Stage 2 Preliminary Assessment

California Department of Technology, SIMM 19B (Rev. 2.1), Revision 5/21/2018

2.1 General Information

Agency or State Entity Name:	
Transportation, Department of	
Organization Code:	
2660	
Proposal Name:	
Transportation System Network Replacement	
Department of Technology Project Number:	2660-545

2.2 Preliminary Submittal Information

Contact Information:	
Contact First Name:	**Contact Last Name:**
Dale	Minatoya
Contact Email:	**Contact Phone:**
dale.minatoya@dot.ca.gov	9166530151
Preliminary Submission Date:	**Preliminary Assessment Transmittal**:
7/31/2019	Attachment #1_S1BA_Modified Attachment #2_S2PA_Signed

2.3 Stage 2 Preliminary Assessment

2.3.1 Impact Assessment

	Yes	No
1. Has the Agency/state entity identified and committed subject matter experts from all business sponsors and key stakeholders?	☒	☐
2. Are all current baseline systems that will be impacted by this proposal documented and current (e.g., data classification and data exchange agreements, privacy impact assessments, design documents, data flow diagram, data dictionary, application code, architecture descriptions)?	☐	☒
3. Does the Agency/state entity anticipate needing support from the California Department of Technology (CDT) Statewide Technology Procurement (STP) to conduct market research for this proposal (Market Survey, Request for Information)?	☒	☐
4. Does the Agency/state entity anticipate submitting a budget request to support the procurement activities of this proposal?	☒	☐
5. Could this proposal involve the development and/or purchase of systems to support activities included in Financial Information System for California (FI$Cal) (e.g., financial accounting, asset management, human resources, procurement/ordering, inventory management, facilities management)?	☐	☒
6. Does the Agency/state entity have a designated Chief Architect or Enterprise Architect to lead the development of baseline and alternative solutions architecture descriptions?	☒	☐
7. Will the Agency/state entity's Information Security Officer be involved in the development and review of any security related requirements?	☒	☐
8. Does the Agency/state entity anticipate performing a business-based procurement to have vendors propose a solution?	☒	☐

2.3.2 Business Complexity Assessment

Business Complexity:	2.9	Business Complexity Zone:	☐	High	☒ Medium	☐ Low

Stage 2 Alternatives Analysis

2.4 Submittal Information

Contact Information:

Contact First Name:	Contact Last Name:
Dale	Minatoya
Contact Email:	**Contact Phone:**
Dale.minatoya@dot.ca.gov	9166530151
Submission Date:	**Project Approval Executive Transmittal:**
6/30/2019	Attachment #3_Executive_Transmittal

Submission Type:

- ☒ New Submission
- ☐ Updated Submission (Pre-Approval)
- ☐ Updated Submission (Post-Approval)
- ☐ Withdraw Submission
  - Reason: Select...
  - If "Other," specify:

Sections Updated (For Updated Submissions Only) – (check all that apply)

- ☐ 2.1 General Information
- ☐ 2.2 Preliminary Submittal Information
- ☐ 2.3 Stage 2 Preliminary Assessment
  - ☐ 2.3.1 Impact Assessment
  - ☐ 2.3.2 Business Complexity Assessment
- ☐ 2.4 Submittal Information
- ☐ 2.5 Baseline Processes and Systems
  - ☐ 2.5.1 Description
  - ☐ 2.5.2 Business Process Workflow
  - ☐ 2.5.3 Current Architecture Information
  - ☐ 2.5.4 Current Architecture Diagram
  - ☐ 2.5.5 Security Categorization Impact Table
- ☐ 2.6 Mid-Level Solution Requirements
- ☐ 2.7 Assumptions and Constraints
- ☐ 2.8 Dependencies
- ☐ 2.9 Market Research
  - ☐ 2.9.1 Market Research Methodologies/Timeframes
  - ☐ 2.9.2 Results of Market Research
- ☐ 2.10 Alternative Solutions
  - ☐ 2.10.1 Solution Type)
    - ☐ Recommended
    - ☐ Alternative
  - ☐ 2.10.2 Name
  - ☐ 2.10.3 Description
  - ☐ 2.10.4 Benefit Analysis
  - ☐ 2.10.5 Assumptions and Constraints
  - ☐ 2.10.6 Implementation Approach
  - ☐ 2.10.7 Architecture Information
- ☐ 2.11 Recommended Solution
  - ☐ 2.11.1 Rationale for Selection
  - ☐ 2.11.2 Technical/Initial IT Project Oversight Framework Complexit Assessment
  - ☐ 2.11.3 Procurement and Staffing Strategy
  - ☐ 2.11.4 Enterprise Architecture Alignment
  - ☐ 2.11.5 Project Phases
  - ☐ 2.11.6 High Level Proposed Project Schedule
  - ☐ 2.11.7 Cost Summary
- ☐ 2.12 Staffing Plan
  - ☐ 2.12.1 Administrative
  - ☐ 2.12.2 Business Program
  - ☐ 2.12.3 Information Technology (IT)
  - ☐ 2.12.4 Testing
  - ☐ 2.12.5 Data Conversion/Migration
  - ☐ 2.12.6 Training and Organizational Change Management
  - ☐ 2.12.7 Resource Capacity/Skills/Knowledge for Stage 3 Solution Development
  - ☐ 2.12.8 Project Management
    - ☐ 2.12.8.1 Project Management Maturity Assessment
    - ☐ 2.12.8.2 Project Management Planning
  - ☐ 2.12.9 Organization Charts
- ☐ 2.13 Data Conversion/Migration
- ☐ 2.14 Financial Analysis Worksheets

Summary of Changes:

Condition(s) from Previous Stage(s):	
Condition #	….
Condition Category	Select...
Other, specify	….
Condition Sub-category	Select...
Other, specify	….
Condition	
Assessment	Select...
Other, specify	….
Agency/state Entity Response	
Status	Select...
Other, specify	….
Select + to add conditions.	

2.5 Baseline Processes and Systems

2.5.1 Description

The existing Transportation System Network (TSN) application, which consists of four separate modules (roadway inventory data, traffic volume, collision data, and traffic investigation reporting), is a California Department of Transportation (Caltrans) database application used to store, maintain, and link traffic volume, collision, and roadway inventory data for the state-owned highway system. It serves as the base information system for all traffic safety analysis that helps Caltrans achieve its goals in reducing the number and severity of traffic collisions by ensuring that opportunities to improve highway safety are identified, considered, evaluated, and implemented in all phases of highway planning and operation. In addition, it also supports legal allegations, and other federally mandated programs (e.g., Highway Performance Monitoring System [HPMS], and Traffic Census). The roadway inventory data includes elements such as district, county, route, postmiles, lanes, shoulders, medians, and other geometric attributes for the State Highway System (SHS) which consists of over 15,000 centerline miles, 15,000 ramps, and 17,000 intersections. The existing TSN system is an enterprise ORACLE application that was developed in the 1990s and is maintained by Information Technology (IT) Division of Application Development and Support; the data is maintained and updated by the Division of Research, Innovation and System information (DRISI) and Division of Traffic Operations (DTO).

The Moving Ahead for Progress in the 21st Century (MAP-21), https://www.fhwa.dot.gov/map21/, transportation legislation, signed into law on July 6, 2012, emphasizes the importance of safety data for all public roads and requires that States have in place a safety data system that can be used to perform enhanced analysis supporting the strategic and performance-based goals in the Strategic Highway Safety Plans and Highway Safety Improvement Program (HSIP). This Federal law also requires states to use their safety data systems to identify fatalities and serious injuries on all public roads by location, and specifies that all states have the capability to link collision, roadway, and traffic data by geolocation.

Caltrans has determined that the existing TSN application does not meet the MAP-21 and the Fixing America's Surface Transportation (FAST) Act requirements. Notably, the system consists of state highway data only and lacks geospatial capabilities to integrate safety data as required by MAP-21. In addition, as a reporting and analysis tool for users, the TSN system has limited capability as it lacks flexible reporting functions and the ability to integrate with other Caltrans programs and systems. Furthermore, Caltrans has a strategic goal to add bicycle or pedestrian data to TSN, to improve safety. Therefore, Caltrans has decided to replace the existing TSN system with a more modern safety database system that will meet the Federal mandates and improve program operations across Caltrans.

To meet the regulatory requirements, the new TSN system must:

- Integrate/synchronize with Caltrans All Roads Linear Referencing System (LRS) system
- Provide geospatial enabled capability
- Provide geolocation functionality to identify collision locations on state and local roads
- Store temporal and historical safety data so reports can be created that identify the characteristics of the roadway at a specific point in time
- Store and maintain collision, roadway inventory (including Model Inventory of Roadway Elements or MIRE), and traffic volume (including bicyclist and pedestrican), on State and local roads
- Integrate with Caltrans' internal and external database systems
- Provide ad hoc reporting capability
- Store and maintain a centralized repository of SHS geometric, inventory, and postmile information
- Perform benefit/cost analysis of possible countermeasures for safety projects
- Conduct safety analysis

The current processes are very siloed in that there are 3 modules with very distinct processes that work independently of each other (Highway Inventory Maintenance, Traffic Census Updates, and the Collision Coding process). Once all of these processes have been completed at a given time throughout the year, the data derived from each is run through the Safety Analysis Process in order to identify High Concentration Collision Locations across the state highway system in order to perform prioritized Traffic Investigations. The output of the Safety Analysis Processes result in Traffic Investigations which determine priorities for safety related projects. The overall process is represented in the attached Safety Analysis Program High Level Process flowchart.
There are also two ancillary administrative support processes that are also documented within the As-Is attachments (IT Support and Legal Support).
Refer to the As-Is Assessment attachment for more detail on each of these processes.

2.5.2 Business Process Workflow

Attachment #4_As-Is_Business_Process_Workflows

2.5.3 Current Architecture Information

Business Function/Process(es)		Roadway Inventory		
Business Function/Process(es)		Traffic Census		
Business Function/Process(es)		Collision Coding		
Business Function/Process(es)		Traffic Investigations		
Business Function/Process(es)		Safety Analysis		
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.				
Application, System or Component		Transportation System Network		
		Select + to add an application, system, or component.		
COTS, MOTS or Custom		Custom application		
Name/Primary Technology:		Transportation System Network/Oracle 12c		
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:	Select...
	Server/Device Function	DB and App Server		
	Hardware	Oracle SPARC Virtual Machine		
	Operating System	Unix Solaris 10/11		

	System Software	Oracle Forms and Reports 10g
	System Software	Unix
	System Software	
		Select + to add system software.
System Interfaces		CHP Web Service for CCRS module
Data Center Location		State data center operated by CDT
	Other, specify	Tenant Managed Services at Gold Camp
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☐ Other, specify:
	Type of Information (check all that apply)	☒ Personal ☐ Health ☐ Tax ☐ Financial ☒ Legal ☒ Confidential ☐ Other, specify:
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒ Backup and Recovery ☐ Other, specify:
Data Management	Data Owner	Name: Mandy Chu/Thomas Schriber
		Title: Office Chief
		Business Program: DRISI/Traffic Operations
	Data Custodian	Name: Chitra Chitturi / Ala Yousefi
		Title: Office Chief, BAMSO/DBA
		Business Program: Application Development Support Division
Select + to add business functions/processes.		

