Subject:	**SCADA/Communications Routing and Basic Design Approach – Bethany Reservoir Alternative (Final Draft)**
Project feature:	Projectwide
Prepared for:	California Department of Water Resources (DWR) / Delta Conveyance Office (DCO)
Prepared by:	Delta Conveyance Design and Construction Authority (DCA)
Copies to:	Files
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Reference no.:	EDM_PW_CE_TMO_SCADA-Coms-Des-Approach-Bethany_001002

1. Introduction

This technical memorandum (TM) describes the communication routes for the supervisory control and data acquisition (SCADA) system serving the Bethany Reservoir Alternative for the Delta Conveyance Project (Project). The communications network connects major operations centers and remote data sites that require high-speed, reliable data communications throughout construction and long-term operations. This TM establishes a network architecture and identifies potential routes for each fiber optic connection, using existing telecommunications routes and planned road modifications as much as possible. The purpose of this TM is to identify potential media routes with the minimum environmental footprint for the Bethany Reservoir Alternative, which includes the Eastern corridor north of Lower Roberts Island shaft.

This TM builds on the information presented in the SCADA/Communications Route Design Approach (Revised Final Draft) TM for the Central and Eastern Corridors (DCA, 2021). Refer to that TM for additional information.

1.1 Document Organization

This TM contains the following sections:

- Network Sites
- Network Route Design
- References
- Document History and Quality Assurance

2. Network Sites

The data communications network connects three operations centers, as shown in the Communication Diagram in Attachment 1. The operations centers are the Project Operations Center (POC), Delta Field Division Area Control Center (DACC), and the Bethany Reservoir Pumping Plant. In addition, the communications network monitors and controls the intakes and the Delta-Mendota Canal facilities

(7,500 cfs project design capacity only, not include on Attachment 1) and monitors up to four remote data sites with instrumentation for level, flow, or intrusion indicators.

- **POC:** The POC is the central operations control for the State Water Project, remotely monitoring 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 on the operations and maintenance campus 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 Bethany Reservoir Pumping Plant. It would also require reliable and responsive access to the project SCADA system.
- **Bethany Reservoir Pumping Plant:** This operations center would operate the entire project facilities, including the intakes, tunnel shafts, Bethany Reservoir Pumping Plant (BRPP), and Bethany Reservoir Discharge Structure. 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 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 BRPP) through the backbone network. Internet access would be required during construction.
- **Delta-Mendota Canal (DMC) Facilities:** For the 7,500 cfs project design capacity option only, the DMC facilities would be monitored by the Project communications system, but controlled by the CVP 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 Bethany Reservoir Pumping Plant. The CVP would control the DMC Control Structure. A Project PLC located at the electrical/control building at the DMC discharge site would communicate with a CVP PLC at that location (configuration not defined at this time) and also send signals to the Project's Master PLC through the Project network, which would be separate and independent from the CVP network. The CVP PLC at that location would send signals to the Jones Pumping Plant control system (configuration not defined at this time) through a separate and independent CVP network.
- **Remote data sites:** The remote monitoring of level, flow, or intrusion data points at three tunnel shaft locations (Twin Cities, Lower Roberts, and Terminous), plus monitoring and control at the Bethany Reservoir Discharge Structure would be anticipated. Internet access would be required at launch shafts during construction.

3. Network Route Design

Each operations center, intake, 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 input 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 10-GB 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 Bethany Reservoir Pumping Plant operations centers would be a fiberoptic cable installed in dedicated conduits along future and existing road rights-of-way. Some redundancy would be achieved by using multiple fiberoptic pairs or multiple cables, but the path remains singular over approximately 4 miles.
    - **Link 3:** The link between the BRPP 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 4 miles between the BRPP and the leased router in Mountain House.
    - **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 route selected is the most direct and would be installed in the existing DMC acces road and would have minimal impacts. The path would have a length of approximately 1 mile.

- **Mission-supportive Remote Data Sites**
  - **SCADA Data:** Remote data points with surface water elevations and 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 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 in accessible locations. 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 or in a common trench (UGT). Attachment 2 includes GIS-based maps that show the proposed fiberoptic routes using each installation approach, including;

- **Bethany Reservoir Alternative 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 Eastern corridor. Proposed route segments are color-coded by installation method.

The Attachment 2 maps show potential fiberoptic routes to establish the network backbone and SCADA connections to all applicable facilities, including certain remote sites.

3.3 Cost Estimating Guidance

Refer to the SCADA/Communications Route Design Approach (Revised Final Draft) TM for the Central and Eastern Corridors (DCA, 2021) for Cost Estimating Guidance.

3.4 Network Route Groups

For identification purposes, the physical network fiber routes are organized into three groups (Table 1).

