Electrical Systems Design Manual

Division of Traffic Operations, First Edition (July 2020)

Acknowledgments

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Introduction

This manual describes typical practices for designing new or modified electrical systems for all projects. This manual is a supplement to the *California Manual on Uniform Traffic Control Devices* (*CA MUTCD*), *Ramp Metering Design Manual*, Standard Plans, Standard Specifications, Standard Special Provisions, *Plans Preparation Manual*, Transportation Electrical Equipment Specifications (TEES), and other current related Caltrans policies and directives.

In this manual, the electrical designer shall be referred to as the designer.

Deviations are allowed based on informed and documented engineering decisions. The designer should contact the project engineer to determine whether there are any special requirements for a project. Justifications for deviations shall be documented and a copy shall be kept in the project history file and resident engineer (RE) pending file.

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Chapter 1 – General

Section 1.1 – General

The designer shall place electrical equipment in accordance with the Clear Recovery Zone (CRZ) requirements contained in the Caltrans *Highway Design Manual*. Electrical equipment should be, in order of preference, placed outside the CRZ, or protected, preferably behind a guardrail or barrier.

The designer shall coordinate with the project engineer for placing electrical systems needed in areas outside of the State right-of-way, especially service points, advanced detection at signalized intersections, census loops, etc. Any project-related agreement shall be documented and placed in the resident engineer RE pending file.

When designing, modifying, or removing an electrical system, the designer shall:

- Search as-builts (if present) and GIS digital files (if present), and conduct a field visit to verify the locations of existing electrical systems equipment within the project limits.
- Communicate with the project engineer on the scope of work and consider the impact on electrical systems when preparing the design. For example, during the project design phase, the roadway design may change before ready-to-list (RTL). It is important that the designer regularly communicates with the project engineer to ensure the final geometric design is used for placing the electrical systems.
- Coordinate with district transportation management center (TMC) support staff to determine if existing field elements need to be updated, or if new field elements and communication equipment are needed. The final design of TMC field elements shall be agreed to by district TMC support staff before RTL.

A lack of coordination or planning with other functional units may lead to costly change orders and deplete project funding.

The designer must recommend adjusting the number of working days when considering the lead time for the contractor to order electrical equipment.

The designer should design for the load requirements of field elements.

Specifications for electrical work are mainly covered in section 86 and section 87 of the Standard Specifications. The following sections apply to performing electrical work: Sections 1, 5, 6, 9, 10, 12, 15, 19, 20, 48, 56, 74, 75, 77 (if electrical work is with local agencies), 78, 91, 94, and 95.

The designer should communicate to the project engineer that a Geotech report may need to be submitted to Division of Engineering Services, Office of Structure Design for foundation design.

The designer should ensure mapping of electrical equipment in a GIS map is required.

Poles, posts, standards, and sign structures that are not covered by the Standard Plans will require extra planning and a special design.

The special design shall be initiated by a request to Special Design Branch under the Office of Design and Technical Services under the Division of Engineering Services.

Section 1.2 – Plan Sheets

The plan sheets shall be according to the *Plans Preparation Manual*, “Chapter 2 – Project Plans.”

The designer is to coordinate with the PE to ensure proper design is included for all structures within the project limits.

The material in the electrical design shall be detailed on the quantity sheet to encompass the Bid Item cost estimate. The total cost shall be adjusted by the amount of the profit margin depending upon geographic area and recent bid results. Keep a copy of the designer’s estimate (See Appendix A) showing material and labor in the project file and provide a copy to the resident engineer (RE) pending file.

Deviations from the Standard Plans shall be shown on the project plans.

Section 1.3 – Staging Plans

Staging plans are used to show sequencing of work from one stage to another to maintain continuous and reliable operation of existing electrical elements. The designer shall ensure that all existing electrical elements are shown in these plans.

Section 1.4 – Conduit

There are five types of conduits defined in the specifications. The following are typical applications:

- Type 1 is used on structures and may be used for foundations, buildings, and underground facilities where the soil is not alkaline.
- Type 2 is used in close proximity to gas stations and is also used where Type 1 is used, but for areas where corrosion is an issue.
- Type 3 is used in underground facilities, and where corrosion is an issue. It may be used in foundations. Do not use Type 3 on structures.
- Type 4 is used for transitions where flexibility is required.
- Type 5 is used for panel connections for indoor applications.

Determine the proper size of conduit by calculating the number of conductors and cables to be used inside each conduit. When calculating conduit fill, consider spare conductors for future use, the grounded circuit conductor, and the grounding copper conductor and tracer wire if required. Consider the possibility for future expansion.

Projects for new installations should be designed to the 26% fill limitation. Projects for existing conduit should be designed to the 35% fill limitation.

There are at least two conduits entering a controller cabinet. Because of the number of conductors in the conduit and for future expansion, the minimum size of the conduits shall be 3". An additional separate conduit for communication should be considered.

The size of the conduit shall be shown for all conduit runs.

Section 1.5 – Pull Boxes

These are the following different types of pull boxes:

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- Non-traffic pull box: Usually installed in sidewalks, unpaved surroundings, and locations that are not subjected to vehicular traffic.
- Traffic pull box: Usually installed in locations that are subjected to occasional vehicular traffic; however, the metal cover is not designed for continuous vehicular traffic.
- Structure pull box: To be used on bridges, overpasses, or other structures. When installing structure pull boxes, verify the barrier is thick enough to have a minimum of 3 inches of concrete all around the structure pull box.

Pull boxes should be shown on the plans:

- At locations where conduits branch.
- Adjacent to the foundation for each standard, enclosure, and cabinet.
- At the toe or hinge point of a slope, when required.
- On the downstream side of traffic and within 5 feet of poles, posts, standards, and sign structures if practical.
- At the transition to a structure.

New pull boxes should not be shown in the following:

- Painted medians
- Paved shoulders
- The roadway or inside traveled way
- Parking areas
- Within the boundaries of the curb ramp

When showing that type 9 and 9A pull boxes are in a structure, consider the types of barriers, and if it has a fence installation on the barrier.

If more space for conductors and cables is required, a pull box extension may be considered.

The maximum spacing between pull boxes should be 200 feet to minimize the pulling tension of the conductors and cables.

A No. 6 pull box should be used when:

- The pull box is adjacent to the controller cabinet.
- Four or more conduits enter the pull box.

A pull box marker may be used where a pull box is shown in unpaved areas or where the pull box is not shown adjacent to a standard.

Pull boxes with a transformer should be shown with an extension.

1.5.1 Tamper-Resistant Pull Boxes

Consider using tamper-resistant pull boxes as a tool under the Guidelines of Effective and Practical Wire Theft Prevention Methods. See Appendix B for Deputy Directive 113.

Section 1.6 – Conductors and Cables

The designer shall prepare a calculation sheet showing the quantity, size, voltage drop for each circuit. The calculation sheet shall be stored in the project file.

The designer should show all conductors, including the grounded circuit conductors, equipment-grounding conductor, and tracer wire (if needed) for all conduit runs. Include the size, number of conductors and cables, and function for all conduit runs.

Interconnected conduits and cables between coordinated signal systems shall be shown in a separate conduit, pull box, or raceway.

When the existing conductors are reused, the number and size shall be indicated on the plans. Conductors to be added or removed shall also be noted. Any existing conductors smaller than No. 2 that have Thermoplastic High Heat-resistant Nylon-coated (THHN) or Thermo Heat and Water-resistant Nylon-coated (THWN) insulation shall be replaced.

Flashing beacon conductors for signalized intersections and lighting conductors shall not be shown entering a controller cabinet.

Cables shall not be spliced.

1.6.1 Inductive Loop Conductors

There are two different types of loop wire, Type 1 (No. 12) and Type 2 (No. 14). Verify the thickness of the pavement within the project limits for all the intersection approaches where the loops are to be installed. Coordinate with the project engineer and district maintenance staff. The roadway may have a minimal thickness of pavement that may not be deep enough for the standard loop installation. If loops installation is impractical, consider an alternative method of detection.

1.6.2 Conductor Signal Cable

The conductor signal cable shall be used.

1.6.3 Detector Lead-In-Cables

There are two different types of detector lead-in cables, Type B and Type C.

1.6.4 Signal Interconnect Cables

Signal interconnect cables shall be continuous between cabinets and shall not be installed with power conductors and cables.

1.6.5 Communication Cables

Communication cables are low voltage and typically smaller than no. 20 American Wire Gauge (AWG).

Limit the ethernet cable length to no more than 300 feet between active components.

1.6.6 Determining Adequate Conductor Size

Voltage Drop (V_D) calculations shall be performed for all branch and feeder circuits to determine if the conductor size is adequate. The National Electrical Code (NEC) recommends the following maximum voltage drops:

- Branch circuit: 3%
- Feeder circuit: 2%

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- Entire circuit: 5%

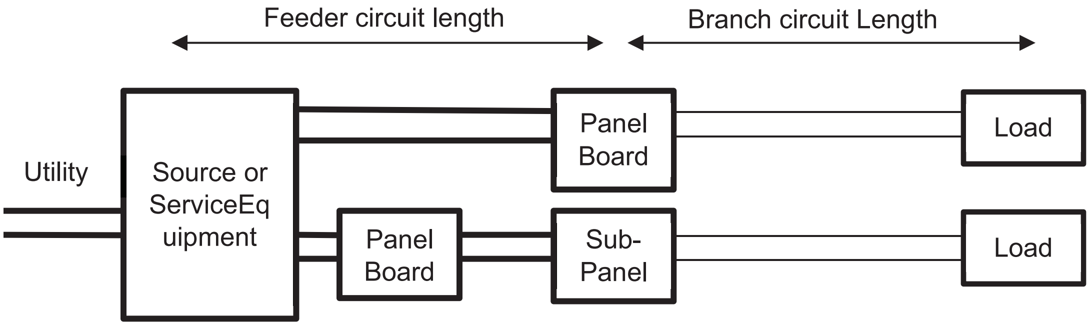

Figure 1: Voltage Drop Circuit

Where electric loads cause (V_D) to exceed the allowable % (V_D) limits (e.g., due to long circuits lengths) consider one of the following:

- Increase the conductor size
- Increase the voltage by providing a step-up and step-down transformer
- Provide a buck/boost transformer where applicable

1.6.7 Voltage Drop Calculations for Single Phase

These calculations are for copper conductors.

For Single Phase: $V_D = 2 \times D \times \mathrm{I_L} \times \mathrm{Z_{effective}}$

$$\% \, V_D = \frac{\mathrm{V_D}}{\mathrm{Voltage}} \times 100$$

Circuit Length: D is one-way circuit length in feet

Line Current: $\mathrm{I_L} = \frac{\mathrm{P(watt)}}{\mathrm{V \times Cos\,\theta}}$

Effective Impedance $\mathrm{Z_{effective/1000}} = (\mathrm{R} \cdot \mathrm{Cos}\,\theta + \mathrm{X} \cdot \mathrm{Sin}\theta)$

For the values of Resistance ® and Reactance (X), refer to NEC chapter 9, table 9. Note, $\mathrm{E_{ffective}}$ is calculated per 1,000 ft.

Example: Calculate voltage drop for single phase

A No. 12 AWG conductor is selected from table 310.16 of NEC, based on design requirement for 75º C, type THW copper wires in PVC conduit with a 25 amp load. The applied voltage is 120 V. D is 150 ft for the branch circuit, 1,020 W @ power factor (p.f.) of 0.85.

The voltage drop is calculated by the following:

Power factor: $\mathrm{Cos}\,\theta = 0.85$

$\theta = 31.79°$, Then $\mathrm{Sin}\,\theta = 0.527$

Find R and X: R=2 and X=0.054, for 1000’ per NEC

$\mathrm{Z_{effective,}}$ $Z_{\mathrm{effective/1000}} = (\mathrm{R} \cdot \mathrm{Cos}\theta + \mathrm{X} \cdot \mathrm{Sin}\theta)$

$$Z_{effective/1000'} = (2 \cdot 0.85 + 0.054 \ \cdot 0.527) \ \rightarrow 1.728 \ \Omega$$

Line Current: $I_L = \frac{1020 \text{ W}}{120 \text{ V} \cdot 0.85} \rightarrow 10 \text{ amps}$

Voltage Drop: $V_D = 2 \ \times D \times \ I_L \times \ Z_{effective}$

$$V_D = 2 \ \cdot \ \frac{150 \text{ ft}}{1000 \text{ ft}} \cdot 10 \text{ amps} \ \cdot 1.728 \ \Omega$$

Percent Voltage Drop: $\% \ V_D = \frac{5.18 \text{ V}}{120 \text{ V}} \times 100 \ \rightarrow 4.32\%$

Since 4.32% is more than the allowable 3% V_D, it is unacceptable. One of the three possible solutions mentioned earlier is to increase the conductor size.

The next larger size is a no. 10 AWG conductor, where R=1.2, X=0.5 per NEC.

For 10 AWG: $Z_{effective/1000'} = (1.2 \ \cdot 0.85 + 0.05 \cdot 0.527) \rightarrow 1.05 \ \Omega$

The line current will remain 10 amps and the new calculated V_D is 3.15 V.

Then: $\% \ V_D = \frac{3.15 \text{ V}}{120 \text{ V}} \times 100 = 2.62\%$

Since 2.62% is less than the allowable 3% V_D, the no. 10 AWG conductor size is adequate for the mentioned parameters.

Lighting circuits use parallel branch circuits. Each branch circuit must be evaluated from the farthest electrolier to each spliced branch circuit that are paralleled to the power source. The total voltage drop with any combination of branch circuits and feeder circuits must not exceed 5%.

1.6.8 Voltage Drop Calculation for 3-ø

These calculations are based on copper conductors.

For three phase: $V_D = \ \sqrt{3} \ \times D \times \ I_L \times Z_{effective}$

$$\% \ V_D = \frac{V_D}{\text{Voltage}} \times 100$$

Circuit Length: D is one-way circuit length in feet

Line Current: $I_L = \frac{P_{Line} \text{ (watt)}}{\sqrt{3} \times V_{line} \times \text{Cos } \theta}$

Effective Impedance: $Z_{effective/1000} \ = (\text{ T} \cdot \text{Cos}\theta + \text{X} \cdot \text{Sin}\theta)$

For the values of R and X, refer to NEC chapter 9, table 9. Note $Z_{Effective}$ is calculated per 1,000 ft.

Section 1.7 – Service Equipment Enclosure

Service equipment enclosures shall meet the requirements of the power utility company. The name of the power utility company must appear on the plans at the service point.

The service point is the location where a conductor makes a physical connection with a power utility company. This location may be on a wooden pole, transformer vault, pull box, or at the designated location provided by the power utility company. Caltrans shall provide the conduit

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and pull box from the service point to the service equipment enclosure as recommended by the power utility company.

When installing new or modifying existing electrical service, the designer should consider combining all loads to minimize the number of service equipment enclosures at one location. Consult with district maintenance staff for their input.

Show the service equipment enclosure within the right-of-way fence nearest the service point and coordinate with the project engineer to determine if an access gate is necessary.

When there is a subpanel between the service equipment enclosure and the electrical load, a disconnecting means with the proper rating for the electrical loads must be in the subpanel. The circuit breaker of the branch circuit in the service equipment enclosure must match the disconnecting means in the subpanel.

Section 1.8 – Cabinets

The designer shall consult with TMC support staff for the preferred types of cabinets.

1.8.1 Controller Cabinet

There are different types of controller cabinets.

For signal and lighting systems, the following cabinets can be used:

- Model 332 LS
- Model 342 LX

For traffic management systems, the following cabinets can be used:

- Model 334 LS
- Model 334 LC
- Model 336 LS
- Model 344 LX

Model 332 LS and 334 LS are single-wide cabinets. Model 342 LX and 344 LX are double-wide cabinets. If feasible, a Model 342 LX or 344 LX controller cabinet should be considered.

1.8.1.a Department-Furnished Cabinet

Department-furnished cabinets are used for traffic signals, pedestrian hybrid beacons, and ramp metering.

1.8.1.b Contractor-furnished Cabinet

Contractor-furnished controller cabinets are used for traffic management systems, except for ramp metering systems.

1.8.2 Telephone Demarcation Cabinet

The telephone demarcation cabinet should be Type B. Coordinate with the telephone utilities for the type of equipment that goes in the telephone demarcation cabinet and include on electrical project plans and specifications.

1.8.3 Battery Backup System Cabinet

Battery Backup System (BBS) cabinets are used to house batteries and an electronic assembly at signalized intersections in case there is a loss of power to the signals. BBS cabinets may be used for a pedestrian hybrid beacon system.

The BBS cabinet is contractor-furnished.

Add a note in the plan sheet for either 4 or 8 batteries with the ampere hour rating to be installed in the BBS cabinet.

Refer to Transportation Electrical Equipment Specifications (TEES) chapters 4 and 12 for more information.

Section 1.9 – Controller Assembly

A controller assembly is Department-furnished and is used for signal and lighting systems and ramp metering systems.

For use of the controller assembly, refer to TOPD 17-01 dated April 1, 2017 (See Appendix C). If using the Model 2070 controller unit, refer to the TEES.

Section 1.10 – Vehicle Detectors

Detectors may be an inductive loop type or other types of detection.

For a lane wider than a standard 12 ft wide lane, adjust the width of the type A inductive loop to maintain a 3 ft width between the lane line or edge-of-travel-way. There are wider lanes at the tapers at the connectors, interchanges, ramps, and the truck lanes on truck routes.

Vehicle detection can be combination of different types of technologies. Every detection technology has advantages and disadvantages.

1.10.1 Preformed Loop Detectors

Preformed loops shall be shown for new structures.

The designer shall coordinate with the project engineer and district signal operations staff. Preformed loops shall be secured in place before the concrete pour.

Preformed loops may be considered for roadway locations.

Section 1.11 – Loop Detector Sealants

Asphaltic emulsion, elastomeric, epoxy, and hot-melt rubberized asphalt are sealants used in the installation of the loops.

These different types have their own applications:

- Asphaltic emulsion: Use on flat asphalt pavement.
- Elastomeric: Use on concrete and asphalt pavement.
- Epoxy: Use on concrete surfaces so traffic can be restored in a timely fashion.
- Hot-melt rubberized: Use on all roadway surfaces.

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Section 1.12 – Batteries

The batteries for the BBS are contractor-furnished, unless they are used for Green Technology. The designer shall use 4 batteries.

Section 1.13 – Utility Service

Arrangements shall be made with the power utility company to establish or provide service points for the installations during the design stage or when the preliminary plans are completed. It is recommended to review the proposed service point locations in the field with a utility representative. Three sets of plans (minimum) with proposed service points indicated shall be sent to the utility company for approval, and a copy of the correspondence should be kept in the project file and in the RE pending file.

Please refer to other requirements listed in Chapter 17 of the *Project Development Procedure Manual* under "Encroachment and Utilities." See Appendix L for the web address.

The designer will check the existing high- and low-risk facilities within the construction limits and request subsurface locating and potholing for existing subsurface high- and low-risk facilities to avoid conflict with standards and foundations.

The designer will coordinate with district maintenance staff to initiate or update a district maintenance agreement with the agency regarding costs and maintenance.

1.13.1 Communication Service

The designer shall make a site visit and propose a communication service location closest to the proposed cabinet housing the communication equipment. When the preliminary design is completed, notify the communication service provider to establish or provide service during the design stage. A copy of the request should be kept in the project file and in the RE pending file.

When the communication service provider appoints a communication service coordinator for the project, the designer is required to review the proposed service location in the field with the service coordinator and agree on service locations shown on the X/Y form provided by the service provider. The designer shall then sign and send the X/Y forms to the service provider and keep a copy in the RE pending file. (Use your district's established forms; see an example in Appendix D). The designer shall submit the RE file to the district or region construction division by the RTL date. When a service will be installed during construction, the RE shall contact the service coordinator who informs the service provider to activate the service.

Use your district's established process flow.

1.13.2 Electrical Service

Construction staff are responsible for ordering the service connection. However, the designer should first investigate for available existing service in the area and complete the needed form to finalize service points with the service utility.

During the design stage, the designer shall establish a unique, 14-digit Caltrans ID Number (CTID No.) for each electrical service point. The CTID number shall be shown on the contract plans.

The CTID number shall follow the format shown below:

XX	District (two-digit numeric, zero fill – 01 thru 12)
XX	County Codes (two-digit numeric, zero fill – 01 thru 58)
XXX	Route (three-digit numeric, zero fill – 001 thru 999)
X	Alternate (R = realign, O = overlap, zero for no alternate)
XXX.XXX	Postmile (zero fill)

For example, a CTID No. for District 3 shall be shown as 03240500016084

If the district uses a 15th digit, the format for the 15th digit is shown below:

X	Service (M = Metered, U = Unmetered, T = Signals, L = Lighting, or G = General)

For example, a CTID No. for District 6 shall be shown as 0642180R056190L

Use the two-digit county codes as shown in the following table:

Numeric Identification for County

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County	2-Digit Code	County	2-Digit Code	County	2-Digit Code
Alameda	33	Marin	27	San Mateo	35
Alpine	31	Mariposa	40	Santa Barbara	51
Amador	26	Mendocino	10	Santa Clara	37
Butte	12	Merced	39	Santa Cruz	36
Calaveras	30	Modoc	03	Shasta	06
Colusa	15	Mono	47	Sierra	13
Contra Costa	28	Monterey	44	Siskiyou	02
Del Norte	01	Napa	21	Solano	23
El Dorado	25	Nevada	17	Sonoma	20
Fresno	42	Orange	55	Stanislaus	38
Glenn	11	Placer	19	Sutter	18
Humboldt	04	Plumas	09	Tehama	08
Imperial	58	Riverside	56	Trinity	05
Inyo	48	Sacramento	24	Tulare	46
Kern	50	San Benito	43	Tuolumne	32
Kings	45	San Bernardino	54	Ventura	52
Lake	14	San Diego	57	Yolo	22
Lassen	07	San Francisco	34	Yuba	16
Los Angeles	53	San Joaquin	29		
Madera	41	San Luis Obispo	49		

Service equipment enclosures and metering equipment shall meet the requirements of the service utility. The designer shall check with utility provider for their requirements.

The grounding conductor between the service point shall be a minimum No. 6 AWG. The grounding conductor between the service equipment enclosure and the field elements shall be minimum No. 8 AWG.

For any service or load conductors, the designer must size the copper ground conductor accordingly. Refer to the NEC.

Transformers shall be provided with main primary and main secondary over-current protection, except as listed in the NEC. Single-phase, 2-wire, and 3-phase 3-wire ∆-∆ connected secondary transformer are considered to be protected by the primary over-current device as per the NEC. Additional overcurrent protection shall be provided for each circuit connected to the transformer.

When a transformer is required and cannot be installed in an existing service equipment enclosure, install it in a separate enclosure or pull box.The service equipment enclosure should be located 10 ft from the controller cabinet on a common Portland Cement Concrete (PCC) pad.

1.13.2.a Electrical Service Irrigation

The designer is only responsible for electrical service to the irrigation controller that consists of a breaker in a service equipment enclosure and provides conductors to the irrigation controller. This will be a separate bid item shown on a separate sheet independent of the landscape plans.

1.13.2.b Electrical Service Booster Pump

The designer shall work with structure design staff on providing service to the booster pump and controller that consists of a breaker in a service equipment enclosure or its own standalone service equipment enclosure.

Section 1.14 – Communication

The designer shall ensure communication back to the TMC for all transportation management system elements. The designer shall consult with district traffic operations TMC support staff for preferred communication methods based on compatibility with the existing infrastructure. The chosen communication method will also depend on the geographic location and service availability in the area.

Section 1.15 – Accessible Pedestrian Signals

Accessible Pedestrian Signals (APS) are a standard requirement for pedestrian detection.

Coordinate with signage staff for installing signs.

Section 1.16 – Transformers

When the designer encounters a situation where the supply voltage is not a single-phase or a 3-phase system, the use of the transformer is necessary to transfer the input from the service utility to the load.

Section 1.17 – Electrical Fault Protection

The designer is responsible for designing circuitry that delivers power from the supplying utility to a given load, economically and at its rated voltage. For safety reasons, the electrical equipment and associated circuitry should be designed to facilitate:

- Operating over-current devices to protect equipment
- Limiting the voltage-to-ground during a fault for personnel safety

Limiting the voltage-to-ground also facilitates operation of the over-current protective devices.

All equipment in an installation, including protective devices, must be able to interrupt any limited fault currents that may be present. When designing, be sure to consider the following:

- All equipment must have the capacity to operate safely at the prospective fault current
- If fault current limiters are to be used, they must be selected to prevent the fault condition from exceeding a predetermined level (e.g., the maximum rating of equipment used in that part of the installation or maximum ampacity of the conductors) and installed to comply with the required standard.

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1.17.1 Type of Fault

The most common types of electrical faults are:

- Line-to-line fault
- Line-to-ground fault
- Arcing fault to ground

The arcing fault to ground is the worst type of fault that can occur on an electrical circuit. There is a substantial voltage drop across the arc that results in less voltage available for driving the fault current in the circuit for the timely operation of the over-current protective devices. Therefore, the designer must pay close attention during design so that the resultant circuitry for supplying a given load performs in a predictable manner to protect personnel and equipment during adverse conditions.

1.17.2 Fault Current Path

The fault current path shall be permanent, electrically continuous, capable of safely carrying the maximum fault likely to be imposed on it and shall have sufficiently low impedance to facilitate the operation of the over-current protective device under fault conditions. Electrical equipment, wiring, or other electrically conductive material likely to get energized shall be installed in a manner that creates a permanent, low-impedance circuit from any point on the wiring system to the electrical supply source. The earth shall not be used as the sole equipment grounding conductor or as a fault current path. For more details refer to the California Electrical Code and the NEC.

1.17.3 Energy Dissipated During Fault

The energy generated during any kind of fault shall not be more than:

- 4,000 kW-cycles for aboveground faults
- 10,000 kW-cycles for underground faults

When this limit is used, all lighting fuses shall be installed inside the pull box and not inside the pole. If a tamper resistant pull box is used, add an additional fuse inside the pole.

The high levels of energy dissipated during faults involving high currents can cause extensive damage and could lead to injury or death for anyone working nearby. The following conclusions were made by experiments in the past to estimate the resultant damage from the fault energy.

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Table 1. Damage from Fault Energy*

Fault Energy	Damage Severity
100 kW-cycles	Location of fault identifiable from spit marks on metal and from smoke marks.
2,000 kW-cycles	Minor damage; probably no damage to hardware; equipment usually can be restored to service by cleaning smoke marks and repairing insulation.
10,000 kW-cycles	Serious damage but usually contained within 12-gauge metal enclosure.
20,000 kW-cycles	Severe damage. Fault probably will burn through metal enclosure and spread to other sections of the equipment.
Over 20,000 kW-cycles	Considerable destruction of equipment in proportion to the amount of fault energy.

*Electrical Contractor Magazine

1.17.4 Short Circuit Analysis

The energy generated during a ground fault can be calculated in kW-cycles:

$$\text{kW cycles} = \frac{I_f \cdot V_{arc} \cdot t_{sec} \cdot 60\ \text{cycles/sec}}{1000}$$

Where: t_{sec} = maximum tripping time in seconds for the circuit breaker

V_{arc} = Voltage across fault arc

= 50 volts, empirically for a 120 V system

Fault Current: $I_f = \frac{V_{effective}}{Z_{effective}}$

$V_{effective}$ = effective voltage producing fault current

$= V_{available} - V_{arc}$, e.g. 115 V – 50 V

$Z_{effective}$ = effective impedance (See Section 2.3.2)

$Z_{effective/1000'} = (R \cdot \text{Cos}\ \theta + X \cdot \text{Sin}\ \theta)$

Total circuit length: $Z_{effective/1000'} = 2\ (R \cdot \text{Cos}\ \theta + X \cdot \text{Sin}\ \theta) \cdot$ for single-phase

$Z_{effective/1000'} = \sqrt{3}\ (R \cdot \text{Cos}\ \theta + X \cdot \text{Sin}\ \theta) \cdot$ for 3-phase

For the values of R and Z, refer to NEC chapter 9, table 9.

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Arcing Fault Chart

Voltage (Line to Ground)	Arc Voltage	V_{eff} Voltage
120	50	64
240	80	148
277	100	163

$\mathrm{m} =$ Multiples of circuit breaker rated currents

Example: Calculate ground fault energy for the following circuit parameters: uncoated copper wire in PVC conduit, single phase, circuit breaker rating of 15-25. See circuit breaker curve in Appendix E.

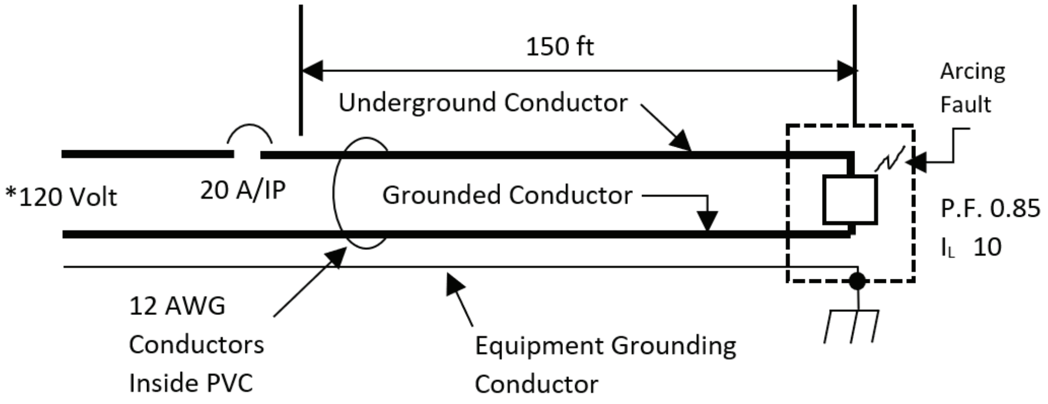

Figure 2: Circuit Diagram

*120 volts at service equipment and 115 volts at arcing fault location due to V_d.

Here: $\mathrm{V}_{\mathrm{arc}} = 50$ volts (empirically)

Then: $\mathrm{V}_{\mathrm{effective}} = \mathrm{V}_{\mathrm{available}} - \mathrm{V}_{\mathrm{arc}}$

$\mathrm{V}_{\mathrm{effective}} = 115 - 50 = 65$ volts

Power Factor: $\cos\theta = .85$

$\theta = 31.79°$, then $\sin\theta = .527$

Find R and X: $\mathrm{R} = 2$ and $\mathrm{X} = 0.054$, for 1,000 ft per NEC

Impedance: $\mathrm{Z}_{\frac{\text{effective}}{1000'}} = (\mathrm{R} * \cos\theta + \mathrm{X} * \sin\theta)$

$$\mathrm{Z}_{\frac{\text{effective}}{1000'}} = (2 * 0.85 + 0.054 * 0.527) = 1.728\,\Omega$$

$$\mathrm{Z}_{\frac{\text{effective}}{1000'}} = 2 * 1 * 1.728\,\Omega * \frac{150'}{1000'} \rightarrow 0.52\,\Omega$$

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Note: for 1-phase, the circuit length is multiplied by 2 to account for return path.

Fault current: $\mathrm{I_f} = \frac{\mathrm{V_{effective}}}{\mathrm{Z_{effective}}}$

$$\mathrm{I_f} = \frac{65\ \mathrm{V}}{.52} \rightarrow 125\ \mathrm{amps}$$

Multiples of rated current: $\mathrm{m} = \frac{\mathrm{I_f}}{\mathrm{C.B.Rating}}$

$$m = \frac{125\ \mathrm{Amps}}{20\ \mathrm{Amps}} = 6.25 \qquad \text{(20 A, C.B. from Figure 5)}$$

Maximum trip time: $\mathrm{t_{sec}} \approx 5\ \mathrm{seconds}$ (See C.B. curve in Appendix E)

Finally: $\mathrm{energy} = \frac{\mathrm{I_f} \cdot \mathrm{V_{arc}} \cdot \mathrm{t_{sec}} \cdot 60 \frac{\mathrm{cylces}}{\mathrm{sc}}}{1000}\ (\mathrm{kW\ cycle})$

$$\mathrm{energy} = \frac{125 \cdot 50 \cdot 5 \cdot 60 \frac{\mathrm{cylces}}{\mathrm{sc}}}{1000}\ (\mathrm{kW\ cycle})$$

$$\mathrm{energy} = 1875\ \mathrm{kW\ cycles}$$

Since a 1,875 kW cycle is less than a 4,000 kW cycle for aboveground installation, it is sufficient.

Section 1.18 – Equipment Near Gasoline Stations

Controller cabinets, service equipment enclosures, poles, and pull boxes should not be located within 20 feet from any gas pump, 10 feet from any underground tank fill opening, or 5 feet from any underground tank vent opening. Any conduit within these limits shall be a Type 1 or 2 conduit. If it is impossible to adjust equipment locations to place the conduits outside these limits, then the conduit must be sealed in accordance with the NEC.

Section 1.19 – American Disabilities Act (ADA) Requirements

The designer shall coordinate with the district ADA coordinator and the project engineer for the location of the APS or push-button assemblies (PBA) on posts or standards. Civil designers are now using three-dimensional modeling for the ramp areas and slowly phasing in the exact locations of poles and standards within this area. Coordination between the project engineer and the designer shall require one of the following:

- The designer adds the following note below or to the “Standard and Equipment Schedule”: Exact locations of APS or PBA on posts or standards are shown on the “Construction Details.”
- The designer shows the dimensions for A and B in a column in the “Standard and Equipment Schedule” as noted on “Standard Plans Sheet ES-4C.”

Section 1.20 – Maintenance Vehicle Pullout

A maintenance vehicle pullout should be provided for maintenance of electrical facilities, including but not limited to the following systems: signals and lighting, ramp meters, camera locations, changeable message signs (CMS), highway advisory radio (HAR), roadside weather information system (RWIS), extinguishable message signs (EMS) and traffic monitoring station (TMS). Consult electrical maintenance staff for preferred pullout locations.

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Coordinate with the project engineer to ensure that a pullout is provided if required.

A maintenance vehicle pullout is an all-weather surface, typically asphalt concrete, that is of sufficient size to allow maintenance personnel to park out of the public's way (both vehicular and pedestrian), while allowing full access to their vehicle (utility truck storage bins, etc.) and to the electrical equipment they are maintaining.

The pullout for some elements should be larger if possible to accommodate the large bucket trucks with outriggers necessary to reach higher devices like cameras. Consider providing protection for the vehicle while personnel are in the bucket working on equipment by placing the pullout behind any barrier or guardrail to protect the travelling public from the electrical equipment. Ensure that the pullout is accessible to the vehicles.

Consider designing the maintenance vehicle pullout as a pull through so that vehicles can simply pull through to enter and exit, thereby avoiding the need for personnel to back their vehicle into or out of a pullout. If the maintenance vehicle pullout cannot be designed as a pull through, then it should provide ample space for the vehicle to turn around and re-enter the roadway driving forward. The vehicle should never have to back out onto a roadway.

Consider designing the facility so that all equipment at an element can be maintained from the same pullout. However, if it is necessary to place equipment far apart, such as a camera pole located away from the controller cabinet, additional pullouts should be provided. If two or more pullouts are needed, the pullouts should be sized appropriately for the vehicle likely to be using it. For example, the pullout by the camera needs to be large enough to accommodate a large bucket truck with outriggers, but a pullout by a controller cabinet can be sized for a normal maintenance utility truck.

On rural highways, it may not be reasonable or even possible to place a maintenance vehicle pullout for all elements of an installation. For example, a HAR located at a T or four-leg intersection may have a HAR controller cabinet and antenna tower accessible from a single pullout, but the three or four beacon/signs or EMS packages telling the public to tune into the radio for information may be located a significant distance away from the HAR. In this instance, if it is not possible or feasible to provide a paved pullout at each element, consider providing a shoulder area for the maintenance personnel to pull out of the travelled way next to the elements needing maintenance.

Consider the need for snow removal from the maintenance vehicle pullout in higher elevations. The pullout should allow space for the snowplow or loader to drive through pushing snow without damage to the electrical equipment (cabinets, poles, guard rails, etc.). There should also be space for the snow to be piled until it can melt in the spring if the pullout requires snow removal during the winter season.

Section 1.21 – Supplemental Work

Supplemental funds are used for either: 1) work that may be required to complete the project; or 2) work that is not biddable. When approved, supplemental funds may be used for work that is anticipated but cannot be quantified. Supplemental work must be within the contract scope.

Do not use supplemental items to:

- cover and incomplete design or lack of quantities.
- add more contingency funds.

- pay for work that should be paid by maintenance funds (Maintenance work is not eligible for federal funding).
- pay for work not performed by the contractor, such as the inspection of work by a railroad agency.

Supplemental work must be identified, justified, and approved. Approval request forms and procedures are provided in the project development directive “PD-04 Project Contingencies and Supplemental Work.”

Section 1.22 – Department-Furnished Materials and Expenses

The Department-furnished materials are listed under Section 7.8 of the Construction Contract Development Guide. Items for Department-furnished materials are numbered 066XXX.

The list of Department-furnished materials is included as part of the Public Interest Finding (PIF) Guidelines under the Caltrans Division of Budgets.

If items on the FHWA pre-approved Department-furnished materials list are included in a contract, the project engineer must sign a letter justifying the cost of each item and send it to the Office of Federal Resources. A copy of this letter must be included in the construction contract submittal.

For items not on the FHWA pre-approved list, the project engineer must generate a PIF. A new PIF is required for each contract.

Toward the completion of the design, the designer shall fill out the Department-furnished material local request form. Ensure that the order is in place so that the material is available for construction without causing a delay to the contract. Consult the specific district for their procurement process.

The designer should refer to the latest Caltrans policy for Department-furnished electrical material.

Department expenses are directly related to project construction and do not include work done by the Contractor. For a list of Department expenses approved by FHWA that is eligible for federal reimbursement, please refer to Table 7-7 of the Construction Contract Development Guide.

For a list of Department-furnished materials and costs along with Department expenses, see Appendix F.

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Chapter 2 – Lighting and Sign Illumination Systems

Lighting and sign illumination systems are a combination of elements used to provide lighting and illumination to signs.

For more information, please refer to the *Roadway Lighting Manual*.

The designer shall keep a document in the project history file that shows that lighting levels are met.

For lighting and sign illumination system design, see Appendix N, Example A, sheets E-1 and EQ-1.

Chapter 3 – Signal and Lighting Systems

Section 3.1 – General

A signal and lighting system is a combination of elements used to control vehicular and pedestrian traffic, including lighting to provide illumination.

For new signal and lighting projects, it is recommended that the designer coordinates with the project engineer to verify that the final road configuration will accommodate the locations of the signal and lighting standards and equipment. For new geometric designs, the designer may need to provide temporary signal and lighting during the road construction.

The designer must coordinate with staff in the district signal operations branch on deciding what type of detection will work at each location.

Some local agencies may require special (e.g., decorative) signal and lighting standards and special paint for standards. The designer should coordinate with the district structures and maintenance staff for review and approval. A maintenance agreement shall be processed and in place for covering the additional cost over the standard equipment at the local agency's expense, including spare parts and equipment maintenance.

If the signal location is near a railroad track, it may include an activated blank-out sign.

Where emergency vehicle detection is requested by local agencies, refer to the *California MUTCD* for guidance. Work for emergency vehicle detection should be shown on a separate sheet separate from signal and lighting and shall be paid for in a separate bid item.

Where marked crosswalks are installed at a signalized intersection to channelize pedestrian traffic, front detector loops should not be installed inside the crosswalk areas.

The designer can use push buttons as an alternate method for bicycle detection.

For typical signal and lighting design, see Appendix N, Example B, sheets E-1 and E-2.

Section 3.2 – Signal and Lighting Standards

Signal and lighting standard designs are mostly affected by location, configuration, attachments, and soil conditions. The Standard Plans cover many of the standard situations.

A mast arm standard should be placed a minimum of 70 feet downstream of the limit line on the approach.

Median installation of traffic signal and lighting standards should be avoided.

Where possible, a 4-foot clearance on the roadside of the signal equipment should be provided.

The designer can help plan their layout and special design request using the following method.

This is ONLY an example, the designer shall contact the Special Design Branch A under the Office of Design and Technical Services under the Division of Engineering Services for their nonstandard design.

Example: Comparing Your Project Signal Standard Design to the Standard Plans. Your design moments should not exceed the Standard Plan moments.

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Select a signal arm from the Standard Plans similar to your signal layout. Look for a standard that has an equal or greater number of signs or signals on the mast arm. Signal arm loading should be carefully selected to meet current and future needs. If either wind moments fail, try the next higher standard plan signal pole. Any special loading should be reviewed and approved by Special Design Branch A under the Office of Design and Technical Services under the Division of Engineering Services.

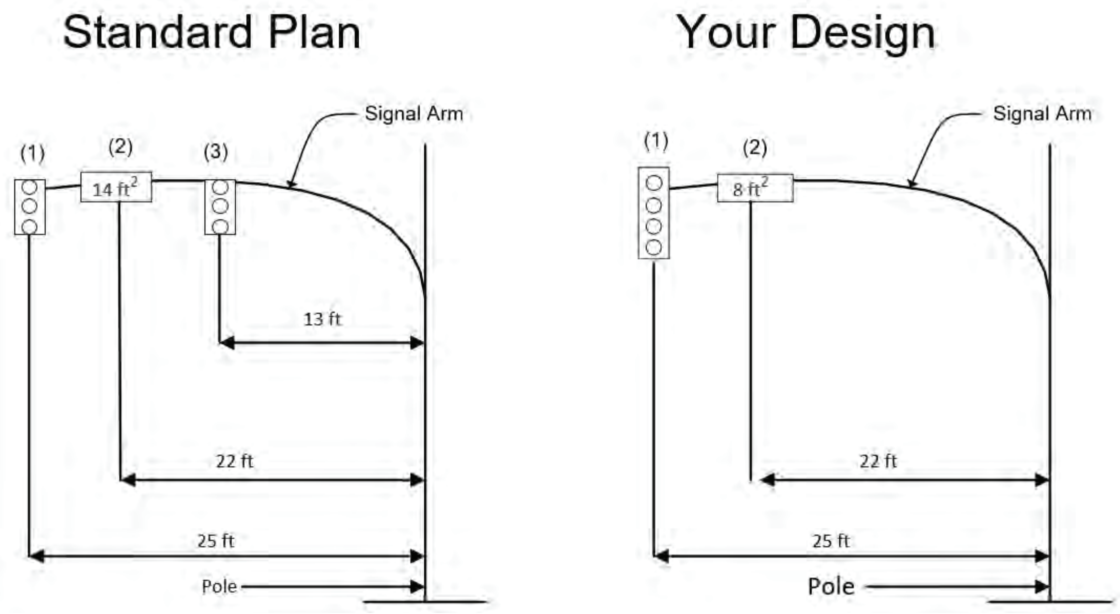

Figure 3: Signal Standard 18-3-100, with 25 ft Arm

Standard Plan	Your Design
(1) Projected Area = 10.24 ft² Weight = 55 lb	(1) Projected Area = 12.37 ft² Weight = 64 lb
(2) Projected Area =14 ft² Weight = 44 lb	(2) Projected Area = 8 ft² Weight = 44 lb
(3) Projected Area = 10.24 ft² Weight = 55 lb	

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Compare Wind Moments about Signal Arm Support or Pole

	Standard Plan	**Your Design**
	18-3-100 Signal Arm 25 ft	18-3-100 Signal Arm 25 ft
Signal/Sign No.	Project Arm Area x Distance from Pole	Project Arm Area x Distance from Pole
1.	10.24 ft^2 x 25 ft = 256	12.37 ft^2 x 25 ft = 309
2.	14 ft^2 x 22 ft = 308	8 ft^2 x 22 ft =176
3.	10.24 ft^2 x 13 ft =133	
	Total = 697	Total = 485

Since 485 is less than 697, your design is sufficient for the wind loading.

Compare Dead Load (Weight) Moments about Signal Support

	Standard Plan		**Your Design**	
Signal/Sign No.	Weight Arm	Moment	Weight Area	Moment
1.	55 lb. x 25 ft	= 1,375	64 lb. x 25 ft	= 1,600
2.	44 lb. x 25 ft	= 1,100	44 lb. x 22 ft	= 968
3.	55 lb. x 13 ft	= 715		
	Total	= 3,190	Total	= 2,568

Since 2,568 is less than 3,190, your design is sufficient for the given weight.

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The following table lists the projected areas and weights for the traffic signal and sign.

Projected Areas and Weights for Traffic Signal and Sign		
Signal and Sign	**Projected Area**	**Weight**
3 - Section Signal	10.24 ft^2	55 lb*
4 - Section Signal	12.37 ft^2	64 lb
5 - Section Signal	14.53 ft^2	80 lb
Left-Turn Flat Sign (not illuminated)	14.10 ft^2	44 lb*
6 ft Internally Illuminated Street Sign	11.0 ft^2	65 lb
8 ft Internally Illuminated Street Sign	14.64 ft^2	85 lb
3M Program Visibility Head	8.75 ft^2	55 lb

*Use for Standard Plan unless shown otherwise

Section 3.3 – Backplates

The two types of backplates are metal and plastic.

Plastic backplates offer resistance to corrosion in areas close to the ocean and near water bodies. Section 3.4 – Programmed Visibility Signal Sections

The programmed visibility (PV) signal section is to be used at signalized intersections that are closely spaced approaches, or where the driver may get confused when looking at two successive signal indications with different phasing caused by irregular roadway design. Complicated or skewed angle approaches in the same intersection may use the PV to provide clarity to drivers for the proper controlling signal indication.

Section 3.5 – Visors and Directional Louvers

Visors and directional louvers are attachments to the signal to enhance visibility.

Tunnel visors provide considerable protection from snow buildup in cold areas; limit the chance for birds to build nests inside the visor; and offer considerable shade around the signal indication.

The cap or cut-away type visor may provide some advantage to areas where high winds are present. The visors provide considerable protection from snow buildup.

The angle visor adds weight and wind force on the signal standard. The angle visor is used to enhance the visibility of the driver for the intended signal indication where the intersection geometric includes a sharp or acute angle less than 90 degrees between the cross street and main street, or to the roadway approach. The visor will somewhat shield the view of the close signal indication installed on the same signal standard. The designer shall consult with the

Special Design Branch A under the Office of Design and Technical Services under the Division of Engineering Services for permission to use the angle visor.

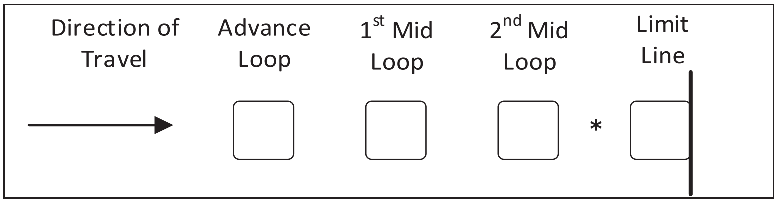
Refer to the Standard Plans for the different types of visors and louvers.

Section 3.6 – Inductive Loops

An inductive loop is a conductor coiled in a series of turns in the pavement.

All types of inductive loops are covered in the Standard Plans.

Advance detectors should have a separate Detector Lead-In Cable (DLC) per loop designation and should be located as follows. Refer to the *California MUTCD*.



*Loop types/location per district guidelines

Figure 4: Advance and Mid Loop Detector

Table 3. Speed and Loop Distance for Advance Detection

Approach Speed, mph	Distance of Advance Loop from Limit Line (ft)*	Distance of Intermediate Loop from Limit Line (ft)	
		1st Mid Loop	2nd Mid Loop
25	105**		
30	140		
35	185		
40	230	113**	
45	285	153	
50	345	198	
55	405	244	83**
60***	475	300	125
65***	550	495	168
70***	630	425	220

*Per table 4D-101 (CA) in the *California MUTCD*

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**Intermediate loop may or may not be needed. Consult HQ Signal Operations Branch.

***Two mid loops per lane are recommended.

The placement of intermediate loop detectors from the limit line is obtained by subtracting the distance traveled in 2 seconds at that speed from the distance of advance loop detectors.

The advance loop distance is given by *California MUTCD* figure 4D-101:

$$\text{Detector Setback} = \text{Deceleration Distance} + \text{Reaction Distance}$$

$$\text{Detector Setback} = \frac{V^2}{2 \cdot d} + V \ \cdot T$$

$$\text{Where deceleration d} = 10\text{ft/sec}^2$$

$$\text{Where reaction time t} = 1 \text{ sec}$$

For example, at 55 mph the advance loop distance:

$$55 \text{ mph } (5280 \text{ ft/mi}) \text{ X } (1 \text{ hr/3600 2}) = 80.6 \text{ ft/s}$$

$$\text{Detector Setback} = \frac{(80.6\ ft/sec)^2}{2 \cdot (10\ ft/sec^2)} + (80.6\ ft/sec) \cdot (1\ sec)$$

$$\text{Detector Setback} = 405 \text{ ft}$$

The distance for the 1st mid loop from the limit line:

$$405 \text{ ft} - 80.6 \text{ ft/sec X 2 sec} = 244 \text{ ft}$$

The distance for the 2nd mid loop from the limit line:

$$244 \text{ ft} - 80.6 \text{ ft/sec X 2sec} = 83 \text{ ft}$$

The approach speed is the posted speed limit, or the prima facie, in the absence of the posted speed. Where approach speeds exceed 70 mph, consult with the district signal operation branch staff.

Type A and Type E loops are interchangeable. Type D and Type F loops are interchangeable.

The use of detector handholes should be considered in all paved areas. Wherever possible, detector handholes should be shown on the right shoulder, adjacent to the curb or edge of pavement.

For the project plans, use and show Type D loops for bicycle detection, and as the front loop on each approach at the traffic signal that is not on permanent recall or fixed time operation.

Run a separate DLC for the Type D loops to the controller cabinet or connect the Type D loops parallel with Type A loops in the series as shown below.

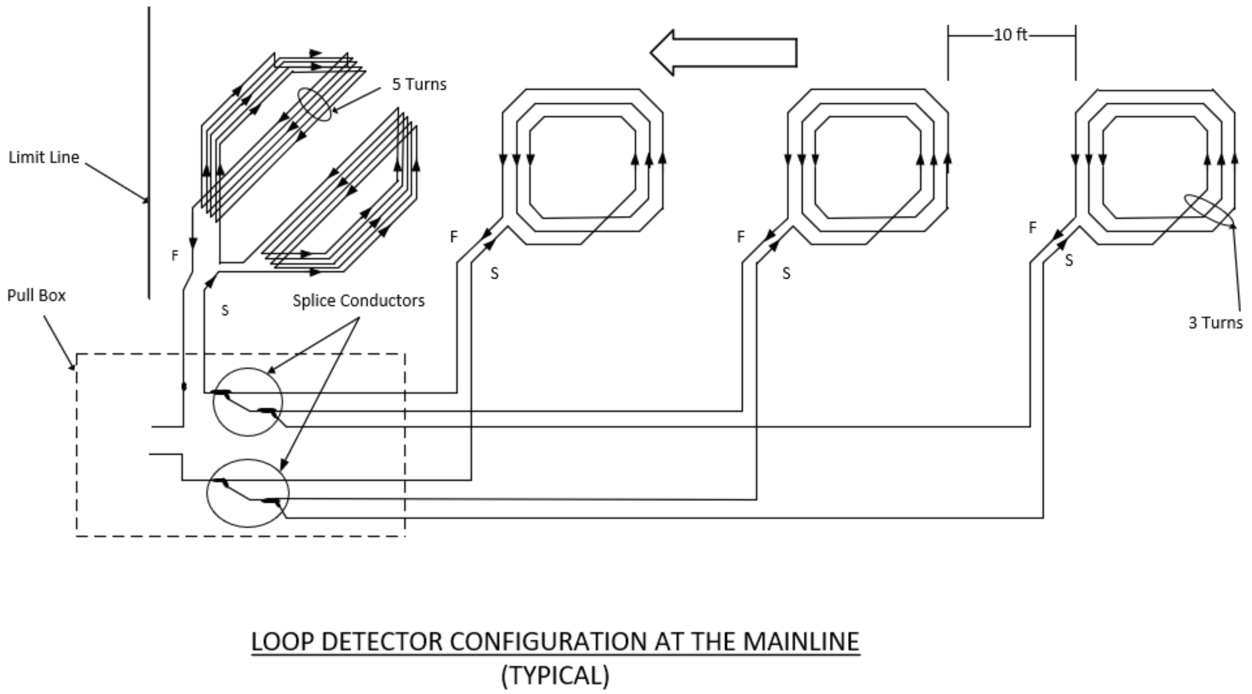

Figure 5: Loop Detector Configuration

The maximum recommended DLC length from loop to controller is 2,500 feet for a standard loop.

When possible, damaged pavement should be replaced before installing loop detectors.

When inductive loops are to be installed by cutting into an existing bridge deck, the designer shall submit electrical plans for review and approval by Special Design Branch A under the Office of Design and Technical Services under the Division of Engineering Services staff.

The designer shall consult with the district signal operations engineer regarding the distance for advance detection for signalized off-ramps or when alternative detection other than inductive loops is considered.

The designer should consider installing departing loops for count data. Consult the district traffic census coordinator for assistance in this determination

Section 3.7 – Video Imaging Vehicle Detection System (VIVDS)

Video imaging vehicle detection is a camera used for vehicle detection when loops are not preferred.

When using video imaging vehicle detection for bicycle detection, the designer shall state in the specification that the detection card must have this capability.

Video imaging vehicle detection is effective in intersections not facing south or at the base of the vertical curve of a road due to sun burst.

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Fog is a factor when installing video imaging vehicle detection. The detector card has an adjustment to compensate for various degree of visibility but will require seasonal adjustments when fog is no longer a concern.

Video imaging vehicle detection is susceptible to false positive detection due to shadows and insects on the camera lens. Traffic signals near bridges facing south will cause various missed calls or false positives detection due to the changing shadow patterns throughout the day and throughout the annual solar inclination.

Section 3.8 – Overhead Clearance

The minimum radial clearance between overhead utility lines and new or relocated signal or lighting standards shall be as follows:

Table 4. Minimum Overhead Clearance

Voltage (Phase to Phase)	Minimum Clearance (ft)
Up to 600	3.3
Over 600 to 50,000	10
Over 50,000 to 75,000	11
Over 75,000 to 125,000	13
Over 125,000 to 175,000	15
Over 175,000 to 250,000	17
Over 250,000 to 370,000	21
Over 370,000 to 550,000	27
Over 550,000 to 1,000,000	42

For additional information relating to overhead clearances, refer to California Code of Regulations, Title 8, Section 2946, “Provisions for Preventing Accidents Due to Proximity of Overhead Lines.”

Section 3.9 – Battery Backup Systems

A BBS is a system that provides emergency power in the event of a power failure or interruption. The BBS shall be used for signal and lighting systems and pedestrian hybrid-beacon systems. The BBS cabinet is attached to the Department-furnished controller assembly. The BBS includes the following:

- electronic assembly
- batteries
- all necessary hardware and interconnect wiring

The electronic assembly for the BBS is Department-furnished.

The designer shall coordinate with district signal operations personnel on the preferred type of BBS system. Only one Standard Plan sheet for the BBS should be referenced for project submittal.

Section 3.10 – Signal Heads

A signal head is a component on the signal standard used to give visual indication to control movement of traffic through the signalized intersection.

Normally, mast arm left-turn signal heads should be located as close as practical to the following:

1. One head in line with the center of a one-lane left-turn approach. See Placement – 3
2. One head in line with the stripe between the two lanes of a two-lane left-turn approach. See Placement – 5

Normally, mast arm signal heads for through lanes should be located as close as practical to the following*:*

1. One head in line with the lane stripe between the two through lanes for a two-lane approach. See Placement – 1.
2. One head in line with the center of the two through lanes for a three-lane approach without a protected left turn. See Placement – 2.
3. One head in line with the lane strip between the first and second through lanes for a three-lane approach with a protected left-turn phase and a separate left-turn lane. See Placement – 3.
4. Two heads, one in line with the stripe between the first and second lanes, and the second in line with the lane stripe between the third and fourth lanes for a four-lane approach. See Placement – 9.

For mast arm signal head placements not described above, see drawings of mast arm signal head placements 1 through 11.

For guidance on placing near-side signal indications at a signal location, please refer to the *California MUTCD*.

For the minimum distances between the limit and the placement of through traffic mast arm mounted signal heads, the designer shall refer to the *California MUTCD*.

At least two signal heads shall be provided on each approach for each signal phase and shall be installed in accordance with *California MUTCD* requirements.