2.5.4 Current Architecture Diagram

Attachment #5_Architecture_Diagram

2.5.5 Security Categorization Impact Table

Attachment #6_Security_Categorization_Table

SECURITY CATEGORIZATION IMPACT TABLE SUMMARY

SECURITY OBJECTIVE	LOW	MODERATE	HIGH
Confidentiality	☐	☒	☐
Integrity	☐	☒	☐
Availability	☐	☐	☒

2.6 Mid-Level Solution Requirements

Attachment #7_Mid_Level_Requirements

2.7 Assumptions and Constraints

Assumptions/Constraints	Description/Potential Impact
Funding is available	Funding will be available for PAL through existing redirected funds. BCP will be approved for implementation and ongoing maintenance.
New software functionality is as stated	New software versions will have all the functions as stated in the vendor demonstrations.
New hardware is set up and maintained by Caltrans IT	New hardware (virtual app servers, physical database servers) will be available and fully supported by Caltrans staff.
Planned testing is sufficient to address the new system.	Online Transaction Processing testing will be done to verify performance is at least as good as the existing system. Deep system testing is not planned.
Training	Training will be sufficient and satisfactory to enable Caltrans staff to operate and maintain the new system components.
Data from multiple systems can be converted to a common format and measurement	Data from local agencies can be input and stored in new TSN in a common format so that it can be used in analysis.
SME availability	The various SMEs needed to complete the project will be available as scheduled
No scope change	Scope remains unchanged after Stage 4 of the PAL process
University of California Berkely (UCB) safety analysis excel based tool and selected safety analysis application(s) compatibility	Screening results from UCB could be consumed by a new safety analysis application(s). The new safety analysis application will replace the UCB tools currently in use by Caltrans if the functionality is available in the new tool.
System Support	New staffing will be required. The future staffing levels to support the new TSN system will be determined based on the results of the Financial Analysis Worksheet (FAWs).
Select + to add assumptions/constraints.	

2.8 Dependencies

Element	Description
Availability of LRS in Esri R&H Platform	The LRS project will be complete and implemented prior to the implementation of the new TSN system
Select + to add dependencies.	

2.9 Market Research

2.9.1 Market Research Methodologies/Timeframes

Methodologies Used To Perform Market Research (check all that apply):

☒	Request for Information (RFI)	☐	Trade shows
☒	Internet Research	☐	Published Literature
☒	Vendor Forums/Presentation	☐	Leveraged Agreements
☒	Collaboration with other Agencies/state entities or governmental entities	☐	Other, specify:

Time spent conducting market research:	4 months
Date market research was started:	6/22/2018
Date all market research was completed:	10/15/2018

2.9.2 Results of Market Research

Attachment #8_Market_Research

2.10 Alternative Solutions

2.10.1 Solution Type

☒ **Recommended**

2.10.2 Name

Independent Transactional Schemas and Components

2.10.3 Description

Background

The current Transportation System Network (TSN) is an Oracle Forms application using an Oracle database. Data tables are updated by four "modules" consisting of Oracle Forms screens and reports, one for each program area that uses TSN as a primary business tool. Other Caltrans systems also retrieve data from the TSN database, but these systems do not add or edit data in TSN. The existing TSN is not capable of meeting Federal mandates under the MAP-21 and FAST Act; it also lacks GIS (map-based) interfaces for data entry, query, and general data display.

Caltrans is replacing the existing TSN through a project process: the Transportation System Network Replacement (TSNR). The resulting system, the New TSN, will meet Federal mandates and be a more capable, modern, system.

The TSNR SIMM 19B Stage 1 Business Analysis defined business objectives for the Transportation System Network replacement. These have been revised by the project team throughout the Stage 2 Alternatives Analysis. Business objectives for the New TSN (as of March, 2019) are shown below.

1. Implement geolocation functionality to identify locations on state and local public roads where fatalities and serious injuries have occurred.
2. Implement a safety data system that stores temporal and historical roadway data, so reports can be created that identify the characteristics of the roadway at a specific point in time.
3. Implement a Model Inventory of Roadway Elements (MIRE) FDE (Fundamental Data Elements) safety data system that collects data and reports on the subset elements to meet the MIRE FDE requirements.
4. Provide a software solution that includes a secured application programming interface (API) that allows new TSN to be accessed by external agencies and proform data exchange.
5. Provide a solution that reduces the time and manual effort of TSN reporting by providing ad-hoc reporting capability that can export results into standard formats (CSV, Excel, PDF).
6. Provide a solution that enables access to TSN data and reports by all authorized users
7. Provide a solution that stores and maintains a centralized repository of current roadway Inventory, Traffic volume, and Collision data.
8. Provide a solution that integrates with Caltrans internal databases.
9. Provide a solution that incorporates updated safety analysis using the new methods and algorithms.
10. Provide a solution that will fully integrate new TSN post-mile system with Caltrans' implementation of Esri Roads and Highways Linear Referencing System.
11. Provide a solution which can host roadway inventory, traffic volume, collision coding, and safety analysis & investigation data.

Mid-level requirements (see Section 2.6) and mid-level capabilities were built upon the business objectives. The capabilities the solution meets are shown in schematic form in the following figure.

Recommended Alternative

The recommended alternative consists of three major elements, shown in the figure below. These are: (1) transactional user interfaces/user experiences (UI/UX) each of which is paired with a data store (transactional database); (2) a Authoritative Data Store that retains corporate data from each of the transactional elements; (3) APIs, procedure calls, and mechanisms to populate the Authoritative Data Store and make authoritative data available to other processes or systems.

The recommended alternative's first element is the **four transactional user interfaces and data stores**, one for each of the main areas of Transportation System Network: roadway inventory, traffic volume, collision information, and safety analysis, research, and mitigations. Features of this element of the solution are:

- Each UI/database contains Caltrans-specific schema additions
    - Common fields for identity and ascribed location
        - County-route-postmile, postmile variations unique to Caltrans
    - Fields specific to business needs of Caltrans that are not in "per-area" COTS data schema
        - Expectation is that there are relatively few fields specific to business needs that would need to be included in each transactional schema, so that the implementation would be far more COTS than MOTS
    - Each UI/database combination performs create/read/update/delete on just its business data
    - Each UI contains the quality assurance (in-built) logic for that business domain
    - Each UI contains the quality control process interfaces for that business domain
    - Each UI/database combination can synchronize with the LRS as needed
        - The Roadway Inventory would be within the Esri Roads & Highways (R&H) geodatabase, facilitating frequent synchronization
    - Each UI/database can call on dynamic segmentation to visualize non-point data

  - Each UI/database combination offers some form of read-only API so that other UI/database combinations can query it if needed (e.g., as part of quality assurance)
  - An exception to this is the Roadway Inventory program area, where the transactional tables are part of the R&H geodatabase because this is a proven use case
    - UI may still be a separated product but it uses R&H geodatabase
- The second element of the alternative is the **Authoritative Data Store** – a data store that is based upon appropriate business logic
  - The Authoritative Data Store receives data *from* the transactional data stores of each module via synchronization methods, such as APIs and ETLs (see discussion below). The synchronization process may use techniques like change data capture to minimize writes to the database. Note that data are synchronized (copied to the Authoritative Data Store) based upon business rules that determine when data are authoritative and when such data should be moved to the Authoritative Data Store.
  - The Authoritative Data Store is the source of most fixed-format time-bound reports (e.g., annual reports)
  - The Authoritative Data Store is the source of data used by the Network Screening API as part of safety analysis
  - The Authoritative Data Store is the source of data used by other APIs and systems
  - Because the Authoritative Data Store has multiple sources of data, it is possible that a change in the Authoritative Data Store will have an effect on a transactional database but this is expected to be rare since data flows from transactional data stores to the Authoritative Data Store rather than the reverse
  - The Authoritative Data Store will likely also include a read-only (static) copy of the Roads and Highways geodatabase so that queries are not run against the production geodatabase; the static geodatabase will be refreshed on a scheduled basis (per business needs that are yet to be defined in detail)
- The third element of the recommended alternative consists of **application programming interfaces (APIs), Extract-Transform-Load tools (ETLs)** and computer messaging techniques. These deliver results from queries as data payloads that accomplish several things:
  - Data values are moved from one data store to another, undergoing appropriate transformations if needed. For example, data from a transactional database that has passed quality control checks and is thus authoritative is moved to the Authoritative Data Store by some form of API.
  - APIs may trigger specific actions within the system
    - For instance, a change in the linear referencing system geometry may notify the user or a process of a need to resynchronize geometry in other parts of the system
  - APIs expose data needed for reporting and data exchange outside of the TSN

The recommended alternative meets the capabilities and requirements defined for the TSN. Based upon market research, many of the desired UI/UX data store elements are available in the marketplace. However no single vendor is likely to have all of the desired major areas as “best in class”. Consequently, the recommended alternative is to procure a single master vendor who will incorporate all products, a system integrator (SI). This alternative makes no assumption about the necessary topology of the transactional components or even the overall solution (cloud-based, Software-as-a-Service, etc.) but leaves this topology open to proposals from potential vendors.

The recommended alternative involves multiple kinds of implementation work, requiring the SI to design and implement the system as a whole:

1. Enterprise architecture
   a. Orchestration of multiple user interface + transactional databases

b. The design and implementation of a TSN Authoritative Data Store holding authoritative records from the transactional element of the TSN
c. The design and implementation of communication methods (APIs, etc.) to support the capabilities and requirements for
    i. Cross-business area transactional communication (e.g., verifying a collision location requires determining the highway segment on which it occurred and confirming there is an inventory record for that segment
    ii. Maintaining information within the Authoritative Data Store element
    iii. Reporting from the Authoritative Data Store and use of TSN data by other systems external to the TSN ecosystem

2. Data quality and cleansing for migration from the old system to the new TSN
3. Configuration and customization of the UI/UX and transactional data store elements to meet revised (new) workflows within the program areas
4. Integration with other Caltrans and external systems
5. Integrate with Active Directory and support single sign-on for users with access to multiple parts of the system (e.g., modules)

Caltrans subject matter experts (SMEs) and IT specialists (IT) are required participants in the work. SMEs participate by informing the SI about business needs, participating in iterative testing of their program area (transactional) components and the Authoritative Data Store, and taking training on the completed system. Caltrans IT participates in many ways: by providing the environment(s) needed for the solution, by informing the SI of general agency and state requirements for systems, assisting the SI in designing the Authoritative Data Store and APIs, and ensuring the solution meets appropriate security requirements.

