Subject:	**SCADA/Communications Routing and Basic Design Approach – Central and Eastern Corridors (Final Draft)**
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1. Introduction

This technical memorandum (TM) describes the communications criteria and physical characteristics to establish planning level communication routes for the supervisory control and data acquisition (SCADA) system serving the Delta Conveyance Project (Project). The communications network connects three major operations centers, up to three intakes, and up to four remote data sites that require high speed, reliable data communications throughout construction and long-term operations. This TM defines communications design criteria, describes physical characteristics of communications media, and provides planning level installation notes. It then identifies potential routes for each fiberoptic connection, using existing telecommunications routes and planned road modifications as much as possible. Finally, network route design approaches are analyzed with relative costs. The purpose of this TM is to evaluate physical media options, recommend the most viable media, and identify potential media routes with the minimum environmental footprint.

1.1 Document Organization

This TM contains the following sections:

- Network Sites
- Network Route Design
- Alternatives Analysis
- Delta Broadband Action Plan
- Recommendations
- Document History and Quality Assurance

2. Network Sites

The data communications network connects three operations centers, as shown in the Communications Diagram in Attachment 1. The operations centers are the Project Operations Center (POC), Delta Field Division Area Control Center (DACC), and the South Delta Pumping Plant (SDPP. In addition, the communications network monitors and controls up to three intakes, the South Delta Control Structures at one combined network site, and monitors up to three remote data sites (depending on alternative) with instrumentation for level, flow, or intrusion indicators. The Delta-Mendota Control Structure

(7,500 cfs design capacity options only) is described in this TM but would be monitored and controlled by a separate and independent control system provided by the Central Valley Project (CVP).

- **POC:** The POC is the central operations control for the State Water Project, located in the suburban Sacramento area. It remotely monitors water conveyance both north and south of the Project. It would be the remote operations control for the Project as well, and it would require reliable and responsive access to the Project SCADA system.
- **DACC:** This operations center is located in the administration building located at the site of the Harvey O. Banks Pumping Plant (Banks). The DACC operates the pumping plants and California Aqueduct system south of the Delta. Its operations would be closely coordinated with those of the South Delta Pumping Plant. It would also require reliable and responsive access to the Project SCADA system.
- **SDPP:** This operations center would operate the entire Project facilities, including the intakes, tunnel shafts, SDPP, and South Delta Control Structures. The Project SCADA system servers and master programmable logic controller (PLC) would be located here, which would require reliable and responsive SCADA data to be directly and independently accessible. All pumping plant PLCs, individual pump PLCs, and individual control structure PLCs would communicate directly to the Master PLC through a separate and independent network. SCADA data from the intakes, control structures, and other remote data points would communicate directly through the backbone links described here.
- **Intakes:** These facility-level network sites would control and monitor the intakes associated with the Project. They would include a PLC at each intake that monitors and controls intake features and communicates to the main operations centers (POC, DACC, and SDPP) through the backbone network. Internet access would be required during construction.
- **South Delta Control Structures:** This facility-level network site would control and monitor the South Delta Outlet and Control Structure and the California Aqueduct Control structure. This site would include one or more PLCs a located in a common control room and would monitor and control these features and communicate to the main operations centers (POC, DACC, and SDPP) through a short connection to the backbone network fiberoptic cable. Internet access would be required during construction.
- **Delta-Mendota Canal (DMC) Facilities:** For the 7,500 cfs design flow capacity option only, the DMC facilities would be monitored and controlled by a separate and independent CVP communications and control system using a direct connection to their existing network(s) at the Jones Pumping Plant. Flows delivered by the Project to the DMC for this option would be controlled by the Project at the Jones Control Structure appended to the Project's South Delta Outlet and Control Structure. Control and monitoring of the Jones Control Structure would be accomplished using an extension of the system proposed for the South Delta Outlet and Control Structure to this appended feature on the same structure. No additional facilities covered by this TM would be required. For planning purposes, it was assumed that the CVP and Project data centers would share applicable monitoring and status data between the Project and CVP operations teams using commercial systems, such as leased communications lines.
- **Remote data sites:** The remote monitoring of level, flow, or intrusion data points at three tunnel shaft locations (Twin Cities, Bouldin or Lower Roberts, and Terminous, depending on corridor would be anticipated. Internet access would be required at these shafts during construction.

3. Network Route Design

Each operations center, intake, control structure, and selected remote data site requires data communications for the SCADA system, information technology (IT)/Internet access, and video security cameras. The data communication requirements dictate design criteria, such as segregation, redundancy, and bandwidth. All network and communications transport topology and equipment would be specified by the DWR Operations and Management (O&M) Communications Branch.

3.1 Network Design Criteria

The basis of design for the data communication network includes the following criteria:

- **Mission-critical Segregated Networks**
  - **SCADA:** The SCADA system, a mission-critical component, continuously monitors process and equipment performance, collects these data for historical trending and analysis, displays performance in real time, and enables automatic operations where necessary or desired. This criticality requires high reliability achieved by using redundancy and recovery strategies. SCADA data typically requires relatively low bandwidth even with thousands of inputs and outputs at a SCADA-connected site. SCADA networks would be based on 1-gigabyte (GB) links.
  - **Business:** Access to business applications and the Internet at some sites is also mission-critical. Employees access maintenance and financial systems for more efficient and effective maintenance work practices. They access the Internet for documentation and diagnostic assistance. IT and Internet access typically requires a low to high range of bandwidth, depending on the data requested at any specific time period. Business networks would be based on 1-GB links, upgradeable to 10 GB.
  - **Security (Video cameras):** Video security is mission-neutral. Video security cannot prevent malicious intervention; it can only record interventions to be used as forensic evidence. Video cameras require high bandwidth capacity. Security networks would be based on 10GB links.
  - **SCADA Segregation:** Due to the mission critical nature of the SCADA system, DWR requires network segregation. Network segregation prevents high data traffic events from overwhelming SCADA specific data communications that could cause operational issues in a 24/7 environment. The Project SCADA network will be segregated from the Business and Security networks and will integrate with the existing State Water Project SCADA network.
- **Mission-critical Redundant Backbone Links**
  - The backbone links described here would achieve redundancy by establishing two independent paths from each operations center to every other operations center:
    - **Link 1:** The link between the POC and the DACC is already established through leased lines, and consists of redundant fiberoptic lines leased from a telecommunications provider. Redundancy is achieved by two independent paths between the data centers over approximately 59 miles.
    - **Link 2:** The link between the DACC and the SDPP operations centers would be a fiberoptic cable installed in dedicated conduits along future and existing road and conveyance canal rights-of-way. Some redundancy would be achieved by using multiple fiber-optic pairs or multiple cables, but the path remains singular over approximately 6 miles. Note that the physical cable for Link 2 would be routed through the control room at the South Delta Outlet

and Control Structure on the path between the DACC and the SDPP. Use of spare fibers in the backbone cable would allow the control structures PLC(s) to communicate with the main operations center at the SDPP. For a nominal cost (not included in this TM), the backbone cable for this link could contain an increased number of fibers to accomaodate this dual service.

- **Link 3:** The link between the SDPP operations center and the intakes would require leased communication links for all segregated networks. Installation options are overhead (OH) or buried along Project access and public roads (underground [UG]). The path would have a length of approximately 11 miles between the intakes (assume Intake C-E-3) and the leased router (CTX) at Eschinger Road and a length of approximately 10 miles between the SDPP and the leased router in Brentwood.
- **Link 4:** The link between the intakes and the POC would use leased lines and new fiberoptic cable installed along existing telecommunications or road rights-of-way. Installation options are overhead (OH) or buried along Project access and public roads (underground [UG]). The path would have a length of approximately 11 miles between the intakes (assume Intake C-E-3) and the leased router in Freeport.
- **Link 5** (7,500 cfs option only)**:** The link between the DMC structures and the existing Jones Pumping Plant would be a fiberoptic cable installed in dedicated conduits along the existing DMC access road right-of-way. The path would have a length of approximately 1 mile.

- **Mission-supportive Remote Data Sites**
  - **SCADA Data:** Remote data points with surface water elevations, flows, or intrusion sensors would require a network connection with minimal bandwidth. These do not require redundancy because the remote data points are noncritical to the process.
  - **Internet Access:** Internet access could be provided to remote data points during construction.
  - **Security Cameras:** Video cameras would need a network connection with high bandwidth but would not require redundancy.

3.2 Physical Media Options

Data communications over long distances (further than 300 m) use fiberoptic cables, satellite radio, or microwave radio signals. All communication media have inherent characteristics that must be considered when selecting the physical media for a given communication application. These characteristics are described here and summarized in Table 1.

- Capacity (bandwidth based on the frequency range of the underlying electro-magnetic waveform)
- Vulnerability (based on sensitivity to electro-magnetic interference [EMI])
- Constructability (based on installation and construction requirements)
- Maintenance (based on accessibility, frequency of routine maintenance, and replaceability)
- Cost (based on construction and maintenance (includes leasing) costs)

Table 1. Characteristics of Communication Media

Installation/ Media Option	Capacity (Hz)	Vulnerability (to EMI)	Constructability	Maintenance	Cost ($)
Overhead/ Fiberoptic	500 THz	N/A	Use existing or new power poles along existing ROW	Splices every 3-5 miles; repeaters every 20 miles	$$ initial cost $ maintenance
Underground/ Fiberoptic	500 THz	N/A	Use dedicated conduit along Project or public ROW	Splices every 3-5 miles; repeaters every 20 miles	$$$ initial cost $ maintenance
Inside Tunnel/ Fiberoptic	500 THz	N/A	Design and construction issues for installation in Project tunnels	Splices every 3-5 miles; repeaters every 20 miles; difficult access	$$ initial cost $$ maintenance
Leased/ Satellite Radio	3 GHz	High	Building or pole mounted dish antennas	Covered by lease agreement	$ initial cost $$ maintenance
Leased/ Cellular	900 MHz	Medium	Building or pole mounted Yagi antennas, signals may be unavailable	Covered by lease agreement	$$ initial cost $$ maintenance
Unlicensed/ Microwave	900 MHz	Medium	Building or pole mounted Yagi antennas, Omni antenna on TV tower	Antenna replacement	$$$ initial cost $ maintenance
Licensed/ Microwave	450 MHz	Low	Building or pole mounted Yagi antennas, Omni antenna on TV tower	Antenna replacement	$$$ initial cost $ maintenance

Notes:
Comparative cost:
 $ = low
 $$ = medium
 $$$ = high
GHz = gigahertz
MHz = megahertz
N/A = not applicable
THz = terahertz
TV = television

3.3 Installation Notes

When possible, the construction of fiberoptic-based communications systems for the Project would use existing telecommunications infrastructure, dedicated conduits within public roads and planned Project-specific road modifications, and termination panels installed inside or on the buildings or structures.

The constructability of radio-based communications systems, whether satellite or microwave, relies on clear lines of sight to provide reliable signal strength. Leased systems (satellite and cellular) depend on the availability and power of existing radio transmitters to provide signal strength within the vicinity of potential Eastern or Central corridors. Satellite signals are assumed to be available, while cellular signals are known to be generally unavailable within these corridors.

The signal strength of microwave systems (licensed and unlicensed) depends on elevation to clear most obstacles in the lines of sight. Assuming a master radio transmitter could be placed at sufficient elevation on one of the TV towers (which are up to 1,000 feet tall) near Walnut Grove, it is likely that most receiving antennas would need to be only 20 to 30 feet high to clear undergrowth and most trees. Geological topology and buildings are unlikely to be significant obstacles within the boundary of potential corridors. A microwave radio system would require an omni-directional antenna on the TV tower, and directional antennas (also known as Yagi) antennas pointed toward the TV tower at each remote site.

Attachment 2 includes installation details for microwave antenna mounts. Figure A2-1 shows installation details of a Yagi antenna for both building and pole mounts. Figure A2-2 shows installation details of an Omni antenna for both building and pole mounts. Table 2 summarizes the general specifications for both antennas.

Table 2. Microwave Antenna Specifications

Antenna Type	Dimensions Length x Width	Structural Height (feet)	Color	Footprint
Yagi (directional) (pole mount)	36” x 8”	20 – 30	Bronze or Aluminum (pole can be painted)	3 feet x 3 feet concrete base
Yagi (directional) (building mount)	36” x 8”	20 – 30	Bronze or Aluminum	N/A
Omni-directional (existing TV Tower)	36” x 3”	1,000	Bronze or Aluminum	N/A

3.4 Fiberoptic Routes

For high speed, reliable and secure data communications, fiberoptic is the preferred media for this project. Installation methods include OH on existing power poles and UG. The preferred installation method is UG. UG includes four underground installation approaches: (1) adjacent to roadway (UGA), (2) in existing roadway (UGE), (3) in proposed roadway (UGN), and (4) trenchless (UGT). Attachments 3 and 4 include GIS-based maps that show the proposed fiberoptic routes using each installation approach for the Central and Eastern Corridors, respectively, including:

- **Central Corridor SCADA Maps:** This set of one key map and 13 detailed maps includes four backbone routes, three facility routes, and three remote site routes to individual shafts on the Central corridor. Proposed installation methods are color-coded by segment.
- **Eastern Corridor SCADA Maps:** This set of one key map and 14 detailed maps includes four backbone routes, three facility routes, and three remote site routes to individual shafts on the Eastern corridor. Proposed installation methods are color-coded by segment.

The maps in Attachments 3 and 4 show potential fiberoptic routes to establish the network backbone and SCADA connections to all applicable facilities, including certain remote sites. Section 4 compares the Central and Eastern corridors and summarizes the investigation of the Inside Tunnel and Delta Broadband options.

4. Alternatives Analysis

Connecting the operations centers and all remote data sites with a fiberoptic system requires point-to-point routes. One point is defined by the facility site locations. The other point is defined by router locations in an existing fiberoptic network, typically owned by a telecommunication provider. Surface connections will require OH or UG installations. Each design assumes no spare fiber pairs in existing fiber cables and therefore, new fiberoptic cable must be installed from the nearest router to each operations center and to each remote data site. For relative cost comparison purposes only, each design assumes the cost-estimating guidelines listed below. Equipment costs are minor and not included. Each cable includes at least six fiber pairs, to include three segregated networks (SCADA, Business, and Security) with three spare pairs.

Fiber cable material and installation cost estimating guidance are:

- 6 pair single mode cable — $6,000/mile
- 24 pair single mode cable — $16,000/mile
- 36 pair single mode cable — $18,000/mile
- 48 pair single mode cable — $21,000/mile
- OH installation using existing power poles with overlash — $15,000/mile
- OH installation using existing power poles without overlash — $26,000/mile
- UG installation pulled through existing or new conduit — $25,000/mile
- UG direct burial (plowing into ground along existing ROW) — $70,000/mile
- UG duct bank installation (trench and cover two 2-inch conduits) — $100,000/mile
- UG horizontally directionally drilled cable in carrier pipe — $400/foot

All costs presented herein are raw construction costs for relative comparisons and do not include markups for contractor's overhead, profit, and general conditions. They also do not include contingencies, soft costs, and related markups.

4.1 Network Route Groups

For identification purposes, the physical network fiber routes are organized into six groups (Table 3).

Table 3. Physical Fiber Route Groups

ID	Start Point	End Point	ID	Start Point	End Point
Backbone			**Eastern Corridor**		
B01	SDPP(Link 2)	DACC	E01	B03, Lambert Road	Twin Cities Shaft
B02	SDPP (Link 3)	Brentwood Router	E02	Galt Router	New Hope Tract Eastern
B03	C-E-3 (Link 3)	Eschinger Road Router	E03	N Lodi Router	Canal Ranch Shaft
B04	C-E-3 (Link 4)	Freeport Router	E04	Lodi Router	Terminous Shaft
B05	DMC Control Structure	Jones Pumping Plant	E05	8 Mile Rd Router	King Island Shaft

Table 3. Physical Fiber Route Groups

ID	Start Point	End Point	ID	Start Point	End Point
Central Corridor			E06	R&R Island Router	Lower Roberts Island
C01	B03, Lambert Road	Twin Cities Shaft	E07	Stockton Router	Lower Jones Tract Shaft
C02	Galt Router	New Hope Tract Central	E08	SDPP	Byron Tract Working Shaft
C03	Galt Router	Staten Island Shaft	**Delta Broadband**		
C04	Lodi Router	Bouldin Island Shaft	DB1	Hood (Intake C-E-3)	Clarksburg
C05	Stockton Router	Mandeville Island Shaft	DB2	Hood (Intake C-E-3)	Courtland, Walnut Grove
C06	Stockton Router	Bacon Island Shaft	**Facilities**		
C07	SDPP	Byron Tract Working Shaft	F01	C-E-2	B04, Access Road
Inside Tunnel			F02	C-E-5	B03, Access Road
TN1	SDPP (Link 3)	C-E-3 (Link 3)	F03	B01, South Delta Outlet and Control Structure	South Delta Control Structure (CA Aq)
TN2	SDPP (Link 3)	C-E-3 (Link 3)			

Notes:

For 3,000 cfs design capacity option only, B03 and B04 would connect to the C-E-5 site versus the C-E-3 site and would therefore each be 0.46 miles shorter than for other design flow capacity options. The cost and length of connection to Intake C-E-5 in that case is covered by facility group F02 which as the same length and size of cable required for the backbone group

4.1.1 Backbone Group

The Backbone Group of network routes would connect the intakes, control structures, and SDPP operations center to each other and the POC and DACC operations centers through leased lines. Also included is the separate and independent connection from the DMC control structure to the existing CVP Jones pumping plant.

Link 1 is an existing communications link already in use by the SWP. Link 2 (SDPP to DACC) would be established by a direct fiber route. Links 3 and 4 would be established by installing new fiber cables from the operations centers to the nearest router for the leased line network. Link 5 would be established by a new direct fiber route. The Backbone Group assumes 24 fiber pairs for all routes.

Conceptual routes were developed as follows:

- B01: The route follows Project roads to the Byron Highway, then along Project-improved North Bruns Way to the South Delta Outlet and Control Structure, then follows the existing CA Aqueduct access road to the DACC. No other reasonable route choices are available because it uses the shortest direct path to the DACC, utilizes roads that would already be disturbed by other Project needs, and the remainder of the route would be in existing SWP access roads.
- B02: The route follows Project roads north to State Route (SR) 4, then goes overhead on existing poles to the router in Brentwood. No other reasonable route choices are available since the route is the

shortest direct route to SR 4, it would be in roads already disturbed by other Project needs, and would use existing overhead lines for the remainder of its length.

- B03: The route follows Project roads south to Lambert Road, then east along Project-improved Lambert Road to Franklin Blvd, then follows existing public roads on the shortest path to the Eschinger Road Router, which is one of the two closest routers to the intakes area. No other reasonable route choices are available since the route would be in roads already disturbed by other Project needs, and follows the shortest and most direct public roads to the connection point.
- B04: The route follows existing rural roads on the shortest path to an existing overhead line along Scribner Road, then utilize the existing overhead line north to SR 160, then follows existing SR 160 on the shortest path to an existing overhead line that leads the rest of the way to the Freeport Router. No other reasonable route choices are available since the route would connect to the other one of the two closest routers to the intakes area (see B03) and follows the shortest and most direct existing roads; plus, it would maximize the use of existing overhead lines.
- B05: This route is only included in the 7,500 cfs design capacity option. The route follows the existing access road on the shortest path between the new DMC control structure and the existing Jones Pumping Plant. No other reasonable route choices are available since the route is direct and is the shortest path to the connection point. Also, it would be installed in an existing CVP gravel road which would help minimize environmental impacts.

Note that for the 3,000 cfs design flow capacity option, the backbone routes B03 and B04 would originate from Intake C-E-5 instead of Intake C-E-3.

Table 4 shows relative cost estimates for the Backbone Group fiber routes.

Table 4. Backbone Group Fiber Routes and Relative Costs

Route ID	OH Miles	UGA Miles	UGE Miles	UGN Miles	UGT Miles	Total Miles	Cable Cost	Installation Cost	Total Cost
B01			1.31	4.62		5.93	$ 95,000	$ 415,000	$ 510,000
B02	7.91			2.25		10.16	$ 163,000	$ 363,000	$ 526,000
B03[1]		3.43		7.70	0.17	11.30 (10.84[1])	$181,000 ($173,000[1])	$ 1,139,000 ($1,107,000[1])	$ 1,320,000 ($1,280,000[1])
B04[1]	5.02	3.1	.87	2.30	0.12	11.41 (10.95[1])	$ 183,000 ($175,000[1])	$ 823,000 ($791,000[1])	$ 1,006,000 ($966,000[1])
B05[2]			0.88			0.88	$14,000	$62,000	$76,000
	12.93					**38.80[3] (39.68[2]) (37.88[1])**			**$3,362,000[3] ($3,438,000[2]) ($3,282,000[1])**

Notes:

[1] For 3,000 cfs design capacity option only, B03 and B04 would connect to the C-E-5 site versus the C-E-3 site and would therefore each be 0.46 miles shorter than for other design flow capacity options. The cost and length of connection to Intake C-E-5 in that case is covered by facility group F02 which as the same length and size of cable required for the backbone group.

[2] 7,500 cfs design capacity only

[3] 4,500 and 6,000 cfs capacity only

All five Backbone Group surface routes are included in the design approaches for both the Central and Eastern corridors, depending on design flow capacity option. Only B01 and B04 surface routes are used for comparison with the Inside Tunnel design approach. Attachments 3 and 4 show the Backbone Group OH and UG segments.

4.1.2 Facilities Group

The Facilities Group of network routes would connect the intakes (C-E-2, C-E-5) and South Delta Outlet and Control Structure to the Backbone Group routes adjacent to each facility. Each connection would be established by a direct fiber route and assumes two parallel routes separated by the access road width, each with six fiber pairs, and each connecting at a patch panel at the Backbone cable route junction.

The Facilities Group routes are short direct connections to the Backbone routes passing the respective sites, therefore they are all the only reasonable routes.

Table 5 shows the relative cost estimates for the Facilities Group fiber routes.