A near-side signal head should be provided for through traffic. The designer should use the maximum case loading for the signal mast arm length needed.

The designer shall refer to Table 4D-1 of the *California MUTCD* for recommended number of primary signal faces for through traffic on approaches with posted, statutory, or 85th-percentile speed of 45 mph or higher.

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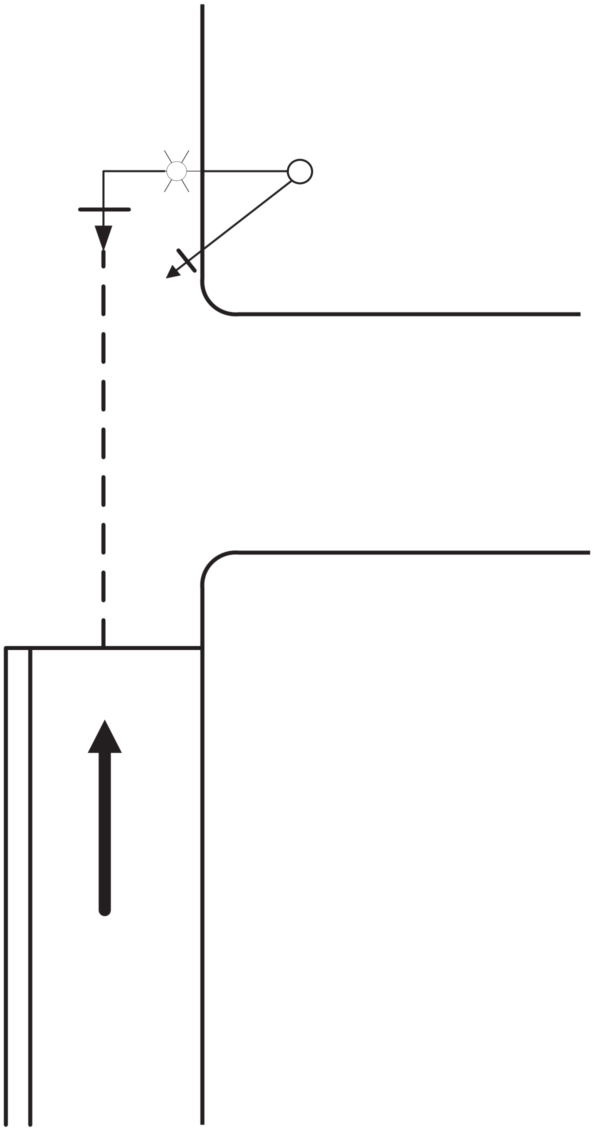
One Through Lane Only

Could Be Combined Through/Right-Turn Lane

- - - - - - Preferred Placement



Caltrans Mast Arm Signal Heads Placement #1

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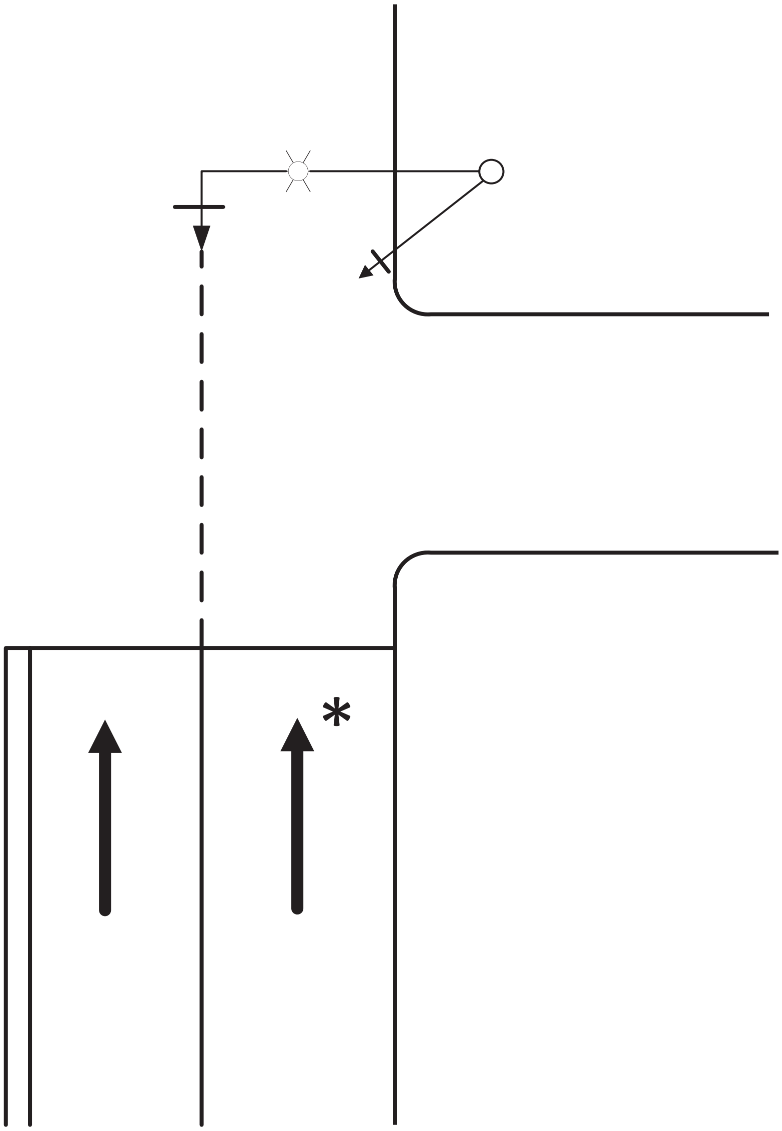
Two Through Lanes

Three-Section 12” Circular Mast Arm Mounted Signal Indication

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane.



Caltrans Mast Arm Signal Heads Placement #2

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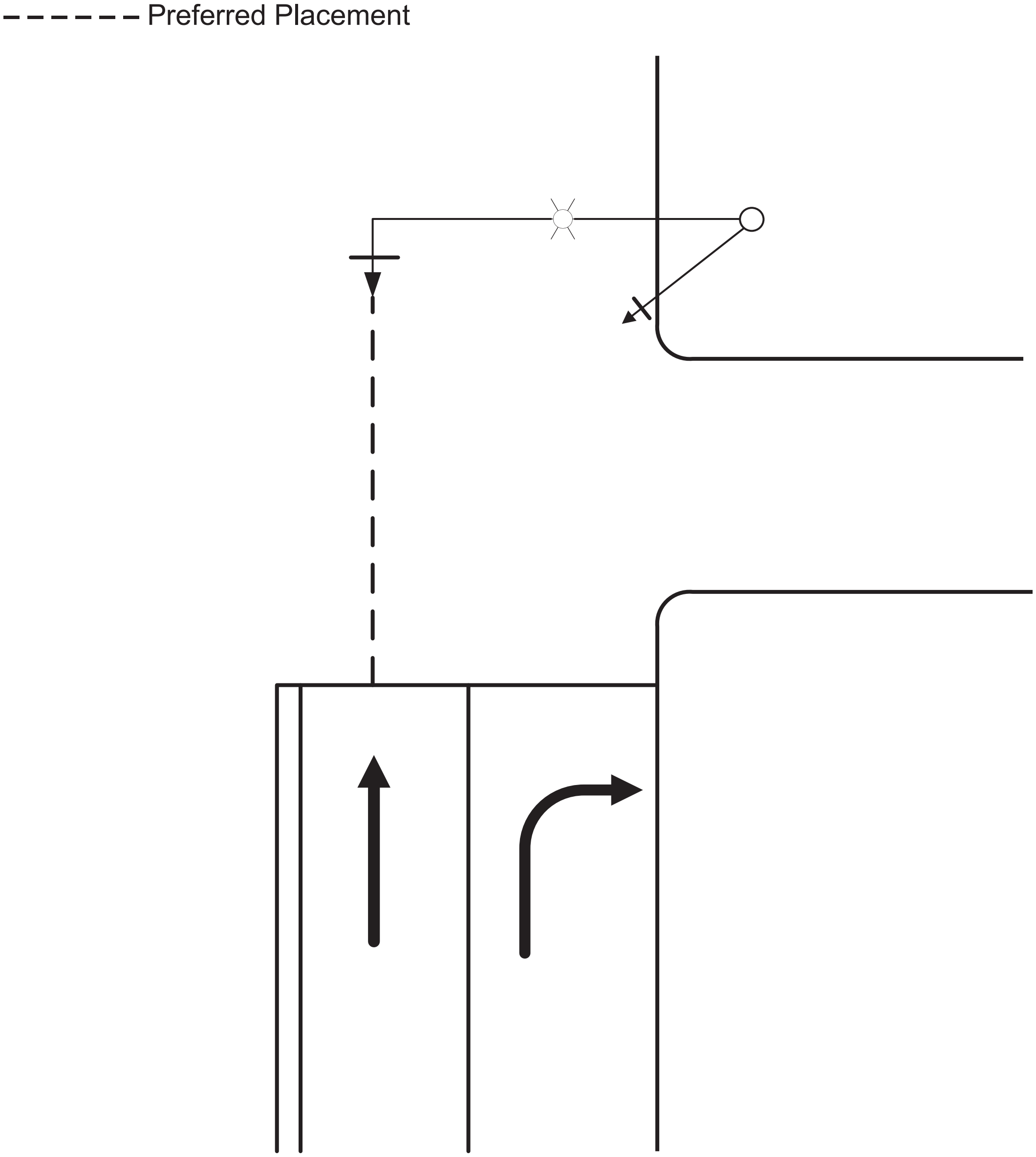
One Through Lane and a Right-Turn Only Lane



Caltrans Mast Arm Signal Heads Placement #3

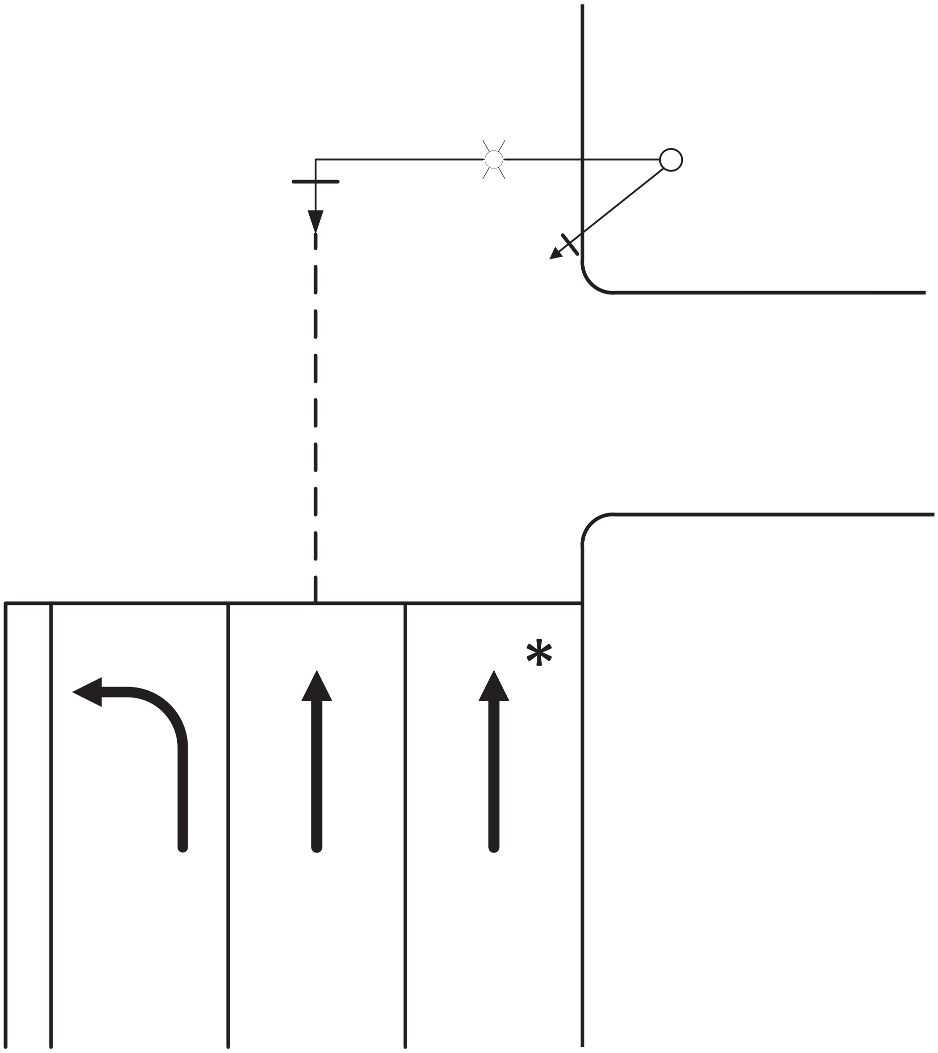
Two Through Lanes with Permissive Left-Turn Only and a Separated Left-Turn Lane

Three-Section 12’ Circular Mast Arm Mounted Signal Indication

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Install R73-7 sign when recommended by district signing and striping branch.



Caltrans Mast Arm Signal Heads Placement #4

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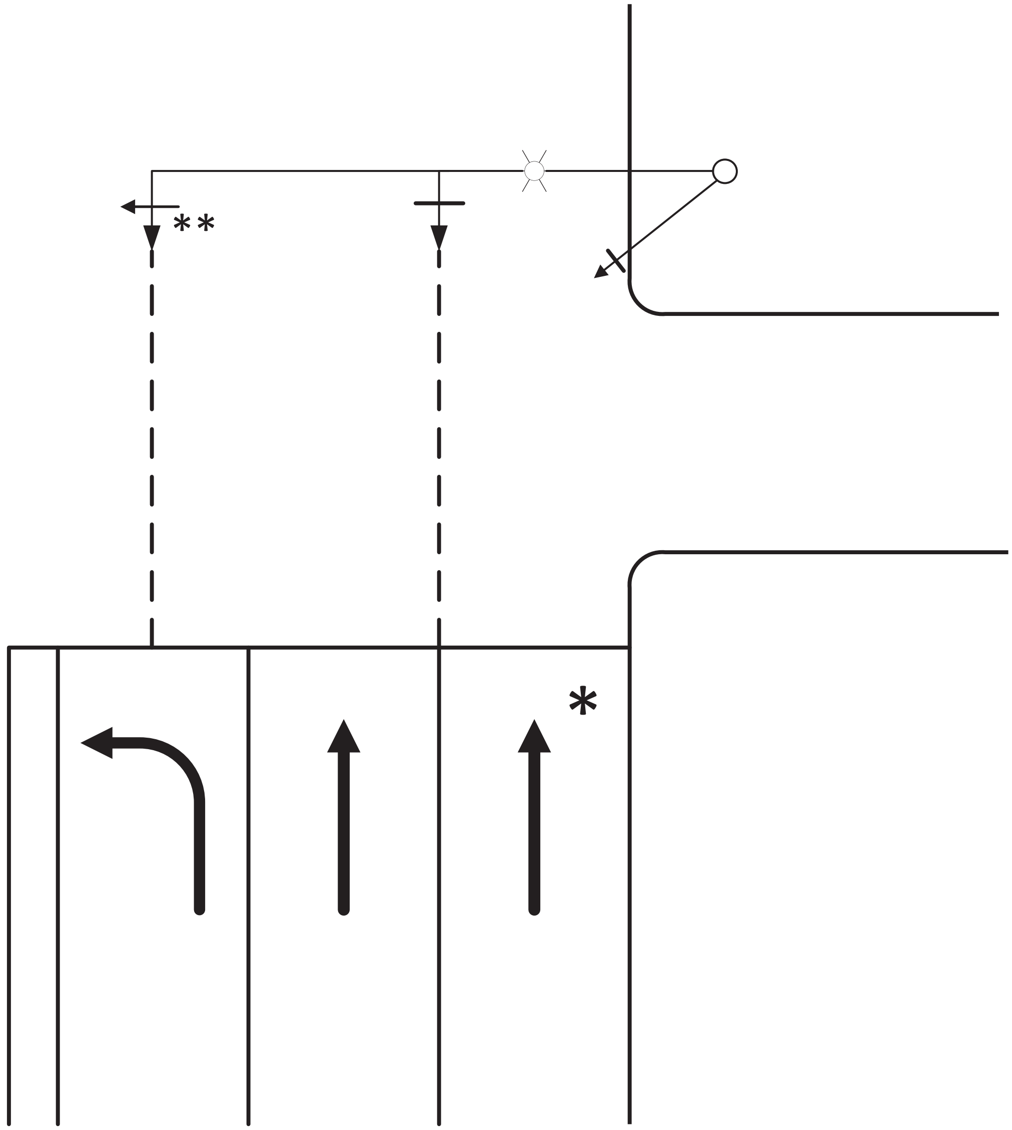
Two Through Lanes with Protected Left-Turn Phase and a Separated Left-Turn Lane

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown or a maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities.



Caltrans Mast Arm Signal Heads Placement #5

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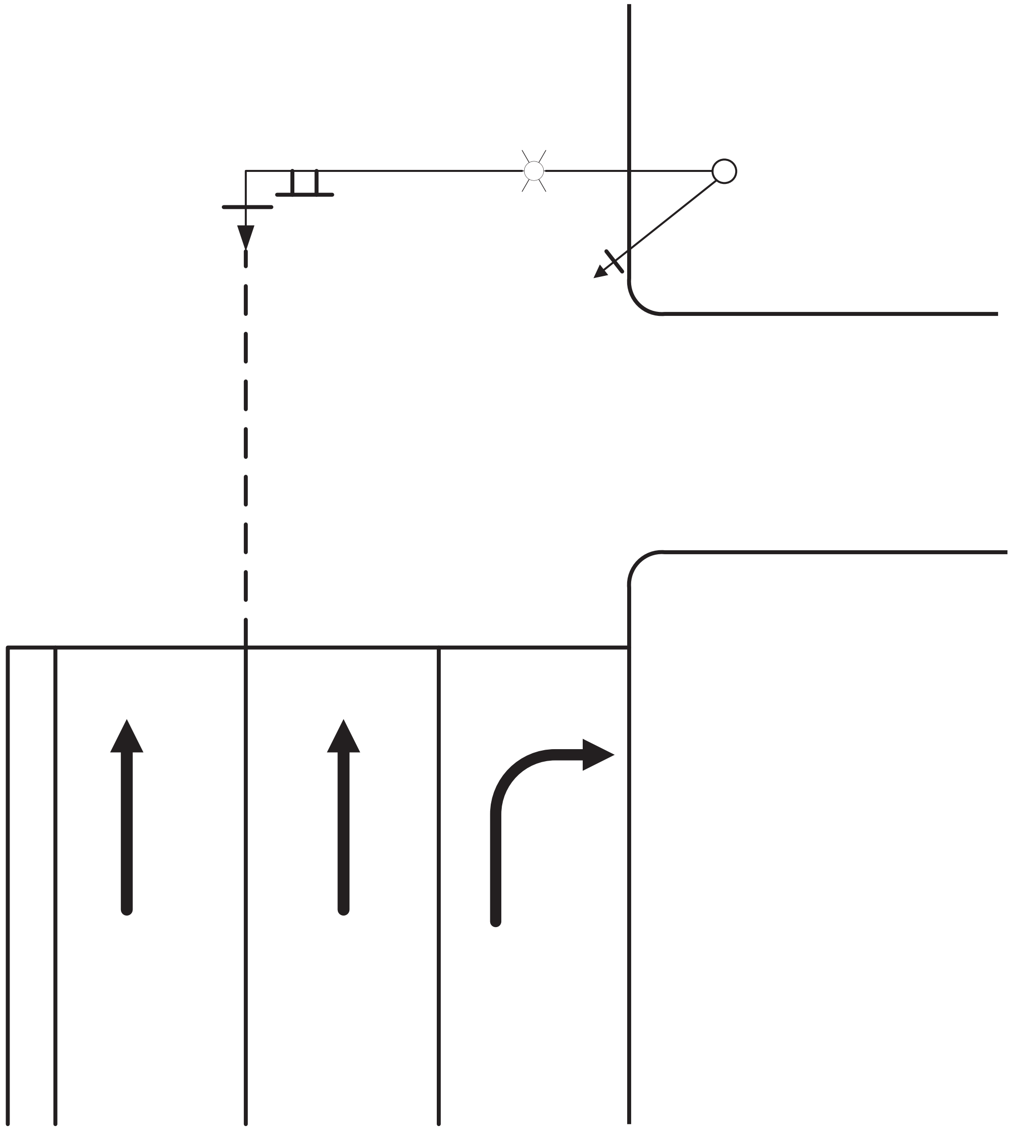
Two Through Lanes and a Right-Turn Only Lane

– – – – – – Preferred Placement

*Install R73-7 sign when recommended by district signing and striping branch



Caltrans Mast Arm Signal Heads Placement #6

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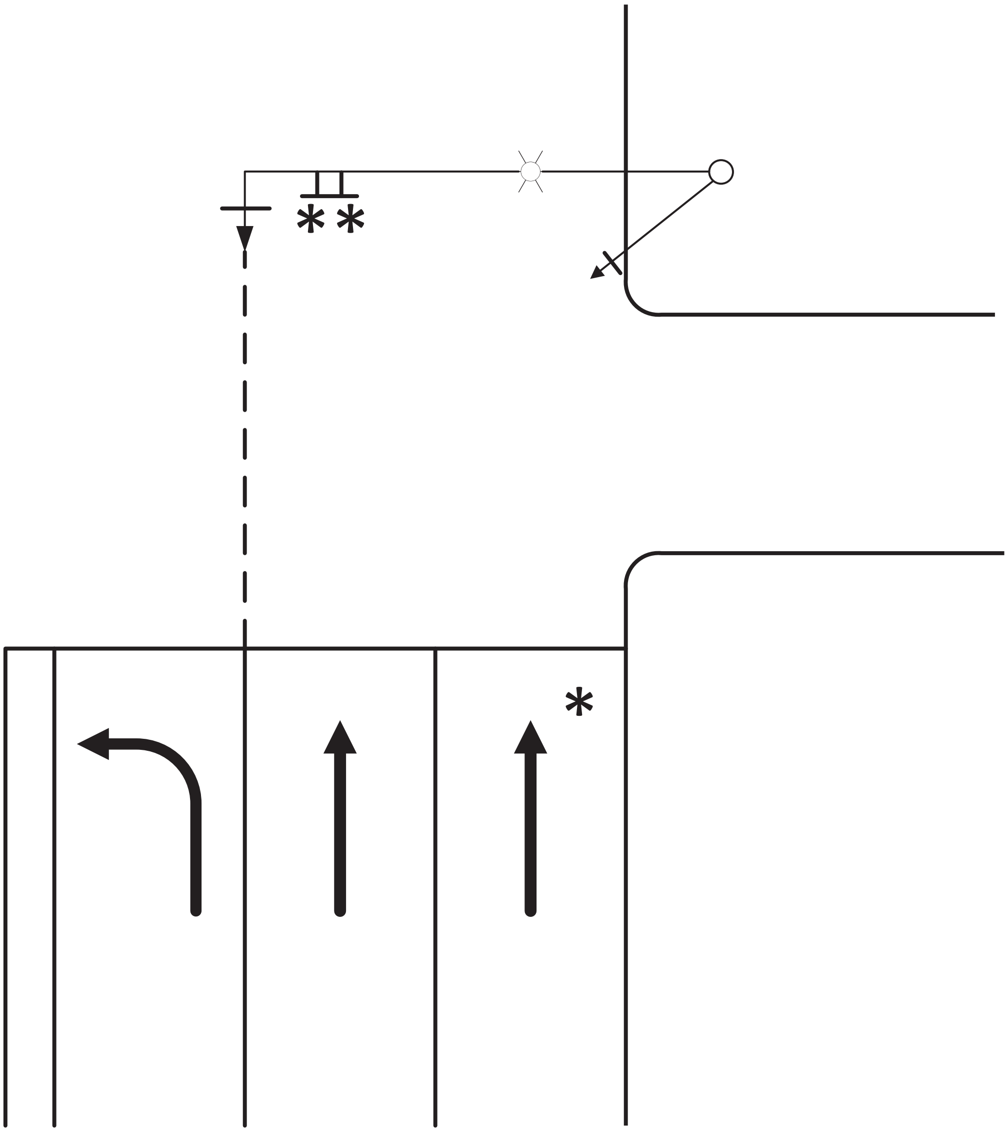
Protected Permissive Left-Turn or Permissive Protected Left Turn with Mast Arm Mounted Signal Indication (MAS-5A)

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Install R73-7 sign when recommended by district signing and striping branch.



Caltrans Mast Arm Signal Heads Placement #7

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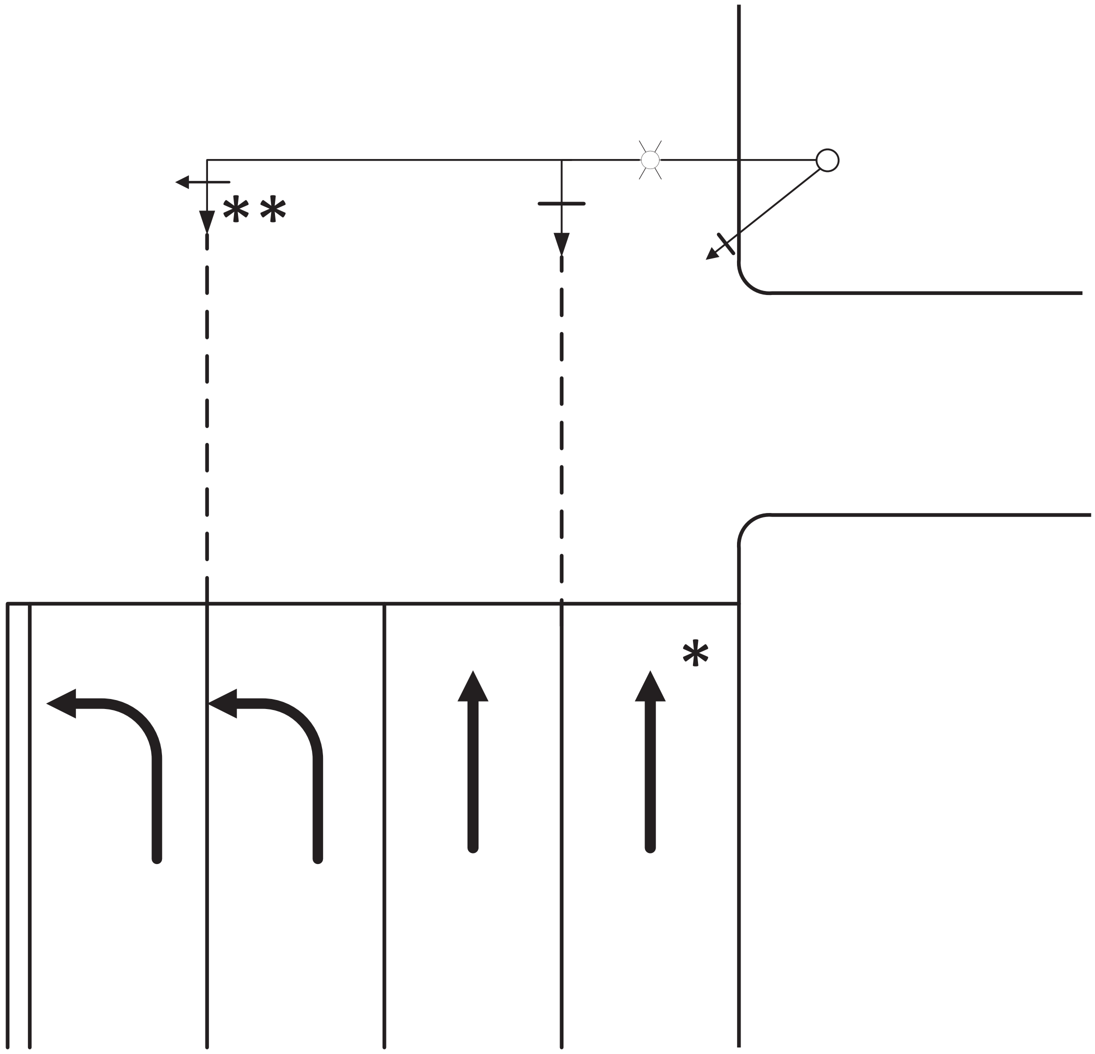
Two Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown or a maximum 5 ft to the left form the lane line between the two left-turn lanes, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities.



Caltrans Mast Arm Signal Heads Placement #8

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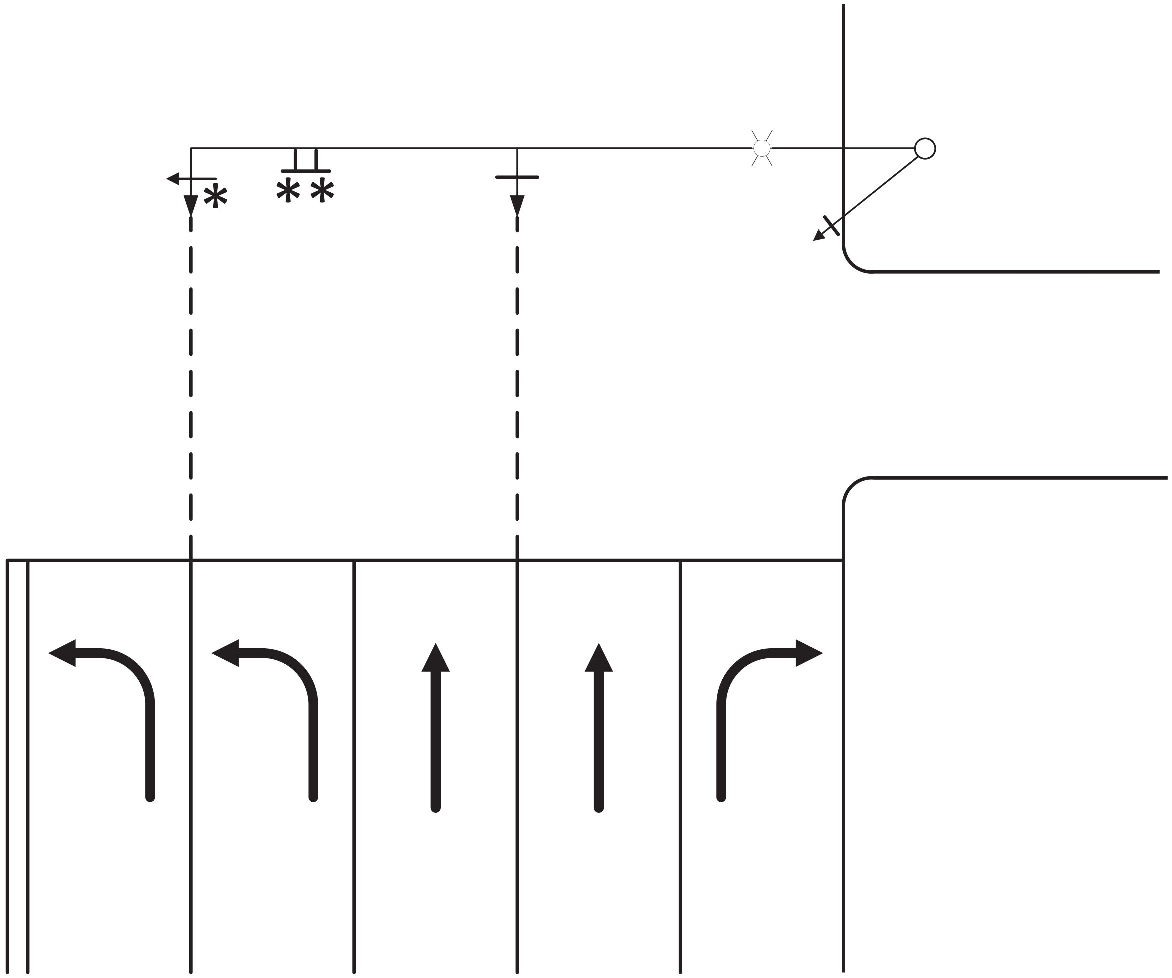
Two Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes and One Right-Only Lane

– – – – – – Preferred Placement

*Left-turn head should be as shown or a maximum 5 ft to the left form the lane line between the two left-turn lanes, unless otherwise prevented by field conditions, such as aboveground obstructions or underground utilities.

**Install R73-7 sign when recommended by district signing and striping branch.



Caltrans Mast Arm Signal Heads Placement #9

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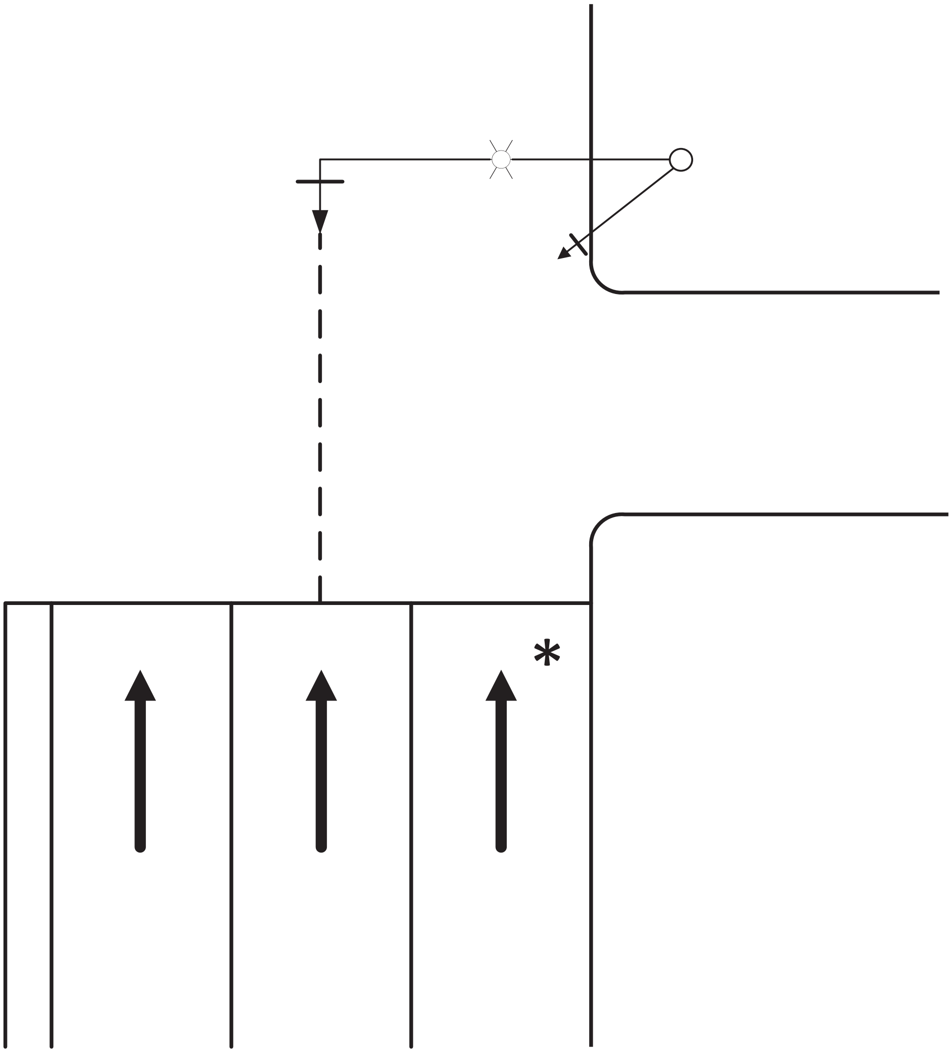
Three Through Lanes Only

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane



Caltrans Mast Arm Signal Heads Placement #10

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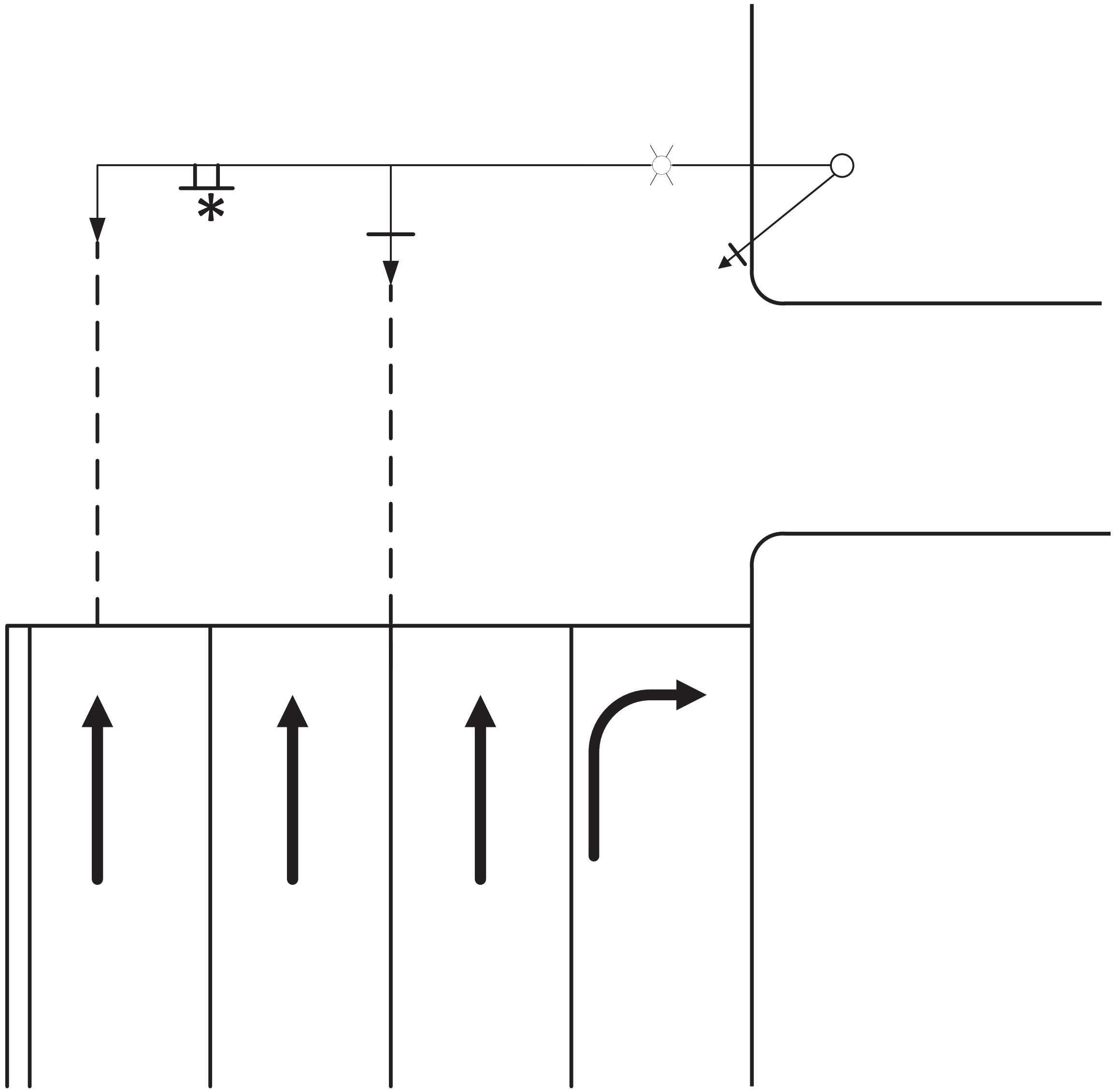
Three Through Lanes Only and a Right-Turn Only Lane

– – – – – – Preferred Placement

*Install R73-7 sign when recommended by district signing and striping branch



Caltrans Mast Arm Signal Heads Placement #11

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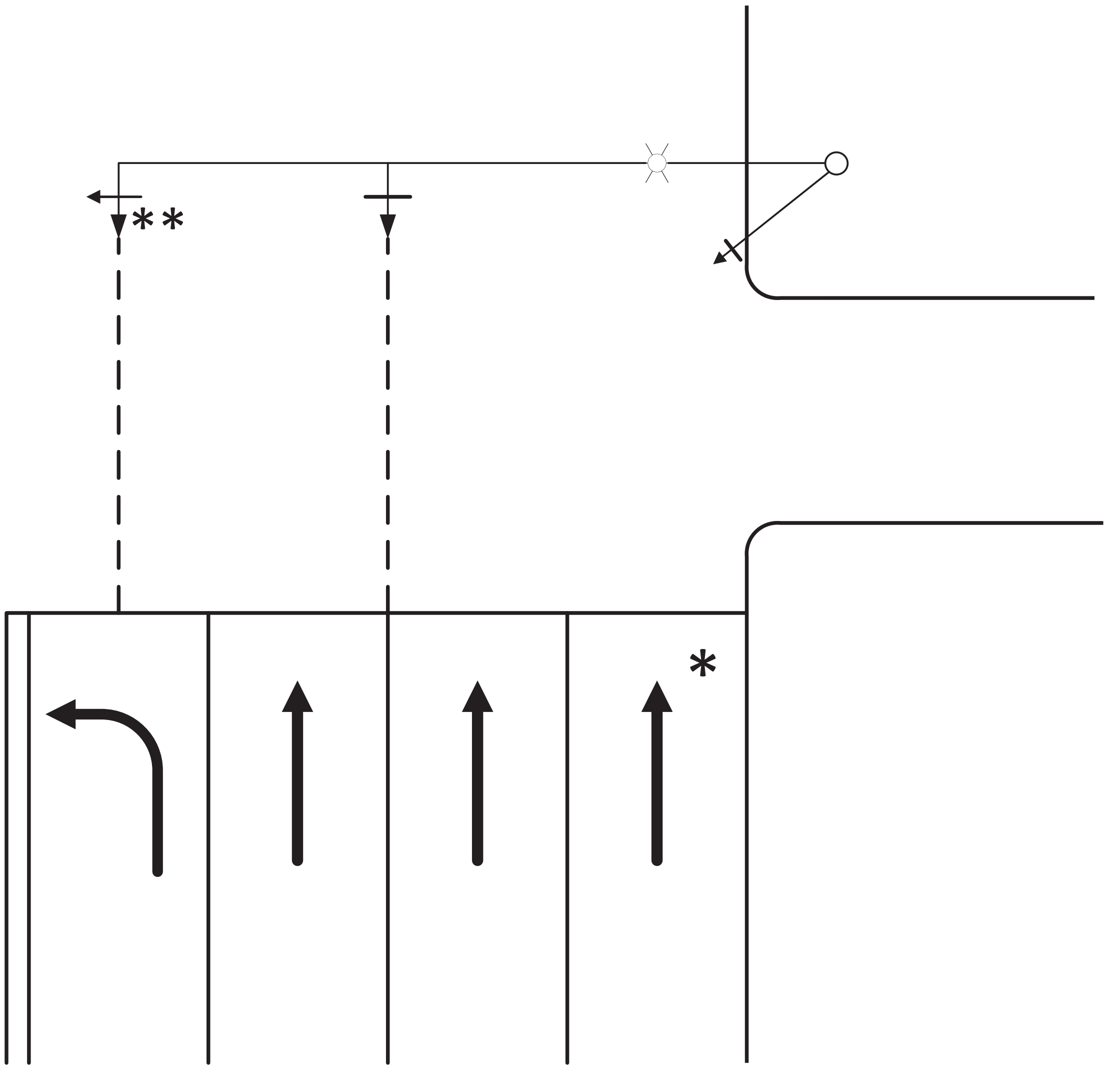
Three Through Lanes with Protected Left-Turn Phase and a Separate Left-Turn Lane

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstruction or underground utilities.



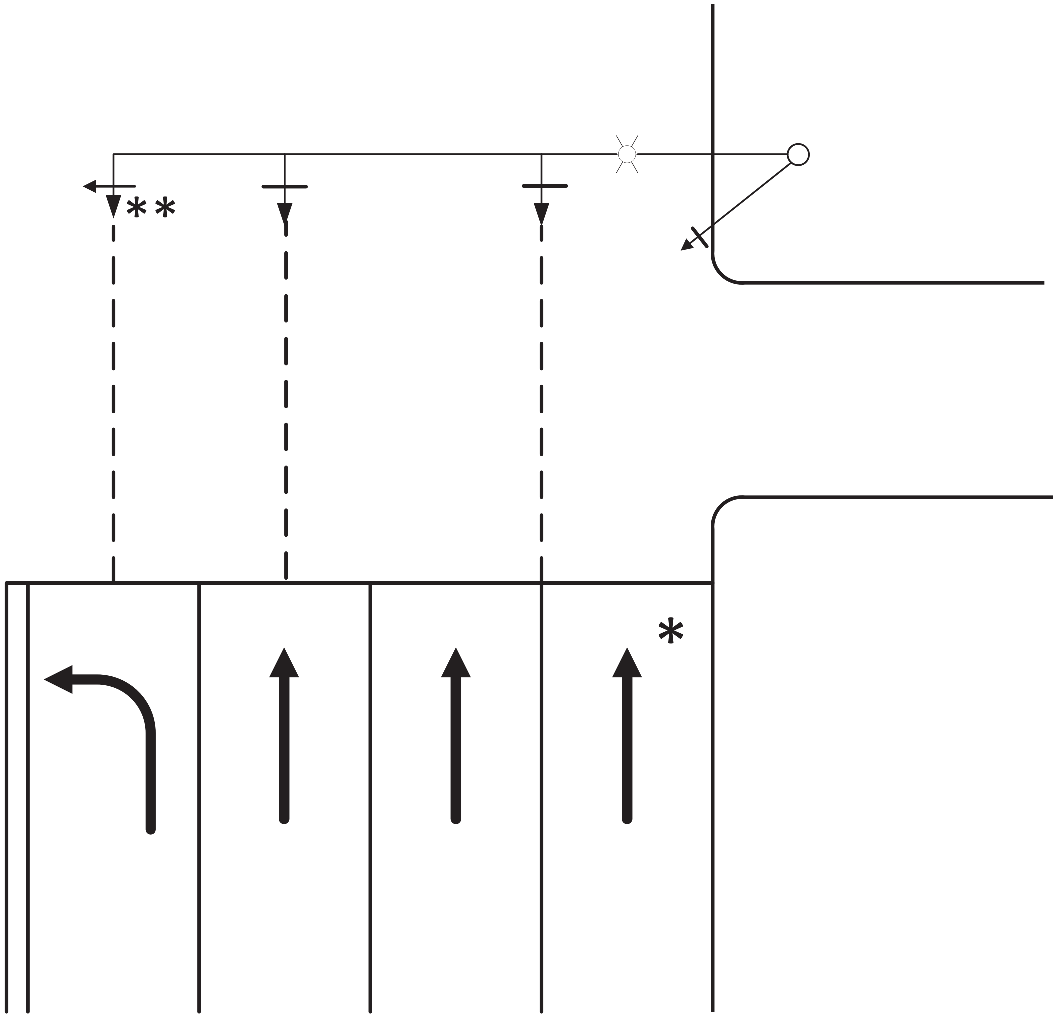
Caltrans Mast Arm Signal Heads Placement #12

Three Through Lanes with Protected Left-Turn Phase and a Separate Left-Turn Lane

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown or a maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities



Caltrans Mast Arm Signal Heads Placement #13

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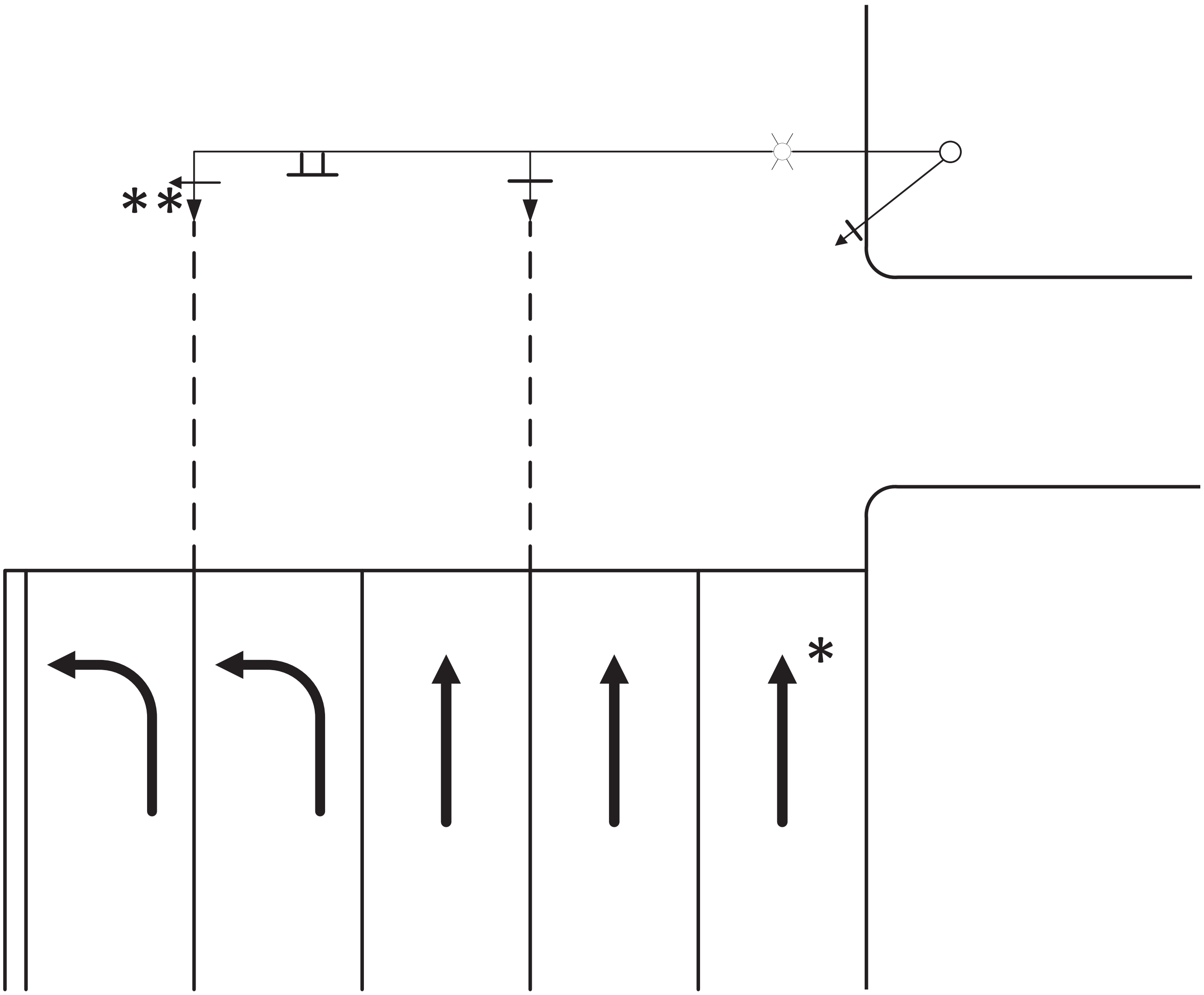
Three Through Lanes with Protected Left-Turn Phase and Two Left-Turns

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown maximum 5 ft to the left from the lane line between the two left-turn lanes, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities.