Table 1. Physical Fiber Route Groups

ID	Start Point	End Point	ID	Start Point	End Point
Backbone			***Eastern Corridor Remote Sites***		
B01	Bethany Reservoir Pumping Plant (Link 2)	DACC	E01	B03, Lambert Road	Twin Cities Shaft

Table 1. Physical Fiber Route Groups

ID	Start Point	End Point	ID	Start Point	End Point
B02	Bethany Reservoir Pumping Plant (Link 3)	Mountain House Router	E04	Lodi Router	Terminous Shaft
B03	C-E-3 (Link 3)[2]	Eschinger Road Router	E06	R&R Island Router	Lower Roberts Island
B04	C-E-3 (Link 4)[2]	Freeport Router			
B05	DMC Control Structure (Link 5)	Jones Pumping Plant			
Facilities					
F01	C-E-2	B04, Access Road (included for 7,500 cfs option only)			
F02	C-E-5	B03, Access Road			
F03	Bethany Reservoir Pumping Plant	Bethany Reservoir Discharge Structure[1]			
F04[1]	Bethany Reservoir Pumping Plant	DMC Control Structure Electrical/Control Building			

Notes:

[1] The Bethany Reservoir Discharge Structure would have a supplemental connection to the DACC since an existing fiberoptics cable originating at the DACC traverses the site of the structure and data from that structure would also be communicated into the system via a connection to the existing cable.

[2] For 3,000 cfs project 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 project design 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.

Note that it was established in the SCADA/Communications Route Design Approach TM for the Central and Eastern Corridors (DCA, 2021) that no maintenance shafts require long-term SCADA connectivity, so they are not included in the Network Route Groups Shown in Table 1.

3.4.1 Backbone Group

The Backbone Group of network routes would connect the intakes and Bethany Reservoir Pumping Plant operations centers to each other, and the POC and DACC operations centers through leased lines. Link 2 (Bethany Reservoir Pumping Plant 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. The Backbone Group assumes 24 fiber pairs for all routes.

Segments B03, B04, and B05 are identical to those previously presented (DCA, 2021) and are not described in detail here.

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

Conceptual Routes for Segments B01 and B02 were developed as follows:

- B01: The route follows west from the BRPP to Mountain Road to Kelso Road, then west along Kelso Road to the DACC on the campus of DWR's existing Harvey O. Banks Pumping Plant. No other reasonable route choices are available because it follows the shortest and most direct public roads to the DACC.
- B02: The route follows Project roads to Kelso Road, then east along Kelso Road to Great Valley Parkway on the west side of the Mountain House development. The it goes south on Great Valley to West Hargrove Avenue, east on West Hargrove, and south on S Jacobs Driver to its termination point at the Mountain House Router. No other reasonable route choices are available because it follows the shortest and most direct public roads to the router location.

Table 2 shows relative cost estimates for the Backbone Group fiber routes.

Table 2. 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	0	.12	2.69			2.81	$ 45,000	$ 197,000	$ 242,000
B02		.29	3.60	1.58		3.89	$ 62,000	$ 272,000	$ 334,000
B03[1]		3.43		7.7	.17	11.3 (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	.12	11.41 (10.95[1])	$ 183,000 ($175,000[1])	$ 823,000 ($791,000[1])	$ 1,006,000 ($966,000[1])
B05[2]			.88			.88[2]	$14,000	$62,000	$76,000
						29.41[3] (30.29[2]) (28.49[1])			**$2,902,000[3] ($2,978,000[2]) ($2,822,000[1])**

Notes:

[1] For 3,000 cfs project 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 project design 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 project design capacity only

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

All five Backbone Group surface routes are included in the design for the Bethany Reservoir Alternative SCADA configuration, depending on the project design capacity option. Attachment 2 shows the Backbone Group OH and UG segments.

3.4.2 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. F01 and F02 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. F03 would be a single six fiber pair cable. It would be backed up by connecting the system to an existing DWR c=fiberoptic cable in the roadway crossing the Bethany Reservoir Outlet Structure.

F01 and F02 routes are short direct connections to the Backbone routes passing the respective sites, therefore they are all the only reasonable routes. F03 follows the Project's Bethany Reservoir Aqueduct and would be installed as part of that effort, therefore it is the only reasonable route.

F04 route follows the proposed DMC connection aqueduct and would not result in additional impacts.

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

Table 3. 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					2.51	2.51	$ 15,000	$ 0[2]	$15,000[2]
F04[1]					0.67	0.67[1]	$3,000	$0[2]	$3,000[1,2]
						5.07 (6.32[1])			**$209,000 ($256,000[1,2])**

Notes:

[1] 7,500 cfs project design capacity option only

[2] F03 and F04 installation cost assumed to be part of Aqueduct installation cost

All four Facilities Group routes are included in the design for the Bethany Reservoir Alternative SCADA configuration. Attachment 2 shows the Facilities Group OH and UG segments.

3.4.3 Eastern Corridor Group

The Eastern corridor group of network routes would connect the Twin Cities Shaft (E01), the Terminous Shaft (E04), and Lower Roberts Island Shaft (E06) to the Bethany Reservoir Pumping Plant operations center via leased lines. The analysis assumes six fiber pairs are needed for each remote data point. Each route would require new fiberoptic cables from the shafts to the nearest leased line router.

The routes for the Eastern Corridor Group were developed in the Central and Eastern Corridor TM (DCA, 2021) and are identical. This group is included for all project design capacity options.

Table 4 provides relative cost estimates for the Eastern Corridor Group.

Table 4. 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	.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 2 shows the Eastern corridor OH and UG segments.