Table 5. Facilities Group Fiber Routes and Relative Costs

Route ID	OH Miles	UGA Miles	UGE Miles	UGN Miles	UGT Miles	Total Miles	Cable Cost	Installation Cost	Total Cost
F01[1]				.58		.58[1]	$ 4,000	$ 40,000	$ 44,000[1]
F02				2.56		2.56	$ 15,000	$ 179,000	$194,000
F03				0.12		0.12	$ 1,000	$ 8,000	$9,000
						2.68 (3.26[1])			**$202,000 $(246,000[1])**

Notes:

[1] 7,500 cfs option only

All three Facilities Group routes are included in the design approaches for both the Central and Eastern corridors, depending on design flow capacity option. Attachments 3 and 4 shows the Facilities Group OH and UG segments.

4.1.3 Unneeded Shaft Data Connections

Data communications requirements at the shafts are assumed to be minimal SCADA instrumentation (level or flow) with no control devices, IT/Internet access during construction, and possible video security cameras in the future. Some shafts do not require level or flow data. Communications performance needed to support IT/Internet access during construction can be readily achieved using on-site connections (C07, E08), satellite, or microwave radio channels, and video security is not required for long-term use at maintenance or reception shafts. Therefore, table 6 lists the fiberoptic routes considered for these shafts but were ultimately removed from further consideration because there is no current DWR requirement for SCADA communication at these shafts.

Table 6. Fiberoptic Routes Not Needed

ID	Start Point	End Point	ID	Start Point	End Point
Central Corridor			**Eastern Corridor**		
C02	Galt Router	New Hope Tract Central	E02	Galt Router	New Hope Tract Eastern
C03	Galt Router	Staten Island Shaft	E03	N Lodi Router	Canal Ranch Shaft
C05	Stockton Router	Mandeville Island Shaft	E05	8 Mile Rd Router	King Island Shaft
C06	Stockton Router	Bacon Island Shaft	E07	Stockton Router	Lower Jones Tract Shaft
C07	SDPP	Byron Tract Working Shaft	E08	SDPP	Byron Tract Working Shaft

4.1.4 Central Corridor Group

The Central corridor group of network routes would connect the launch shafts to the system as follows:

- Twin Cities Shaft (C01) directly to the Backbone Group extending from the intakes to the Eschinger Road Router (B03) at Lambert Road
- Bouldin Island (C04) Shaft directly to the Lodi Router

The analysis assumes six fiber pairs are needed for each remote data location. Dual cables and associated connections are not required because, unlike the intakes, these sites will not be long-term mission-critical connections to the system.

Conceptual routes were developed as follows:

- C01: The route would follow Franklin Blvd to Lambert Road, then connect to B03. No other reasonable route choices are available since the route would be the shortest direct route and would be adjacent to an existing public road; part of which would be improved as part of the Project.
- C04: The route would follow Project roads north on Bouldin Island, then turn east and follow SR 12 to the Lodi Router at Lower Sacramento Road in Lodi. No other reasonable route choices are available since the route would be the shortest direct route to the closest router and about half of the distance would be in the portion of SR 12 that would already be disturbed by other Project needs.

This group is included for all design flow capacity options for the Central Corridor.

Relative cost estimates for the Central corridor group are shown in Table 7.

Table 7. Central Corridor Group Relative Costs

Route ID	OH Miles	UGA Miles	UGE Miles	UGN Miles	UGT Miles	Total Miles	Cable Cost	Installation Cost	Total Cost
C01		1.11		1.11		2.22	$ 13,000	$ 155,000	$ 168,000
C04	3.53	1.86		7.8	0.45	13.64	$ 82,000	$ 985,000	$1,718,000
						17.18			**$1,886,000**

Central corridor OH and UG segments are shown in Attachment 3.

In summary, the potential media routes with the minimum environmental footprint for the Central Corridor, establishes the network backbone and SCADA connections to all operations centers, facilities, and selected remote sites. This includes 57.74 to 60.12 miles of new fiberoptic cable, with a total relative cost of $5,370,000 to $5,570,000, depending on design flow capacity option.

4.1.5 Eastern Corridor Group

The Eastern corridor group of network routes would connect launch shafts and one reception shaft to the system as follows:

- Twin Cities Shaft (E01) directly to the Backbone Group extending from the intakes to the Eschinger Road Router (B03) at Lambert Road
- Terminous Reception (E04) Shaft directly to the Lodi Router; this reception shaft is included for long-term water level monitoring midway along the Eastern Corridor
- Lower Roberts Shaft (E06) shaft directly to the Rough and Ready Island Router

The analysis assumes six fiber pairs are needed for each remote data location. Dual cables and associated connections are not required because, unlike the intakes, these sites will not be long-term mission-critical connections to the system.

Conceptual routes were developed as follows:

- E01: Identical to C01 above; would follow Franklin Blvd to Lambert Road, then connect to B03. No other reasonable route choices are available since the route would be the shortest direct route and would be adjacent to an existing public road; part of which would be improved as part of the Project.
- E04: Shares portion of C04 above east of Terminous Shaft; the route would follow SR 12 to the Lodi Router at Lower Sacramento Road in Lodi. No other reasonable route choices are available since the route would be the shortest direct route to the closest router and about half of the distance would be in the portion of SR 12 that would already be disturbed by other Project needs.
- E06: The route would follow on-site roads and Project-improved House Road east from the shaft over the new bridge over Burns Cut, then follow the new Project access road south along the west side of the Port of Stockton on Rough and Ready Island to Davis Avenue where it would turn east and be routed on existing overhead lines to the Rough and Ready Island Router at Hooper Street. No other reasonable route choices are available since the route would be in the only disturbed roadway path to Davis Avenue and the remainder would be overhead.

This group is included for all design flow capacity options for the Eastern Corridor.

Table 8 shows the relative cost estimates for the Eastern Corridor Group.

Table 8. Eastern Corridor Group Relative Costs

Route ID	OH Miles	UGA Miles	UGE Miles	UGN Miles	UGT Miles	Total Miles	Cable Cost	Installation Cost	Total Cost
E01		1.11		1.11		2.22	$ 13,000	$ 155,000	$ 168,000
E04	3.53	1.33		2.02	0.33	7.21	$ 43,000	$ 1,024,000	$ 1,067,000
E06	1.29	0.00	0.00	5.50	0.00	6.79	$ 41,000	$ 172,000	$ 213,000
						16.22			**$1,448,000**

Attachment 4 shows the Eastern Corridor Group OH and UG segments.

In summary, the potential media routes with the minimum environmental footprint for the Central Corridor, establishes the network backbone and SCADA connections to all operations centers, facilities, and selected remote sites. This includes 56.78 to 59.16 miles of new fiberoptic cable, with a total relative cost of $4,932,000 to $5,132,000, depending on design flow capacity option.

4.1.6 Inside Tunnel Group

The Inside Tunnel Group of network routes would install a new fiber cable inside the tunnel from the SDPP operations center to Intake C-E-3, with drop-off connections to each remote data point. This eliminates the need for leased lines for Link 3 and all the shafts. This design approach assumes 24 fiber pairs are needed for the Backbone link and another 24 pairs for the remote data connections for a total of 48 pairs on the Link 3 cable. Installation costs are assumed to be comparable to OH installation on existing power poles with overlash since the tunnel itself provides the same support as the power poles.

Table 9 shows the relative cost estimates for the Inside Tunnel Group.

Table 9. Tunnel Groups and Relative Costs

Route ID	OH Miles	UGA Miles	UGE Miles	UGN Miles	UGT Miles	Total Miles	Cable Cost	Installation Cost	Total Cost
B01			1.31	4.62		5.93	$ 95,000	$ 415,000	$ 510,000
B04	5.02	3.1	0.87	2.30	0.12	11.41	$ 183,000	$ 823,000	$ 1,006,000
F03				0.12		0.12	$ 1,000	$ 8,000	$9,000
TN1 (C)	39.42					39.42	$ 828,000	$ 1,025,000	$ 1,853,000
TN2 (E)	42.12					42.12	$ 885,000	$ 1,095,000	$ 1,980,000
Central Corridor Totals (B01, B04, F03, TN1)						**56.88**			**$ 3,378,000**
Eastern Corridor Totals (B01, B04, F03, TN2)						**59.58**			**$ 3,505,000**

Note: Costs shown reflect 4,500 through 7,500 cfs Project design flow capacity options. 3,000 cfs option would be slightly lower, but was not estimated for this comparative analysis.

4.2 Comparison of Design Approaches

The purpose of the fiberoptic network is to connect operations centers, the intakes, and remote data sites with high speed, reliable data communications throughout construction, and long-term operations. Each design approach consists of groups of fiberoptic routes, using existing telecommunications routes and planned road modifications as much as possible. Two design approaches, Surface Installation and Inside Tunnel, are analyzed, along with an option to upgrade broadband capacity in the Delta communities.

- The Surface Installation design approach for the Central corridor would connect the operations centers and intakes via leased line Backbone networks, and three remote data sites. The SDPP operations center would directly connect to the South Delta control structures and the DACC operations center. All connections require a combination of new fiber cable installed along existing surface routes, including both underground and overhead installations, and existing leased lines.
- The Surface Installation design approach for the Eastern corridor would connect the operations centers and intakes via leased line Backbone networks, and three remote data sites. The SDPP operations center would directly connect to the South Delta control structures and the DACC operations center. All connections require a combination of new fiber cable installed along existing surface routes, including both underground and overhead installations, and existing leased lines.
- The Inside Tunnel design approach would connect the Backbone network at Intake C-E-3, directly to the remote data sites, and to the SDPP with a new fiber cable installed inside the tunnels. The SDPP operations center would directly connect to the South Delta control structures and the DACC operations center. The backbone link from the Intakes to the POC is connected via surface routes to an existing fiber-based leased line network.

The selection of one of the two design approaches is required to design and install the fiberoptic network for construction and long-term operations. Table 10 summarizes the fiber cable mileage and installation costs to establish fiber connections to all operations centers, the intakes, and remote data points.

Table 10. Relative Costs for Central, Eastern, and Inside Tunnel Design Approaches

Surface Routes	Total Miles	Total Cost	Inside Tunnel Routes	Total Miles	Total Cost
Central Corridor			**Central Corridor**		
Backbone	38.80	$ 3,362,000	Backbone	56.76	$ 3,369,000
Facilities	2.68	$ 202,000	Facilities	0.12	$ 9,000
Remote Sites	17.18	$ 1,886,000	Remote Sites	0.00	0
	58.66	$ 5,450,000		56.88	$ 3,378,000
Eastern Corridor			**Eastern Corridor**		
Backbone	38.80	$ 3,362,000	Backbone	59.46	$ 3,496,000
Facilities	2.68	$ 202,000	Facilities	0.12	$ 9,000
Remote Sites	16.22	$ 1,448,000	Remote Sites	0.00	0
	57.70	$5,012,000		59.58	$ 3,505,000

Note: 6,000 cfs design flow capacity option values are used in this table.

Fiber cable installation inside the tunnel would not provide data communications during the construction period. Assuming video camera data communications would be unnecessary during construction, two options that could provide high speed Internet data communications during the construction period are:

- Installing a microwave master station on one of the TV towers near Walnut Grove
- Leasing a satellite channel dedicated to the Project for the duration of the construction period

Depending on the tunnel alignment, the Inside Tunnel design approach would eliminate about 11 to 12 miles of surface route installation. The Inside Tunnel design approach also would eliminate fiber-based leased line costs during construction and long-term operations, although satellite channel lease costs or microwave radio installation costs during construction could be incurred.

The Inside Tunnel design approach would only provide access to the fiberoptics cable at the tunnel shafts, or about every 5 miles. This distance of cable inside the tunnel is too long to replace the cable by simple pulling methods, so any repair or replacement of the cable would require entry into the tunnel. In actual practice, this would likely mean the tunnel would have to be drained, which would result in a lengthy shutdown to drain the tunnel, conduct the repair, and refill the system. Therefore, a problem with the cable inside the tunnel would probably result in the system being operated without the full loop of link segments for some period of time. This would result in some remote sites not being monitored and would severely reduce the overall reliability of the system. Also, the cost of a cable replacement operation inside the tunnel would be expected to be several times the cost of periodic replacement of surface installed cables, which can simply be repulled through their existing conduits.

Further, the presence of the cable in the tunnel would potentially be subject to failure of supports in the tunnel and may interfere with tunnel maintenance and cleaning.

For these reasons, the Inside Tunnel design approach is not recommended and it is recommended that the Surface Installation design approach utilizing new and leased lines to complete the full loop of link segments be used for the Project.

5. Delta Broadband Action Plan

With the installation of fiberoptic cables near the Delta for the tunnel project, a potential opportunity to enhance community relations by improving Delta broadband capacity was evaluated for informational purposes only. The opportunity is based on the information developed in the Delta Broadband Action Plan.

In August 2019, a Delta Broadband Action Plan (shown in Attachment 5) was prepared by Valley Vision and the Delta Protection Commission. The purpose of this report was to provide a detailed, tangible broadband improvement plan for five historic legacy communities, including Clarksburg, Courtland, Hood, Isleton, and Walnut Grove. This Action Plan described the state of broadband in the Delta, including the communities' challenges and concerns.

Existing challenges include the quality and access to reliable, high-speed broadband. Currently, Frontier Communications is the only wireline Internet Service Provider (ISP) that serves these communities, and they rely on copper-based connections. Wireless options are available, but these frequently degrade due to physical barriers, geographical terrain and weather events. Returns on infrastructure investment typically do not justify improvements, and the Action Plan concluded that supplemental resources would be needed.

In March 2019, the Delta was designated the first national heritage area (NHA) in California, which provides many opportunities for funding and economic development. The Action Plan identifies nine federal funding programs and five state funding programs for rural broadband development. It also provides several examples of public-private partnership models for the Delta communities to consider.

Finally, the Action Plan strongly recommends coordinating all infrastructure opportunities and authorizes broadband development companies to coordinate conduit installation with Caltrans. It identifies several capital improvement projects currently in planning or under consideration, including a road improvement of State Route 84 to Clarksburg, and authorization for the Delta Protection Commission to plan the California Delta Trail.

Table 11 shows relative costs to install a fiber cable from Intake C-E-3 near Hood to Clarksburg (DB1) and to Walnut Grove (DB2), generally along State Route 160. These broadband links are only part of the overall Delta Broadband Action plan. They were considered since they would serve the communities most impacted by the Project, including Clarksburg, Hood, Courtland, Locke, and Walnut Grove. Installing fiber to improve the Delta broadband capability is optional for all design approaches.

Table 11. Delta Broadband Group Routes and Relative Costs

Route ID	Fiber Pairs	OH Miles	UGA Miles	UGE Miles	UGT Miles	Total Miles	Cable Cost	OH Cost	UG Cost	Total Cost
DB1	24	2.87		0.57	0.16	3.60	$ 58,000	$ 75,000	$ 338,000	$ 471,000
DB2	36	10.46	1.52	0.82		12.8	$ 230,000	$ 272,000	$ 164,000	$ 666,000
		13.33	1.52	1.39	0.16	16.4				$ 1,137,000

6. Recommendations

The selection of the Surface Installation design approach is recommended and would be compatible with either tunnel corridor.

It is also recommended overhead fiber installation be minimized in favor of installing fiberoptic cables underground along existing or proposed road rights-of-way. Given the cost advantage and ability to minimize impacts, overhead installation would still appear to be the best option for the B02 (SDPP to Brentwood Router) and portions of the B04 (C-E-3 to Freeport Router) Backbone segments.

7. Document History and Quality Assurance

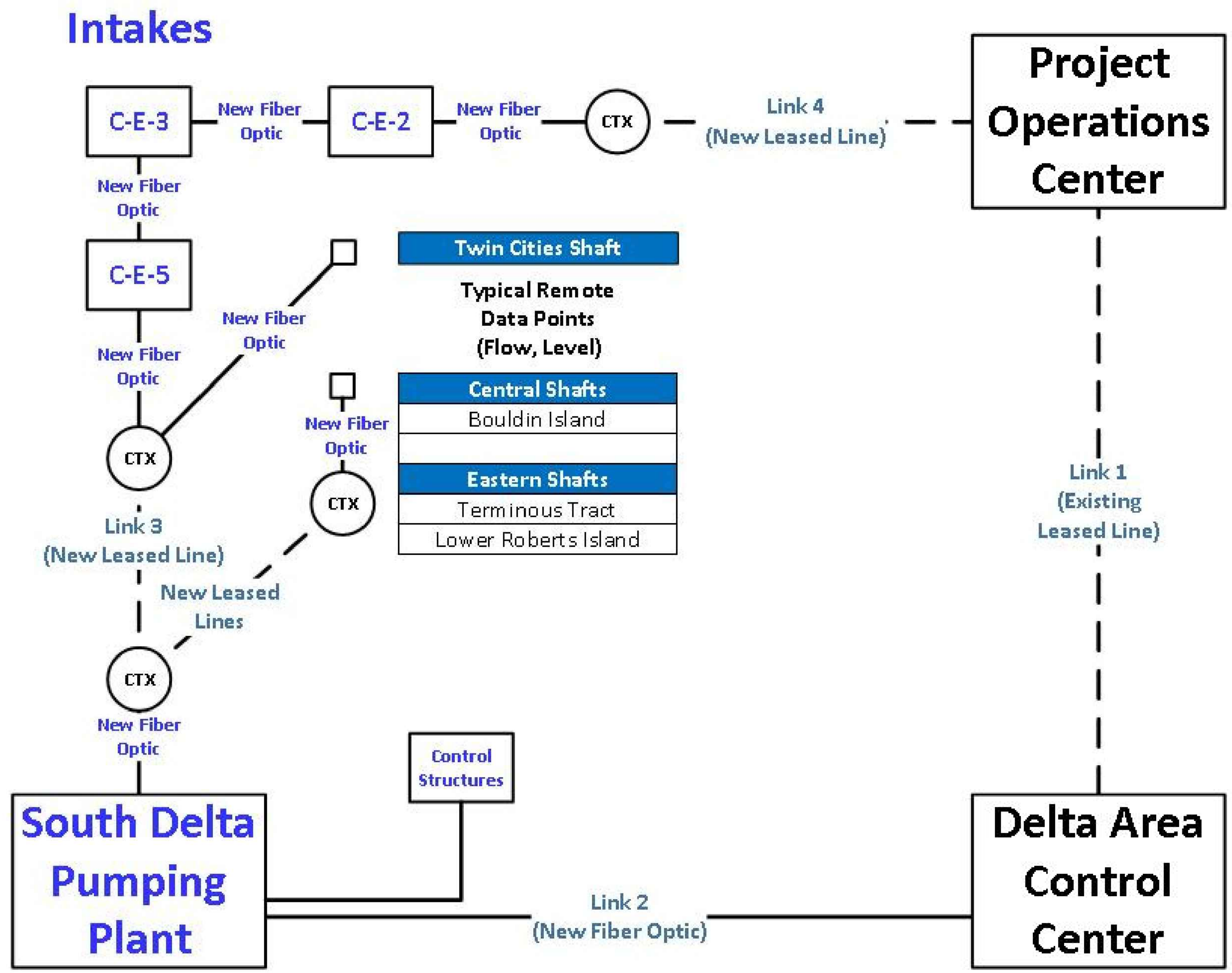
Reviewers listed have completed an internal quality review check and approval process for deliverable documents that is consistent with procedures and directives identified by the Engineering Design Manager (EDM) and the DCA.

	Approval Names and Roles			
Date	**Prepared by**	**Internal Quality Control review by**	**Consistency review by**	**Approved for submission by**
12/23/2021	Phil Ryan / EDM Design Manager	Michael Johnson / EDM SCADA Engineer	Gwen Buchholz / DCA Environmental Consultant	Terry Krause / EDM Project Manager
This interim document is considered preliminary and was prepared under the responsible charge of Michael D. Johnson, California Professional Engineering License ME29233.				

Attachment 1
Communications Diagram

Delta Conveyance Communications Diagram

Symbol	Description	Count
□	Remote Data Point	2
C-E-3	Local Control Point	4
CTX	Leased Line Point (Router)	4



GENERAL

VERIFY SCALE
BAR IS ONE INCH ON ORIGINAL DRAWING.
0 1"

REV	DATE	DESCRIPTION	SUB.	APPD
	12/23/2021	FINAL DRAFT BASELINE DRAWINGS		

DESIGNED
APPROVAL RECOMMENDED
DRAWN
APPROVAL BY
CHECKED

DCA
DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

ENGINEERING PROJECT REPORT
DELTA CONVEYANCE PROJECT
SINGLE TUNNEL - CENTRAL AND EASTERN CORRIDORS

COMMUNICATION DIAGRAM

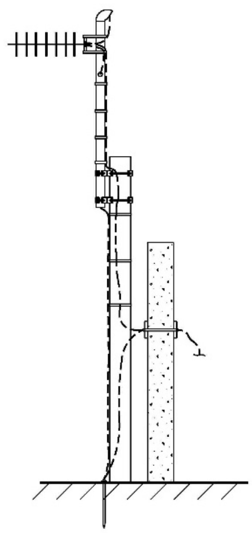
PROJECT NO. W8X97000
SHEET NO. STX-E-0030GN
REV
SEQUENCE NO.

