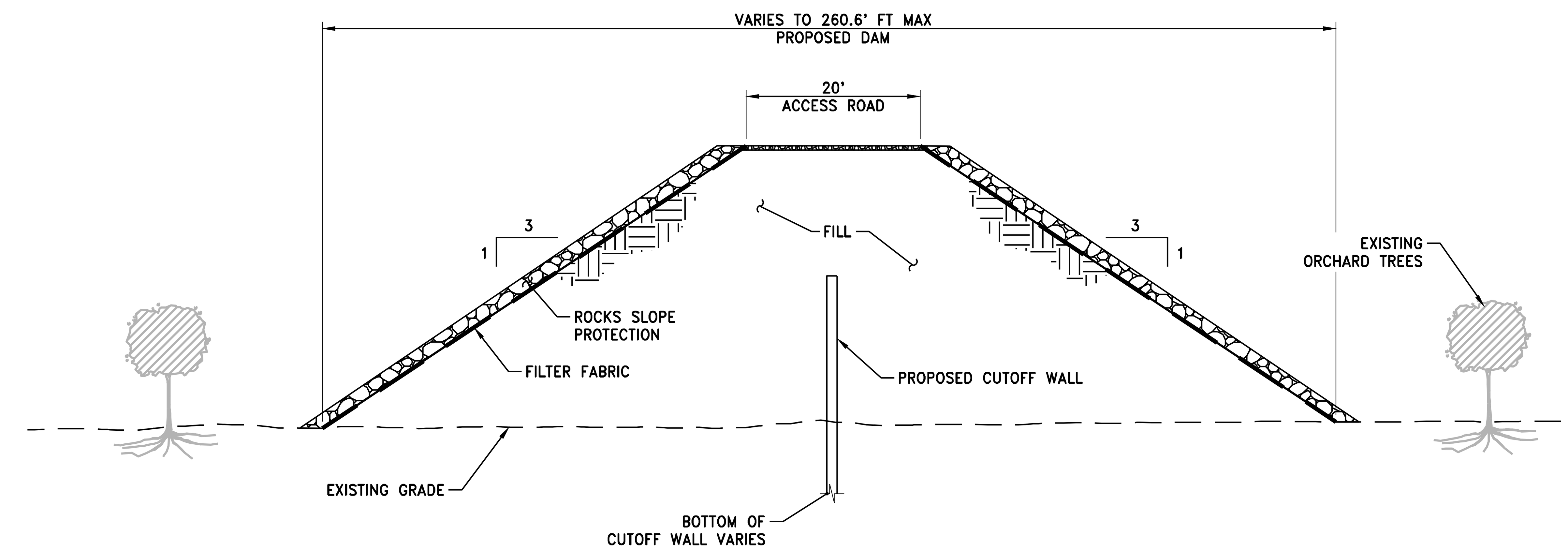
SITE 8 - PLAN VIEW

SCALE: 1"=100'



SITE 8 - PROFILE VIEW

SCALE: HORZ-1"=100'
VERT-1"=25'



A-A SITE 8 -TYPICAL SECTION

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:

DRAWN BY:

CHECKED BY:

IN CHARGE:

DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED

APPROVED

GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 8 DAM

DRAWING NO.

SHEET

J:\3000-s\3772_GSA\3772001_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-06_SITE-08_DC-SMG.dwg 10/14/2021 10:58 PM Jenny Priest

SITE 9 - PLAN VIEW

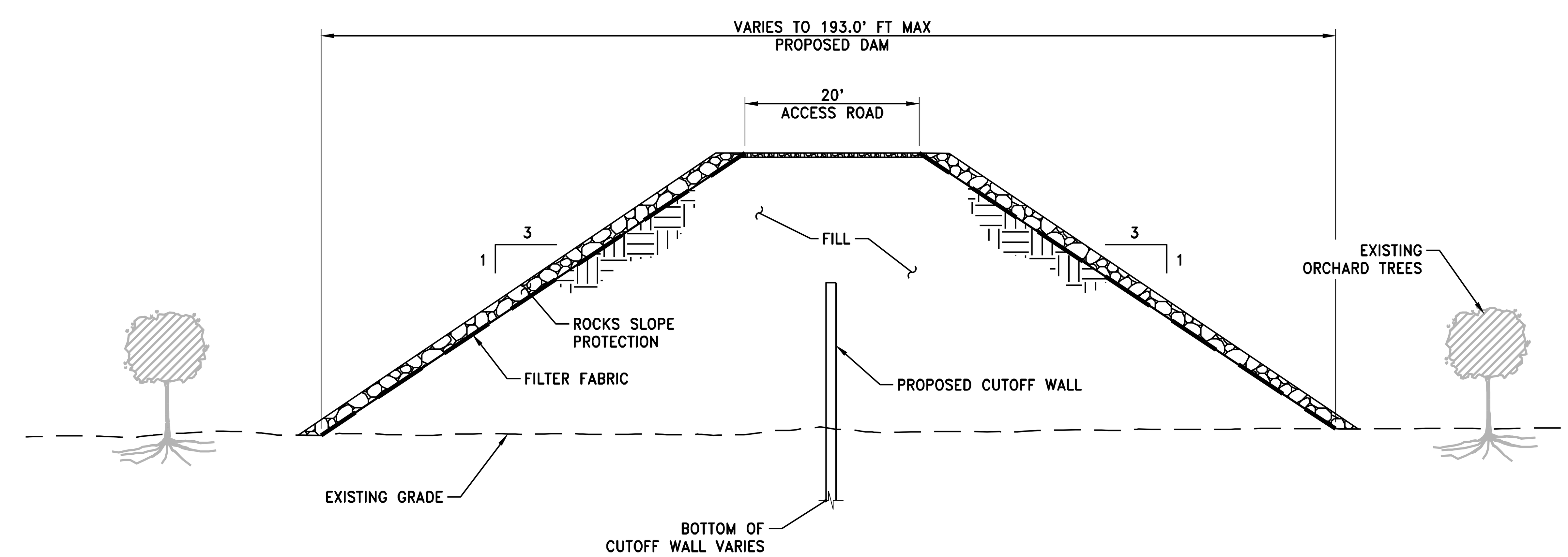
SCALE: 1"=120'

SITE 9 - PROFILE VIEW

SCALE: HORZ-1"=120'
VERT-1"=30'

LEGEND:

	PROPOSED ACCESS ROAD
	PROPOSED ROCK SLOPE PROTECTION
	EXISTING ORCHARD TREE



A-A / — **SITE 9 -TYPICAL SECTION**

SCALE: NOT TO SCALE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:
DRAWN BY:
CHECKED BY:
IN CHARGE:
DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED | APPROVED

GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 9 DAM

DRAWING NO. | SHEET

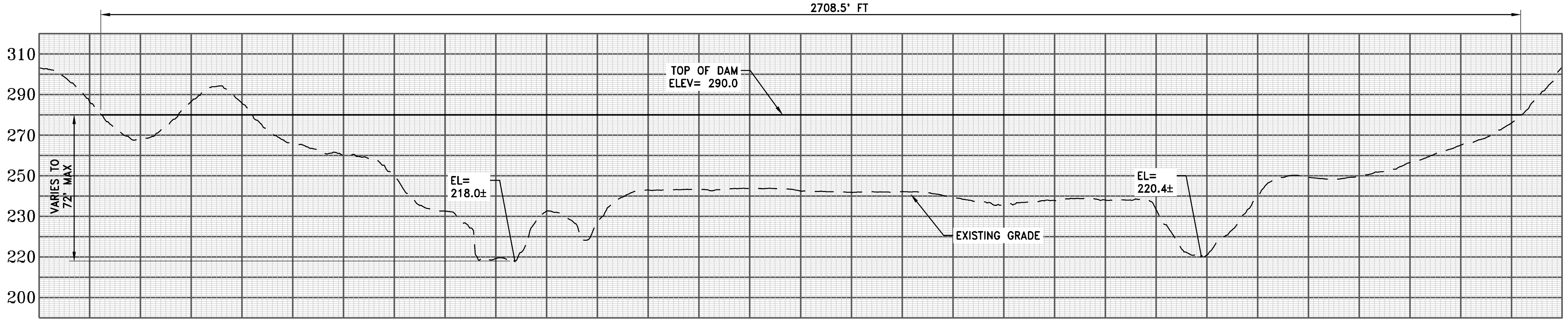
J:\3000-s\3772_GSA\3772001_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-07_SITE-09_DC-SMG.dwg 9/10/2021 9:22 PM Jenny Priest

SITE 13 - PLAN VIEW

SCALE: 1"=100'