3.4.4 Bethany Reservoir Alternative Fiberoptic Route Summary

The potential media routes with the minimum environmental footprint for the Bethany Reservoir Alternative, which includes portions of the Eastern corridor, establishes the network backbone and SCADA connections to all operations centers, facilities, and selected remote sites. This includes 49.78 to 52.83 miles of new fiberoptic cable, with a total relative cost of $4,479,000 to $4,682,000, depending on project design capacity option.

4. References

Delta Conveyance Design and Construction Authority (DCA). 2021. SCADA/Communications Routing and Basic Design Approach – Central and Eastern Corridors. Final Draft.

5. 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.

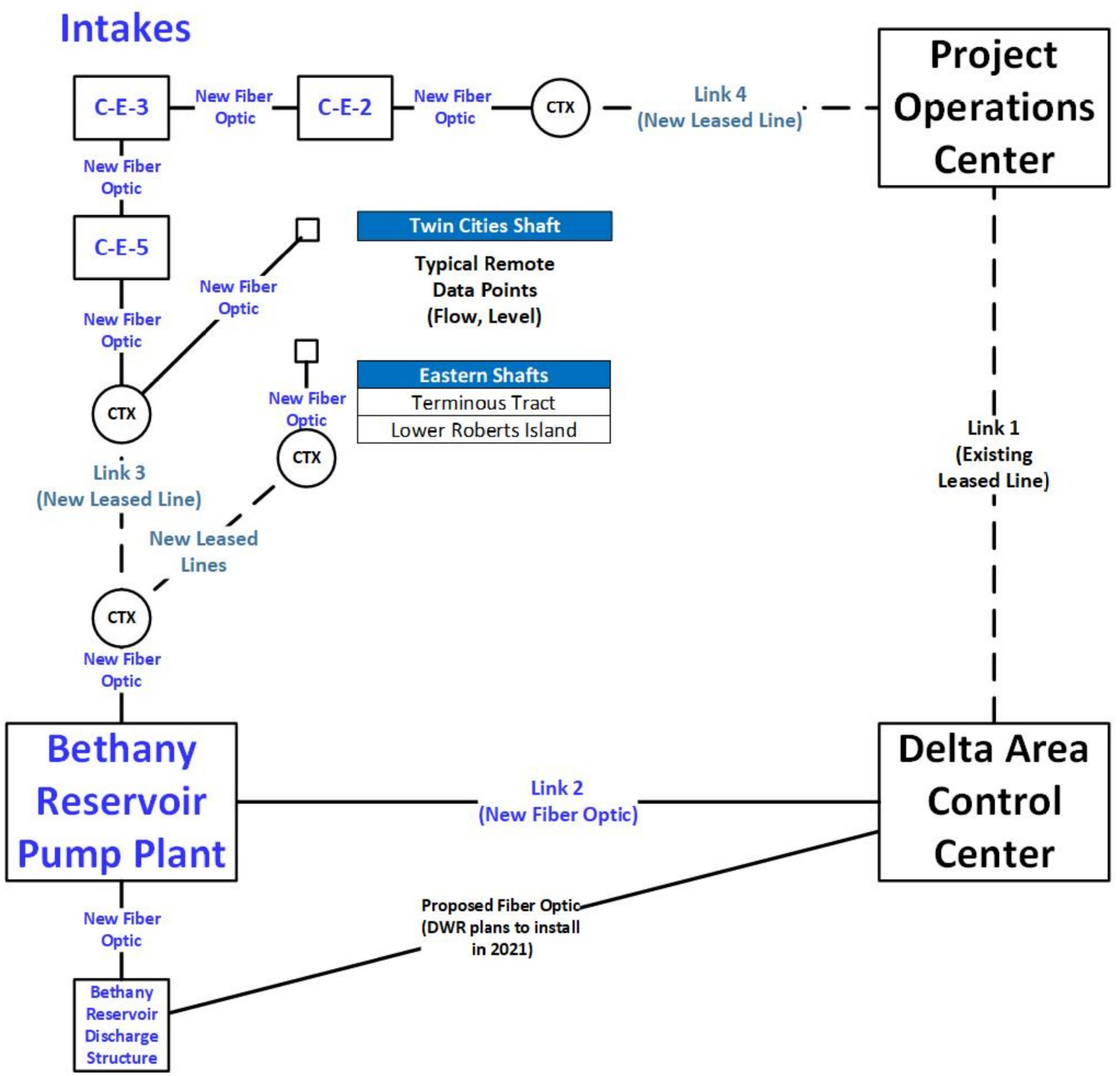
Approval Names and Roles			
Prepared by	**Internal Quality Control review by**	**Consistency review by**	**Approved for submission by**
Michael Johnson / EDM SCADA Engineer	Jim Landman / EDM QC Reviewer	Gwen Buchholz / DCA Environmental Liaison Phil Ryan / EDM Design Manager	Terry Krause / EDM Project Manager
Michael Johnson / EDM SCADA Engineer	Jim Landman / EDM QC Reviewer	Gwen Buchholz / DCA Environmental Consultant Phil Ryan / EDM Design Manager	Terry Krause / EDM Project Manager

Approval Names and Roles			
Prepared by	**Internal Quality Control review by**	**Consistency review by**	**Approved for submission by**
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