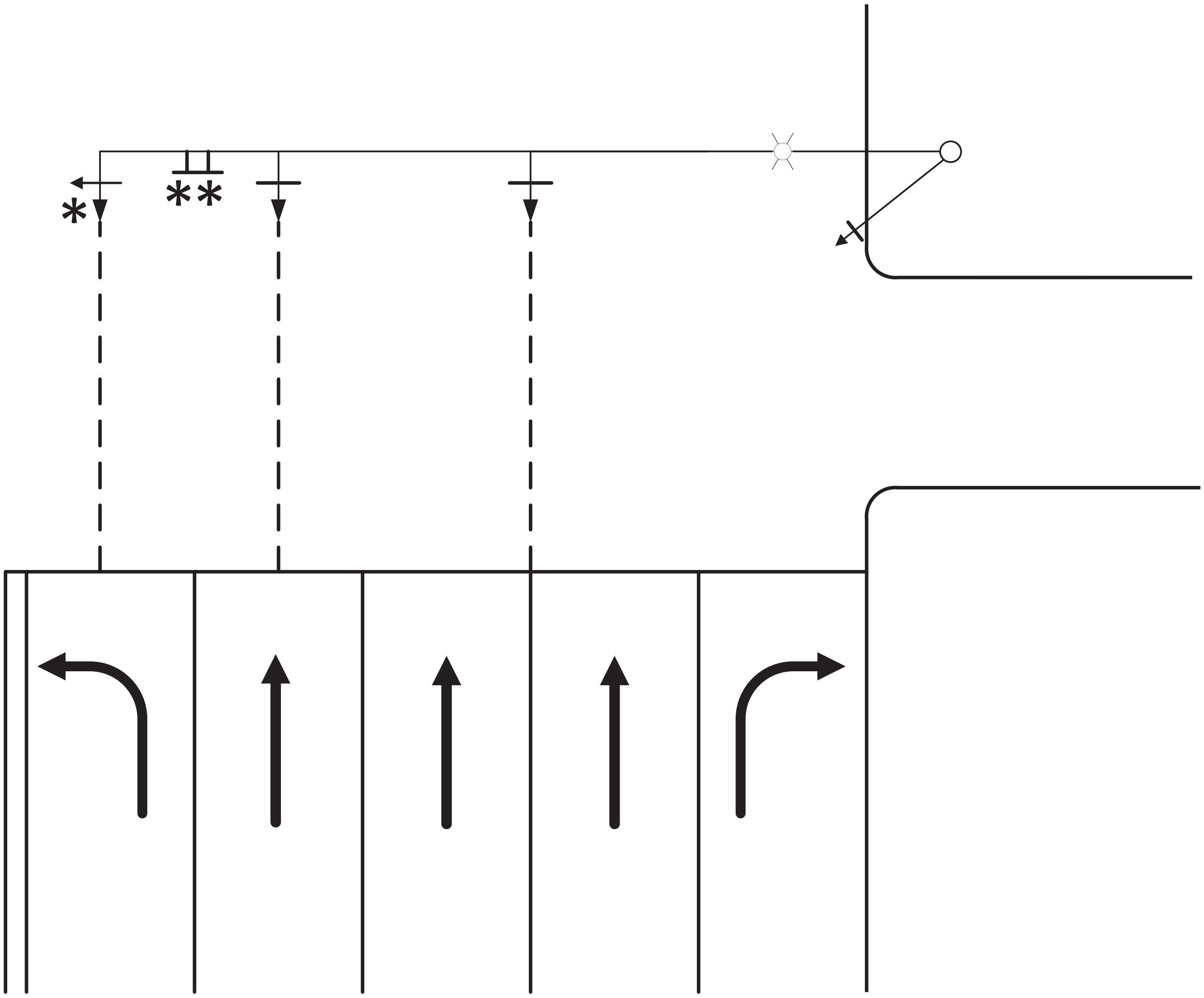
Caltrans Mast Arm Signal Heads Placement #14

Three Through Lanes with Protected Left-Turn Phase and a Separated Left-Turn Lane and One Right-Turn Only Lane

– – – – – – Preferred Placement

*Left-turn head should be as shown or a maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities

**Install R73-7 sign when recommended by district signing and striping branch



Caltrans Mast Arm Signal Heads Placement #15

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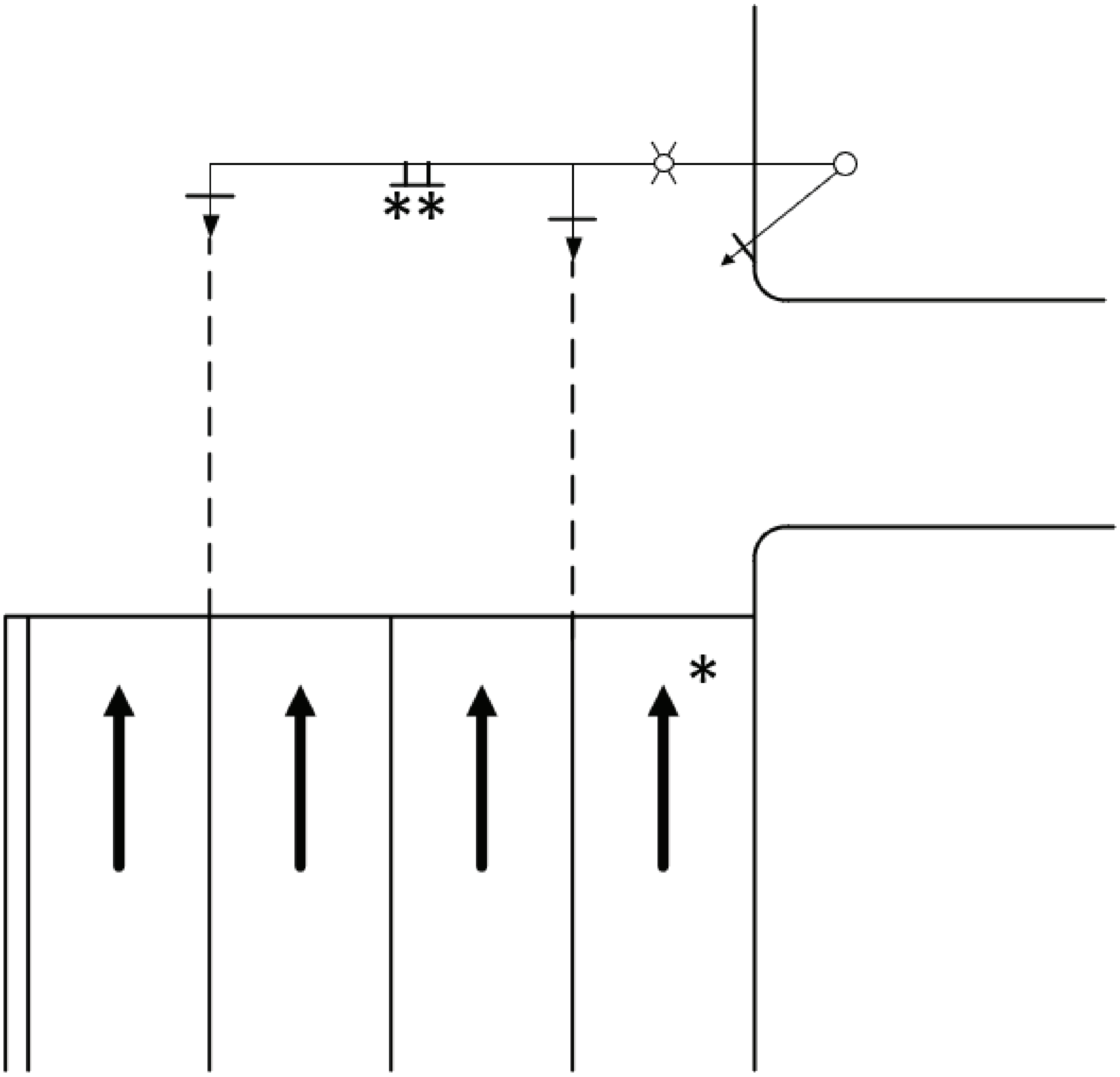
Four Through Lanes Only

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Install R73-7 sign when recommended by district signing and striping branch



Caltrans Mast Arm Signal Heads Placement #16

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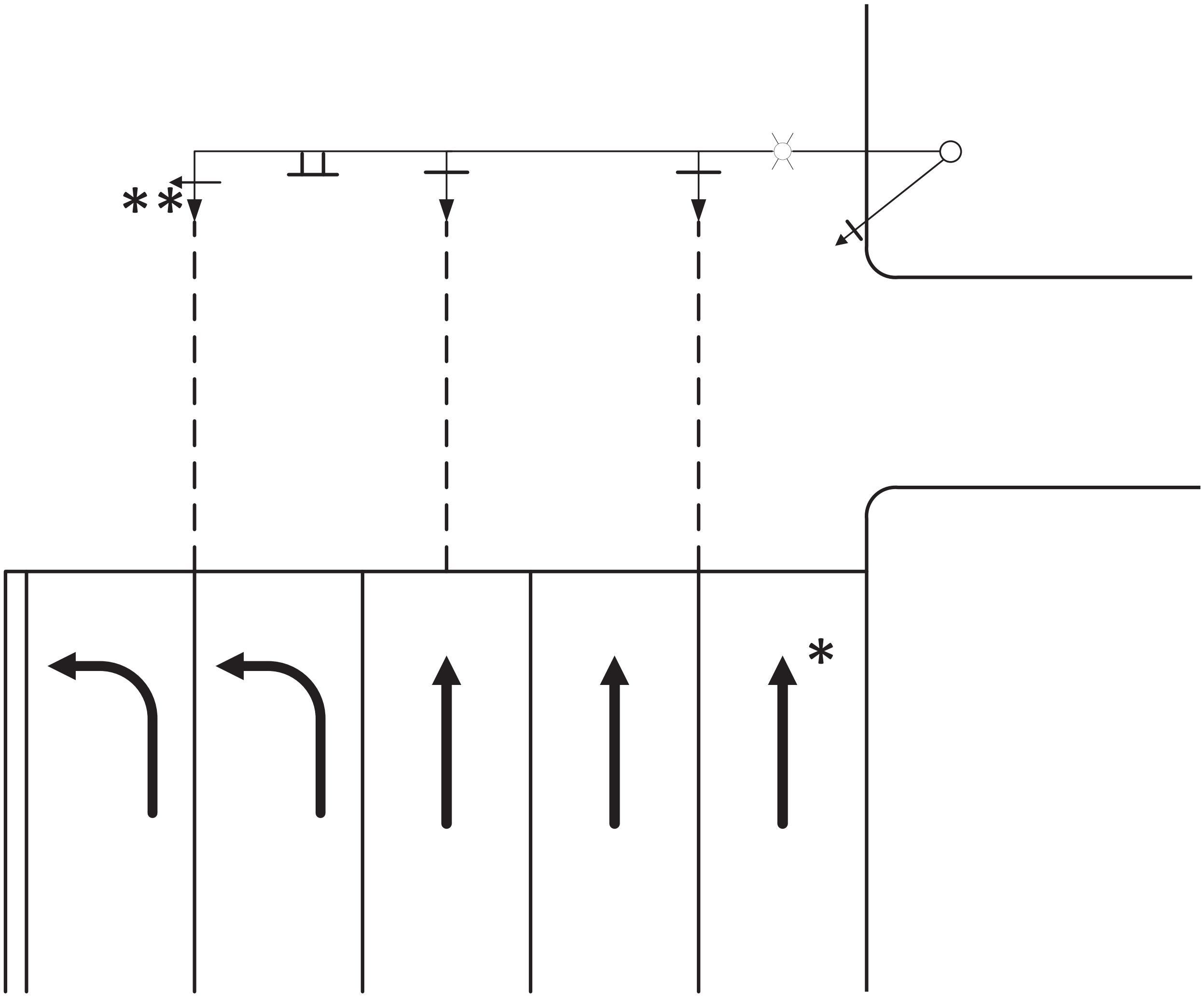
Three Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left turn should be as shown or maximum 5 ft to the left from lane line between the two left-turn lanes, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities



Caltrans Mast Arm Signal Heads Placement #17

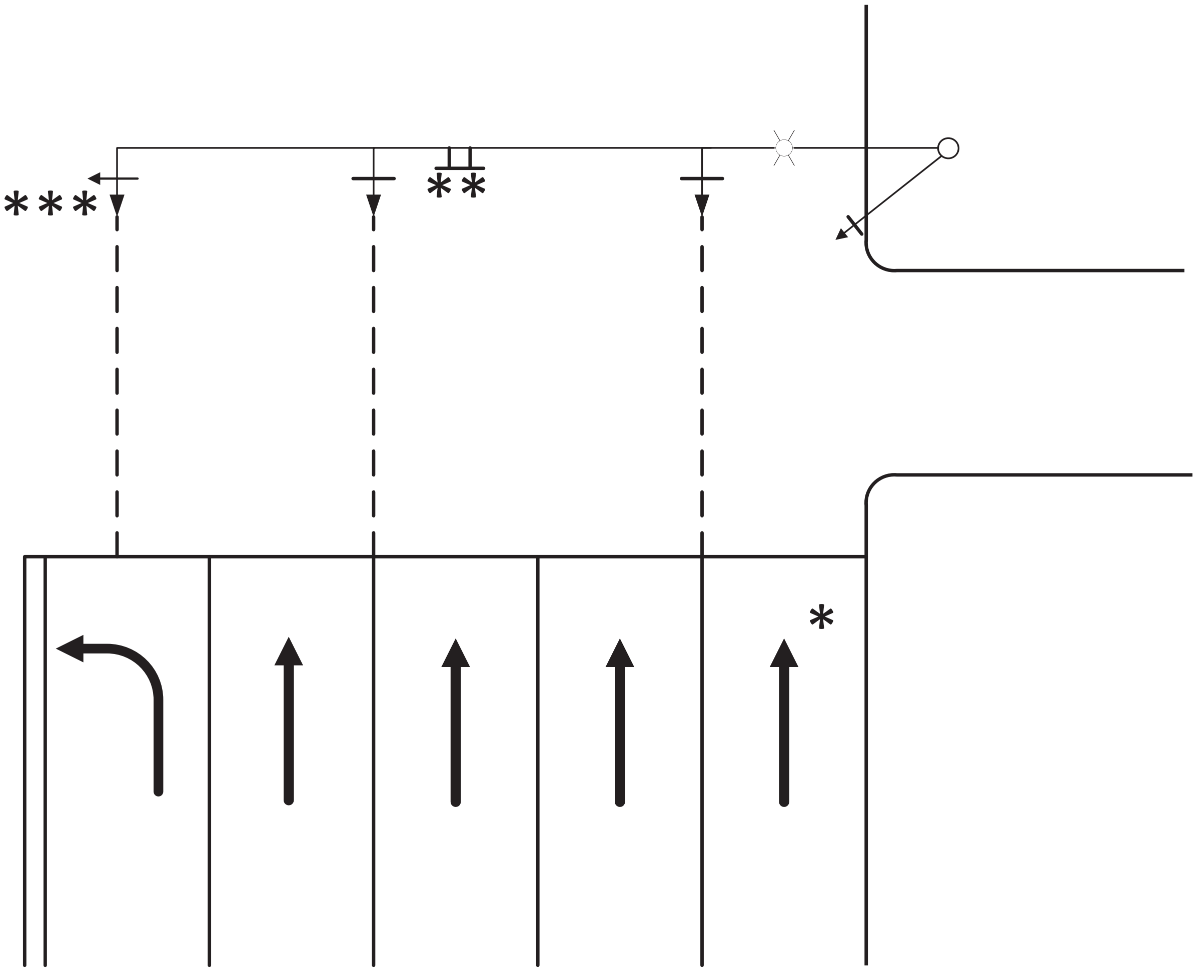
Four Through Lanes with Protected Left-Turn Phase and a Separate Left-Turn Lane

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Install R73-7 sign when recommended by district signing and striping branch

***Left-turn head should be as shown or a maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities.



Caltrans Mast Arm Signal Heads Placement #18

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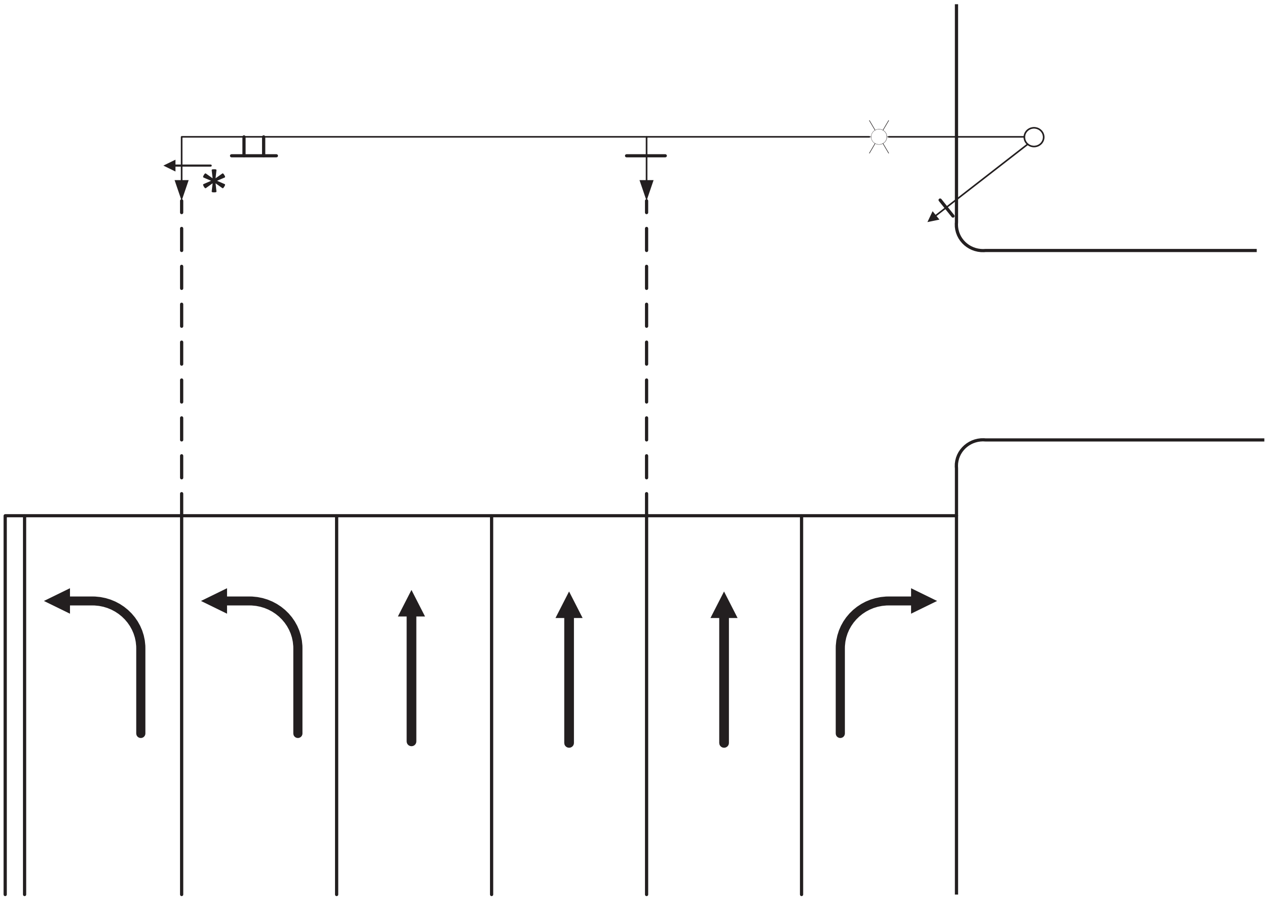
Three Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes and One Right-Only Lane

– – – – – – Preferred Placement

*Left-turn head should be as shown or a maximum 5 ft to the left form the lane line between the two left-turn lanes, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities.



Caltrans Mast Arm Signal Heads Placement #19

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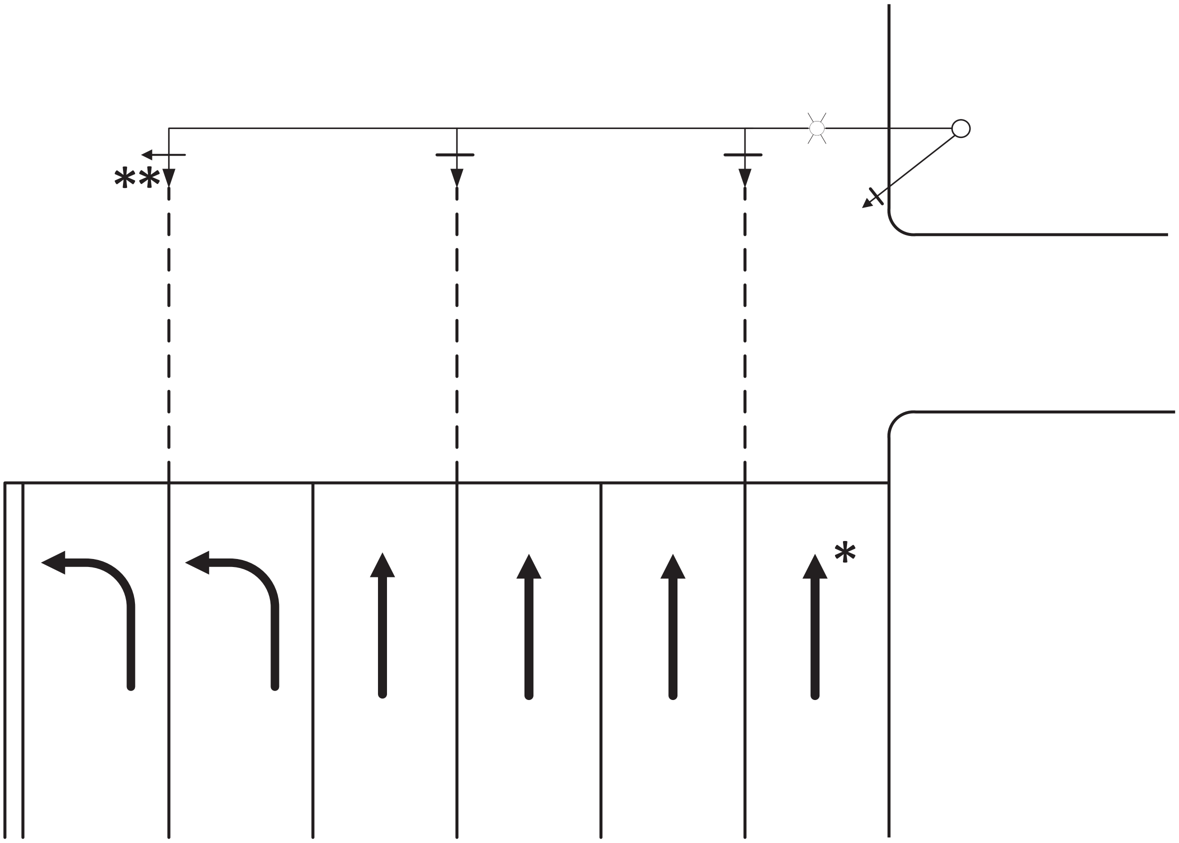
Four Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes and One Right-Only Lane

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown or a maximum 5 ft to the left form the lane line between the two left-turn lanes, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities.



Caltrans Mast Arm Signal Heads Placement #20

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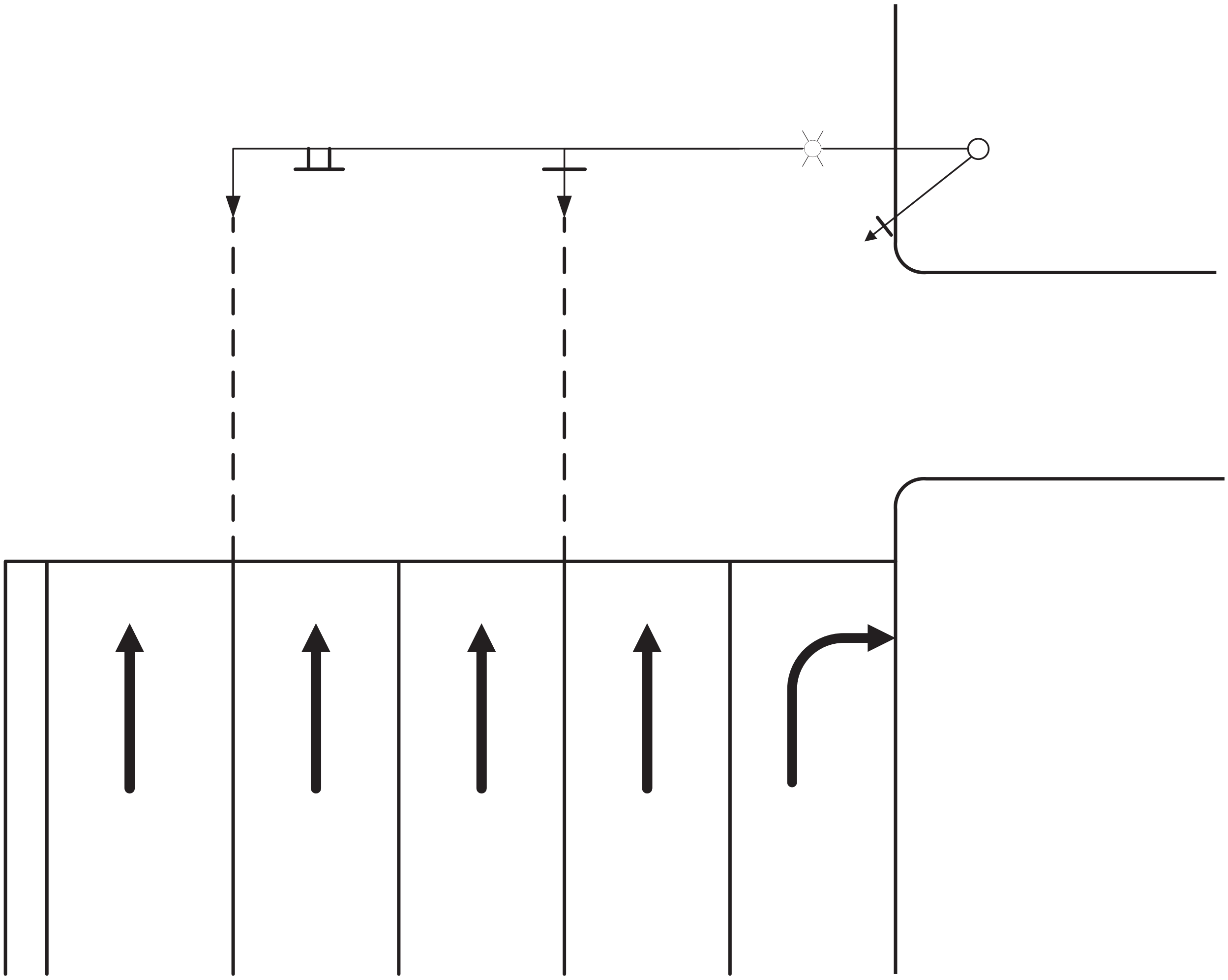
Four Through Lanes and One Right-Turn Only Lane

- - - - - - Preferred Placement



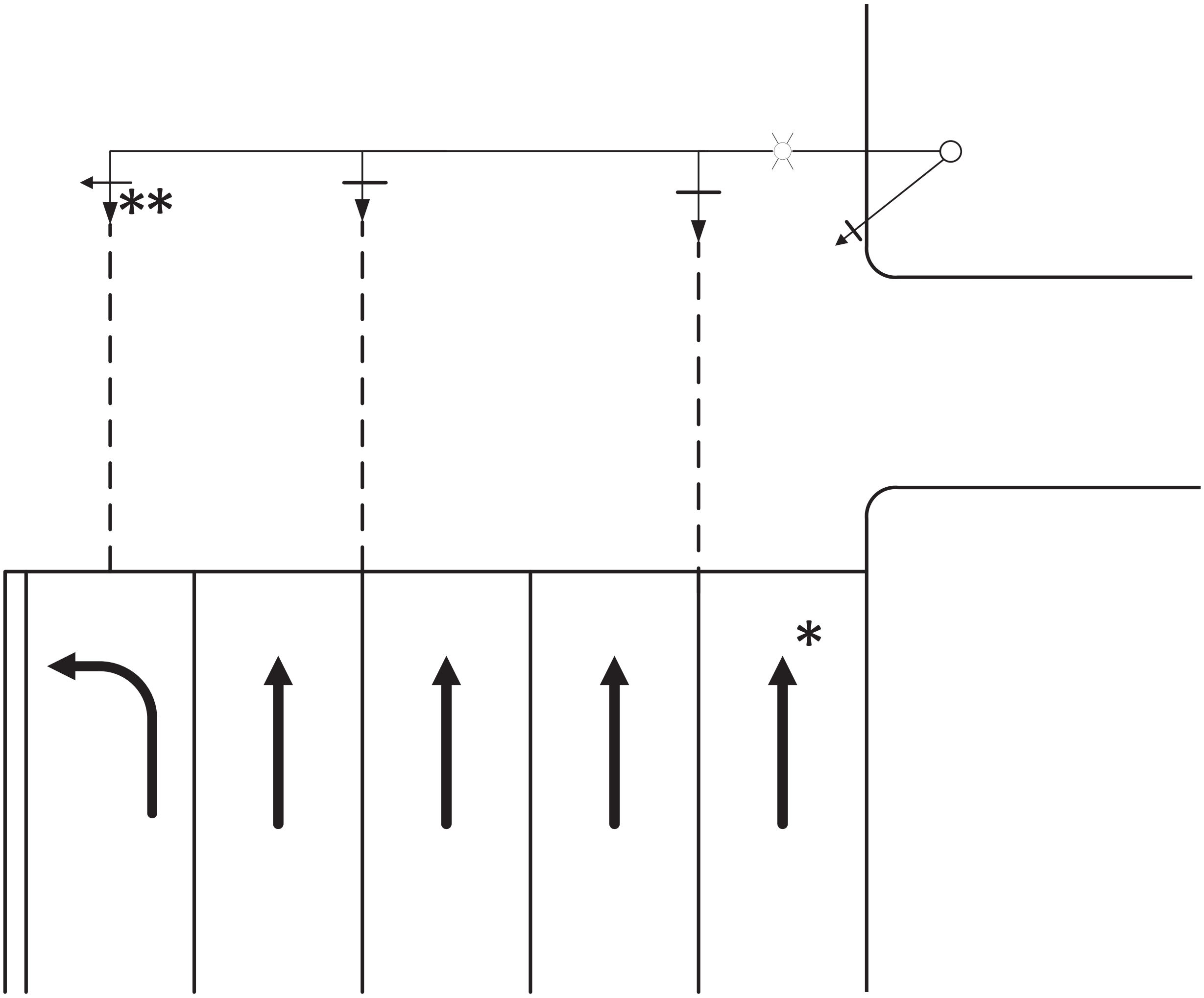
Caltrans Mast Arm Signal Heads Placement #21

Four Through Lanes with Protected Left Turn and a Separate Left-Turn Lane

– – – – – – Preferred Placement

*Optional lane with a through and right-turn lane

**Left-turn head should be as shown or a maximum to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities



Caltrans Mast Arm Signal Heads Placement #22

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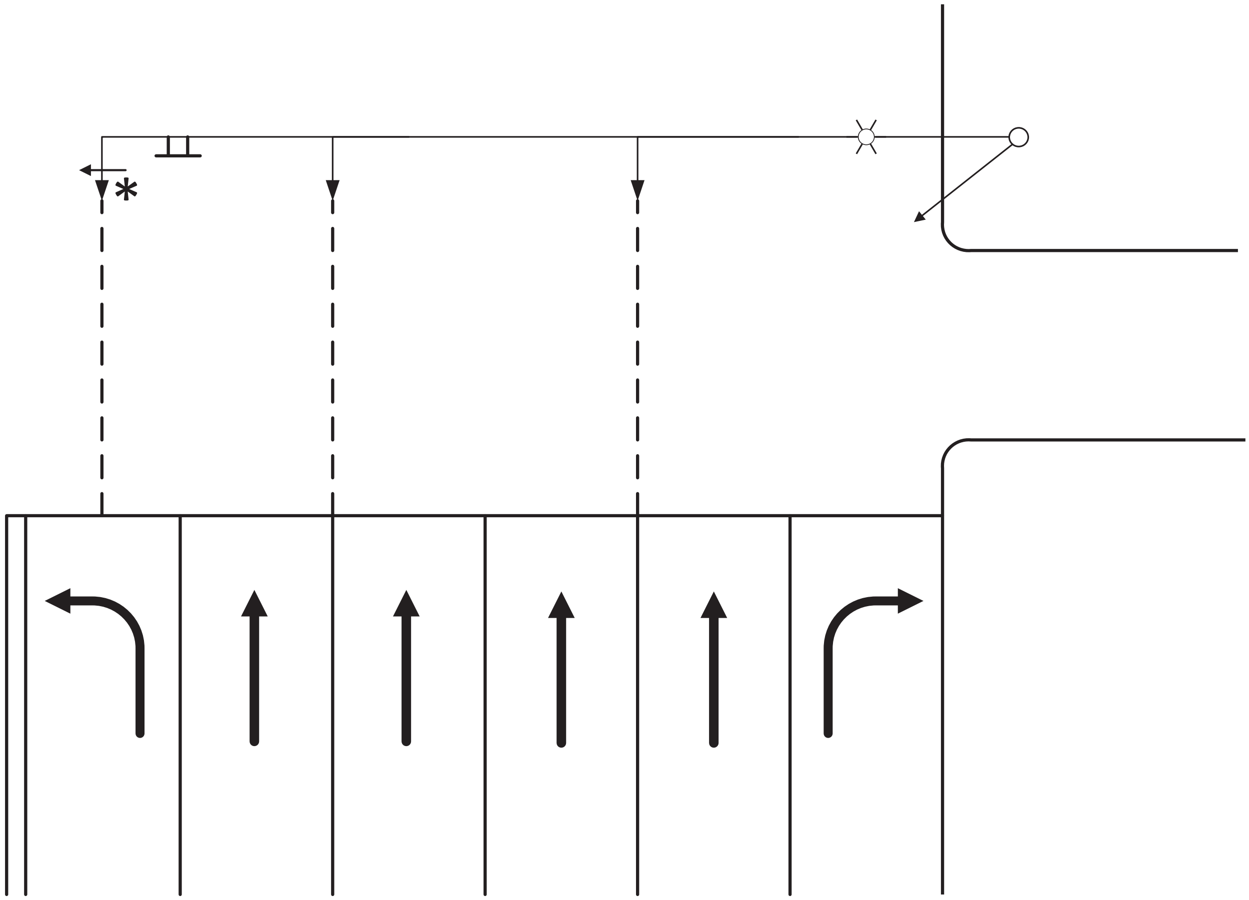
One Right Turn and Four Through Lanes with Protected Left Turn and a Separate Left-Turn Lane

– – – – – – Preferred Placement

*Left-turn head should be as shown or a maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities



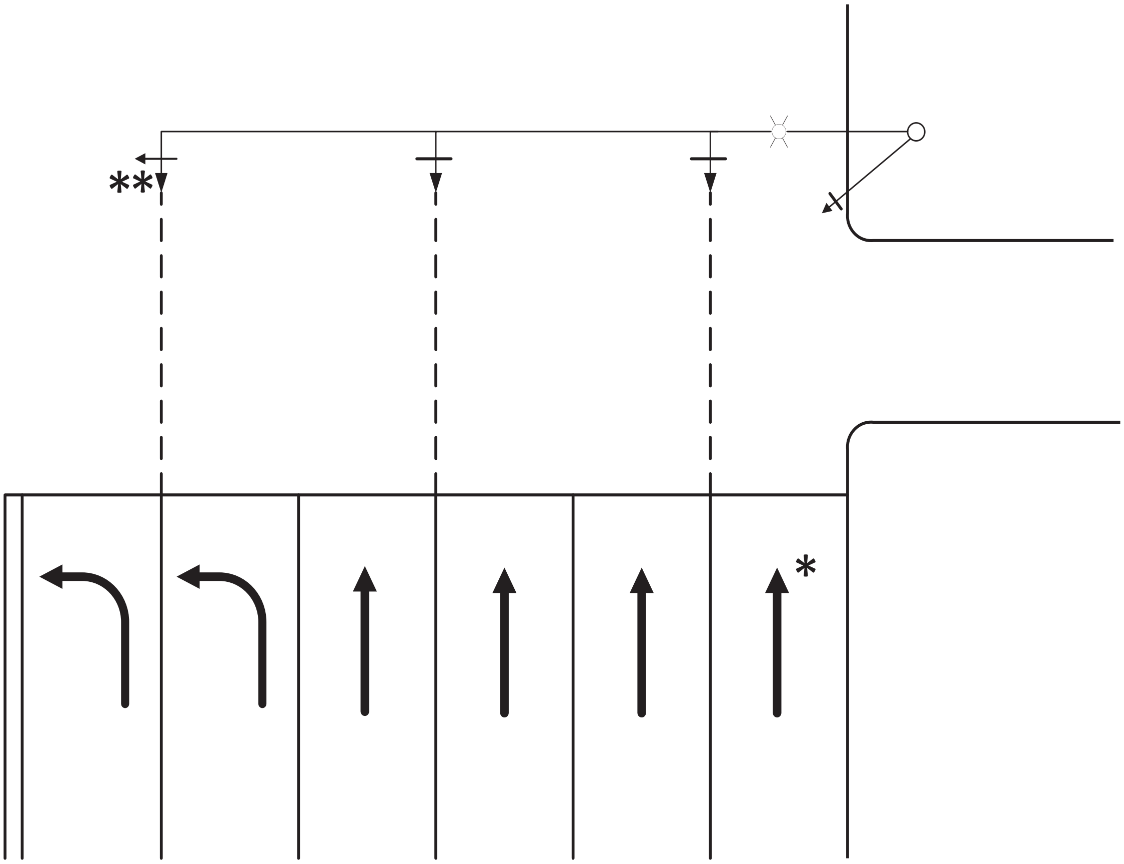
Caltrans Mast Arm Signal Heads Placement #23

Four Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes

– – – – – – Preferred Placement

*Optional lane with a through and right turn lane

**Left-turn head should be as shown or a maximum 5 ft from the lane line between the two left-turn lanes, unless otherwise prevented by field conditions such aboveground obstructions or underground utilities



Caltrans Mast Arm Signal Heads Placement #24

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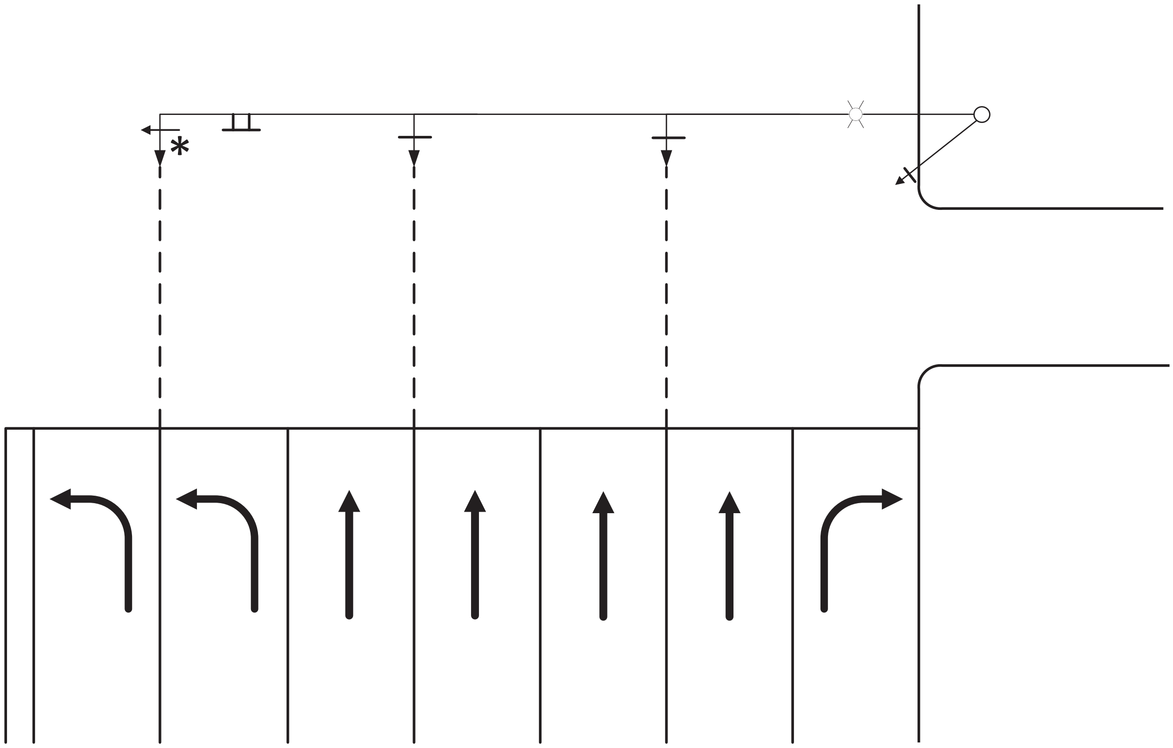
Four Through Lanes with Protected Left-Turn Phase and Two Left-Turn Lanes and One Right-Turn Only Lane

– – – – – – Preferred Placement

*Left-turn head should be as shown or a maximum 5 ft to the left from the center of the left-turn lane, unless otherwise prevented by field conditions such as aboveground obstructions or underground utilities



Caltrans Mast Arm Signal Heads Placement #25

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Section 3.11 – Pedestrian Signal Heads

A pedestrian signal head is a component on the signal standard used to give visual indication to control movement of pedestrian traffic through the signalized intersection.

Pedestrian signal heads should be located where there is minimum visibility interference from vehicles stopped at the crosswalk or limit line.

Section 3.12 – Phase Diagram

A phase diagram is a visual representation that depicts the vehicle and pedestrian movement through an intersection.

A phase diagram shall be provided for each signal plan. All the phases including the overlaps should be properly designated.

The designer must coordinate with district signal operations branch for the phase diagram at each location. The designer must ensure the proper phases are identified in the Conductor and Conduit Schedule and at the signal heads in the plan view sheets.

Section 3.13 – Conductor and Conduit Schedule

A conductor and conduit schedule is a table shown in the project plans that depicts the conduit and conductor sizes for a signalized intersection.

The designer shall show a conduit and conductor schedule for the design of new signalized intersections.

For a sample of a conductor and conduit schedule, see Appendix N, Example B, Sheet E-2.

Section 3.14 – Pole and Equipment Schedule

A pole and equipment schedule is a table shown in the project plans that depicts the signal standards and attachments for a signalized intersection.

A pole and equipment schedule shall be provided. It should be on the same sheet as the Conduit and Conductor Schedule. For a sample pole and equipment schedule, see Appendix N, Example B, Sheet E-2.

Section 3.15 – Signal Interconnect Cable

A signal interconnect cable is a multi-conductor cable used to connect signalized intersections for coordination purposes.

The designer should consider using a signal interconnect cable for signals less than 0.5 miles apart. See Section 15 – Interconnection Conduit and Cable.

Section 3.16 – Railroad Preemption

Railroad preemption is a process where a railroad is given priority at a signalized intersection.

For railroad preemption, refer to *Standard Interconnect for Traffic Signal Preemption at Railroad Crossings.*

The designer shall show a No. 6 pull box should be installed within the roadway right-of-way as close to the train control box as practical. New railroad preemption cables should be provided in

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a 2” (minimum conduit run (when separate conduit is necessary between the pull box and the controller cabinet.

The designer shall consider that the length of the railroad preemption cable shall not exceed 500 feet due to signal loss when placing the controller cabinet near the railroad cabinet.

For railroad preemption, slots T12-T14 in Input File J shall be used. Other slots may be used for emergency vehicle preemption as needed.

Arrangements shall be made with the railroad authority to provide contact closure input by installing a conduit with preemption cable from the train control box to the state pull box.

Section 3.17 – Pedestrian Barricades

A pedestrian barricade is a barrier that prohibits pedestrian movement.

Where pedestrians are not allowed to cross certain legs of the intersection, a pedestrian barricade may be installed in addition to the R96, “NO PED XING” sign.

Section 3.18 – Flashing Beacons

A flashing beacon is a signal head that flashes intermittently to provide warning to the travelling public.

Chapter 4 – Ramp Metering Systems

A ramp metering system is a combination of elements used to control the flow of traffic entering a state highway.

A ramp metering system includes signals, cabinets, Department-furnished controller assemblies, inductive loop detectors, and flashing beacons. The designer shall place an electrolier at the ramp metering merge point. The designer can consider placing a luminaire at the limit line.

For ramp metering systems, the design engineer shall refer to *Ramp Metering Design Manual*.

For a typical ramp metering system design, see Appendix N, Example C, sheets E-1, ED-1, and EQ-1.

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Chapter 5 – Traffic Monitoring Station Systems

A TMS system is combination of elements that collects data for traffic volume, speed, and occupancy. This data can be relayed back to the TMC.

A TMS includes inductive loop detectors, cabinets, Department-furnished controller units, and Department-furnished inductive loop detector sensor units.

The designer shall place the inductive loop detectors on the mainline at a location where they can detect the flow of traffic. They should be placed in a location where the traffic is not weaving or merging, and away from on and off ramps. The designer shall coordinate the placement of the system with the project engineer.

The designer may consider other off-pavement detection technologies.

For a typical traffic monitoring station system design, see Appendix N, Example D, Sheet E-1.

Chapter 6 – Traffic Census Station Systems

Section 6.1 – General

A traffic census station system is combination of elements that counts or classifies vehicles depending on the equipment configuration.

Section 6.2 – Count Station

A count station includes a traffic counter, cabinet or National Electrical Manufacturers Association (NEMA) 3R enclosure, and inductive loop detector.

A count station has one loop per lane to collect data for traffic volumes. This data may be relayed back to the TMC, which is used to produce the Annual Average Daily Traffic report to FHWA to justify future projects.

Section 6.3 – Automatic Vehicle Classification Station

An automatic vehicle classification (AVC) includes a traffic counter, cabinet, inductive loop detector, and piezoelectric axle sensors.

An AVC station collects the data for traffic volumes and vehicle classifications.

A piezoelectric axle sensor is provided with the cable attached. The designer shall make measurements in the field to ensure that the length of the screened transmission cable is less than 500 feet.

For a typical AVC layout, see figure below.

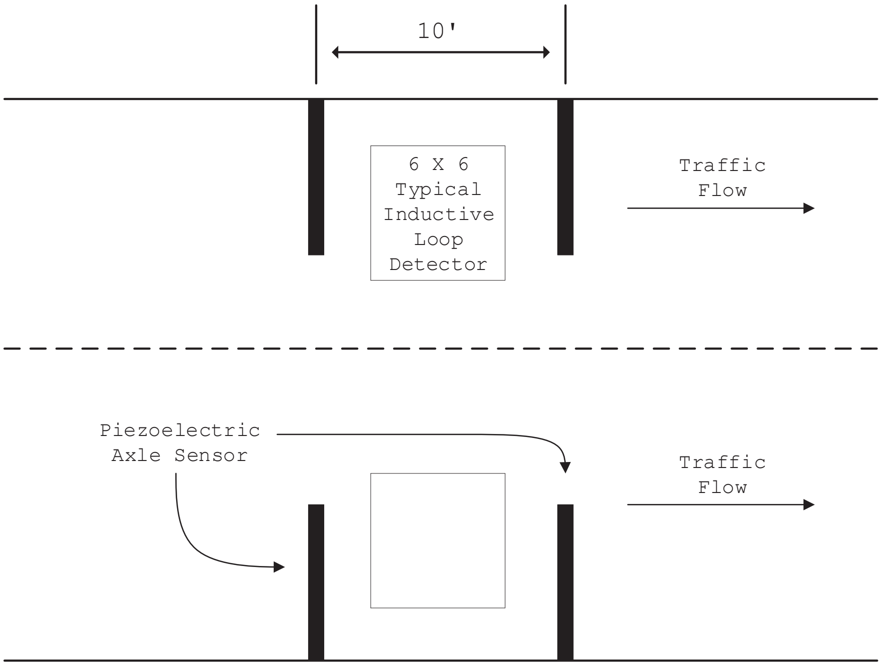

Figure 6: Piezoelectric Axle Sensors

The AVC is requested by the district census coordinator or HQ census coordinator.

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The piezoelectric axle sensors should be placed on one edge of each lane. The exact location of the AVC shall be provided by the district census coordinator. Center the inductive loop between the piezoelectric axle sensors.

For a typical traffic census station design, see Appendix N, Example E, sheets E-1 and ED-1. The bid item Traffic Monitoring Station should be used for the design of traffic census station system.

Chapter 7 – Flashing Beacon Systems

The flashing beacon system includes flashing beacon(s), flashing beacon control assembly, and typically a sign to provide warning to the travelling public.

Coordinate with the district signing staff to ensure proper signs are installed with the system.

The design and operation of a flashing beacon system must comply with the *California MUTCD*, "Chapter 4L."

The designer should coordinate with the project engineer to determine the location for the flashing beacon system.

For a typical flashing beacon system design, see Appendix N, Example F, Sheet E-1.

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Chapter 8 – Pedestrian Hybrid Beacon Systems

A pedestrian hybrid beacon system is a combination of elements to control vehicular and pedestrian traffic, including lighting to provide illumination.

Per the *California MUTCD*, a pedestrian hybrid beacon system may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants or at a location that meets traffic signal warrants, but a traffic control signal will not be installed.

The designer shall use Type MAS-3A as a signal head for a pedestrian hybrid beacon system and designate this on the plan sheet.

For a typical pedestrian hybrid beacon system design, see Appendix N, Example G, Sheet E-1.

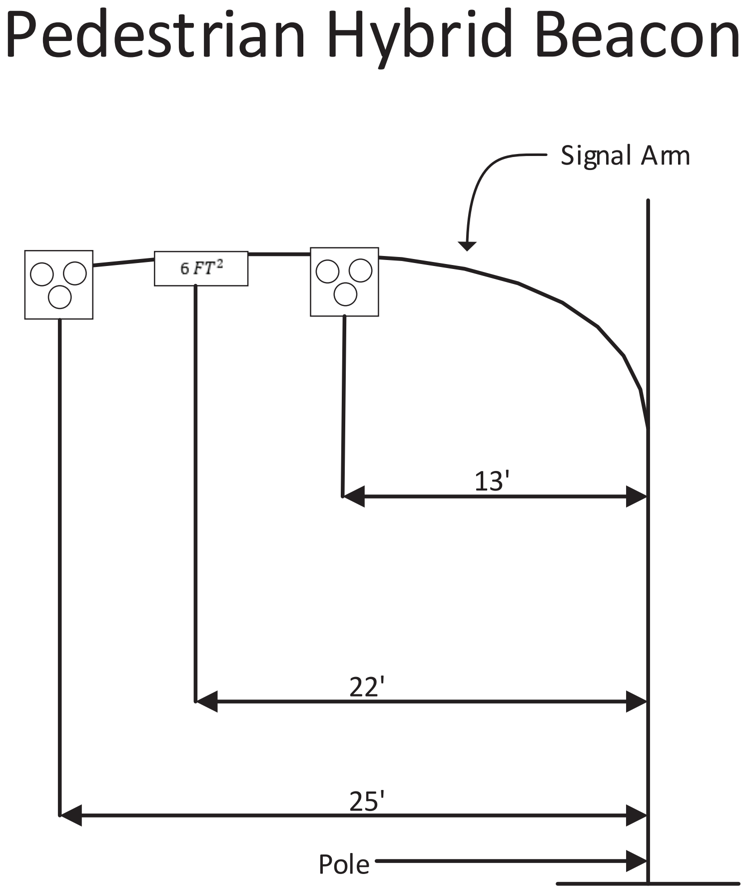

Figure 7: Example of Pedestrian Hybrid Beacon on a Signal Standard 18-31-100 with 25 ft mast arm.

Chapter 9 – Extinguishable Message Sign Systems

An extinguishable message sign (EMS) system is a combination of elements used to display a preset message to the travelling public to provide warning messages.

The EMS may be mounted on a sign structure or on two-wood posts on the roadside. A NEMA 3R enclosure is typically mounted on the same structure or posts where the sign is installed.

Consider placing the EMS for maximum visibility to the traveling public while keeping in mind the sunburst just before sunset and after sunrise.

For a typical EMS system design, see Appendix N, Example H, Sheet E-1.

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Chapter 10 – Highway Advisory Radio Systems

A highway advisory radio (HAR) system is a combination of elements used to broadcast messages on a radio station to the traveling public.

The HAR system includes a pole, grounding system, antenna, radio transmitter and associated equipment, and shall include one of the following signs:

- Static signs with flashing beacons
- EMS with or without flashing beacons
- CMS

The HAR system uses an enclosure or a Model 334L controller cabinet to house the transmitter and associated equipment.

Signs used in conjunction with a HAR should be placed approximately 1.5 to 2 miles from a HAR, taking into consideration the transmitter coverage area of the HAR. The HAR should be located where the best transmission of the radio signal will occur. Consider the drivers' ability to tune their radio while driving. The HAR should also be located where it is convenient for the traveling public to alter their routes.

The designer shall consult with the district TMC on the location of the HAR system.

Early in the design stage, the designer shall coordinate with the district radio engineer for system licensing. A Federal Communications Communication (FCC) license for the operation of the HAR is required. A license may take up to 6 months after the application is accepted before it is granted. The designer shall take into consideration that the HAR system must be built within one year of the granting of the license.

For a typical highway advisory radio system design, see Appendix N, Example I, sheets E-1 and ED-1.

Chapter 11 – Changeable Message Sign Systems

A changeable message sign (CMS) system is a combination of elements used to display dynamic messages to provide information to the travelling public.

The CMS system includes the following Department-furnished equipment: Model 700 series sign, controller, and test box.

The designer shall ensure that the sign is procured through the Department-furnished material ordering process.

The following are typical locations on where to place the sign types:

- The Model 700 is used alongside major freeways.
- The Model 710 is used on conventional highways.
- The Model 720 may be used on two-lane highways or for special conditions.

The designer must note the model of the CMS to be installed on the project plans.

The sign requires a 120V, one-pole circuit breaker at the service equipment enclosure. Refer to the TEES, "Chapter 11" for more information.

The designer should avoid installing a CMS in the median.

The designer must allow time for Special Design Branch A under the Office of Design and Technical Services under the Division of Engineering Services to design the CMS structure and foundation.

For a typical changeable message sign system design, see Appendix N, Example J, sheets E-1 and ED-1.

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Chapter 12 – Camera Systems

A camera system is a combination of elements used to monitor state highways.

The designer should design for an IP-based camera system.

An IP-based camera system may require a power injector or power over ethernet (POE)++-enabled communication device with an outdoor Ethernet cable connection. The appurtenance may be installed in a cabinet or a NEMA 3R enclosure mounted to a pole.

The camera shall be located to maximize the field of view to monitor traffic.

The designer shall coordinate with the district landscape architect for tree planting and tree trimming to maximize the field of view by the camera.

The IP-based camera may operate on single-phase, 120V(ac) or between 12 to 48 V(dc).

For a typical camera system design, see Appendix N, Example K, Sheet E-1.

Chapter 13 – Radar Speed Feedback Sign Systems

A radar speed feedback sign system is a combination of elements used to display the speed of the travelling public for information purposes and may alert the travelling public to reduce speeds.

The designer shall coordinate with the project engineer for placement of the sign.

For a typical radar speed feedback sign system design, see Appendix N, Example L, Sheet E-1.

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Chapter 14 – Roadside Weather Information Systems

A roadside weather information system (RWIS) is a combination of elements used to gather current weather information and relay this information back to a district TMC.

A RWIS includes a tower or pole, enclosure, environmental sensors, wind direction and speed sensors, and roadway sensors.

The designer shall consult with the district TMC and the manufacturer on the location of the RWIS equipment for maximum weather exposure. The RWIS should be placed in an area where it is accessible to maintenance staff and will not create a traffic safety hazard.

The designer should place roadway sensors per manufacturers' recommendations.

The sensors are usually installed in the roadbed and sometimes on the bridge deck. If the sensors are placed on a bridge deck, the designer shall consult with the Division of Engineering Services, Structure Maintenance and Investigations Branch for coordinating the work.

For a typical RWIS design, see Appendix N, Example M, sheets E-1 and ED-1.

Chapter 15 – Interconnection Conduit and Cable

An interconnection conduit and cable are used for coordinating between signalized intersections.

The designer shall consult with the district traffic signal operations staff for the recommended signal interconnect cable.

In lieu of an interconnection conduit and cable, wireless technology may be used.

The designer should consider master/slave locations.

For a typical interconnection conduit and cable design, see Appendix N, Example N, Sheet E-1.

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Chapter 16 – Fiber Optic Cable Systems

Chapter 16.1 – General

A fiber optic cable system is used as a connection for field elements to relay information back to the district TMC.

The fiber optic cable system is a communication means for providing high-speed data transfer. The return on investment of the high initial cost of installation is the longevity of the fiber optic cable.

Minimize splicing points to improve transmission rate and extend transmission distance.

The following are the typical conduit choices:

4” conduit with four 1¼” or smaller innerducts.

Two-, four-, or six-conduit bundles, with a typical 1½” conduit size

Multi ducts may use various other colored ducts to aid in differentiating each duct in the matrix.

For a typical fiber optic cable system design, see Appendix N, Example O, sheets E-1 and ED-1.

Chapter 16.2 – Vaults

There are two types of vaults: circular and rectangular. The circular vault is smaller in volume compared with the rectangular.

The designer should place vaults in areas with adequate drainage and accessible for maintenance staff.

When designing for long runs, the designer should take into consideration the following when placing the vaults:

- manufacturer’s cable length
- installation method
- location of the field elements

The designer may use a cabinet in lieu of a vault for termination and splicing.

The designer should consider placing a vault at an interchange for future fiber expansion.

Chapter 16.3 – Fiber Optic Cable

The designer should show the fiber optic cable installation separately from other conduits, cables, conductors, pull boxes, and vaults.

A mainline cable consists of 144 to 288 fiber strands connecting to a hub or to the district TMC. The distribution cable consists of a single cable with either 12 or 24 fiber strands connecting field elements. Caltrans uses singlemode fiber optic cable operating at either 1,310 or 1,550 nm wavelength on a mainline and distribution cables.

Lateral fiber optic cable connected to distribution cable shall be a singlemode fiber optic cable.

The designer shall consider the cable’s minimum bending radius when designing the fiber optic cable system.

Cables can be installed by a pull, air blown, bundled microduct, or direct burial method.

The bundled microduct method is only used for new installations in pavement. A bundled microduct installation is when two or more microducts are bundled and a cable already in each of the microducts are laid in the trench. A bundled microduct can be installed without a break up to 1.5 miles.

The direct burial cable method has the same typical installation as the bundled microduct method, except without the conduit. A direct burial cable must be armor clad. The maximum length of installation is dependent on the manufacturer's maximum length of cable on a reel.

Splicing and connectors diminish the transmission rate and distance. It is optimal to have no breaks in a fiber strand for maximum transmission rate and distance. Connectors have a higher loss compared to splicing.

If possible, do not place fiber optic cable and electrical wiring in the same pull box, as it is possible to damage the fiber optic cable without any outward physical signs. If fiber optic cable must be placed in a common pull box with electrical wiring, provide a physical barrier (i.e., orange electrical, non-metallic tubing or orange smurf tubing).

Fiber optic cable installation shall have a tracer wire. When either the conduit or fiber optic cable has a tracer wire imbedded, a tracer wire is not required.

A termination point is the end of the fiber optic cable.

The designer should show fiber optic cable terminations in a splice enclosure, fiber distribution unit, or at an active component (modems, communication switches, or intelligent transportation system (ITS) elements, etc.)

The critical need and accessibility of the termination point in the fiber optic topology may require additional environmental protection. The designer should consult with the district TMC staff to evaluate site conditions and the level of significance of the termination point in the topology.

The designer shall contact district TMC support staff to determine what fiber termination equipment will be needed.

Chapter 16.4 – Fiber Optic Splice Enclosures

The fiber optic splice enclosure is a box that houses the splices.

Chapter 16.5 – Fiber Optic Distribution Units

A fiber optic distribution unit (FDU) is used for accommodating fiber cable terminations, connections, and patching. The FDU helps manage fiber optic strands and connection points in a cabinet.

Chapter 16.6 – Fiber Optic Markers

Fiber optic markers are used to indicate the location of the elements of the fiber optic cable system.

The designer shall use delineators in unpaved areas and disk markers in paved areas. Quantities of fiber optic markers shall be shown on the “Electrical Quantity” sheets.

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Chapter 16.7 – Topologies

A fiber optic topology is the way in which the elements in the fiber optic cable system are interrelated or arranged.

Fiber optic topology must have the redundancy, reliability, ease of access, and scalability.

The star topology is the least expensive, but it is least reliable. A ring topology with an inner ring and cluster of inner rings provides redundancy, reliability, and scalability, but it is expensive in installation and maintenance due to its complexity.

The designer shall consult with TMC before starting preliminary fiber optic design on a project.