Approach (Check all that apply):	
☒	Increase staff – new or existing capabilities
☒	Modify the existing business process or create a new business process
☐	Reduce the services or level of services provided
☐	Utilize new or increased contracted services
☐	Enhance the existing IT system
☒	Create a new IT system
☒	Perform a business-based procurement to have vendors propose a solution
☐	Other, specify:

2.10.4 Benefit Analysis

Benefits/Advantages
System will meet federal requirements for data collection and reporting.
The solution's architecture simplifies data management by separating transactional business data stores from authoritative data used for reporting and analysis, making the system as a whole easier to maintain and designed for longevity.
By using modular components for the most complex parts of the system, changing parts of the system in the future is easier. If one program area's module is upgraded or altered, then there is no need to rebuild the whole system.
Modular approach for user interface and transactional data makes it possible to select "best of breed" COTS modules that are most effective for users with the least modification by the system integrator.
APIs, and ETLs, created by coding, between elements increases flexibility of the system because the APIs and ETLs can be modified without changing other parts of the system.
The Authoritative Data Store provides a single source of authoritative data, separating transactional records from those that have passed quality control.

Separating the Authoritative Data Store from the transactional data stores localizes data reads/writes to appropriate data stores, rather than a single large data store; this creates a more responsive system that is also easier to maintain over time.
The system leverages the agency's investment in geospatial technology using it as the system framework without creating a second, separate, geospatial framework that requires its own maintenance.
Using a System integrator (SI) for implementation reduces the risk of a complex, multi-product approach in which multiple (different vendors) proceed semi-independently.
Using different modules for each business unit (program area) allows for a phased roll-out, program area by program area, but still allows the modules to form a single, integrated, system.
The system will use contemporary, mainstream, technologies that reduce the current burden of maintaining legacy technologies.
Select + to add benefits/advantages.
Disadvantages
The system is inherently complex with different program area UI/UX and transactional data stores, perhaps necessitating supporting several different software environments (cloud, on-premise, SaaS) as part of an overall system.
Use of multiple modules within the transactional UI and database element may make implementation complicated involving several subsidiary vendors and not provide lowest cost.
System implementation relies upon timely availability of Caltrans' Roads and Highways GIS/LRS, currently in development.
If each Caltrans program area uses a somewhat different interface, then cross-program training is more difficult.
The system integrator (SI) approach to implementation could cost more because the SI has to engage sub-vendors.
The loosely coupled component and element design may expose more potential points of failure.
Select + to add disadvantages.

Anticipated Time to Achieve Objectives After Project Go-Live

	Objective Timeframe				
Objective Number	**Within 1 Year**	**2 Years**	**3 Years**	**4 Years**	**Over 4 Years**
1	☐	☒	☐	☐	☐
2	☐	☒	☐	☐	☐
3	☐	☒	☐	☐	☐
4	☒	☐	☐	☐	☐
5	☒	☐	☐	☐	☐
6	☒	☐	☐	☐	☐
7	☐	☐	☒	☐	☐
8	☒	☐	☐	☐	☐
9	☐	☐	☒	☐	☐
10	☒	☐	☐	☐	☐
11	☐	☒	☐	☐	☐
Roadway Inventory	☒	☐	☐	☐	☐
Collision Coding	☐	☒	☐	☐	☐
Traffic Volume	☐	☒	☐	☐	☐
Safety Analysis and Investigation	☐	☐	☒	☐	☐

Select + to add objectives.

Anticipated Time to Achieve Financial Benefits After Project Go-Live					
Financial Benefit	Within 1 Year	2 Years	3 Years	4 Years	Over 4 Years
Increased Revenues	☐	☐	☐	☐	☐
Cost Savings	☐	☐	☐	☐	☐
Cost Avoidance	☐	☒	☐	☐	☐
Cost Recovery	☐	☐	☐	☐	☐

2.10.5 Assumptions and Constraints

Cost assumptions in Section 2.10.4 assume: (1) roll-out will be staged by program area modules in the years shown with continued use of legacy system for programs that have not rolled over to new system; (2) cost avoidance consists of avoiding the cost to the State that loss of federal funds would create; (3) many of the business objectives apply across the different business units that will use the alternative so the year an objective will be achieved is shown as the first year in which the business objective is met by one or more of the system modules (business unit components)

The alternative will be implemented by a vendor working with Caltrans staff. The vendor will be responsible for providing, installing, and configuring the individual UI / transactional database components (modules). The vendor will also bear overall responsibility for implementing the Authoritative Data Store element and the APIs the system uses to communicate between components.

UI / transactional database components (modules) may come from several sources. The vendor will be responsible for providing these, regardless of source, i.e., Caltrans will not acquire these outside of the vendor contract.

Caltrans program area staff will work with the vendor as subject matter experts.

Caltrans IT (information technology) staff will work with the vendor, assisting with design, implementation and requirements.

Agency's advanced linear referencing system (ALRS) will be operational early in Year 1 of implementation, allowing transition from system design to roadway inventory module implementation to proceed without a delay.

The recommended alternative is not intended to achieve a reduction of the number of program staff who use the system.

The recommended alternative will achieve cost avoidance because federal mandates require the capabilities that the alternative supports.

UI components and data stores will consist of COTS applications with only minor configuration to meet Caltrans needs and standards, so that the solution uses MOTS applications but the goal is to make the fewest modifications to each COTS module.

The vendor will be responsible for migrating data from the current TSN database to the new TSN.

Caltrans' Roads and Highways GIS/LRS will be fully operational when the implementation of this solution begins.

Select + to add assumptions/constraints

2.10.6 Implementation Approach

Identify the type of existing IT system enhancement or new system proposed (check all that apply):

- ☐ Enhance the current system
- ☒ Develop a new custom solution
- ☒ Purchase a Commercial off-the-Shelf (COTS) system
- ☐ Purchase or obtain a system from another government agency (Transfer)
- ☒ Subscribe to a Software as a Service (SaaS) system
- ☐ Other, specify: NOTE: The recommended alternative may draw from several of the implementation approaches for the UI/UX transactional element.

Identify cloud services to be leveraged (check all that apply):

- ☐ Software as a Service (SaaS) provided by OTech
- ☒ Software as a Service (SaaS) provided by commercial vendor
- ☐ Platform as a Service (PaaS) provided by OTech

☒ Platform as a Service (PaaS) provided by commercial vendor
☐ Infrastructure as a Service (IaaS) provided by OTech
☐ Infrastructure as a Service (IaaS) provided by commercial vendor
☐ No cloud services will be leveraged by this alternative. Provide a description of why cloud services are not being leveraged:

Identify who will modify the existing system or create the new system (check all that apply):

☒ Agency/state entity IT staff
☒ A vendor will be contracted
☐ Inter-agency agreement will be established with another governmental agency. Specify Agency name(s):

☐ Other, specify:

Identify the implementation strategy:

☒ All requirements will be addressed in this proposed project in a single implementation.
☐ Requirements will be addressed in incremental implementations in this proposed project.
☐ Some requirements will be addressed in this proposed project. The remaining requirements will be addressed at a later date.
Specify the year when the remaining requirements will be addressed:

Identify if the technology for the proposed project will be mission critical and public facing:

☐ The technology implemented for this proposed project will be considered mission critical and public facing.

2.10.7 Architecture Information

Business Function/Process(es)		Maintain Roadway Inventory Information		
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.				
Application, System or Component		Roadway Inventory User Interface (UI) and Transactional Data Store		
		Select + to add an application, system, or component.		
COTS, MOTS or Custom		Modified off-the-shelf (MOTS)		
	Name/Primary Technology:	Esri Roads and Highways Inventory Maintenance Interface		
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:	Select...
	Server/Device Function	Roads and Highways LRS Server and Database		
	Hardware	Per requirements of Roads and Highways (non-TSN external system)		
	Operating System	Per requirements of Roads and Highways (non-TSN external system)		
	System Software	Per requirements of Roads and Highways (non-TSN external system)		
Select + to add system software.				
System Interfaces		1. Geospatial information interface with Esri Roads and Highways installation (external system) to retrieve highway geographic information and to update measures along linear referencing system for entities stored in transactional database 2. Application programming interfaces to TSN Authoritative Data Store by which records are moved to data structures within the authoritative data store following quality control 3. MOTS User interfaces and transactional data store for data entry, edit, quality control, visualization, and work in progress reporting		

		4. APIs that allow other TSN components to query transactional data store for work in progress information		
Data Center Location	Other, specify	Agency/state data center operated by Agency/state entity		
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☒ Other, specify: government partners from local, federal, tribal agencies		
	Type of Information (check all that apply)	☐ Personal ☐ Health ☐ Tax ☐ Financial ☐ Legal ☐ Confidential ☒ Other, specify: Highway engineering and descriptive information, such as number of lanes, protective barriers, etc.		
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒ Backup and Recovery ☐ Other, specify:		
Data Management	Data Owner	Name: Aaron Truong		
		Title: Branch Chief, Traffic Accident Surveillance & Analysis System (TASAS)		
		Business Program: Division of Research, Innovation and System Information		
	Data Custodian	Name: Chitra Chitturi		
		Title: Section Manager, Business Applications Mtnc Support Section (BAMSS)		
		Business Program: Application Development and Support Division (ADSD)		
Business Function/Process(es)		Maintain Collision Information		
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.				
Application, System or Component		Collision Coding User Interface (UI) and Transactional Data Store		
		Select + to add an application, system, or component.		
COTS, MOTS or Custom		Modified off-the-shelf (MOTS)		
	Name/Primary Technology:	Vendor-Provided Component		
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:	Note: depending on vendor, may require use of cloud computing Software as a Service (SaaS)
	Server/Device Function	Vendor-determined: application server and data store (RDBMS)		
	Hardware	Per vendor requirement (web server, database server)		
	Operating System	Per vendor requirement (web server, database server)		
	System Software	Per vendor requirement (web server, database server)		
Select + to add system software.				
System Interfaces		1. Geospatial information interface with Esri Roads and Highways installation (external system) to retrieve highway geographic information and to update measures along linear referencing system for entities stored in transactional database 2. Application programming interfaces to TSN Authoritative Data Store by which records are moved to data structures within the authoritative data store following quality control		