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



GENERAL

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REV	DATE	DESCRIPTION	SUB.	APP'D
	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 - BETHANY RESERVOIR ALTERNATIVE

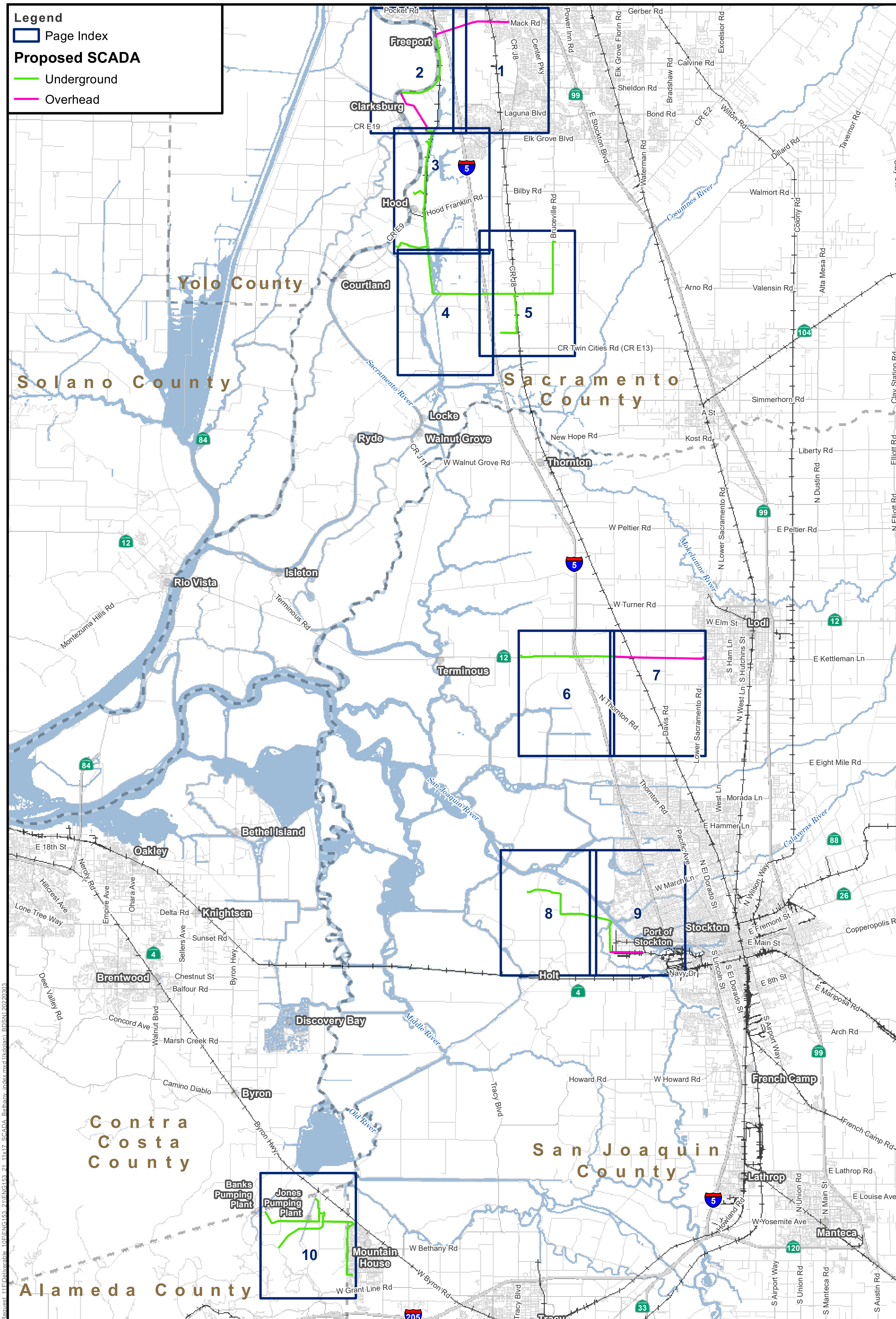
COMMUNICATION DIAGRAM

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

STB-E-0030GN_W8X97000.dgn

PLOT DATE:11/17/2021 PLOT TIME:2:41:44 PM

Attachment 2
Bethany Reservoir Alternative Route Maps



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0 3.5 Miles

Key Map
Bethany SCADA
03/04/2022

Data Source: DCA, DWR

Legend

Page Index

Connection to Existing Router

SCADA Proposed Fiber Routes

Proposed Overhead SCADA

New Line on Existing Poles

Permanent Subsurface Impact

Permanent Surface Impact

Temporary Surface Impact

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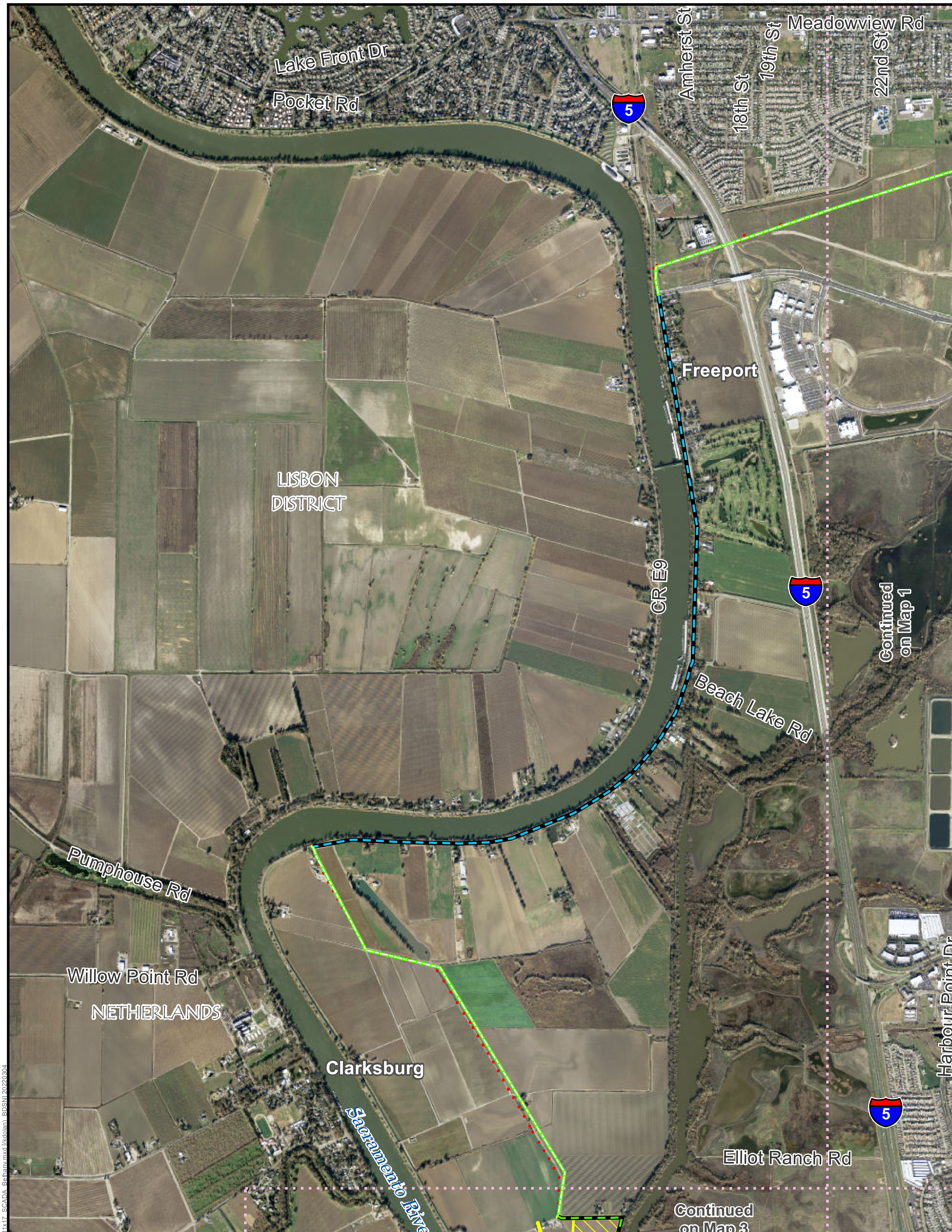
Map 1
SCADA - Bethany Option
03/04/2022

Data Source: DCA, DWR



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Page Index

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 - Bethany Option
03/04/2022

Data Source: DCA, DWR

Legend

- Page Index

SCADA Proposed Fiber Routes

Proposed Underground SCADA

- Within Existing Roadway
- Within Proposed Roadway Improvements

Proposed Overhead SCADA

- New Line on Existing Poles
- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

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Map 3
SCADA - Bethany Option
03/04/2022

Data Source: DCA, DWR

Legend

Page Index

SCADA Proposed Fiber Routes

Proposed Underground SCADA

Within Proposed Roadway Improvements

Trenchless Installation

Permanent Subsurface Impact

Permanent Surface Impact

Temporary Surface Impact

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Map 4
SCADA - Bethany Option
03/04/2022