STX-E-0030GN_W8X97000.dgn

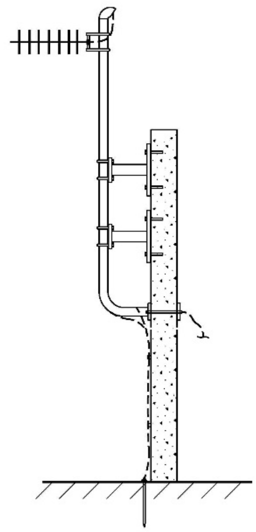
PLOT DATE:2021\11\15 PLOT TIME:8:28:51 AM

Attachment 2
Antenna Installation Details

Attachment 2. Antenna Installation Details

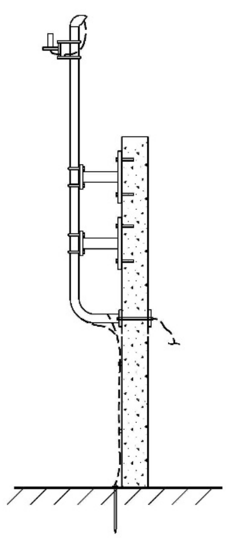


TYPICAL POLE MOUNTED YAGI ANTENNA INSTALLATION
NTS

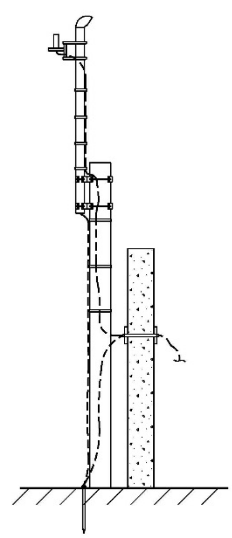


TYPICAL BUILDING MOUNTED YAGI ANTENNA INSTALLATION
NTS

Figure A2-1. Typical Yagi Antenna Installations



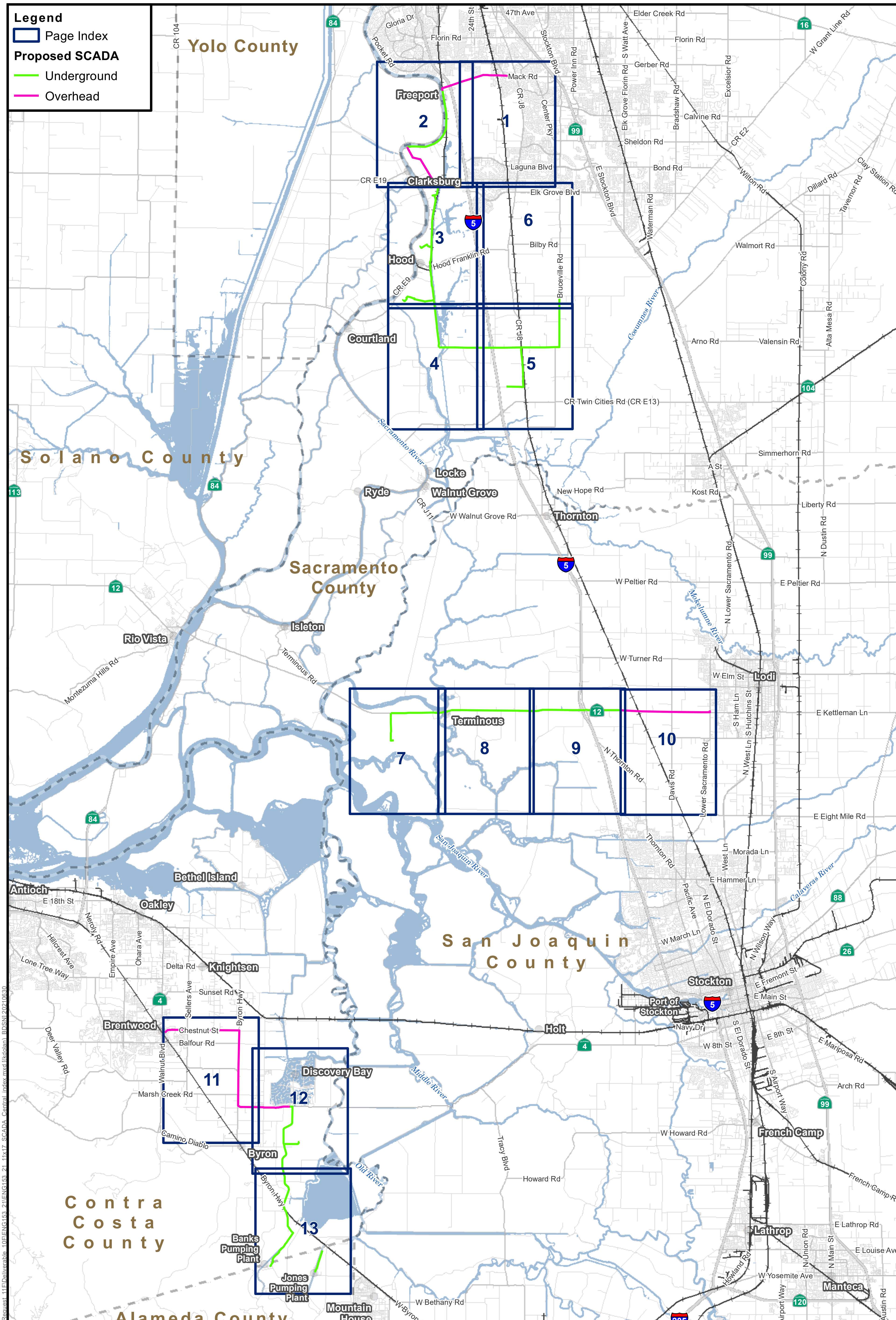
TYPICAL BUILDING MOUNTED OMNI ANTENNA INSTALLATION
NTS



TYPICAL POLE MOUNTED OMNI ANTENNA INSTALLATION
NTS

Figure A2-2. Typical Omni Antenna Installations

Attachment 3
Central Corridor Route Maps



CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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0 3.5 Miles

Key Map
Central SCADA
06/30/2021

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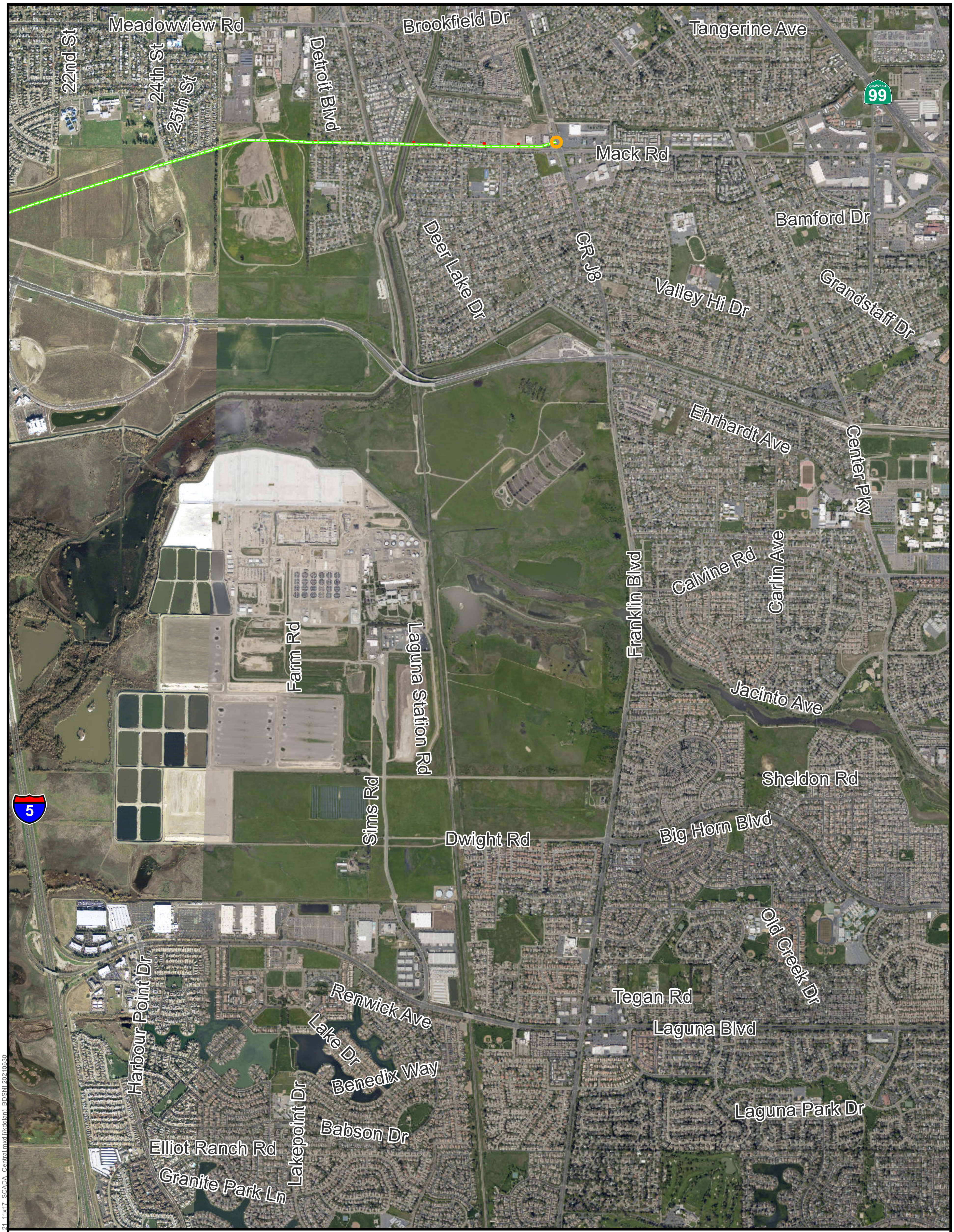

SCADA Proposed Fiber Routes
Proposed Overhead SCADA
New Line on Existing Poles
Connection to Existing Router

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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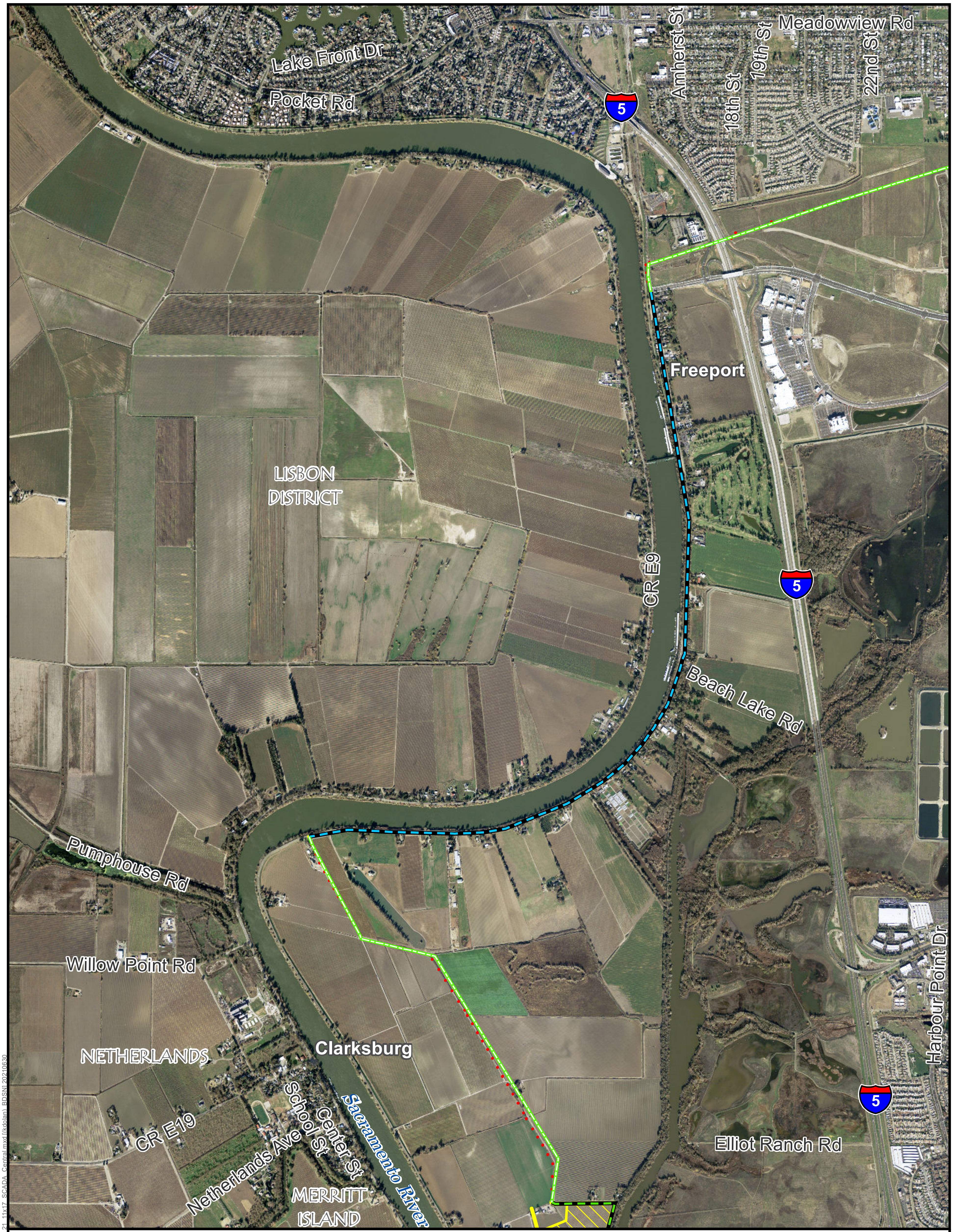
0 1,000 2,000 Feet

Map 1
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Existing Roadway
Outside Roadway
Proposed Overhead SCADA
New Line on Existing Poles

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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Map 2
SCADA - Central
06/30/2021

Data Source: DCA, DWR

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SCADA Proposed Fiber Routes

Proposed Underground SCADA

- Within Existing Roadway
- Within Proposed Roadway Improvements

Proposed Overhead SCADA

- New Line on Existing Poles

- Tunnel
- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

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0 1,000 2,000 Feet

Map 3
SCADA - Central
06/30/2021

Data Source: DCA, DWR

SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Proposed Roadway Improvements

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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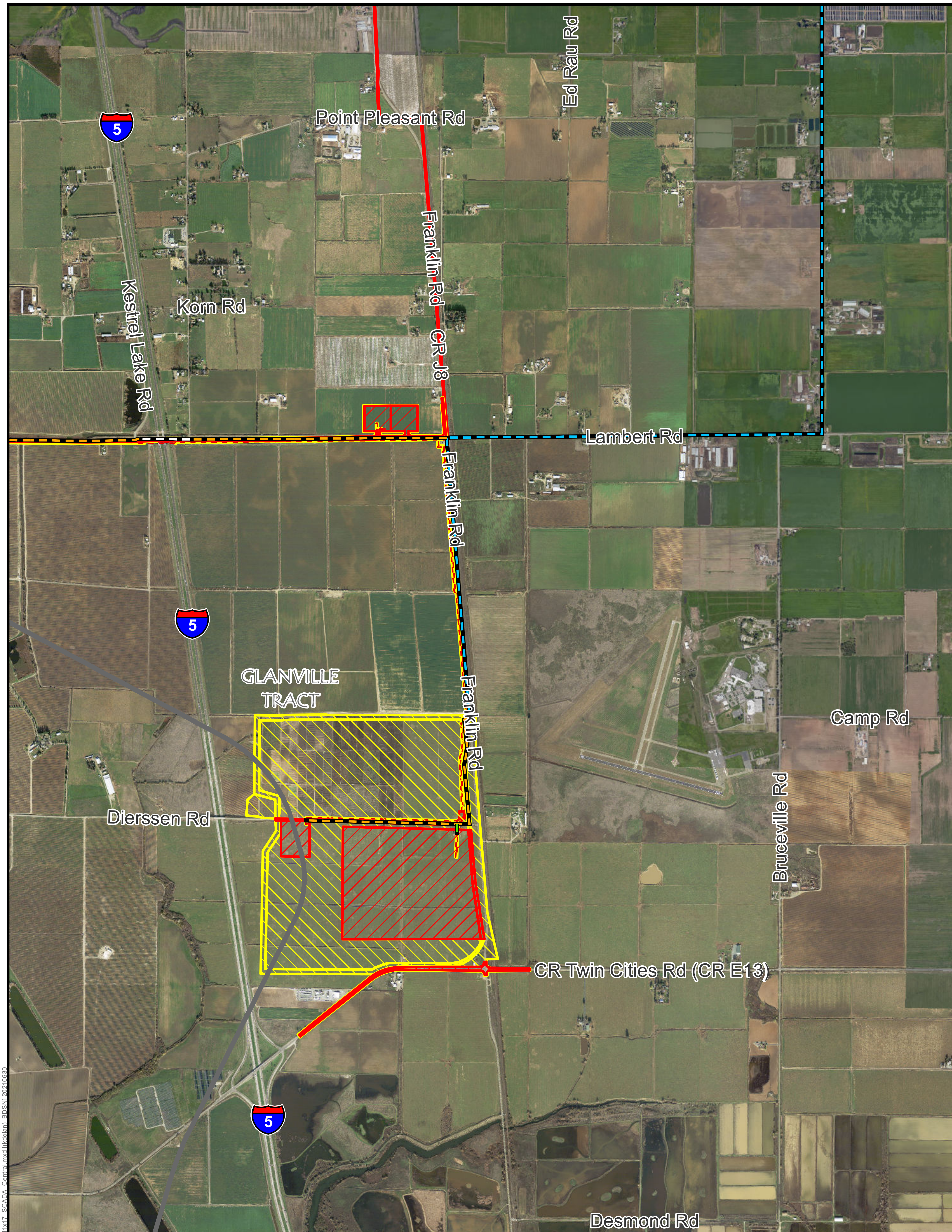
For Illustration Purposes Only

N

0 1,000 2,000 Feet

Map 4
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Existing Roadway
Within Proposed Roadway Improvements
Outside Roadway
Trenchless Installation

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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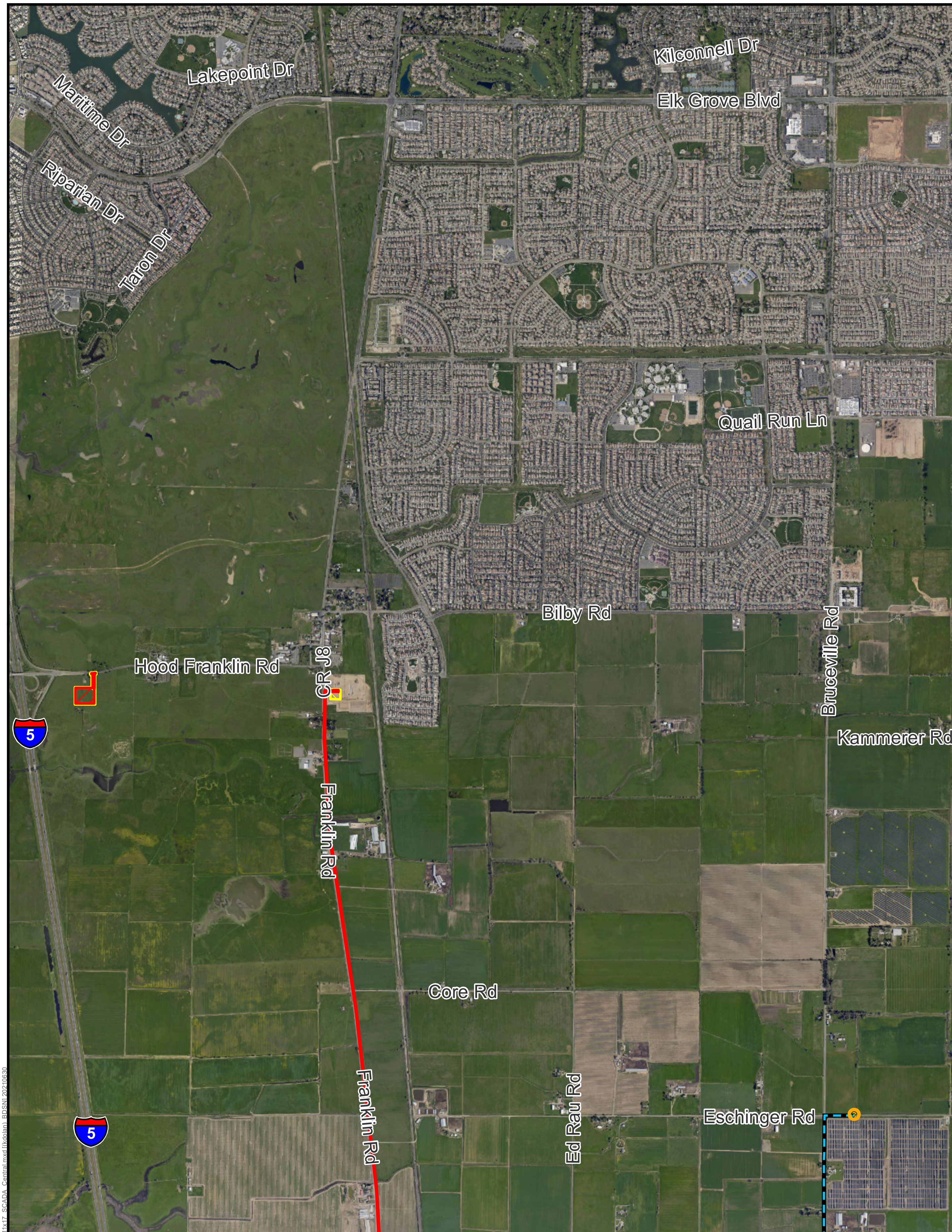
Map 5
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
- Within Existing Roadway
- Outside Roadway
- Connection to Existing Router

- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

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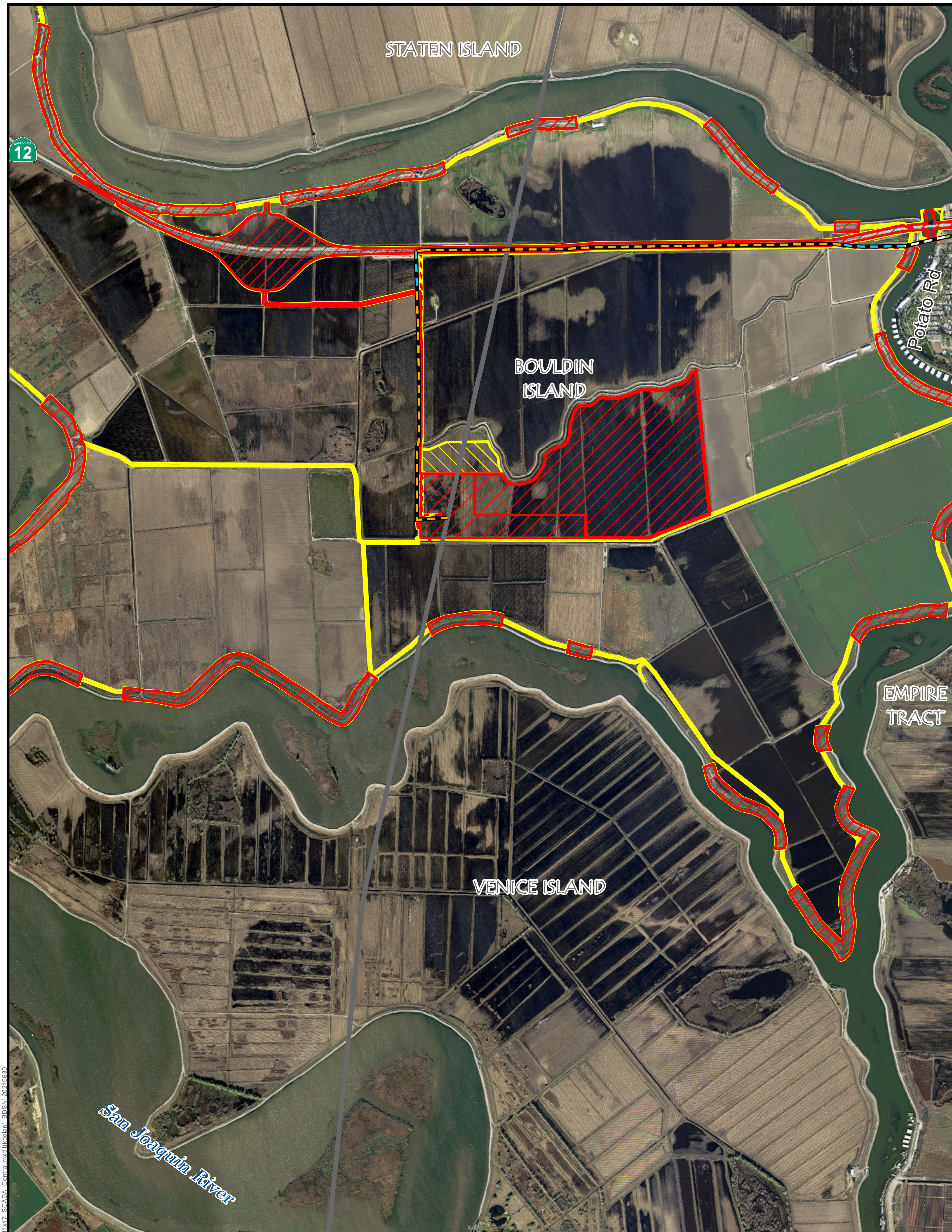
0 1,000 2,000 Feet

Map 6
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
- Within Existing Roadway
- Within Proposed Roadway Improvements
- Outside Roadway
- Trenchless Installation

- Tunnel

- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

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0 1,000 2,000 Feet

Map 7
SCADA - Central
06/30/2021

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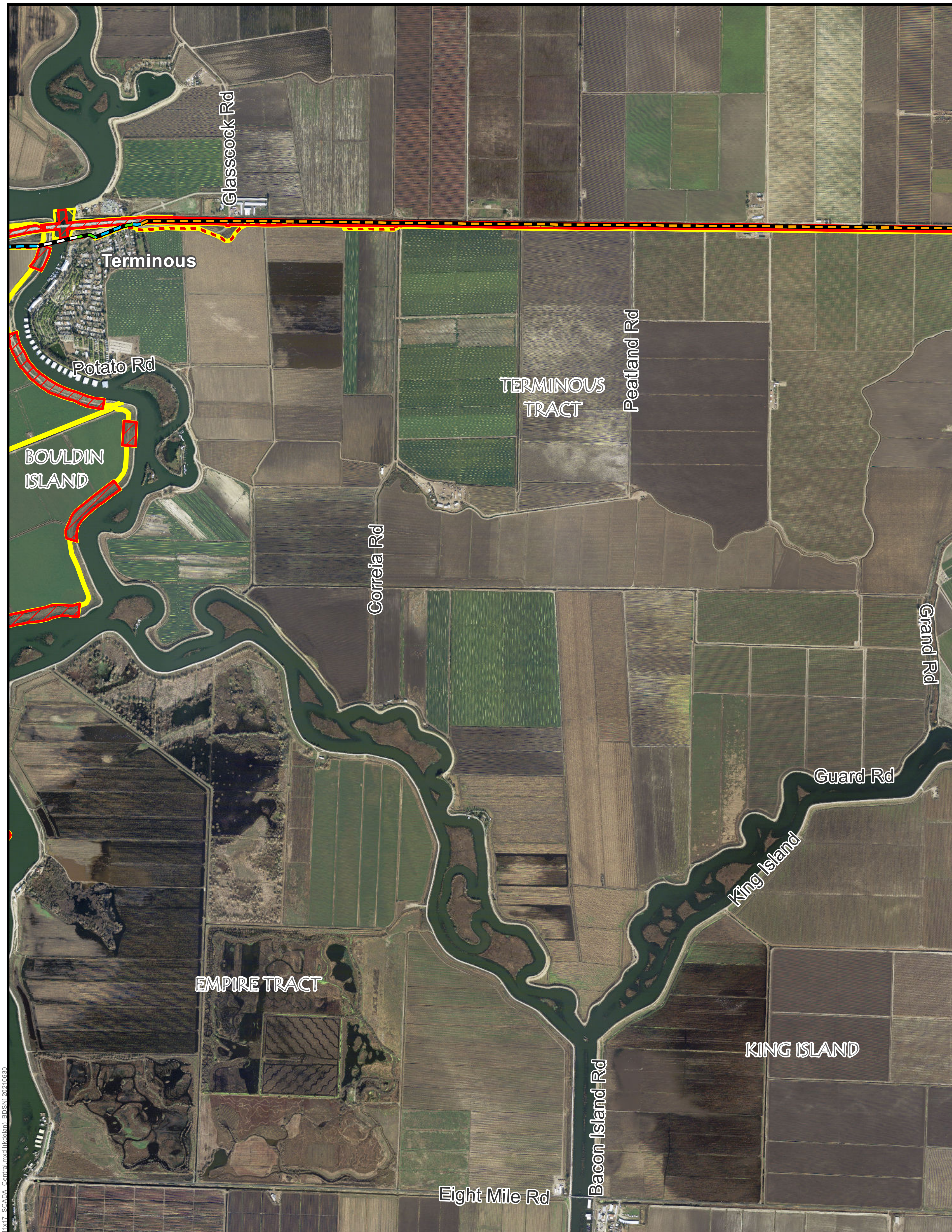

SCADA Proposed Fiber Routes
Proposed Underground SCADA
- Within Existing Roadway
- Within Proposed Roadway Improvements
- Outside Roadway
- Trenchless Installation

- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

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N

0 1,000 2,000 Feet

Map 8
SCADA - Central
06/30/2021

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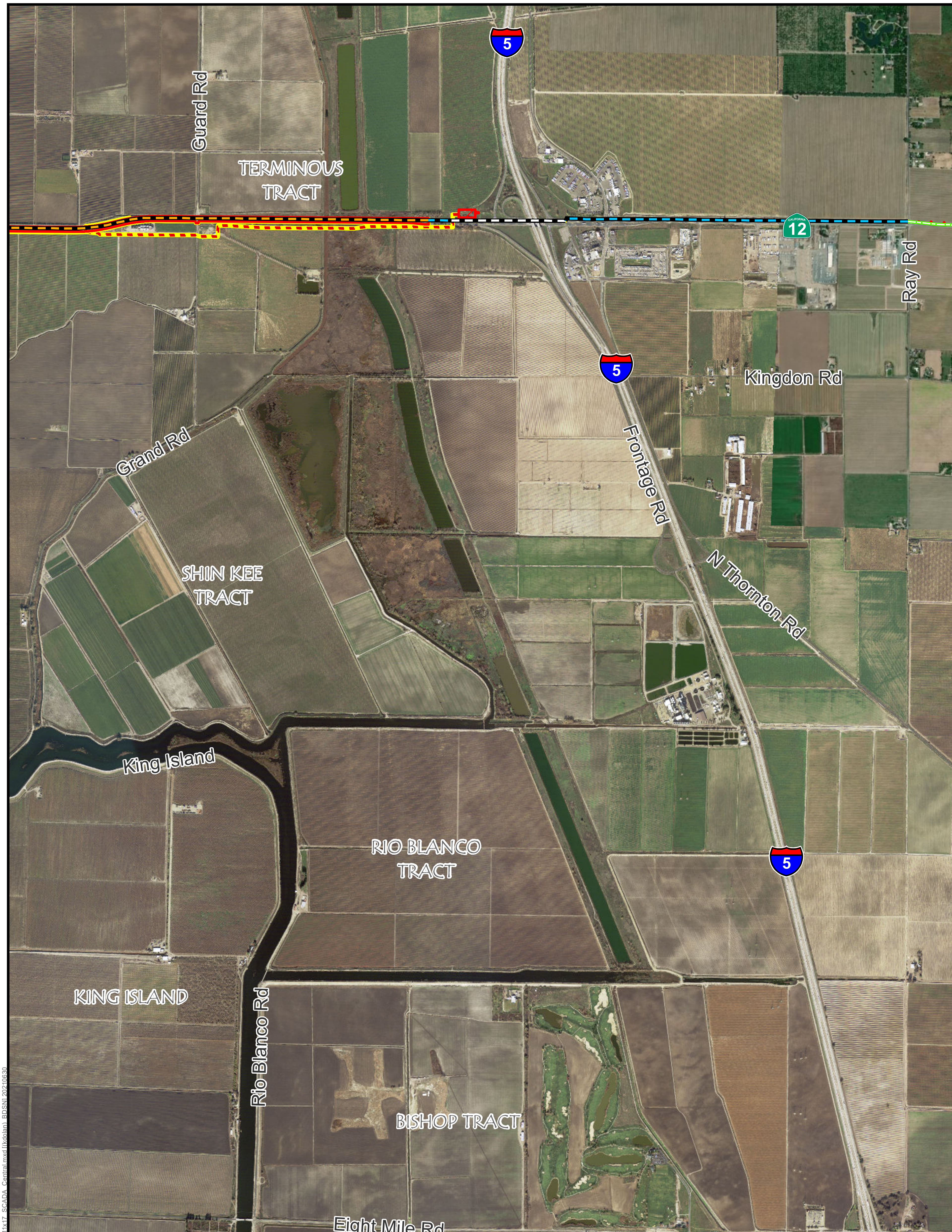

SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Proposed Roadway Improvements
Outside Roadway
Trenchless Installation
Proposed Overhead SCADA
New Line on Existing Poles

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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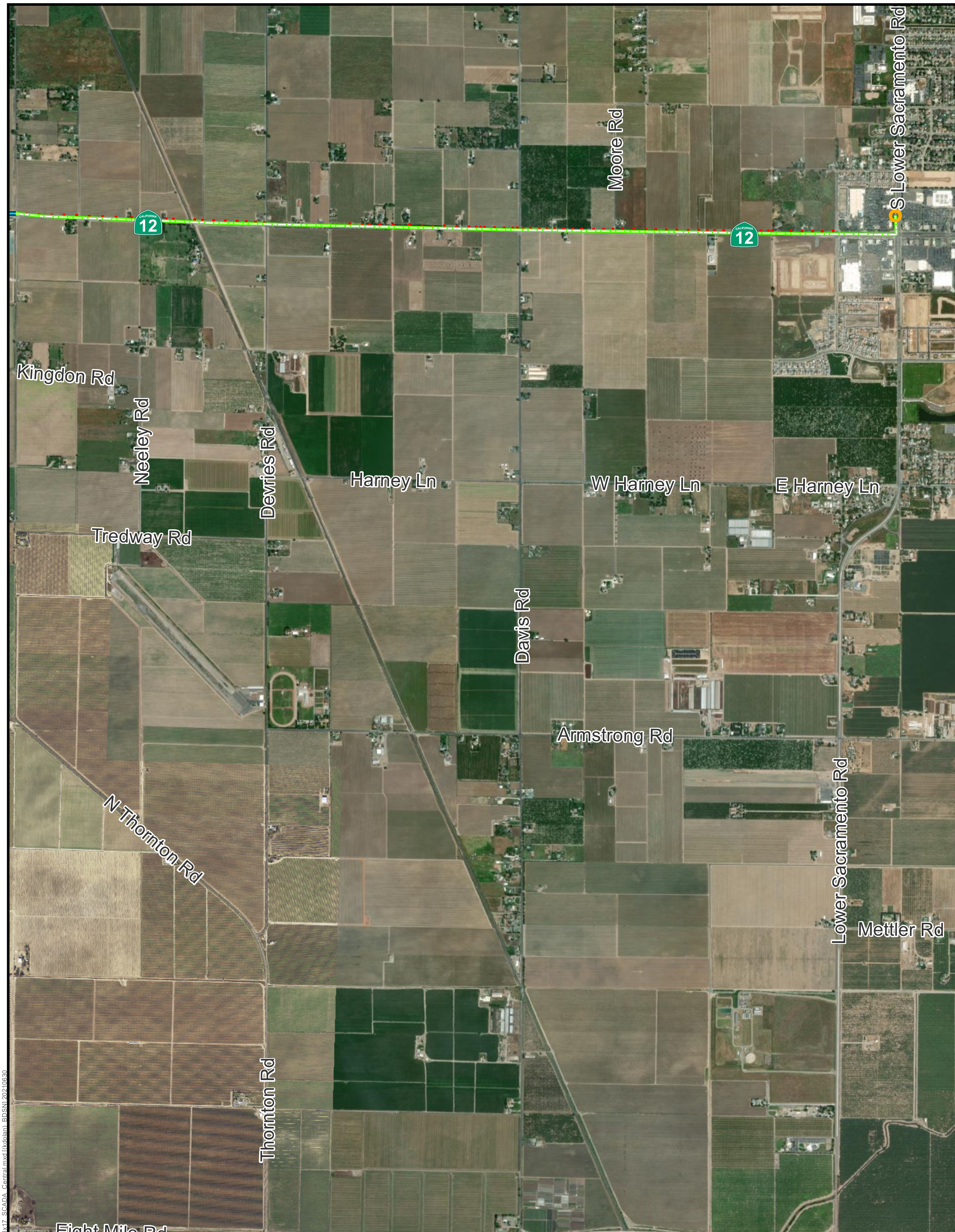
0 1,000 2,000 Feet

Map 9
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Outside Roadway
Proposed Overhead SCADA
New Line on Existing Poles
Connection to Existing Router

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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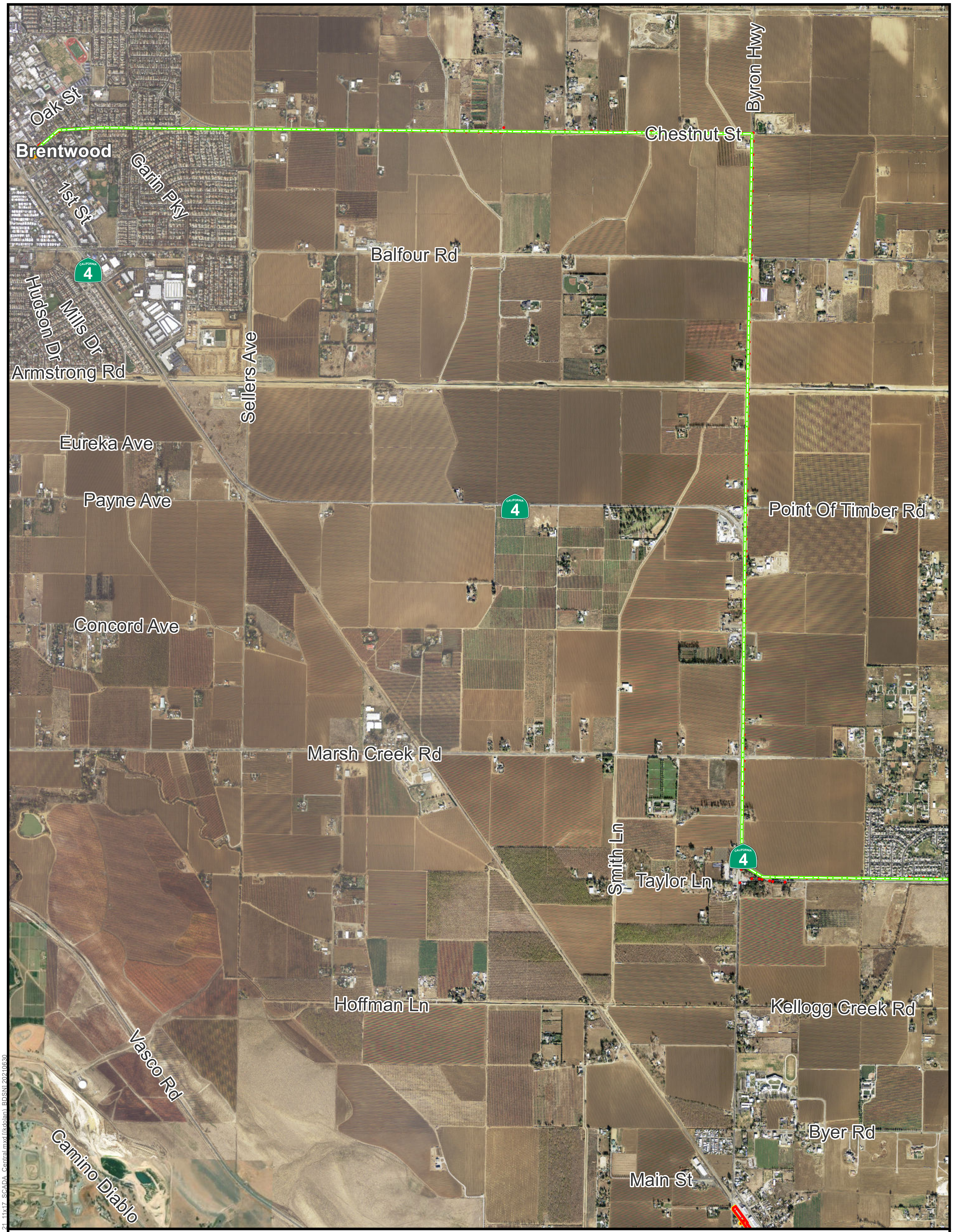
0 1,000 2,000
Feet

Map 10
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Overhead SCADA
New Line on Existing Poles
Connection to Existing Router

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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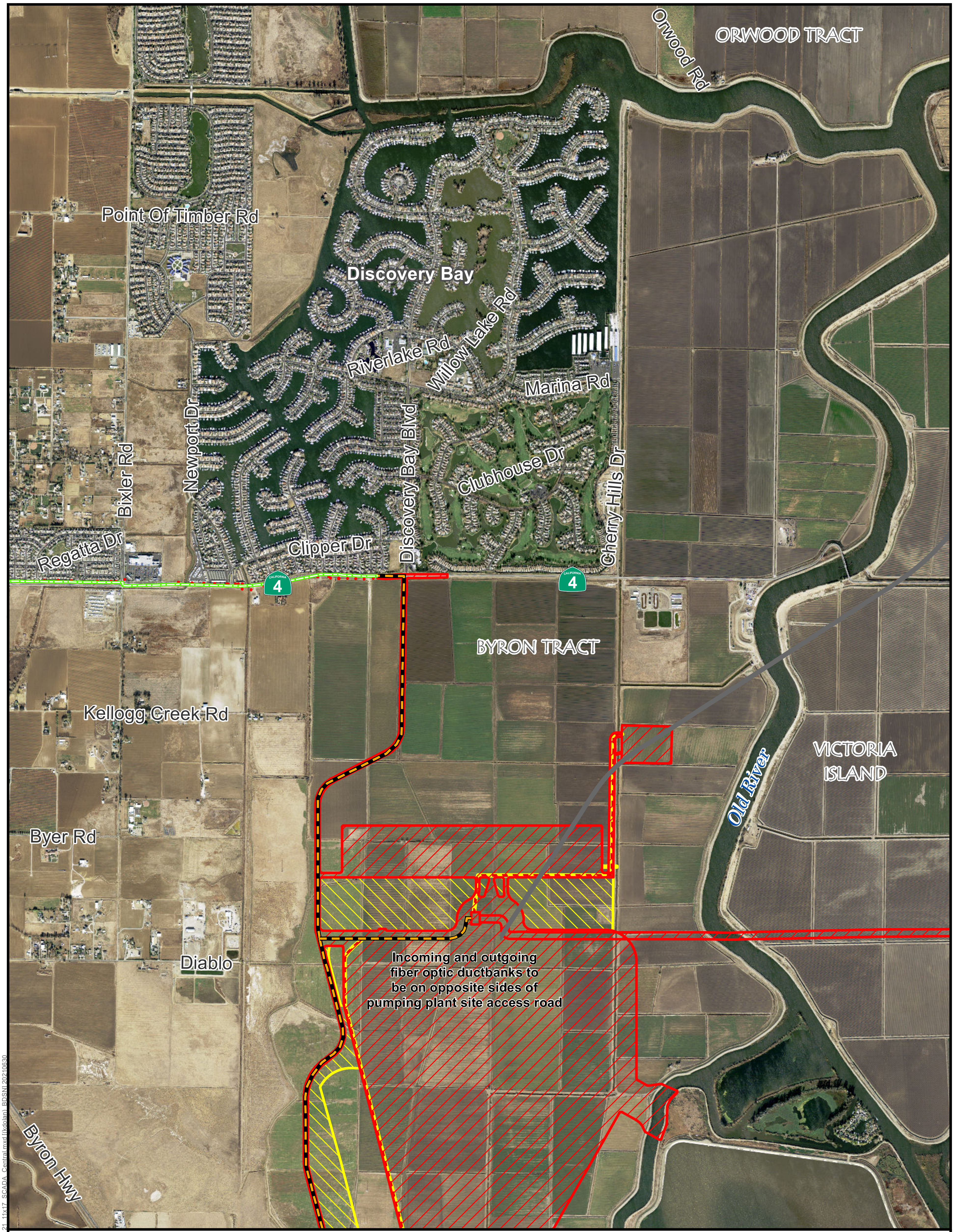
N

0 1,000 2,000 Feet

Map 11
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes

Proposed Underground SCADA

Within Proposed Roadway Improvements

Proposed Overhead SCADA

New Line on Existing Poles

Tunnel

Permanent Subsurface Impact

Permanent Surface Impact

Temporary Surface Impact

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DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