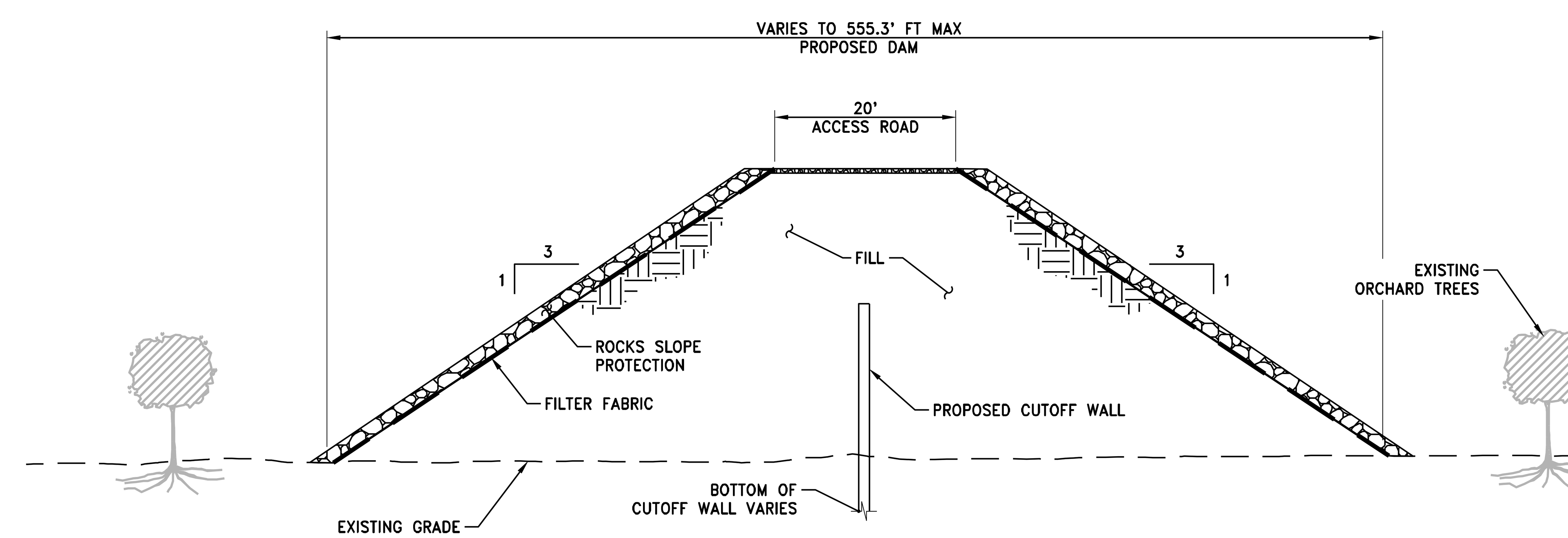
LEGEND:

- PROPOSED ACCESS ROAD
- PROPOSED ROCK SLOPE PROTECTION
- EXISTING ORCHARD TREE



SITE 13 - PROFILE VIEW

SCALE: HORZ-1"=150'
VERT-1"=50'



A-A SITE 13 -TYPICAL SECTION

SCALE: NOT TO SCALE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:
DRAWN BY:
CHECKED BY:
IN CHARGE:
DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

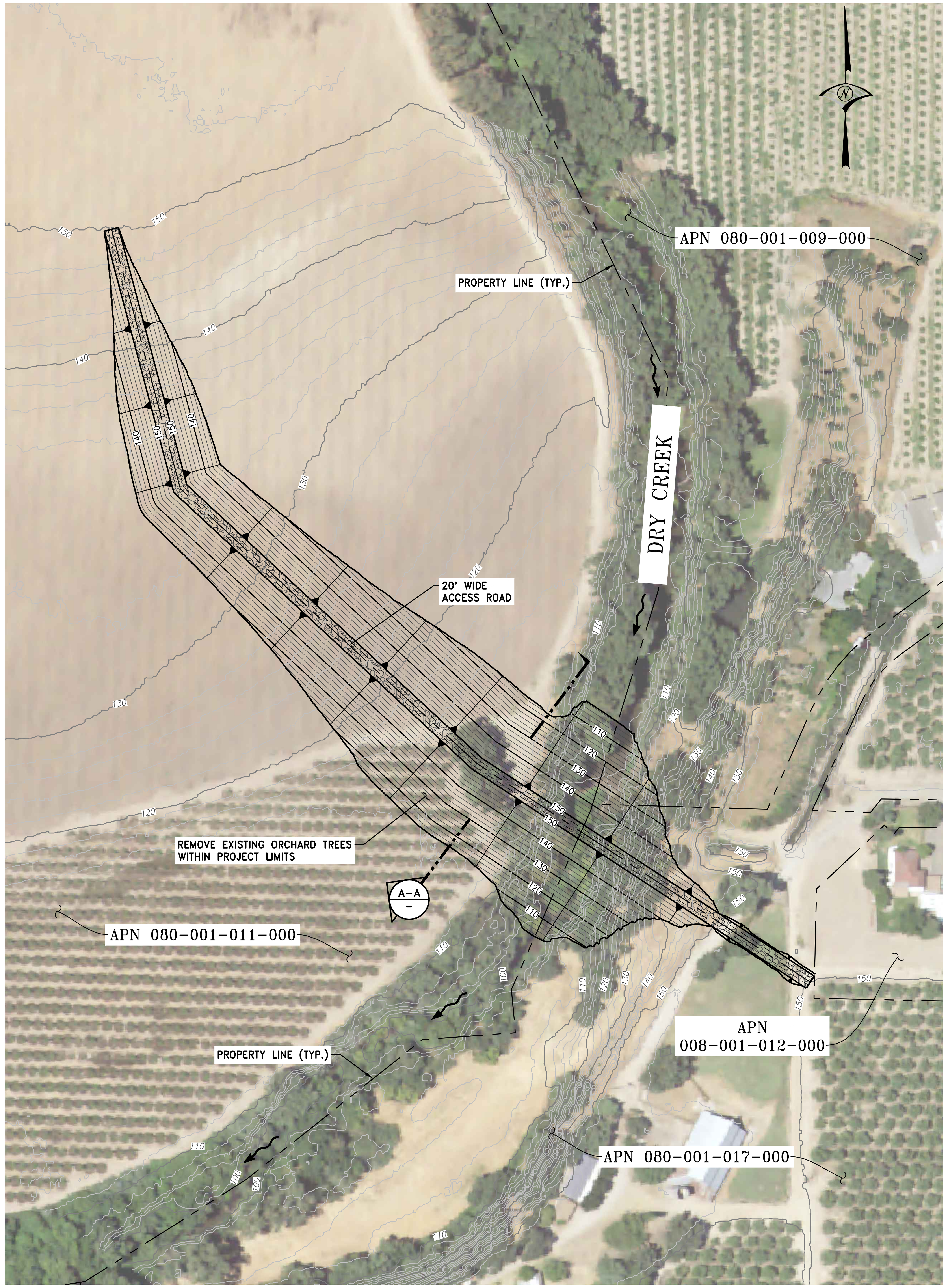
SUBMITTED
APPROVED

GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

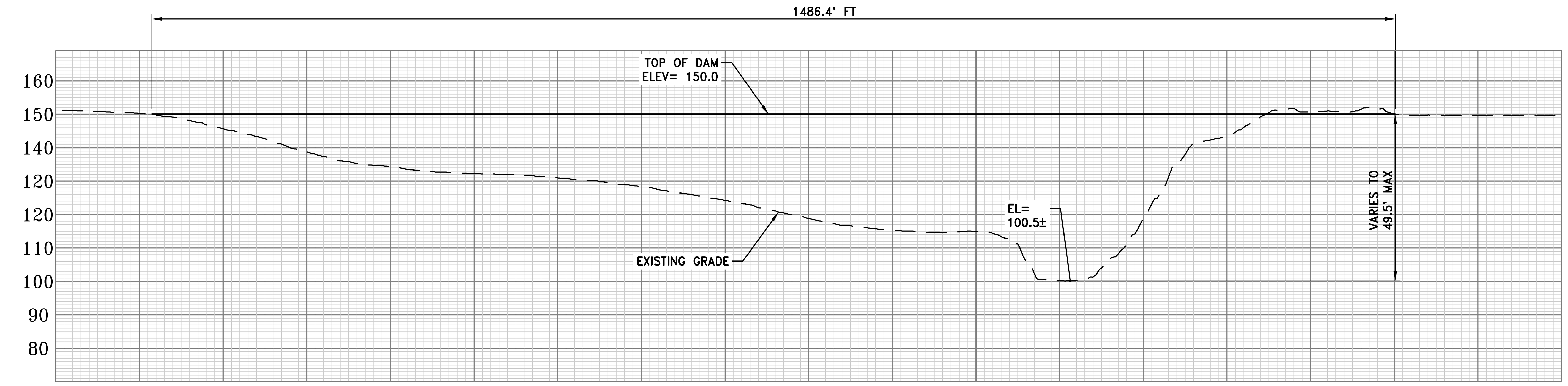
SITE 13 DAM

DRAWING NO.
SHEET



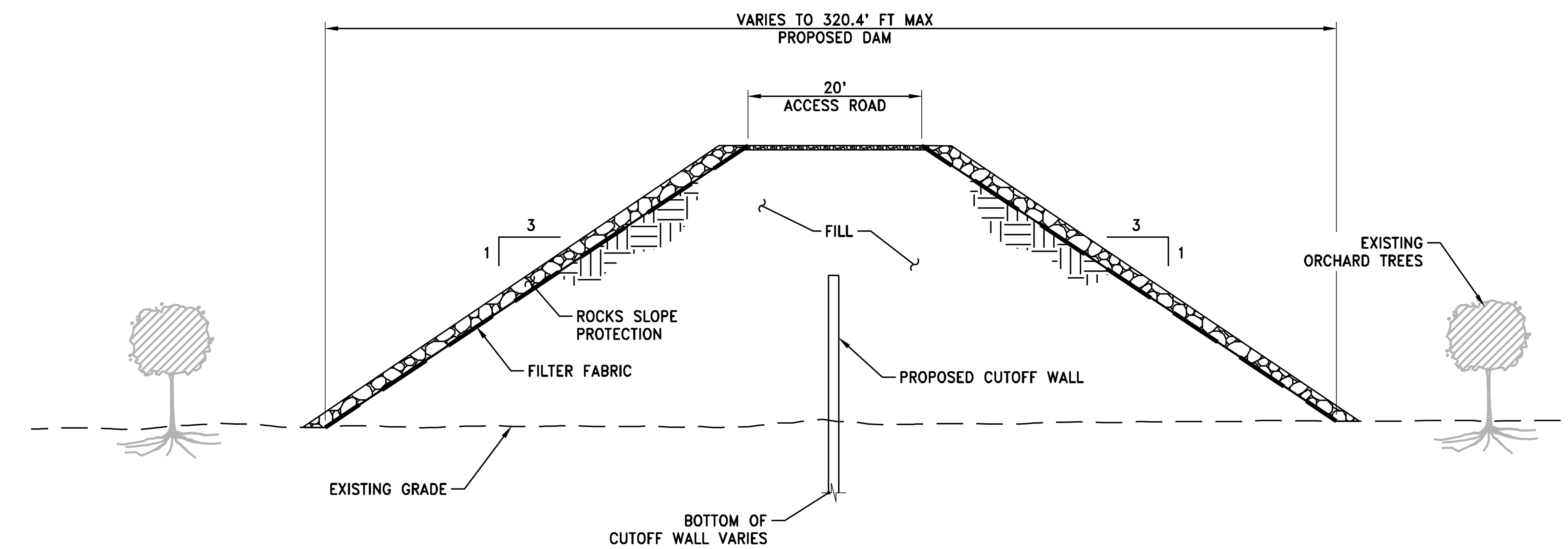
SITE 14 - PLAN VIEW

SCALE: 1"=100'