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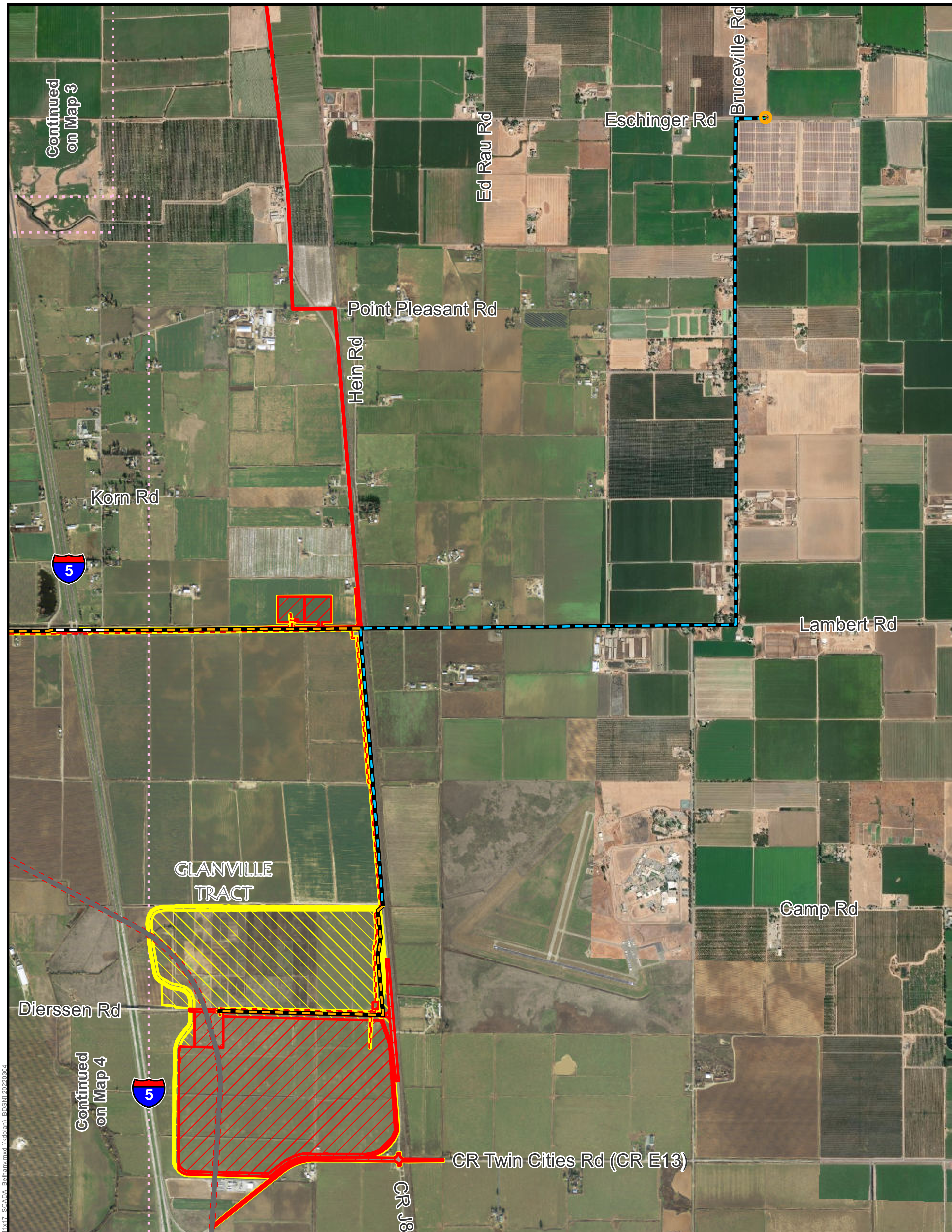

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Page Index
Connection to Existing Router

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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Map 5
SCADA - Bethany Option
03/04/2022

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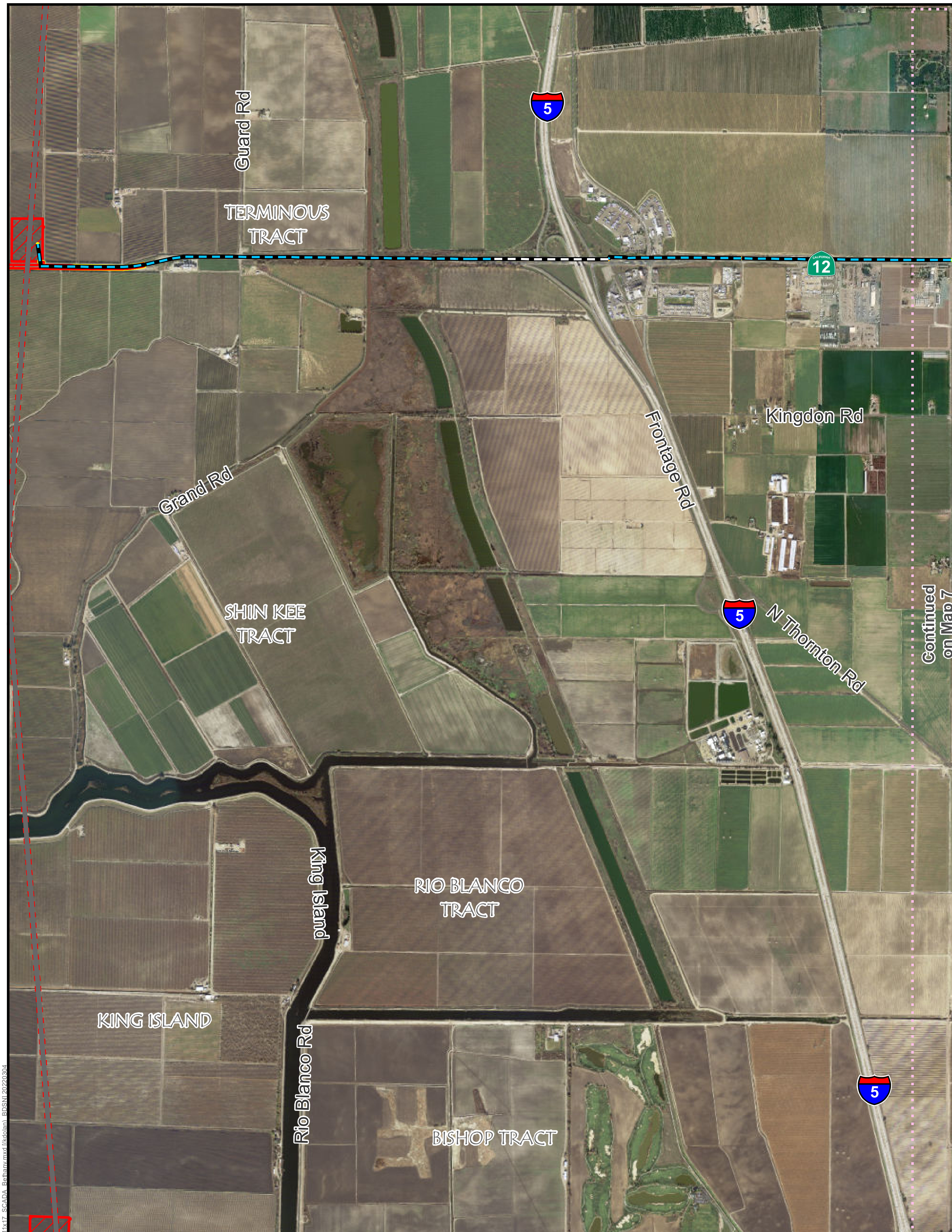