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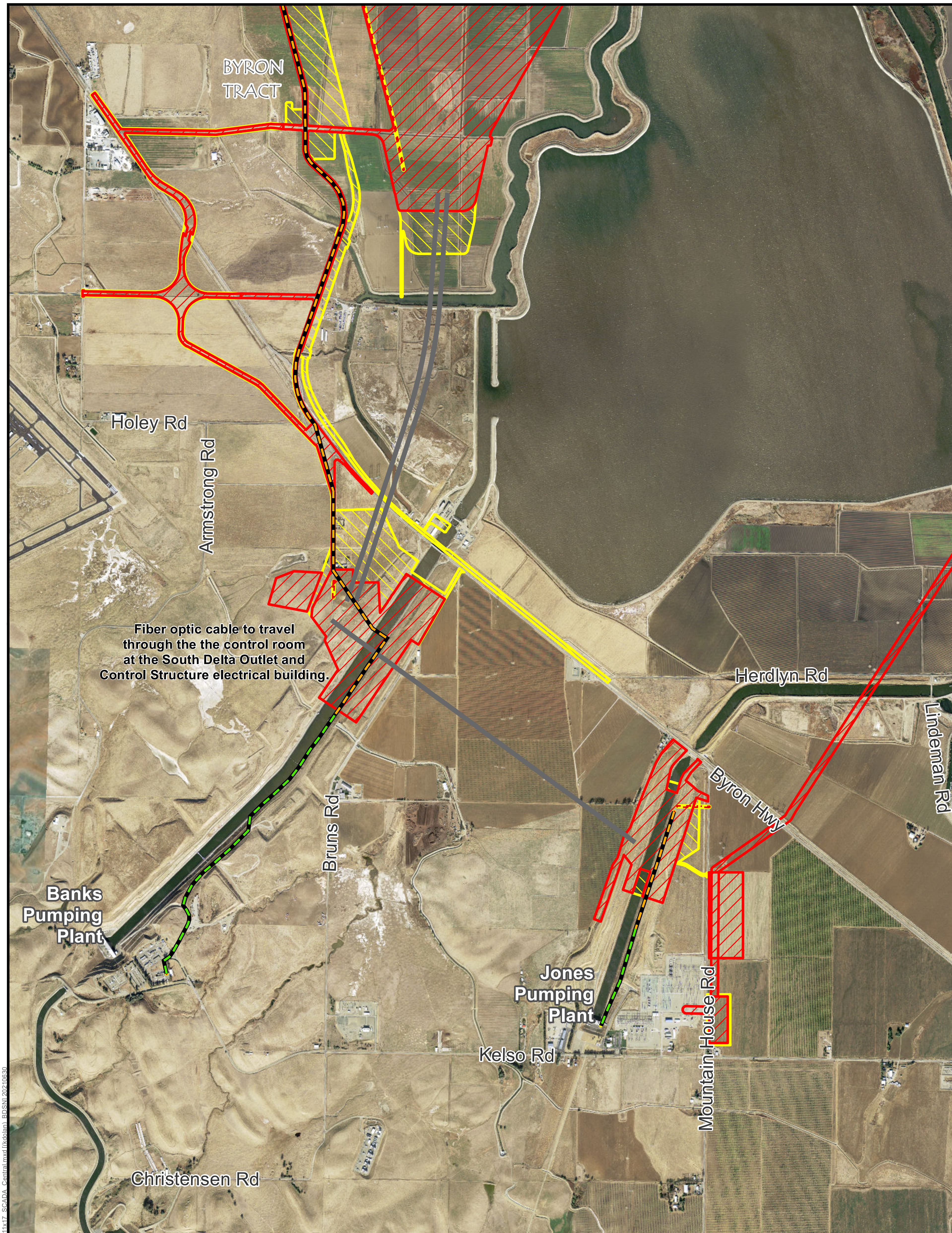
N

0 1,000 2,000 Feet

Map 12
SCADA - Central
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Existing Roadway
Within Proposed Roadway Improvements

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

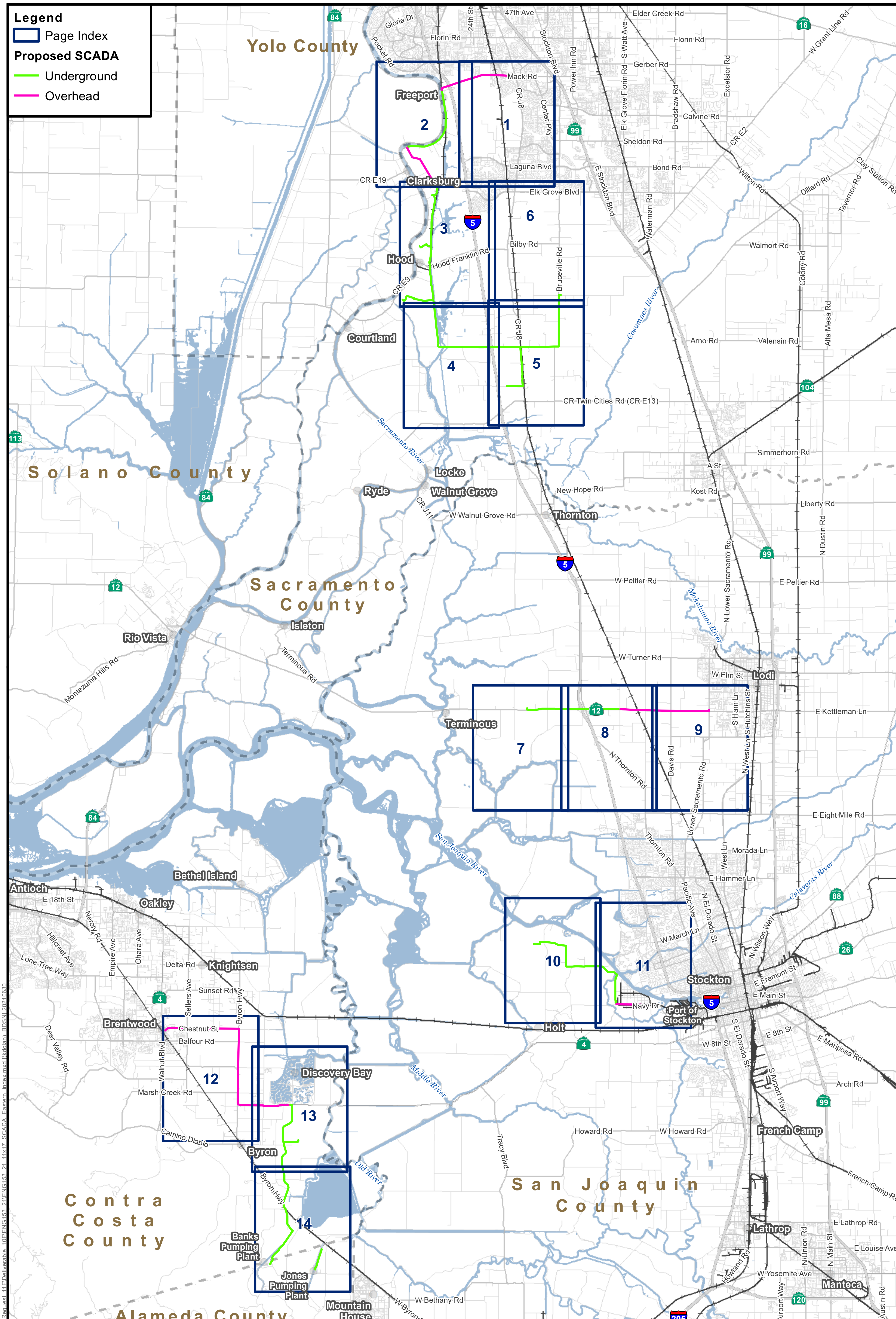
N

0 1,000 2,000 Feet

Map 13
SCADA - Central
06/30/2021

Data Source: DCA, DWR

Attachment 4
Eastern Corridor Route Maps



For Illustration Purposes Only

N

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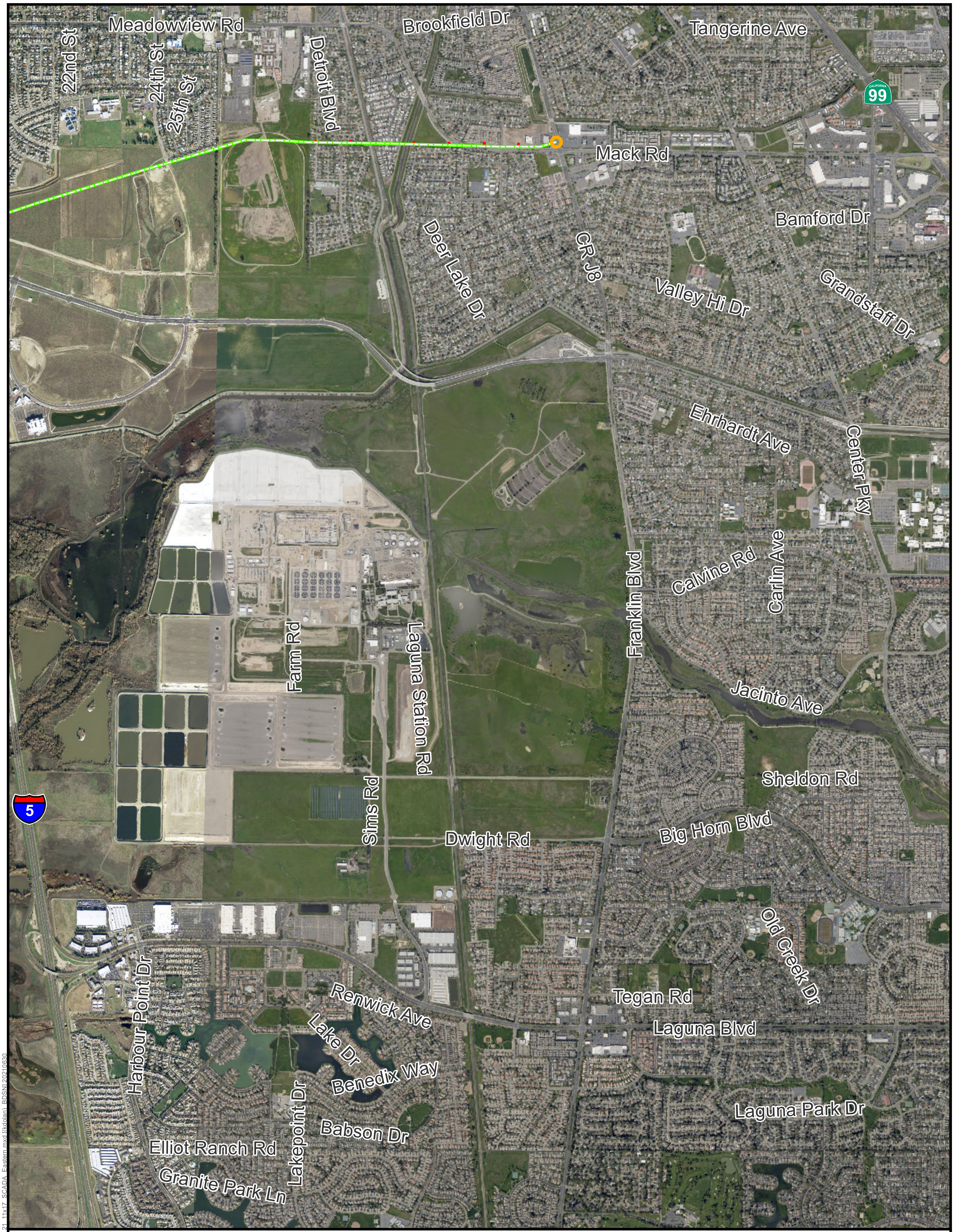
Key Map
Eastern SCADA
06/30/2021

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Overhead SCADA
- New Line on Existing Poles
- Connection to Existing Router

- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA
DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

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N

0 1,000 2,000 Feet

Map 1
SCADA - Eastern
06/30/2021

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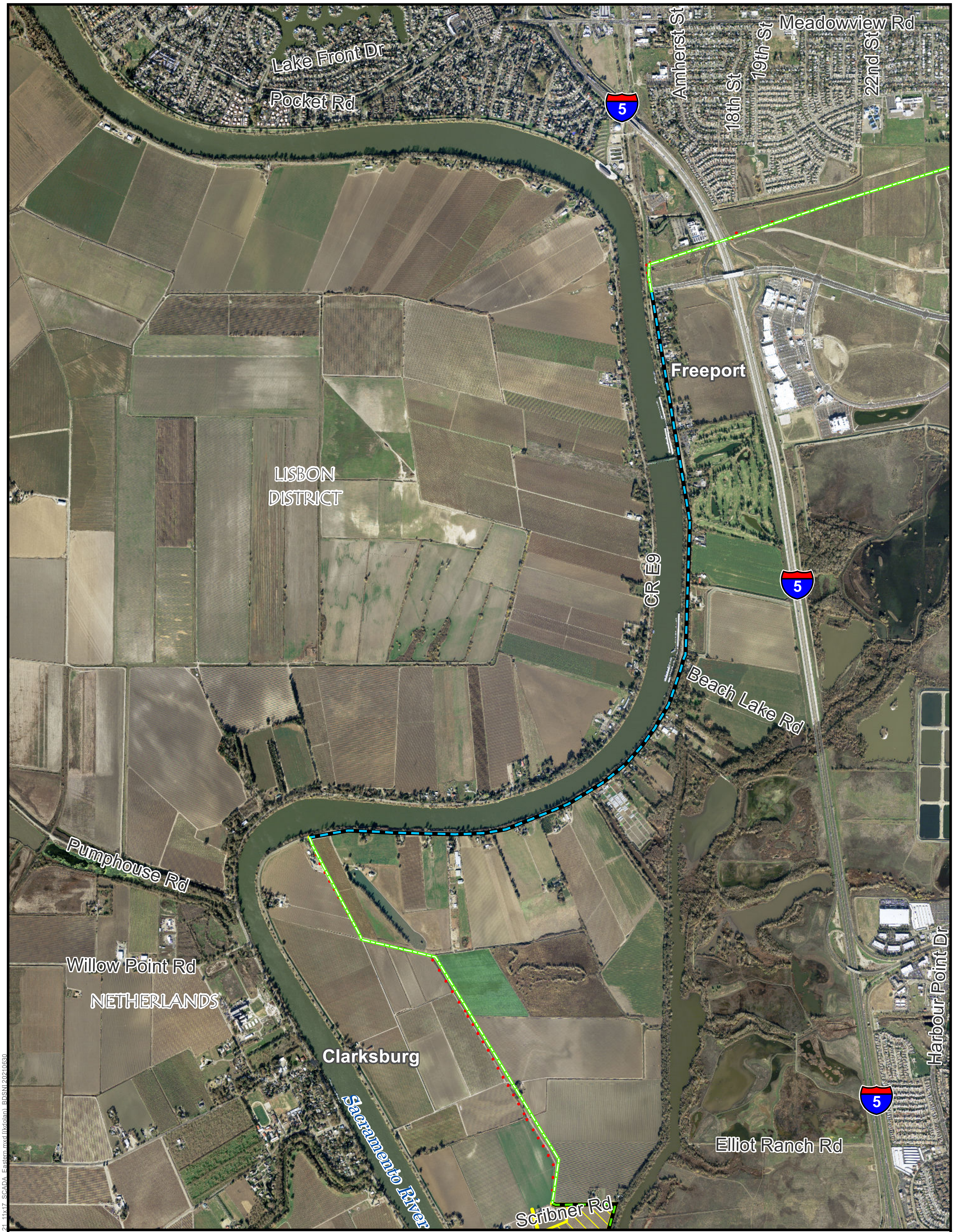

SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Existing Roadway
Outside Roadway
Proposed Overhead SCADA
New Line on Existing Poles

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

N

0 1,000 2,000 Feet

Map 2
SCADA - Eastern
06/30/2021

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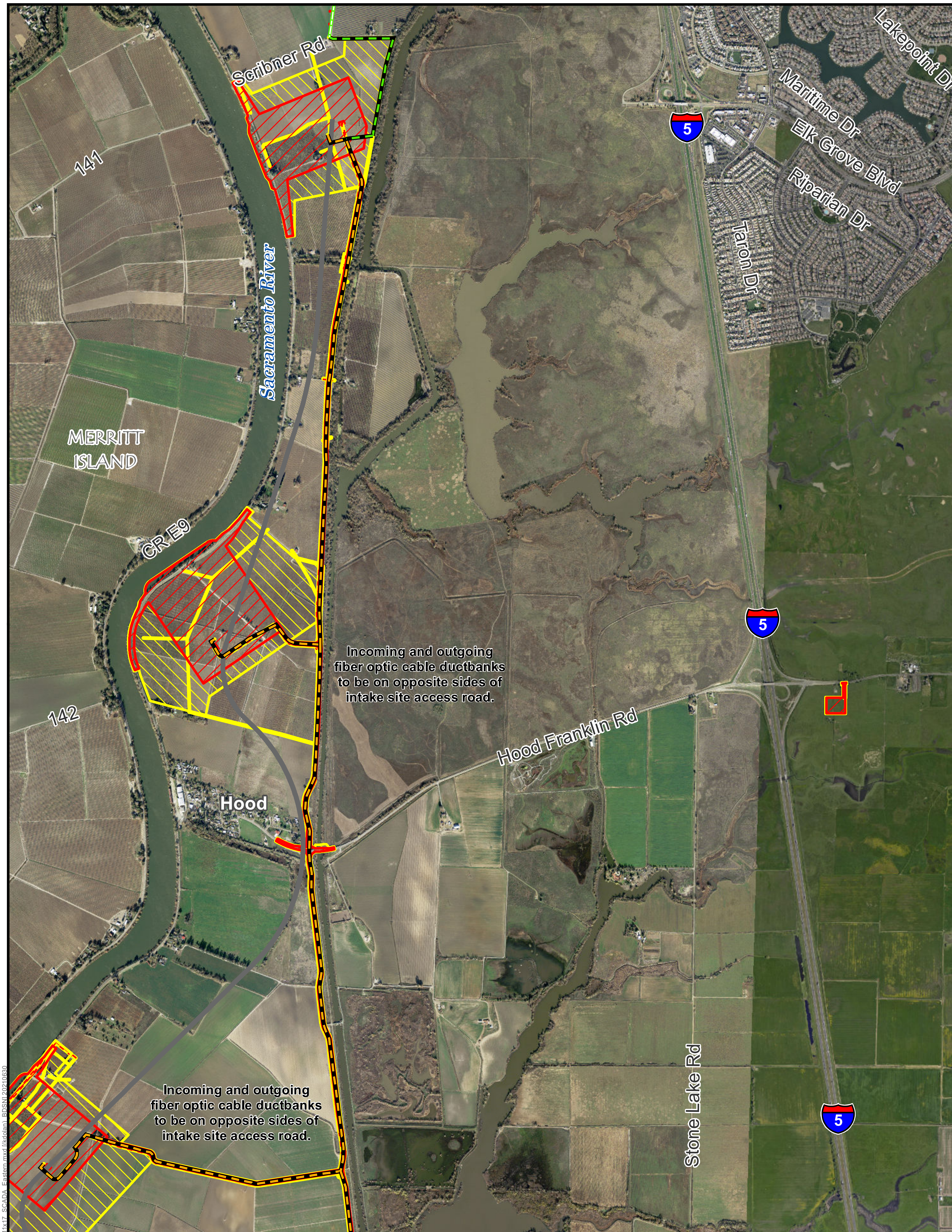

SCADA Proposed Fiber Routes

Proposed Underground SCADA
- Within Existing Roadway
- Within Proposed Roadway Improvements

Proposed Overhead SCADA
- New Line on Existing Poles

Tunnel

- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

N

0 1,000 2,000 Feet

Map 3
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR

SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Proposed Roadway Improvements
Trenchless Installation

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

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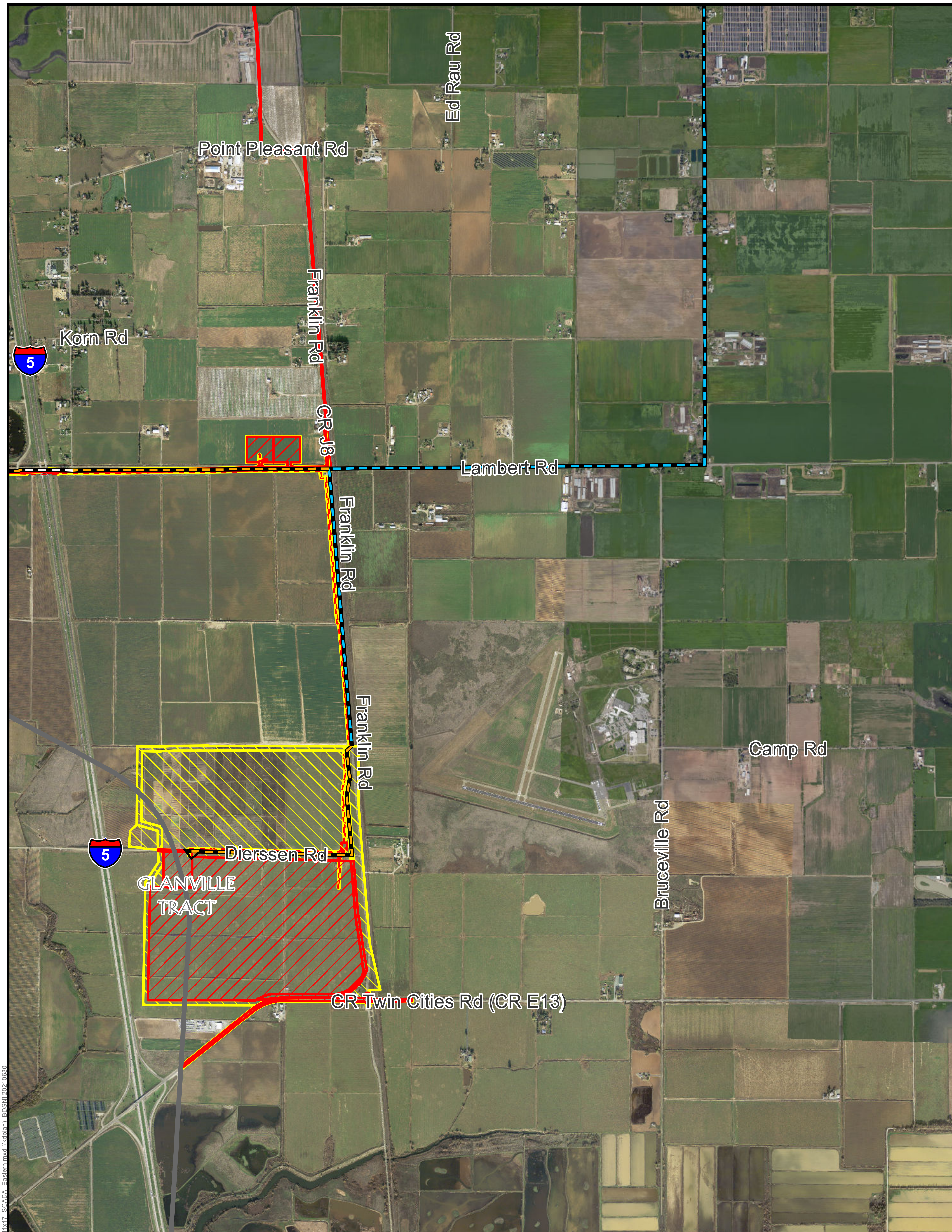
Map 4
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Proposed Roadway Improvements
Outside Roadway
Trenchless Installation