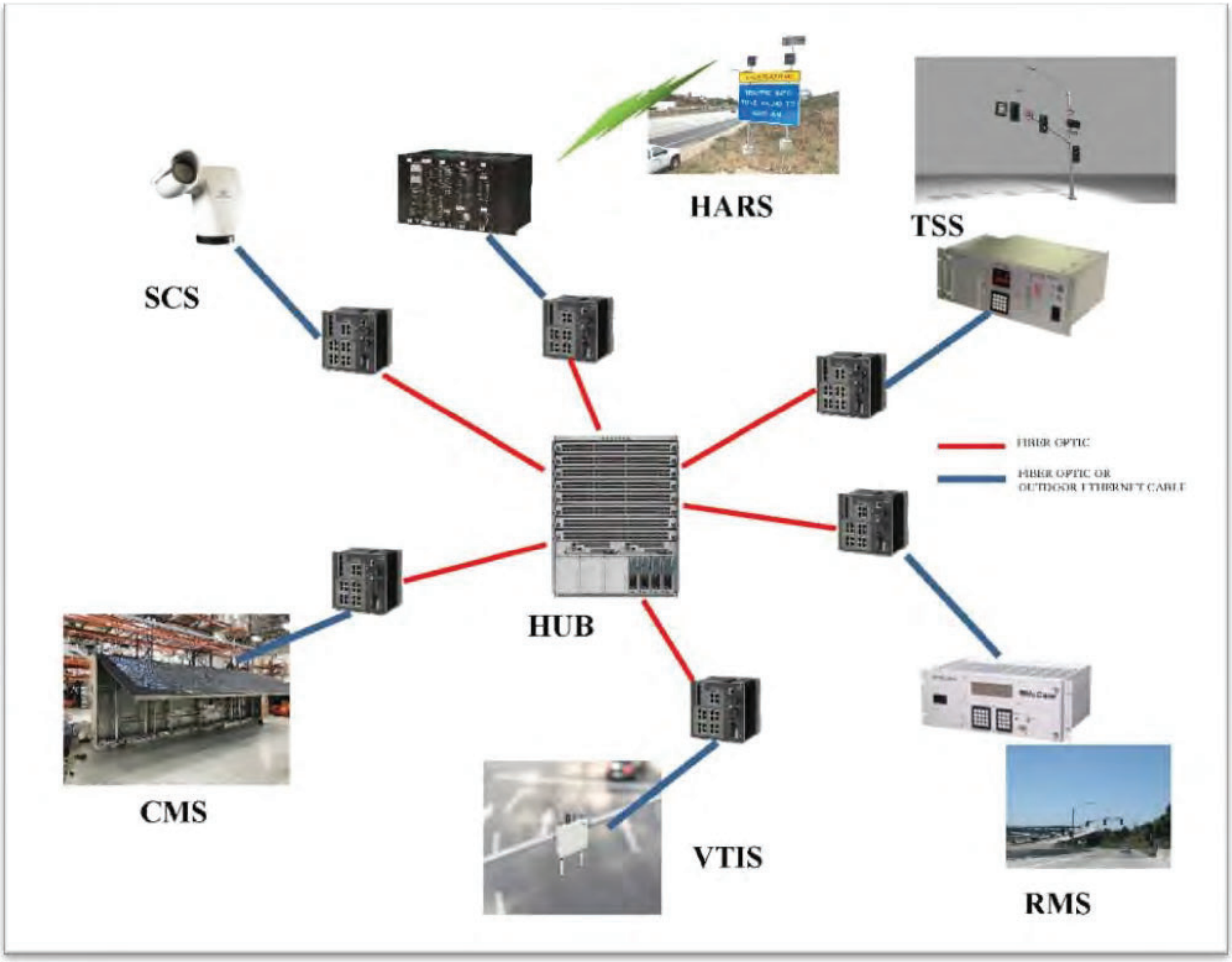

Figure. 8 Star Topology

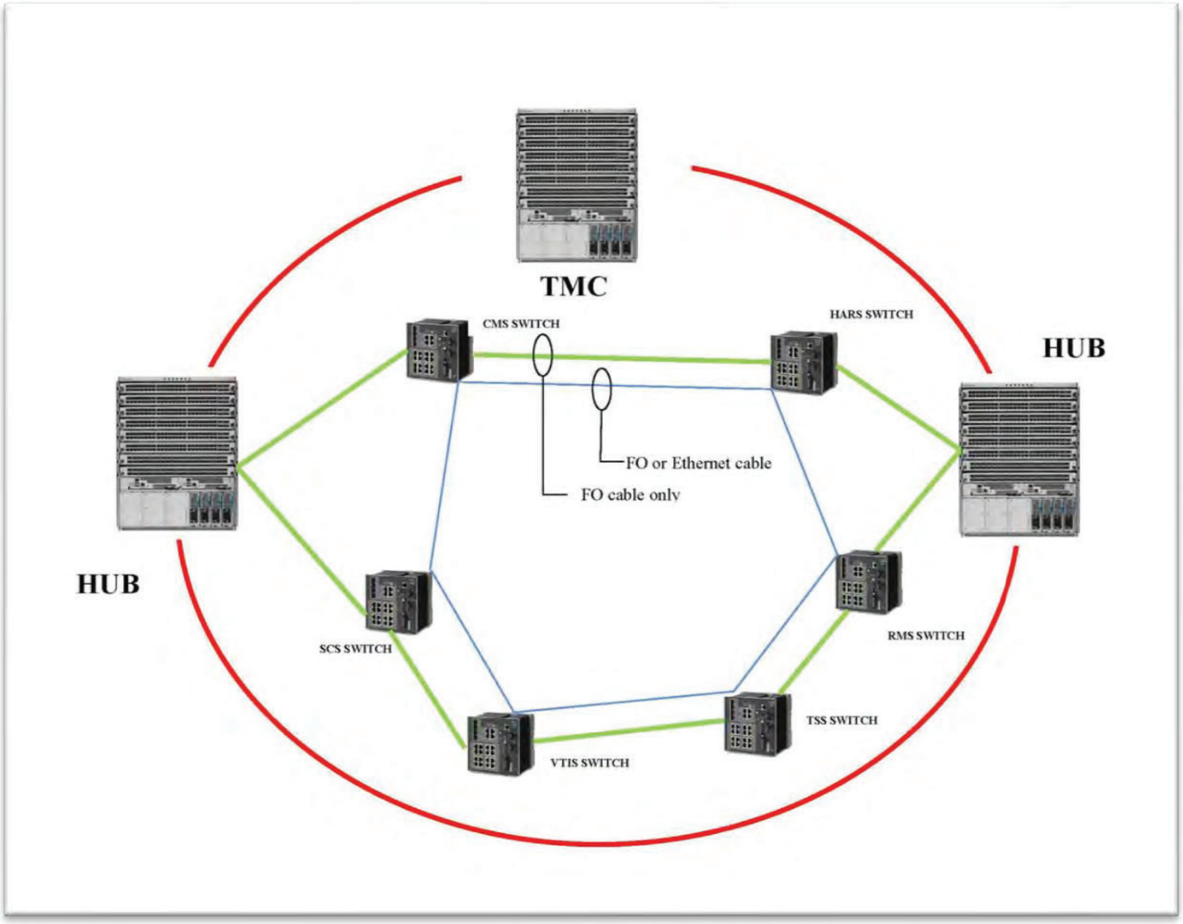

Figure 9 Self-Healing Ring Topology

The distribution cable should be routed to a field element or mini hub.

A new system of technologies is emerging that is creating a shift in data collection and transmission where the past topology will require modification to meet the needs of these technologies.

Chapter 16.8 – Innerducts

An innerduct is a smaller conduit used to subdivide a larger conduit.

An innerduct is made of plastic and has smooth walls or is corrugated.

An innerduct provides additional protection for the fiber and adds a physical barrier.

The designer shall determine the size of the innerduct by the size of the conduit and show this on the plan sheets.

Chapter 17 – Temporary Electrical Systems

The temporary electrical system includes temporary signal systems, temporary lighting, temporary flashing beacons, and temporary radar speed feedback sign systems. Temporary electrical systems are used for different stages of construction until permanent installations are completed.

Temporary electrical equipment may be mounted on:

- Wood poles or posts
- Portable trailers

The designer shall coordinate with the project engineer on developing the timeline for stage construction and take this duration into consideration when placing temporary electrical equipment.

The designer shall place temporary electrical systems on electrical plan sheets for stage construction. When available, the designer shall use the stage construction, layout, and pavement delineation project plan sheets from the project engineer.

The service is established by the contractor.

The designer needs to verify If telecommunication service is needed for a temporary electrical system and take this into consideration when designing the system. Telecommunication service is established by the contractor.

When grid power is not available or not used, the designer should provide a calculation sheet for off-grid power (power demand, power generation, and power storage). The calculation sheet should be kept in the project history file.

For a typical temporary electrical system design, see Appendix N, Example P, sheet E-1.

Chapter 18 – Existing Electrical Systems

Chapter 18.1 – General

The designer shall show all work for modifying various existing electrical systems at various locations throughout the project on the plan sheets.

Likewise, the designer shall show all work for removing various existing electrical systems (entire existing electrical systems or components of existing electrical systems) at various locations throughout the project on the plan sheets.

All existing conduits affected by a modification should be examined to see if they should be replaced. When existing metallic conduits are more than 10 years old and are in a corrosive environment, the designer should consider showing replacement of these conduits.

If existing service or communication equipment is no longer needed, the designer shall show removal of this equipment on the plan sheets.

The designer shall consider removing cabinet foundations when not shown to be reused or abandoned.

Where installations are to be modified, the designer shall check with the district electrical design branch chief and the electrical maintenance supervisor, or TMC support staff to see whether any existing equipment to be removed and not reused should be salvaged.

The address to deliver the salvaged equipment shall be specified in the special provisions for chapter 15.

Chapter 18.2 – Maintaining Existing Traffic Management System Elements During Construction

The bid item “Maintaining Existing Traffic Management System Elements During Construction” is used to maintain, protect, or provide temporary devices for existing electrical elements to mitigate damage to the TMS elements.

A list of traffic management system elements within the project limits shall be included in the Information Handout (see Appendix G) and must include:

- Operational status check (functional elements)
- Operational status check (nonfunctional elements)
- Communication status (connected and communicating with the TMC or Not)

If a list is not needed, a justification must be documented and signed and placed in the project history file and RE pending file. See Appendix H.

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Appendix A – Designer Estimate

See Following Pages

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County-Route-PM:	COUNTY, ROUTE, POST-MILE		
Item No/ Work Description:	MODIFY RAMP METERING SYSTEM		
EA No/ Project No:	XXXXX		
Estimated By:	XXXXX	**Date**	
Checked By:		**Date**	
Submitted To Ali On:		**Rev.**	03/24/15

List of Materials

Item #	DESCRIPTION	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9	E-10	Total Quant	Unit	Unit Man Hour	Total Man Hour	Unit Mat/Equip Cost	Total Mat/Equip Cost
001	t&b- in dirt by machine (12"X30" Deep)											0.0	100 ft	4.000	0.000	$0.00	$0.00
002	t&b- in dirt by machine (6"X30" Deep)	1.00	16.00	3.00	1.00	2.00	4.00	4.00			0.00	31.0	100 ft	3.000	93.000	$0.00	$0.00
003	t&b- in dirt by hand											0.0	ft	0.300	0.000	$0.00	$0.00
004	t&b- in sidewalk by hand + cover											0.0	ft	0.285	0.000	$1.70	$0.00
005	t&b- in street(12" deep) + cover											0.0	ft	0.220	0.000	$3.40	$0.00
006	t&b- in street (30" deep) + cover											0.0	ft	0.250	0.000	$3.40	$0.00
007	jack- per day/set-up (not including conduit)											0.0	day	50.000	0.000	$0.00	$0.00
008	Boring -per 100 feet set up (not including conduit)	2.00	3.00	5.00	1.00	2.00	2.00	2.00	2.00		0.00	19.0	100ft	24.000	456.000	$2,000.00	$38,000.00
009												0.0					
010	1" conduit (TYPE 1)											0.0	ft	0.030	0.000	$2.07	$0.00
011	conduit- 1" steel terminate											0.0	ea	0.200	0.000	$10.08	$0.00
012	1-1/2" conduit (TYPE 1)											0.0	ft	0.036	0.000	$3.32	$0.00
013	conduit- 1-1/2" steel terminate											0.0	ea	0.240	0.000	$20.52	$0.00
014	2" conduit (TYPE 1)											0.0	ft	0.043	0.000	$4.08	$0.00
015	conduit- 2" steel terminate											0.0	ea	0.288	0.000	$23.13	$0.00
016	2-1/2" conduit (TYPE 1)											0.0	ft	0.052	0.000	$9.23	$0.00
017	conduit- 2-1/2" steel terminate											0.0	ea	0.346	0.000	$48.15	$0.00
018	3" conduit (TYPE 1)											0.0	ft	0.062	0.000	$10.47	$0.00
019	conduit- 3" steel terminate											0.0	ea	0.415	0.000	$59.31	$0.00
020	3-1/2" conduit (TYPE 1)											0.0	ft	0.075	0.000	$13.69	$0.00
021	conduit- 3-1/2" steel terminate											0.0	ea	0.498	0.000	$65.42	$0.00
022	4" conduit (TYPE 1)											0.0	ft	0.090	0.000	$14.49	$0.00
023	conduit- 4" steel terminate											0.0	ea	0.597	0.000	$83.14	$0.00
024	1" conduit (TYPE 3)											0.0	ft	0.027	0.000	$0.42	$0.00
025	conduit- 1" pvc terminate											0.0	ea	0.150	0.000	$1.91	$0.00
026	1-1/2" conduit (TYPE 3)											0.0	ft	0.029	0.000	$0.66	$0.00
027	conduit- 1-1/2" pvc terminate											0.0	ea	0.165	0.000	$3.80	$0.00
028	2" conduit (TYPE 3)	170.0	1650.0	800.0	60.0	200.0	600.0	550.0	200.0		0.0	4,230.0	ft	0.032	135.360	$0.86	$3,637.80
029	conduit- 2" pvc terminate	4.0	24.0	17.0	5.0	12.0	12.0	10.0	4.0		0.0	88.0	ea	0.182	16.016	$5.13	$451.44
030	2-1/2" conduit (TYPE 3)											0.0	ft	0.035	0.000	$1.47	$0.00
031	conduit- 2-1/2" pvc terminate											0.0	ea	0.200	0.000	$10.18	$0.00
032	3" conduit (TYPE 3)	0.0	60.0									60.0	ft	0.039	2.340	$1.80	$108.00
033	conduit- 3" pvc terminate	0.0	4.0									4.0	ea	0.220	0.880	$19.21	$76.84
034	3-1/2" conduit (TYPE 3)											0.0	ft	0.043	0.000	$2.29	$0.00
035	conduit- 3-1/2" pvc terminate											0.0	ea	0.242	0.000	$25.15	$0.00
036	4" conduit (TYPE 3)											0.0	ft	0.047	0.000	$2.50	$0.00
037	conduit- 4" pvc terminate											0.0	ea	0.266	0.000	$31.19	$0.00
038	conduit- 1-1/2" expansion fitting											0.0	ea	1.500	0.000	$98.00	$0.00
039	conduit- 1-1/2" expansion deflection fitting											0.0	ea	2.000	0.000	$205.00	$0.00
040	(BC) install pull box in exist conduit											0.0	ea	2.000	0.000	$0.00	$0.00
041	(CB) install conduit to exist pull box	2.0	4.0	3.0		2.0	2.0	2.0	2.0		0.0	17.0	ea	2.000	34.000	$0.00	$0.00
042	(CC) connect new and exist conduit	0.0	1.0									1.0	ea	2.000	2.000	$0.00	$0.00
043	install conduit on structure (excluding conduit)											0.0	ft	0.041	0.000	$2.00	$0.00
044												0.0					
045	No. 3-1/2 PB											0.0	ea	2.000	0.000	$92.90	$0.00
046	No. 3-1/2 (T) PB											0.0	ea	2.500	0.000	$265.81	$0.00
047	No. 5 PB											0.0	ea	2.500	0.000	$105.83	$0.00
048	No. 5(E) PB											0.0	ea	3.000	0.000	$422.79	$0.00

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049	No. 5(T) PB	1.0	11.0	6.0		4.0	4.0	3.0			0.0	29.0	ea	2.500	72.500	$263.48	$7,640.92
050	No. 5(T)(E) PB											0.0	ea	3.000	0.000	$355.00	$0.00
051	No. 5 LOCKJAW LID											0.0	ea	0.500	0.000	$120.00	$0.00
052	No. 6 LOCKJAW LID											0.0	ea	0.500	0.000	$165.00	$0.00
053	**LOCKJAW SECURITY TOOL**											0.0	**ea**	0.000	**0.000**	$25.00	**$0.00**
054												0.0					
055	No. 6 PB											0.0	ea	3.000	0.000	$137.79	$0.00
056	No. 6(E) PB											0.0	ea	3.500	0.000	$495.75	$0.00
057	No. 6(T) PB	0.0	1.0									1.0	ea	3.000	3.000	$525.00	$525.00
058	No. 6(T)(E) PB											0.0	ea	3.500	0.000	$399.07	$0.00
059	Utility PB (PG&E, SCE)											0.0	ea	3.500	0.000	$318.23	$0.00
060	No. 7 PB											0.0	ea	3.000	0.000	$75.00	$0.00
061	No. 8 PB											0.0	ea	3.000	0.000	$60.00	$0.00
062	No. 9 PB											0.0	ea	3.000	0.000	$37.00	$0.00
063	No. 9a PB											0.0	ea	3.000	0.000	$60.00	$0.00
064	adjust pull box to new grade											0.0	ea	0.500	0.000	$0.00	$0.00
065	remove pullbox	1.0	11.0	6.0		4.0	4.0	2.0				28.0	ea	0.350	9.800	$0.00	$0.00
066	remove traffic rated pull box	2.0				2.0	2.0	1.0			0.0	7.0	ea	1.000	7.000	$0.00	$0.00
067												0.0					
068	No. 14 CONDUCTOR (Cu)	0.0	5600.0								0.0	5,600.0	ft	0.000	0.000	$0.21	$1,199.18
069	No. 12 CONDUCTOR (Cu)											0.0	ft	0.000	0.000	$0.26	$0.00
070	No. 10 CONDUCTOR (Cu)	0.0	1130.0									1,130.0	ft	0.000	0.000	$0.38	$428.91
071	No. 8 CONDUCTOR (Cu)	0.0	1460.0								0.0	1,460.0	ft	0.000	0.000	$0.52	$760.76
072	No. 6 CONDUCTOR (Cu)											0.0	ft	0.000	0.000	$0.79	$0.00
073	No. 4 CONDUCTOR (Cu)											0.0	ft	0.000	0.000	$1.19	$0.00
074	No. 2 CONDUCTOR (Cu)	0.0		700.0								700.0	ft	0.000	0.000	$1.94	$1,355.39
075	No. 1/0 CONDUCTOR (Cu)											0.0	ft	0.000	0.000	$3.28	$0.00
076	No. 8 CONDUCTOR (G) (Cu)											0.0	ft	0.000	0.000	$0.34	$0.00
077	No. 6 CONDUCTOR (G) (Cu)											0.0	ft	0.000	0.000	$0.54	$0.00
078	No. 6 CONDUCTOR (Al)											0.0	ft	0.000	0.000	$0.63	$0.00
079	No. 4 CONDUCTOR (Al)											0.0	ft	0.000	0.000	$0.61	$0.00
080	No. 2 CONDUCTOR (Al)											0.0	ft	0.000	0.000	$0.84	$0.00
081	No. 1/0 CONDUCTOR (Al)											0.0	ft	0.000	0.000	$1.44	$0.00
082	splice conductors (SC)	1.0	2.0	2.0			1.0	1.0	2.0		0.0	9.0	ea	0.500	4.500	$20.00	$180.00
083	remove conductors	2800.0	1500.0		600.0	400.0	500.0	300.0	200.0		0.0	6,300.0	ft	0.007	44.100	$0.00	$0.00
084	pull rope											0.0	ft	0.005	0.000	$0.13	$0.00
085	12 CONDUCTOR SIGNAL CABLE											0.0	ft	0.000	0.000	$2.57	$0.00
086	3 CONDUCTOR SIGNAL CABLE											0.0	ft	0.000	0.000	$0.64	$0.00
087	Warning Tape											0.0	ft	0.000	0.000	$0.10	$0.00
088	pull new conductors											0.0	ft	0.010	0.000	$0.00	$0.00
089	CAT 5E Cable											0.0	ft	0.000	0.000	$0.70	$0.00
090												0.0					
091	detector loop, type a	16.0	28.0	20.0	6.0	12.0	14.0	14.0	12.0	85.0	0.0	207.0	ea	2.000	414.000	$280.00	$57,960.00
092	detector loop, type b											0.0	ea	2.000	0.000	$280.00	$0.00
093	detector loop, type c (20')											0.0	ea	**4.340**	0.000	**$610.00**	$0.00
094	detector loop, type c (35')											0.0	ea	**6.840**	0.000	**$960.00**	$0.00
095	detector loop, type c (60')											0.0	ea	**11.000**	0.000	**$1,540.00**	$0.00
096	detector loop, type d											0.0	ea	4.000	0.000	$320.00	$0.00
097	detector loop, type e											0.0	ea	2.000	0.000	$280.00	$0.00
098	detector loop, type q											0.0	ea	5.000	0.000	$240.00	$0.00
099	detector- stub curb											0.0	ea	3.000	0.000	$15.00	$0.00
100	detector- stub shoulder											0.0	ea	2.000	0.000	$27.00	$0.00
101	detector- handhole type a	4.0	6.0	4.0	2.0	4.0	4.0	4.0	4.0		0.0	32.0	ea	2.500	80.000	$50.00	$1,600.00
102	DLC, type a	2800.0	7800.0	5200.0	650.0	1600.0	4500.0	4000.0			0.0	26,550.0	ft	0.000	0.000	$0.50	$13,275.00
103	install SF magnetometer probe											0.0	ea	1.000	0.000	$0.00	$0.00
104												0.0					
105	anchor bolts - set of 4 for											0.0	ea	1.000	0.000	$176.00	$0.00
106	standard foundation- 15/30/31/32											0.0	ea	6.000	0.000	$435.00	$0.00

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107	standard- 15/30/31 slip base insert											0.0	ea	0.000	0.000	$710.00	$0.00
108	standard- type 15 w/ 15' la											0.0	ea	2.500	0.000	$1,192.00	$0.00
109	standard- type 15-sb w/ 15' la											0.0	ea	3.000	0.000	$1,747.00	$0.00
110	standard- type 21 w/ 12'/15' la											0.0	ea	3.500	0.000	$1,533.00	$0.00
111	standard- type 30/30-sb w/ 15' la											0.0	ea	4.000	0.000	$2,548.00	$0.00
112	standard- type 31/31-sb w/ 20' la											0.0	ea	4.500	0.000	$3,783.00	$0.00
113	standard- type 32 w/ 30' la											0.0	ea	5.000	0.000	$3,140.00	$0.00
114	reinstall standard on freeway											0.0	ea	3.000	0.000	$0.00	$0.00
115	reinstall standard on street											0.0	ea	4.000	0.000	$0.00	$0.00
116	remove freeway electrolier											0.0	ea	2.000	0.000	$0.00	$0.00
117	remove street electrolier											0.0	ea	2.000	0.000	$0.00	$0.00
118												0.0					
119												0.0					
120	luminaire - 165W LED											0.0	ea	2.000	0.000	$350.00	$0.00
121	luminaire - 235W LED											0.0	ea	2.000	0.000	$425.00	$0.00
122	luminaire - flush soffit 70w hps											0.0	ea	4.000	0.000	$700.00	$0.00
123	luminaire- flush soffit retrofit											0.0	ea	3.000	0.000	$150.00	$0.00
124	luminaire - pendant soffit 70w hps											0.0	ea	4.000	0.000	$400.00	$0.00
125	luminaire - wall type 70w hps											0.0	ea	4.000	0.000	$450.00	$0.00
126	luminaire - wall type 100w hps											0.0	ea	4.000	0.000	$460.00	$0.00
127	ped oc fluorescent fixture											0.0	ea	2.000	0.000	$430.00	$0.00
128	ped uc fluorescent fixture											0.0	ea	2.000	0.000	$600.00	$0.00
129	remove luminaire											0.0	ea	1.000	0.000	$0.00	$0.00
130	high mast lighting- complete system											0.0	ea	0.000	0.000	$20,000.00	$0.00
131	sign lighting - 85w IL includes ballast											0.0	ea	2.500	0.000	$600.00	$0.00
132	remove sign lighting											0.0	ea	1.000	0.000	$0.00	$0.00
133	glare shield											0.0	ea	0.250	0.000	$50.00	$0.00
134												0.0					
135												0.0					
136	sign control LC-1 240V											0.0	ea	2.000	0.000	$315.00	$0.00
137	sign control LC-2 240V											0.0	ea	2.000	0.000	$315.00	$0.00
138	sign control LC-3 240V											0.0	ea	2.000	0.000	$325.00	$0.00
139	sign control LC-3 480V											0.0	ea	2.000	0.000	$445.00	$0.00
140	sign control SC-1 240V											0.0	ea	2.000	0.000	$295.00	$0.00
141	sign control SC-2 480V											0.0	ea	2.000	0.000	$295.00	$0.00
142	sign control SC-2 240V											0.0	ea	2.000	0.000	$295.00	$0.00
143	sign control SC-3											0.0	ea	2.000	0.000	$455.00	$0.00
144												0.0					
145												0.0					
146	**standard- type 1 w bolts (10')**											0.0	**ea**	2.000	**0.000**	$390.00	**$0.00**
147	standard foundation- type 1											0.0	ea	4.000	0.000	$225.00	$0.00
148	**remove type 1 signal standard**											0.0	**ea**	1.000	**0.000**	$0.00	**$0.00**
149	relocate type 1 signal w new bolts											0.0	ea	3.000	0.000	$110.00	$0.00
150												0.0					
151												0.0					
152	standard- type 16-1-100 w/ 15' sa											0.0	ea	2.500	0.000	$2,200.00	$0.00
153	standard- type 16-1-100 w/ 20' sa											0.0	ea	2.500	0.000	$2,250.00	$0.00
154	standrad - type 18-1-100 w/ 15' sa											0.0	ea	4.000	0.000	$2,634.00	$0.00
155	standard- type 18-1-100 w/ 20' sa											0.0	ea	4.000	0.000	$2,658.00	$0.00
156	standard- type 19-1-100 w/ 25' sa & 15' la											0.0	ea	5.500	0.000	$3,456.00	$0.00
157	standard- type 19-1-100 w/ 30' sa & 15' la											0.0	ea	5.500	0.000	$3,481.00	$0.00
158	standard- type 19a-1-100 w/ 25' sa & 12' la											0.0	ea	5.500	0.000	$3,733.00	$0.00
159	standard- type 19a-1-100 w/ 30' sa & 12' la											0.0	ea	5.500	0.000	$3,757.00	$0.00
160	standard foundation- Load Case 1											0.0	ea	6.000	0.000	$450.00	$0.00
161	anchor bolts - set of 4 - Load Case 1											0.0	ea	1.000	0.000	$335.00	$0.00
162	remove standard signal											0.0	ea	4.000	0.000	$0.00	$0.00
163												0.0					
164	standard- type 16-2-100 w/ 15' sa											0.0	ea	3.000	0.000	$2,601.00	$0.00

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165	standard- type 16-2-100 w/ 20' sa											0.0	ea	3.000	0.000	$2,651.00	$0.00
166	standard- type 17-2-100 w/ 15' sa & 12' la											0.0	ea	5.500	0.000	$3,423.00	$0.00
167	standard- type 17-2-100 w/ 20' sa & 12' la											0.0	ea	5.500	0.000	$3,473.00	$0.00
168	standard- type 17A-2-100 w/ 15' sa & 15' la											0.0	ea	6.000	0.000	$3,730.00	$0.00
169	standard- type 17A-2-100 w/ 20' sa & 15' la											0.0	ea	6.000	0.000	$3,780.00	$0.00
170	standard- type 18-2-100 w/ 25' sa											0.0	ea	4.500	0.000	$2,779.00	$0.00
171	standard- type 18-2-100 w/ 30' sa											0.0	ea	4.500	0.000	$2,859.00	$0.00
172	standard- type 19-2-100 w/ 25' sa & 12' la											0.0	ea	5.500	0.000	$3,602.00	$0.00
173	standard- type 19-2-100 w/ 30' sa & 12' la											0.0	ea	5.500	0.000	$3,681.00	$0.00
174	standard- type 19A-2-100 w/ 25' sa & 15' la											0.0	ea	6.000	0.000	$4,367.00	$0.00
175	standard- type 19A-2-100 w/ 30' sa & 15' la											0.0	ea	6.000	0.000	$4,447.00	$0.00
176	anchor bolts - set of 4 - Load Case 2											0.0	ea	1.000	0.000	$335.00	$0.00
177	standard foundation- Load Case 2											0.0	ea	6.000	0.000	$450.00	$0.00
178												0.0					
179												0.0					
180	standard- type 16-3-100 w/ 15' sa											0.0	ea	3.500	0.000	$2,629.00	$0.00
181	standard- type 16-3-100 w/ 20' sa											0.0	ea	3.500	0.000	$2,679.00	$0.00
182	standard- type 17-3-100 w/ 15' sa & 12' la											0.0	ea	3.500	0.000	$3,423.00	$0.00
183	standard- type 17-3-100 w/ 20' sa & 12' la											0.0	ea	3.500	0.000	$3,473.00	$0.00
184	standard- type 17-3-100 w/ 20' sa & 15' la											0.0	ea	3.500	0.000	$3,502.00	$0.00
185	standard- type 18-3-100 w/ 25' sa											0.0	ea	4.500	0.000	$3,603.00	$0.00
186	standard- type 18-3-100 w/ 30' sa											0.0	ea	4.500	0.000	$3,667.00	$0.00
187	standard- type 19-3-100 w/ 25' sa & 12' la											0.0	ea	6.500	0.000	$4,461.00	$0.00
188	standard- type 19-3-100 w/ 30' sa & 12' la											0.0	ea	6.500	0.000	$4,524.00	$0.00
189	standard- type 19a-3-100 w/ 25' sa & 15' la											0.0	ea	6.500	0.000	$5,098.00	$0.00
190	standard- type 19a-3-100 w/ 30' sa & 15' la											0.0	ea	6.500	0.000	$5,161.00	$0.00
191	standard- type 23-3-100 w/ 35' sa											0.0	ea	7.000	0.000	$4,426.00	$0.00
192	standard- type 24-3-100 w/ 35' sa & 12' la											0.0	ea	7.500	0.000	$5,400.00	$0.00
193	standard- type 24a-3-100 w/ 35' sa & 15' la											0.0	ea	7.500	0.000	$5,811.00	$0.00
194	standard- type 26-3-100 w/ 40' sa & 12' la											0.0	ea	8.000	0.000	$6,520.00	$0.00
195	standard- type 26-3-100 w/ 45' sa & 12' la											0.0	ea	8.000	0.000	$7,160.00	$0.00
196	standard- type 26a-3-100 w/ 40' sa & 15' la											0.0	ea	8.000	0.000	$6,934.00	$0.00
197	standard- type 26a-3-100 w/ 45' sa & 15' la											0.0	ea	8.000	0.000	$7,574.00	$0.00
198	standard- type 27-3-100 w/ 40' sa											0.0	ea	8.500	0.000	$5,469.00	$0.00
199	standard- type 27-3-100 w/ 45' sa											0.0	ea	8.500	0.000	$6,110.00	$0.00
200	anchor bolts - set of 4 - Load Case 3											0.0	ea	1.000	0.000	$335.00	$0.00
201	standard foundation- Load Case 3											0.0	ea	8.000	0.000	$675.00	$0.00
202												0.0					
203	standard- type 18-4-100 w/ 25' sa											0.0	ea	4.500	0.000	$3,732.00	$0.00
204	standard- type 18-4-100 w/ 30' sa											0.0	ea	4.500	0.000	$3,938.00	$0.00
205	standard- type 19-4-100 w/ 25' sa & 12' la											0.0	ea	6.500	0.000	$4,765.00	$0.00
206	standard- type 19-4-100 w/ 30' sa & 12' la											0.0	ea	6.500	0.000	$4,971.00	$0.00
207	standard- type 19a-4-100 w/ 25' sa & 15' la											0.0	ea	6.500	0.000	$5,278.00	$0.00
208	standard- type 19a-4-100 w/ 30' sa & 15' la											0.0	ea	6.500	0.000	$5,485.00	$0.00
209	standard- type 23-4-100 w/ 35' sa											0.0	ea	7.000	0.000	$4,508.00	$0.00
210	standard- type 24-4-100 w/ 35' sa & 12' la											0.0	ea	7.500	0.000	$5,489.00	$0.00
211	standard- type 24a-4-100 w/ 35' sa & 15' la											0.0	ea	7.500	0.000	$5,901.00	$0.00
212	standard- type 26-4-100 w/ 12' la & 40' sa											0.0	ea	8.000	0.000	$6,549.00	$0.00
213	standard- type 26-4-100 w/ 45' sa & 12' la											0.0	ea	8.000	0.000	$7,160.00	$0.00
214	standard- type 26a-4-100 w/ 15' la & 40' sa											0.0	ea	8.000	0.000	$6,960.00	$0.00
215	standard- type 26a-4-100 w/ 15' la & 45' sa											0.0	ea	8.000	0.000	$7,573.00	$0.00
216	standard- type 27-4-100 w/ 40' sa											0.0	ea	8.500	0.000	$5,498.00	$0.00
217	standard- type 27-4-100 w/ 45' sa											0.0	ea	8.500	0.000	$6,110.00	$0.00
218	anchor bolts - set of 4 - Load Case 4											0.0	ea	1.000	0.000	$335.00	$0.00
219	standard foundation- Load Case 4											0.0	ea	8.000	0.000	$900.00	$0.00
220												0.0					
221												0.0					
222	standard- type 28-5-100 w/ 50' sa											0.0	ea	9.000	0.000	$7,061.00	$0.00

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223	standard- type 28-5-100 w/ 55' sa											0.0	ea	9.000	0.000	$7,794.00	$0.00
224	standard- type 29-5-100 w/ 50' sa & 15' la											0.0	ea	9.000	0.000	$8,499.00	$0.00
225	standard- type 29-5-100 w/ 55' sa & 15' la											0.0	ea	9.000	0.000	$9,231.00	$0.00
226	standard- type 29a-5-100 w/ 50' sa & 15' la											0.0	ea	9.000	0.000	$9,079.00	$0.00
227	standard- type 29a-5-100 w/ 55' sa & 15' la											0.0	ea	9.000	0.000	$9,810.00	$0.00
228	anchor bolts - set of 4 - Load Case 5											0.0	ea	1.000	0.000	$335.00	$0.00
229	standard foundation- Load Case 5											0.0	ea	11.000	0.000	$900.00	$0.00
230	standard- type 60-5-100 w/60' sa											0.0	ea	9.000	0.000	$9,404.00	$0.00
231	standard- type 60-5-100 w/65' sa											0.0	ea	9.000	0.000	$11,520.00	$0.00
232	standard- type 61-5-100 w/ 60' sa & 15' la											0.0	ea	9.000	0.000	$10,905.00	$0.00
233	standard- type 61-5-100 w/ 65' sa & 15' la											0.0	ea	9.000	0.000	$13,020.00	$0.00
234	anchor bolts - set of 4 - Load Case 5											0.0	ea	1.000	0.000	$735.00	$0.00
235	standard foundation- Load Case 5 (60 or 61 only)											0.0	ea	11.000	0.000	$1,350.00	$0.00
236												0.0					
237												0.0					
238	signal turn on - contractor											0.0	ea	8.000	0.000	$0.00	$0.00
239	signal mount lt-2											0.0	ea	2.500	0.000	$185.00	$0.00
240	signal mount lt-2-t											0.0	ea	3.000	0.000	$260.00	$0.00
241	signal mount sv											0.0	ea	1.000	0.000	$65.00	$0.00
242	signal mount sv-1											0.0	ea	2.000	0.000	$75.00	$0.00
243	signal mount sv-1-t											0.0	ea	2.500	0.000	$140.00	$0.00
244	signal mount sv-2a/b/c											0.0	ea	2.000	0.000	$130.00	$0.00
245	signal mount sv-2-ta/b/d											0.0	ea	2.500	0.000	$185.00	$0.00
246	signal mount sv-3-ta/b/c											0.0	ea	3.000	0.000	$197.00	$0.00
247	signal mount tv-1											0.0	ea	0.500	0.000	$120.00	$0.00
248	signal mount tv-1-t											0.0	ea	1.000	0.000	$165.00	$0.00
249	signal mount tv-2											0.0	ea	1.500	0.000	$145.00	$0.00
250	signal mount tv-2-t											0.0	ea	2.000	0.000	$245.00	$0.00
251	signal mount tv-3-t											0.0	ea	2.500	0.000	$235.00	$0.00
252	signal mount MAS											0.0	ea	0.500	0.000	$60.00	$0.00
253	signal mount MAT											0.0	ea	0.500	0.000	$60.00	$0.00
254	signal 1-12" (housing, backplate, LED)											0.0	ea	0.500	0.000	$270.00	$0.00
255	signal 3-12" (housing, backplate, LED's)											0.0	ea	1.000	0.000	$590.00	$0.00
256	signal 4-12" (housing, backplate, LED's)											0.0	ea	1.500	0.000	$700.00	$0.00
257	signal 5-12" (housing, backplate, LED's)											0.0	ea	2.000	0.000	$830.00	$0.00
258	signal pv arrow lens											0.0	ea	0.500	0.000	$70.00	$0.00
259	signal louver for 12" section											0.0	ea	0.250	0.000	$34.00	$0.00
260	remove mastarm signal standard											0.0	ea	3.000	0.000	$0.00	$0.00
261												0.0					
262												0.0					
263	ped signal mount sp-1											0.0	ea	1.500	0.000	$185.00	$0.00
264	ped signal mount sp-1-t											0.0	ea	2.000	0.000	$235.00	$0.00
265	ped signal mount sp-2											0.0	ea	2.500	0.000	$185.00	$0.00
266	ped signal mount sp-2-t											0.0	ea	3.000	0.000	$235.00	$0.00
267	ped signal mount tp-1											0.0	ea	0.500	0.000	$85.00	$0.00
268	ped signal mount tp-1-t											0.0	ea	1.000	0.000	$165.00	$0.00
269	ped signal mount tp-2-t											0.0	ea	1.500	0.000	$125.00	$0.00
270	ped signal- type a (w/ LED Countdown)											0.0	ea	1.000	0.000	$200.00	$0.00
271	ped barricade (no sign)											0.0	ea	2.000	0.000	$375.00	$0.00
272												0.0					
273	ppb post w/ flange & bolts (10')											0.0	ea	2.500	0.000	$198.00	$0.00
274	ppb & sign - pole= 2.5 NPS											0.0	ea	2.000	0.000	$78.00	$0.00
275	ppb & sign - pole> 2.5 NPS											0.0	ea	2.000	0.000	$82.00	$0.00
276	APS PPB assembly											0.0	ea	4.000	0.000	$610.00	$0.00
277												0.0			0.000		$0.00
278	6' IISNS ES-7O											0.0	ea	8.000	0.000	$510.00	$0.00
279	8' IISNS ES-7O											0.0	ea	8.000	0.000	$560.00	$0.00
280												0.0					

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281												0.0					
282	FB controller (FBCA)											0.0	ea	2.000	0.000	$1,090.00	$0.00
283	FB flasher (housing and Led)											0.0	ea	3.000	0.000	$570.00	$0.00
284	FB sign lighting fixture											0.0	ea	2.500	0.000	$350.00	$0.00
285	FB Type 15-FBS Pole											0.0	ea	13.500	0.000	$1,055.00	$0.00
286	FB type 15-FBS Foundation											0.0	ea	5.000	0.000	$435.00	$0.00
287	FB Type 9 w/ 18' ma (no sign frame)											0.0	ea	9.000	0.000	$2,664.00	$0.00
288	FB Sign Frame Type 9											0.0	ea	4.000	0.000	$850.00	$0.00
289	FB Sign Frame Type 9A											0.0	ea	2.000	0.000	$235.00	$0.00
290	FB Sign Frame Type 9B											0.0	ea	2.000	0.000	$280.00	$0.00
291	FB Type 9 Foundation											0.0	ea	8.000	0.000	$660.00	$0.00
292	FB Type 40-0-100 w/ 40' sa											0.0	ea	12.000	0.000	$4,690.00	$0.00
293	FB Type 40 foundation											0.0	ea	8.000	0.000	$660.00	$0.00
294	service type b- 120/240v 60A2P main (fb)											0.0	ea	4.000	0.000	$700.00	$0.00
295	solar fb w/ battery backup- complete system											0.0	ea	0.000	0.000	$10,000.00	$0.00
296	remove FB (pole, arm & flasher)											0.0	ea	6.000	0.000	$0.00	$0.00
297	remove FB (pole & flasher)											0.0	ea	4.000	0.000	$0.00	$0.00
298	remove flasher											0.0	ea	1.000	0.000	$0.00	$0.00
299												0.0					
300	pole top pec adapte- 1 pec											0.0	ea	1.000	0.000	$35.00	$0.00
301	pole top pec adapter- 2 pec											0.0	ea	1.500	0.000	$110.00	$0.00
302	_type 3 service foundation with anchor bolts											0.0	ea	5.000	0.000	$235.00	$0.00
303	_type III-A service enclosure (ES-2D)											0.0	ea	3.000	0.000	$1,955.00	$0.00
304	_type III-B service enclosure (ES-2E)											0.0	ea	3.000	0.000	$1,955.00	$0.00
305	_type III-C service enclosure (ES-2F)											0.0	ea	4.000	0.000	$2,155.00	$0.00
306	30A, 2P contactor (120/240/480V sign ltg)											0.0	ea	0.400	0.000	$53.00	$0.00
307	60A, 2P contactor (120/240/480V lighting)											0.0	ea	0.400	0.000	$90.00	$0.00
308	pec/base (120/240/480V peu)											0.0	ea	0.250	0.000	$75.00	$0.00
309	15A, 1P test switch (600V)											0.0	ea	0.300	0.000	$15.00	$0.00
310	15A, 20A, 30A or 50A, 1P CB (600V)											0.0	ea	0.300	0.000	$40.00	$0.00
311	30A, 2P CB (600V)											0.0	ea	0.350	0.000	$50.00	$0.00
312	100A, 2P CB (600V)											0.0	ea	0.350	0.000	$150.00	$0.00
313	100A, 3P CB (600V)											0.0	ea	0.450	0.000	$190.00	$0.00
314	NEMA 3R - 2P2W 240v 60A sw											0.0	ea	4.000	0.000	$120.00	$0.00
315	NEMA 3R - 2P3W 240v cb											0.0	ea	4.000	0.000	$220.00	$0.00
316	NEMA 3R - 2P3W 480v 60A sw											0.0	ea	4.000	0.000	$250.00	$0.00
317	NEMA 3R - 2P3W 480v cb											0.0	ea	4.000	0.000	$290.00	$0.00
318	NEMA 3R - 3P4W 240v 60A sw											0.0	ea	4.000	0.000	$150.00	$0.00
319	NEMA 3R - 3P4W 240v cb											0.0	ea	4.000	0.000	$260.00	$0.00
320	NEMA 3R - 3P4W 480v cb											0.0	ea	4.000	0.000	$340.00	$0.00
321	NEMA 3R - 4P5W 240v 60A sw											0.0	ea	4.000	0.000	$180.00	$0.00
322	NEMA 3R - 4P5W 480v 60A sw											0.0	ea	4.000	0.000	$260.00	$0.00
323	_type h service riser											0.0	ea	2.000	0.000	$44.00	$0.00
324	_type pge service riser											0.0	ea	3.000	0.000	$120.00	$0.00
325	remove service - type 3											0.0	ea	1.000	0.000	$0.00	$0.00
326	remove service - type a											0.0	ea	0.500	0.000	$0.00	$0.00
327	remove foundation											0.0	cubic ft	0.230	0.000	$0.00	$0.00
328	concrete											0.0	cubic ft	0.170	0.000	$3.40	$0.00
329	fused splice connector- 1 pole											0.0	ea	0.250	0.000	$12.00	$0.00
330	fused splice connector- 2 pole											0.0	ea	0.250	0.000	$20.00	$0.00
331												0.0					
332												0.0					
333	transformer- 1 kva (1 phase)											0.0	ea	1.000	0.000	$317.00	$0.00
334	transformer- 1.5 kva (1 phase)											0.0	ea	1.500	0.000	$379.00	$0.00
335	transformer- 2 kva (1 phase)											0.0	ea	2.000	0.000	$470.00	$0.00
336	transformer- 3 kva (1 phase)											0.0	ea	2.500	0.000	$620.00	$0.00
337	transformer- 5 kva (1 phase)											0.0	ea	3.000	0.000	$838.00	$0.00
338	transformer-10 kva (1 phase)											0.0	ea	3.000	0.000	$1,000.00	$0.00

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339	transformer- 6 kva (3 phase)											0.0	ea	3.000	0.000	$1,344.00	$0.00
340	transformer- 9 kva (3 phase)											0.0	ea	3.500	0.000	$1,665.00	$0.00
341	transformer-15 kva (3 phase)											0.0	ea	4.000	0.000	$2,135.00	$0.00
342												0.0					
343	generator (stand-by) - rental + fuel											0.0	month	8.000	0.000	$750.00	$0.00
344	generator (no service) - rental											0.0	month	0.000	0.000	$500.00	$0.00
345	generator fuel											0.0	week	1.000	0.000	$399.00	$0.00
346	In-roadway flashing beacon - individual light only											0.0	ea	2.000	0.000	$705.00	$0.00
347	In-roadway flashing beacon - controller without cabinet											0.0	ea	4.000	0.000	$3,610.00	$0.00
348	wood pole- 25ft											0.0	ea	2.000	0.000	$170.00	$0.00
349	wood pole- 30'											0.0	ea	2.000	0.000	$200.00	$0.00
350	wood pole- 35ft											0.0	ea	2.000	0.000	$240.00	$0.00
351	wood pole- 40ft											0.0	ea	2.100	0.000	$270.00	$0.00
352	wood pole- 45ft											0.0	ea	2.200	0.000	$350.00	$0.00
353	wood pole - guy and anchors											0.0	ea	3.000	0.000	$75.00	$0.00
354	messenger wire- 16mm											0.0	ft	0.081	0.000	$2.62	$0.00
355	span wire- 8mm (7 strand)											0.0	ft	0.050	0.000	$0.64	$0.00
356	span wire- 9.5mm (7 strand)											0.0	ft	0.061	0.000	$1.03	$0.00
357	wood pole mastarm- 8ft											0.0	ea	4.500	0.000	$83.00	$0.00
358	wood pole mastarm- 12ft											0.0	ea	5.000	0.000	$140.00	$0.00
359	wood pole mastarm- 16ft											0.0	ea	5.500	0.000	$170.00	$0.00
360	wood pole mastarm- 18ft											0.0	ea	6.000	0.000	$230.00	$0.00
361	reinforced cidh foundation- 30in											0.0	ft	8.540	0.000	$430.00	$0.00
362	reinforced cidh foundation- 36in											0.0	ft	10.370	0.000	$520.00	$0.00
363	reinforced cidh foundation- 42in											0.0	ft	12.200	0.000	$605.00	$0.00
364	reinforced cidh foundation- 48in											0.0	ft	13.720	0.000	$690.00	$0.00
365												0.0					
366	controller 332/334 foundation with anchor bolts											0.0	ea	6.000	0.000	$360.00	$0.00
367	install controller cabinet											0.0	ea	6.000	0.000	$0.00	$0.00
368	install battery backup											0.0	ea	4.000	0.000	$0.00	$0.00
369	remove controller cabinet											0.0	ea	2.000	0.000	$0.00	$0.00
370	remove cabinet foundation											0.0	ea	1.000	0.000	$0.00	$0.00
371	controller cabinet											0.0	ea	6.000	0.000	$3,000.00	$0.00
372												0.0					
373	tdc cabinet foundation with anchor bolts											0.0	ea	5.000	0.000	$235.00	$0.00
374	tdc cabinet type a											0.0	ea	4.000	0.000	$645.00	$0.00
375	tdc cabinet type b											0.0	ea	4.000	0.000	$975.00	$0.00
376	tdc cabinet type c											0.0	ea	4.000	0.000	$645.00	$0.00
377	telephone cable- 12 #19	0.0	600.0								0.0	600.0	ft	0.000	0.000	$2.16	$1,296.00
378	telephone cable- 4 #18											0.0	ft	0.000	0.000	$0.72	$0.00
379	interconnect cable- 3 pr #16											0.0	ft	0.000	0.000	$0.71	$0.00
380	interconnect cable- 6 pr #16											0.0	ft	0.000	0.000	$1.32	$0.00
381	modem											0.0	ea	1.000	0.000	$200.00	$0.00
382	wireless modem											0.0	ea	1.000	0.000	$800.00	$0.00
383												0.0					
384	cctv- pole type 5 w/ anchor bolts											0.0	ea	2.000	0.000	$742.00	$0.00
385	cctv- pole type 10 w/ anchor bolts											0.0	ea	2.000	0.000	$796.00	$0.00
386	cctv- pole type 15 w/ anchor bolts											0.0	ea	2.000	0.000	$1,022.00	$0.00
387	cctv- pole type 25 w/ anchor bolts											0.0	ea	1.500	0.000	$1,361.00	$0.00
388	cctv- pole type 30 w/ anchor bolts											0.0	ea	1.500	0.000	$1,406.00	$0.00
389	cctv- pole type 35 w/ anchor bolts											0.0	ea	2.000	0.000	$1,652.00	$0.00
390	cctv- pole type 40 w/ anchor bolts											0.0	ea	2.000	0.000	$1,779.00	$0.00
391	cctv-pole type 45 w/ anchor bolts											0.0	ea	2.000	0.000	$2,327.00	$0.00
392	cctv- pole type 25/30/35/40/45 foundation											0.0	ea	8.000	0.000	$450.00	$0.00
393	cctv- pole type 60											0.0	ea	2.500	0.000	$1,100.00	$0.00
394	cctv- pole type 60 foundation											0.0	ea	10.000	0.000	$540.00	$0.00
395	cctv- coaxial RG-6/U cable (TVC)											0.0	ft	0.012	0.000	$3.25	$0.00
396	cctv- Cohu 9300 rackmount local control panel											0.0	ea	1.000	0.000	$1,300.00	$0.00

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397	cctv- sealed cable interface for digital camera											0.0	ea	0.600	0.000	$230.00	$0.00
398	cctv- Pelco Spectra IV SE Camera											0.0	ea	1.500	0.000	$2,500.00	$0.00
399	cctv- Pelco 1WM24-GY Mounting Arm											0.0	ea	0.500	0.000	$150.00	$0.00
400	cctv- Pelco mounting adapter											0.0	ea	0.500	0.000	$250.00	$0.00
401	Video Encoder (DSL line)											0.0	ea	2.000	0.000	$4,500.00	$0.00
402	Video Encoder (cell Modem)											0.0	ea	2.000	0.000	$500.00	$0.00
403	cctv-Axis 241S Video Server											0.0	ea	2.000	0.000	$500.00	$0.00
404												0.0					
405	RWIS Complete System											0.0	ea	300.000	0.000	$25,000.00	$0.00
406	Visibility Sensor											0.0	ea	80.000	0.000	$6,000.00	$0.00
407	Solar Power Supply (battery and panel)											0.0	ea	0.000	0.000	$0.00	$0.00
408												0.0			0.000		$0.00
409	Ethernet- Wireless Access Point Bridge (AP)/WCB											0.0	ea	1.000	0.000	$400.00	$0.00
410	Ethernet- Directional Anthena											0.0	ea	1.000	0.000	$100.00	$0.00
411	Ethernet- Omni directional antenna											0.0	ea	1.000	0.000	$200.00	$0.00
412	Ethernet- Power Over Ethernet											0.0	ea	0.500	0.000	$100.00	$0.00
413	Ethernet- Switch											0.0	ea	1.000	0.000	$400.00	$0.00
414												0.0					
415	HAR Equipment (excluding wood pole, EMS, and 334C)											0.0	ea	16.000	0.000	$22,647.00	$0.00
416	Wireless Detection-repeaters											0.0	ea	2.000	0.000	$700.00	$0.00
417	Wireless Detection-repeater mounting bracket											0.0	ea	1.000	0.000	$145.00	$0.00
418	Wireless Detection-serial to Ethernet (SEC)											0.0	ea	2.000	0.000	$450.00	$0.00
419	Wireless Detection-Power Supply											0.0	ea	1.000	0.000	$150.00	$0.00
420	Wireless Detection-Cellular Modem											0.0	ea	1.000	0.000	$800.00	$0.00
421	Wireless Detection-Cellular CDMA antenna											0.0	ea	0.500	0.000	$100.00	$0.00
422	Wireless Detection-Bluetooth Radio											0.0	ea	0.500	0.000	$450.00	$0.00
423	Wireless Detection-VSN Node	0.0							40.0		0.0	40.0	ea	1.000	40.000	$500.00	$20,000.00
424	Wireless Detection-VSN access point											0.0	ea	1.000	0.000	$2,550.00	$0.00
425	Wireless Detection-VSN access point w/ cell modem											0.0	ea	1.000	0.000	$3,554.00	$0.00
426	Wireless Detection-VSN mounting bracket											0.0	ea	1.000	0.000	$145.00	$0.00
427												0.0					
428	cms - led modules (60 total)											0.0	ea	16.000	0.000	$21,585.00	$0.00
429	cms- install complete cabinet assembly											0.0	ea	48.000	0.000	$0.00	$0.00
430	cms- install complete system											0.0	ea	160.000	0.000	$0.00	$0.00
431	ems standard w/ 30' ma											0.0	ea	6.000	0.000	$4,000.00	$0.00
432	ems sign on wood post- complete system											0.0	ea	16.000	0.000	$6,550.00	$0.00
433	cms- install sign											0.0	day	24.000	0.000	$2,100.00	$0.00
434												0.0					
435	fiber optic - warning tape											0.0	ft	0.001	0.000	$0.30	$0.00
436	fiber optic - tracer wire											0.0	ft	0.001	0.000	$0.50	$0.00
437	fiber optic - 6 smfo											0.0	ft	0.010	0.000	$0.20	$0.00
438	fiber optic - 12 smfo											0.0	ft	0.010	0.000	$0.24	$0.00
439	fiber optic - 24 smfo											0.0	ft	0.010	0.000	$0.33	$0.00
440	fiber optic - 36 smfo											0.0	ft	0.015	0.000	$0.42	$0.00
441	fiber optic - 72 smfo											0.0	ft	0.020	0.000	$0.76	$0.00
442	fiber optic - 96 smfo											0.0	ft	0.020	0.000	$0.88	$0.00
443	fiber optic - 144 smfo											0.0	ft	0.020	0.000	$1.31	$0.00
444	fiber optic - 1 1/2" HDPE Conduit											0.0	ft	0.020	0.000	$0.58	$0.00
445	fiber optic - 2" HDPE Conduit											0.0	ft	0.020	0.000	$0.95	$0.00
446	fiber optic - 4" HDPE Conduit											0.0	ft	0.020	0.000	$2.00	$0.00
447	fiber optic - spacers											0.0	1/10ft	0.020	0.000	$3.00	$0.00
448	fiber optic - vault											0.0	ea	8.000	0.000	$3,000.00	$0.00
449	fiber optic - splice											0.0	ea	8.000	0.000	$500.00	$0.00
450	fiber optic to ethernet converter											0.0	ea	4.000	0.000	$1,500.00	$0.00
451	fiber optic to serial converter											0.0	ea	4.000	0.000	$1,200.00	$0.00
452	fiber optic HUB Jumbo Swithc											0.0	ea	8.000	0.000	$20,000.00	$0.00
453	fiber distribution unit (144)											0.0	ea	1.000	0.000	$500.00	$0.00
454	portable atc											0.0	ea	1.000	0.000	$2,720.00	$0.00