		3. MOTS User interfaces and transactional data store for data entry, edit, quality control, visualization, and work in progress reporting 4. APIs that allow other TSN components to query transactional data store for work in progress information 5. APIs to interact with collision data from CHP SWITRS system		
Data Center Location	Other, specify	Agency/state data center operated by Agency/state entity		
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☐ Other, specify:		
	Type of Information (check all that apply)	☒ Personal ☐ Health ☐ Tax ☐ Financial ☒ Legal ☐ Confidential ☒ Other, specify: Information from CHP SWITRS data system on traffic collisions. If this data contains personal information such as name and address, then the New TSN may also contain this data if (and only if) it is necessary for business needs. Police reports are legal documents by definition.		
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒ Backup and Recovery ☒ Other, specify: documents stored in the system with personal information are redacted/deidentified (removing all PII); if not redacted, documents are stored so as to be available only to individuals with appropriate role(s) and are encrypted at rest and in transit per state and department requirements.		
Data Management	Data Owner	Name: Phillip Poon Title: Chief, Research Deployment Support Branch, Division of Research Business Program: Division of Research, Innovation and System Information		
		Name: Chitra Chitturi		
		Title: Section Manager, Business Applications Mtnc Support Section (BAMSS)		
	Data Custodian	Business Program: Application Development and Support Division (ADSD)		
Business Function/Process(es)		Maintain Traffic Volume and Traffic Census Information		
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.				
Application, System or Component		Traffic Volume User Interface (UI) and Transactional Data Store		
		Select + to add an application, system, or component.		
COTS, MOTS or Custom		Modified off-the-shelf (MOTS)		
	Name/Primary Technology:	Vendor-Provided Component		
Runtime Environment	Cloud Computing Used?	☐ Yes ☐ No	If "Yes," specify:	Note: depending on vendor, may require use of cloud computing Software as a Service (SaaS)
	Server/Device Function	Vendor-determined: application server and data store (RDBMS)		
	Hardware	Per vendor requirement (web server, database server)		
	Operating System	Per vendor requirement (web server, database server)		
	System Software	Per vendor requirement (web server, database server)		

Select + to add system software.				
System Interfaces		1. Geospatial information interface with Esri Roads and Highways installation (external system) to retrieve highway geographic information and to update measures along linear referencing system for entities stored in transactional database 2. Application programming interfaces to TSN Authoritative Data Store by which records are moved to data structures within Authoritative Data Store following quality control 3. MOTS User interfaces and transactional data store for data entry, edit, quality control, visualization, and work in progress reporting 4. APIs that allow other TSN components to query transactional data store for work in progress information 5. APIs to interact with traffic volume collection applications and systems from Districts and other locations		
Data Center Location	Other, specify	Agency/state data center operated by Agency/state entity		
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☒ Other, specify: government partners from local, federal, tribal agencies		
	Type of Information (check all that apply)	☐ Personal ☐ Health ☐ Tax ☐ Financial ☐ Legal ☐ Confidential ☒ Other, specify: Traffic volumes and types of vehicles		
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒ Backup and Recovery ☐ Other, specify:		
Data Management	Data Owner	Name: Tenille J. Haberman		
	Data Custodian	Title: Chief, Traffic Census Branch Business Program: Division of Traffic Operations Name: Chitra Chitturi Title: Section Manager, Business Applications Mtnc Support Section (BAMSS) Business Program: Application Development and Support Division (ADSD)		
Business Function/Process(es)		Safety Network Screening, Analysis, and Investigation		
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.				
Application, System or Component		Safety Investigation and Analysis Interface and Data Store		
		Select + to add an application, system, or component.		
COTS, MOTS or Custom		Modified off-the-shelf (MOTS)		
	Name/Primary Technology:	Vendor-Provided Component		
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:	Note: depending on vendor, may require use of cloud computing Software as a Service (SaaS)
	Server/Device Function	Vendor-determined: application server and data store (RDBMS)		

	Hardware	Per vendor requirement (web server, database server)
	Operating System	Per vendor requirement (web server, database server)
	System Software	Per vendor requirement (web server, database server)
Select + to add system software.		
System Interfaces		1. Geospatial information interface with Esri Roads and Highways installation (external system) to retrieve highway geographic information and to update measures along linear referencing system for entities stored in transactional database 2. Application programming interfaces to TSN Authoritative Data Store by which records are moved to data structures within Authoritative Data Store following quality control 3. MOTS User interfaces and transactional data store for data entry, edit, quality control, visualization, and work in progress reporting 4. APIs that allow other TSN components to query transactional data store for work in progress information 5. APIs to provide data to network screening tools (external system) or to (eventual) internal screening tools 6. APIs to gather information from Caltrans asset management and project management systems (external to TSN) for safety project tracking
Data Center Location	Other, specify	Agency/state data center operated by Agency/state entity
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☒ Other, specify: government partners from local, federal, tribal agencies
	Type of Information (check all that apply)	☐ Personal ☐ Health ☐ Tax ☒ Financial ☐ Legal ☐ Confidential ☒ Other, specify: Information on collision concentration locations, collision frequencies, documents resulting from safety investigations, and safety project planning documents and information on resulting projects that incorporate safety improvement
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒ Backup and Recovery ☐ Other, specify:
Data Management	Data Owner	Name: Dean Samuelson
	Data Custodian	Title: Chief, Traffic Investigations Branch Business Program: Caltrans Headquarters, Traffic Operations Name: Chitra Chitturi Title: Section Manager, Business Applications Mtnc Support Section (BAMSS) Business Program: Application Development and Support Division
Business Function/Process(es)		Authoritative Authoritative Data Store Maintenance and Query

Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.			
Application, System or Component		Authoritative Data Store, API and ETL Interfaces to Business Unit Modules and Other Systems	
		Select + to add an application, system, or component.	
COTS, MOTS or Custom		Modified off-the-shelf (MOTS)	
	Name/Primary Technology:	Vendor-Provided Component	
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:
	Server/Device Function	RDBMS Server (Oracle, SQL Server, or other enterprise RDBMS) Application server to run API server	
	Hardware	64-bit RDBMS server, appropriate memory and storage Application server (64-bit server, appropriate memory and storage)	
	Operating System	Per Caltrans standard (Microsoft Windows Server)	
	System Software	Per Caltrans Standard (Microsoft SQL Server or Oracle) Per Caltrans Standard (IIS, .NET, appropriate javascript libraries)	
		Select + to add system software.	
System Interfaces		1. APIs to interact with transactional databases a. Receive data from a transactional database post-QC b. Post reference data back to a transactional database if necessary c. Query APIs that return appropriate authoritative data to transactional user interfaces or services that support user interfaces and workflows 2. APIs to provide outputs needed for creating formal report documents and mandatory data exports (e.g., federal reporting and data deliveries) a. MIRE b. Other state and federal reporting requirements 3. APIs to provide outputs needed for use by other Caltrans enterprise systems a. Transportation Asset Management System (TAMS) b. Pavement Management and Performance Monitoring (PeMS) c. Highway Performance Monitoring System (HPMS) 4. APIs needed for TSN-specific functions requiring aggregated data a. Safety network screening tools (external) b. Safety network screening tools (internal)	
Data Center Location	Other, specify	Agency/state data center operated by Agency/state entity	
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☐ Other, specify:	
	Type of Information (check all that apply)	☐ Personal ☐ Health ☐ Tax ☒ Financial ☐ Legal ☐ Confidential ☒ Other, specify: Information from all transactional databases uses by system (see above sections for descriptions).	
	Protective Measures	☒ Technical Security ☒ Identity Authorization and Authentication	

	(check all that apply)	☒ Physical Security ☒ Backup and Recovery ☐ Other, specify:
Data Management	Data Owner	Name: Mandy Chu
		Title: Office Chief, Office of Highway System Information and Performance
		Business Program: Division of Research, Innovation and System Information
	Data Custodian	Name: Chitra Chitturi
		Title: Section Manager, Business Applications Mtnc Support Section (BAMSS)
		Business Program: Application Development and Support Division (ADSD)

Select + to add business functions/processes.

2.10.1 Solution Type

☒ **Alternative**

2.10.2 Name

Unified Transactional Schemas and Components

2.10.3 Description

Background

The current Transportation System Network (TSN) is an Oracle Forms application using an Oracle database. Data tables are updated by four "modules" consisting of Oracle Forms screens and reports, one for each program area that uses TSN as a primary business tool. Other Caltrans systems also retrieve data from the TSN database, but these systems do not add or edit data in TSN. The existing TSN is not capable of meeting Federal mandates under the MAP-21 and FAST Act; it also lacks GIS (map-based) interfaces for data entry, query, and general data display.

Caltrans is replacing the existing TSN through a project process: the Transportation System Network Replacement (TSNR). The resulting system, the New TSN, will meet Federal mandates and be a more capable, modern, system.

The TSNR SIMM 19B Stage 1 Business Analysis defined business objectives for the Transportation System Network replacement. These have been revised by the project team throughout the Stage 2 Alternatives Analysis. Business objectives for the New TSN (as of March, 2019) are shown below.

1. Implement geolocation functionality to identify locations on state and local public roads where fatalities and serious injuries have occurred.
2. Implement a safety data system that stores temporal and historical roadway data, so reports can be created that identify the characteristics of the roadway at a specific point in time.
3. Implement a Model Inventory of Roadway Elements (MIRE) FDE (Fundamental Data Elements) safety data system that collects data and reports on the subset elements to meet the MIRE FDE requirements.
4. Provide a software solution that includes a secured application programming interface (API) that allows new TSN to be accessed by external agencies.
5. Provide a solution that reduces the time and manual effort of TSN reporting by providing ad-hoc reporting capability that can export results into standard formats (CSV, Excel, PDF).
6. Provide a solution that enables access to TSN data and reports by all authorized users
7. Provide a solution that stores and maintains a centralized repository of current roadway Inventory, Traffic volume, and Collision data.
8. Provide a solution that integrates with Caltrans internal databases.
9. Provide a solution that incorporates updated safety analysis using the new methods and algorithms.
10. Provide a solution that will fully integrate new TSN post-mile system with Caltrans' implementation of Esri Roads and Highways Linear Referencing System.

11. Provide a solution which can host roadway, traffic volume, collision, and bike/ped data.

Mid-level requirements (see Section 2.6) and mid-level capabilities were built upon the business objectives. The capabilities the solution meets are shown in schematic form in the following figure.

Alternative System

The alternative system is shown in the figure below. This alternative has one to four user interfaces, each of which creates, reads, and updates its data in a single, shared, transactional database. This transactional database holds all of the work-in-progress data in the system. The work-in-progress data is transformed into the TSN Authoritative Data Store when it passes quality control (QC) according to each program area's business rules.

The alternative solution is similar to the recommended solution (above), except that all user interfaces share a common transactional database. The alternative solution contains three major elements, shown in the figure below. (1) transactional user interfaces/user experiences (UI/UX modules); (2) a transactional database that supports the UI/UX components. This database schema will have to be designed to support all of the UI/UX modules. If the UI/UX modules come from different vendors, the transactional database element will need to be custom-designed to hold all component / vendor data models; (3) a Authoritative Data Store that retains corporate data from the transactional database after data passes business rules for quality control and publication; (4) APIs, procedure calls, and mechanisms to populate the Authoritative Data Store and make data in the Authoritative Data Store available to other processes or systems.