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- Page Index

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

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Map 6
SCADA - Bethany Option
03/04/2022

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Data Source: DCA, DWR

Legend

- Page Index
- Connection to Existing Router

SCADA Proposed Fiber Routes

Proposed Underground SCADA

- Outside Roadway

Proposed Overhead SCADA

- New Line on Existing Poles

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

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Map 7
SCADA - Bethany Option
03/04/2022

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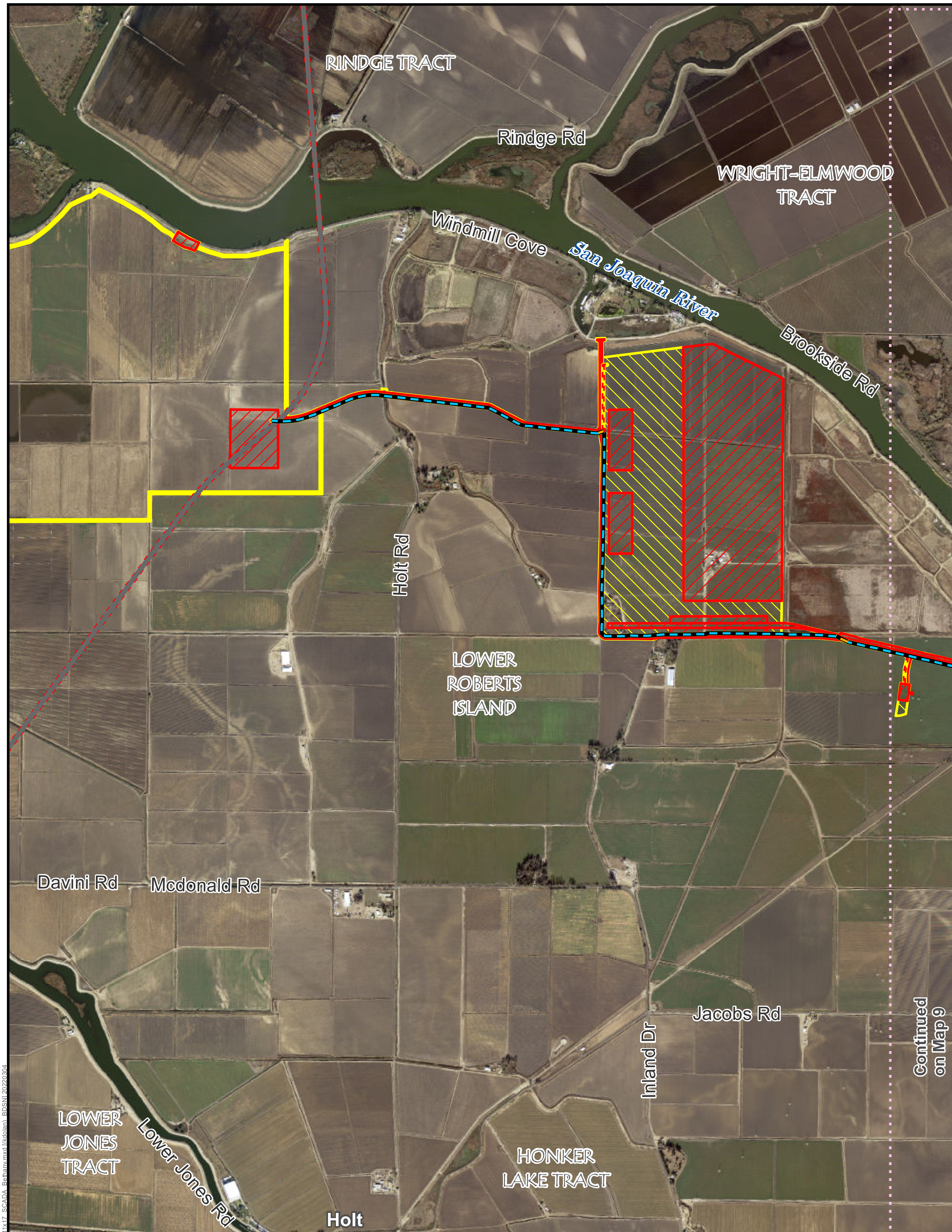