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455	Piezo Sensor (100' stc)											0.0	ea	1.500	0.000	$360.00	$0.00
456	Piezo Sensor (150' stc)											0.0	ea	1.500	0.000	$390.00	0.00
457	Piezo Sensor (200' stc)											0.0	ea	1.500	0.000	$421.00	$0.00
458	Piezo Sensor (250' stc)											0.0	ea	1.500	0.000	$451.00	0.00
459	Piezo Sensor (300' stc)											0.0	ea	1.500	0.000	$481.00	$0.00
460	Piezo Sensor (350' stc)											0.0	ea	1.500	0.000	$511.00	0.00
461	Piezo Sensor (400' stc)											0.0	ea	1.500	0.000	$541.00	$0.00
462	Piezo Sensor (450' stc)											0.0	ea	1.500	0.000	$571.00	0.00
463	Piezo Sensor (500' stc)											0.0	ea	1.500	0.000	$601.00	$0.00
464	rack mounted atc											0.0	ea	2.000	0.000	$5,768.00	$0.00
465	mvds controller assembly (AC powered)											0.0	ea	6.000	0.000	$2,800.00	$0.00
466	mvds isolation board											0.0	ea	2.000	0.000	$300.00	$0.00
467	mvds radar unit RTMS-X2											0.0	ea	8.000	0.000	$3,800.00	$0.00
468	mvds cable- 12 pr #20 (<150 m runs)											0.0	ft	0.015	0.000	$3.30	$0.00
469	mvds connector & backshell for 12 pr #20											0.0	ea	1.000	0.000	$80.00	$0.00
470	mvds cable- 12 pr #18 (500-1000 ft runs)											0.0	ft	0.018	0.000	$7.30	$0.00
471	mvds connector & backshell for 12 pr #18											0.0	ea	1.500	0.000	$180.00	$0.00
472	mvds test cable (include in supplemental)											0.0	ea	0.000	0.000	$300.00	$0.00
473	mvds tech assist (include in supplemental)											0.0	ea	0.000	0.000	$400.00	$0.00
474	MVDS Surge Protector Module											0.0	ea	4.000	0.000	$250.00	$0.00
475	MVDS HD Radar Model 125											0.0	ea	8.000	0.000	$5,500.00	$0.00
476	mvds cable- 12 pr #20 (<150 m runs)											0.0	ft	0.015	0.000	$3.30	$0.00
477	mvds connector & backshell for 12 pr #20											0.0	ea	1.000	0.000	$80.00	$0.00
478	MVDS cable- 12 pr #18 (500-1000 ft runs)											0.0	ft	0.018	0.000	$7.30	$0.00
479	MVDS connector & backshell for 12 pr #18											0.0	ea	1.500	0.000	$180.00	$0.00
480	MVDS test cable (include in supplemental)											0.0	ea	0.000	0.000	$300.00	$0.00
481	MVDS tech assist (include in supplemental)											0.0	ea	0.000	0.000	$100.00	$0.00
482	MVDS mount											0.0	ea	4.000	0.000	$125.00	$0.00
483	MVDS Susyem Functional Testing											0.0	ea	16.000	0.000	$0.00	$0.00
484	85 Watt Solar Panel											0.0	ea	8.000	0.000	$500.00	$0.00
485	50 Amp Hour, 12 V, Gel Battery											0.0	ea	1.000	0.000	$200.00	$0.00
486	2' x 2' Nema 3R Enclosure & Mounting Straps											0.0	ea	8.000	0.000	$500.00	$0.00
487	12 V Charge Controller with Meter											0.0	ea	1.000	0.000	$300.00	$0.00
488	Solar Panel Mounting Bracket											0.0	ea	8.000	0.000	$500.00	$0.00
489	MVDS pole with anchor bolts											0.0	ea	4.000	0.000	$2,500.00	$0.00
490	MVDS foundation											0.0	ea	6.000	0.000	$435.00	$0.00
491	remove MVDS pole											0.0	ea	2.000	0.000	$300.00	$0.00
492	remove MVDS											0.0	ea	2.000	0.000	$300.00	$0.00
493												0.0					
494	VDS - Camera assembly											0.0	ea	8.000	0.000	$1,525.00	$0.00
495	VDS - Camera bracket (standard mount)											0.0	ea	4.000	0.000	$56.00	$0.00
496	VDS - processor - 1 camera input											0.0	ea	4.000	0.000	$2,206.00	$0.00
497	VDS - Module - 2 channel											0.0	ea	4.000	0.000	$295.00	$0.00
498	VDS - Surge panel											0.0	ea	2.000	0.000	$234.00	$0.00
499	VDS - 10" LCD color monitor w/ dual video input											0.0	ea	1.000	0.000	$448.00	$0.00
500	VDS - coax cable, belden 8281											0.0	ft	0.030	0.000	$0.89	$0.00
501	VDS - power cable, 3 conductor #16											0.0	ft	0.020	0.000	$0.52	$0.00
502												0.0					
503	clamshell mount											0.0	ea	2.000	0.000	$75.00	$0.00
504	guard post											0.0	ea	2.000	0.000	$50.00	$0.00
505	sidewalk flag - 4x4 (replace)											0.0	ea	3.000	0.000	$10.00	$0.00
506	number equipment											0.0	ea	0.100	0.000	$0.00	$0.00

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STATE-FURNISHED MATERIALS AND EXPENSE				
Last Modified		Last Price Update	7/1/2014	

ITEM #	DESCRIPTION	PART #	QUANTITY	EACH	TOTAL
1	2-Ch. A.C. Isolation Module(IC, Type F, pre-emp-Hw)	252		51.00	$ -
2	2-Ch. Isolating Module	242		44.00	$ -
3	2-Ch. Isolating Module - Railroad	252RXR		51.00	$ -
4	2-Ch. Loop Detector	222		73.00	$ -
5					$ -
6					$ -
7					$ -
8					$ -
9	Power Distribution Assambly 2	PDA 2		642.00	$ -
10	Power Distribution Assambly 3	PDA 3		571.00	$ -
11	Power Distribution Assambly 4 (for CMS)	PDA-4		830.00	$ -
12					
13	Battery Backup System (BBS)	BBS		963.00	$ -
14	Modem (Model 2070)	6A		465.00	$ -
15	Wireless Modem			800.00	$ -
16	Modem	400		100.00	$ -
17	Dual Magnetic Amplifier Module	232E		500.00	$ -
18	Model 206 Power Supply (Module)	206		280.00	$ -
19	CP-2 Modem Harness	Harness		51.00	$ -
20					$ -
21					$ -
22					$ -
23	Model 500 CMS Cabinet	CMS Cabinet		7,000.00	$ -
24	CMS 5KVA Transformer	Transformer		330.00	$ -
25	CMS Harness #1	Harness		383.00	$ -
26	CMS Harness #4 for model 500	Harness		2,240.00	$ -
27	CMS Harness #5 for model 500	Harness		697.00	$ -
28	Pixel Matrix Module (Model 510 CMS)	PMM		300.00	$ -
29	Pixel Matrix Module (Model 500 CMS)	PMM		128.00	$ -
30	Magnetic Detector Probe	231		161.00	$ -
31	DualMagnetic Detector Amplifier Module	232(E)		500.00	$ -
32					$ -
33	LED Ped Signal Face (Upraised Hand)	Up Hand		130.00	$ -
34	LED Ped. Signal COMBO HEAD	LED		180.00	$ -
35	Model 204 Flasher Unit	204		19.12	$ -
36	Model 208 Monitor Unit	208		106.00	$ -
37	Model 210 Monitor	210		237.00	$ -
38	Swichpack	200		18.44	$ -
39	System Module Model 412/C	412/C		127.00	$ -
40	UV Erasable Programmable -ROM-UVE 27-128	UVE-27-128		7.00	$ -
41	UV Erasable Programmable -ROM-UVE 27-256	UVE-27-256		2.98	$ -
42	Model 170E Traffic Controller			1,028.00	$ -
43	Model 2070E Traffic Controller			1,523.00	$ -
44	Model 334L Cabinet		1.00	3,582.00	$ 3,582.00
45	Model 332L Cabinet			3,876.00	$ -
46					$ -
47	Chageable Message Sign (Model 520 CMS System)	CMS		35,676.00	$ -
48	Changeable Message Sign(Model 500 system)	CMS		59,545.00	$ -
49	Changeable Message Sign(Model 510 system)	CMS		59,304.00	$ -
50	TRAFFIC SIGNAL CONTROLLER ASSEMBLY	66840		7,000.00	$ -
51	TRAFFIC CONTROLLER ASSEMBLY W/ MAGS	66841		10,000.00	$ -
52	MODEL 170 CONTROLLER ASSEMBLY	7440-0173-4		6,000.00	$ -
53	TRAFFIC COUNT STATION CABINET INCLUDING I	66858		6,000.00	$ -
54	TELEPHONE SERVICE CONNECTION			500.00	$ -
55	ELECTRICAL SERVICE CONNECTION	66871		6,000.00	$ -
56	ELECTRICAL SERVICE CONNECTION(w/ trans)	66871		10,000.00	$ -
	TOTAL STATE-FURNISHED MATERIAL AND EXPENSE				$ 3,582.00
	TOTAL PROJECT COST				$ 387,685.60
	SFM COUNTER		1		

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TOTALS FROM PREVIOUS PAGE: **MANHOURS** 1414.496 **MATERIALS** $148,495.25

*************** SUMMARY ***************

NO. OF 3 MAN CREWS: 1 MILES FROM OFFICE 0
N0. OF WORKING DAYS:
NUMBER OF WEEKS: 11.8

LABOR MAKEUP(ENTER AS DECIMAL)		1414.50		RAW TOTAL MAN HOURS
ELEC	50.00%	1.00	0	% ADJUSTMENT FACTOR
OPERATOR	10.00%	---------		
LABORER	40.00%	1414.50		ADJUSTED TOTAL MAN HOURS
LABOR RATES		0.00		TRAVEL TIME
ELEC	$100.00	14.14		LOST TIME
OPERATOR	$100.00	----------		
LABORER	$75.00	1428.64		TOTAL MAN HOURS @
COMBINED	$90.00	$90.00		LABOR RATE
RATE		----------		
		$128,577.69		**TOTAL LABOR COST**
		$148,495.25		MATERIAL COST
		$13,364.57	9	% SALES TAX
		$0.00		QUOTE DISPLAY
		$0.00		QUOTE STANDARDS
		$0.00		SUB BID(IDENTIFY)
		$0.00		SUB BID(IDENTIFY)

		$290,437.51		**SUB-TOTAL DIRECT JOB COSTS**
(*for Main Electrical Projects Only)		$0.00		ALLOWANCE FOR SHACK. PHONE, ETC.
(*Use Only when needed)		$0.00		ALLOWANCE FOR SPECIAL TOOLS & EQUIPMENT
		$0.00		**SUB-TOTAL INDIRECT JOB COSTS**

		$290,437.51		**SUBTOTAL JOB COST**
		$43,565.63	15	% GENERAL OVERHEAD
		$50,100.47	15	% PROFIT ON (COST+OVERHEAD)

		$384,103.60		**TOTAL ITEM COST(BONDS EXCLUDED)**

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County-Route-PM:	COUNTY, ROUTE, POST-MILE		
Work Description:	MODIFY RAMP METERING SYSTEM 0		
Dist-Project No:	XXXXX		
Estimated By:	XXXXX	**Date**	01/00/00
Checked By:	0	**Date**	01/00/00
Submitted To Ali On:	01/00/00	**Rev.**	03/24/15

Item #	DESCRIPTION	Quant	Unit	Unit Man Hour	Total Man Hour	Unit Mat/Equip Cost	Total Mat/Equip Cost
002	t&b- in dirt by machine (6"X30" Deep)	31.0	100 ft	3.000	93.000	0.00	0.00
008	Boring -per 100 feet set up (not including conduit)	19.0	100ft	24.000	456.000	2,000.00	38,000.00
28	2" conduit (TYPE 3)	4230.0	ft	0.032	135.360	0.86	3,637.80
29	conduit- 2" pvc terminate	88.0	ea	0.182	16.016	5.13	451.44
32	3" conduit (TYPE 3)	60.0	ft	0.039	2.340	1.80	108.00
33	conduit- 3" pvc terminate	4.0	ea	0.220	0.880	19.21	76.84
41	(CB) install conduit to exist pull box	17.0	ea	2.000	34.000	0.00	0.00
42	(CC) connect new and exist conduit	1.0	ea	2.000	2.000	0.00	0.00
49	No. 5(T) PB	29.0	ea	2.500	72.500	263.48	7,640.92
57	No. 6(T) PB	1.0	ea	3.000	3.000	525.00	525.00
65	remove pullbox	28.0	ea	0.350	9.800	0.00	0.00
66	remove traffic rated pull box	7.0	ea	1.000	7.000	0.00	0.00
68	No. 14 CONDUCTOR (Cu)	5600.0	ft	0.000	0.000	0.21	1,199.18
70	No. 10 CONDUCTOR (Cu)	1130.0	ft	0.000	0.000	0.38	428.91
71	No. 8 CONDUCTOR (Cu)	1460.0	ft	0.000	0.000	0.52	760.76
74	No. 2 CONDUCTOR (Cu)	700.0	ft	0.000	0.000	1.94	1,355.39
82	splice conductors (SC)	9.0	ea	0.500	4.500	20.00	180.00
83	remove conductors	6300.0	ft	0.007	44.100	0.00	0.00
91	detector loop, type a	207.0	ea	2.000	414.000	280.00	57,960.00
101	detector- handhole type a	32.0	ea	2.500	80.000	50.00	1,600.00
102	DLC, type a	26550.0	ft	0.000	0.000	0.50	13,275.00
377	telephone cable--12 #19	600.0	ft	0.000	0.000	2.16	1,296.00
423	Wireless Detection-VSN Node	40.0	ea	1.000	40.000	500.00	20,000.00

TOTALS FROM PREVIOUS PAGE: **MANHOURS** 1414.496 **MATERIALS** $148,495.25

*************** SUMMARY ***************

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LABORER	40.00%	1414.50		ADJUSTED TOTAL MAN HOURS
LABOR RATES		0.00		TRAVEL TIME
ELEC	$100.00	14.14		LOST TIME
OPERATOR	$100.00	———		
LABORER	$75.00	1428.64		TOTAL MAN HOURS @
COMBINED	$90.00	$90.00		LABOR RATE
RATE		---------		
		$128,577.69		TOTAL LABOR COST

***DISCLAIMER**: The prices listed in this estimate reflect District 6 installation and material cost. If used outside of District 6, material/installation cost should be changed to the individual District cost. Use at your own risk.*

	$148,495.25		MATERIAL COST
	$13,364.57	9	% SALES TAX
	$0.00		QUOTE DISPLAY
	$0.00		QUOTE STANDARDS
	$0.00		SUB BID(IDENTIFY)
	$0.00		SUB BID(IDENTIFY)
	$290,437.51		**SUB-TOTAL DIRECT JOB COSTS**
(*for Main Electrical Projects Only)	$0.00		ALLOWANCE FOR SHACK, PHONE, ETC.
(*Use Only when needed)	$0.00		ALLOWANCE FOR SPECIAL TOOLS & EQUIPMENT
	$0.00		**SUB-TOTAL INDIRECT JOB COSTS**
	$290,437.51		**SUBTOTAL JOB COST**
	$43,565.63	15	% GENERAL OVERHEAD
	$50,100.47	15	% PROFIT ON (COST+OVERHEAD)
	$384,103.60		**TOTAL ITEM COST(BONDS EXCLUDED)**

STATE-FURNISHED MATERIALS AND EXPENSE

Last Modified		Last Price Update	7/1/2014

ITEM #	DESCRIPTION	PART #	QUANTITY	EACH	TOTAL
44	Model 334L Cabinet		1	3,582	3,582.00
	TOTAL STATE-FURNISHED MATERIAL AND EXPENSE				**$3,582.00**
	TOTAL PROJECT COST				**$387,685.60**

DISCLAIMER: The prices listed in this estimate reflect District 6 installation and material cost. If used outside of District 6, material/installation cost should be changed to the individual District cost. Use at your own risk.

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

COUNTY-ROUTE-POSTMILE

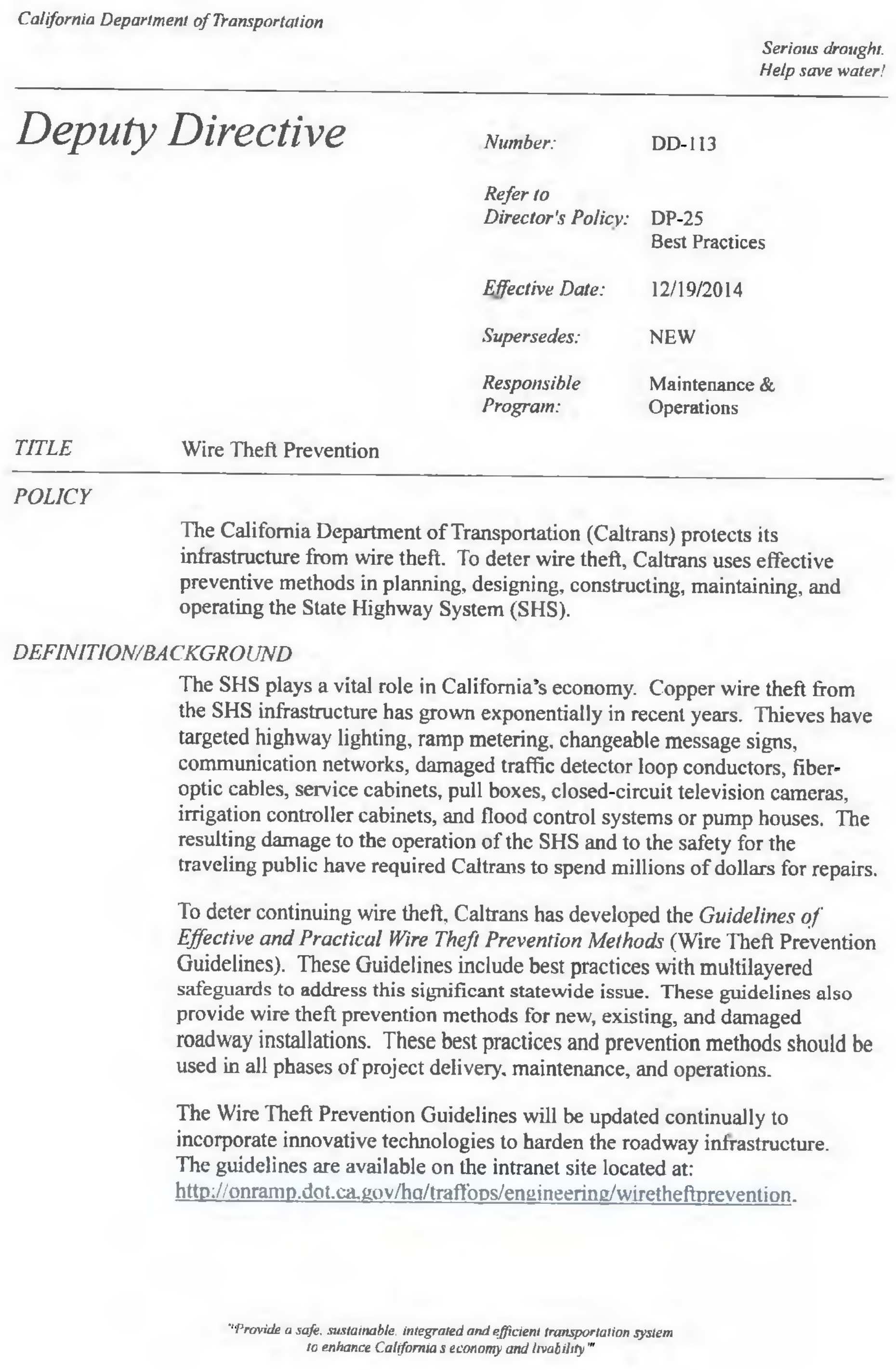
EA:XX-XXXXX

ELECTRICAL COST ESTIMATE

September 12, 2017

ITEM NO./CODE	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
872130	Modifying Existing Electrical System	LS	Lump Sum	$385,000.00	$385,000.00
870009	Maintaining Existing Traffic Management System Elements During Construction	LS	Lump Sum	$15,000.00	$15,000.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
				SUB-TOTAL :	$400,000.00
	" Department Furnished Material "				
					$0.00
066841	TRAFFIC CONTROLLER ASSEMBLY	LS	Lump Sum	$3,582.00	$3,582.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
				SUB-TOTAL	$3,582.00
				TOTAL :	$403,582.00

Appendix B - DD-113



California Department of Transportation

Serious drought.
Help save water!

Deputy Directive

Number:	DD-113
Refer to Director's Policy:	DP-25 Best Practices
Effective Date:	12/19/2014
Supersedes:	NEW
Responsible Program:	Maintenance & Operations

TITLE Wire Theft Prevention

POLICY

The California Department of Transportation (Caltrans) protects its infrastructure from wire theft. To deter wire theft, Caltrans uses effective preventive methods in planning, designing, constructing, maintaining, and operating the State Highway System (SHS).

DEFINITION/BACKGROUND

The SHS plays a vital role in California's economy. Copper wire theft from the SHS infrastructure has grown exponentially in recent years. Thieves have targeted highway lighting, ramp metering, changeable message signs, communication networks, damaged traffic detector loop conductors, fiber-optic cables, service cabinets, pull boxes, closed-circuit television cameras, irrigation controller cabinets, and flood control systems or pump houses. The resulting damage to the operation of the SHS and to the safety for the traveling public have required Caltrans to spend millions of dollars for repairs.

To deter continuing wire theft, Caltrans has developed the *Guidelines of Effective and Practical Wire Theft Prevention Methods* (Wire Theft Prevention Guidelines). These Guidelines include best practices with multilayered safeguards to address this significant statewide issue. These guidelines also provide wire theft prevention methods for new, existing, and damaged roadway installations. These best practices and prevention methods should be used in all phases of project delivery, maintenance, and operations.

The Wire Theft Prevention Guidelines will be updated continually to incorporate innovative technologies to harden the roadway infrastructure. The guidelines are available on the intranet site located at: http://onramp.dot.ca.gov/hq/traffops/engineering/wiretheftprevention.

"Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability"

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RESPONSIBILITIES

Deputy Directors:

- Provide leadership, direction, and guidance to ensure their respective functions coordinate projects to support implementation of the Wire Theft Prevention Guidelines.

District Directors:

- Provide leadership, direction, and guidance to ensure projects and operations support system wide implementation of the Wire Theft Prevention Guidelines regardless of funding source.
- Support staff development and increased knowledge and expertise in wire theft prevention methods.

Deputy District Directors and District Division Chiefs, Divisions of Planning/Local Assistance, Program/Project Management, Design, Construction:

- Ensure applicable wire theft preventive measures are included in project initiating documents developed and utilized during all phases of planning, programming, project management, design for construction, and all improvements and emergency repairs (or Director's Orders) on the SHS, along with appropriate funding and support resources.

Deputy District Directors, Division of Traffic Operations:

- Coordinate with respective District Divisions and external counterparts to ensure appropriate wire theft preventive measures are included and funded as part of all new projects on the SHS.
- Disseminate appropriate information to District and California Highway Patrol (CHP) field personnel and transportation management centers relative to authorized highway work, including nature and scope, location, type of work and name of contractors and permitees, so wire theft may be recognized more easily while in progress.

Deputy District Directors, Division of Maintenance:

- Ensure that District Maintenance Regions report and document all wire theft occurrences on the SHS and initiate repair action to restore services.
- Coordinate with California Highway Patrol to identify wire-theft to help raise awareness, enhance enforcement, and identify other remedial action.
- Ensure that wire theft preventive measures are included as part of emergency repairs (or Director's Orders) on the SHS.

Chief, Division of Traffic Operations:

- Provide appropriate policies, procedures, and guidance to ensure compliance with this directive.

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- Ensures the Wire Theft Prevention Guidelines are updated continually to include new and innovative wire theft prevention methods.
- Ensures statewide distribution of the Wire Theft Prevention Guidelines.
- Ensures wire theft prevention methods and procedures are incorporated into standards, specifications, and guidelines.
- Develop training on Wire Theft Prevention for new installations to ensure appropriate wire theft preventive measures are used.

Chief, Division of Design:

- Provide appropriate policies, procedures, and guidance to ensure compliance with this directive.

Chief, Division of Construction:

- Provide appropriate policies, procedures, and guidance to ensure compliance with this directive.

Chief, Division Maintenance:

- Provides guidance and training on the repair and maintenance of damaged installations to ensure appropriate wire theft preventive measures remain in use and operational.
- Supports staff development and increased knowledge and expertise in wire theft prevention methods.
- Initiates corrective actions to report damaged installations and improvement opportunities to deter wire theft.
- Ensures that all wire theft occurrences are reported and documented by Districts.
- Provide appropriate policies, procedures, and guidance to ensure compliance with this directive.

District Project Managers:

- Ensure applicable wire theft preventive measures are included in project initiation documents developed and utilized during all phases of planning, programming, project management, design for construction of improvements on the SHS, along with appropriate funding and support resources.
- Implement wire theft prevention methods on all existing construction projects to the maximum extent feasible.
- Ensure wire theft prevention methods are included throughout each project and in accordance with established policies, standards, and procedures.
- Program appropriate resources to respective functions to support implementation of the Wire Theft Prevention Guidelines.

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District Project Engineers:

- Ensure applicable wire theft prevention methods are included during planning, programming, project management, design, construction, maintenance, and operation of the SHS.
- Ensure wire theft prevention methods are included throughout each project and in accordance with established policies, standards, and procedures.
- Do not accept the project if the wire theft prevention guidelines are not followed.

District Electrical Design Engineers:

- Ensure appropriate design standards and specifications from the Wire Theft Prevention Guidelines are used to the maximum extent feasible.
- Do not accept the project if the wire theft prevention guidelines are not followed.

District Resident Engineers:

- Provide appropriate guidance to contractors to ensure compliance with wire theft prevention specifications for new, existing, and damaged roadway installations, including as part of any emergency repairs (or Director's Orders).
- Ensure that all wire theft occurrences on the SHS within their respective project limits are reported to the CHP, in coordination with respective Maintenance Regions, and that repair action is initiated to restore services.
- Ensure accurate records identifying the location and alignment of underground conduit, pull boxes and other underground facilities.
- Ensure accurate as-built plans of constructed infrastructure.

APPLICABILITY

All Caltrans employees.

Kome Ajise
KOME AJISE
Chief Deputy Director

12/19/14
Date Signed

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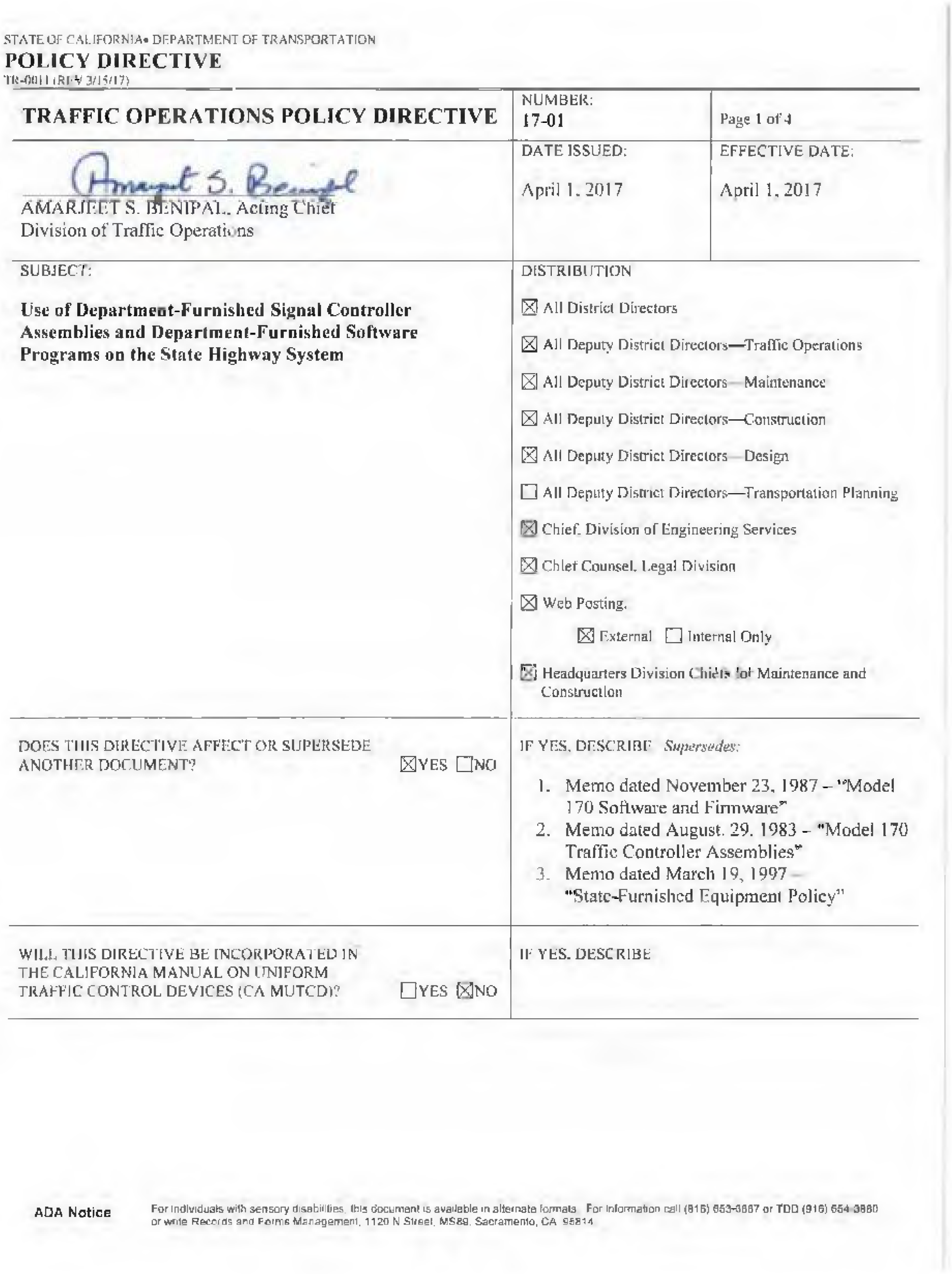
Appendix C – TOPD -17-01



STATE OF CALIFORNIA• DEPARTMENT OF TRANSPORTATION
POLICY DIRECTIVE
TR-0011 (REV 3/15/17)

TRAFFIC OPERATIONS POLICY DIRECTIVE	NUMBER: 17-01	Page 1 of 4
Amarjeet S. Benipal AMARJEET S. BENIPAL, Acting Chief Division of Traffic Operations	DATE ISSUED: April 1, 2017	EFFECTIVE DATE: April 1, 2017

SUBJECT:

Use of Department-Furnished Signal Controller Assemblies and Department-Furnished Software Programs on the State Highway System

DISTRIBUTION

☒ All District Directors

☒ All Deputy District Directors—Traffic Operations

☒ All Deputy District Directors—Maintenance

☒ All Deputy District Directors—Construction

☒ All Deputy District Directors—Design

☐ All Deputy District Directors—Transportation Planning

☒ Chief, Division of Engineering Services

☒ Chief Counsel, Legal Division

☒ Web Posting.

☒ External ☐ Internal Only

☒ Headquarters Division Chiefs for Maintenance and Construction

DOES THIS DIRECTIVE AFFECT OR SUPERSEDE ANOTHER DOCUMENT? ☒YES ☐NO

IF YES, DESCRIBE *Supersedes:*

1. Memo dated November 23, 1987 – "Model 170 Software and Firmware"
2. Memo dated August. 29, 1983 – "Model 170 Traffic Controller Assemblies"
3. Memo dated March 19, 1997 – "State-Furnished Equipment Policy"

WILL THIS DIRECTIVE BE INCORPORATED IN THE CALIFORNIA MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES (CA MUTCD)? ☐YES ☒NO

IF YES, DESCRIBE

ADA Notice For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 653-6667 or TDD (916) 654-3880 or write Records and Forms Management, 1120 N Street, MS89, Sacramento, CA 95814.

DIRECTIVE

All signalized intersections on the State Highway System (SHS) shall be operated utilizing Department-Furnished equipment which includes the controller, cabinet and traffic signal control software program [as defined in the 2015 Standard Specifications 86-1.02Q(2)].

This directive shall apply to all signalized intersections on the SHS as follows:

- **Only the Department-Furnished signal controller cabinet assembly shall be used.**
- **Only Department Furnished Model 170 or 2070 firmware and software programs shall be operated at existing locations.**
- **Only Department-Furnished Model 2070 controllers and software programs shall be operated at new or modified locations.**

IMPLEMENTATION

This directive updates and combines three policies:

1. "Model 170 Traffic Controller Assemblies" memo dated August 29, 1983, to include Model 170 controller assemblies;
2. "Model 170 Software and Firmware" memo dated November 23, 1987, to include both the Model 170 and 2070 Software and Firmware programs, and
3. "State-Furnished Equipment Policy" memo dated March 19, 1997.

The California Department of Transportation (Caltrans) will **only**, under an approved license agreement, furnish software to cities and counties for signalized intersections operated and/or maintained by Caltrans that are not part of the SHS.

The Headquarters (HQ) Division of Traffic Operations, Office of Traffic Management, **must** approve any request for an exception to this policy. Prior to requesting HQ approval, the exception request must be approved by the Deputy District Director(s) of Traffic Operations and Maintenance for compatibility and operations on the SHS. A full justification for an exception **must** be initiated by the local agency requesting the exception, and **must** accompany the exception request.

Joint-funded projects with cooperative agreements:
If the project is cooperatively financed by the State and a local agency, in accordance with the provisions of the California Department of Transportation Standard Plans and Standard Specifications, the cost of the controller assembly will be included in the cost of the project.

Local-agency-sponsored project (encroachment permit project):
If the project includes an installation of new traffic signal(s) or the modification of existing traffic signal(s) and the project is financed solely by the local agency, the permittee is **required** to install a Department-Furnished Model 2070 controller procured from the Department's warehouse. The cost of the controller will be recovered from the permittee's contractor as Department-furnished material before issuing the double permit.

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Private entity project (encroachment permit project):
The project includes the installation of new traffic signal(s) or the modification of existing traffic signal(s), and the project is financed solely by a private entity. The permittee is **required** to install a Department-Furnished Model 2070 controller procured from the Department's warehouse. The cost of the controller will be recovered from the permittee as Department-furnished material before issuing the permit.

Exception process:
See Attachment 1– Exception Process for TOPD 17-01

DELEGATIONS

No new delegations of authority are created under this policy.

BACKGROUND

Since the mid-1970s, Caltrans, in partnership with the State of New York, designed a traffic signal controller assembly – the Model 170 controller, which provided complete interchangeability of controller units, cabinets, detector sensor units, isolation modules, switch packs, conflict monitors, flashers and modems. Since 1977, Caltrans has been purchasing the Model 170 controllers and providing them to the districts as Department-Furnished Material to benefit from cost savings and quality control. In the 1990's, Caltrans developed specifications to update the Model 170 controller, resulting in the Model 2070 controller. The Model 2070 controller is also Department-Furnished.

To achieve operational uniformity and to reduce maintenance cost, Caltrans requires that engineers maintain the Traffic Signal Control Program (TSCP) software installed in the controller units. This applies to state-highway intersections as well as local-agency intersections that are operated and/or maintained by Caltrans.

This policy reduces maintenance costs for training staff on a standardized product. Use of standardized software that has been fully tested for reliability improves the safety record and preserves the integrity of the traffic signal control system. This policy also results in cost savings through a master purchase agreement for procurement of large quantities. This long-standing policy is also intended to reduce Caltrans' exposure to tort liability.

ADA Notice For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 653-3657 or TDD (916) 654-3880 or write Records and Forms Management, 1120 N Street, MS89, Sacramento, CA 95814.

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DEFINITIONS

When used in this Traffic Operations Policy Directive, the text shall be defined as follows:

1. **Standard** – a statement of required, mandatory or specifically prohibited practice. All standards text appears in **bold** type. The verb "**shall**" is typically used. Standards are sometimes modified by Options.
2. Guidance – a statement of recommended, but not mandatory, practice in typical situations, with deviations allowed if engineering judgment or engineering study indicates the deviation to be appropriate. All Guidance statements text appears in underline type. The verb "should" is typically used. Guidance statements are sometimes modified by Options.
3. Option – a statement of practice that is a permissive condition and carries no requirement or recommendation. Options may contain allowable modifications to a Standard or Guidance. All Option statements text appears in normal type. The verb "may" is typically used.
4. Support – an informational statement that does not convey any degree of mandate, recommendation, authorization, prohibition, or enforceable condition. Support statements text appears in normal type. The verbs "**shall**," "**should**," and "**may**" are not used in Support statements.

ATTACHMENTS

1. Exception Process for TOPD 17-01
2. Flowchart for Exception Process for TOPD 17-01
3. Memorandum dated August 29, 1983, "Model 170 Traffic Controller Assemblies"
4. Memorandum dated November 23, 1987, "Model 170 Software and Firmware"
5. Memorandum dated March 19, 1997, "State-Furnished Equipment Policy"

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Attachment 1

3/24/2017

Exception Process for TOPD 17-01

"Use of Department-Furnished Signal Controller Assemblies and Department-Furnished Software Programs on the State Highway System"

OBJECTIVE: **Caltrans needs to be able to operate and maintain a state traffic signal if/when it is deemed needed, and as quickly as possible while allowing local agencies to improve mobility on their adjacent facility by using traffic signal controllers compatible with their existing system.**

Non-standard equipment and/or non-standard software shall be consistent with the National Intelligent Transportation System (ITS) Architecture and be interoperable with the Caltrans Integrated Corridor Management (ICM) or "connected corridors " and **are to be solely funded and maintained by a Local Agency.** The local agency is required to enter into a Maintenance and Operations agreement prior to installation of the non-standard equipment and/or non-standard software.

All agreements with local agencies for signalized intersection locations with non-standard equipment and/or non-standard software shall have agreements that document specific details of the exception. All existing agreements must have a "sunset" date of 3 years (April 2020), at which time the local agency may re-apply to renew the agreement. If approved, the agreement would be valid for a maximum of 3 years. If there is no documented agreement for an exception, the district must enter into an agreement with the local agency. The approved document would be valid for a maximum of 3 years. An agency may re-apply for agreement renewals.

Review/Approval/Renewal Process is described below:
Applicable to:
  Joint-funded projects with cooperative agreements
  Local-agency-sponsored project (encroachment permit project)

1. Requests for an exception to operate and/or maintain a state-owned and/or operated traffic signal shall be reviewed for approval or denial with primary considerations to safety and appropriateness, and is initiated by the local agency and submitted to the district Encroachment Permit Engineer.

2. Initial requests are reviewed by Deputy District Director (DDD) of Operations, with concurrence from DDD of Maintenance. If the DDD's approve, the district notifies Headquarters Traffic Ops of pending request for exception, with specifics on location and proposed hardware and software for the traffic signal controller cabinet, and who will operate and maintain the signalized intersection.

3. Headquarters Traffic Ops reviews pending request and responds to district Permit engineer with initial approval, or requests more information/data within 30 days.

4. The district responds to local agency with the following possible responses:
    - Accepts as submitted
    - Denies request for exception
    - Accepts with specific changes/revisions

5. If local agency wishes to comply with Caltrans-required changes for approval, local agency resubmits updated request for approval to the district. The district resubmits request to Headquarters.

6. If Headquarters *denies* request, the response shall document the explanation(s) for denial in writing within one month.

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7. If Headquarters responds *favorably*, the district will draft an agreement. The steps are described below.
    - I. Using your district's standard agreement template, the agreement is then submitted to the local agency for comments/feedback. A copy of the draft agreement is submitted to Headquarters Division of Traffic Operations, Office of Traffic Management. The agreement will have an expiration date of a maximum 3-year time frame.

    - II. If approved the District Permit Engineer is responsible for the following:
        - a) Forwarding the final approved submittal to District Maintenance Signal & Lighting Coordinator
        - b) Forwarding the final approved submittal to District Maintenance Agreement Coordinator
            - (i) Agreement Coordinator will draft the agreement, coordinate review with HQ & Legal, and obtain signatures
        - c) Ensuring a Maintenance & Operations Agreement is completed priori to issuance of the encroachment permit
        - d) Issuing the Encroachment Permit to the Local Agency
        - e) Notifying the District Signal & Lighting Coordinator of construction completion
        - f) Provide copies of permit and agreement to HQ Traffic Ops

    - III. Headquarters Division of Traffic Operations, with input from Headquarters Maintenance, reviews the draft agreement. Headquarters Division of Traffic Operations submits response with feedback to district within one month, with a copy to 1) DDD of Operations, 2) DDD of Maintenance, 3) Headquarters Division Chief for Operations and Maintenance and 4) district senior traffic signal operations engineer.

    - IV. Updated/modified agreement is submitted for the following signatures:
        - District Deputy Director Traffic Operations
        - District Deputy Director Maintenance (if not the same)
        - Headquarters Legal
        - Headquarters Traffic Operations, Office Chief of Traffic Management

    - V. Copies of the signed agreement must be archived in the district and Headquarters Office of Traffic Management.

    - VI. Agreements will be reviewed annually by the districts, to evaluate the performance of the exceptions. If there are issues, the district will inform the local agency and request that a response be submitted within one month. The district will decide whether the exception should continue. Two months prior to expiration of the agreement, the district will alert the local agency that the agreement will soon expire. The local agency may apply for renewal of the agreement. Headquarters, Division of Traffic Operations, Office of Traffic Management will follow up with the district to track and document whether a request for extension was requested or whether the district withdrew the exception.

Private entity project (encroachment permit project):

If the Local Agency having jurisdiction in the project location refuses to execute a Maintenance and Operations Agreement for the non-standard equipment and/or non-standard software, a Permit Special Provisions shall constitute the maintenance and operations agreement requirements.

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The agreement should contain the following conditions:

- The agreement must clearly state the roles and responsibilities of operations and maintenance of the specific traffic signal.
- The agreement must be clear that vehicle traffic may not be allowed to back up onto the freeway and that Caltrans may take back control of a traffic signal at any time if the signal is not meeting Caltrans standards.
- The yellow signal timing must be compliant with the latest version of the CA MUTCD.
- The pedestrian timing must be compliant with TOPD 12-01. Traffic signals shall be maintained in compliance with ADA requirements.
- The expiration date must be clearly documented in the agreement.
- The agreement may be renewed after a full traffic signal review by the district's traffic signal operations staff.
- Standards shall not be revised or modified.

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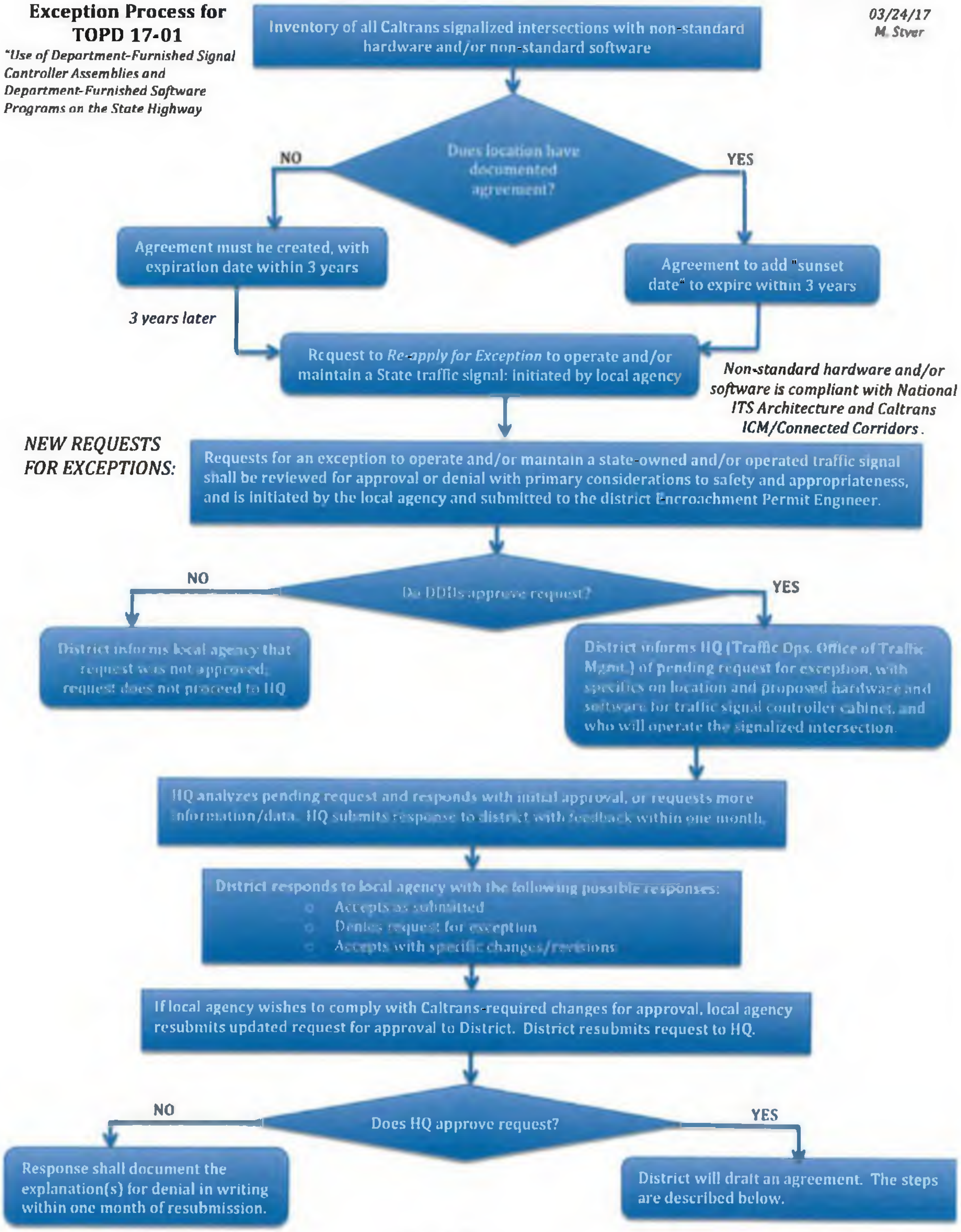
Exception Process for TOPD 17-01

"Use of Department-Furnished Signal Controller Assemblies and Department-Furnished Software Programs on the State Highway

Attachment 2

03/24/17
M. Styer



Inventory of all Caltrans signalized intersections with non-standard hardware and/or non-standard software

Does location have documented agreement?

NO

Agreement must be created, with expiration date within 3 years

3 years later

YES

Agreement to add "sunset date" to expire within 3 years

Request to *Re-apply for Exception* to operate and/or maintain a State traffic signal: initiated by local agency

Non-standard hardware and/or software is compliant with National ITS Architecture and Caltrans ICM/Connected Corridors.

NEW REQUESTS FOR EXCEPTIONS:

Requests for an exception to operate and/or maintain a state-owned and/or operated traffic signal shall be reviewed for approval or denial with primary considerations to safety and appropriateness, and is initiated by the local agency and submitted to the district Encroachment Permit Engineer.

Do DDDs approve request?

NO

District informs local agency that request was not approved; request does not proceed to HQ

YES

District informs HQ (Traffic Ops. Office of Traffic Mgmt.) of pending request for exception, with specifics on location and proposed hardware and software for traffic signal controller cabinet, and who will operate the signalized intersection.

HQ analyzes pending request and responds with initial approval, or requests more information/data. HQ submits response to district with feedback within one month.

District responds to local agency with the following possible responses:
- Accepts as submitted
- Denies request for exception
- Accepts with specific changes/revisions

If local agency wishes to comply with Caltrans-required changes for approval, local agency resubmits updated request for approval to District. District resubmits request to HQ.

Does HQ approve request?

NO

Response shall document the explanation(s) for denial in writing within one month of resubmission.

YES

District will draft an agreement. The steps are described below.

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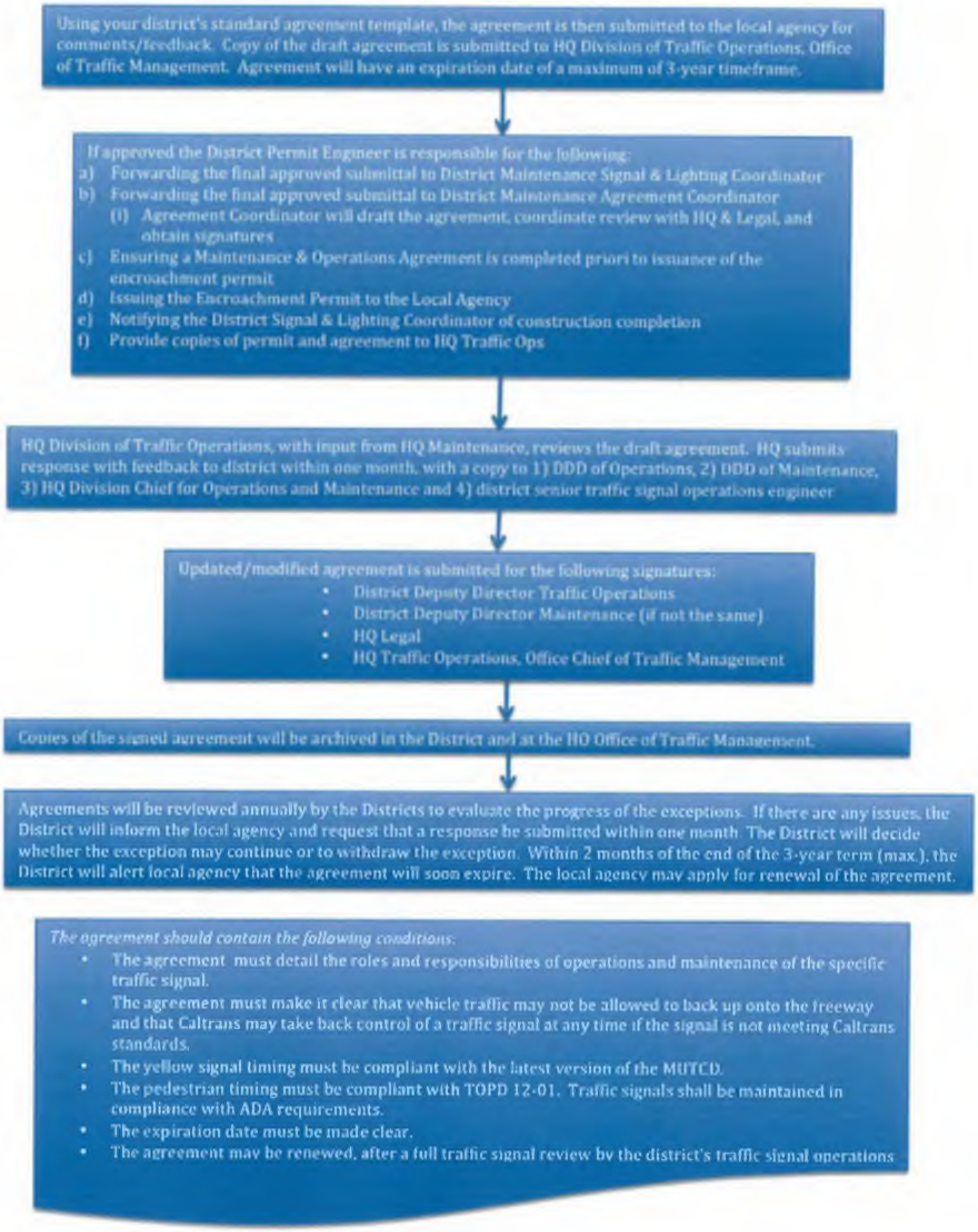
03/24/17
M. Stver

Steps for Agreement for TOPD 17-01



Using your district's standard agreement template, the agreement is then submitted to the local agency for comments/feedback. Copy of the draft agreement is submitted to HQ Division of Traffic Operations, Office of Traffic Management. Agreement will have an expiration date of a maximum of 3-year timeframe.

If approved the District Permit Engineer is responsible for the following:

a) Forwarding the final approved submittal to District Maintenance Signal & Lighting Coordinator
b) Forwarding the final approved submittal to District Maintenance Agreement Coordinator
    (i) Agreement Coordinator will draft the agreement, coordinate review with HQ & Legal, and obtain signatures
c) Ensuring a Maintenance & Operations Agreement is completed priori to issuance of the encroachment permit
d) Issuing the Encroachment Permit to the Local Agency
e) Notifying the District Signal & Lighting Coordinator of construction completion
f) Provide copies of permit and agreement to HQ Traffic Ops

HQ Division of Traffic Operations, with input from HQ Maintenance, reviews the draft agreement. HQ submits response with feedback to district within one month, with a copy to 1) DDD of Operations, 2) DDD of Maintenance, 3) HQ Division Chief for Operations and Maintenance and 4) district senior traffic signal operations engineer

Updated/modified agreement is submitted for the following signatures:

- District Deputy Director Traffic Operations
- District Deputy Director Maintenance (if not the same)
- HQ Legal
- HQ Traffic Operations, Office Chief of Traffic Management

Copies of the signed agreement will be archived in the District and at the HQ Office of Traffic Management.

Agreements will be reviewed annually by the Districts to evaluate the progress of the exceptions. If there are any issues, the District will inform the local agency and request that a response be submitted within one month. The District will decide whether the exception may continue or to withdraw the exception. Within 2 months of the end of the 3-year term (max.), the District will alert local agency that the agreement will soon expire. The local agency may apply for renewal of the agreement.

The agreement should contain the following conditions:

- The agreement must detail the roles and responsibilities of operations and maintenance of the specific traffic signal.
- The agreement must make it clear that vehicle traffic may not be allowed to back up onto the freeway and that Caltrans may take back control of a traffic signal at any time if the signal is not meeting Caltrans standards.
- The yellow signal timing must be compliant with the latest version of the MUTCD.
- The pedestrian timing must be compliant with TOPD 12-01. Traffic signals shall be maintained in compliance with ADA requirements.
- The expiration date must be made clear.
- The agreement may be renewed, after a full traffic signal review by the district's traffic signal operations

Page 2 of 2

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Attachment 3

Memorandum

To : All District Directors

Attention Traffic Operations Engineers
Maintenance Engineers

Date : August 29, 1983

File No.:

From : **DEPARTMENT OF TRANSPORTATION**
Director's Office

Subject: Model 170 Traffic Controller Assemblies

PURPOSE

To establish policy for the use of State-furnished Model 170 Traffic Signal Controller Assemblies on the State highway system (SHS).

To provide procedures for State-furnishing these controller assemblies.

BACKGROUND

In the mid-1970's, Caltrans, with New York, designed a traffic signal controller assembly—the Model 170—that provided complete interchangeability of controller units, cabinets, detector sensor units, isolation modules, switchpacks, conflict monitors, flashers and MODEMS.

Caltrans has had six years of favorable experience with the Model 170. Because of demonstrated significant improvement over conventional controller assemblies in cost, reliability, flexibility of operation and ease of maintenance, Caltrans has standardized on the Model 170.

Since 1977, Caltrans has been purchasing and warehousing the Model 170 in OBM warehouses. From this source, the traffic controller signal assemblies can be requisitioned by the Districts.

POLICY

Only Model 170 Traffic Signal Controller Assemblies will be installed on the SHS.

This policy applies to each new and existing traffic signal including those at the intersection of freeway ramps and local streets, whether they be maintained by the State or by a local agency.

All new traffic-actuated signals shall use Model 170 Traffic Signal Controller Assemblies. Consideration shall be given to using Model 170 for a pretimed signal where pre-emption or actuated phases are involved.

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All electromechanical traffic-actuated controller assemblies shall be replaced with Model 170's. Solid-state (Type 90) traffic-actuated controller assemblies shall be replaced with Model 170's as they become obsolete or develop high maintenance costs. Electromechanical pretimed controller assemblies may also be replaced with Model 170's.

IMPLEMENTATION

State Project

On a State project, the cost of the controller assemblies will be identified in the project report and the preliminary report and will be included in the PS&E. Funding will be from the appropriate allotment.

If the State project is cooperatively financed by the State and a local agency, in accordance with the provisions of the Traffic Manual, the cost of the controller assembly will be included in the cost of the project.

Local Agency Project

The State will furnish a Model 170 Controller Assembly at no cost to the local agency if:

a) The project includes the replacement of an existing controller assembly in advance of the State's planned replacement. The approval document will be the encroachment permit.

b) The project includes the installation of new signal(s) or the modification of existing signal(s) and the project is financed solely by the local agency. The approval document will be the project report.

Private Party Project (Permit Project)

If, as a mitigating factor, the project requires a private party to install a new signal or to relocate or modify an existing controller assembly, the State, in the encroachment permit, will require the private party to install a Model 170. The private party must obtain the Model 170 from the private sector and have it tested by the State's Transportation Laboratory—both at his expense.

However, when a private party is relocating an existing controller assembly as part of a signal modification and the controller assembly is of a type that is scheduled for replacement, the private party will be directed to install a State-furnished Model 170.

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PROCEDURES

Ordering

a) All Model 170 Controller Assemblies that are State-furnished will be requisitioned from the Office of Business Management (OBM) warehouse inventory on standard local request (LR EDP) forms.

b) Assemblies that are back ordered by the warehouse may be purchased by the Districts directly from manufacturers/suppliers if they are urgently needed--through individual District contract delegations, with prior approval from Materiel Operations Branch.

c) Assemblies that are not routinely stocked by the warehouse will be requisitioned from OBM on purchase estimates or through individual District contract delegations.

Charges and Coding

a) When Model 170 Controller Assemblies are requisitioned for either a State or State/Local Agency project, the appropriate EA will be used and the assemblies will be transferred by the warehouse on a Transaction Code 200 (TC 200).

b) Assemblies may also be requisitioned at any time as a transfer from OBM warehouse inventory to a District's inventory. EA's will not be used in these transactions and the warehouse will transfer assemblies on a TC 220.