SITE 14 - PROFILE VIEW

SCALE: HORZ-1"=100'
VERT-1"=25'



A-A **SITE 14 -TYPICAL SECTION**

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:

DRAWN BY:

CHECKED BY:

IN CHARGE:

DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED

APPROVED

GEOSYSTEMS ANALYSIS, INC

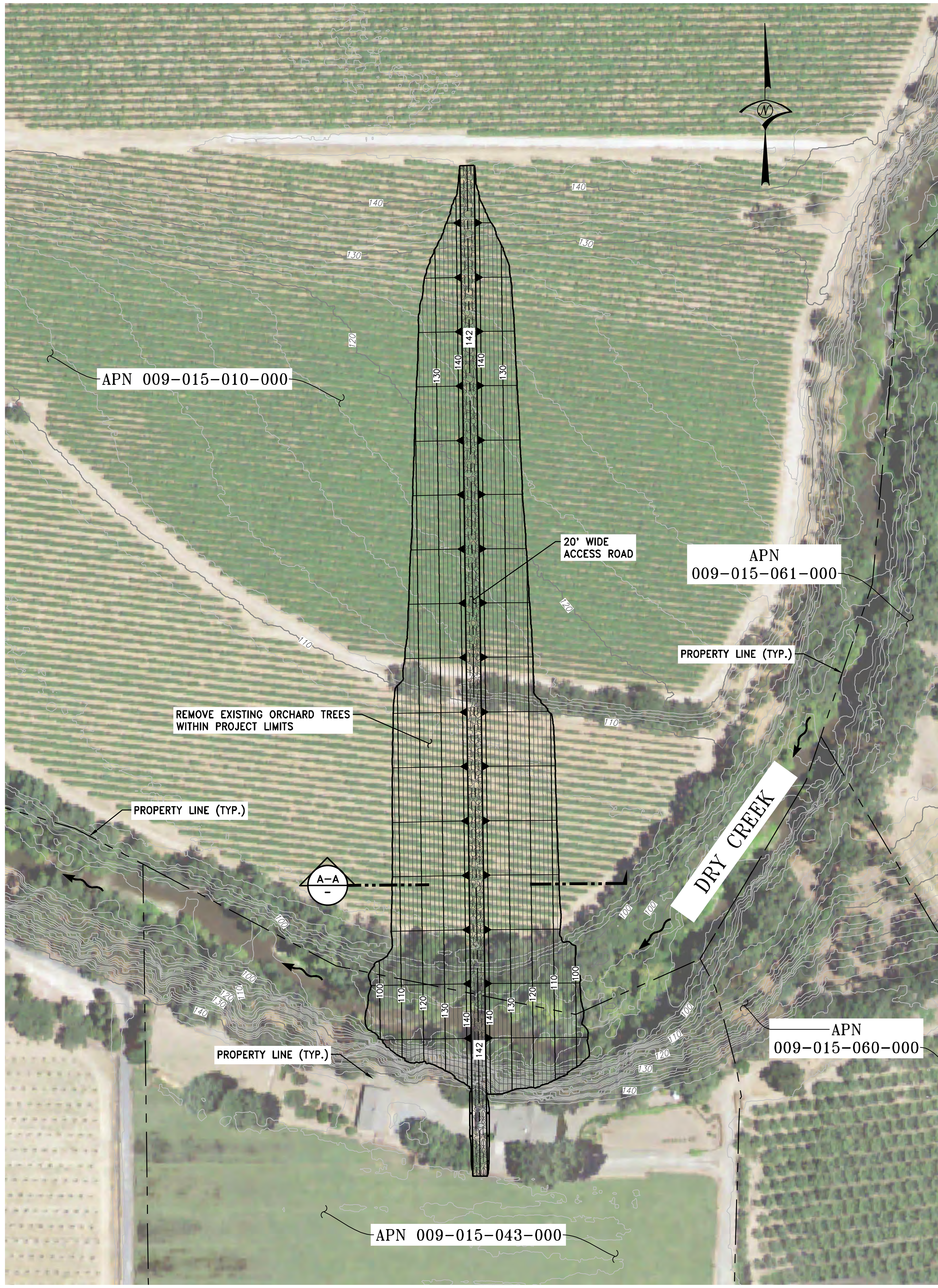
DRY CREEK STORMWATER MANAGEMENT
AND GROUNDWATER RECHARGE PROJECT

SITE 14 DAM

DRAWING NO.

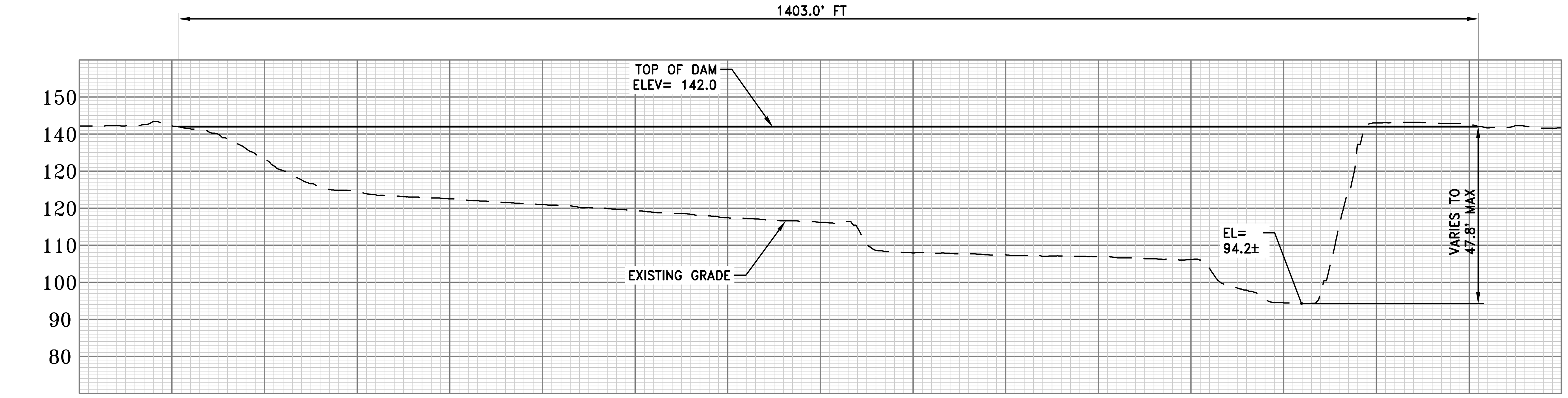
SHEET

z:\3000-s\3772_GSA\377200_Stanislaus_SM_GR_Projects\Civil\Exhibits\Dam_Structures_Cost_Estimates\EXH-09_SITE-14_DC-SMG.dwg 9/11/2021 3:41 PM Jenny Priest



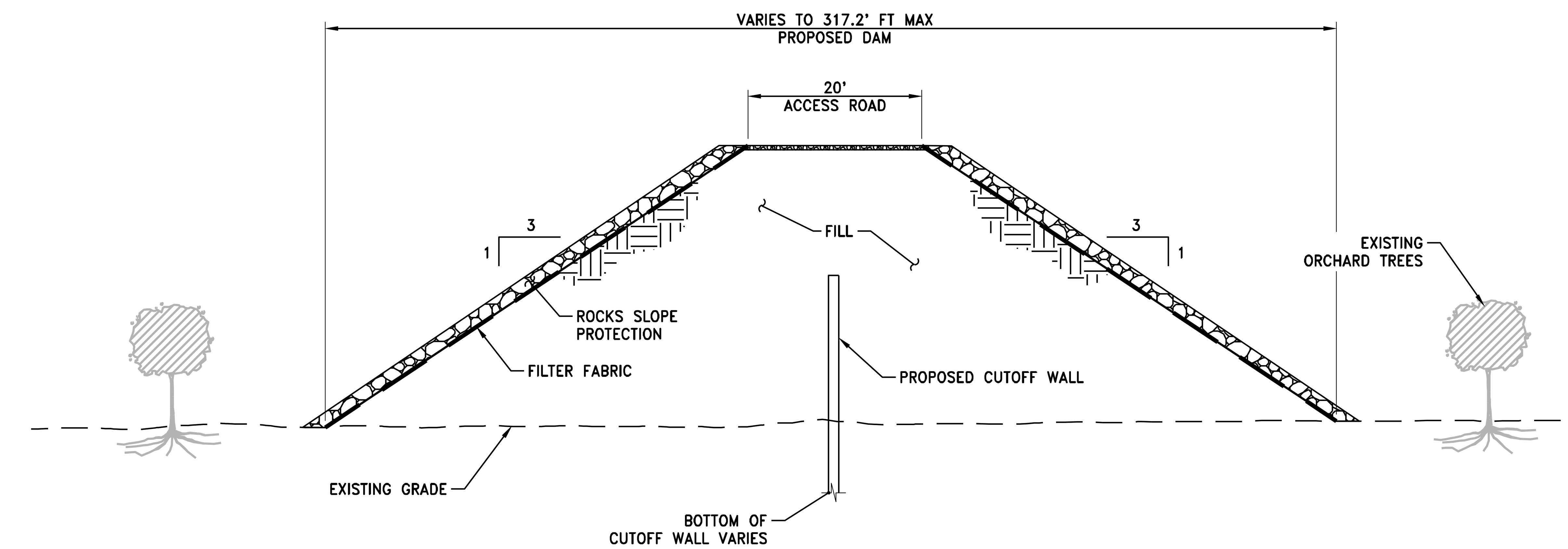
SITE 15 - PLAN VIEW

SCALE: 1"=100'