The alternative solution is similar to the recommended solution (above), except that all user interfaces share a single transactional database. The alternative solution consists of four major elements, shown in the figure below.

The alternative solutions first element is the **four transactional user interfaces**. These may be separate products, procured from multiple sources by the implementation vendor, or they could be procured from a single source (vendor) that has user interfaces meetin Catlrans' requirements for all of the TSN program areas. The market research did not find such a single source. In either case:

- Each user interface must
    - Allow its users to perform create/read/update/delete on just its business data
    - Support required quality assurance (in-built) logic for that business domain
    - Support required quality control process interfaces for that business domain
    - Support synchronization with the Caltrans LRS as needed, and also be able to gather data from other business areas (program areas) necessary to the user interface supporting its program area business needs

The second element of the alternative solution is the **Common Transactional Database**. This database contains all data used by the UI/UX components during the process of create, read, update prior to a batch of data passing quality control and being "published" to the Authoritative Data Store element of the solution (see below). In the alternative described here, even the data for Roadway Inventory, closely allied to the Esri Roads and Highways (R&H) data model is stored outside of the R&H geodatabase in the TSN Common Transactional Database. The user interfaces are responsible for methods that synchronize their respective data stores within the Common Transactional Database. The Common Transactional Database:

- Has appropriate table sets (storage schema) for each UI/UX component

- Will likely have to mimic the UI/UX vendor (source) database schema
- Must support additional common Caltrans attributes (e.g., county-route-postmile location references)
- Must support update from the ALRS (advanced linear referencing system) API of the Esri Roads and Highways (R&H) LRS that Caltrans is creating

The third element of the alternative solution is the **Authoritative Data Store** – a data store that is based upon appropriate business logic

- The Authoritative Data Store is the source of most fixed-format time-bound reports (e.g., annual reports)
- The Authoritative Data Store is the source of data used by the Network Screening API as part of safety analysis
- The Authoritative Data Store is likely the source of data used by other APIs and systems
- The Authoritative Data Store will contain a static copy of the Roads and Highways geodatabase to minimize query traffic to the production geodatabase

The fourth element of the recommended alternative consists of **application programming interfaces (APIs)** and messaging techniques including queries and data payloads that accomplish several tasks:

- Data elements are moved from one data store to another, undergoing appropriate transformations if needed
- APIs may trigger specific actions within the transactional element or the Authoritative Data Store
  - For instance, a change in the linear referencing system geometry may notify the user or a process of a need to resynchronize geometry in other parts of the system
- APIs provide values needed for reporting and data exchange outside of the TSN

Creation of the alternative would probably involve use of MOTS commercial applications for most of the user interfaces. Market research suggests that there will likely be more than one vendor needed since no vendor has tools that work for all of the required business functions equally well. Consequently, a system integrator (SI) would serve as the primary vendor, making appropriate arrangements for products from others as needed. The SI would be responsible for modifying the COTS applications, stripping their separate databases from them and causing them to use a single transactional database. The amount of modification is not known, but is likely to be significantly greater modification effort than that needed for the recommended alternative solution described above.

Vendor (SI) responsibilities include:

- Enterprise architecture
  - Design of a combined transactional data schema for all business capabilities
    - Design must support user interfaces and workflows from 1 to 4 different sources
  - The design and implementation of a TSN Authoritative Data Store to store authoritative records from the transactional element of the TSN
  - The design and implementation of communication methods (APIs, etc.) to support the capabilities and requirements for
    - Cross-business area transactional communication (e.g., verifying a collision location requires determining the highway segment on which it occurred and confirming there is an inventory record for that segment. This would be built-in to the logic of the transactional database for the sake of efficiency
    - Maintaining information within the Authoritative Data Store element
    - Reporting from the Authoritative Data Store and use of TSN data by other systems
- Data quality and cleansing for migration from the old system to the new TSN
- Configuration and customization of the UI/UX and transactional data store elements to meet revised (new) workflows within the program areas

- Integration with other Caltrans and external systems

The System Integrator (SI) would work with Caltrans program and IT staff closely. Caltrans subject matter experts (SMEs) and IT specialists (IT) are required participants in the work. SMEs participate by informing the SI about business needs, participating in iterative testing of their program area (transactional) components and the Authoritative Data Store, and taking training on the completed system. Caltrans IT participates in many ways: by providing the environment(s) needed for the solution, by informing the SI of general agency and state requirements for systems, assisting the SI in designing the Authoritative Data Store and APIs, and ensuring the solution meets appropriate security requirements.

Approach (Check all that apply):	
☒	Increase staff – new or existing capabilities
☒	Modify the existing business process or create a new business process
☐	Reduce the services or level of services provided
☒	Utilize new or increased contracted services
☐	Enhance the existing IT system
☒	Create a new IT system
☒	Perform a business-based procurement to have vendors propose a solution
☐	Other, specify:

2.10.4 Benefit Analysis

Benefits/Advantages
System will meet federal requirements for data collection and reporting.
Modular approach for user interface makes it possible to select "best of breed" COTS modules for *user interfaces* that are most effective for users.
APIs, ETLs, and other methods that will be used to move data between components and elements are more flexible than hard-coded relationships between the different parts of the system.
The Authoritative Data Store provides a single source of authoritative data, separating transactional records from those that have passed quality control.
The system leverages the agency's investment in geospatial technology using it as the system framework without creating another geospatial solution to maintain.
Using a System integrator (SI) for implementation reduces the risk of a complex, multi-product approach in which multiple (different vendors) proceed semi-independently.
The system will use contemporary, mainstream, technologies that will reduce the current burden of maintaining legacy technologies.
The system is similar to the existing TSN architecture in which all data are stored in a single relational database
Select + to add benefits/advantages
Disadvantages
The entire transactional schema must be designed at the start of the process in order to put the system in place. This is a fairly inflexible approach to system design that can limit the ability to change the system in the future without major reworking of many components.
The system is inherently complex with many different program area UI/UX and transactional data stores, perhaps necessitating supporting several different software environments (cloud, on-premise, SaaS) as part of an overall system
Use of UI/UX module sources may make implementation complicated involving several subsidiary vendors and not provide lowest cost
The single transactional database schema will probably involve discarding the UI/UX module vendors' databases that they provide for their application and connecting the UI/UX part of the vendor product to a custom-designed and implemented database (the Common Transactional Database). This does not provide Caltrans with best value for the

cost of the UI/UX application from the vendor, since part of their product is not being used. It also puts a large workload burden of design and implementation on both the SI (system integrator) vendor and perhaps on Caltrans IT staff too.

The solution relies upon timely completion of Caltrans' Roads and Highways GIS/LRS system prior to the start of implementing the solution.

Each Caltrans program area may use somewhat different interfaces (UIs), increasing the support staff load and diminishing cross-program training

The system cost may be more expensive than compromising by using a single product vendor (although the procurement effort may reveal a vendor who can provide the majority of the transactional element components)

Select + to add disadvantages

Anticipated Time to Achieve Objectives After Project Go-Live

	Objective Timeframe				
Objective Number	**Within 1 Year**	**2 Years**	**3 Years**	**4 Years**	**Over 4 Years**
1	☐	☒	☐	☐	☐
2	☐	☒	☐	☐	☐
3	☐	☒	☐	☐	☐
4	☐	☒	☐	☐	☐
5	☐	☒	☐	☐	☐
6	☐	☒	☐	☐	☐
7	☐	☒	☐	☐	☐
8	☐	☒	☐	☐	☐
9	☐	☐	☒	☐	☐
10	☐	☒	☐	☐	☐
11	☐	☒	☐	☐	☐
Roadway Inventory	☐	☒	☐	☐	☐
Collision Coding	☐	☒	☐	☐	☐
Traffic Volume	☐	☐	☒	☐	☐
Safety Analysis and Investigation					

Select + to add objectives

Anticipated Time to Achieve Financial Benefits After Project Go-Live

Financial Benefit	**Within 1 Year**	**2 Years**	**3 Years**	**4 Years**	**Over 4 Years**
Increased Revenues	☐	☐	☐	☐	☐
Cost Savings	☐	☐	☐	☐	☐
Cost Avoidance	☐	☒	☐	☐	☐
Cost Recovery	☐	☐	☐	☐	☐

2.10.5 Assumptions and Constraints
2.10.4 assumes: (1) after an initial year of system design, including the creation of the composite transactional database, roll-out will be staged by program area in the years shown with continued use of legacy system for programs that have not rolled over to new system; (2) cost avoidance consists of avoiding the cost to the State that loss of federal funds would create; many of the business objectives apply across the different business units that will use the alternative so the year an objective will be achieved is shown as the first year in which the business objective is met by one or more of the system modules (business unit components)
The alternative will be implemented by a vendor working as a system integrator with Caltrans staff. The vendor will take primary responsibility for marshalling the individual UI modules and for designing the transactional database and the Authoritative Data Store. The vendor will work with Caltrans staff to design and configure APIs for the system as a whole and for individual business workflows including reporting. The vendor will work with Caltrans staff to define, and then implement, the Authoritative Data Store element, including the APIs for data update and federal and state reporting requirements.
Agency's ALRS will be in place early in Year 1 of implementation, allowing transition from system design to roadway inventory module implementation to proceed without a delay.
The alternative is not intended to achieve a reduction of the number of program staff who use the system
The alternative will achieve cost avoidance because federal mandates require the capabilities that the alternative supports.
The alternative requires that the transactional data schema be in place before UI components are put in place that use the transactional schema, so the design and implementation of the schema must occur before any business workflows ar available for testing, both user-acceptance testing and business logic testing.
The speed with which the first UI/UX components (modules) can be put in place depends upon the system design effort and successfully creating the transactional database that all modules must use.
The solution cannot use UI/UX components that depend on proprietary data models that cannot be implemented in the unified transactional database.
Caltrans IT staff will work with the system integrator (SI) vendor to design the unified transactional database, the Authoritative Data Store, and the API elements of the solution.
Caltrans program area staff will servfe as subject matter experts for the vendor, including validating business logic, reviewing UI/UX modules, and performing acceptance testing.
The vendor will be responsible for migrating data from the current TSN database to the New TSN.
Caltrans' Roads and Highways GIS/LRS will be fully operational when the implementation of this solution begins.
Select + to add assumptions/constraints

2.10.6 Implementation Approach	
Identify the type of existing IT system enhancement or new system proposed (check all that apply):	
☐	Enhance the current system
☒	Develop a new custom solution
☒	Purchase a Commercial off-the-Shelf (COTS) system
☐	Purchase or obtain a system from another government agency (Transfer)
☒	Subscribe to a Software as a Service (SaaS) system
☐	Other, specify:
Identify cloud services to be leveraged (check all that apply):	
☐	Software as a Service (SaaS) provided by OTech
☒	Software as a Service (SaaS) provided by commercial vendor
☐	Platform as a Service (PaaS) provided by OTech
☒	Platform as a Service (PaaS) provided by commercial vendor
☐	Infrastructure as a Service (IaaS) provided by OTech
☐	Infrastructure as a Service (IaaS) provided by commercial vendor

☐ No cloud services will be leveraged by this alternative. Provide a description of why cloud services are not being leveraged:

Identify who will modify the existing system or create the new system (check all that apply):

☒ Agency/state entity IT staff
☒ A vendor will be contracted
☐ Inter-agency agreement will be established with another governmental agency. Specify Agency name(s):

☐ Other, specify:

Identify the implementation strategy:

☒ All requirements will be addressed in this project in a single implementation phase
☐ Requirements will be addressed in incremental implementations in this proposed project.
☐ Some requirements will be addressed in this proposed project. The remaining requirements will be addressed at a later date.
Specify the year when the remaining requirements will be addressed:

Identify if the technology for the proposed project will be mission critical and public facing:

☐ The technology implemented for this proposed project will be considered mission critical and public facing.