Maintenance should order all their requirements on a TC 220.

Districts will transfer assemblies from their inventory to specific projects on a TC 100 using an appropriate EA.

c) When a controller assembly is to be supplied at no cost to a local agency or to a private party, the District can take the assembly from their own inventory or requisition one from OBM on a TC 220 for shipment to the District for pretest. In either case, the assembly will be transferred out of the District's inventory to the local agency or to the private party on a TC 451.

Permit numbers will be used on these documents.

Original Signed J. R. Cropper

R. G. ADAMS
Deputy Director
Highway Maintenance and
Transportation Operations

HLBegin:sb
bcc:HLBegin
WAJHoversten
KCGilbert
HFox - FOC
SCarlson - FOC
RNevis - OBM
All Dist. Materiel Managers
Director's Files
Director's X-Ref.

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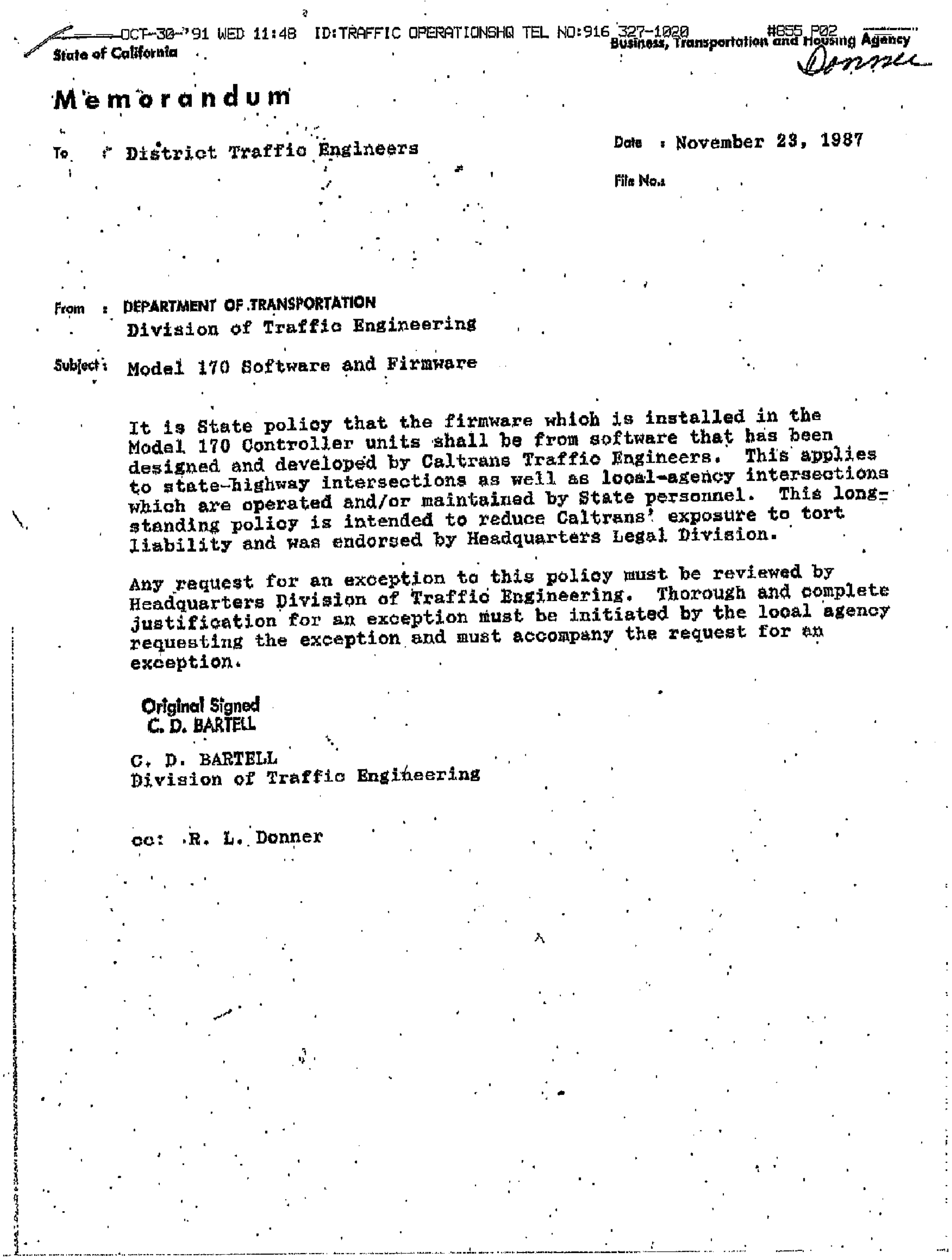
Attachment 4



OCT-30-'91 WED 11:48 ID:TRAFFIC OPERATIONSHQ TEL NO:916 327-1020 #855 P02

State of California

Business, Transportation and Housing Agency

Donner

Memorandum

To : District Traffic Engineers

Date : November 23, 1987

File No.:

From : DEPARTMENT OF TRANSPORTATION
Division of Traffic Engineering

Subject: Model 170 Software and Firmware

It is State policy that the firmware which is installed in the Model 170 Controller units shall be from software that has been designed and developed by Caltrans Traffic Engineers. This applies to state-highway intersections as well as local-agency intersections which are operated and/or maintained by State personnel. This long-standing policy is intended to reduce Caltrans' exposure to tort liability and was endorsed by Headquarters Legal Division.

Any request for an exception to this policy must be reviewed by Headquarters Division of Traffic Engineering. Thorough and complete justification for an exception must be initiated by the local agency requesting the exception and must accompany the request for an exception.

Original Signed
C. D. BARTELL

C. D. BARTELL
Division of Traffic Engineering

cc: R. L. Donner

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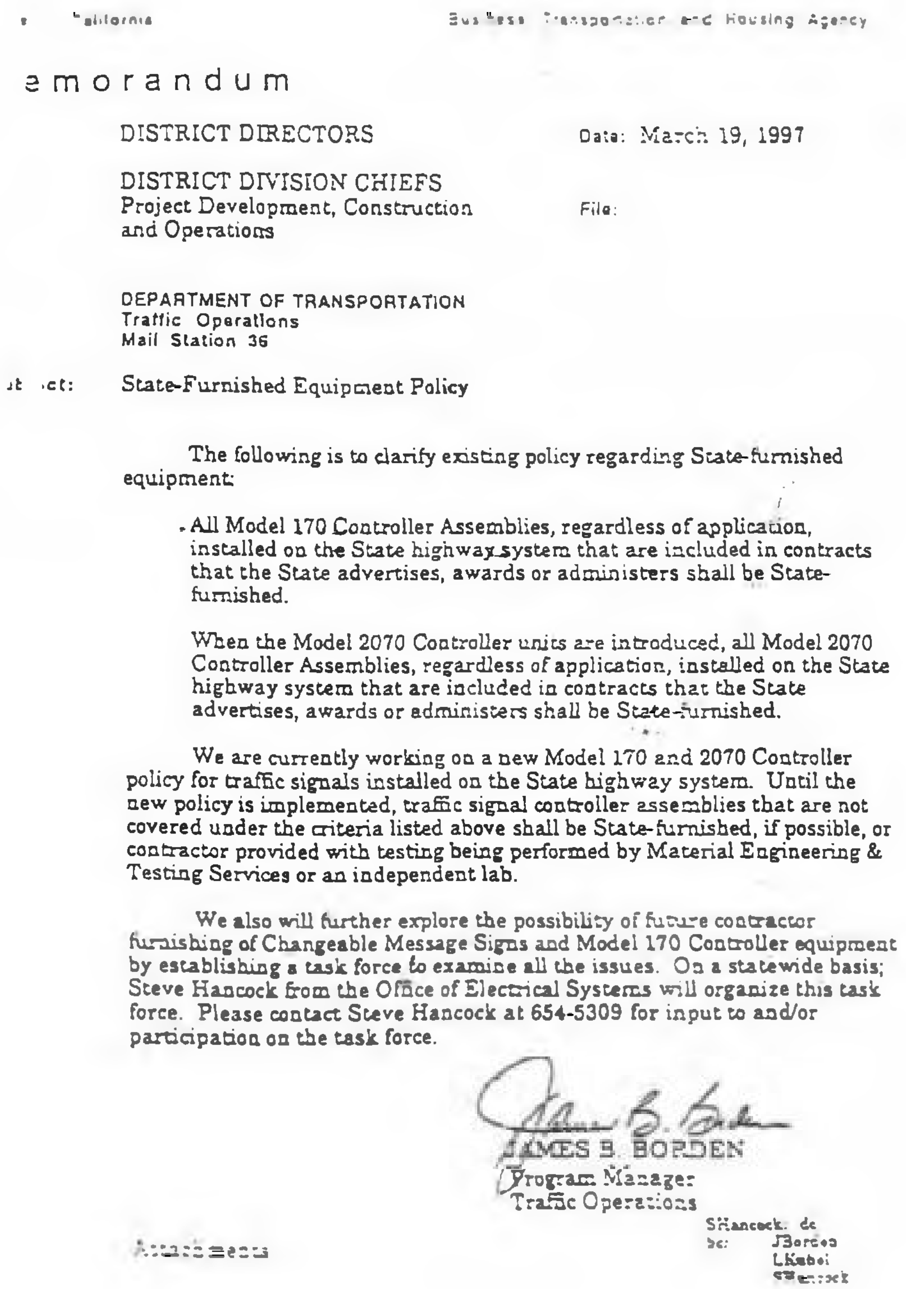
Attachment 5



California Business, Transportation and Housing Agency

emorandum

DISTRICT DIRECTORS

DISTRICT DIVISION CHIEFS
Project Development, Construction
and Operations

Date: March 19, 1997

File:

DEPARTMENT OF TRANSPORTATION
Traffic Operations
Mail Station 36

Subject: State-Furnished Equipment Policy

The following is to clarify existing policy regarding State-furnished equipment:

- All Model 170 Controller Assemblies, regardless of application, installed on the State highway system that are included in contracts that the State advertises, awards or administers shall be State-furnished.

  When the Model 2070 Controller units are introduced, all Model 2070 Controller Assemblies, regardless of application, installed on the State highway system that are included in contracts that the State advertises, awards or administers shall be State-furnished.

We are currently working on a new Model 170 and 2070 Controller policy for traffic signals installed on the State highway system. Until the new policy is implemented, traffic signal controller assemblies that are not covered under the criteria listed above shall be State-furnished, if possible, or contractor provided with testing being performed by Material Engineering & Testing Services or an independent lab.

We also will further explore the possibility of future contractor furnishing of Changeable Message Signs and Model 170 Controller equipment by establishing a task force to examine all the issues. On a statewide basis; Steve Hancock from the Office of Electrical Systems will organize this task force. Please contact Steve Hancock at 654-5309 for input to and/or participation on the task force.

James B. Borden
JAMES B. BORDEN
Program Manager
Traffic Operations

Attachments

SHancock: dc
bc: JBorden
LKabei
SHancock

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Appendix D – Example of a XY Form

(NOTE: Use Your Own District's Established Forms)

(CT) LOCATION NO.__________ *X-FORM, Page 1*

CALTRANS ELECTRICAL PROJECT

This form is to be completed by TELCO Outside Plant Engineer and contains all the necessary information regarding the POINT OF DELIVERY (demarcation box or housing) and SERVICE POINT (terminal). Information determined to be provided by Caltrans is identified as '**CT'** in the left margin and information provided by **Telephone Company** is identified as '**Telco'** in the left margin. Please print information legibly.

TELCO:

OSP Construction Required YES: __________ NO:_________

Job # ________________ Days Required:____________

Comp. Date (if known)_________

(CT) CALTRANS: (if known)

District_____ County_________ Route ______ Post Mile _____

Contract #: ____________

A. POINT OF SERVICE DELIVERY*:* (demarcation box or housing)

(CT) 1. Place Demarcation Box ______ or Housing________________

(CT) & 2. Location of: Jack / SM (circle one) - list street name and address,

(Telco) Provide additional description of location if needed. (See Note No. 1)

____

(CT) & Cross Street reference. Direction: ______ ft mi (circle one)

(Telco) N S E W (circle one) of cross street: _______________________

____

B. SERVICE POINT (terminal pole, manhole, etc.)

(Telco) 1. Terminal Address or Manhole Location (SERVICE POINT),

(See Note 2)

____

Cable Count (if known)_____________________________

5 Pair placed by: OSP Const. ______ or AIM/SS ______ # of feet ___

(Telco) 2. Telephone Company Serving CO (exchange name): ____________

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(Telco) 3. Common Language Code: ________________________________

C. FIELD VISIT and POINT OF DELIVERY LOCATION:

(Telco) 1. Date of Field Visit:

(Telco) 2. Representative in attendance during Field Visit (list name, title, and telephone number, including telephone area code):

(CT) a. CALTRANS

Name: ______________________Phone #:________________

Name: ______________________Phone #:________________

(CT) ** SIGNATURE ** agreeing to POINT OF DELIVERY location

____

(Telco) b. TELCO (General Tel. or other)

Name: ______________________Phone #:_______________

Name: ______________________Phone #:_______________

(Telco) ** SIGNATURE ** agreeing to POINT OF DELIVERY location

____

(Telco) 3. Did the CALTRANS Representative agree to build their conduit directly to the telephone company's SERVICE POINT? (Terminal pole, manhole, etc.): YES: _____NO: _____(if no, See Note Number 3)

(CT) & 4. Remarks: ____

(Telco) ____

____

____

____

____

--NOTES--

Note #1:

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Express the POINT OF DELIVERY location in words. The street names and addresses and the “additional description” (footage ties, property lines, etc.) must be the same as shown on the attached sketch (Y form). This information will also be placed on the TELCO service order and will be used by TELCO field technicians to locate the POINT OF DELIVERY

during trouble calls. Each sketch must contain any “construction notes” that are pertinent to the location.

TELCO Engineer will distribute both the “X FORM” and the sketch as follows:

1. One copy to TELCO Construction Department
2. One copy to be retained by TELCO Engineer
3. Original copy to TELCO Coordinator
4. One copy to the TELCO Marketing Representative

Note #2:

TELCO Construction Department or Special Services will place a five (5) pair cable from the SERVICE POINT to the agreed POINT OF DELIVERY.

Note #3:

If “No” the TELCO Engineer must determine if the STATE will be billed for the cost of building telephone plant from the State’s termination point to TELCO’s nearest existing facility. ‘SPECIAL CONSTRUCTION OF EXCHANGE FACILITIES” as guide. Reference PUC Traffic No. A2, Rule No. 36.

Note #4:

When drawing the information on the attached sketch (Y FORM) please do not use an existing map or plan to draw it upon.

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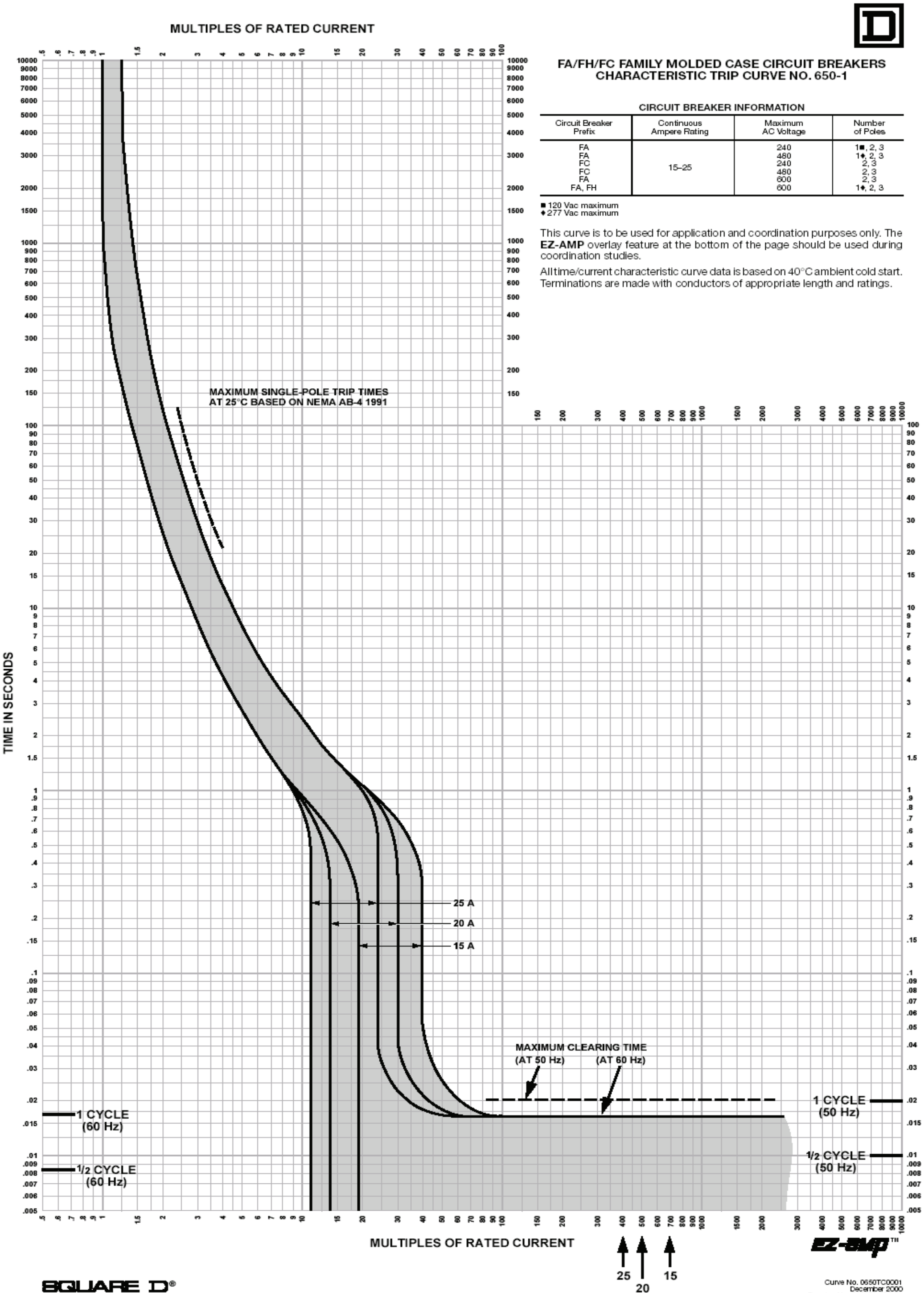
Appendix E – Circuit Breaker Curve



FA/FH/FC FAMILY MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIP CURVE NO. 650-1

CIRCUIT BREAKER INFORMATION

Circuit Breaker Prefix	Continuous Ampere Rating	Maximum AC Voltage	Number of Poles
FA	15–25	240	1■, 2, 3
FA		480	1♦, 2, 3
FC		240	2, 3
FC		480	2, 3
FA		600	2, 3
FA, FH		600	1♦, 2, 3

■ 120 Vac maximum
♦ 277 Vac maximum

This curve is to be used for application and coordination purposes only. The **EZ-AMP** overlay feature at the bottom of the page should be used during coordination studies.

All time/current characteristic curve data is based on 40°C ambient cold start. Terminations are made with conductors of appropriate length and ratings.

SQUARE D®

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Curve No. 0650TC0001
December 2000
Drawing No. B48095-650-01
(Replaces 0650TC9001)

Appendix F – List of Department Furnished Materials

Electrical List

🟨	2070
🟩	2070 LX
🟧	170
🟥	BBS
🟦	Cabinet
🟦	CMS500
🟫	CMS700 (Amber)
⬜	CMS700C (Full-Color)
🟪	Signal LEDs

Item #	CT Number	Description
1	7440 0090 8	Module Traffic Control System, Model 2070E
2	7440 0136 7	Modem Traffic Component, Model 2070-6A Modem
3	7440 0137 9	Modem Traffic Component, Model 2070-6B Modem
4	7440 0134 2	Modem Traffic Component, Model 2070-7A Serial Comm Modem, Dual RS232 ports
5	7440 0552 9	Modem Traffic Component, Model 2070-7B Serial Comm Modem, EIA-485
6	7440 0117 7	Traffic Control Equipment, Model 2070-9A, FSK/Dialup Comm Modem
7	7440 0555 6	Traffic Control Equipment, Model 2070-9B, FSK/Dialup Comm Modem
8	7440 0119 1	Traffic Control Equipment, Model 2070-9D, Dialup Comm Modem
9	7440 0123 9	Traffic Control Equipment, Model 2070-6D, Fiber Optic Modem
10	7440 8055 3	Traffic Control Equipment, Model 2070-J, Network Jack Module
11	7440 8061 5	Traffic Control Equipment, Model 2070-WE, Wireless Ethernet Communication Module
12	7440 0116 5	Modem Traffic Component, Model 2070-6W Wireless Comm Modem
13	7440 0553 1	Traffic Control Equipment, Model 2070-7G card (GPS), Universal Time Base Module
14	7440 0160 7	Module Traffic Control System, Model 2070LX
15	7440 0551 7	Traffic Control Equipment, Model 2070-1C CPU Card
16	7440 0130 4	Modem Traffic Control System, Model 400 modem, 1200 bps, internal for 170E or Rack Mounted Leased Telco or Private Wire
17	7440 0557 0	Modem Traffic Control System, Model 400N, Ethernet module
18	7440 0890 5	Modem Traffic Component, Harness for C2S Serial Connector of 170E Controller

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19	7440 0131 6	Module Traffic Control System, Harness for Model C2P Modem
20	7440 8071 6	Cabinet Traffic Controller, Model 334LS Cabinet
21	7440 8072 8	Cabinet Traffic Controller, Model 332LS Cabinet
22	7440 8039 9	Cabinet Traffic Controller, Model 336LS Cabinet with PDA #2L
23	7440 0201 5	Cabinet Traffic Controller, Model 342LX Cabinet
24	7440 0203 9	Cabinet Traffic Controller, Model 344LX Cabinet
25	7440 0290 2	Switch Pack Traffic Control System, Model 200 Switch Pack
26	7440 0560 6	Flasher Unit Traffic Control System, Model 204 Flasher Unit
27	7440 0350 0	Detector Vehicle, Model 222 Two-Channel Loop Detector
28	7440 0330 8	Signal Monitor, Model 210
29	7440 0325 8	Signal Monitor, Model 208
30	7440 0400 7	Detector Vehicle Magnetic Probe, Model 231 Probe
31	7440 0430 0	Module Traffic Control System, Model 232 Dual Magnetic Detector Amplifier Module
32	7440 0475 5	Module Traffic Control System, Model 242L Two-Channel DC Isolator
33	7440 0196 3	Module Traffic Controller, Model 252 Isolator Two-Channel AC Isolators
34	7440 8062 7	Traffic Control Component, Model 280, Input File Ethernet Switch Unit
35	7440 8057 7	Intelligent Vehicle Detector, Model 222i Two-Channel Loop Detector
36	7440 8058 9	Intelligent Vehicle Detector, Model 224i Four-Channel Loop Detector
37	7440 8054 0	Cabinet Traffic Controller CMS, Model 334LC Cabinet with PDA #3L
38	7440 0065 6	Model 206L Power Supply
39	7440 0057 9	Model C11 Harness
40	7440 0550 5	Model 420 Output File No. 2 (Aux. file)
41	7440 8056 5	Model 520 Output File for Railroad Crossings
42	7440 8060 3	Model 206E Power Supply
43	7440 8064 1	Model C1 Harness
44	7440 8066 6	Model 207 Integrated Power Filter
45	7440 0187 4	Model 2070-4A Power Supply
46	7440 0066 8	Model 206LS Power Supply
47	7440 0105 2	Model PDA #2LS Power Distribution Assembly
48	7440 0673 5	Battery Back Up System (BBS) Inverter, Type II
49	7440 0672 3	External Battery Back Up System Cabinet, Model E-BBS
50	7440 8063 9	External Battery Back Up System Cabinet, Model LX-BBS
51	7440 8059 1	Battery Back Up System Model GT-BBS, Green Technology
52	7440 8032 4	CMS Model 700C Right Handed
53	7440 8031 2	CMS Model 700C Left Handed

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54	7440 8038 7	CMS Model 710C Right Handed
55	7440 8037 5	CMS Model 710C Left Handed
56	7440 8044 9	CMS Model 720C Right Handed
57	7440 8043 7	CMS Model 720C Left Handed
58	7440 8050 2	Type 3 Pixel Matrix Module PMM-7T3 for CMS 700C
59	7440 8051 4	Type 4 Pixel Matrix Module PMM-7T4 for CMS 710C and 720C
60	7440 8033 6	Test Box TB700 for CMS 700/710/720/700C/710C/720C
61	7440 8034 8	Remote I/O Box RIO700 for CMS 700/710/720/700C/710C/720C
62	7440 0145 6	CMS Model 700 Right Handed (aka AVMS710)
63	7440 8018 5	CMS Model 700 Left Handed (aka AVMS710)
64	7440 8036 3	CMS Model 710 Right Handed
65	7440 8035 1	CMS Model 710 Left Handed
66	7440 8042 5	CMS Model 720 Right Handed
67	7440 8041 3	CMS Model 720 Left Handed
68	7440 8047 6	Type 1 Pixel Matrix Module PMM-7T1 for CMS 700
69	7440 8049 0	Type 2 Pixel Matrix Module PMM-7T2 for CMS 710 and 720
70	7440 0175 9	CMS Model 500 Right Handed
71	7440 0218 1	CMS Model 500 Left Handed
72	7440 0181 1	CMS Model 510 Right Handed
73	7440 0140 5	CMS Model 510 Left Handed
74	7440 0188 6	CMS Model 520
75	7440 0615 4	Harness #1 for CMS 500, 510 and 520
76	7440 0613 9	Harness #4 for CMS 500 (300ft)
77	7440 0614 1	Harness #5 for CMS 500 (300ft)
78	7440 8052 6	Type 1 Pixel Matrix Module PMM-5T1 for CMS 500
79	7440 8053 8	Type 2 Pixel Matrix Module PMM-5T2 for CMS 510 and 520
80	7440 0611 5	Power Distribution Assembly PDA #4L
81	7440 8067 8	Model CIA-CMS Control Isolation Assembly for CMS
82	7440 0623 0	Signal Traffic Component, LED 200 MM 8", Green Ball Type I
83	7440 0627 9	Signal Traffic Component, LED 200 MM 8", Red Ball Type I
84	7440 0625 5	Signal Traffic Component, LED 200 MM 8", Yellow Ball Type I
85	7440 0630 5	Signal Traffic Component, LED 300 MM 12", Red Ball Type I
86	7440 0635 6	Signal Traffic Component, LED 300 MM 12", Red Arrow Type I
87	7440 0629 3	Signal Traffic Component, LED 300 MM 12", Green Ball Type I
88	7440 0634 3	Signal Traffic Component, LED 300 MM 12", Green Arrow Type I

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89	7440 0655 8	Signal Traffic Component, LED 300 MM 12", Yellow Ball Type I
90	7440 0656 0	Signal Traffic Component, LED 300 MM 12", Yellow Arrow Type I
91	7440 0670 9	Signal Traffic Component, LED Pedestrian, Combo Face, Combination Module
92	7440 0657 2	Signal Traffic Component, LED 300 MM 12” PV Green, Type 2 Plug-in Base (6” for 12” Head)
93	7440 0658 4	Signal Traffic Component, LED 300 MM 12” PV Yellow, Type 2 Plug-In Base, (6” for 12” Head)
94	7440 0659 6	Signal Traffic Component, LED 300 MM 12” PV Red, Type 2 Plug-In Base, (6” for 12” Head)

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Appendix G – Information Handout

See Following Page

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Office of ITS Engineering and Support

TMS Element Operational Status Certified List

PROJECT NAME: RAMP METERING

PROJECT ID:

POSTMILE LIMITS: COUNTY-ROUTE

PROJECT EA: XX-XXXX

CONSTRUCTION START DATE:

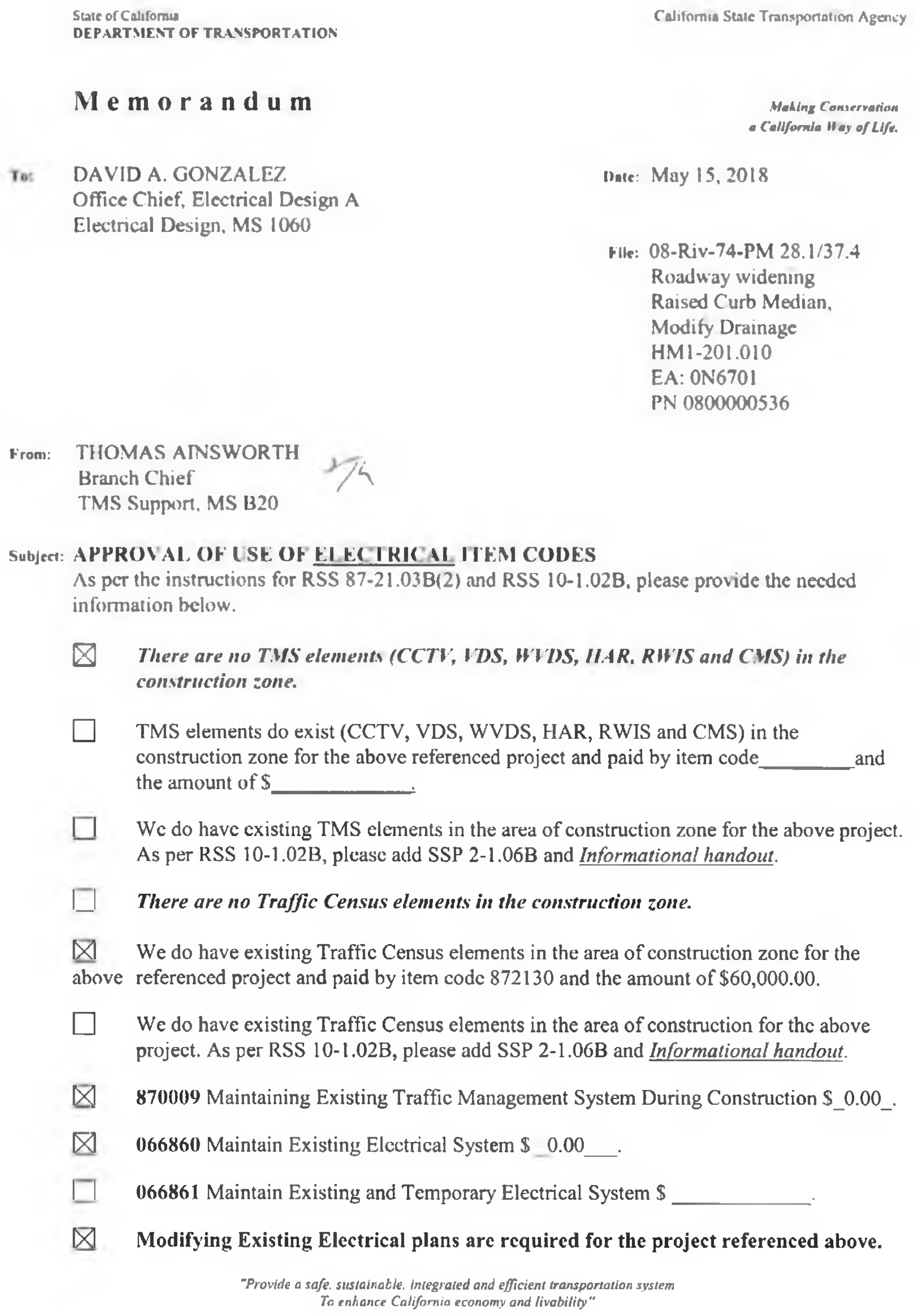
ELECTRICAL INSPECTOR:

CONSTRUCTION END DATE:

CONTRACTOR'S REP:

TMS ELEMENT	LOCATION				PREBID STATUS	PRECONSTRUCTION			POSTCONSTRUCTION		
	COUNTY	ROUTE	PM	DIRECTION		STATUS	DATE CHECKED	CHECKED BY	STATUS	DATE CHECKED	CHECKED BY
Eastern Street TMS	XXX	XX	4.20	SB	Partially Operational		17-Dec	Brett Current			
Oak St.	XXX	XX	1.00	SB	Operational		17-Dec	Brett Current			
Telly Road	XXX	XX	0.50	SB	N/A		17-Dec	Brett Current			
A Street	XXX	XX	0.00	SB	Operational		17-Dec	Brett Current			
Broadway	XXX	XX	23.80	SB	Operational		17-Dec	Brett Current			
Electric Avenue	XXX	XX	22.9	SB	N/A		17-Dec	Brett Current			
Warden Way	XXX	XX	21.8	SB	non-operational		17-Dec	Brett Current			
18th Street.	XXX	XX	21.6	SB	operational		17-Dec	Brett Current			
Fiona Blvd.	XXX	XX	20.8	SB	Operational		17-Dec	Brett Current			
Rubble Road	XXX	XX	21	SB	N/A		17-Dec	Brett Current			
Maxwell Avenue	XXX	XX	19.7	SB	Operational		17-Dec	Brett Current			
Jupiter Lane	XXX	XX	19.5	SB	Operational		17-Dec	Brett Current			
Secret River Blvd,	XXX	XX	15.9	SB	Operational		17-Dec	Brett Current			
Secret River Blvd,	XXX	XX	15.7	SB	Operational		17-Dec	Brett Current			

Appendix H – Justification Letter



State of California
DEPARTMENT OF TRANSPORTATION

California State Transportation Agency

Memorandum

Making Conservation
a California Way of Life.

To: DAVID A. GONZALEZ
Office Chief, Electrical Design A
Electrical Design, MS 1060

Date: May 15, 2018

File: 08-Riv-74-PM 28.1/37.4
Roadway widening
Raised Curb Median,
Modify Drainage
HM1-201.010
EA: 0N6701
PN 0800000536

From: THOMAS AINSWORTH
Branch Chief
TMS Support, MS B20

Subject: **APPROVAL OF USE OF ELECTRICAL ITEM CODES**
As per the instructions for RSS 87-21.03B(2) and RSS 10-1.02B, please provide the needed information below.

☒ ***There are no TMS elements (CCTV, VDS, WVDS, HAR, RWIS and CMS) in the construction zone.***

☐ TMS elements do exist (CCTV, VDS, WVDS, HAR, RWIS and CMS) in the construction zone for the above referenced project and paid by item code________and the amount of $_____________.

☐ We do have existing TMS elements in the area of construction zone for the above project. As per RSS 10-1.02B, please add SSP 2-1.06B and *Informational handout*.

☐ ***There are no Traffic Census elements in the construction zone.***

☒ We do have existing Traffic Census elements in the area of construction zone for the
above referenced project and paid by item code 872130 and the amount of $60,000.00.

☐ We do have existing Traffic Census elements in the area of construction for the above project. As per RSS 10-1.02B, please add SSP 2-1.06B and *Informational handout*.

☒ **870009** Maintaining Existing Traffic Management System During Construction $_0.00_.

☒ **066860** Maintain Existing Electrical System $ _0.00___.

☐ **066861** Maintain Existing and Temporary Electrical System $ ____________.

☒ **Modifying Existing Electrical plans are required for the project referenced above.**

"Provide a safe, sustainable, integrated and efficient transportation system
To enhance California economy and livability"

The information provided in this memo was approved by the electrical department mentioned above.

"Caltrans improves mobility across California"

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Appendix I – Supply Line Communication Conduit and Sprinkler Conduit on Bridges

Supply Lines, Communication Conduit and Sprinkler Control Conduit on Bridges

Supply Line and Sprinkler Control Conduit

1. The Headquarters Landscape Architect or the District will return a print of the General Plan to the Office of Structure Design and the District Traffic Engineer with comments on supply lines and conduits required for irrigation. General Plans for bridges on which no pipes are anticipated will also be returned so noted.

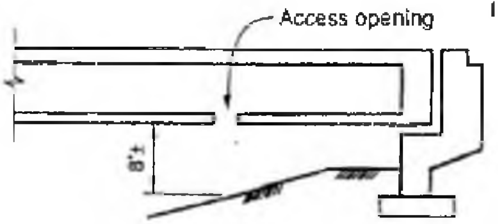
2. Unless otherwise noted by the comments, the Office of Structure Design will furnish a 3″ standard galvanized steel pipe for supply lines. Pipe diameters less than 4″ can be furnished with the use of Standard Plan B 14-3. For pipes 4″ or larger, use Standard Plan B 14-4. All details of the supply lines shall be reviewed by our Mechanical Engineers.

3. Expansion assemblies for supply lines and electrical conduit shall be provided according to bridge length as follows:

   a) Up to 600 feet - one assembly placed at each abutment and another only near an expansion joint if a bridge expansion joint is required.

   b) Over 600 feet - one assembly placed at each abutment and equally spaced at approximately 300 foot intervals preferably near bridge expansion joints.

   Access openings to these expansion joints shall be located in the bottom slab, at the abutment end of each box girder cell which contains supply lines. The opening shall be offset from the utilities and placed a sufficient distance from the abutment to prevent unauthorized access. Access to other expansion assemblies may be gained through openings in caps and diaphragms. Access openings near bents adjacent to expansion joints are permitted if openings in bent caps are impossible. Detail openings on the plans.



4. A supply line pipe is not permitted in any bridge barrier.

Supersedes Memo to Designers I 8-3 dated October 1988

5. The supply line will be carried as a bridge item in the Engineer's Estimate. For estimating, give the total length of pipe (linear feet). Items such as pipe cradles, inserts, bolts, access doors, hangers and expansion assemblies will be included in the price paid per linear foot.

6. Occasionally we have requests from the Landscape Architect to carry a sprinkler control conduit in addition to the water supply line across the structure. This conduit should be handled similar to that for Communication Conduits except the Districts' pay item will be "Sprinkler Control Conduit" The supply line and conduit should cross the bridge in the same general area. The minimum size conduit will be 2".

Communication Conduit

The need for communication lines and their size will be determined by the Districts. The Office of
Structure Design will work with the Districts in determining the exact location within the structure to carry the conduits. The conduits should be placed in the bridge railing or sidewalk if at all possible. If this is done, no detailing is required on the bridge plans and all plans will be prepared by the District. If placed elsewhere, the following items shall be considered:

1. The communications conduit will normally be a District item. Keep separate from other items so that Estimating can distinguish District pay items.

2. All openings shall be fully detailed on the Bridge Plans. We should review the Road Plans to be sure they show the communications conduit and make reference to the details shown on the Bridge Plans.

3. The quantity estimator should take off the linear feet of conduit from pull box to pull box at the ends of the bridge.

4. A pull box is required in the structure every 200'. Where a conduit is used in the railing, the standard electrical pull box can be used. Where larger conduits are required, a special pull box in the soffit can be used where it can be reached without interfering with traffic. For special box details the designer should consult with our Electrical Engineer.

5. Conduits can be cast within various concrete sections where room permits. Expansion fittings for various sizes of conduits have the following outside dimensions:

Conduit Size	Expansion Fitting Outside Dimension
1"	2-5/8"'
1-1/2"	3-1/2"'
2"	4"
3"	5-5/8""

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A barrier parapet can readily accommodate a 3" conduit as shown on Standard Plan B 14-3. However,
if more conduits are required in a standard Type 25 barrier, the following combinations may be used:

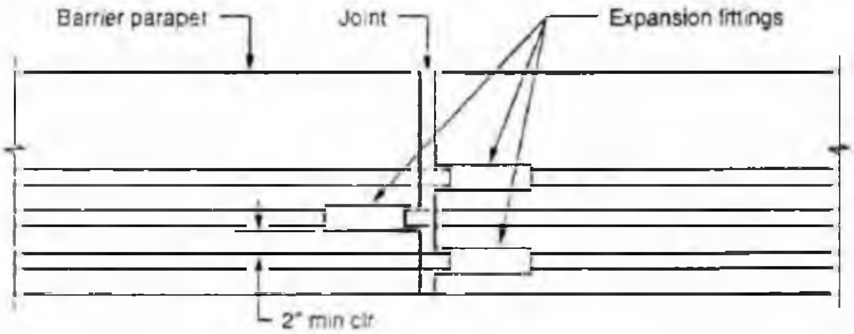
1. One 3" and one 1-1/2" or 2"" conduit.

2. Three 1-1/2" conduits.

2.
3.

3. Adjacent conduits shall have 2" minimum clear distance between them. When multiple conduits are used, expansion fittings at barrier joints shall be shown on the plans and staggered as shown below.

4.



ELEVATION

If a lighting conduit is to be placed within the parapet it may be necessary to place the communications conduit elsewhere. Keep in mind that the additional short lighting conduit lengths from pull boxes to soffit lights, signs, or electroliers can cause congestion in the parapet.

Expansion fittings are not suitable if barrier has both deflection and expansion.

Joint seals may conflict with placement of conduits in the barriers. *Refer to Standard Plan B6-21 for probable joint seal posit on in barrier.*

[original signed by Floyd L. Mellon and Guy D. Mancarti]

Floyd L. Mellon Guy D. Mancarti

JPH:jgf
Attachment

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Appendix J – Clarification of Voltage Drop Calculations

OFFICE MEMO Date: *April 4, 1995*

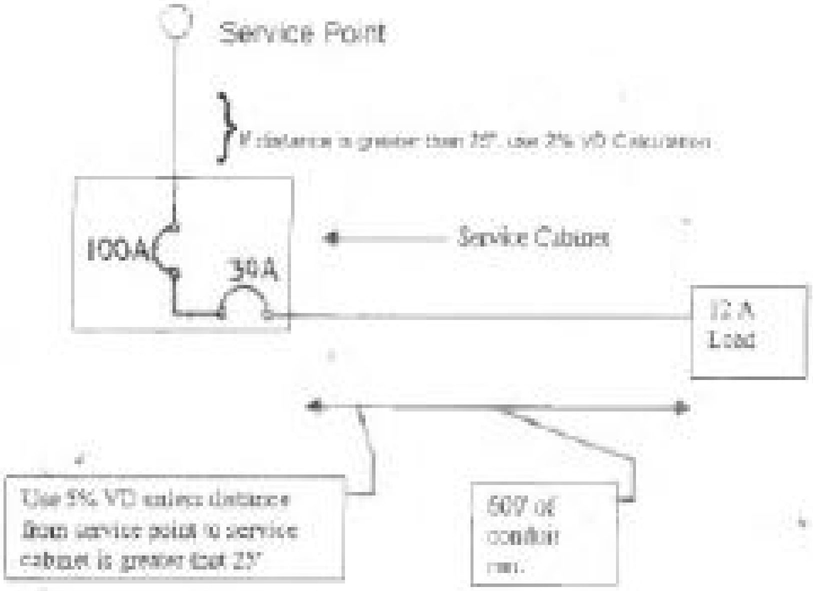
STAFF
Electrical Design

From **DEPARTMENT OF TRANPORTATION**
District 3- Electrical Design/Operations

Subject Clarification of Voltage Drop Calculation

This office memo is to clarify the method in calculating voltage drop. The Electrical Design Branch will now use the criteria stated below:

1. Use the Voltage Drop Calculation stated in the Traffic Manual.
   $VD=2IRL$, $R=VD/2IL$.
2. The Voltage Drop Calculation should be connected load only.
3. If the distance from the Service Point to the Service Cabinet is less than 25', you should consider this distance as negligible and calculate a 5% Voltage Drop from the Service Point to the Load.
4. If the distance from the Service Point to the Service Cabinet is greater than 25', calculate 2% Voltage Drop for the Service Feeder and 3% Voltage Drop for the Load Feeder.



If you have any questions, please call me at *4370*.

David A. Gamboa, Chief
Electrical Design/Operations

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Appendix K – List of Manuals and Online Resources

The following are useful references related to electrical design.

Manuals

California Electrical Code (CEC)

California Manual on Uniform Traffic Control Devices (superseded the Traffic Manual, 1996

Construction Contract Development Guide

Construction Manual

Highway Design Manual (Caltrans

National Electrical Code (NEC)

Plans Preparation Manual

Ramp Meter Design Manual

Roadway Lighting Manual

Signals Operation Manual, Model 2070 Controller

Traffic Signal Control Equipment Specification

Traffic Signal Operations Manual

Transportation Electrical Equipment Specifications (TEES)

Online Resources

California Dept. of Transportation (Caltrans	http://www.dot.ca.gov
Construction Contract Standards	https://dot.ca.gov/programs/design/
Project Development Procedures Manual	https://dot.ca.gov/programs/design/manual-project-development-procedures-manual-pdpm
California MUTCD	https://dot.ca.gov/programs/traffic-operations/camutcd
Federal Highway Dept. of Transportation	http://mutcd.fhwa.dot.gov
The National Technical Information Service	http://www.ntis.gov
CA Public Utilities Commission	http://www.cpuc.ca.gov/
Performance Management System (PeMS)	http://pems.dot.ca.gov/

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Appendix L – Acronyms, Abbreviations, and Symbols

Short Form	Full Name or Meaning
A	Amperes
ac	Alternating Current
ADA	Americans with Disabilities Act
APS	Accessible Pedestrian Signals
AVC	Automatic Vehicle Classification
AWG	American Wire Gauge
BBS	Battery Backup System
CA	California
Ch.	Channel
CIA	Controller Isolation Assembly
CMS	Changeable Message Sign
Co	County
CRZ	Clear Recovery Zone
CT	Caltrans
CTID	Caltrans Identification Number
DLC	Detector Lead-in Cable
EMS	Extinguishable Message Sign
FCC	Federal Communications Commission
FDU	Fiber (Optic) Distribution Unit
FHWA	Federal Highway Administration
HARS	Highway Advisory Radio System
HDM	Highway Design Manual
HQ	Headquarters
HUB	Hub
ILD	Inductive Loop Detector
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
Kg	Kilogram
Km	Kilometer

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LED	Light Emitting Diodes
m^3	Cubic meter
Mm	Millimeter
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
PCC	Portland Cement Concrete
PDA	Power Distribution Assembly
PE	Project Engineer
RE	Resident Engineer
RTL	Ready to List
RWIS	Roadway Weather Information System
SCS	Surveillance Camera System
TEES	Transportation Electrical Equipment Specifications
TELCO	Telephone Company
THHN	Thermoplastic High Heat Resistant Outer Nylon jacket
THWN	Thermoplastic Heat and Water Resistant Outer Nylon jacket
TIS	Traveler Information System
TMC	Transportation Management Center
TMS	Transportation Management System or Traffic Management System
TSS	Traffic Signal System
V	Volt
VC	Vertical Curve
V_D	Voltage Drop
VIVDS	Video Imaging Vehicle Detection System
W	Watt
VTIS	Vehicle to Infrastructure System
Y	Wye
Z	Impedance (R + jX
Δ	Delta
°C	Degree Celsius

Appendix M – Glossary

Term	Definition
branch circuit	Circuit conductor between the final overcurrent protective device and the outlets (load).

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buck/boost transformer	Transformer to buck or boost the voltage in a circuit by a small amount to remedy voltage drop problems in lengthy circuits or to feed a specific load.
clear recovery zone	Unobstructed, relatively flat area provided beyond the traveled way to permit the recovery of cars that accidentally run off the road.
conduit	Pipe or tube in which smaller pipes, tubes, or electrical conductors are inserted or are to be inserted.
detector	Device for indicating the passage or presence of vehicles or pedestrians.
electrolier	Complete assembly of lighting standard, luminaire, ballast, and lamp.
feeder	Circuit conductor between the service equipment and the final branch circuit overcurrent protective device.
flasher	Device used to open and close signal circuits at a repetitive rate.
ground	Conductive connection, whether intentional or accidental, between an electrical circuit or equipment to an earth surface or to some other substantially large conductive body acting as an earth surface.
lighting Standard	Pole and mast arm supporting the luminaire.
luminaire	Assembly that houses the light source and controls the light emitted from the light source.
operation status	Verification of the operating condition of the electrical system (including detection system) whether working or non-working.
service	Conductors and equipment for delivering energy from the serving utility to the premise’s wiring.
service equipment	Necessary equipment connected to load end of service conductors to supply a building or structure.
service point	The point of connection between the facilities of the serving utility and the premises wiring (location defined by every utility)
short-circuit analysis	A calculation to select the proper characteristics of an overcurrent protection device to disconnect an electrical circuit from the source safely.

signal face	A part of the signal head provided for controlling traffic in a single direction and consisting of one or more signal sections.
signal head	An assembly containing one or more signal faces.

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Appendix N – Plan Sheet Examples

See Following Pages

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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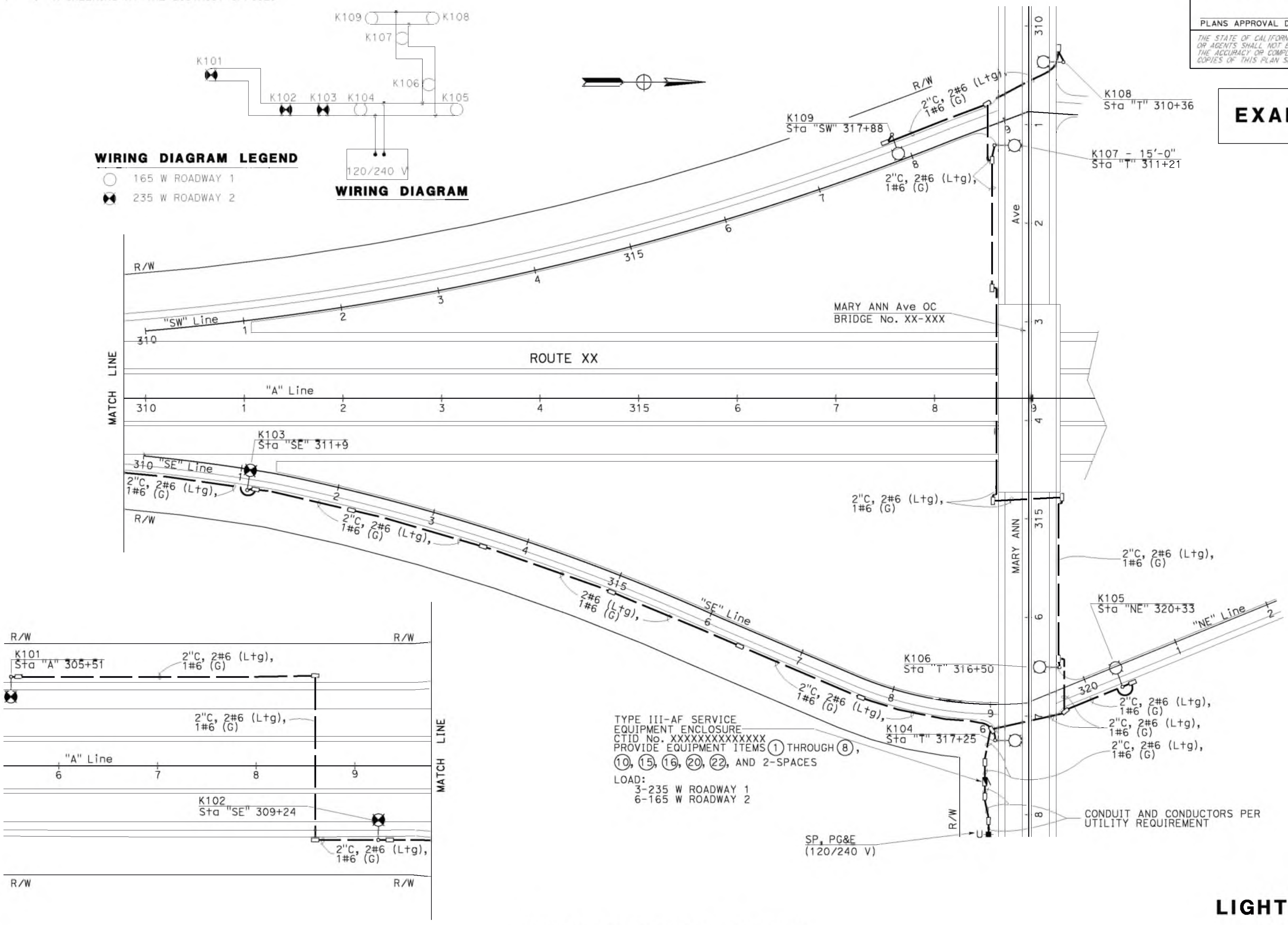
REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
ELECTRICAL
STATE OF CALIFORNIA

EXAMPLE A

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



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LIGHTING SYSTEM

SCALE: 1" = 50'

E-1

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ELECTRICAL DESIGN

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DATE PLOTTED => 13-MAR-2020

TIME PLOTTED => 14147

BORDER LAST REVISED 7/2/2010

USERNAME => s149782
DGN FILE => 03.13.20 Ltg.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000000

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

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Exp.
ELECTRICAL

EXAMPLE A

NOTE:

ELECTRICAL SYSTEMS QUANTITY TABLE SUMMARIZES SIGNIFICANT COMPONENTS. SEE ELECTRICAL SYSTEMS PLANS AND SPECIFICATIONS TO DETERMINE ALL MATERIALS NEEDED FOR EACH SYSTEM.