SITE 15 - PROFILE VIEW

SCALE: HORZ-1"=100'
VERT-1"=25'



A-A **SITE 15 -TYPICAL SECTION**

SCALE: NOT TO SCALE

LEGEND:

PROPOSED ACCESS ROAD

PROPOSED ROCK SLOPE PROTECTION

EXISTING ORCHARD TREE

REV.	DATE	BY	CHK.	APPR.	DESCRIPTION	REV.	DATE	BY	CHK.	APPR.	DESCRIPTION

DESIGNED BY:
DRAWN BY:
CHECKED BY:
IN CHARGE:
DATE: 8/31/2021

PRELIMINARY

WOOD RODGERS
DEVELOPING • INNOVATIVE • DESIGN • SOLUTIONS
3301 C STREET, BLDG. 100-B, SACRAMENTO, CA 95816
PHONE: (916) 341-7760 FAX: (916) 341-7767

SUBMITTED APPROVED

GEOSYSTEMS ANALYSIS, INC

DRY CREEK STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECT

SITE 15 DAM

DRAWING NO. SHEET

Appendix B

HEC-RAS Model Predicted 25-year Storm Event Inundation Area and Maximum Flood Depth With and Without Flood Control Structure (Sites 2, 4, 5, and 15)

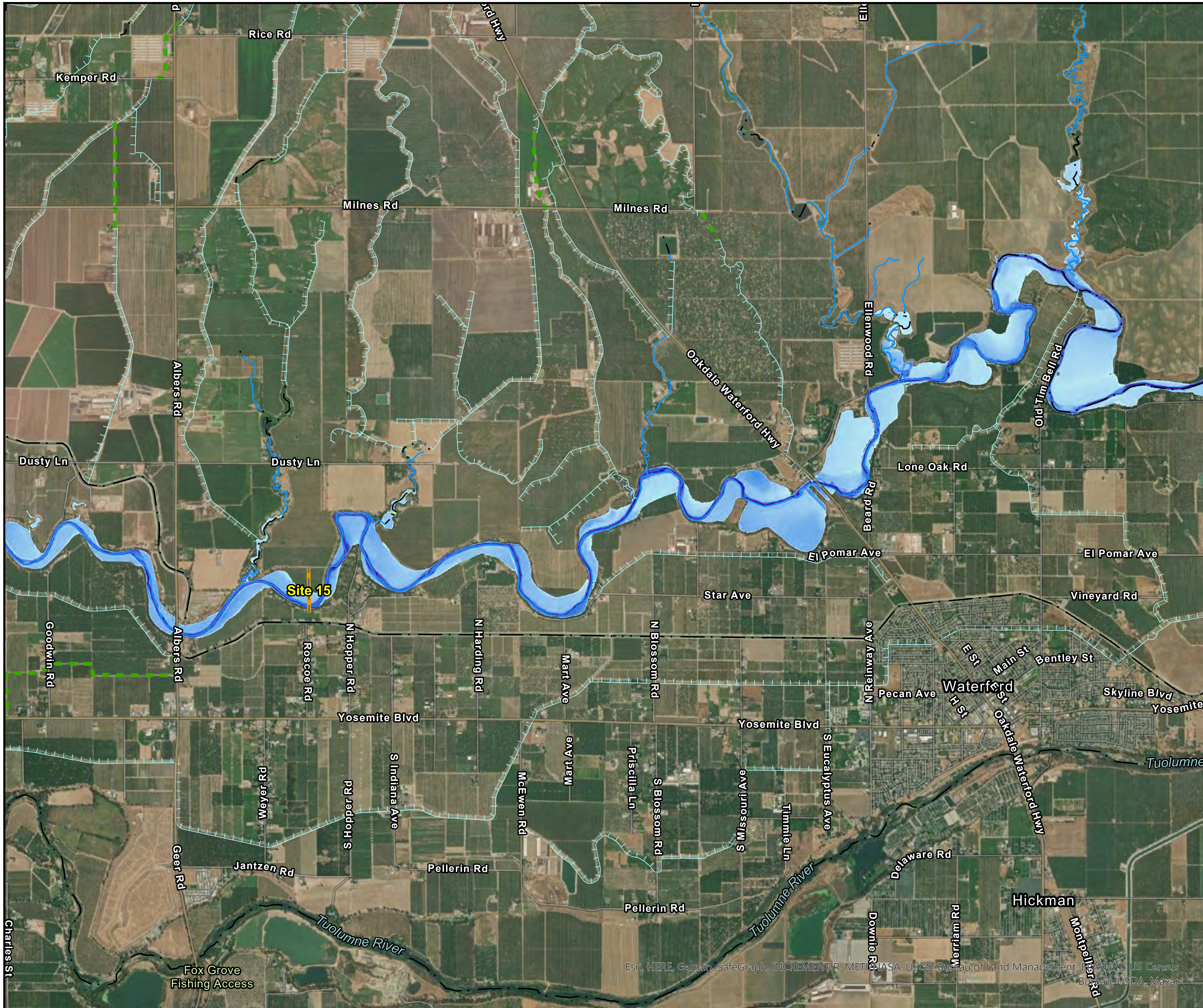
FIGURE 1

SITE 15
EXISTING CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021



Legend

Site15CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

NoProject_Q25_Depth__Max

Max Depth, Feet

High : 28.0675

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/20/2021 7:52 PM dmueller

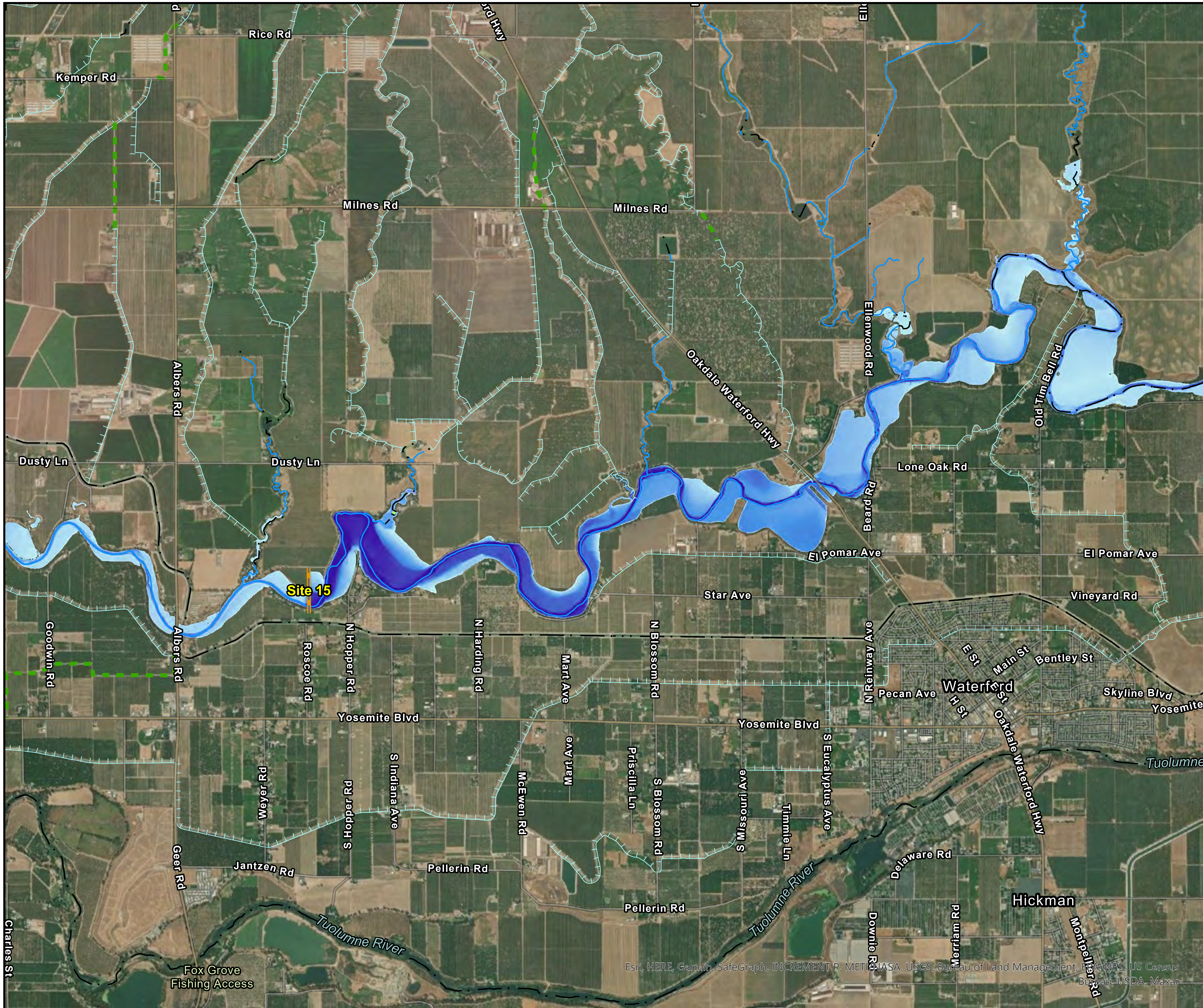


FIGURE 2

SITE 15
PROPOSED CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site15CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