2.10.7 Architecture Information

Business Function/Process(es)		Store Transactional Data		
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.				
Application, System or Component		Transactional Database Server and Software, APIs		
		Select + to add an application, system, or component.		
COTS, MOTS or Custom		Custom application		
	Name/Primary Technology:	SQL RDBMS, Structured Query Language, REST APIs (various programming languages per Caltrans standards)		
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:	Select...
	Server/Device Function	RDBMS server for database component; may also support REST API services (acting as API endpoint) OR a second server may be used to support APIs		
	Hardware	Caltrans standard RDBMS server hardware; Microsoft Windows Server		
	Operating System	Caltrans standard: Microsoft Windows Server (Caltrans standard)		
	System Software	Caltrans standard: (Microsoft, SQL Server or Oracle)		
Select + to add system software				
System Interfaces		1. Application Integration: The system component will need interfaces that allow the front-end (UI) modules to create, read, update, and delete data in the transactional database 2. Esri Roads and Highways integration and synchronization via API calls to Caltrans' Advanced Linear Referencing System (ALRS; Esri Roads and Highways) 3. Application programming interfaces to TSN Authoritative Data Store by which records are moved to data structures within Authoritative Data Store following quality control		
Data Center Location		Agency (Caltrans) or on servers hosted at state data center but managed by Agency (Caltrans)		

	Other, specify	
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☐ Other, specify:
	Type of Information (check all that apply)	☒ Personal ☐ Health ☐ Tax ☒ Financial ☒ Legal ☐ Confidential ☒ Other, specify: Roadway inventory information; traffic volume information; collision locations and collision reports (which may contine personal information); areas and characteristics of safety investigations and projects which may contain financial project information
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒Backup and Recovery ☐ Other, specify:
Data Management	Data Owner	Name: Mandy Chu
		Title: Office Chief, Office of Highway System Information and Performance
		Business Program: Division of Research, Innovation and System Information
	Data Custodian	Name: Chitra Chitturi
		Title: Section Manager, Business Applications Mtnc Support Section (BAMSS)
		Business Program: Application Development and Support Division (ADSD)

Business Function/Process(es)			Maintain business data (Roadway Inventory, Collision Coding, Traffic Volume, Safety Analysis and Investigation)
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.			
Application, System or Component			User Interfaces (Web-Based, 1 to 5 Different Applications)
			Select + to add an application, system, or component.
COTS, MOTS or Custom			Modified off-the-shelf (MOTS)
	Name/Primary Technology:		Vendor-licensed software
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No	If "Yes," specify:
	Server/Device Function		Web application server(s)
	Hardware		Per Caltrans standard within vendor requirements
	Operating System		Per Caltrans standard within vendor requirements
	System Software		Per Caltrans standard within vendor requirements
Select + to add system software			
System Interfaces			1. Vendor modified versions of COTS applications will serve as user interfaces for data maintenance, visualization, query, and interactions 2. All applications must communicate with the transactional data store (database) to persist data and retrieve data 3. All applications must communicate with geospatial data tools (Esri Roads and Highways services) for visualization of geographic data, for synchronization with agency's authoritative road network

		4. APIs to provide data to network screening tools (external system) or to (eventual) internal screening tools 5. APIs to gather information from Caltrans asset management and project management systems (external to TSN) for safety project tracking
Data Center Location	Other, specify	Click here to enter text.
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☐ Other, specify:
	Type of Information (check all that apply)	☒ Personal ☐ Health ☐ Tax ☒ Financial ☒ Legal ☐ Confidential ☒ Other, specify: Roadway inventory information; traffic volume information; collision locations; areas and characteristics of safety investigations and projects. Personally Identfiable Information (PII) will be encrypted at rest and in transit per state and agency standards.
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒Backup and Recovery ☐ Other, specify:
Data Management	Data Owner	Name: Mandy Chu
		Title: Office Chief, Office of Highway System Information and Performance
		Business Program: : Division of Research, Innovation and System Information
	Data Custodian	Name: Chitra Chitturi
		Title: Section Manager, Business Application Mtnc Support Services (BAMSS)
		Business Program: Application Development and Support Division (ADSD)
Business Function/Process(es)		Authoritative Data Store (Reporting and APIs)
Select + to add a business process with the same application, system, or component; COTS, MOTS or custom solution; runtime environment; system interfaces, data center location; and, security.		
Application, System or Component		Authoritative Data Store, API Interfaces to Transactional Data Store
		Select + to add an application, system, or component.
COTS, MOTS or Custom		Custom application
	Name/Primary Technology:	Vendor-Provided Code and Database Instance
Runtime Environment	Cloud Computing Used?	☐ Yes ☒ No If "Yes," specify:
	Server/Device Function	RDBMS Server (Oracle, SQL Server, or other enterprise RDBMS) Application server to run API server
	Hardware	64-bit RDBMS server, appropriate memory and storage Application server (64-bit server, appropriate memory and storage)
	Operating System	Per Caltrans standard
	System Software	Per Caltrans Standard (Oracle, Microsoft SQL Server, or similar) Per Caltrans Standard (IIS, .NET or appropriate javascript libraries)

Select + to add system software		
System Interfaces		1. APIs to interact with transactional databases a. Receive data from a transactional database post-QC b. Post reference data back to a transactional database if necessary 2. APIs to provide outputs needed for creating formal report documents and mandatory data exports (e.g., federal reporting and data deliveries) a. MIRE 3. APIs to provide outputs needed for use by other Caltrans enterprise systems a. Transportation Asset Management System (TAMS) b. Pavement Management and Performance Monitoring (PeMS) c. Highway Performance Monitoring System (HPMS) 4. APIs needed for TSN-specific functions requiring aggregated data a. Safety network screening tools (external) b. Safety network screening tools (internal)
Data Center Location		Agency/state data center operated by Agency/state entity
	Other, specify	Click here to enter text.
Security	Access (check all that apply)	☐ Public ☒ Internal State Staff ☐ External State Staff ☐ Other, specify:
	Type of Information (check all that apply)	☐ Personal ☐ Health ☐ Tax ☒ Financial ☒ Legal ☐ Confidential ☒ Other, specify: Information from transactional database used by system (see above sections for descriptions).
	Protective Measures (check all that apply)	☒ Technical Security ☒ Identity Authorization and Authentication ☒ Physical Security ☒Backup and Recovery ☐ Other, specify:
Data Management	Data Owner	Name: Mandy Chu
		Title: Office Chief, Office of Highway System Information and Performance
		Business Program: Division of Research, Innovation and System Information
	Data Custodian	Name: Chitra Chitturi
		Title: Section Manager, Business Applications Mtnc Support Section (BAMSS)
		Business Program: Application Development and Support Division (ADSD)
Select + to add business functions/processes		

2.11 Recommended Solution

2.11.1 Rationale for Selection

General

The Recommended Solution is a business-based procurement.

Overall, the Recommended Solution was chosen because it is the system that will best meet agency program area business needs (cf. this document Section 2.10.1 and Section 2.6 worksheet), it integrates well with other Caltrans information systems, it is flexible enough to modify in the future, and it can be implemented using "best in class" commercial off the shelf (COTS) products. The Recommended Solution is not the simplest solution, but it is the solution that, year over year, should yield the greatest efficiency and value to the State.

The New TSN is both a transactional system (supporting business workflows that require data entry, update, deletion, and query as well as quality assurance and control) and a data store of authoritative data, housing authoritative records (that have passed quality control) for each business area. The Authoritative Data Store element of the system is similar in concept to a Authoritative Data Store, using one or more actual databases that store authoritative data in appropriate formats. The Authoritative Data Store might also be thought of as a "single source of truth" for TSN data. Application programming interfaces (communications methods) and extract-transform-load routines (ETLs) will be important in integrating different components to form a single, cohesive, system.

Meeting Business Objectives and Requirements

The Recommended solution meets Caltrans business objectives and mid-level requirements (cf. this document Section 2.10.1 and Section 2.6 worksheet). The feasibility of this approach – integrating COTS tools in a comprehensive system – is borne out by the market research performed as part of this analysis. Most vendors stated that they could meet around 90% of the more than 100 mid-level requirements given to them in the request for information.

Benefits and advantages of the recommended solution include:

- System will meet federal requirements for data collection and reporting
- Architecture simplifies data management by separating transactional business data stores from Authoritative Data Store (single source of truth). The Authoritative Data Store is used for most query, reporting, and as a source of information for other systems. This architecture makes the system as a whole easier to maintain and creates a long-lived source of authoritative data independent of specific applications.
- The modular nature of the system allows modules to be upgraded or altered without requiring changing other modules.
- Since integration between modules and data posting from modules to the Authoritative Data Store is a designed, coded, process, if integration requirements change, the other elements of the system do not need to change, just the coded processes.
- Modular approach for user interface and transactional data makes it possible to select "best in class" COTS modules that are most effective for business (program area) users
- Authoritative Data Store provides a single source of truth for business data, separating transactional records from those that have passed quality control
- The system leverages Caltrans' investment in geospatial technology, using it as the system framework without creating another geospatial solution to maintain
- Using a contractor, who will act as a system integrator in implementation reduces the risk of project failure because the solicitation process can be structured to seek vendors with appropriate experience.
- The per-program area approach to business component implementation allows for a phased roll-out of business (program area) modules that still result in a fully integrated system
- The system will use contemporary, mainstream, technologies that will reduce the current burden of maintaining legacy technologies

Disadvantages of the Recommended Solution

The Recommended Solution does have some disadvantages.