LIGHTING SYSTEM

SHEET No.	(N)						
	No. 5 PB	No. 6 PB	2"C	No. 6 CONDUCTOR	ELECTROLIER TYPE 15	ELECTROLIER TYPE 31	TYPE III-AF SERVICE EQUIPMENT ENCLOSURE
	EA	EA	FT	FT	EA	EA	EA
E-1	23	1	2660	7860	6	3	1

(N) NOT A SEPARATE BID ITEM

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ELECTRICAL SYSTEM QUANTITIES
EQ-1

DATE PLOTTED => 13-MAR-2020
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BORDER LAST REVISED 7/2/2010
USERNAME => s149782
DGN FILE => 03.13.20 Ltg Quantity.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000000

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

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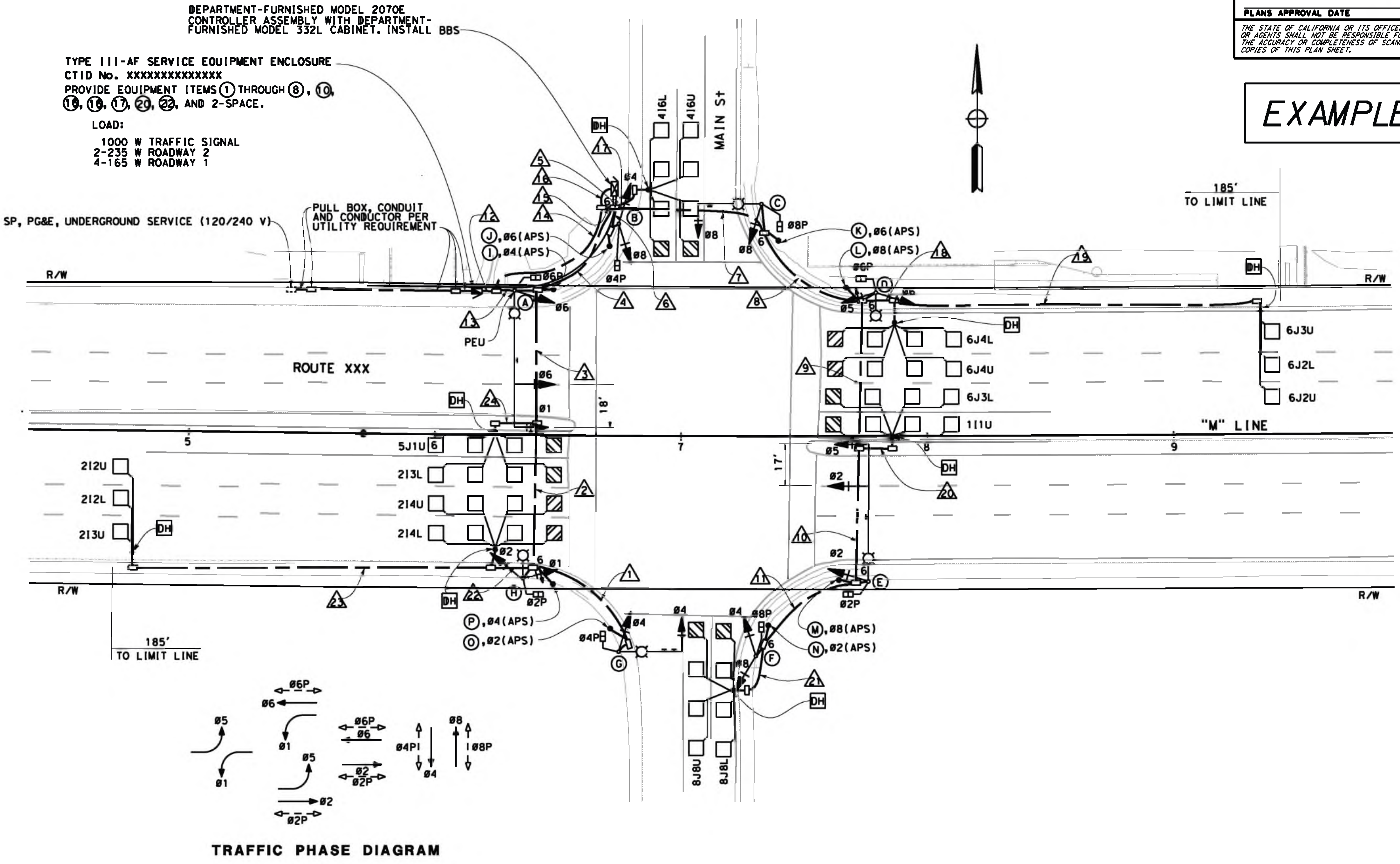
EXAMPLE B

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



SIGNAL AND LIGHTING SYSTEM

SCALE: 1" = 20'

E-1

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	CHECKED BY	DATE REVISED

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DATE PLOTTED => 3/10/2020
TIME PLOTTED => 2:10:23 PM

BORDER LAST REVISED 7/2/2010

USERNAME =>
DGN FILE => ...\SIGNAL AND LIGHTING SYSTEM 1.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000000

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

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EXAMPLE B

CONDUCTOR AND CONDUIT SCHEDULE

CONDUCTOR DESIGNATION			CONDUIT RUN NUMBER CONDUIT SIZE (INCHES) NUMBER OF CONDUCTORS																							
CABLE TYPE	POLE	PHASE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			3	3	3	3	2-3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Veh-Ped 12CSC	Ⓐ	1,6,6P 4				1/1	1/1																			
	Ⓑ	4,8,4P 6					1/1	1/1																		
	Ⓒ	8,8P 6					1/1		1/1																	
	Ⓓ	5,6,6P 8					1/1		1/1	1/1																
	Ⓔ	2,5,2P 8					1/1		1/1	1/1	1/1	1/1														
	Ⓕ	4,8,4P 2					1/1		1/1	1/1	1/1	1/1	1/1													
	Ⓖ	4,4P 2	1/1	1/1	1/1	1/1	1/1																			
	Ⓗ	1,2,2P 4		1/1	1/1	1/1	1/1																			
	Ⓘ	4				1	1																			
	Ⓙ	6					1																			
	Ⓚ	6					1		1																	
	Ⓛ	8					1		1	1																
	Ⓜ	8					1		1	1	1	1														
	Ⓝ	2					1		1	1	1	1	1													
APS 3CSC	Ⓞ	2	1	1	1	1	1																			
	Ⓟ	4		1	1	1	1																			
	CSC TOTAL		1/2	2/4	2/4	3/6	8/16	1/1	4/8	3/6	2/4	2/4	1/2													
AWG	CIRCUIT																									
#8	Ltg													2	2	2	2									
#6	Sig CABINET													2		2		2								
DLC	PHASE																									
	ø1						1		1	1	1											1				
	ø2			2	3	3	3																	2		1
	ø2 ADVANCE			3	3	3	3																	3	3	
	ø4						2												2							
	ø5				1	1	1																			1
	ø6						3		3	3	1									2		1				
	ø6 ADVANCE						3		3	3										3	3					
	ø8						2		2	2	2	2	2										2			
DLC TOTAL				5	7	7	18		9	9	4	2	2						2	5	3	2	2	5	3	2

STANDARD AND EQUIPMENT SCHEDULE

Loc	STANDARD					Veh Sig Mtg		Ped Sig Mtg	APS		Lum (ROADWAY TYPE)	SPECIAL REQUIREMENT
	TYPE	SMA (ft)	LMA (ft)	LOCATION A	LOCATION B	MAST ARM	POLE		Ø	ARROW		
Ⓐ	29A-5-100	55	15	12′	6′	MAS MAS	SV-1-T	SP-1-T			2	SEE SIGNING PLAN FOR SIGNS
Ⓑ	1-B			22′	6′		TV-2-T	SP-1-T				
Ⓒ	19-4-100	25	15	4′	10′	MAS	SV-1-T	SP-1-T			1	SEE SIGNING PLAN FOR SIGNS
Ⓓ	15TS		15	4′	8′		SV-2-T	SP-1-T			1	
Ⓔ	29A-5-100	55	15	7′	9′	MAS MAS	SV-1-T	SP-1-T			2	SEE SIGNING PLAN FOR SIGNS
Ⓕ	1-B			14′	7′		TV-2-T	SP-1-T				
Ⓖ	19-4-100	25	15	27′	7′	MAS	SV-1-T	SP-1-T			1	SEE SIGNING PLAN FOR SIGNS
Ⓗ	15TS		15	6′	6′		SV-2-T	SP-1-T			1	
Ⓘ	PBA POST			4′	6′				4	←		SEE SIGNING PLAN FOR SIGNS
Ⓙ	PBA POST			26′	6′				6	→		SEE SIGNING PLAN FOR SIGNS
Ⓚ	PBA POST			20′	10′				6	←		SEE SIGNING PLAN FOR SIGNS
Ⓛ	PBA POST			8′	8′				8	→		SEE SIGNING PLAN FOR SIGNS
Ⓜ	PBA POST			4′	7′				8	←		SEE SIGNING PLAN FOR SIGNS
Ⓝ	PBA POST			26′	7′				2	←		SEE SIGNING PLAN FOR SIGNS
Ⓞ	PBA POST			37′	6′				2	→		SEE SIGNING PLAN FOR SIGNS
Ⓟ	PBA POST			18′	6′				4	→		SEE SIGNING PLAN FOR SIGNS

SIGNAL AND LIGHTING SYSTEM

NO SCALE

E-2

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EXAMPLE B

INDIVIDUAL CONDUCTOR

CONDUCTOR SCHEDULE

CONDUCTOR DESIGNATION	NUMBER OF CONDUCTORS																							
	RUN NUMBER																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
No. 14 CONDUCTORS																								
01		3	3	3	3																			
02		3	3	3	3		3	3	3	3														
04	3	3	3	3	3	3	3	3	3	3	3													
05					3		3	3	3	3														
06				3	3		3	3																
08					3	3	3	3	3	3	3													
02P		2	2	2	2		2	2	2	2														
04P	2	2	2	2	2	2																		
06P				2	2		2	2																
08P					2		2	2	2	2	2													
PEU												3	3											
APS (02P)	1	1	1	1	1		1	1	1	1	1													
APS (04P)		1	1	1	1																			
APS (06P)					1	1	1																	
APS (08P)					1		1	1	1	1														
APS NEUTRAL	1	1	1	1	1	1	1	1	1	1	1													
SPARE	3	3	3	3	9	3	3	3	3	3	3													
TOTAL No. 14	10	19	19	24	40	13	28	27	22	22	13	3	3											
DETECTOR CABLES																								
1I1U					1		1	1	1											1				
2I2U		1	1	1	1																	1	1	
2I2L		1	1	1	1																	1	1	
2I3U		1	1	1	1																	1	1	
2I3L			1	1	1																			1
2I4U		1	1	1	1																	1		
2I4L		1	1	1	1																	1		
4I6U					1												1							
4I6L					1												1							
5J1U			1	1	1																			1
6J2U					1		1	1										1	1					
6J2L					1		1	1										1	1					
6J3U					1		1	1										1	1					
6J3L					1		1	1	1											1				
6J4U					1		1	1										1						
6J4L					1		1	1										1						
8J8U					1		1	1	1	1	1										1			
8J8L					1		1	1	1	1	1										1			
TOTAL DETECTOR CABLES		5	7	7	18		9	9	4	2	2						2	5	3	2	2	5	3	2
No. 8 CONDUCTORS																								
LIGHTING (240 V)	2	2	2	2			2	2	2	2		2	2	2	2									
GROUNDING COPPER CONDUCTOR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SIGNAL NEUTRAL	1	1	1	1	1	1	1	1	1	1	1	1	1											
TOTAL No. 8	4	4	4	4	2	2	4	4	4	4	2	4	4	3	3	1	1	1	1	1	1	1	1	1
No. 6 CONDUCTORS																								
SERVICE TO CONTROLLER (120 V)												2		2		2								
CONDUIT SIZE (INCHES)	3	3	3	3	2-3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

STANDARD AND EQUIPMENT SCHEDULE

Loc	STANDARD					Veh Sig Mtg		Ped Sig Mtg	APS		Lum (ROADWAY TYPE)	SPECIAL REQUIREMENT
	TYPE	SMA (ft)	LMA (ft)	LOCATION		MAST ARM	POLE		0	ARROW		
				A	B							
Ⓐ	29A-5-100	55	15	12′	6′	MAS MAS	SV-1-T	SP-1-T			2	SEE SIGNING PLAN FOR SIGNS
Ⓑ	1-B			22′	6′		TV-2-T	SP-1-T				
Ⓔ	19-4-100	25	15	4′	10′	MAS	SV-1-T	SP-1-T			1	SEE SIGNING PLAN FOR SIGNS
Ⓓ	15TS		15	4′	8′		SV-2-T	SP-1-T			1	
Ⓔ	29A-5-100	55	15	7′	9′	MAS MAS	SV-1-T	SP-1-T			2	SEE SIGNING PLAN FOR SIGNS
Ⓔ	1-B			14′	7′		TV-2-T	SP-1-T				
Ⓑ	19-4-100	25	15	27′	7′	MAS	SV-1-T	SP-1-T			1	SEE SIGNING PLAN FOR SIGNS
Ⓑ	15TS		15	6′	6′		SV-2-T	SP-1-T			1	
Ⓘ	PBA POST			4′	6′				4	←		SEE SIGNING PLAN FOR SIGNS
Ⓙ	PBA POST			26′	6′				6	→		SEE SIGNING PLAN FOR SIGNS
Ⓚ	PBA POST			20′	10′				6	←		SEE SIGNING PLAN FOR SIGNS
Ⓛ	PBA POST			8′	8′				8	→		SEE SIGNING PLAN FOR SIGNS
Ⓜ	PBA POST			4′	7′				8	←		SEE SIGNING PLAN FOR SIGNS
Ⓝ	PBA POST			26′	7′				2	←		SEE SIGNING PLAN FOR SIGNS
Ⓞ	PBA POST			37′	6′				2	→		SEE SIGNING PLAN FOR SIGNS
Ⓟ	PBA POST			18′	6′				4	→		SEE SIGNING PLAN FOR SIGNS

SIGNAL AND LIGHTING SYSTEM

NO SCALE

E-2

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

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PLANS APPROVAL DATE

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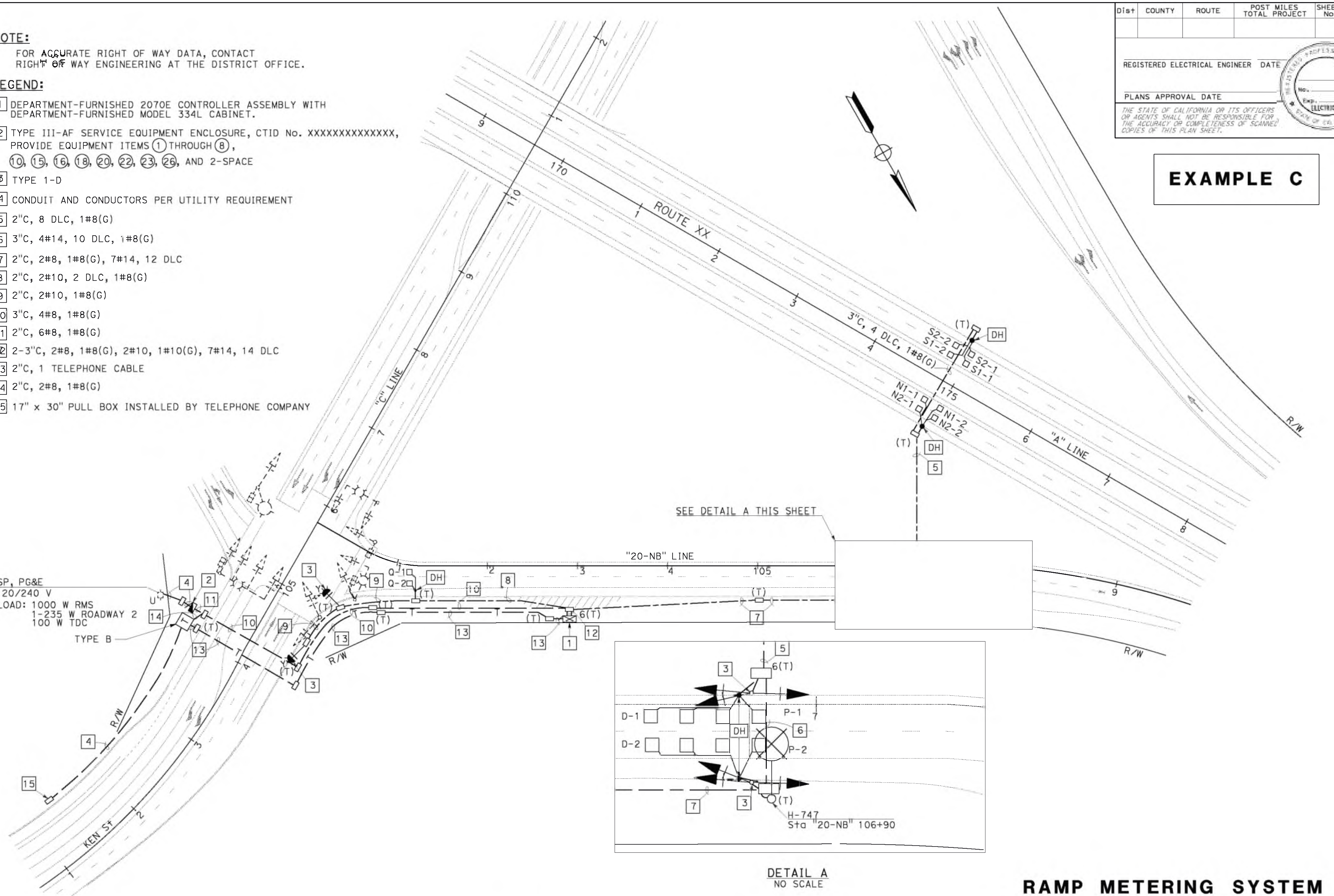
EXAMPLE C

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

LEGEND:

- 1 DEPARTMENT-FURNISHED 2070E CONTROLLER ASSEMBLY WITH DEPARTMENT-FURNISHED MODEL 334L CABINET.
- 2 TYPE III-AF SERVICE EQUIPMENT ENCLOSURE, CTID No. XXXXXXXXXXXXXX, PROVIDE EQUIPMENT ITEMS ① THROUGH ⑧, ⑩, ⑮, ⑯, ⑱, ⑳, ㉒, ㉓, ㉖, AND 2-SPACE
- 3 TYPE 1-D
- 4 CONDUIT AND CONDUCTORS PER UTILITY REQUIREMENT
- 5 2"C, 8 DLC, 1#8(G)
- 6 3"C, 4#14, 10 DLC, 1#8(G)
- 7 2"C, 2#8, 1#8(G), 7#14, 12 DLC
- 8 2"C, 2#10, 2 DLC, 1#8(G)
- 9 2"C, 2#10, 1#8(G)
- 10 3"C, 4#8, 1#8(G)
- 11 2"C, 6#8, 1#8(G)
- 12 2-3"C, 2#8, 1#8(G), 2#10, 1#10(G), 7#14, 14 DLC
- 13 2"C, 1 TELEPHONE CABLE
- 14 2"C, 2#8, 1#8(G)
- 15 17" x 30" PULL BOX INSTALLED BY TELEPHONE COMPANY



DETAIL A
NO SCALE

RAMP METERING SYSTEM

SCALE: 1" = 50'

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DATE PLOTTED => 17-MAR-2020
TIME PLOTTED => 15:27

BORDER LAST REVISED 7/2/2010
USERNAME => s147359
DGN FILE => RampMetering.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000001

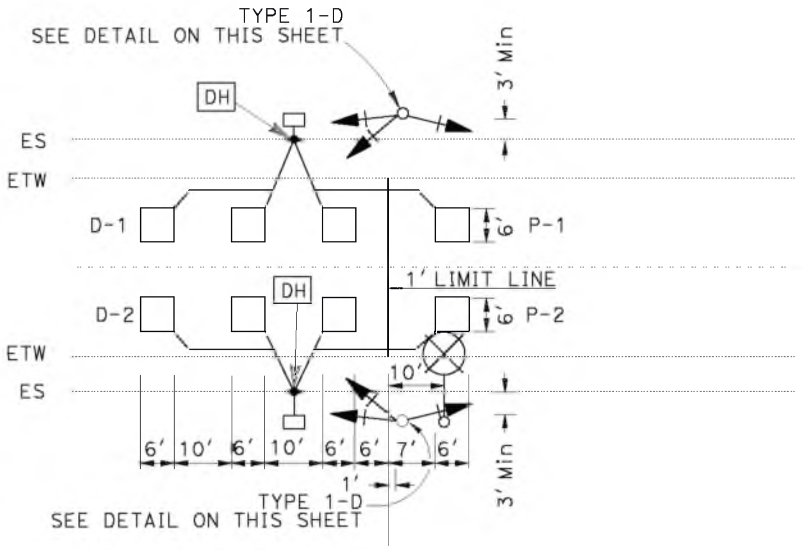
Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

EXAMPLE C



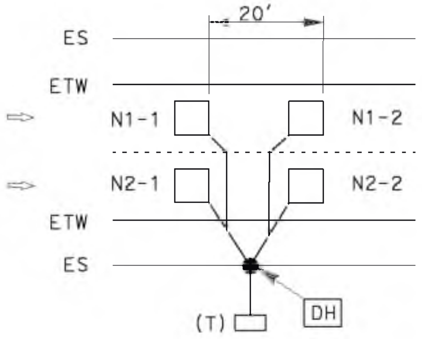
2-LANE RAMP METERING DETECTORS

N1-2
- 1 = ENTERING DETECTOR
- 2 = LEAVING DETECTOR
- LANE NUMBER
  - 1 = 1ST LANE FROM LEFT
  - 2 = 2ND LANE FROM LEFT
  - 3 = 3RD LANE FROM LEFT
  - 4 = 4TH LANE FROM LEFT
- N = NORTHBOUND
- S = SOUTHBOUND
- E = EASTBOUND
- W = WESTBOUND

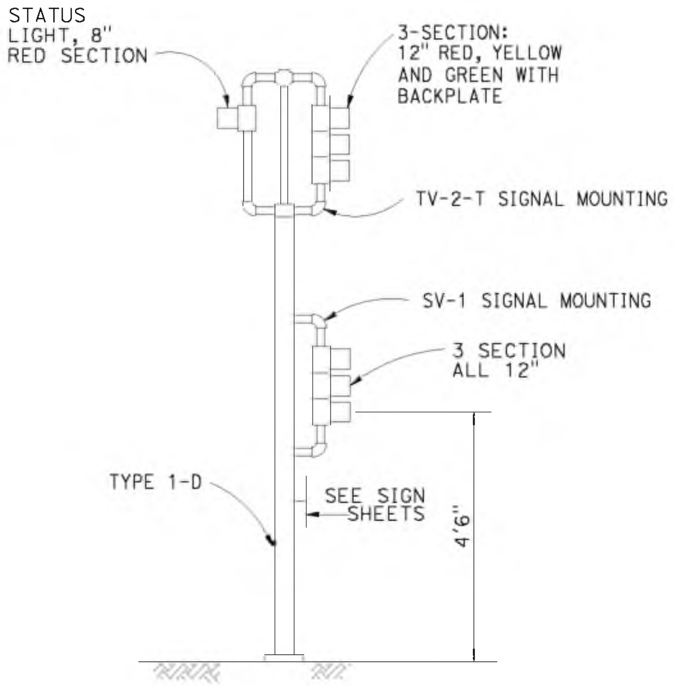
FREEWAY MAINLINE DETECTOR IDENTIFICATION

D-1
- 1 = 1ST LANE FROM LEFT
- 2 = 2ND LANE FROM LEFT
- D = DEMAND DETECTOR
- P = PASSAGE DETECTOR
- Q = QUEUE DETECTOR
- F = OFF RAMP DETECTOR

RAMP DETECTOR IDENTIFICATION



MAINLINE DETECTORS



TYPE 1-D DETAIL

ELECTRICAL SYSTEMS DETAILS

NO SCALE

ED-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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ELECTRICAL DESIGN

FUNCTIONAL SUPERVISOR

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REVISED BY

DATE REVISED

LAST REVISION 00-00-00

DATE PLOTTED => 18-MAR-2020
TIME PLOTTED => 08:59

BORDER LAST REVISED 7/2/2010

USERNAME => s111235
DGN FILE => RampMetering(Detail).dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

EXAMPLE C

NOTE:

ELECTRICAL SYSTEMS QUANTITY TABLE SUMMARIZES SIGNIFICANT COMPONENTS. SEE ELECTRICAL SYSTEMS PLANS AND SPECIFICATIONS TO DETERMINE ALL MATERIALS NEEDED FOR EACH SYSTEM.

RAMP METERING SYSTEMS

	(N)															
SHEET No.	No. 6(T) PB	No. 5(T) PB	No. 8	No. 10	No. 14	DLC	2"C	3"C	TDC	TYPE III-AF	TYPE 1-D FB	TYPE 1-D STANDARD	ELECTROLIER TYPE 30	DETECTOR HANDHOLE	LOOP DETECTOR TYPE A	TELEPHONE CABLE
	EA	EA	FT	FT	FT	FT	FT	FT	EA	EA	EA	EA	EA	EA	EA	FT
E-1	2	16	2000	1800	1700	7500	1500	400	1	1	2	2	1	5	18	1000

(N) NOT A SEPARATE BID ITEM

ELECTRICAL SYSTEM QUANTITIES
EQ-1

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DATE REVISED

LAST REVISION 00-00-00
DATE PLOTTED => 18-MAR-2020
TIME PLOTTED => 08:53

BORDER LAST REVISED 7/2/2010
USERNAME => s111235
DGN FILE => RampMetering(Quantity).dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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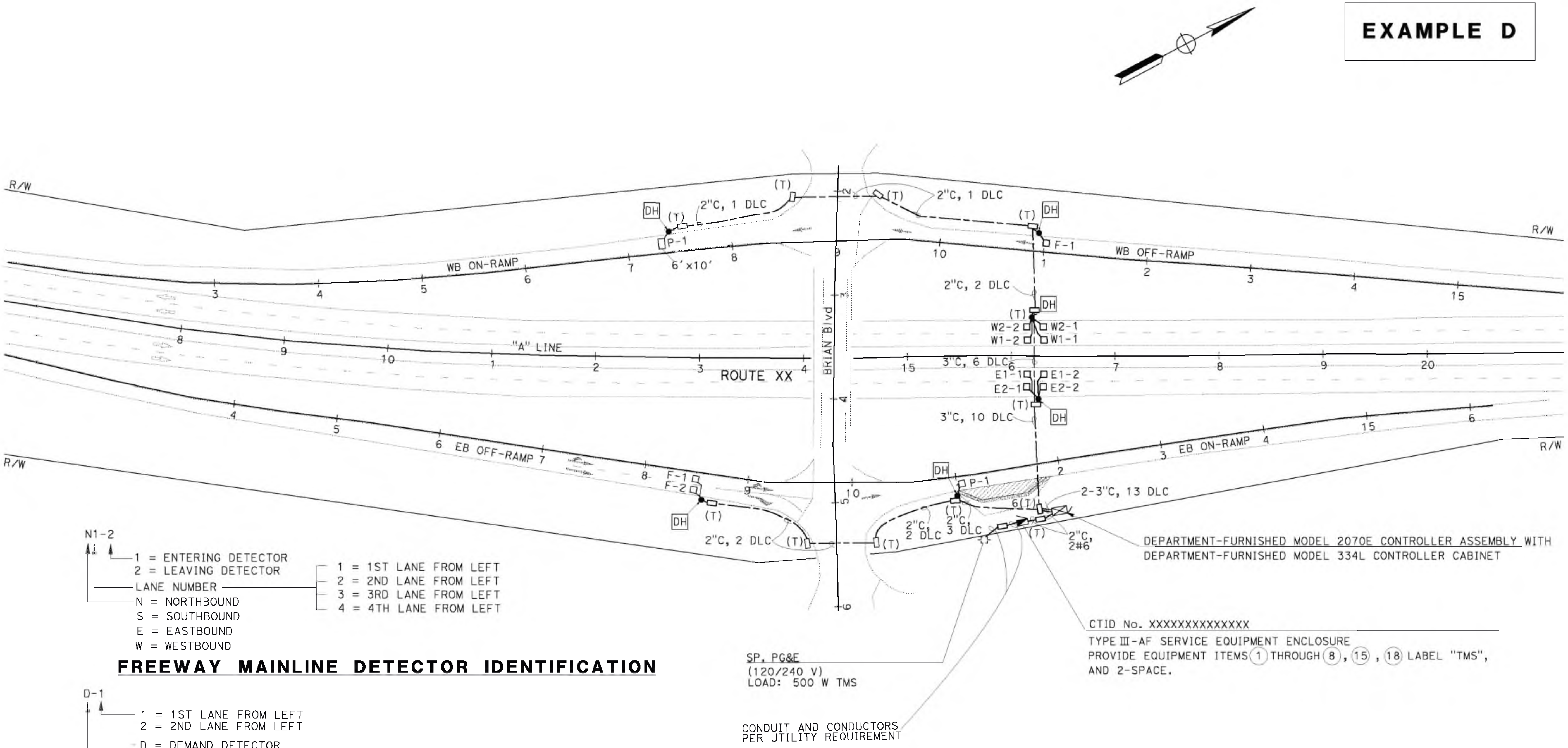
No.
Exp.
ELECTRICAL

EXAMPLE D

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



N1-2

1 = ENTERING DETECTOR
2 = LEAVING DETECTOR

LANE NUMBER
1 = 1ST LANE FROM LEFT
2 = 2ND LANE FROM LEFT
3 = 3RD LANE FROM LEFT
4 = 4TH LANE FROM LEFT

N = NORTHBOUND
S = SOUTHBOUND
E = EASTBOUND
W = WESTBOUND

FREEWAY MAINLINE DETECTOR IDENTIFICATION

D-1

1 = 1ST LANE FROM LEFT
2 = 2ND LANE FROM LEFT

D = DEMAND DETECTOR
P = PASSAGE DETECTOR
Q = QUEUE DETECTOR
F = OFF RAMP DETECTOR

RAMP DETECTOR IDENTIFICATION

TRAFFIC MONITORING STATION SYSTEM

SCALE: 1" = 50'

E-1

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DATE REVISED

LAST REVISION 00-00-10

DATE PLOTTED => 13-MAR-2020
TIME PLOTTED => 14:31

BORDER LAST REVISED 7/2/2010

USERNAME => s147359
DGN FILE => TMS.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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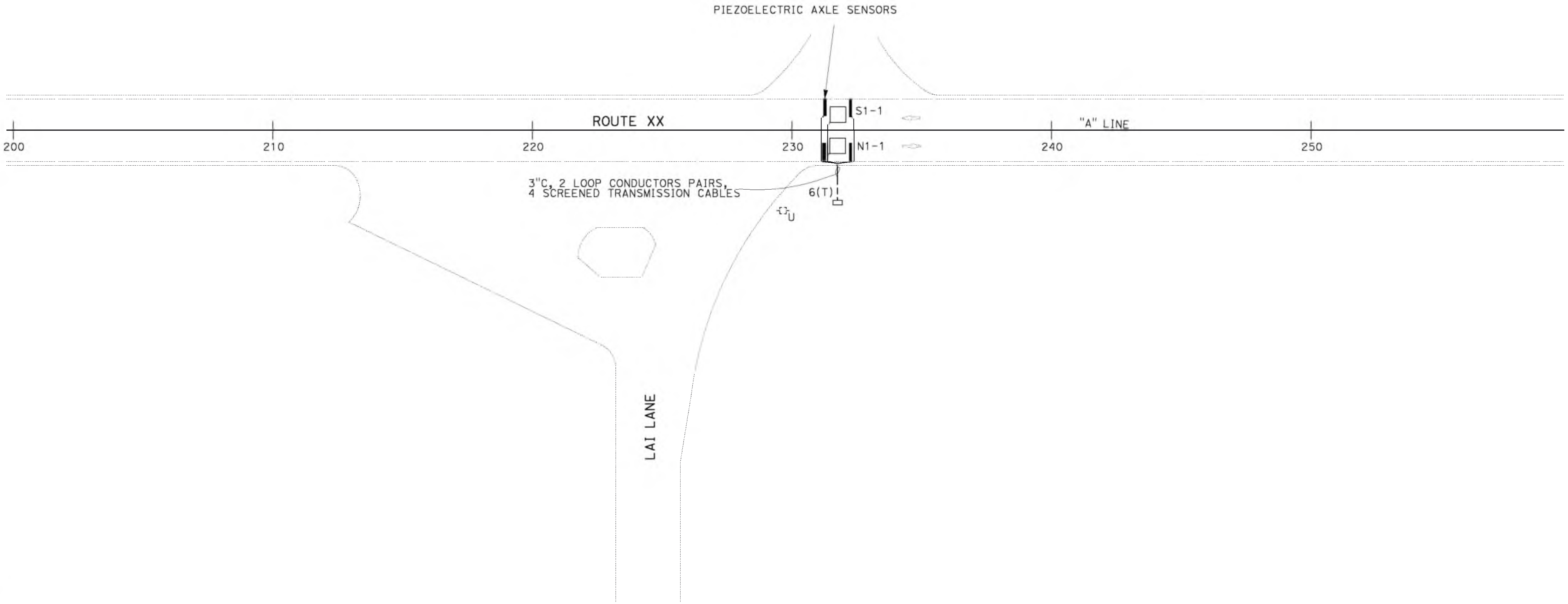
No.
Exp.
ELECTRICAL

EXAMPLE E

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



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DATE REVISED
CALCULATED-DESIGNED BY
CHECKED BY
FUNCTIONAL SUPERVISOR
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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TRAFFIC MONITORING STATION SYSTEM

SCALE: 1" = 20'

E-1

LAST REVISION 00-00-00
DATE PLOTTED => 13-MAR-2020
TIME PLOTTED => 14:29

BORDER LAST REVISED 7/2/2010
USERNAME => s147359
DGN FILE => Traffic Census Station.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

No.

Exp.

ELECTRICAL

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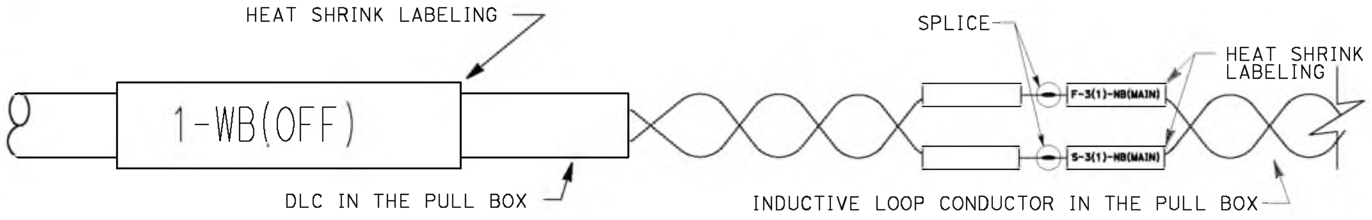
EXAMPLE E

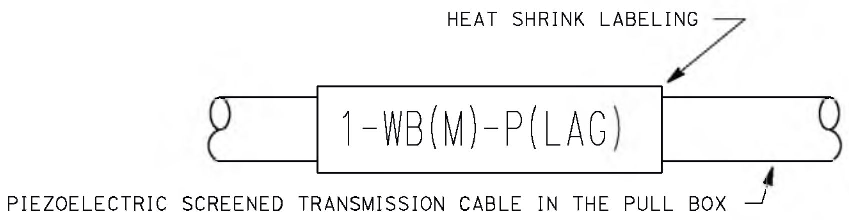
NOTES:

1. INSTALL INDUCTIVE LOOP CONDUCTORS WITH 4 TURNS IN THE LOOP DETECTOR SAW CUT.
2. TYPICAL INDUCTANCE FOR THE LOOP DETECTOR MUST BE MINIMUM 124, MICROHENRIES WHEN MEASURED AT THE NEAREST PULL BOX TO THE LOOP DETECTOR.
3. TAG LOOP CONDUCTOR IN THE PULL BOX WITH A HEAT SHRINK LABEL.



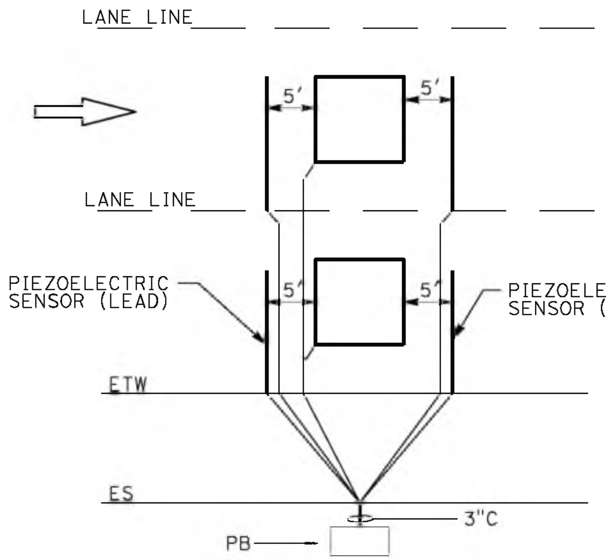
DLC AND INDUCTIVE LOOP CONDUCTOR LABELING

DETAIL A



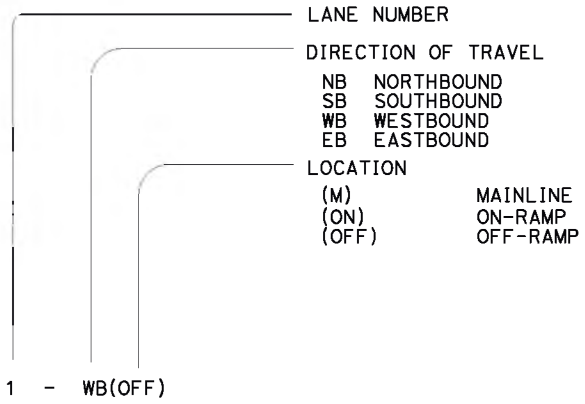
PIEZOELECTRIC SENSOR CABLE LABELING

DETAIL B



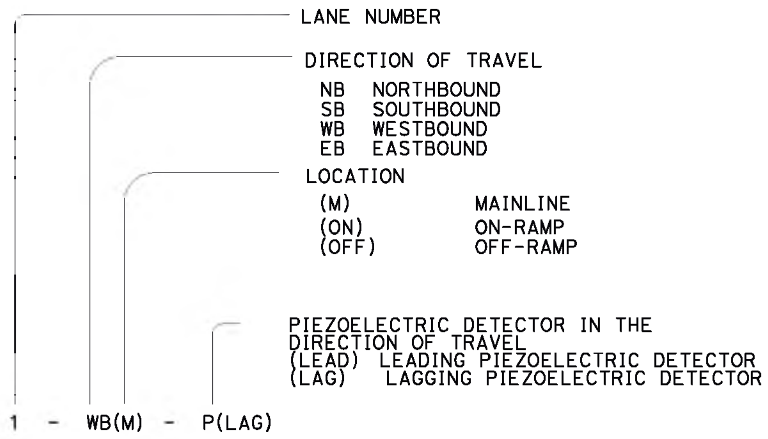
PIEZOELECTRIC SENSOR - INDUCTIVE LOOP DETECTOR - PIEZOELECTRIC SENSOR INSTALLATION

DETAIL C



IDENTIFICATION TAG ON THE DETECTOR LEAD-IN CABLE

DETAIL D



IDENTIFICATION TAG ON THE PIEZOELECTRIC SCREENED TRANSMISSION CABLE

DETAIL E

ELECTRICAL SYSTEMS DETAILS

NO SCALE

ED-1

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DATE REVISED
CALCULATED-DESIGNED BY
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STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
ELECTRICAL DESIGN

LAST REVISION 00-00-00
DATE PLOTTED => 13-MAR-2020
TIME PLOTTED => 15:14

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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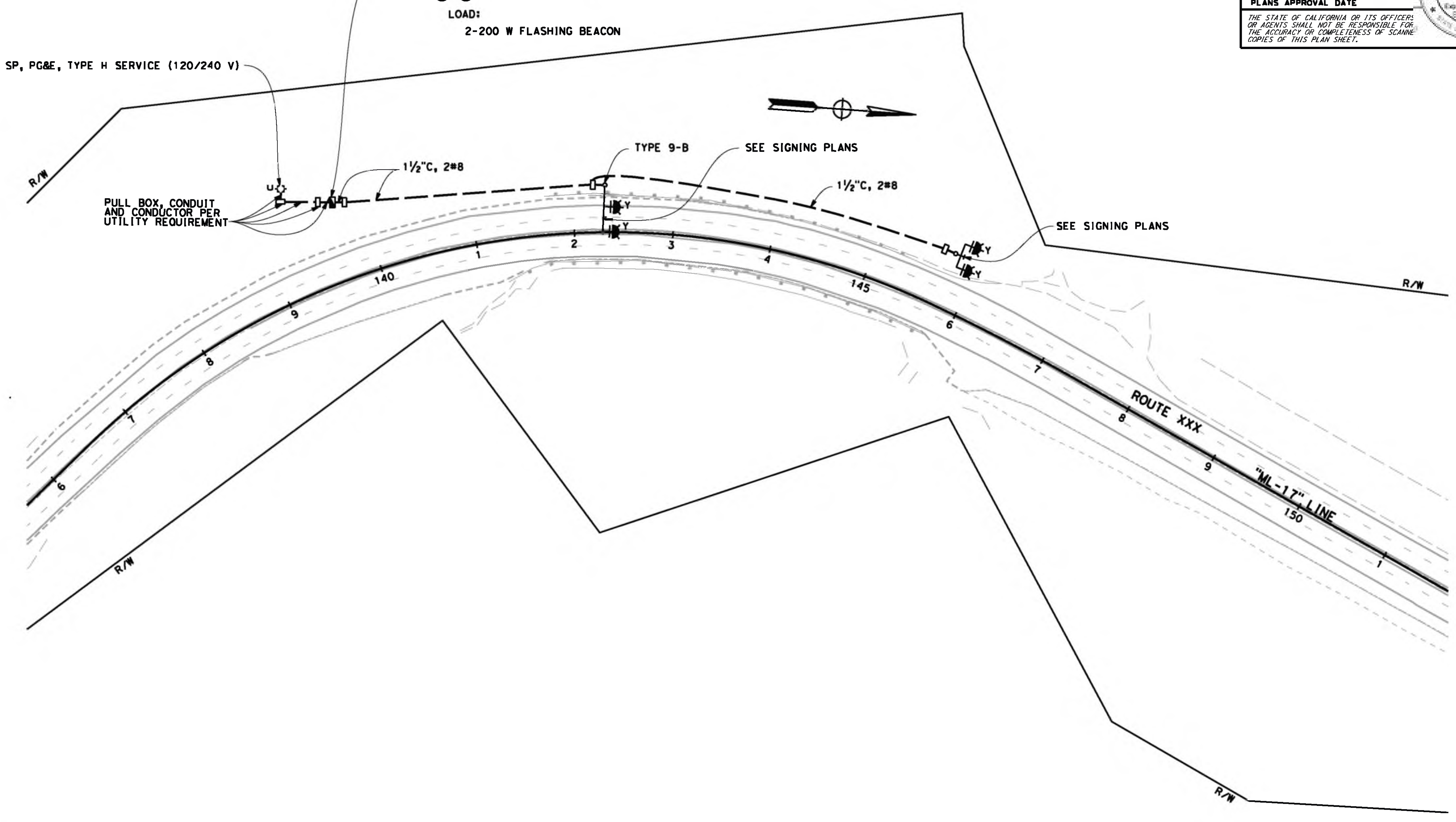
No.
Exp.
ELECTRICAL

EXAMPLE F

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FLASHING BEACON SYSTEM

SCALE: 1"=50'

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E-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans
ELECTRICAL DESIGN

FUNCTIONAL SUPERVISOR
CALCULATED-DESIGNED BY
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REVISED BY
DATE REVISED

LAST REVISION 00-00-00
DATE PLOTTED => 3/10/2020
TIME PLOTTED => 2:16:23 PM

BORDER LAST REVISED 7/2/2010
USERNAME =>
DGN FILE => ...\class sample design\FB.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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EXAMPLE G
INDIVIDUAL CONDUCTOR

NOTE:

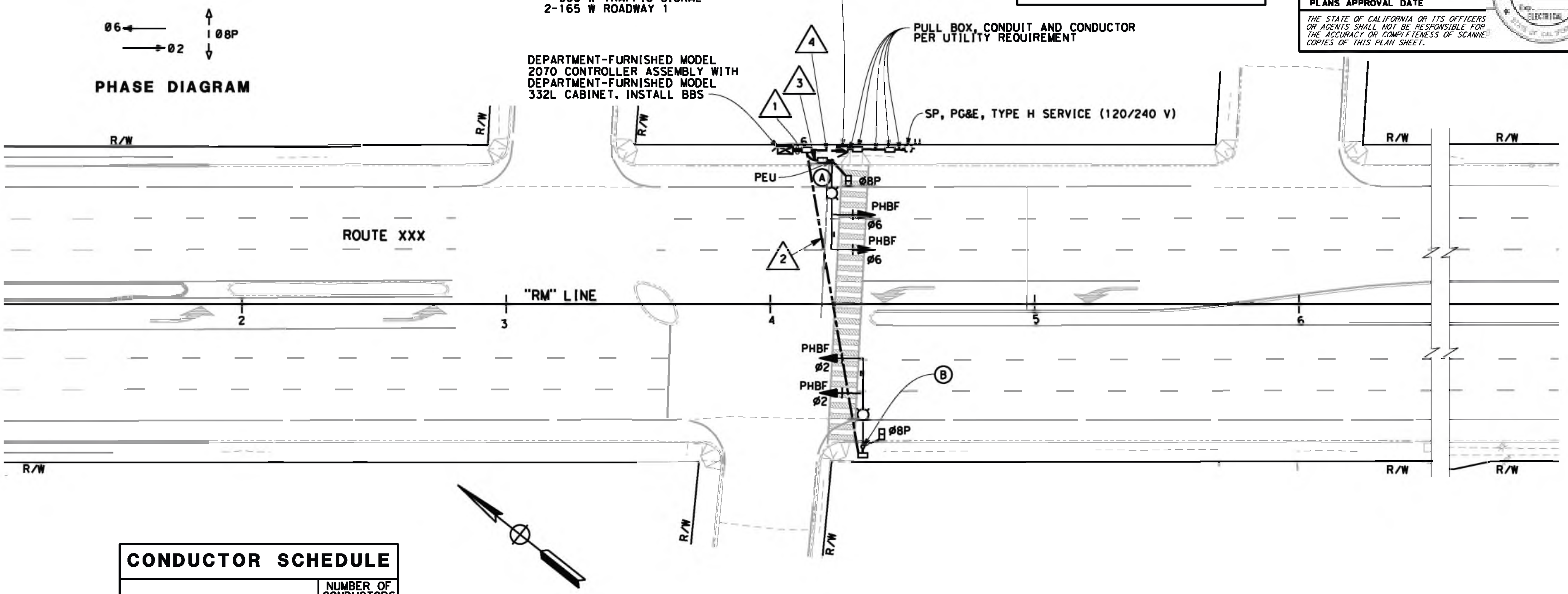
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

TYPE III-AF SERVICE EQUIPMENT ENCLOSURE
CTID No. XXXXXXXXXXXXXX
PROVIDE EQUIPMENT ITEMS ① THROUGH ⑧,
⑯, ⑯, ⑯, ⑰, ⑳, ㉒, ㉓, AND 2-SPACE.
LOAD:
500 W TRAFFIC SIGNAL
2-165 W ROADWAY 1

DEPARTMENT-FURNISHED MODEL 2070 CONTROLLER ASSEMBLY WITH DEPARTMENT-FURNISHED MODEL 332L CABINET. INSTALL BBS

PULL BOX, CONDUIT AND CONDUCTOR PER UTILITY REQUIREMENT

SP, PG&E, TYPE H SERVICE (120/240 V)



CONDUCTOR SCHEDULE

CONDUCTOR DESIGNATION	NUMBER OF CONDUCTORS RUN NUMBER			
	1	2	3	4
No. 14 CONDUCTORS				
Ø2	3	3		
Ø6	3		3	
Ø8P	4	2	2	
APS (Ø8P)	2	1	1	
APS NEUTRAL	1	1	1	
PEU			3	3
SPARE	3	3	3	
TOTAL No. 14	16	10	13	3
No. 8 CONDUCTORS				
LIGHTING (240 V)		2	2	2
SIGNAL NEUTRAL	1	1	1	
TOTAL No. 8	1	3	3	2
No. 6 CONDUCTOR				
SERVICE TO CONTROLLER	2			2
CONDUIT SIZE (INCHES)	2-3	2	2	2

STANDARD AND EQUIPMENT SCHEDULE

Loc	STANDARD					Veh Sig Mtg	Ped Sig Mtg	APS		Lum (ROADWAY TYPE)	SPECIAL REQUIREMENT
	TYPE	SMA (ft)	LMA (ft)	LOCATION A	LOCATION B	MASTARM		Ø	ARROW		
A	24-4-100	35	15	70′	10′	MAS-3A MAS-3A	SP-1-T	8	←	1	SEE SIGNING PLAN FOR SIGNS
B	24-4-100	35	15	3′	10′	MAS-3A MAS-3A	SP-1-T	8	←	1	SEE SIGNING PLAN FOR SIGNS

PEDESTRIAN HYBRID BEACON SYSTEMS

SCALE: 1" = 20′

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E-1

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STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
ELECTRICAL DESIGN

LAST REVISION 00-00-00
DATE PLOTTED => 3/10/2020
TIME PLOTTED => 2:51:16 PM

BORDER LAST REVISED 7/2/2010
USERNAME =>
DGN FILE => ...\class sample design\PHB.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0698
PROJECT NUMBER & PHASE

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF W[redacted] ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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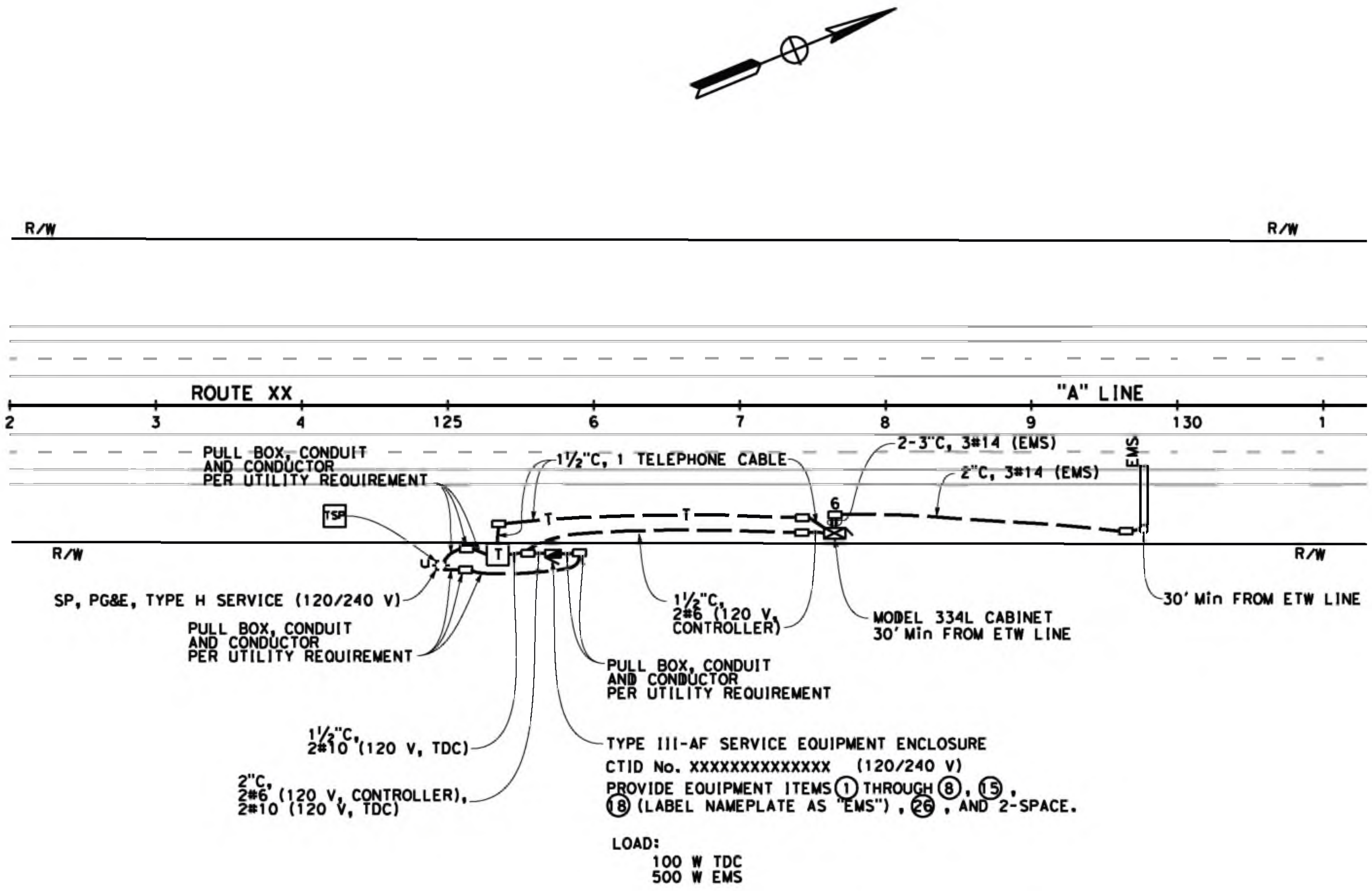
EXAMPLE H



EXTINGUISHABLE MESSAGE SIGN SYSTEM

SCALE: 1"=50'

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E-1

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DATE REVISED
CALCULATED-DESIGNED BY
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FUNCTIONAL SUPERVISOR

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Caltrans ELECTRICAL DESIGN

LAST REVISION 00-00-00
DATE PLOTTED => 3/10/2020
TIME PLOTTED => 1:59:10 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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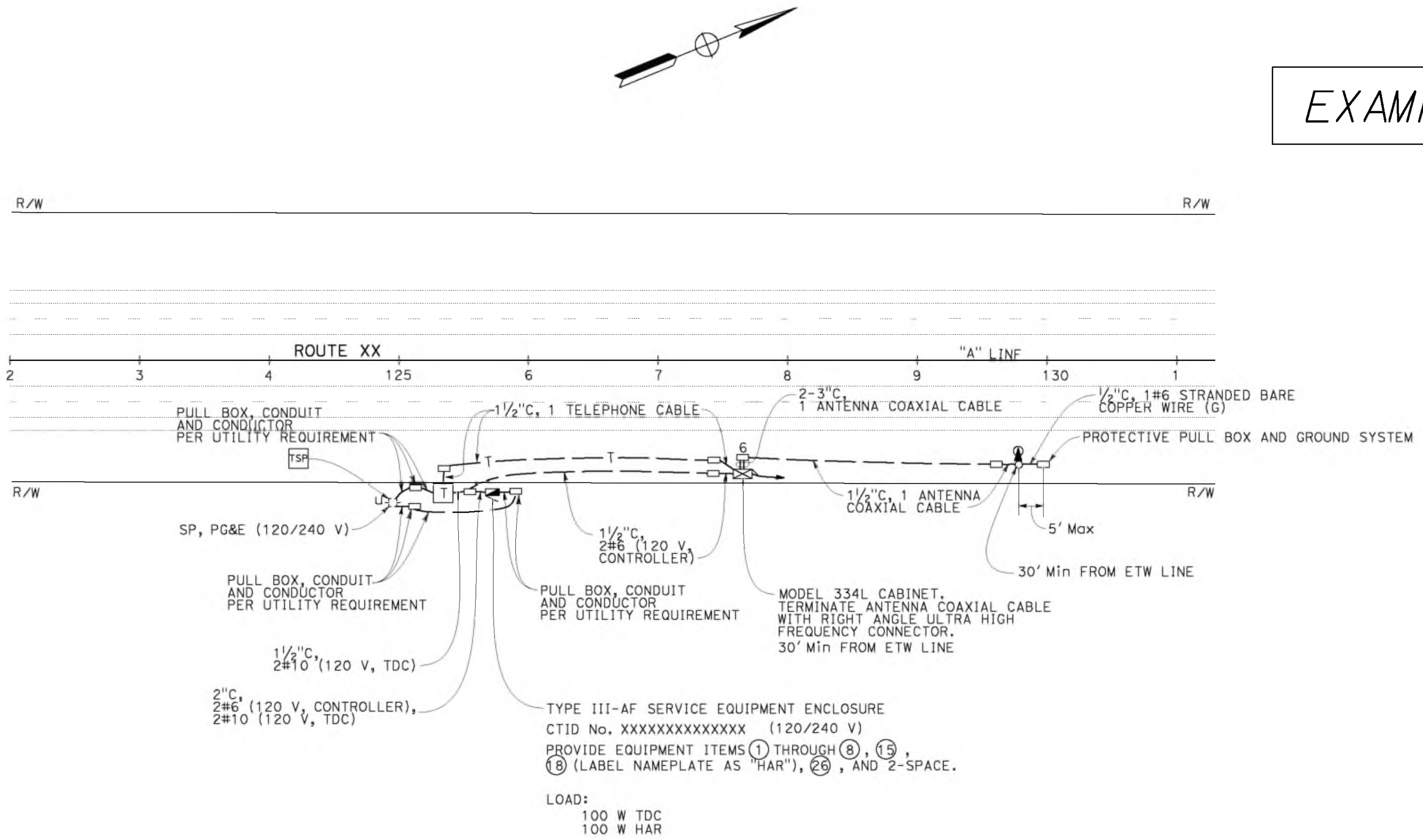
NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

EXAMPLE I



HIGHWAY ADVISORY RADIO SYSTEM

SCALE: 1"=50′

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E-1

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REVISED BY

DATE REVISED

LAST REVISION 00-00-00

DATE PLOTTED => 13-MAR-2020

TIME PLOTTED => 15:23

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

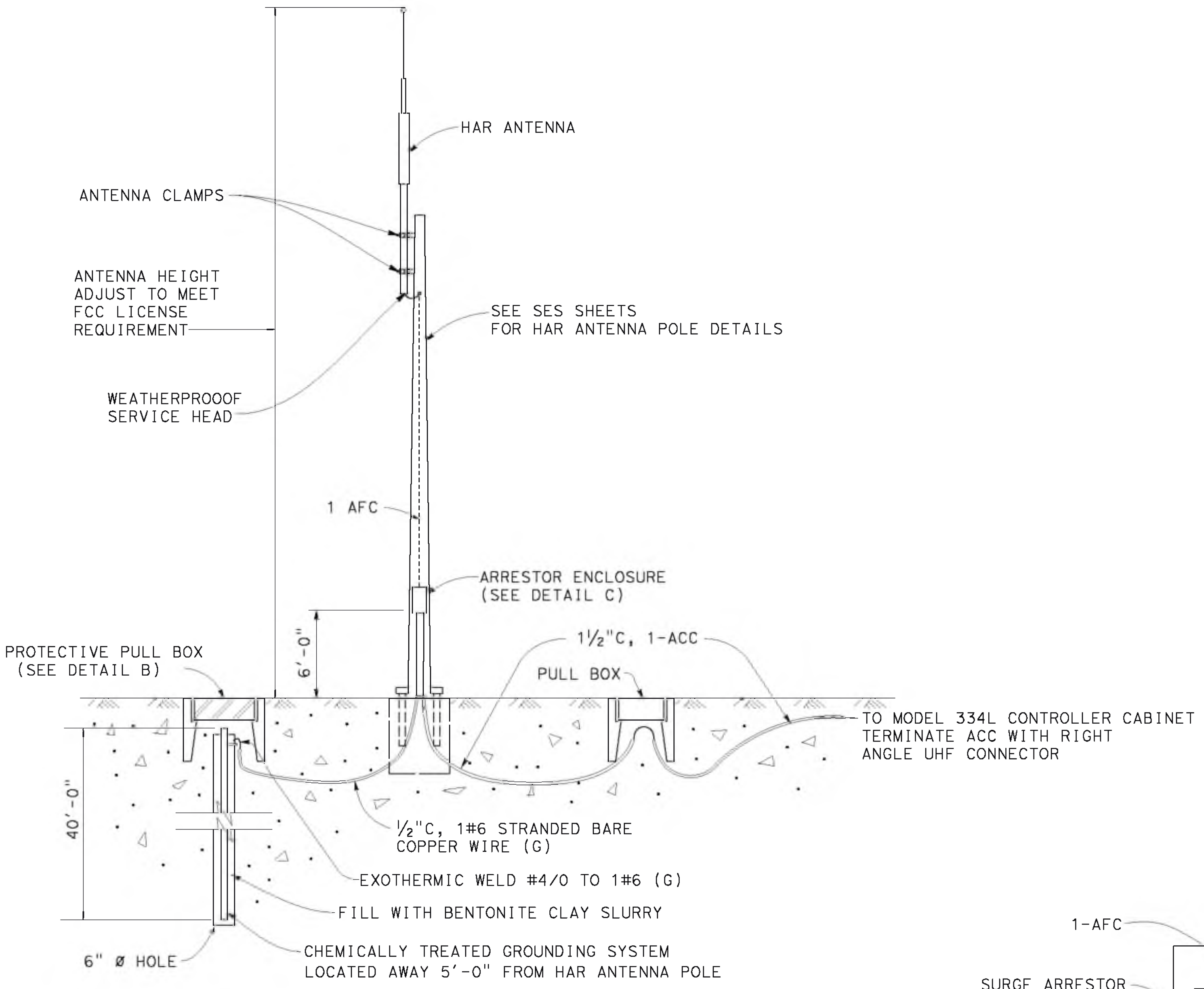
REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

No.
Exp.
ELECTRICAL

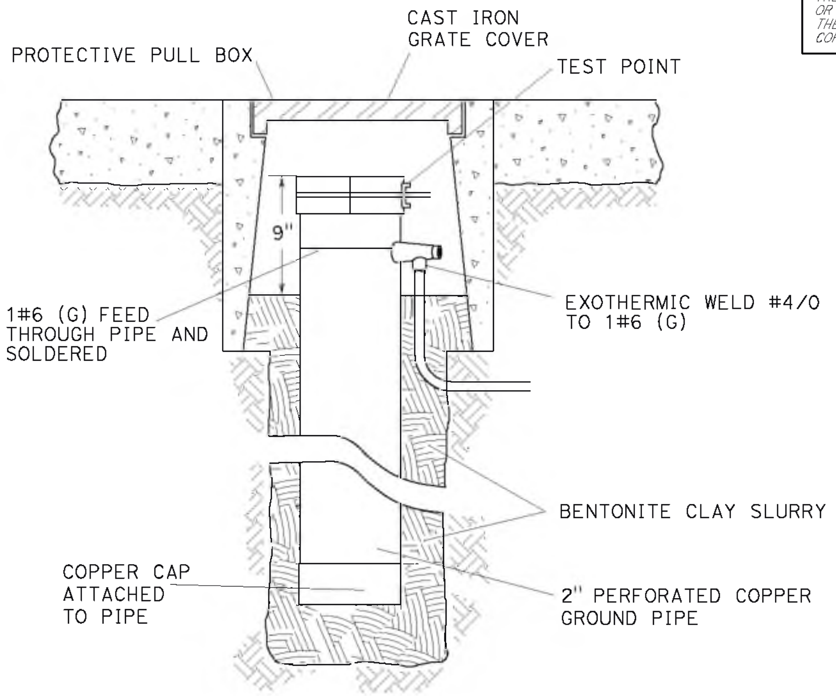
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

EXAMPLE 1



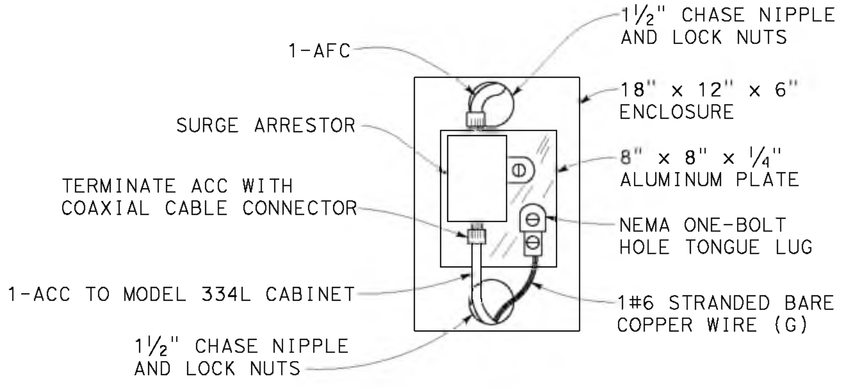
DETAIL A

ANTENNA STATION DETAIL



DETAIL B

PROTECTIVE PULL BOX AND GROUND ROD SYSTEM



DETAIL C

ARRESTOR ENCLOSURE DETAIL

ABBREVIATIONS

ACC -	ANTENNA COAXIAL CABLE
AFC -	ANTENNA FEEDING CABLE
UHF -	ULTRA HIGH FREQUENCY

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ELECTRICAL SYSTEMS DETAILS

ED-1

LAST REVISION 00-00-00
DATE PLOTTED => 13-MAR-2020
TIME PLOTTED => 15:46

BORDER LAST REVISED 7/2/2010
USERNAME => s147359
DGN FILE => HAR Detail.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

No.