Site15Q25Depth__Max

Value

High : 36.2267

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/20/2021 7:54 PM dmueller

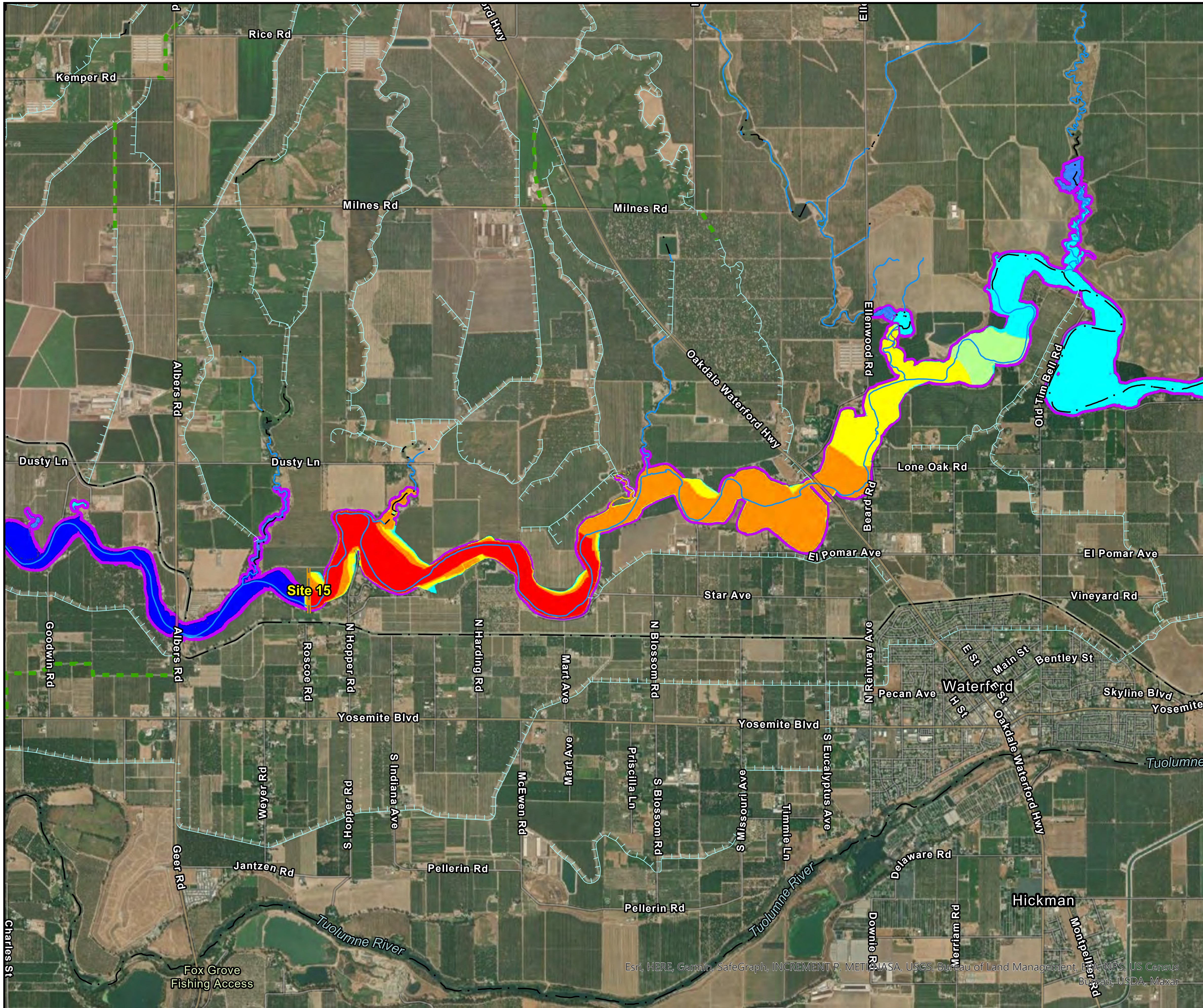


FIGURE 3

SITE 15
MAXIMUM FLOOD DEPTH INCREASE
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site15CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