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

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Map 5
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR

SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Existing Roadway
Outside Roadway
Connection to Existing Router

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

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Map 6
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR

SCADA Proposed Fiber Routes
Proposed Underground SCADA
Outside Roadway

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

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Map 7
SCADA - Eastern
06/30/2021

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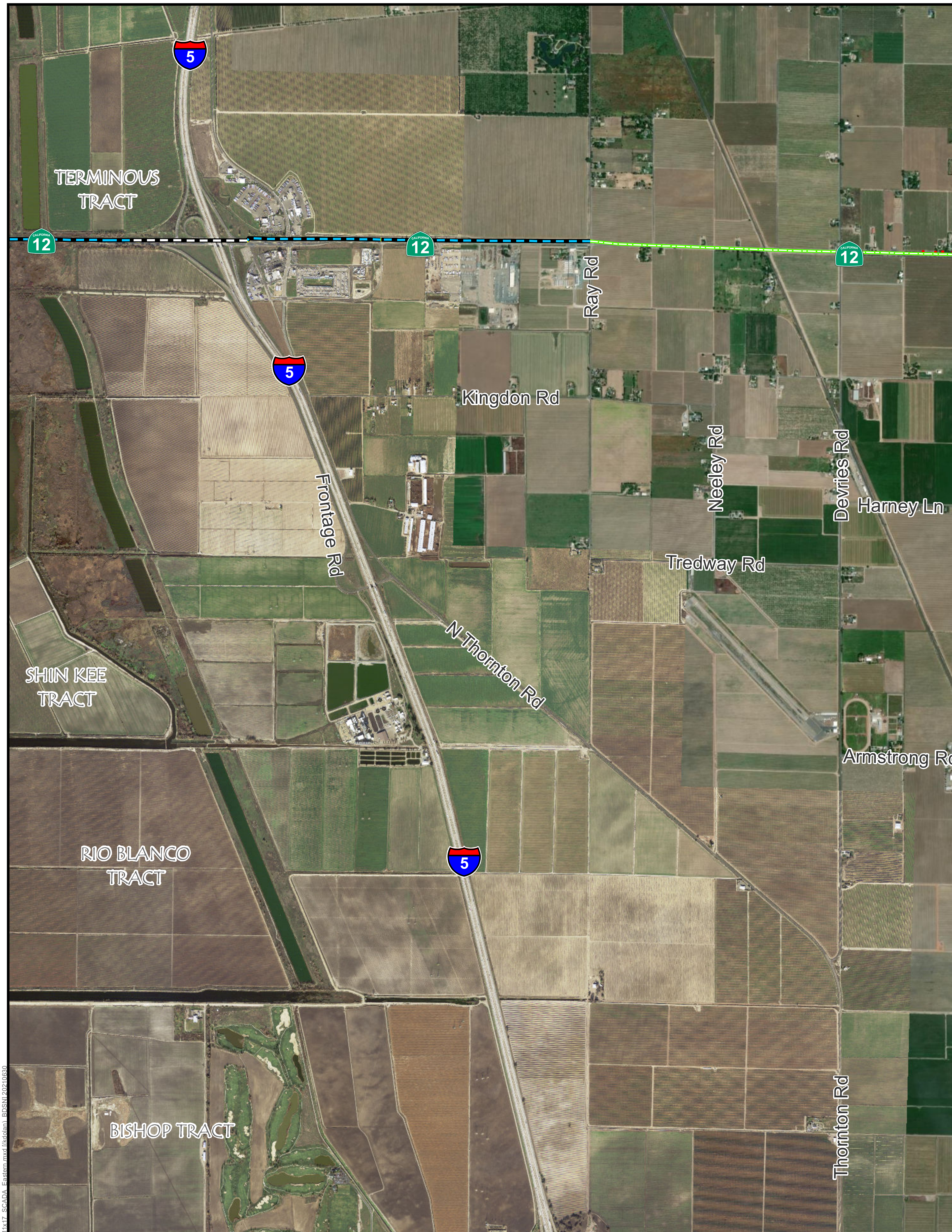
Data Source: DCA, DWR



SCADA Proposed Fiber Routes

Proposed Underground SCADA

Outside Roadway

Trenchless Installation

Proposed Overhead SCADA

New Line on Existing Poles

Permanent Subsurface Impact

Permanent Surface Impact

Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

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Map 8
SCADA - Eastern
06/30/2021

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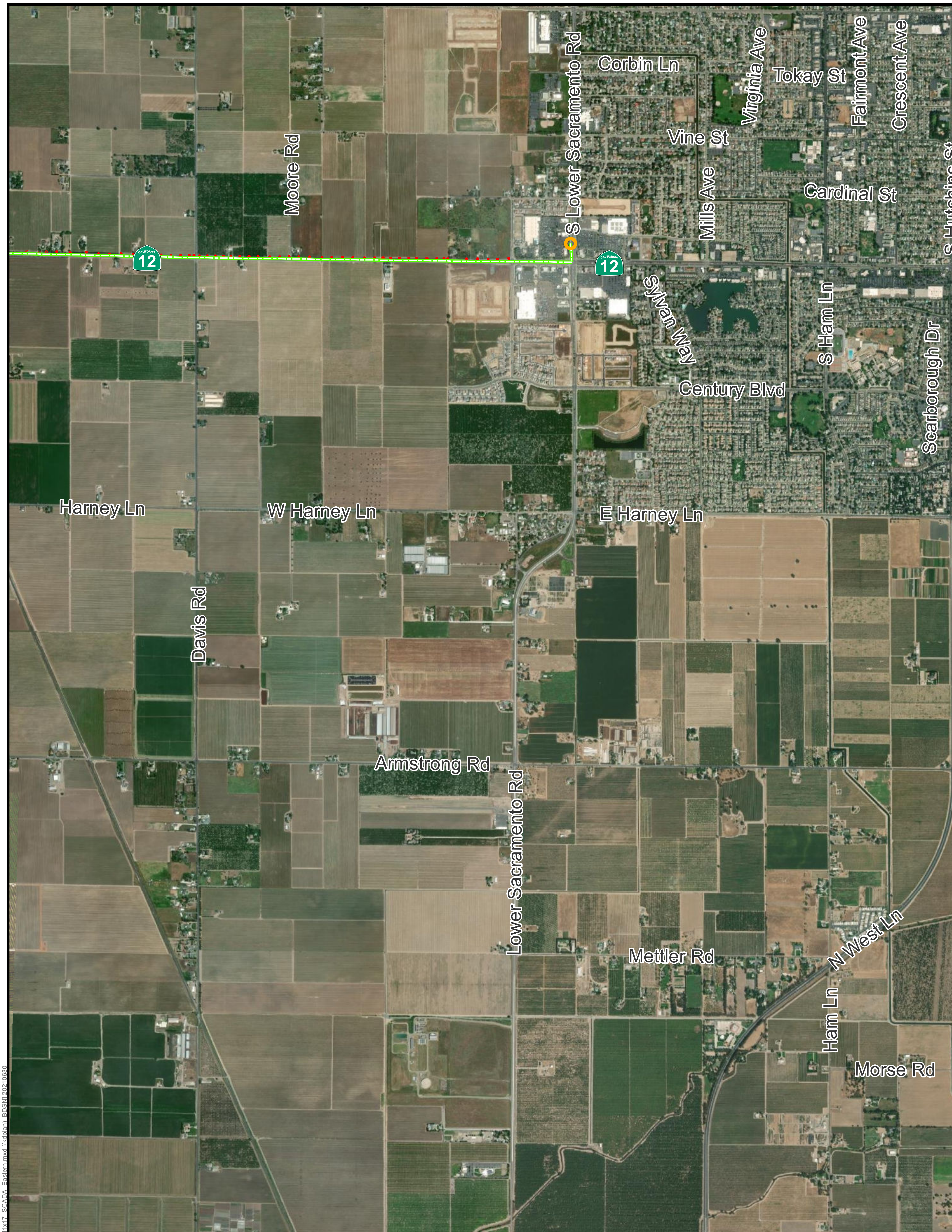
Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Overhead SCADA
New Line on Existing Poles
Connection to Existing Router

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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Map 9
SCADA - Eastern
06/30/2021

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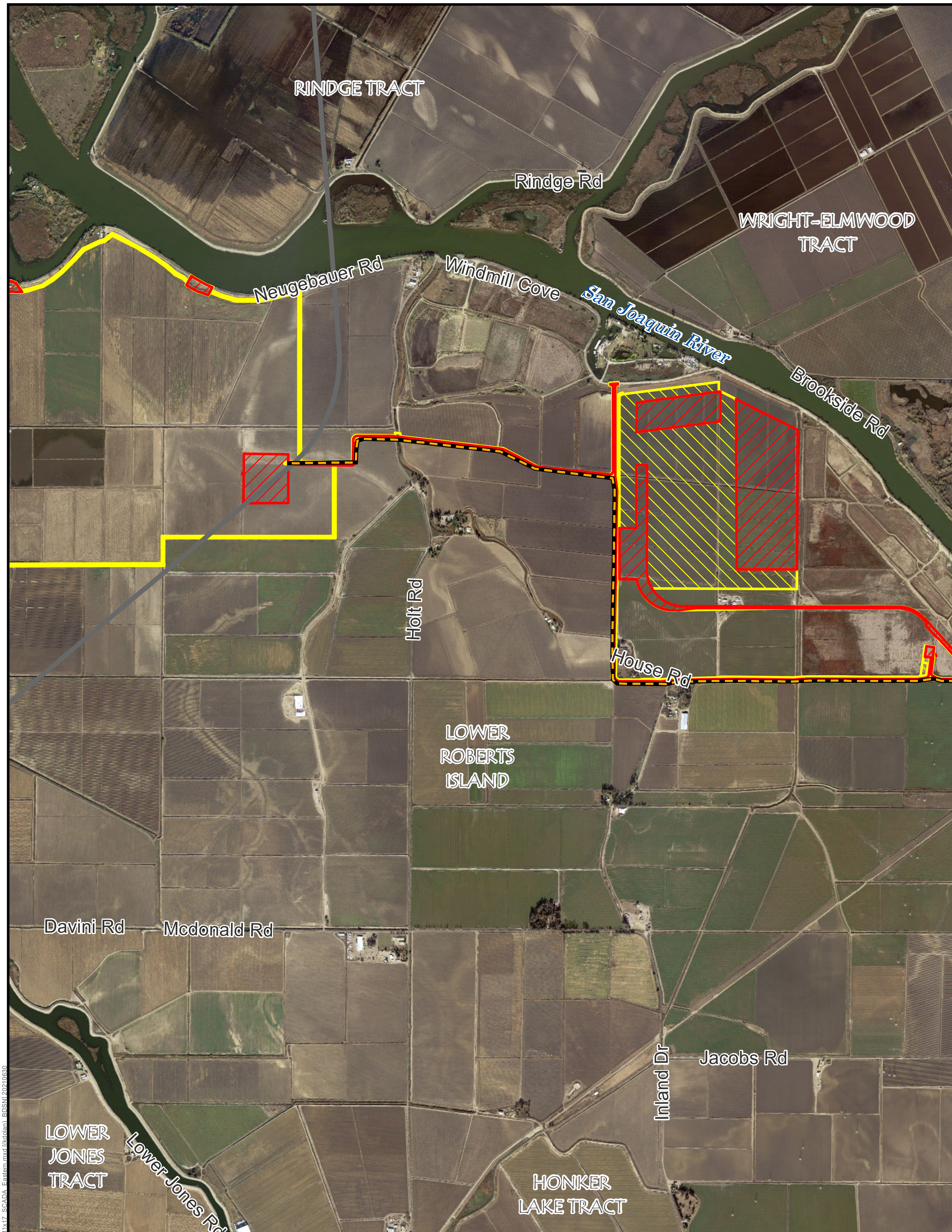
Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Proposed Roadway Improvements

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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Map 10
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR

SCADA Proposed Fiber Routes

Proposed Underground SCADA

Within Proposed Roadway Improvements

Proposed Overhead SCADA

New Line on Existing Poles

Connection to Existing Router

Permanent Subsurface Impact

Permanent Surface Impact

Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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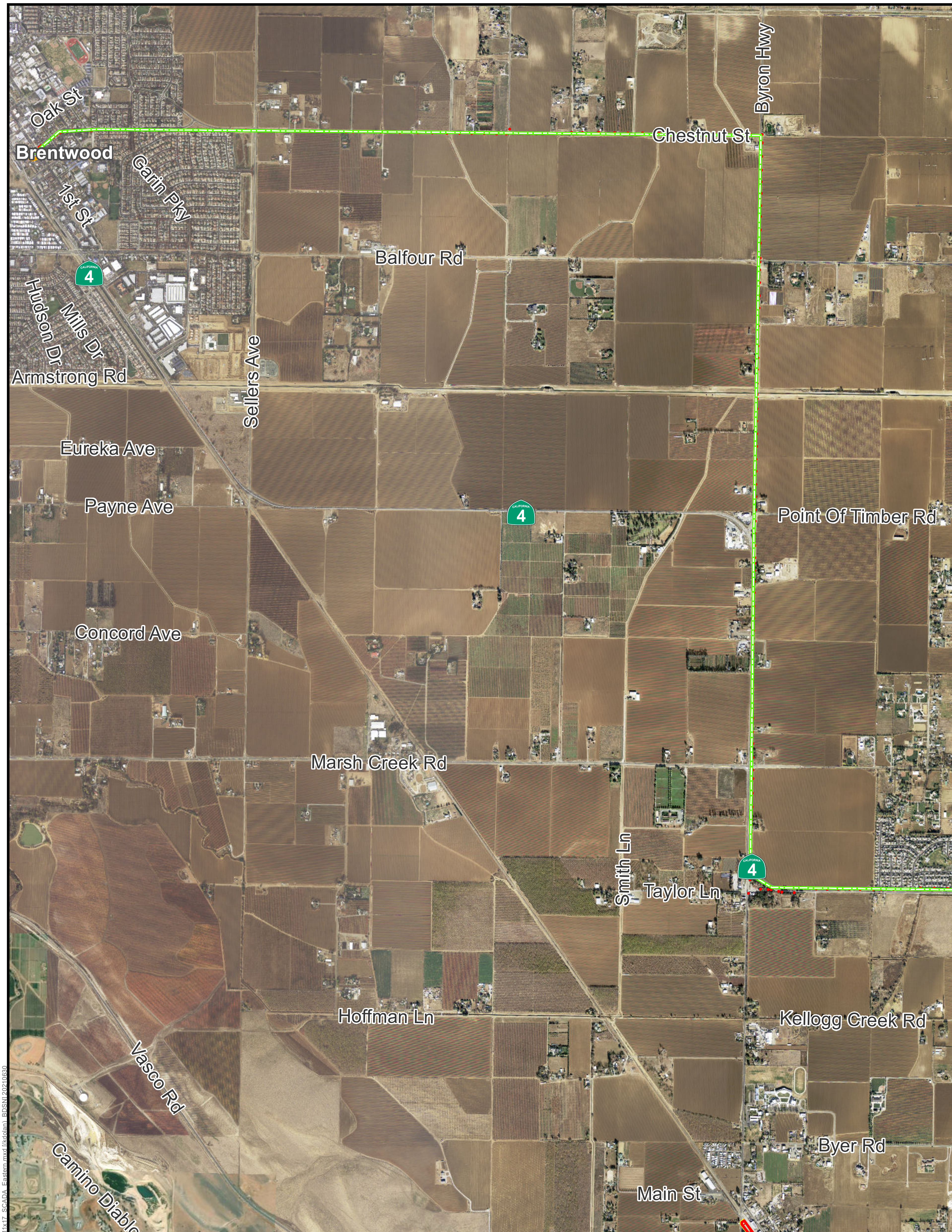
Map 11
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Overhead SCADA
New Line on Existing Poles
Connection to Existing Router

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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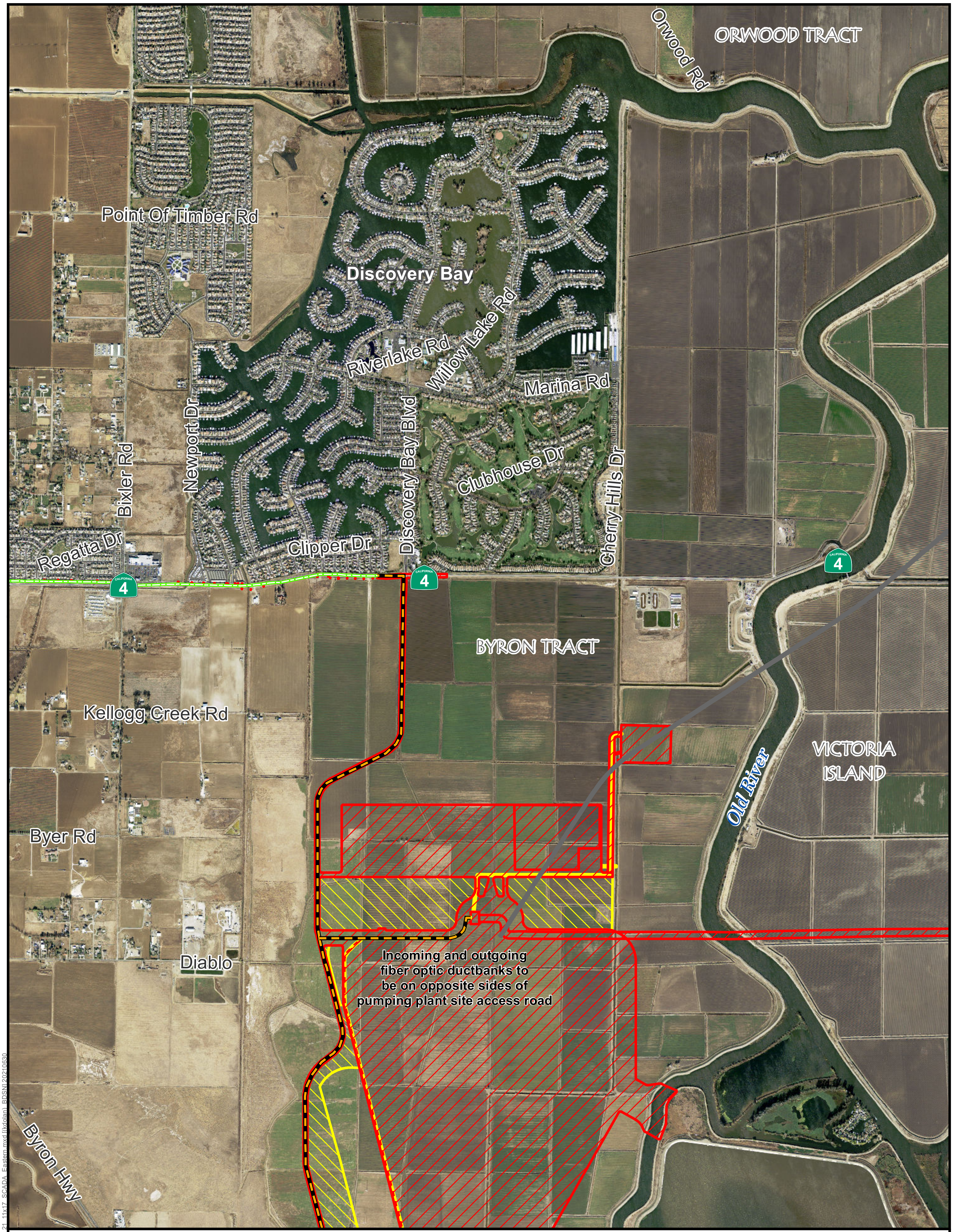
Map 12
SCADA - Eastern
06/30/2021

Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
Within Proposed Roadway Improvements
Proposed Overhead SCADA
New Line on Existing Poles

Tunnel

Permanent Subsurface Impact
Permanent Surface Impact
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CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

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Map 13
SCADA - Eastern
06/30/2021

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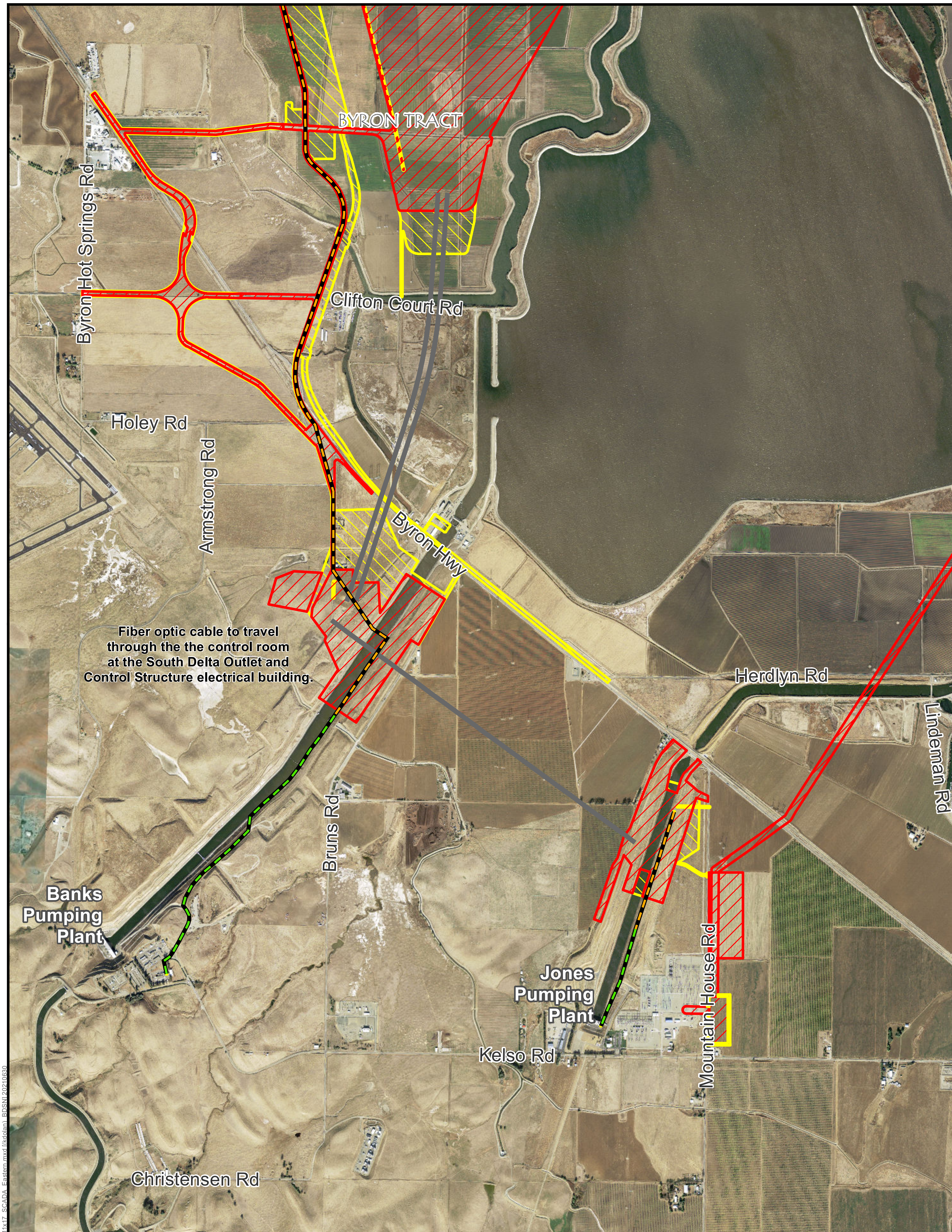
Data Source: DCA, DWR



SCADA Proposed Fiber Routes
Proposed Underground SCADA
- Within Existing Roadway
- Within Proposed Roadway Improvements
- Tunnel
- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

CONFIDENTIAL ATTORNEY-CLIENT PRIVILEGE DISCUSSION DRAFT

DCA DELTA CONVEYANCE DESIGN & CONSTRUCTION AUTHORITY

For Illustration Purposes Only

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Map 14
SCADA - Eastern
06/30/2021

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Data Source: DCA, DWR

Attachment 5
Delta Broadband Action Plan

Connecting the Delta:

Broadband Action Plan

August 2019

Report prepared by Valley Vision
for the Delta Protection Commission

For further information contact:
Yzabelle.DelaCruz@ValleyVision.org

Table of Contents

BACKGROUND AND PURPOSE

In 2014, the Delta Protection Commission (DPC) developed the Delta Community Action Planning project to increase civic vitality and preserve the values and character of historic Delta towns. Through the community action planning process, broadband infrastructure was identified as an essential utility needed to serve residents, businesses (including agricultural operations), and visitors.