Exp.

ELECTRICAL

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EXAMPLE J

NOTES:

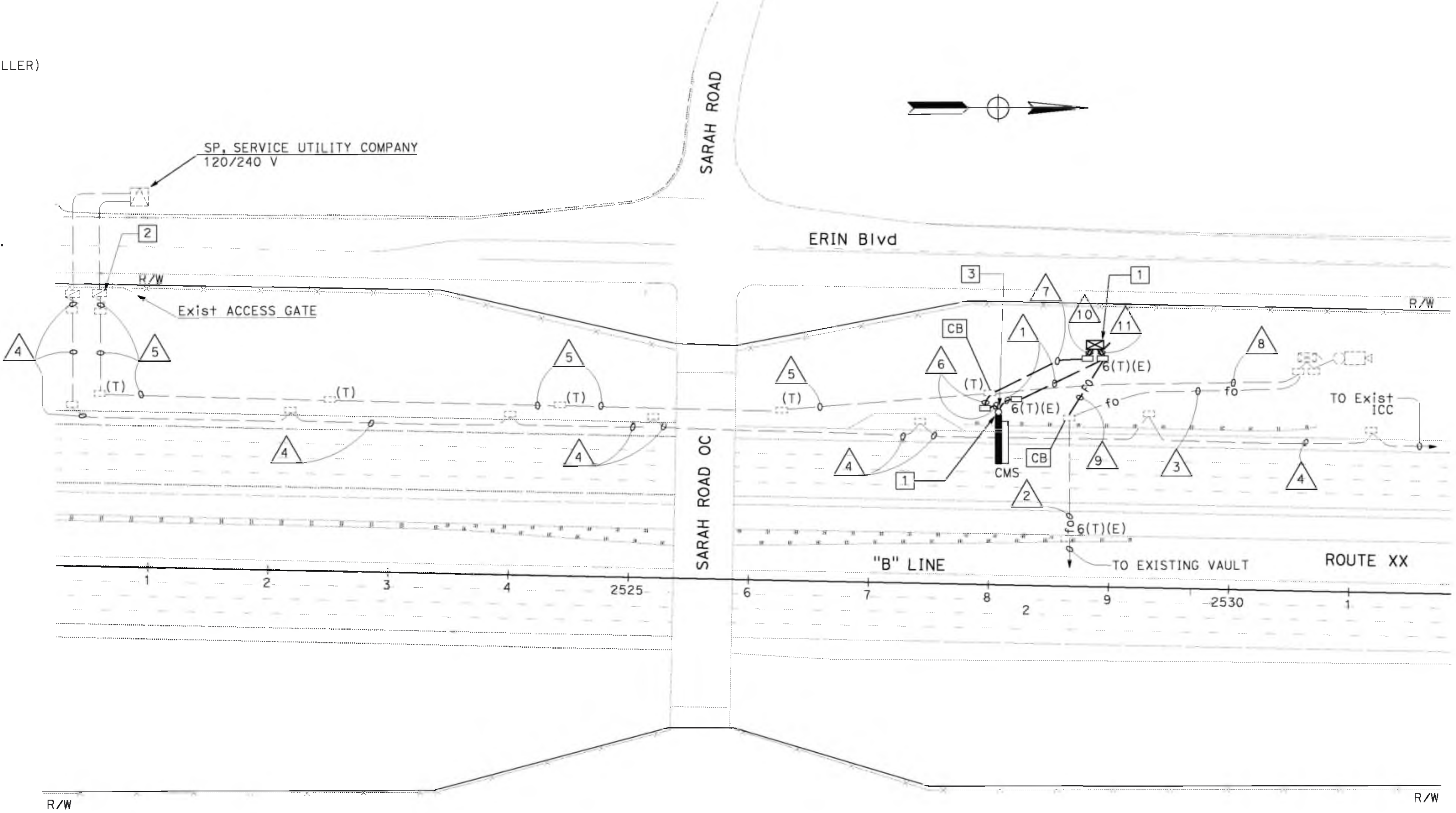
1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. FOR ADDITIONAL DETAILS, SEE SDS AND SIGN PLANS.

LEGEND:

△1	3"C, 1 OEC(CMS CONTROLLER), 1 OEC(TEST BOX), 1 OEC(SPARE)
△2	Exist MDCS(8), 2 FO12. INSTALL 1 FO12
△3	Exist 1"C, 1 FO12
△4	Exist 1½"C, 2#2(SIGN), 2#6(ICC)
△5	Exist 3"C, 2#2(Cam). INSTALL 2#2(CMS SIGN), 2#4(CMS CONTROLLER)
△6	3"C, 2#2(CMS SIGN)
△7	2"C, 2#4(CMS CONTROLLER)
△8	Exist 2"C, 2#2(Cam)
△9	1"C, 1 FO12
△10	3"C, 2#4(CMS CONTROLLER). 3"C, PT
△11	3"C, 1 OEC(CMS CONTROLLER), 1 OEC(TEST BOX), 1 OEC(SPARE), 1 FO12. 3"C, PT
1	MODEL 700 CMS, SEE ED-1
2	EXISITNG TYPE III-BF SERVICE EQUIPMENT ENCLOSURE. INSTALL 1P, 20 A, 120 V CIRCUIT BREAKER AND LABEL "CMS CONTROLLER". INSTALL 1P, 30 A, 120 V CIRCUIT BREAKER AND LABEL "CMS SIGN"
3	INSTALL AN ENCLOSURE WITH A 1P, 30 A, 120 V CIRCUIT BREAKER 5′ ABOVE THE BASE PLATE

ABBREVIATION:

Cam	CAMERA
FO12	FIBER OPTIC, 12 STRAND CABLE
MDCS	MULTIPLE DUCT CONDUIT SYSTEM
OEC	OUTDOOR ETHERNET CABLE



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CHANGEABLE MESSAGE SIGN SYSTEMS

SCALE: 1" = 50′

E-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans® ELECTRICAL DESIGN

FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY

CHECKED BY

REVISED BY

DATE REVISED

LAST REVISION 05-01-20

DATE PLOTTED => 01-MAY-2020

TIME PLOTTED => 08:13

BORDER LAST REVISED 7/2/2010

USERNAME => s133545

DGN FILE => CMS (layout sheet) rev9.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

No.
Exp.
ELECTRICAL

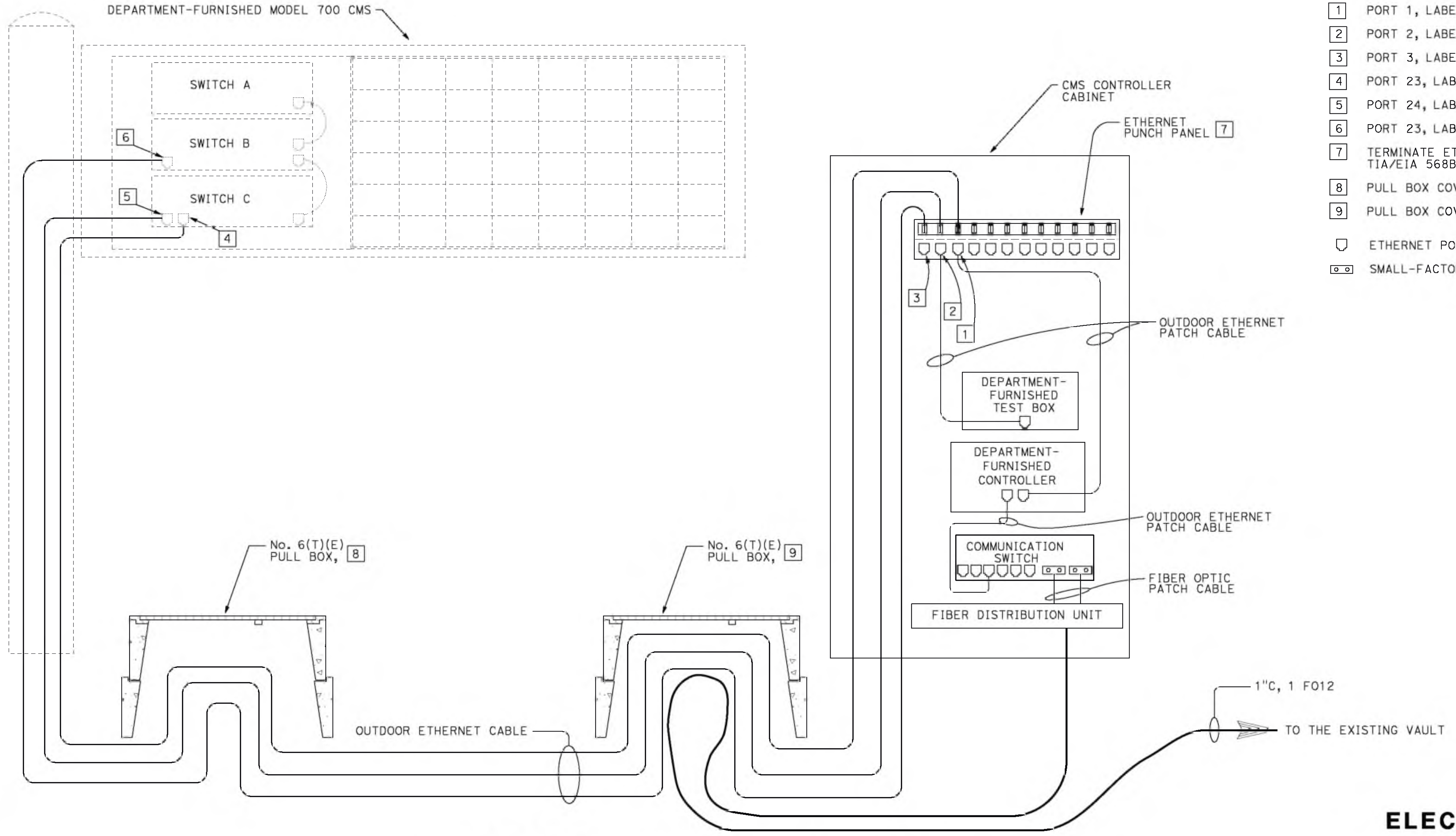
EXAMPLE J

NOTES:

1. THE 110 PUNCH PANEL MUST BE 19 INCH RACK MOUNTABLE.
2. LACE CONDUCTOR AND CABLE.
3. FIBER DISTRIBUTION UNIT MUST BE 3', MAXIMUM, ABOVE THE BASE OF THE CONTROLLER CABINET.

LEGEND:

1	PORT 1, LABEL "CONTROLLER"
2	PORT 2, LABEL "TEST BOX"
3	PORT 3, LABEL "SPARE"
4	PORT 23, LABEL "CONTROLLER"
5	PORT 24, LABEL "TEST BOX"
6	PORT 23, LABEL, "SPARE"
7	TERMINATE ETHERNET CABLE USING TIA/EIA 568B STANDARDS
8	PULL BOX COVER MUST BE MARKED "CMS".
9	PULL BOX COVER MUST BE MARKED "FIBER OPTIC".
▽	ETHERNET PORT
▭	SMALL-FACTOR PLUGGABLE TRANSCEIVER



CMS COMMUNICATION WIRING DIAGRAM

ELECTRICAL DETAILS

ED-1

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LAST REVISION 03-12-20
DATE PLOTTED => 12-MAR-2020
TIME PLOTTED => 15:49

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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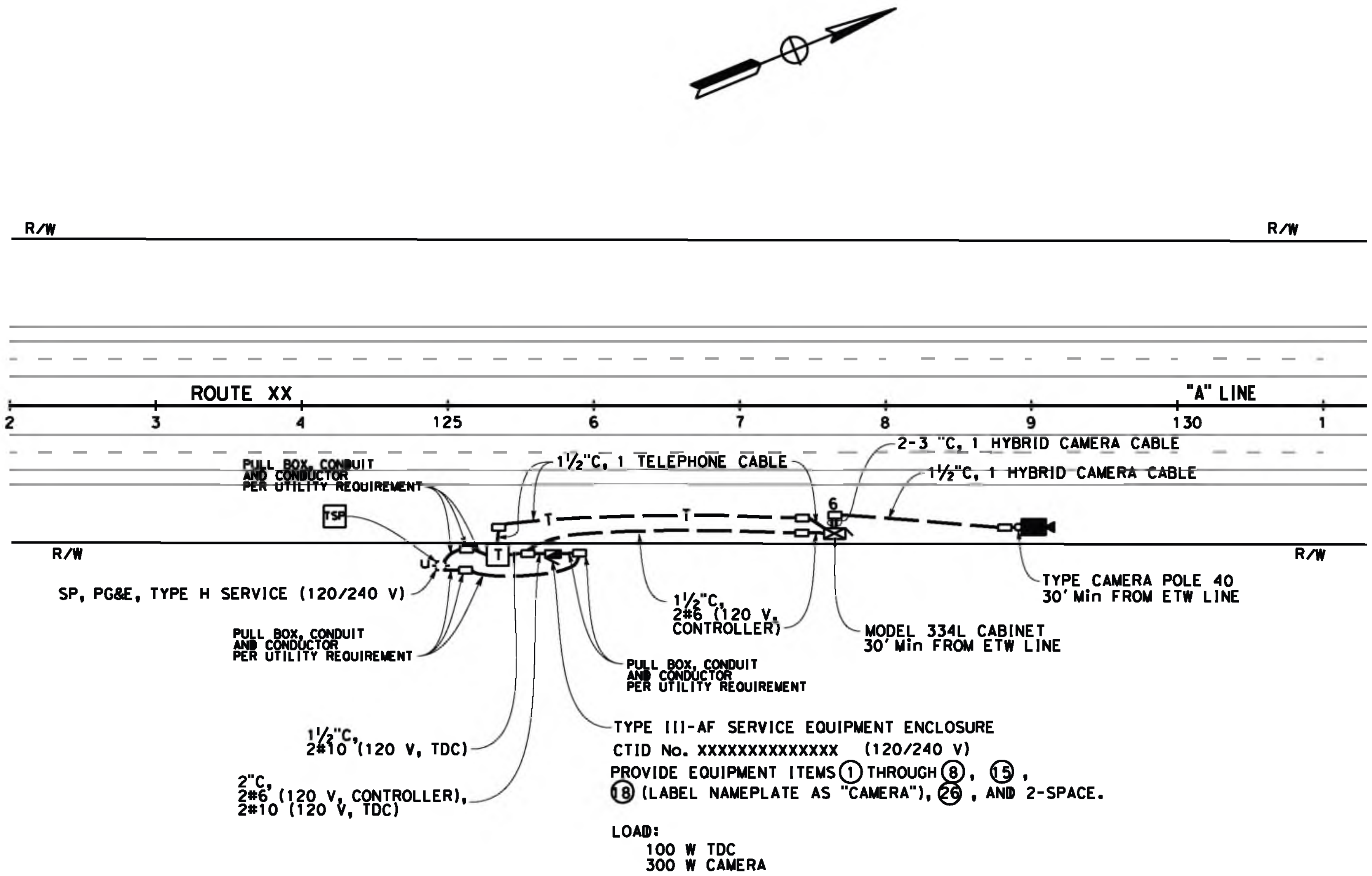
No.
Exp.
ELECTRICAL

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

EXAMPLE K



CAMERA SYSTEMS

SCALE: 1"=50'

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E-1

REVISED BY
DATE REVISED
CALCULATED-DESIGNED BY
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FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans ELECTRICAL DESIGN

LAST REVISION 00-00-00
DATE PLOTTED => 3/10/2020
TIME PLOTTED => 2:00:48 PM

BORDER LAST REVISED 7/2/2010
USERNAME => "s129714"
DGN FILE => ...\CAMERA.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0000
PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
ELECTRICAL
STATE OF CALIFORNIA

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EXAMPLE L

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

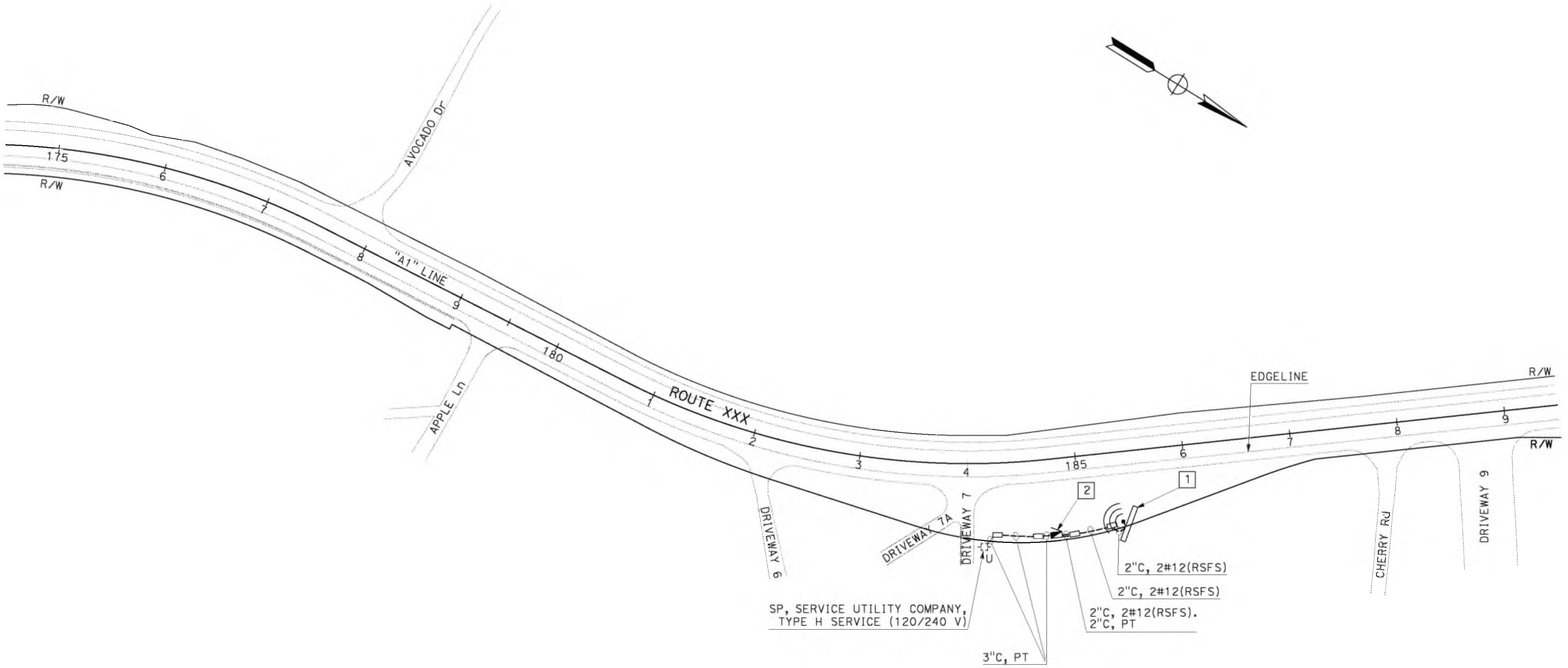
LEGEND:

1 INSTALL A RADAR SPEED FEEDBACK SIGN SYSTEM 55', MINIMUM, FROM THE EDGELINE. SEE SES SHEETS FOR DETAILS

2 INSTALL A TYPE III-BF SERVICE EQUIPMENT ENCLOSURE 55', MINIMUM, FROM THE EDGELINE. REPLACE "FLASHING BEACON" NAMEPLATE WITH A "FEEDBACK SIGN" NAMEPLATE. LABEL THE FRONT OF THE EXTERIOR DOOR, CTID NO. 1157101R123.456U

ABBREVIATION:

RSFSS RADAR SPEED FEEDBACK SIGN



RADAR SPEED FEEDBACK SIGN SYSTEM

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SCALE: 1" = 50'

E-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

ELECTRICAL DESIGN

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DATE REVISED

LAST REVISION 05-01-20

DATE PLOTTED => 01-MAY-2020
TIME PLOTTED => 07:08

BORDER LAST REVISED 7/2/2010

USERNAME => s133545
DGN FILE => RSFSS (layout) rev4.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
ELECTRICAL
STATE OF CALIFORNIA

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LEGEND: (FOR THIS SHEET ONLY)

1 120/240 V, 1Ø, 3-WIRE, TYPE III-CF SERVICE EQUIPMENT ENCLOSURE WITH THE FOLLOWING CIRCUIT BREAKERS:

CTID No. XXXXXXXXXXXXXXX

AMPERES	VOLTS	POLES	NAMEPLATE	METER	PEC TYPE
100	240	2	MAIN BREAKER	YES	-
30	120	1	RWIS	YES	-
20	120	1	SPARE	YES	-
-	-	6	SPACE	YES	-

2 PULL BOX PER UTILITY REQUIREMENTS.

3 TYPE VDS 30 POLE WITH RWIS, 30′ MINIMUM FROM ETW. SEE SHEET ED-1 FOR DETAILS.

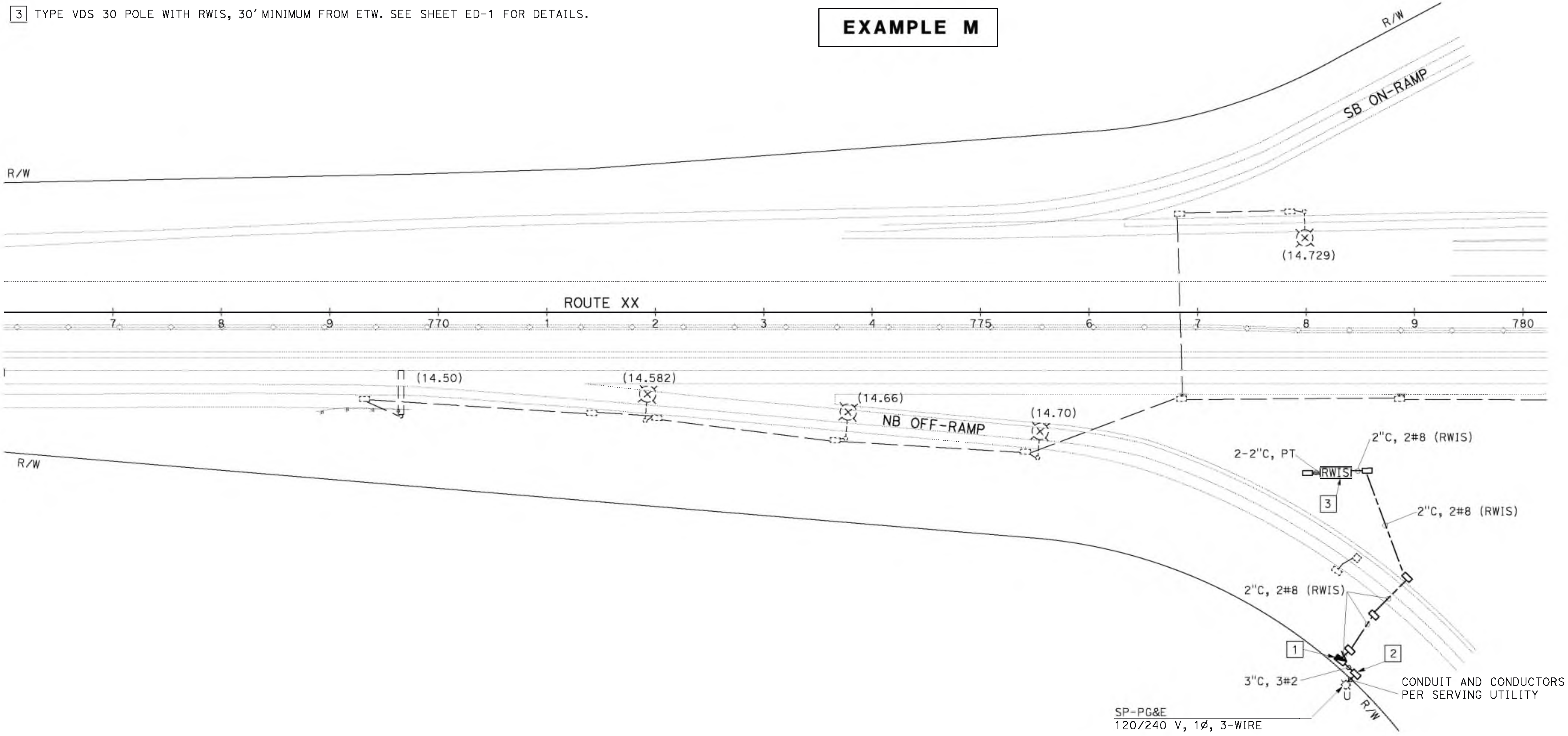
NOTES:

1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. ALL PULL BOXES MUST BE No. 5(E)(T) UNLESS OTHERWISE NOTED.

SYMBOLS:

RWIS ROADSIDE WEATHER INFORMATION SYSTEM

EXAMPLE M



ROADSIDE WEATHER INFORMATION SYSTEM

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SCALE: 1" = 50′

E-1

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DATE REVISED

LAST REVISION 00-00-00

DATE PLOTTED => 11-MAR-2020
TIME PLOTTED => 15:05

USERNAME => s118744
DGN FILE => RWIS E-1.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE XXXXXXXXXXX

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

No.
Exp.
ELECTRICAL

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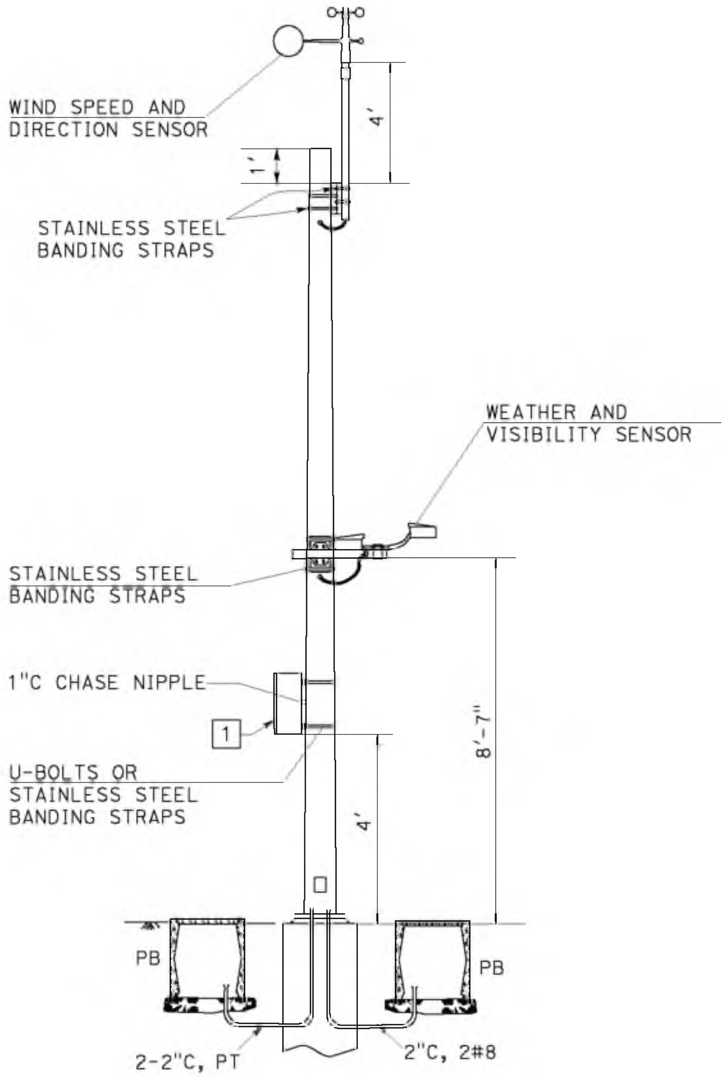
LEGEND: (FOR THIS SHEET ONLY)

1 ENCLOSURE WITH HINGED DOOR, PADLOCK HASP, AND INTERIOR PANEL.

EXAMPLE M



TYPE VDS 30 POLE WITH RWIS

DETAIL A

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ELECTRICAL DESIGN

FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY

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DATE REVISED

ELECTRICAL SYSTEMS DETAILS

NO SCALE

ED-1

LAST REVISION 00-00-00

DATE PLOTTED => 08-MAR-2020
TIME PLOTTED => 09:49

BORDER LAST REVISED 7/2/2010

USERNAME => s118744
DGN FILE => RSIW ED-1.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE XXXXXXXXXXX

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

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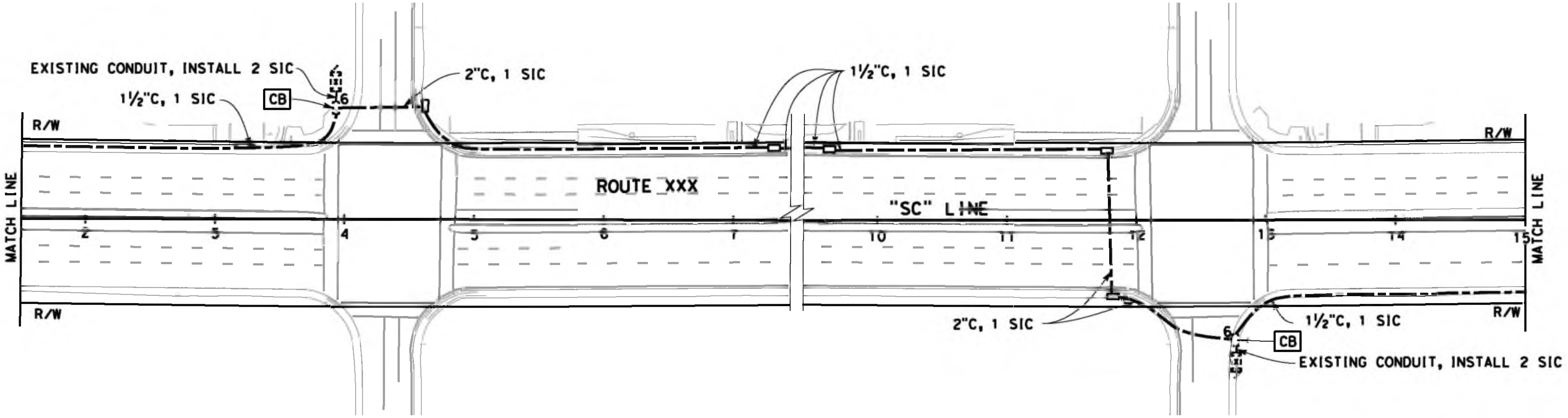
NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

EXAMPLE N



INTERCONNECTION CONDUIT AND CABLE

SCALE: 1" = 50'

E-1

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Caltrans ELECTRICAL DESIGN

FUNCTIONAL SUPERVISOR

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DATE REVISED

LAST REVISION 00-00-00

DATE PLOTTED => 3/10/2020
TIME PLOTTED => 2:32:25 PM

BORDER LAST REVISED 7/2/2010

USERNAME =>
DGN FILE => ...\class sample design\SIC.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE

00000000000

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

REGISTERED PROFESSIONAL ENGINEER
No.
Exp.
ELECTRICAL
STATE OF CALIFORNIA

EXAMPLE O

NOTES:

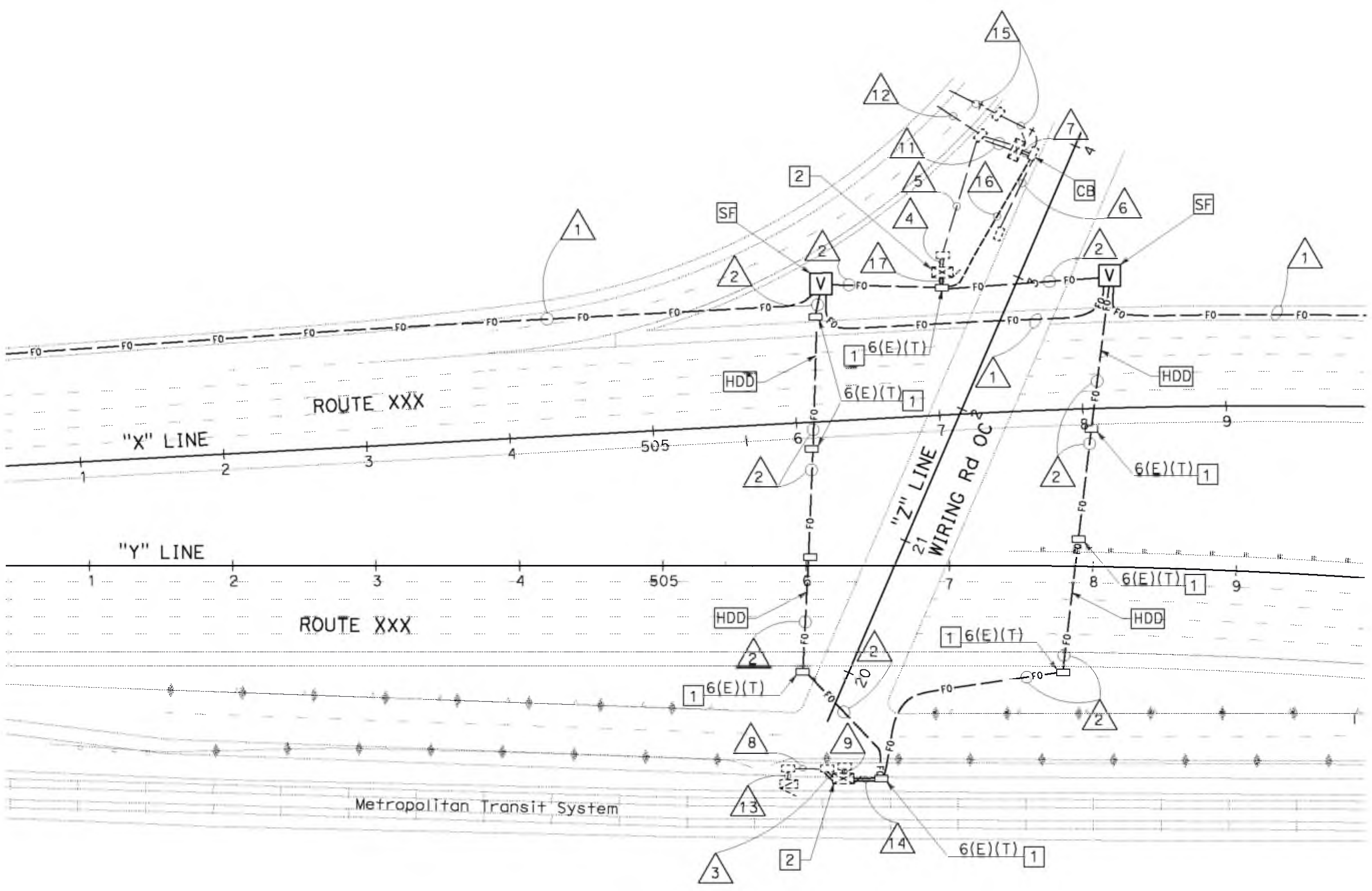
1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. FOR TYPICAL FIBER OPTIC STRAND CONNECTION AT AN OVERCROSSING OR UNDERCROSSING, SEE ED-1.
3. USE T TRENCH WHEN TRENCHING ON THE SHOULDER.

LEGEND:

△1	MDCS(8), 2 FO288
△2	2"C, 1 FO2(SWITCH-SWITCH), 1 FO4(HUB-SWITCH)
△3	Exist 2-2"C, 2#10(RM), PT
△4	Exist 2-2"C, 2#10(Cam), PT
△5	Exist 2½"C, 2#10(Cam)
△6	Exist 2½"C, 7 DLC(RM)
△7	Exist 2-2½"C, 7 DLC(Sig), 1 OEC(Sig), 1 OEC(TDC), PT. ADD 1 OEC(Cam)
△8	Exist 2"C, 2#10(RM), 2#10(Ltg-RM)
△9	Exist 2-3"C, 2-9CSC(RM), 6 DLC(RM), PT
△10	Exist 1½"C, 1 DLC
△11	Exist 2-2"C, 2#6(Sig), PT
△12	Exist 2½"C, 2#6(RM), 2#10(Cam)
△13	Exist 3"C, 4#14(PEU), 2#10(Ltg-RM), 2#8(Ltg), 2#10(Sig), 2#10(Ltg), 2#10(RM), 2#10(Sig)
△14	2-2"C, 2 FO2(SWITCH-SWITCH), 2 FO4(HUB-SWITCH), PT
△15	Exist 2"C, 1 OEC(TDC)
△16	2"C, 1 OEC(Sig)
△17	2-2"C, 2 FO2(SWITCH-SWITCH), 2 FO4(HUB-SWITCH), 1 OEC(Sig), 2"C, PT
1	CONDUIT BENDS MUST BE AT AN ANGLE OF 22.5°, PULL BOX MUST BE MARKED "FIBER OPTIC"
2	CONDUIT MUST ENTER THE EXISTING MODEL 334L CONTROLLER CABINET FOUNDATION TO THE ADJACENT PULL BOX BY ROTOR DRILLING A 2.5" HOLE AT 45°
SF	SPLICE FIBER OPTIC CABLE IN THE SPLICE ENCLOSURE
HDD	HORIZONTAL DIRECTIONAL DRILLING

ABBREVIATION:

OEC	OUTDOOR ETHERNET CABLE
FO288	FIBER OPTIC, 288 STRAND CABLE
FO4	FIBER OPTIC, 4 STRAND CABLE
FO2	FIBER OPTIC, 2 STRAND CABLE
Cam	CAMERA



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FIBER OPTIC CABLE SYSTEMS

SCALE: 1" = 50'

E-1

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FUNCTIONAL SUPERVISOR

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DATE REVISED

LAST REVISION 05-01-20

DATE PLOTTED => 01-MAY-2020
TIME PLOTTED => 07:24

BORDER LAST REVISED 7/2/2010

USERNAME => s133545
DGN FILE => fiber optic system (layout) rev7.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE 00000000001

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

No.
Exp.
ELECTRICAL

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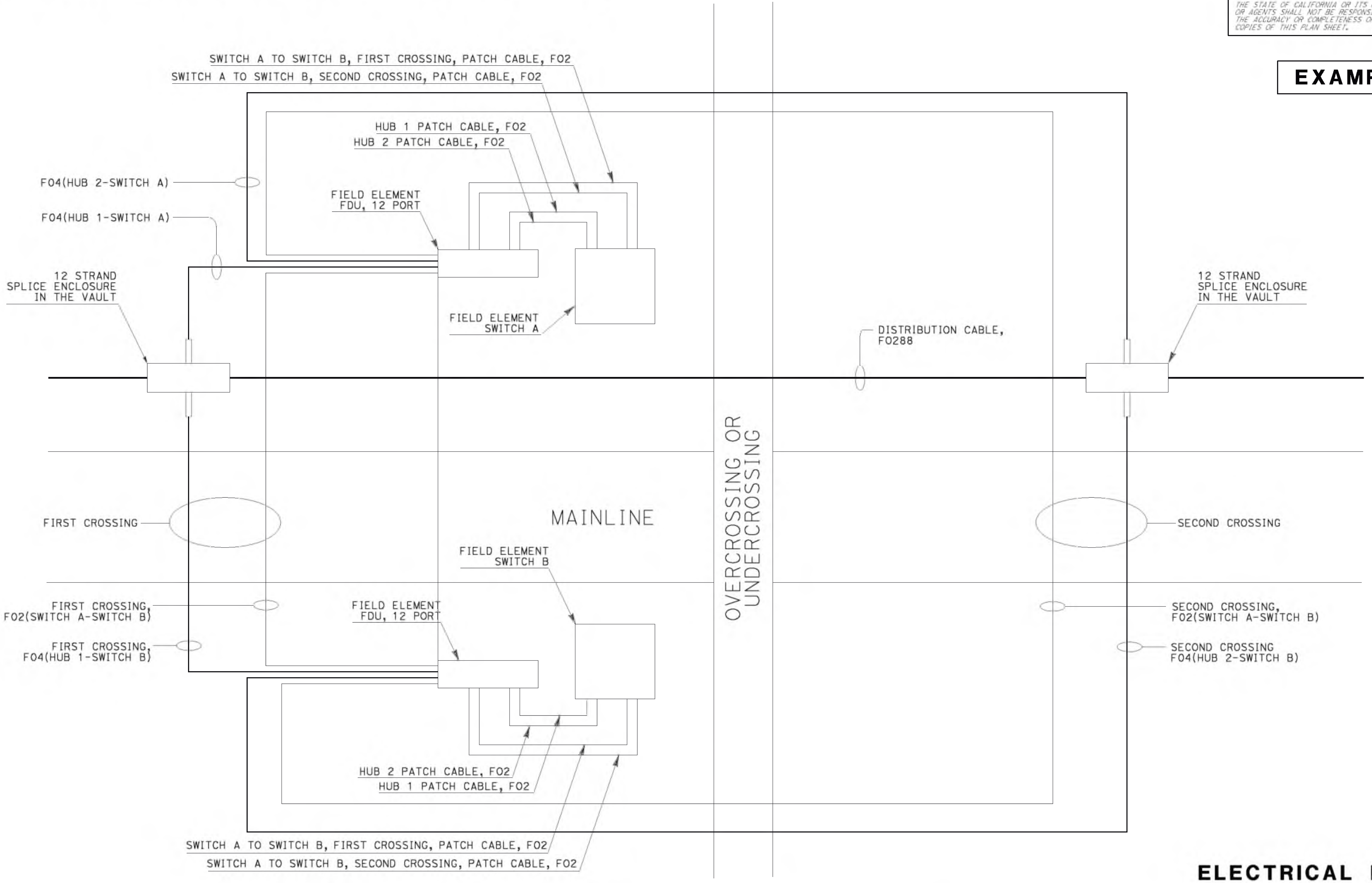
EXAMPLE O

NOTES:

1. VAULT-TO-VAULT, VAULT-TO-HUB AND HUB-TO-HUB ARE FIBER OPTIC CABLE.
2. VAULT-TO-SWITCH, SWITCH-TO-SWITCH AND SWITCH-TO-FIELD ELEMENT ARE FIBER OPTIC RISER.
3. LABEL TERMINATED STRANDS IN THE HUB, IN THE VAULT, AND IN THE FIELD ELEMENT'S ENCLOSURE OR CABINET.



TYPICAL FIBER OPTIC STRAND CONNECTION AT AN OVERCROSSING OR UNDERCROSSING

ELECTRICAL DETAILS

ED-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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DATE PLOTTED => 01-MAY-2020
TIME PLOTTED => 07:34
LAST REVISION 05-01-20

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DATE REVISED

CALCULATED-DESIGNED BY
CHECKED BY

FUNCTIONAL SUPERVISOR

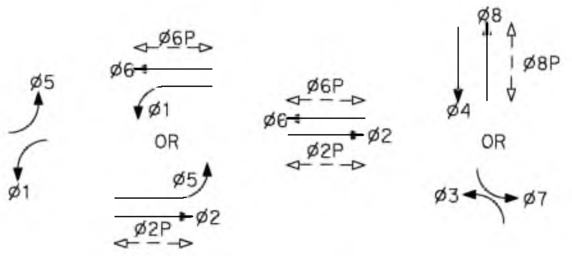
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans
ELECTRICAL DESIGN

NOTE:

FOR ACCURATE RIGHT OF WAY DATA,
CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

LEGEND:

- △1 Exist 4-3"C, 6-3CSC, 9-12CSC, 2#6(Ltg), 16 DLC, 2 EVUC CABLE, 2-6P#20 SIC, 3#14(PEU), 4 VIDEO CABLE
- △2 Exist 4-3"C,6-3CSC, 9-12CSC, 2#10(Ltg), 16 DLC, 2 EVUC CABLE, 2-6P#20(SIC), 3#14(PEU), 4 VIDEO CABLE
- △3 Exist 2-3"C, 3-3CSC, 3-12CSC, 2#10(Ltg), 9 DLC, 2 EVUC, 1-6P#20(SIC), 1 VIDEO CABLE
- △4 Exist 2-3"C, 1-3CSC, 3-12CSC, 2#10(Ltg), 9 DLC, 2 EVUC, 1-6P#20(SIC), 1 VIDEO CABLE
- △5 Exist 3"C, 1-3CSC, 2-12CSC, 2#10(Ltg), 2 DLC, 2 EVUC, 1-6P#20(SIC), 1 VIDEO CABLE
- △6 Exist 3"C, 1-3CSC, 1-12CSC, 2 DLC, 1-6P#20(SIC)
- △7 2-3"C, 3-3CSC, 5-12CSC, 2#10(Ltg) 7 DLC, 1-6P#20(SIC), 2 VIDEO CABLE
- △8 Exist 2-3"C, 3-3CSC, 4-12CSC, 2#10(Ltg), 5 DLC, 2 VIDEO CABLE
- △9 Exist 3"C, 2-3CSC, 3-12CSC, 2#10(Ltg), 5 DLC, 1 VIDEO CABLE
- △10 Exist 3"C, 1-3CSC, 2-12CSC, 2#10(Ltg), 5 DLC, 1 VIDEO CABLE
- △11 Exist 2"C, 1-12CSC, 2#10(Ltg), 1 VIDEO CABLE
- △12 Exist 2"C, 2#6(Sig), 2#10(Ltg), 3#14(PEU)
- △13 Exist 2"C, 2 DLC 1-6P#20(SIC)
- △14 Exist 2"C, 2 DLC
- △15 Exist 2"C, 3 DLC
- △16 Exist 2"C, 5 DLC



PHASE DIAGRAM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS

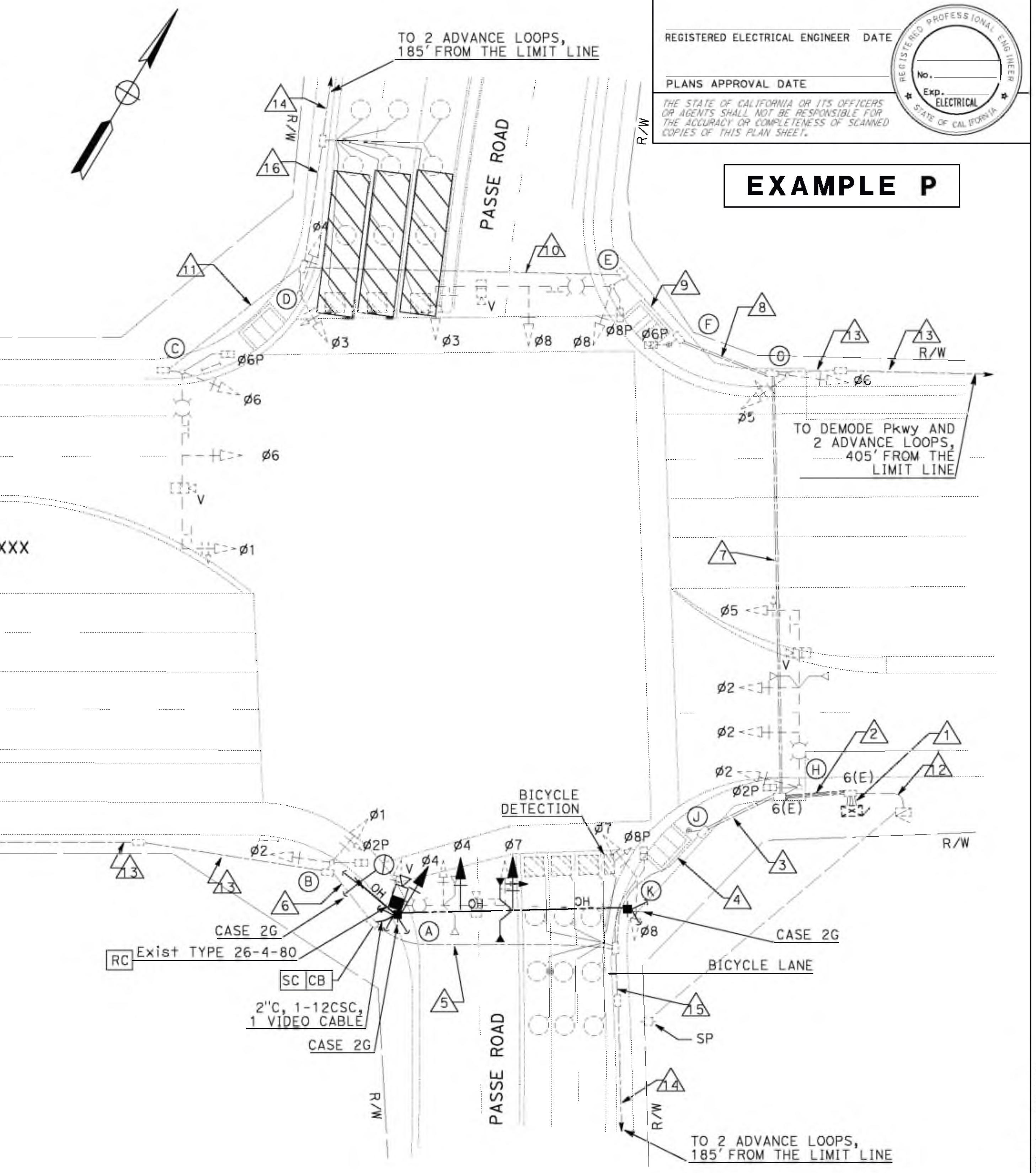
REGISTERED ELECTRICAL ENGINEER DATE

PLANS APPROVAL DATE

No.
Exp.
ELECTRICAL

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

EXAMPLE P



TO PUTRID Dr AND
2 ADVANCE LOOPS,
405' FROM THE LIMIT LINE

R/W

R/W

EXISTING POLE AND EQUIPMENT SCHEDULE

Loc	STANDARD			LOCATION		Veh Sig Mtg		Ped Sig Mtg	APS		LUMINAIRE TYPE	VEHICLE DETECTION
	TYPE	SMA	LMA	A	B	MAST ARM	POLE		ø	ARROW		
Ⓐ	26-4-80	40'	12'	5'	9'	MAS	SV-1-T	—	—	—	ROADWAY 3	VIVDS
Ⓑ	1-A	—	—	7'	5'	—	TV-2-T	—	2	→	—	—
Ⓒ	29-5-80	55'	15'	5'	3'	MAT,MAS	SV-1-T	SP-1-T	—	—	ROADWAY 3	VIVDS
Ⓓ	1-A	—	—	18'	5'	—	TV-2-T	—	6	→	—	—
Ⓔ	26-4-80	45'	12'	24'	8'	MAS	SV-1-T	SP-1-T	6	←	ROADWAY 3	VIVDS
Ⓕ	1-A (7')	—	—	27'	13'	—	—	TP-1-T	8	→	—	—
Ⓖ	1-A	—	—	10'	3'	—	TV-2-T	—	—	—	—	—
Ⓗ	29-5-80	55'	15'	8'	3'	MAT, 2-MAS	SV-1-T	—	—	—	ROADWAY 3	VIVDS
Ⓙ	PPB POST	—	—	25'	14'	—	—	—	2, 8	← →	—	—
Ⓚ	1-A	—	—	24'	9'	—	TV-2-T	SP-1-T	—	—	—	—

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TEMPORARY SIGNAL AND LIGHTING SYSTEMS

SCALE: 1" = 20'

E-1

LAST REVISION 05-01-20
DATE PLOTTED => 01-MAY-2020
TIME PLOTTED => 07:13

BORDER LAST REVISED 7/2/2010

USERNAME => s133545
DGN FILE => temporary signal (layout) rev4.dgn

RELATIVE BORDER SCALE IS IN INCHES
0 1 2 3

UNIT 0000

PROJECT NUMBER & PHASE

00000000001