Site15_MinNoProject

Feet

-5.8 - -1.4

-1.4 - 0

0 - 1

1 - 2

2 - 5

5 - 10

10 - 17.1

NoProjectQ25_Inundation

NoProjectQ25_Inundation

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/20/2021 7:55 PM dmueller

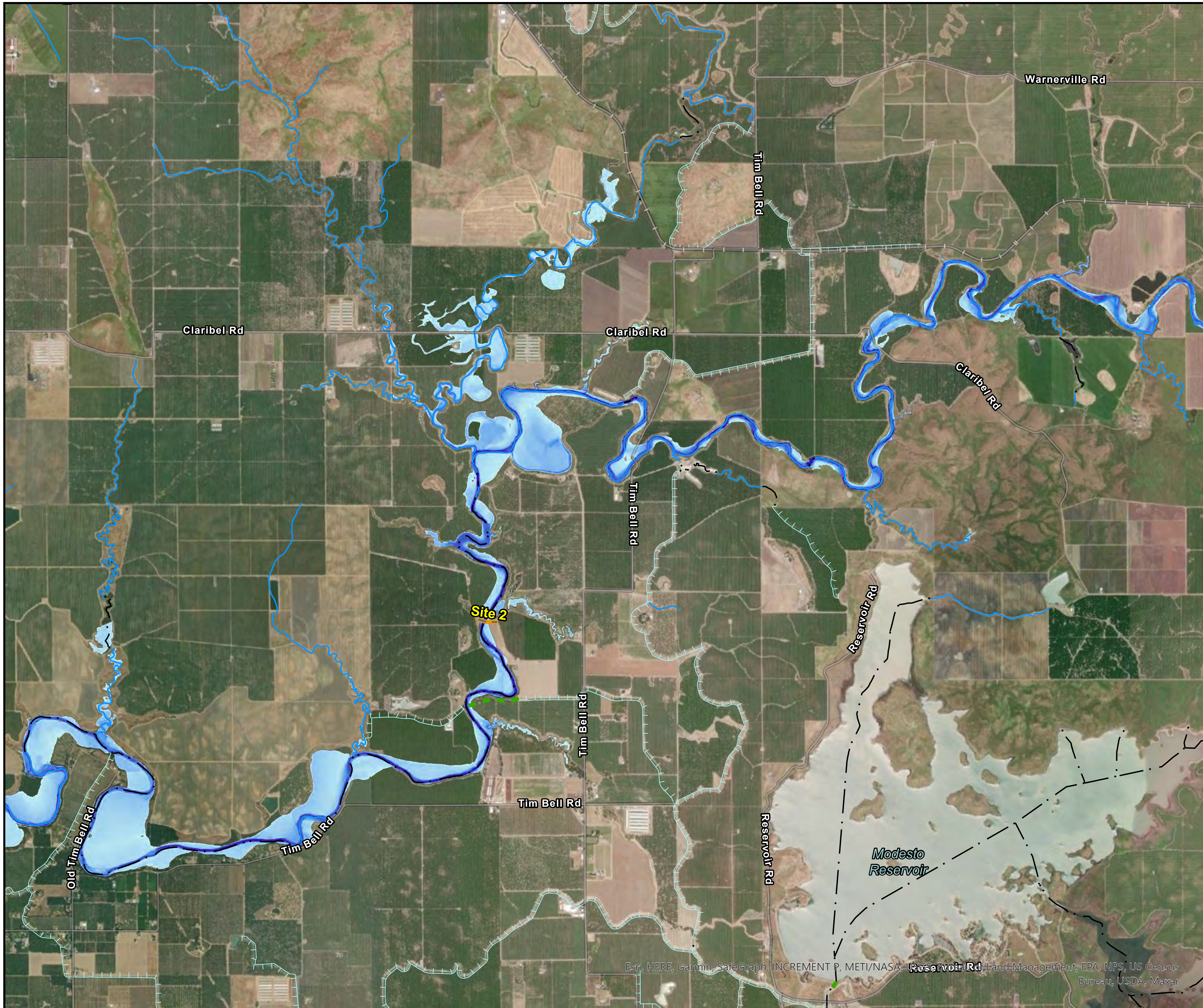


FIGURE 4

SITE 2
EXISTING CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site2CL

NHD_Agree

FType

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

NoProject_Q25_Depth__Max

Max Depth, Feet

High : 28.0675

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/22/2021 12:37 PM dmueller

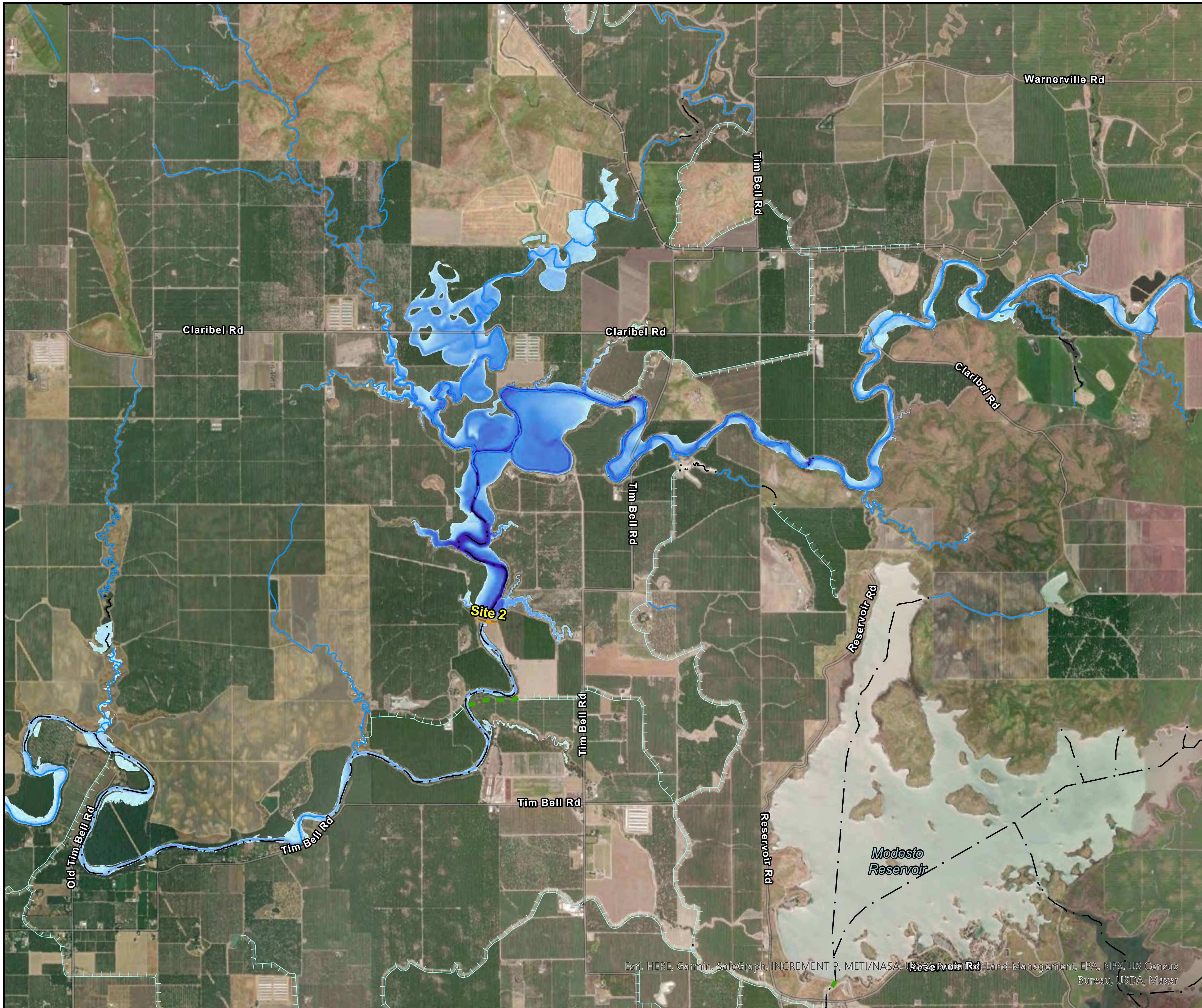


FIGURE 5

SITE 2
PROPOSED CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site2CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

Site2_Q25Depth__Max

Max Depth, Feet

High : 37.0793

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/22/2021 10:47 AM dmueller

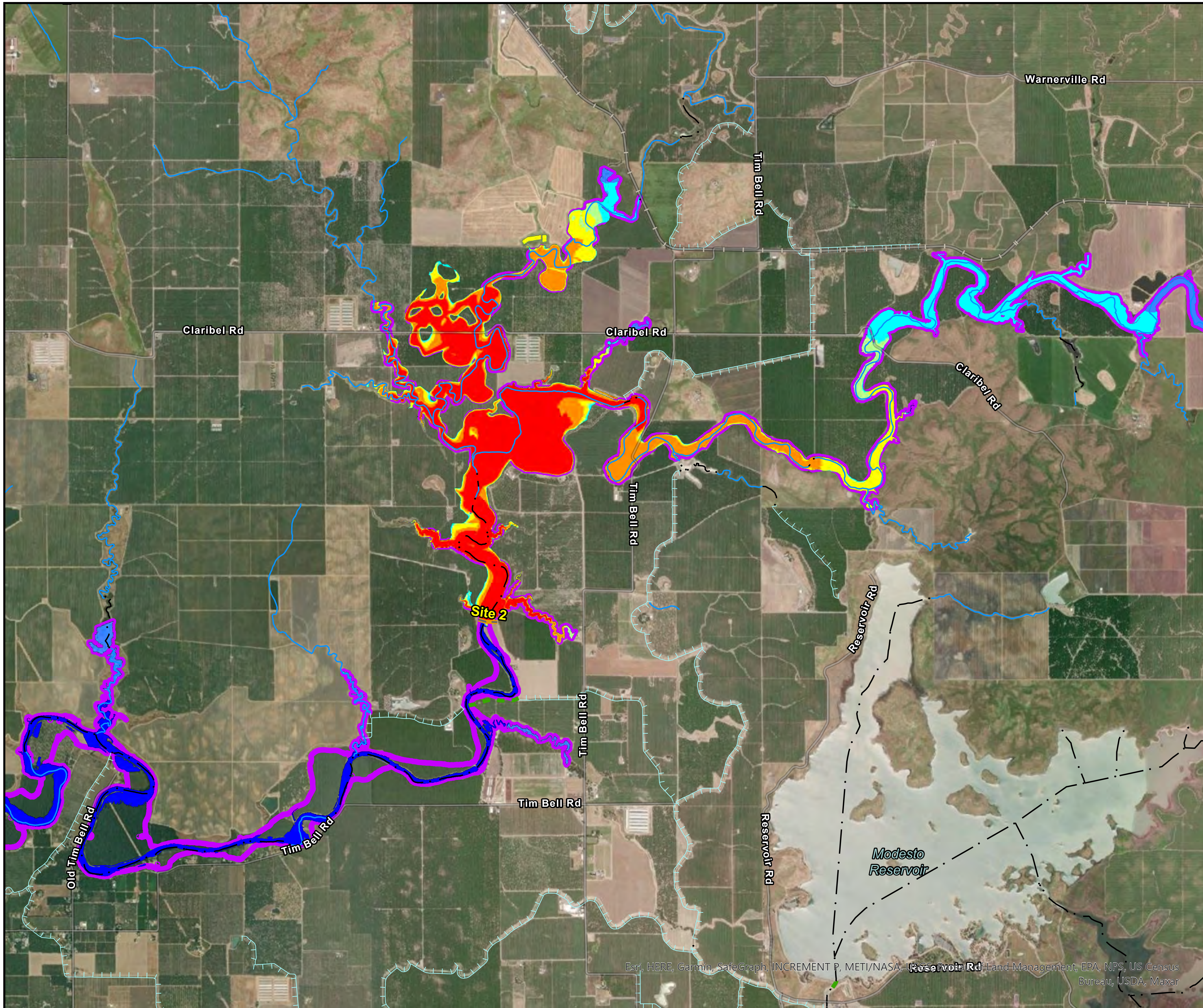


FIGURE 6

SITE 2
MAXIMUM DEPTH INCREASE
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site2CL

NHD_Agree

- ArtificialPath
- CanalDitch
- Connector
- Pipeline
- StreamRiver
- Underground Conduit

Site2MinNoProject

Feet

- -6.2 - -1.8
- -1.8 - 0
- 0 - 1
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 18.1