1. The Recommended Solution is complex, requiring integrating multiple COTS applications, unless a single source can provide an integrated suite of modules (not found in the market research)
2. The Authoritative Data Store, depending on how it is implemented, puts a burden on Caltrans IT to maintain the Authoritative Data Store
3. Use of APIs and ETLs to integrate components of the system puts a potential burden on Caltrans IT of retaining in-house expertise or a long-term vendor relationship for expertise in the event of new or altered integration requirements
4. Using COTS applications from different vendors may make the system more susceptible to "version lock" in which one application holds back upgrades to the other COTS applications due to some external dependency

These disadvantages did not eliminate the Recommended Solution, or promote a different solution. Each of the disadvantages is discussed separately below.

Complexity (1): No other solution was found that allows the best in class approach to the work performed by three of the four different program areas within Caltrans. Each has its own business rules and needs and works, essentially in isolation from the others. The Safety module relies upon authoritative, consistent, data from each of these three modules. So, giving each of the three program areas their own highly efficient COTS application is the only way to build a truly efficient system that supports the fourth program area (Safety) with high-quality timely data. Thus, the system is inherently complex, as proven by the current version of the Transportation System Network that the New TSN will replace.

Authoritative Data Store (2): Regardless of what system one implements, the agency has a need for a "single source of truth" used by many other programs within Caltrans and supporting flexible query, reporting, and other uses. So, this is an inherent part of any solution.

Use of APIs and ETLs For Integration (3): One of the problems with the existing TSN is that it is inflexible and requires substantial database administrator effort to collate or conflate data in new ways. Rather than see this as a disadvantage, it should be seen as a benefit of a more modern approach to component integration, promoting flexibility with some price to be paid in complexity.

Version Locking (4): The principal source of version lock is likely to be a component or module relying upon a particular release of the Esri Roads and Highway software's data model. The alternative is to host everything inside the the Esri Roads and Highway software itself (a poor choice for technical reasons and requiring custom development of interfaces to Esri Roads and Highways). By using major COTS applications, the risk of version locking is minimized because the creators of the COTS applications have strong self-interest in keeping abreast of the Roads and Highway versions. If they did not do so, their products would soon be replaced by their customers with others that did so.

Recommended Solution versus Alternative Solution

The Alternative Solution (Section 2.10.4) also meets agency program area business needs, and integrates with other Caltrans information systems. The major difference is that the Recommended Solution has separate

transactional data stores where the Alternative Solution has a single transactional data store. The former is very likely to be part of a COTS component, and thus does not need to be built from scratch for each module of the New TSN. The latter would need to be custom-designed and then implemented. This makes the Alternative Solution more difficult to modify in the future if needed, and it also requires more customization by the vendor and Caltrans staff during implementation in order to design a centralized transactional data store as well as an Authoritative Data Store. Both solutions involve the creation of the Authoritative Data Store, so the level of effort is likely equal in this regard.

Another idea that was informally examined was for Caltrans' IT staff to design, build, and implement the New TSN. This was discussed early in the planning for the TSN Replacement, during the Stage 1 analysis and at the start of this (Stage 2) analysis. Developing four new modules, from scratch, which integrate correctly with geospatial software and datasets implemented in another, separate, effort would have taken a much larger internal staff of developers with specialized coding skills, a very long design cycle followed by a lengthy period of coding and iterative software development cycles with the Caltrans team. The mandate to meet federal deadlines for new capabilities would have been at significant risk.

Market research (peer surveys and interviews) found that many state DOTs perform safety analysis, safety investigation, and safety project development in a rather similar fashion. The safety programs in many states consume data created, edited, and stored in different software systems – one each for traffic volume and census, collisions, roadway inventory. These systems are often highly separated from each other with no integration. So, when safety analyses are performed, the data from the different systems has to be conflated to a single, appropriate, dataset. The Recommended Solution emulates what these other DOTs do, but with a significant improvement: the New TSN integrates the different data sources right from the start by using a common, shared, geospatial linear referencing system as the framework for all TSN data and explicitly allowing the different kinds of data to draw upon each other appropriately in data editing. For instance, the New TSN will allow someone coding a collision location to see the roadway inventory features in the same geospatial view used to map the collision itself. This allows them to match features with narrative sources like a traffic collision report.

The table below shows scoring of the Recommended Solution and the Alternative Solution using several different factors (note: cost is compared in the financial analysis worksheet, not in this matrix). Each factor is ranked from high to low, with high being most suitable or desirable. These terms are translated to averages using a rubric of High = 3, Medium = 2, Low = 1. The scoring demonstrates that the Recommended Solution is the most rational choice for the TSN Replacement process.

	Recommended Solution	Alternative Solution
Capabilities		
Meeting Business Needs	High	High
Timeliness (Meeting Federal or State Mandates)	High	High
Non-Functional Requirements	High	Medium
System Certainty		
Design Certainty	High	High
Implementation Certainty	High	High
Operational Certainty	Medium	Medium
Flexibility Certainty (Support for future changes)	High	Low

Alignment With Caltrans Systems		
Integration With Geospatial Framework	High	High
Integration With GIS Applications	High	High
Alignment With Data Governance	High	High
Market Availability and Procurement		
Competitive Source Availability	High	Medium
Use of COTS/MOTS	High	Medium
Contract Start Up Time (High = Shortest Time)	High	High
Contract Management Complexity (High = Least Complex)	High	High
Composite Average (High = 3, Medium = 2, Low = 1)	2.9	

Procurement Factors and Procurement Feasibility

Based upon market research, many of the desired UI/UX data store elements are available in the marketplace, however no single vendor is likely to have all of the desired major areas as "best in class". Consequently, the recommended solution is to procure a single vendor through a business-based procurement. The vendor will integrate the incorporation of "best in class", commercial off the shelf (COTS) products. The vendor may use sub-vendors to assist in this work, but sub-vendors are the responsibility of the actual vendor. The vendor will also be responsible for designing and implementing the "Authoritative Data Store concept" and the methods for moving data between solution elements / components. The latter may include application programming interfaces (APIs) and extract-transform-load routines (ETL). This alternative makes no assumption about the necessary topology of the solution (cloud-based, Software-as-a-Service, etc.) but leaves this topology open to proposals from vendors.

Involvement of Caltrans staff in the final design and implementation of the New TSN is part of the rationale for choosing the Recommended Solution. By involving Caltrans staff, the system becomes a "Caltrans system" and not simply a utility product provided by a vendor.

Caltrans program area staff are part of the Recommended Solution. The vendor must work with program area staff to confirm requirements, implement "to-be" workflows called for in the requirements, and iterate over development cycles to produce fully functional modules for each program area. Using COTS technology helps this process but does not negate the need to tailor the system to Caltrans' user needs. Because software products evolve over time, as do business needs, involving subject matter experts in implementing their new system(s) invests them in its long-term success.

Caltrans IT staff provide the New TSN vendor support in several important ways: with infrastructure (hardware, networking, storage), expertise in meeting agency and state system requirements, in understanding and designing appropriate data transformations for the Authoritative Data Store to meet needs of other information systems, and in designing APIs and ETLs used in the new TSN. The New TSN integrates multiple, separate, components. Although many of these are likely to be COTS products, integrating the elements through APIs and ETLs is a key part of the solution. By involving Caltrans IT staff in the creation

of these methods, the recommended solution can effect knowledge transfer from the vendor to the agency, making the system far more maintainable and flexible.

Attachment #9_Complexity_Assessment

2.11.2 Technical/Initial CA-PMM Complexity Assessment

Complexity		Complexity Zone	
Technical Complexity Score: 2.7	☐	Zone I	Low Criticality/Risk
	☒	Zone II/III	Medium Criticality/Risk
	☐	Zone IV	High Criticality/Risk

2.11.3 Procurement and Staffing Strategy

Activity

Requirements Elicitation

Responsible (check all that apply)	When Needed (check all that apply)	Cost Estimate Verification (check all that apply)
☒ Agency/state entity staff ☐ STP staff ☒ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☒ Contractor ☐ Other, specify:	☒ Stage 3 Solution Development ☐ Stage 4 Project Readiness and Approval ☐ After project is approved (after Stage 4 Project Readiness and Approval)	☐ Market research conducted (MR) ☒ Cost estimate provided (CE) ☐ CDT CE ☐ DGS CE ☐ Request for Information (RFI) conducted ☐ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity

Procurement Vehicle	Request for Offer/California Multiple Award Schedules (RFO/CMAS)	**Contract Type**	Fixed Price (FP)
If "Other," specify:	Note: S2AA Contractor (AppGeo) will continue as contractor for Requirements Elicitation	If "Other," specify:	Click here to enter text.

Solicitation Development

Responsible (check all that apply)	When Needed (check all that apply)	Cost Estimate Verification (check all that apply)
☒ Agency/state entity staff ☐ STP staff ☒ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☒ Contractor ☐ Other, specify:	☒ Stage 3 Solution Development ☐ Stage 4 Project Readiness and Approval ☐ After project is approved (after Stage 4 Project Readiness and Approval)	☒ Market research conducted (MR) ☐ Cost estimate provided (CE) ☐ CDT CE ☐ DGS CE ☒ Request for Information (RFI) conducted ☐ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity

Procurement Vehicle	Request for Offer/California Multiple Award Schedules (RFO/CMAS)	Contract Type	Fixed Price (FP)
If "Other," specify:	Note: S2AA Contractor (AppGeo) will continue as contractor for Requirements Elicitation	If "Other," specify:	Click here to enter text.

Conduct Procurement

Responsible (check all that apply)	When Needed (check all that apply)	Cost Estimate Verification (check all that apply)
☒ Agency/state entity staff ☒ STP staff ☒ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☐ Contractor ☐ Other, specify:	☐ Stage 3 Solution Development ☒ Stage 4 Project Readiness and Approval ☐ After project is approved (after Stage 4 Project Readiness and Approval)	☐ Market research conducted (MR) ☐ Cost estimate provided (CE) ☒ CDT CE ☐ DGS CE ☐ Request for Information (RFI) conducted ☐ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity

Procurement Vehicle		Contract Type	
If "Other," specify:	Click here to enter text.	If "Other," specify:	Click here to enter text.

Project Management

Responsible (check all that apply)	When Needed (check all that apply)	Cost Estimate Verification (check all that apply)
☒ Agency/state entity staff ☐ STP staff ☐ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☐ Contractor ☐ Other, specify:	☒ Stage 3 Solution Development ☒ Stage 4 Project Readiness and Approval ☒ After project is approved (after Stage 4 Project Readiness and Approval)	☐ Market research conducted (MR) ☐ Cost estimate provided (CE) ☐ CDT CE ☐ DGS CE ☐ Request for Information (RFI) conducted ☐ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity

Procurement Vehicle		Contract Type	
If "Other," specify:	Attachment #10_Procurement_and_Staffing_Strategy	If "Other," specify:	Click here to enter text.