Broadband access supports economic growth and connects individuals and households to business, government, health, safety, and educational resources. Proper infrastructure and education around this technology are necessary for communities to fully participate in society, democracy, and economy.

According to the Federal Communications Commission's 2018 Broadband Deployment Report, 80% of the approximately 24 million Americans who still lack access to affordable high-speed Internet service reside in rural communities. Among the five legacy communities identified in the Delta community action plans (Clarksburg, Courtland, Hood, Isleton, and Walnut Grove), approximately one-third of households do not have Internet subscriptions. Additionally, 17% of households within Delta communities do not have access to a computing device (desktop, laptop, smartphone or tablet).

Table 1- Household Computers and Internet Subscription Data

	California	Delta Legacy Communities (Combined)	Clarksburg (95612)	Courtland (95615)	Hood (95639)	Isleton (95641)	Walnut Grove (95690)
Total Households		2,432	398	309	84	816	825
Households with an Internet subscription	83%	69%	80%	83%	60%	61%	67%
Cellular data plan only	7%	18%	24%	19%	23%	9%	23%
Cable, fiber optic, DSL, fixed wireless	72%	39%	39%	45%	37%	42%	35%
Satellite	6%	14%	24%	20%	0%	13%	8%
Households without Internet subscription	17%	31%	20%	17%	40%	39%	33%
Households with no computing device	10%	17%	12%	2%	51%	21%	18%

Source: 2013-2017 American Community Survey 5-Year Estimates

The purpose of this report is to prompt specific action by providing a detailed, tangible broadband improvement plan for the five legacy communities. Additionally, it is intended to improve broadband adoption and support by informing local governments and all those affected by the lack of high-speed Internet service.

METHODOLOGY

The Delta Protection Commission engaged Valley Vision to develop this broadband report and action plan. Valley Vision manages the Connected Capital Area Broadband Consortium, which has completed a variety of broadband assessments and developed priorities and recommendations for improving broadband in communities across the Sacramento region. Additionally, Valley Vision managed the Ag Tech Pilot project in the Sacramento region, which assessed and documented needs for broadband access in agricultural settings and tested broadband-reliant precision agriculture technologies.

Valley Vision initiated this broadband action planning project by introducing itself and the project goals to the Delta community by attending standing community meetings with the Clarksburg Citizens Advisory Council, Courtland Town Association, Hood Community Council, Isleton City Council, Walnut Grove Rotary, and Delta Citizens Municipal Advisory Council. Valley Vision then facilitated three community workshops in Clarksburg, Walnut Grove, and Isleton respectively. The workshops were open to the public, and invitations were distributed through posted flyers at community gathering spots and email invitations sent through the entities noted above as well as the Delta River Unified School District, and the Delta Protection Commission.

Each of the workshops were attended by four to nine attendees. At the workshops, Valley Vision shared information on existing capacity and resources in the region, and sought input on community priorities, perceived challenges, and suggested solutions. The following plan reflects priorities and concerns voiced in the introductory meetings, workshops, and Delta Community Action Planning project, as well as successes identified from other places.

THE STATE OF BROADBAND IN THE DELTA

Community Challenges and Concerns

As noted previously in this report (*Table 1 – Household Computer Access and Internet Subscription Data*), households in the legacy communities subscribe to the Internet at a far lower rate than is seen throughout the state (31% of households in legacy communities have no Internet subscription as opposed to 17% in California). Access, quality, reliability, and cost all factor into this circumstance. The Delta is faced with many barriers and substandard conditions of and for broadband, compared to its more urbanized neighboring geographies.

Although each Delta community has unique governance, demographics, and interests, many of the broadband challenges identified in the workshops were shared among these different communities. Delta community members voiced broadband quality and access frustrations, equity discrepancies, and educational and safety concerns. Additionally, while not exclusive to broadband, it must be noted that each community also identified challenges with mobile wireless (i.e. cell phones) and lack of signal availability.

Quality and Access Challenges

Challenges begin with limited options by which to access the Internet. Households and businesses within the legacy communities have no fiber optic options, only one (and in some cases no) digital subscriber line (DSL) provider option, limited fixed wireless options which are entirely dependent on place of residence/business, and two satellite options.

Most of the options that do exists are inadequate. By way of example, the Federal Communication Commission and United States Department of Agriculture have both targeted minimum Internet speeds of 25 megabytes per second (Mbps) download and 3 Mbps upload. These speeds allow users to search the Internet, receive and send email, upload and download pictures and large documents, stream music and movies, control household “smart” appliances and security systems, participate in video conferencing, and other functions that are becoming the norm in everyday life. Speeds lower than this can result in unreliable connections and slow transfer times. While at least one of the fixed wireless options available to some within the Delta is able to deliver at these speeds, none of the other sources (i.e. DSL or satellite) offer services that meet this target.

Broadband quality and access challenges in the Delta are exacerbated by limited provider investment and physical terrain barriers. The underinvestment from service providers can be linked to return on investment. Generally, the Internet service providers (ISPs) look for evidence that costs will be recovered, and ultimately, profit will result from their infrastructure investments. Achieving return on investment in rural communities is a tall order, which may necessitate supplemental resources.

Currently, Frontier Communications is the only wireline Internet Service Provider (ISP) registered with the California Public Utilities Commission (CPUC) as serving the Delta’s legacy communities. Frontier relies on copper-wire connections, which are unable to deliver the bandwidth needed to provide high speed Internet connections to all residents, businesses, schools, and others in the Delta. Maximum advertised speeds cap at 24 Mbps, however, workshop attendees expressed that their own testing commonly reported actual download speeds of less than 3 Mbps.

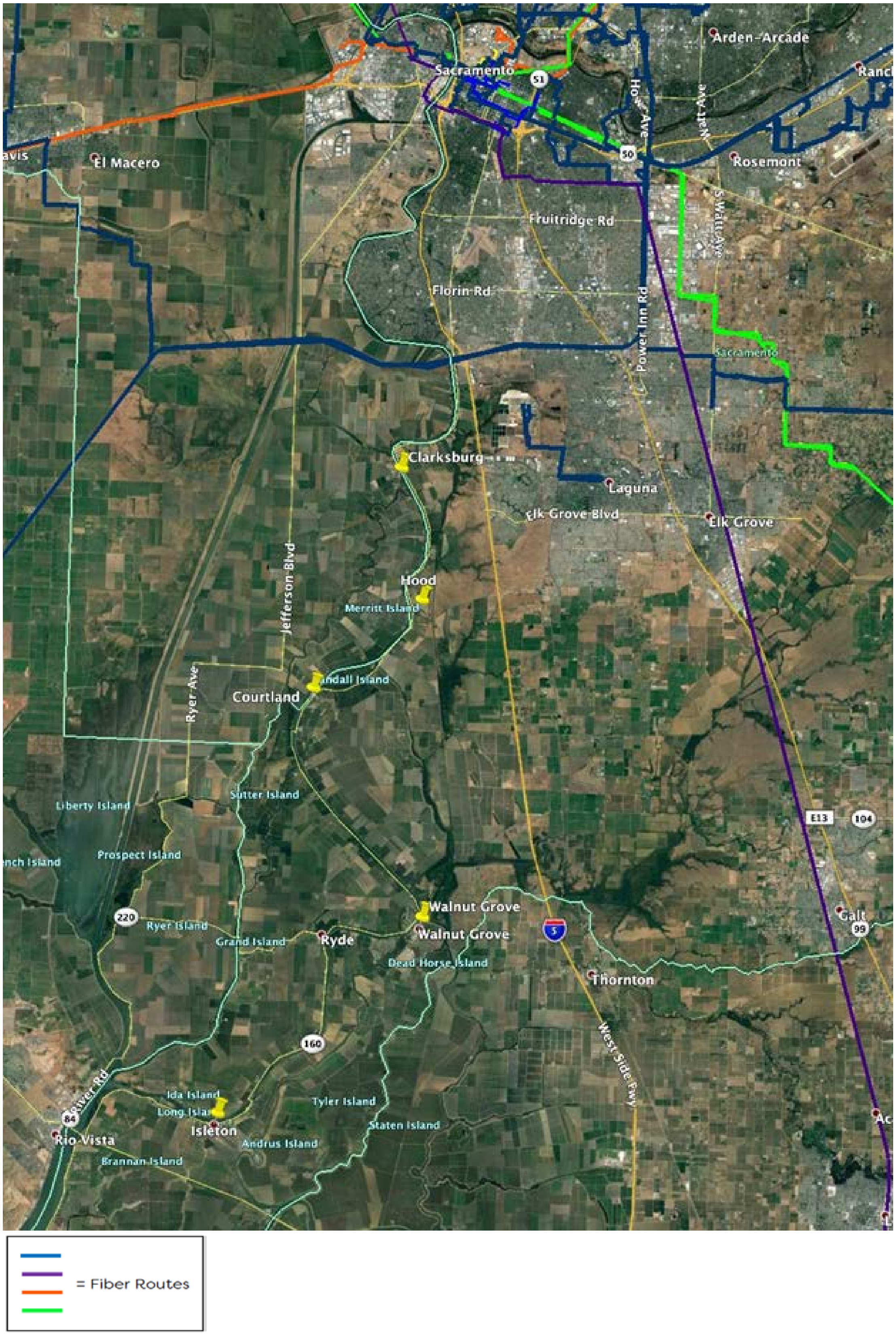
Reported fiber optic routes currently bypass the Delta, limiting connectivity to this broadband source (Figure 1). Connecting to the closest fiber routes is cost prohibitive for service providers, due to the low housing and population density in the Delta. Workshop attendees in Clarksburg and Walnut Grove both noted potential opportunities to link the installation of fiber (or conduit through which fiber could later be installed) with other upcoming capital improvement projects that may create cost saving and generate interest.

While wireline options (fiber, DSL, copper) have not advanced in the recent past, more fixed wireless options have become available in some of the Delta communities, with speeds of 50 and even 100 Mbps. Fixed wireless options were discussed at each of the workshops as a potentially less cost-intensive infrastructure solution than fiber or wireline services. It was noted, however, that wireless services degrade due to physical barriers such as tree canopies, buildings, levees, and even weather events, such as fog, making non-line-of-site connections challenging. Similar problems were reported with satellite technologies, which were further challenged by the presence of monthly data-usage caps.

The challenge of quality and access was reflected in an assessment completed by Tellus Venture Associates, which has graded numerous geographies throughout California based on the number of provider options, broadband speeds, and availability of fiber. Under Tellus Ventures rating instrument, all of the Delta communities received failing grades.

Figure 1 – Fiber Routes Map

Source: Tellus Venture Associates, April 2019



Equity and Social Justice Concerns

Many Delta community members shared that they feel left behind with regards to broadband investment. This sentiment is not out of line with other's perceptions of investment in rural areas. In a comparative study conducted by Pew Research Center, majorities of Americans in rural (71%), suburban (61%) and urban (57%) communities say that, when it comes to how the federal government spends money, rural areas receive less than their fair share.

With the exception of Isleton, Delta communities are unincorporated areas without stand-alone jurisdictional authority or organizing power, leading them to rely on resident volunteers or county government to address public concerns. Individuals from the community workshops shared that broadband priorities can and have been set aside for more pressing issues due to capacity limitations of these communities and their leadership. Generating sustained interest is a challenge.

In addition to challenges in attracting and securing broadband infrastructure investments, workshop attendees also perceived that Delta residents pay a higher cost for inferior service levels compared to residents in urban core areas. Attendees want comparable cost for comparable service.

Concerns for non/non-native English speakers, senior populations and low-income households within the Delta were also identified. The *California Emerging Technology Fund's (CETF) 2016 Annual Survey* found that those without broadband are more likely to be Latino, foreign-born and non-English-speaking, and with a family income of less than $50,000 in comparison to those with broadband. The same factors are greatly impacting broadband use in the Delta communities, where 34% of the residents speak a language other than English in the home; 45% of households have one or more people who are 60 years or older, and 46% of household incomes are less than $50,000 (US Census, American Community Survey). With limited broadband access, these populations will be further isolated and fall further behind, making the Delta as a whole less competitive than other geographies.

Safety and Education Concerns

At all three community workshops, Delta residents emphasized educational and safety factors as reasons for prioritizing broadband. It was expressed that the Delta communities are in particular jeopardy because of inadequate and/or unreliable broadband. As an example, it was reported that the Hood fire department relies on sirens to communicate with volunteer fire fighters because Internet and wireless devices have unreliable connectivity. Workshop attendees in Walnut Grove and Isleton both reported that there have been increasing discussions with the County Sheriff about utilizing more technology to monitor remote areas since there are limited resources from the sheriff's department to monitor or reach these areas directly. But such activities require strong, reliable Internet service.

The community workshops clearly identified resident's priorities around educational broadband needs. In 2014, the California Assessment of Student Performance and Progress (CAASPP) was adopted. This requires students (grades 3-8) to take a computer adaptive test and performance task delivered online. As educational authorities update testing requirements to prepare students for the growing technology usage in the workforce, communities with limited/inadequate broadband services struggle to provide the resources necessary to properly facilitate and support students.

A participant at the Isleton workshop shared that 10% of students in Isleton Elementary School's computer lab commonly lose connection when the lab is full (capacity at 30 students). Additionally, community members throughout the Delta shared common incidences of students and families sitting outside of public libraries to gain access to the Internet for homework or to Skype family members from afar. This gap in access between students who actively use technology in contrast to those who have limited resources to engage with technology (such as the experiences of students in the Delta) is commonly referred to as the Digital Divide. This divide follows other systemic inequalities and reinforces differences in school ratings and related student outcomes, including preparedness for higher education and/or job readiness.

Community Assets and Strengths

In March 2019, the Delta was the first national heritage area (NHA) designated in California. Only 55 NHAs have been designated since 1984 and this designation hosts many opportunities for funding and economic development. *The Economic Impact of National Heritage Areas* provides six case studies that represent the potential revenue, job growth, and partnership opportunities this designation holds for the Delta.

On a local scale, communities in the Delta have proven willingness and ability to come together to drive priorities to action. Issues from youth recreation to preserving and restoring the Delta's waterways have banded Delta towns together for the betterment of their communities. Additionally, young families and businesses are moving into the community that have and can continue to reenergize efforts to improve the quality of life for Delta residents. When residents are passionate about an issue, they will organize. Landing on the message and rationale that will resonate with the appropriate champions is an important first step.

Although the five Delta legacy communities are served by two different counties, Sacramento and Yolo County are both connected to the California Research and Education Network (CalREN) through their public library main branches and county offices of education. CalREN is a high-capacity computer network with more than 8,000 miles of optical fiber operated by CENIC, a nonprofit organization that connects educational and research institutions to broadband. With this network, both counties have access to resources to help educators implement the Common Core and improve teaching and learning. Such connectivity presents potential opportunities for schools in the Delta to further expand their networks to this resource.

RECOMMENDATIONS FOR IMPROVING BROADBAND INFRASTRUCTURE & ACCESS

Findings from the assessment lead to three key recommendations that will have the greatest impact on the Delta communities' ability to secure improved broadband infrastructure. The first priority centers on establishing governance; the second on leveraging existing development opportunities; and the third on pursuing support funding.

Establish Broadband-Focused Leadership

A designated body is needed to drive broadband development among all of the legacy communities. Models such as public private partnerships (P3) and community services districts (CSDs) are able to provide recognized governance authority, access public funding, and create and update policy. These potential models should be considered for improving broadband infrastructure in the Delta.

Figure 2 – Building Partnerships

Four Steps to Building Successful Broadband Partnerships
1. Understanding typical broadband partnership structures
2. Finding the right partners
3. Determining each partner's contribution
4. Developing the partnership framework

Source: The Power of Broadband Partnerships by BroadbandUSA, May 2017

BroadbandUSA published *The Power of Broadband Partnerships* in 2017, which provides a simple breakdown of steps for establishing broadband partnerships (Figure 2). A broadband partnership for the Delta community should be deeply rooted in public interests surrounding educational and safety priorities, while maintaining the flexibility needed to adapt to the fast-paced nature of innovative broadband technology.

Benton Foundation's publication, *The Emerging World of Broadband Public–Private Partnerships: A Business Strategy and Legal Guide,* provides detailed insight on the processes, benefits and risks in establishing P3s (Figure 3). P3s have varying structures of public-private investment and governance. These organizational structures/models are typically differentiated as the following:

- Model 1: Public Facilitation of Private Investment
- Model 2: Public Funding & Private Execution
- Model 3: Shared Investment & Risk/Joint-Ownership

Due to limited resources of local public agencies, large ISP investment, and infrastructure in the Delta, a P3 that follows a joint-ownership model can be mutually beneficial for all participating parties. Joint-ownership models have been utilized for many infrastructure- oriented partnerships and can alleviate time and financial investment burdens on local county governments. Also, P3s incentivize project completion and provide contractual certainty on budgets, schedules, and long-term asset maintenance. In this structure, county governments could serve community institutions – addressing the educational and public safety concerns of Delta residents, and a private/non-profit entity could target services towards residents and businesses.

Figure 3 – Public-Private Partnership Models

Source: Benton Foundation, May 2017

Trade-offs Among Risk, Benefit, and Control in Public–Private Partnership Models

	Model 1	Model 2	Model 3
Risk	Low	High	Moderate
Benefit	Potential but Not Assured	High	High
Control	None	Moderate	Moderate

According to Benton's publication, "joint-ownership broadband partnerships are hybrid arrangements where a locality and private partner find a creative way to share the capital, operating, and maintenance costs of a broadband network." This model is commonly found in metropolitan areas where large ISPs project a high return in investment, however there are rural examples of this model that have been successful through thoughtful public partner planning and research on the front end. Examples of rural joint-ownership partnerships and other P3 models are described in the *Public Private Partnerships Models* section later in this report.

BroadbandUSA also published An Introduction to Effective Public-Private Partnerships for Broadband Investments, which provides a guide to establish P3's with proven practices from successful partnerships that have received federal funding. This publication lists activities that localities should consider early to provide a clear prospectus for private partners, including, but not limited to, identifying committed, community champions and issuing a Request for Information (RFI) to gauge potential partnerships and assess P3 feasibility.

Although Frontier Communications is the only large ISP reported serving all five of the Delta legacy communities, there are other various local ISPs and/or energy/utility-providing companies that serve the community that should be pursued for partnerships. Additionally, partnership with River Delta Unified School District (which serves all five communities) and the county library systems can be beneficial partners to advocate for further CENIC E-rate investment into the community (E-rate funding described later within the report). Public partners should also reflect diverse expertise with representation and support from county supervisors, technology, economic development, land use, transportation, municipal utilities and law enforcement departments. The local broadband consortium, the Connected Capital Area Broadband Consortium – which is funded through the CPUC's Advanced Services Fund to support the development of broadband infrastructure project applications – and the CPUC itself are additional considerations for further funding and advocacy opportunities.

As public pressure for broadband investment persists, key stakeholders need to be identified to mobilize efforts - beginning with committed community partners. The stakeholders can then determine which public and private entities to engage and build prospectuses, accordingly. The community must emphasize cultivating partnerships that diversify competencies and funding resources. Yolo County developed a *Broadband Strategic Plan* in 2015 and may serve as a great public leader in establishing a Delta broadband P3.