NoProjectQ25_Inundation

- NoProjectQ25_Inundation

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/22/2021 10:48 AM dmueller

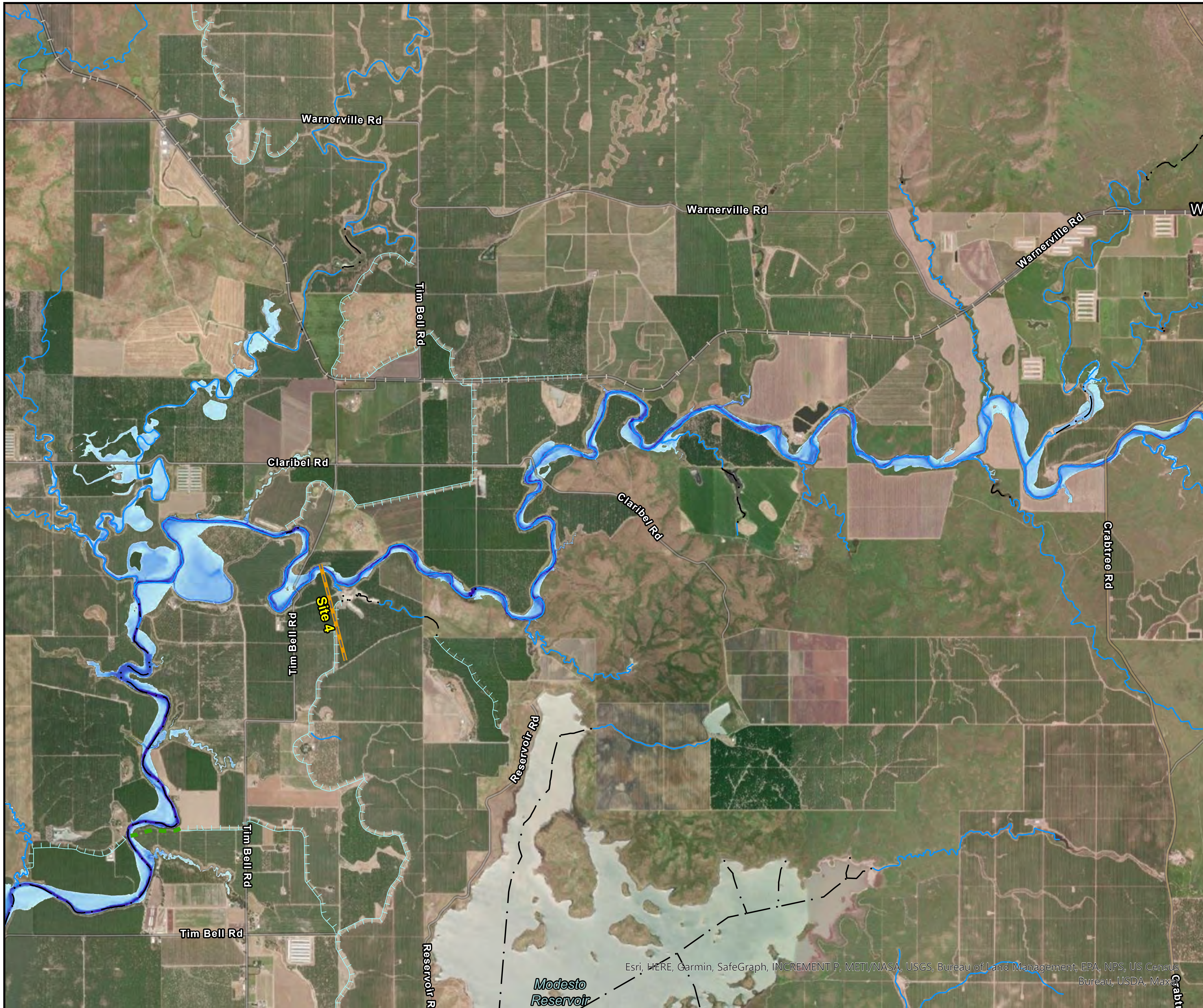


FIGURE 7

SITE 4
EXISTING CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site4CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

NoProject_Q25_Depth__Max

Max Depth, Feet

High : 28.0675

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/22/2021 10:50 AM dmueller

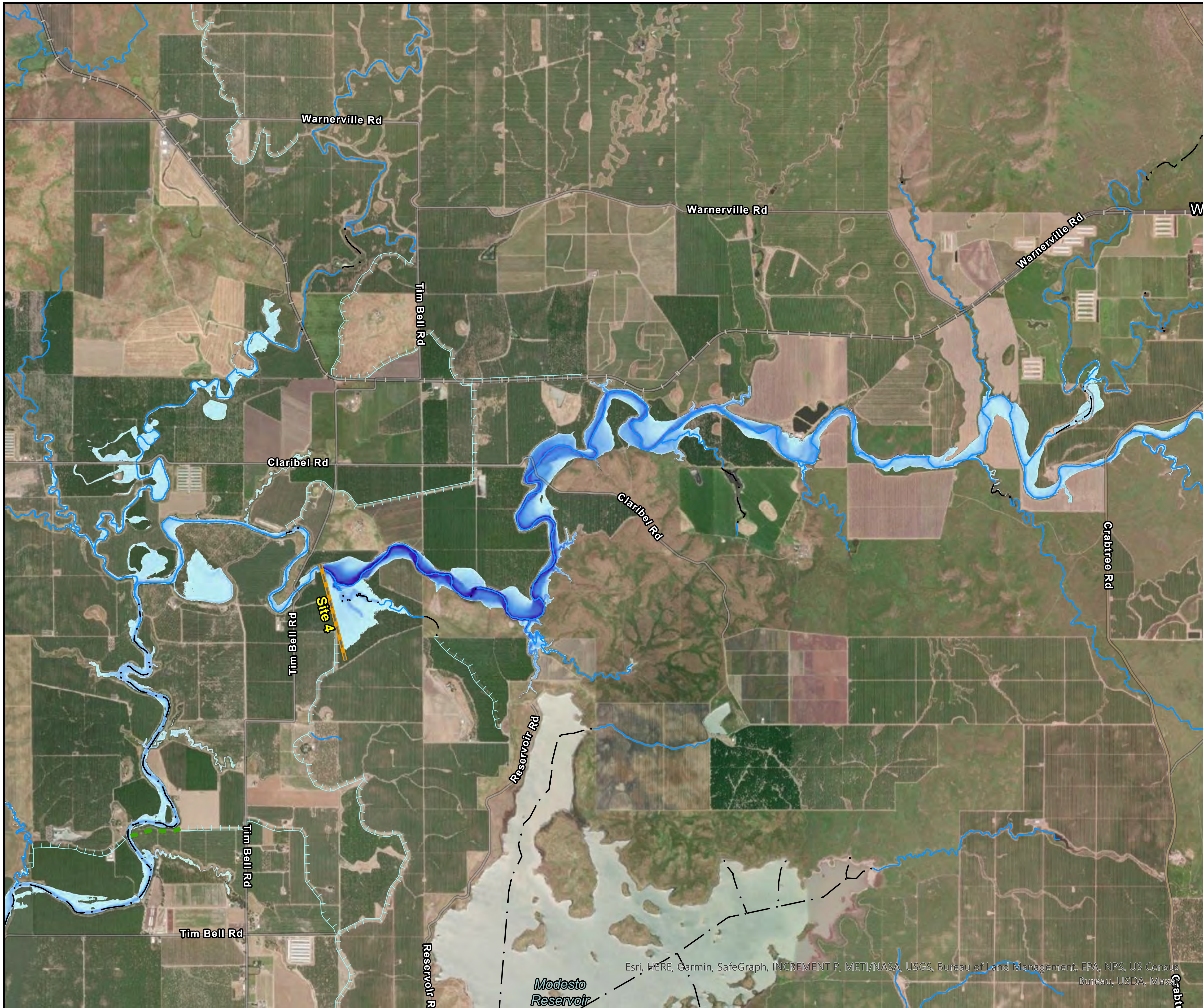


FIGURE 8

SITE 4
PROPOSED CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

- Site4CL

NHD_Agree

- ArtificialPath
- CanalDitch
- Connector
- Pipeline
- StreamRiver
- Underground Conduit

Site4Q25MaxDepth

Max Depth, Feet

High : 52.261

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

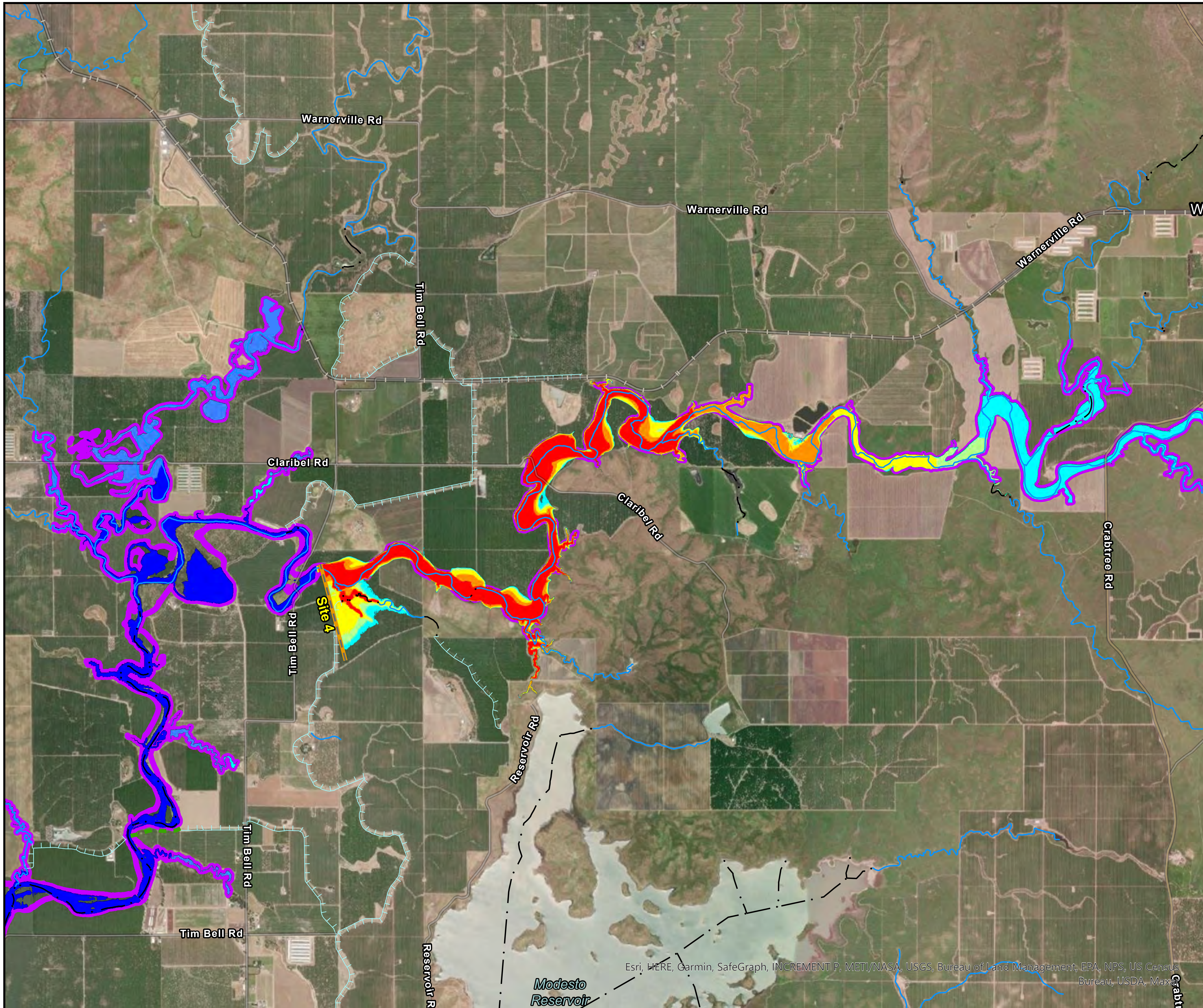


FIGURE 9

SITE 4
MAXIMUM DEPTH INCREASE FROM NO PROJECT
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site4CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