Continued on Map 9

Legend

- Page Index
- **SCADA Proposed Fiber Routes**
- **Proposed Underground SCADA**
- Within Proposed Roadway Improvements
- Outside Roadway
- Permanent Subsurface Impact
- Permanent Surface Impact
- Temporary Surface Impact

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Map 8
SCADA - Bethany Option
03/04/2022

Data Source: DCA, DWR

Legend

Page Index
Connection to Existing Router

SCADA Proposed Fiber Routes

Proposed Underground SCADA

Within Proposed Roadway Improvements
Outside Roadway

Proposed Overhead SCADA

New Line on Existing Poles

Permanent Subsurface Impact
Permanent Surface Impact
Temporary Surface Impact

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Map 9
SCADA - Bethany Option
03/04/2022

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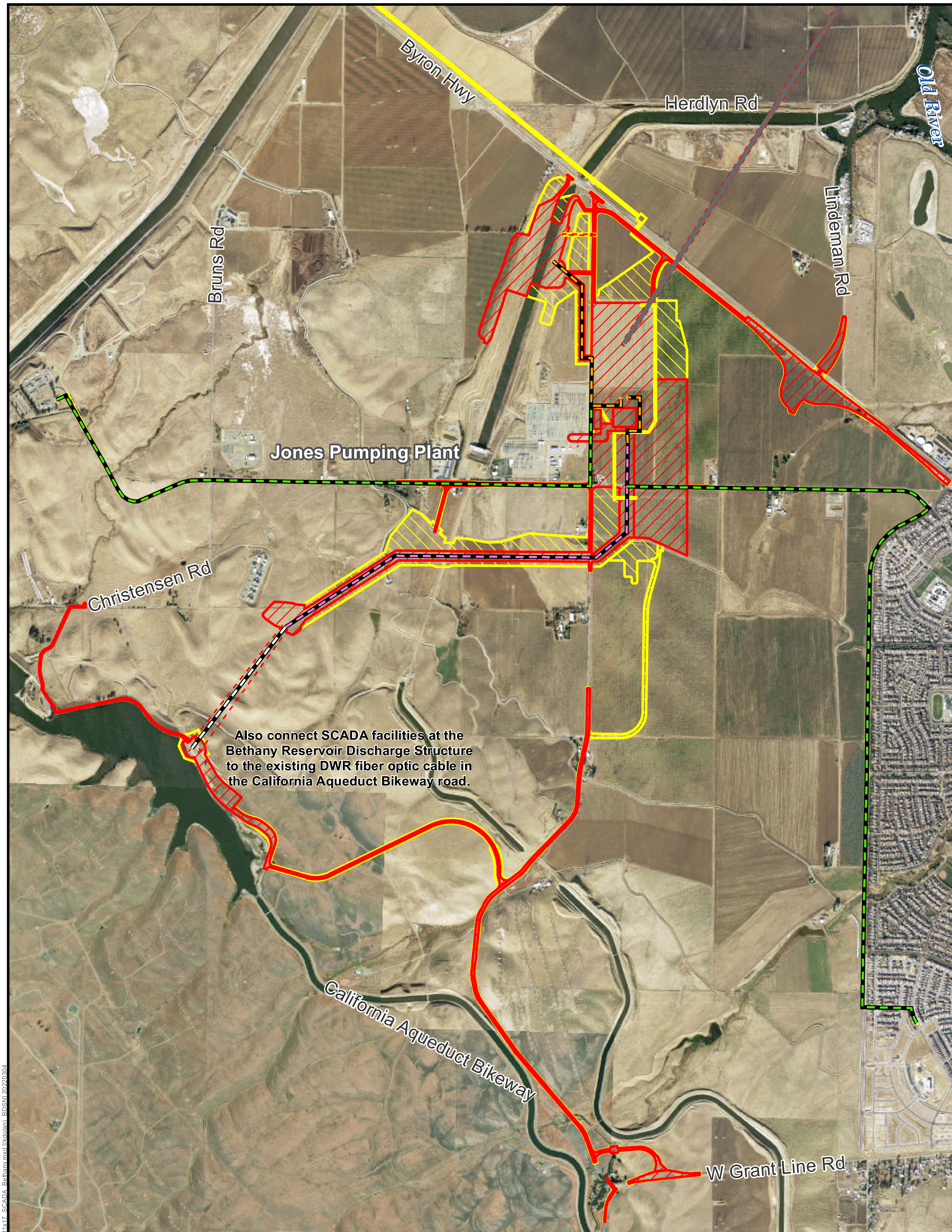

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Page Index

SCADA Proposed Fiber Routes

Proposed Underground SCADA

- Within Existing Roadway
- Within Proposed Roadway Improvements
- Common Trench with Aqueduct
- Trenchless Installation

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 10
SCADA - Bethany Option
03/04/2022

Data Source: DCA, DWR