If formal entities like P3s are not possible, informal networks could still be advantageous. A core group committed to sustained advocacy can help prompt public sector and service provider action. To achieve this, the group must be active, must be vocal, and must be continuously involved in all channels of communication that may present opportunities.

Whether a formal or informal broadband-focused leadership structure is established, it must work closely with the respective county governments, with economic development and the elected supervisors offices being key points of contact. In particular, for activities in Yolo County, actions should be married to the concepts presented in the Yolo Broadband Strategic Plan referenced above.

Piggyback on All Infrastructure Opportunities

The Delta communities can dovetail broadband efforts onto existing and planned capital improvement projects. Section 14051 of the California Government Code (added through the Statutes of 2016, Chapter 505 from California Assembly Bill 1549) authorizes broadband deployment companies to coordinate conduit installation with the Department of Transportation (Caltrans), requiring Caltrans to report highway projects in advance. This is one of many "Dig Once" policies that aim to minimize the number and scale of excavations when installing telecommunications infrastructure.

Local governments can adopt further Dig Once/Climb Once policies that can support coordinated capital investment projects by calling for broadband fiber or cable (or conduit) to be laid whenever ground is opened or wires hung for other utility or infrastructure purposes. Within California, Santa Cruz and San Benito Counties have implemented ordinances that reinforce these dig/climb once policies. Also, the City of Brentwood, located in the Delta, has had a conduit policy in place since 1999, and has extended conduit to over 8,000 homes and businesses, initially established through new home development installations[1]. This approach may be plausible in Isleton through City policy as development in the area increases and possible in the unincorporated areas through county adoption of such ordinances. Additionally, streamlining permitting processes will accelerate projects, making them more attractive to service providers and others by reducing person-hours and duration of time required to move projects to completion.

Several capital improvement projects are currently in planning or under consideration. These could present rich opportunities for expanding fiber conduit. Examples include:

- Yolo County's *Countywide Transportation Capital Improvement Plan* includes designated roadways (Highway 84/Jefferson Blvd) approaching Clarksburg as a key corridor to upgrade. This presents opportunities for concurrent conduit installation along a major roadway within one of the Delta communities.
- California's Statutes of 2006, Chapter 839 (from Senate Bill 1556) designated the Delta Protection Commission to plan the California Delta Trail, a 1,000- mile trail system along the Delta. As further development on this project continues, conduit installations could be appropriate in some segments.
- Sacramento County has a pending project to allow an existing 82-foot monopole to be used as a permanent cell facility (Oxbow Wireless Communication Facility) for the Delta community.
- Residents shared plans for sewer line development in Hood that county officials should consider for concurrent broadband infrastructure expansion.
- The Sacramento Area Council of Government (SACOG) is responsible for the Metropolitan Transportation Plan / Sustainable Communities Strategy (MTP/SCS). Cities, counties, and public agencies that plan on using federal transportation funding for transportation projects or programs must include those projects in the MTP/SCS project list. In this role, SACOG both holds information on planned transportation infrastructure projects – which could be leveraged for broadband infrastructure co-development – and routinely gathers community input on priorities for development. As of the drafting of this report, SACOG was in the process of updating the MTP/SCS.

[1] Kruse, D. *Policies and Ordinances that Facilitate Broadband Deployment*. NEO Connect.

Taking advantage of dig-once/climb-once opportunities requires committed advocacy and proactive communication. An organization, such as a P3, needs to actively research and monitor capital planning discussions and serve as an advocate to shepherd service providers to take advantage of these opportunities.

Secure Funding/Resources to Plan and Implement Projects

Although Delta residents have expressed the need for improved infrastructure in the past, financial barriers have prevented the community from acting on these issues. Broadband deployment and partnership development will require significant financial investment and labor that the community will need in order to move the needle forward on this issue. To help contextualize the scale of resources needed, BroadbandUSA breaks down broadband network deployment types and estimated infrastructure costs in their summary *Costs at-a-Glance: Fiber and Wireless Networks*.

Federal financial resource considerations are listed below. Federal funding resources were compiled from the newly released (June 2019) federal funding database created by the National Telecommunications & Information Administration (NTIA).

Table 2 – Federal Funding Resources

Program Overview	Program Purpose	Eligible Recipients
E-Rate Program: The Federal Communications Commission (FCC) provides school and library discounts (support dependent on the level of poverty and rural/urban designation, ranging from 20-90% of the costs of eligible services).	- Broadband infrastructure - Public computer access	- Libraries - K-12 schools Note: School districts and libraries may apply individually or as part of a consortium
Small, Rural School Achievement (SRSA) Program: The US Department of Education provides rural educational agencies and schools with financial assistance to fund initiatives aimed at improving student academic achievement.	- Broadband adoption - Digital skills training	- Rural recipients - K-12 schools
BUILD Program: The US Department of Transportation funds multi-modal, multi-jurisdictional infrastructure projects that have a significant local or regional impact.	- Planning - Broadband infrastructure	- State governments - Local and tribal governments - U.S. territories - Transit agencies - Port authorities - MPOs - Other public subdivisions of State or local governments
Healthcare Connect Fund Program: The FCC provides a flat 65% discount on an array of communications services for the provision of health care.	- Broadband infrastructure - Broadband adoption	- Higher education institutions - Hospitals - Non-profit organizations Note: Available to both individual rural health care providers and consortia, which can include non-rural health care providers.

Program Overview	Program Purpose	Eligible Recipients
State Community Development Block Grant: The US Department of Housing and Urban Development (HUD) funds rural cities and counties to improve the lives of their low- and moderate-income residents through the creation and expansion of community and economic development opportunities in support of livable communities.	- Broadband infrastructure	- Non-entitlement cities/counties (i.e. cities and counties that have not received a direct allocation) - Non-federally recognized Native American communities - Colonia as defined by the National Affordable Housing Act of 1990
Rural Economic Development Loan and Grant Program (REDLG): The U.S. Department of Agriculture (USDA) provides funding for rural projects through local utility organizations through grants and loans.	- Broadband infrastructure	- Commercial/Internet Service Providers - Electric Utilities/Co-ops
Community Connect Grant Program: The USDA helps fund broadband deployment in rural communities where it is not yet economically viable for private-sector providers to deliver service. The grants offer financial assistance to eligible service providers that will construct, improve, or expand broadband networks in rural areas.	- Broadband infrastructure - Broadband adoption	- State and local governments - Tribal entities - Commercial/Internet Service Providers - Non-Profit Organizations - Small Businesses
Rural Broadband Access Loan and Loan Guarantee Program (Broadband Program): The USDA furnishes loans and loan guarantees for the costs of construction, improvement, or acquisition of facilities and equipment needed to provide service at a minimum speed (which is set/updated by the USDA).	- Broadband infrastructure	- State and local governments - Tribal entities - Commercial/Internet Service Providers - Non-Profit Organizations - Small Businesses - Electric Utilities/Co-ops
ReConnect: The USDA offers three types of funding options for broadband infrastructure to connect rural families, businesses, farms, ranches, schools, libraries, and public safety facilities to modern, high-speed Internet. A rural area is eligible if it currently does not have sufficient access to broadband.		- State and local governments - Tribal entities - Commercial/Internet Service Providers - Non-Profit Organizations - Small Businesses - Electric Utilities/Co-ops - Financial institutions

Source: https://broadbandusa.ntia.doc.gov/new-fund-search

Additionally, the State of California provides further funding opportunities through CPUC's California Advanced Services Fund (CASF). The CASF provides grants to bridge the "digital divide" in unserved and underserved areas throughout the state. The CASF allocates funding to the following programs to address barriers of broadband access and digital equity.

Broadband Adoption Account provides grants to increase publicly available or after-school broadband access and digital inclusion, such as grants for digital literacy training programs and public education to communities with limited broadband adoption. The CPUC will give preference to programs and projects in communities with demonstrated low broadband access, including low income communities, senior citizen communities, and communities facing socioeconomic barriers to broadband adoption.

Broadband Infrastructure Grant Account provides funding for infrastructure projects that provide last-mile broadband access to households that no facility-based broadband provider offers service at speeds of at least 10Mbps download and 1Mbps upload.

Broadband Public Housing Account is available for network projects to be installed in unserved housing developments, with the term 'unserved' defined as a housing development where at least one housing unit is not offered broadband service. A housing unit is ”not offered broadband Internet service” if the unit does not have access to a commercially available broadband Internet service, such as Digital Subscriber Line (DSL), a cable modem, or another protocol, available at the unit.

Line Extension Pilot Program provides funding to an individual household and/or property owner who qualifies for California LifeLine or CARE Program for an infrastructure grant to offset the costs of connecting a household or property to an existing or proposed facility-based broadband provider.

California Emerging Technology Fund makes investments in programs and projects to improve access, applications, affordability, accessibility and assistance, in order to achieve greater broadband adoption and close the digital divide. CETF's direct investments evolve based on the genesis of the funding.

PUBLIC-PRIVATE PARTNERSHIP MODELS

Below are a list of public-private partnerships and applicable joint-ownership models for the Delta community to consider for rural broadband development. These case studies are drawn from California and other parts of the nation, and offer successful practices and important lessons learned that can be adopted or adapted for use in the Delta.

California Broadband Cooperative, Inc.

California Broadband Cooperative, Inc. (CBC) was a National Telecommunications and Information Administration (NTIA) Broadband Technology Opportunities Program (BTOP) grant recipient in 2010. CBC partnered with the CPUC, California State Office of the Chief Information Officer, Caltrans, Nevada Department of Transportation, Inyo County, Mono County, Kern County, Praxis Associates, Communications Workers of America, and Inyo Networks to build a 553-mile middle-mile network along U.S. Route 395 between northern and southern California. You can learn more about CBC's expansion strategy and BTOP grant project at www.cbccoop.com.

Tehama Colusa Canal Authority, California

The Tehama Colusa Canal Authority partnered with the CSU Chico Geographical Information Center, a private consultant, and the water district members to study and develop practices that would allow broadband infrastructure equipment to be deployed along the canal rights of ways to provide broadband access to remote agriculture lands. The project was funded by the US Department of Agriculture Rural Development program. The entities examined the feasibility and possible fund centers, as well as existing assets that could be used to support the infrastructure. This partnership is shaping a new model for how broadband assets could be developed and deployed by utilities and other special districts.

Anza Electric Cooperative, California

In 2015, the Anza Electric Cooperative, its member-owners, and the residents who receive electricity from the Cooperative chose to add fiber optics and high speed Internet into the scope of the Cooperative. The broadband infrastructure now serves more than 4,000 rural members of the Cooperative. Some of the funding to develop the infrastructure was awarded from the California Advanced Services Fund, While this example is specific to electric cooperative, similar approaches could be used for other existing or to be developed utility cooperatives.

OpenCape Corporation, Massachusetts

OpenCape Corporation was awarded a federal grant from NTIA's Broadband Technology Opportunities Program (BTOP) in 2010 to deploy a 350-mile fiber-optic and microwave broadband network, directly connecting anchor institutions in the Cape Cod region to 100 Mbps speeds. OpenCape Corporation is a 501(c)(3) non-profit organization that partnered with Barnstable County, Massachusetts Broadband Institute, RCN Metro Optical Networks, and Woods Hole Oceanographic Institution to receive the BTOP grant. You can learn more about OpenCape Corporation's history and network development at https://www2.ntia.doc.gov/grantees/opencape.

The Emerging World of Broadband Public–Private Partnerships: A Business Strategy and Legal Guide also provides two case studies of successful rural joint-ownership partnerships, which are discussed below.

Garrett County, Maryland

Garrett County, Maryland has partnered with Declaration Networks Group (DNG) and Microsoft to provide broadband to residents and businesses. The County conducted a feasibility study prior to developing private partners to determine the best technology to address the needs of their rural community - fixed wireless technology (TV white space and unlicensed spectrum) were identified. *The Economic Significance of License-Exempt Spectrum to the Future of the Internet* details the economic potential of license-exempt radio spectrum. Additionally, the feasibility study determined six target unserved and underserved areas that the County prioritized broadband efforts in within a three-phase plan. You can read more about Garrett County's broadband expansion efforts at https://www.garrettcounty.org/broadband/press.

Swift County, Minnesota

Swift County, Minnesota partnered with Federated Telephone Cooperative and Minnesota's Office of Broadband to deploy a broadband network throughout the county. Federated Telephone Cooperative was able to receive a grant from the state in 2015 and the County supplemented costs through a bond. You can learn about the cost sharing of the projects at https://www.benton.org/sites/default/files/partnerships.pdf.

Table 3 – Key Takeaways from Public-Private Partnership Models

Model	Lessons Learned
CA Broadband Cooperative, Inc.	• Partnered with private ISPs to plan, build, manage, and operate network
Anza Electric Cooperative	• Mobilized a vote of the members to assess interest and level of commitment • Secured funding through multiple sources, including public sources, private sources, and reserves • Deliberate process for prioritizing and sequencing roll out of fiber infrastructure to homes within the service area
Tehama Colusa Canal Authority	• Partnership of canal authority, water districts, university GIS mapping department, and consultant to design and conduct assessment • Pre-established audience of interested stakeholders wanting to make use of service

Model	Lessons Learned
Open Cape Corporation, MA	• Developed a business & engineering plan with stakeholders • Partnered with a middle mile builder and operator • Partnered with an anchor institution for grant support
Garrett County, MD	• Contracted with a business & engineering consultant • Partnered with a private ISP and a large tech company • County funds matched with grants encourage private investment
Swift County, MN	• Partnered with private company to deploy broadband • Issued and sold County bond • County loan supplemented local telecom coop grant

CONCLUSION

As technological advancement persists, dependence on high-speed Internet access/broadband is crucial to the economic sustainability and competitiveness of communities, both locally and globally. Delta communities and stakeholders must prioritize and advocate for digital equity to ensure that these important legacy communities continue to thrive.

As described in this action plan, there are models to follow and resources to pursue to help improve the status of broadband for households, businesses, and others in the Delta. The recommendations presented in this action plan for achieving improved broadband are straightforward: (1) organize for action; (2) leverage existing opportunities; and (3) pursue and secure funding. The first of these recommendations cannot be emphasized enough. Because infrastructure development is such a time and resource intensive process, there must be champions from within the community who are committed to driving the research and advocacy that will be required. At the same time, the champions must know that they do not have to charge forward alone. Advisors and technical assistance can be found through local sources such as the Connected Capital Area Broadband Consortium (https://valleyvision.org/projects/connected-capital-area-broadband-consortium/).

GLOSSARY

Anchor institutions
Flagship community institutions, including but not limited to: schools, health care centers, and libraries. Anchor institutions are sometimes connected to fiber even when fiber service is not commercially available in the community. Because of this, they can act as a connection to the Internet backbone.

Bandwidth
The rate at which the network can transmit information across it. Generally, higher bandwidth is desirable. The amount of bandwidth available to you can determine whether you download a photo in 2 seconds or 2 minutes.

Broadband Consortia
Representatives of organizations including, but not limited to, local and regional government, public safety, elementary and secondary education, health care, libraries, postsecondary education, and community-based organizations, who facilitate the deployment of broadband services by assisting infrastructure grant applicants in the project development or grant application process under the California Advanced Services Fund.

Conduit
A reinforced tube through which cabling runs. Conduit is useful both to protect fiber-optic cables in the ground and because one can place the conduit underground when convenient and later "blow" or "pull" the fiber cabling through the conduit.

Cooperative (co-op)
A non-profit, member-owned organization that provides a needed service. Members pay a small fee to join and have voting rights within the organization.

Digital equity
The state of all members of a community having equal access and sufficient digital literacy to use communications technologies.

DSL
Digital Subscriber Line - or Internet access offered over the phone lines. DSL allows users to use the Internet at speeds greater than dial-up while also using the phone line for telephone conversations. DSL uses frequencies not used by human voices. Unfortunately, these frequencies degrade quickly over distance, meaning customers must live within a mile of the central office to get the fastest speeds.

Fixed wireless
A connectivity model that uses stationary wireless technology to bridge the “last mile” between the Internet backbone and the subscriber.

Middle mile
Middle mile is a term most often referring to the network connection between the last mile and greater Internet. For instance, in a rural area, the middle mile would likely connect the town's network to a larger metropolitan area where it interconnects with major carriers.

PPP
A public-private partnership divides risks and responsibilities of an infrastructure project between public and private entities.

REFERENCES

2013-2017 ACS 5-year Estimates. (2018, November 28). [Dataset]. Retrieved June 24, 2019, from https://www.census.gov/programs-surveys/acs/technical-documentation/table-and-geography-changes/2017/5-year.html

2018 Broadband Deployment Report. (2018, February 5). Retrieved June 24, 2019, from https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2018-broadband-deployment-report

About 2016 CAASPP - CAASPP Reporting (CA Dept of Education). (n.d.). Retrieved June 24, 2019, from https://caaspp.cde.ca.gov/sb2016/AboutCAASPP

American Legal Publishing - Online Library. (n.d.). Retrieved June 24, 2019, from http://library.amlegal.com/nxt/gateway.dll/California/sanbenitocounty_ca/sanbenitocountycaliforniacodeofordinance?f=templates$fn=default.htm$3.0$vid=amlegal:sanbenitocounty_ca

BroadbandUSA. (2017). *The Power of Broadband Partnership: A Toolkit for Local and Tribal Governments*. Retrieved from https://broadbandusa.ntia.doc.gov/sites/default/files/resource-files/bbusa_power_broadband_partnerships.pdf

BroadbandUSA. (2010, August). BTOP California Broadband Cooperative, Inc. Fact Sheet. Retrieved June 24, 2019, from https://www2.ntia.doc.gov/files/grantees/ca_broadband_coop.pdf

BroadbandUSA. (2015). *An introduction to effective public-private partnerships for broadband investments*. Retrieved from https://broadbandusa.ntia.doc.gov/sites/default/files/resource-files/bbusa_effective_public_private_partnerships.pdf

California Broadband Cooperative. (n.d.). Retrieved June 24, 2019, from http://www.cbccoop.com/

Carpenter, E. (2018). *Case for Support: The Foundational Research Basis for the School2Home Program Design, Recent Findings and Current Policies that Support Action*. Retrieved from https://d3n8a8pro7vhmx.cloudfront.net/cetf/pages/149/attachments/original/1519087809/CaseForSupport.pdf?1519087809

CENIC. (n.d.). About CENIC. Retrieved June 24, 2019, from https://cenic.org/about/about-overview

Chapter 12.25 Telecommunications Infrastructure Improvement Ordinance. (n.d.). Retrieved June 24, 2019, from https://www.codepublishing.com/CA/SantaCruzCounty/html/SantaCruzCounty12/SantaCruzCounty1225.html

The City of Brentwood. (2013). *Advanced Technology Master Plan*. Retrieved from https://www.brentwoodca.gov/civicax/filebank/blobdload.aspx?BlobID=35187

County of Sacramento: Office of Planning and Environmental Review. (2014). *General Plan: Delta Protection Element*. Retrieved from http://www.per.saccounty.net/LandUseRegulationDocuments/Documents/General-Plan/Delta%20Protection%20Element%20Amended%20-%2009-26-17.pdf

FCC Fixed Broadband Deployment. (n.d.). [Dataset]. Retrieved June 24, 2019, from https://broadbandmap.fcc.gov/

The Field Poll. (2016). *Internet Connectivity and the "Digital Divide" in California Households: 2016.* Retrieved from http://www.cetfund.org/files/CETF_Annual_Survey_Digital_Divide_2016.pdf

Glossary. (n.d.). Retrieved July 31, 2019, from https://muninetworks.org/glossary

Hovis, J., Schulhof, M., Baller, J., & Stelfox, A. (2017). *The Emerging World of Broadband Public–Private Partnerships: A Business Strategy and Legal Guide*. Retrieved from https://www.benton.org/sites/default/files/partnerships.pdf

Magellan Advisors, LLC. (2015). *Yolo Broadband Strategic Plan*. Retrieved from https://www.yolocounty.org/home/showdocument?id=29078

Minges, M. (2015). *Exploring the Relationship Between Broadband and Economic Growth: Background Paper prepared for the World Development Report 2016.* Retrieved from http://pubdocs.worldbank.org/en/391452529895999/WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

OpenCape. (n.d.). The Vision Becomes Reality. Retrieved June 24, 2019, from https://opencape.org/uploads/History-REVISED-4.2017.pdf

OpenCape Corporation | BroadbandUSA - NTIA. (n.d.). Retrieved June 24, 2019, from https://www2.ntia.doc.gov/grantees/opencape

Parker, K., Horowitz, J. M., Brown, A., Fry, R., Cohn, D., & Igielnik, R. (2018). *What Unites and Divides Urban, Suburban and Rural Communities: Amid widening gaps in politics and demographics, Americans in urban, suburban and rural areas share many aspects of community life.* Retrieved from https://www.pewsocialtrends.org/2018/05/22/what-unites-and-divides-urban-suburban-and-rural-communities/

Press - Broadband. (n.d.). [Press releases]. Retrieved June 24, 2019, from https://www.garrettcounty.org/broadband/press

Sacramento County. (n.d.). Planning Projects Viewer [Dataset]. Retrieved June 24, 2019, from https://planningdocuments.saccounty.net/

Thanki, R. (2012). *The Economic Significance of Licence-Exempt Spectrum to the Future of the Internet*. Retrieved from https://www.microsoft.com/en-us/research/uploads/prod/2016/02/spectrum-economic-significance-of-license-exempt-spectrum-report_thanki.pdf

Tripp Umbach. (2015). *The Economic Impact of National Heritage Areas: A Case Study Analysis of Six National Heritage Areas in the Northeast and Midwest Regions*. Retrieved from https://www.nps.gov/subjects/heritageareas/upload/The-Economic-Impact-of-National-Heritage-Areas_Six-Case-Studies-2015-1.pdf

U.S. National Park Service. (n.d.). What is a National Heritage Area? Retrieved June 24, 2019, from https://www.nps.gov/articles/what-is-a-national-heritage-area.htm

Yolo County Transportation District. (2018). *Countywide Transportation Capital Improvement Plan*. Retrieved from http://yoloagenda.yolocounty.org:8085/docs/2018/BOS/20180206_1893/6934_CTCIP%20Report%20V14r.pdf