Site4MinNoProject

Feet

-5.3 - -1.1

-1.1 - 0

0 - 1

1 - 2

2 - 5

5 - 10

10 - 34.1

NoProjectQ25_Inundation

NoProjectQ25_Inundation

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

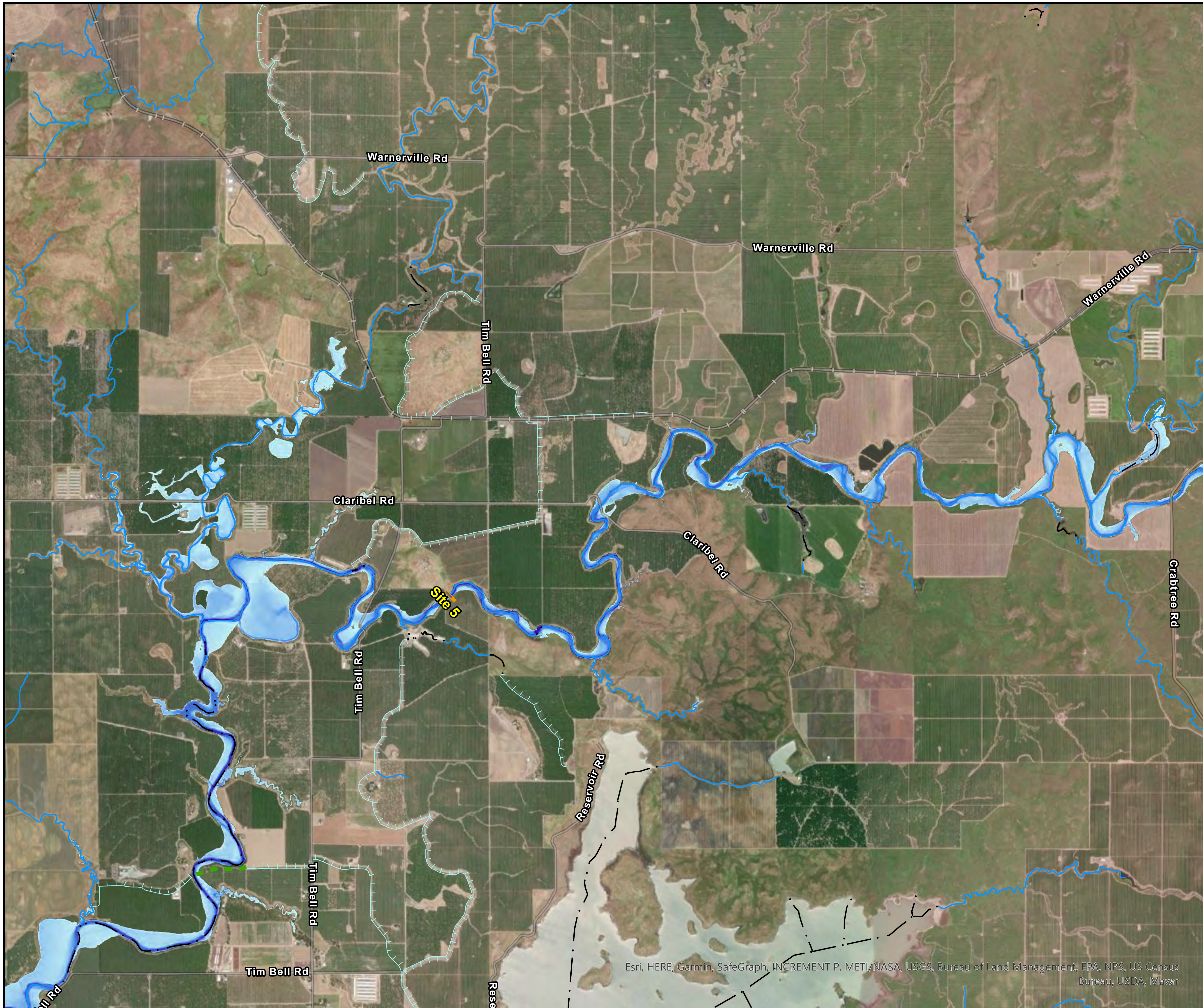


FIGURE 10

SITE 5
EXISTING CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE

PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

Site5CL

NHD_Agree

ArtificialPath

CanalDitch

Connector

Pipeline

StreamRiver

Underground Conduit

Value

High : 28.0675

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

D:\DryCreekFiguresV2\DryCreekFiguresV2.aprx 11/22/2021 10:55 AM dmueller

FIGURE 11

SITE 5
PROPOSED CONDITION
MAXIMUM FLOOD DEPTH
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE

PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

- Site5CL

NHD_Agree

FType

- ArtificialPath
- CanalDitch
- Connector
- Pipeline
- StreamRiver
- Underground Conduit

Site5Q25Depth__Max

Max Depth, Feet

High : 54.4151

Low : 0.000999451

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS

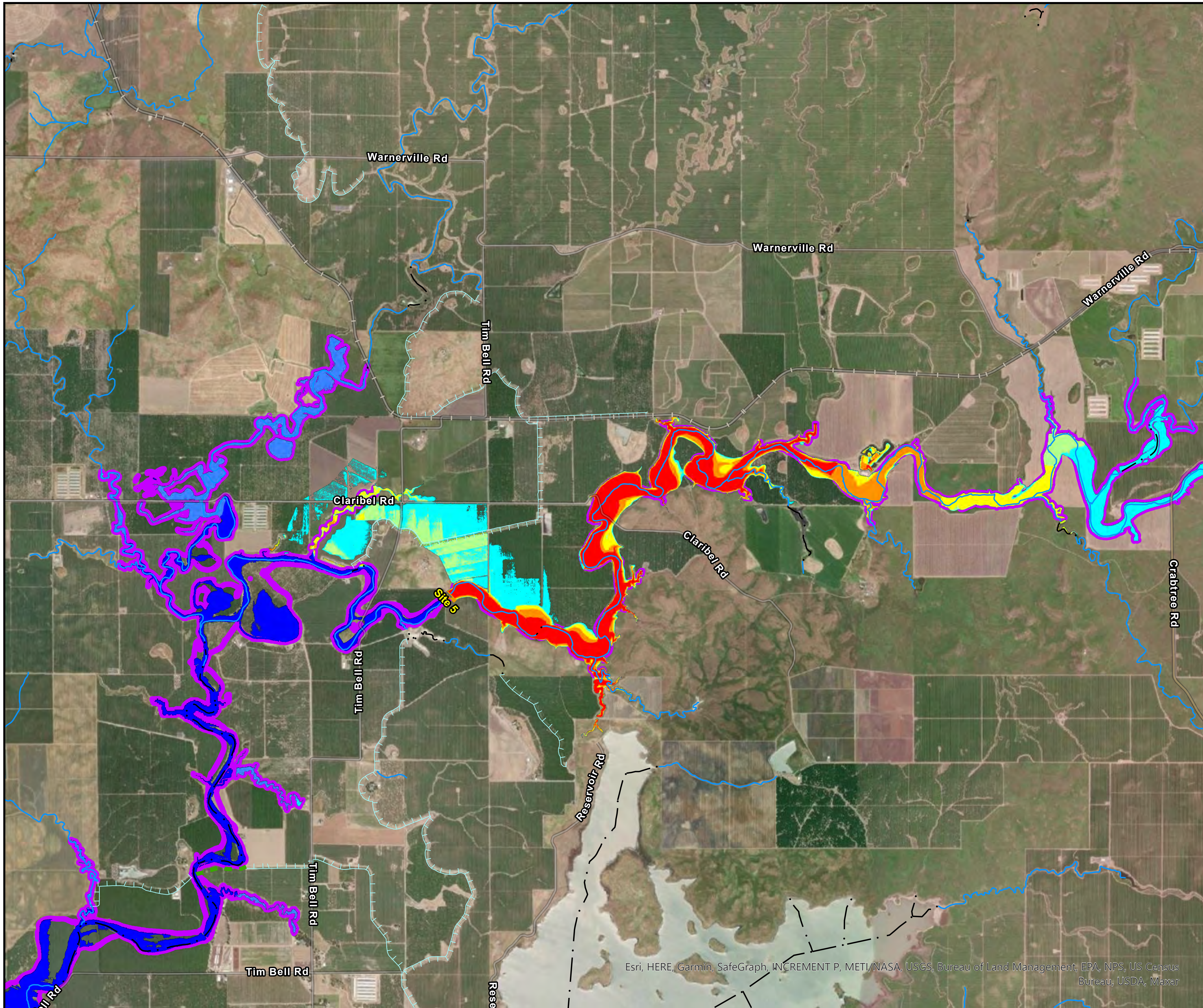


FIGURE 12

SITE 5
MAXIMUM DEPTH INCREASE
25-YEAR STORM EVENT

PHASE II EVALUATION OF STORMWATER MANAGEMENT AND GROUNDWATER RECHARGE PROJECTS IN THE DRY CREEK WATERSHED

STANISLAUS COUNTY, CALIFORNIA

NOVEMBER 2021

Legend

- Site5CL

NHD_Agree

FType

- ArtificialPath
- CanalDitch
- Connector
- Pipeline
- StreamRiver
- Underground Conduit

Site5MinNoProject

Feet

- -4.8 - -1.1
- -1.1 - 0
- 0 - 1
- 1 - 2
- 2 - 5
- 5 - 10
- 10 - 28.9

NoProjectQ25_Inundation

- NoProjectQ25_Inundation

0 1,500 3,000 6,000

Feet

NORTH

WOOD RODGERS