Organizational Change Management

Responsible (check all that apply)	When Needed (check all that apply)	Cost Estimate Verification (check all that apply)

☒ Agency/state entity staff ☐ STP staff ☐ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☒ Contractor ☐ Other, specify:	☐ Stage 3 Solution Development ☐ Stage 4 Project Readiness and Approval ☒ After project is approved (after Stage 4 Project Readiness and Approval)	☐ Market research conducted (MR) ☐ Cost estimate provided (CE) ☐ CDT CE ☐ DGS CE ☐ Request for Information (RFI) conducted ☒ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity

Procurement Vehicle	Request for Offer/Master Service Agreement (RFO/MSA)	**Contract Type**	Fixed Price (FP)
If "Other," specify:	Contractor performs change management oversight and confirmation	If "Other," specify:	Click here to enter text.

Independent Verification and Validation (IV&V)

Responsible (check all that apply)	**When Needed** (check all that apply)	**Cost Estimate Verification** (check all that apply)
☒ Agency/state entity staff ☐ STP staff ☐ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☒ Contractor ☐ Other, specify:	☐ Stage 3 Solution Development ☐ Stage 4 Project Readiness and Approval ☒ After project is approved (after Stage 4 Project Readiness and Approval)	☐ Market research conducted (MR) ☐ Cost estimate provided (CE) ☐ CDT CE ☐ DGS CE ☐ Request for Information (RFI) conducted ☒ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity

Procurement Vehicle	Request for Offer/Master Service Agreement (RFO/MSA)	**Contract Type**	Fixed Price (FP)
If "Other," specify:	IV&V contractor oversees entire project	If "Other," specify:	Click here to enter text.

Integration/Development

Responsible (check all that apply)	**When Needed** (check all that apply)	**Cost Estimate Verification** (check all that apply)
☒ Agency/state entity staff ☐ STP staff ☐ CDT Project Approvals and Oversight staff ☐ CA-PMO staff ☐ DGS staff ☒ Contractor ☐ Other, specify:	☐ Stage 3 Solution Development ☐ Stage 4 Project Readiness and Approval ☒ After project is approved (after Stage 4 Project Readiness and Approval)	☒ Market research conducted (MR) ☐ Cost estimate provided (CE) ☐ CDT CE ☐ DGS CE ☒ Request for Information (RFI) conducted ☐ Comparable vendor services have been used on previous contracts (CV) ☐ Leveraged Procurement Agreement (LPA)

Complete Only if Contractor Responsible for Activity			
Procurement Vehicle	Formal Solicitation (IFB/ RFP)	**Contract Type**	Fixed Price (FP)
If "Other," specify:	Vendor implementation of New TSN including all post-selection actions (design, implementation, testing, training)	If "Other," specify:	Click here to enter text.
Select + to add activities.			

	Yes	No
Will any of the activities identified above result in a competitive or non-competitive solicitation that will be over the Agency/state entity's DGS delegated purchasing authority?	☒	☐

2.11.4 Enterprise Architecture Alignment

As part of the RFI, Caltrans provided hardware and software standards. None of the 7 responding vendors expressed concern with aligning to Caltrans' standards or security practices. Some of the vendors presented Software as a Service (SaaS) solutions that run in the vendor's own (secure) cloud.

Caltrans has standards for SaaS applications. Caltrans IT works with SaaS providers to integrate the SaaS with regard to gateways, network access between SaaS and internal systems, and other such details. This is because each SaaS provider and system are designed differently. In general, SaaS aligns with Caltrans enterprise architecture, so long as it can meet Caltrans SaaS standards (including security standards) and Department of General Service's (DGS) general provisions on cloud computing (in draft) and SaaS provisions (see "DGS Software as a Service Special Provisions, P-02-18"). Vendors of cloud-based components stated that their systems were capable of running on FedRamp-certified clouds, which should align with state and Caltrans requirements overall.

Caltrans enterprise architecture currently contains the following capabilities that will be included in the RFP as enterprise standards and evaluation criteria:
1. Public or Internet Portal/Website
2. Identity and Access Management (both per Caltrans requirements and per DGS requirements)
3. Business Intelligence and Data Warehousing (standards are defined and partially implemented; these will be starting points for the "Authoritative Data Store concept" used by the New TSN as the single source of truth)
4. Master Data Management (planned for implementation under Data Governance).

The New TSN uses application programming interfaces. These are likely to be available in several forms, including web services or web APIs and as messaging services (message emitters and listeners). Exact details cannot be forecast at this time. This architecture aligns with a general goal of having more service-oriented architectures within the Caltrans enterprise. Ultimately, the services used by the new TSN may become part of some larger system that forms an enterprise service bus for Caltrans applicatons. However, building such a bus is not part of the TSN scope. TSN would add to Caltrans' enterprise architecture as a whole, but be only a small piece of it.

Enterprise capabilities that will not be used by the New TSN are:
1. Public or Internal Mobile Application
2. Enterprise Service Bus (not used initially; could be useful as system matures)
3. Enterprise Content Management
4. Big Data Analytics

The New TSN aligns well with Caltrans' data governance goals for several reasons. First, it relies upon the nascent "standard" advanced geospatial linear referencing system (LRS) as the framework in which all TSN data is referenced. This ensures interoperability between TSN datasets and other Caltrans systems that use geospatial information or reference geospatial information. Second, the New TSN creates a single source of truth, separate from transactional

(fluctuating) data, providing single authoritative values. Third, the New TSN can be used by other systems, including non-spatial applications, through a service-oriented architecture of APIs and ETLs.

Overall, the New TSN aligns with a standard 3-tier application architecture, as shown in the figure below.

Through the Authoritative Data Store, the New TSN can provide data in appropriate formats for the State's open data initiative (see CDT Technology Letter 19-01). Some of the information in the authoritative and transactional data stores is sensitive and, in the case of collision data, may contain personal identifier information (PII). Consequently, publishing data in open data formats for public use is technically feasible, but may be limited due to legal constraints, including requirements that PII be encrypted at rest and in transit. Nonetheless, the New TSN certainly supports publication of data in open data forms.

Information Technology Capability Table		
Information Technology Capability	**Existing Enterprise Capability to be Leveraged**	**New Enterprise Capability Needed**
Public or Internal Portal/Website	☐	☒
Public or Internal Mobile Application	☐	☐
Enterprise Service Bus	☐	☐
Identity and Access Management	☒	☐
Enterprise Content Management (including document scanning and eForms capabilities)	☐	☐
Business Intelligence and Data Warehousing	☒	☐
Master Data Management	☐	☒
Big Data Analytics	☐	☐

2.11.5 Project Phases

Stage 3 Solution Development	CDT Project Approval Lifecycle Stage 3 Solution Development
Description	**Phase Deliverable**
1. Completion of the Stage 3 solution development requirements by Caltrans assisted by a contractor on some elements.	1. Procurement Profile 2. Detailed Solution Requirements* 3. Statement of Work* 4. Solicitation Package 5. State Staffing Allocation * indicates item to be completed by contractor
Stage 4 Product Readiness and Approval	**CDT Project Approval Lifecycle Stage 4 Product Readiness and Approval**
Description	**Phase Deliverable**
Completion of Stage 4 of Project Approval Lifecycle	1. Solicitation Release 2. Selection of Vendor 3. Contract Management Readiness 4. Baseline Project (Management) 5. Project Readiness 6. Risk Registration 7. DOF and/or Legislative Approval
New TSN Implementation Project	**New TSN Design, Implementation, and Training**
Description	**Phase Deliverable**
Vendor actions include: 1. System Architecture, Design, and Data Model finalization 2. Instantiating the system architecture for development, testing, and production environments, including the Authoritative Data Store 3. Designing data migration methods, including back-population of old TSN during transition and then testing the migration procedures 4. Installation, customization, testing, and user training for the Roadway Inventory module 5. Installation, customization, testing, and user training for the Collision Coding module 6. Installation, customization, testing, and user training for the Traffic Volume module 7. Installation, customization, testing, and user training for the Traffic Investigation module 8. Installation, customization, testing, and user training for the Safety Analysis functions and processes 9. Project closeout, final training, and documentation Caltrans actions include: Assistance to vendor in items 1 through 9 above	New TSN system*: 1. System architecture, design, and data model documentation 2. Guidelines for installation of all components of the solution 3. Documentation of data migration methods and procedures, including data quality report for migration status and issues 5. Installed and operational program area modules 6. Training materials and guides 7. System maintenance training and guides for Caltrans' IT staff 8. Requisite project management reporting per Caltrans' standards and specifications in the vendor contract *The phase deliverables are described in general terms here; more specific deliverables will be stated in the solicitation itself

2.11.6 High Level Proposed Project Schedule

Stage 2 Alternatives Analysis

Proposed Project Planning Start Date:	7/1/2017	**Proposed Project Planning End Date:**	9/30/2020
Proposed Project Start Date:	10/1/2020	**Proposed Project End Date:**	6/30/2023

Activity Name	Start Date	End Date
Stage 3 Solution Development	7/1/2019	6/30/2020
Stage 4 Project Readiness and Approval	7/1/2020	9/30/2020
Solicitation Award	10/31/2020	10/31/2020
Development	11/1/2020	6/30/2023
Go Live	7/1/2023	7/1/2023
Maintenance and Operations	7/1/2023	

Select + to add activities

2.11.7 Cost Summary

Total Proposed Planning Cost:	$ 2,033,607
Total Proposed Project Cost:	$22,676,201
Total Proposed Future Operations IT Staff & OE&E Costs (Continuing):	$ 2,492,836
Total Proposed Annual Future Operations IT Costs (M&O):	$ 2,492,836

2.12 Staffing Plan

2.12.1 Administrative

To ensure the success of this project Caltrans is committing staff with extensive, high-level administrative experience (budgets, procurement, personnel, and contract and project management). Administrative staffing (contract and project management) are identified through all phases of the project and the staffing is shown in the attached: Attachment #17_FAWs, Attachment #11_TSNR_Planning_Effort_and_Cost, and Attachment #12_TSNR_ Implementation_Effort_and_Cost, spreadsheets. This mandated, critical project will revise and greatly improve Caltrans' core transportation system; roadway inventory, Traffic Census, Traffic Collision and Safety related data and processes. It also meets state and national mandates, supports Caltrans' strategic goals, and will provide the information managers needed to make the best decisions, and as such, has earned management's strong support in staffing and funding.

2.12.2 Business Program

Caltrans is dedicating staff possessing extensive business process knowledge in the areas directly affected by the Transportation System Network (Division of Research Innovation and System Integration, Division of Traffic Operations and Information Technology). The project is guided by the Highway System Information and Performance Office Chief, who has years of high-level experience in all facets of the core processes being addressed by the TSNR project, as well as experience improving transportation business processes with IT solutions. More importantly, the IT and business project managers, who are dedicated to this project , have much knowledge and experience respectively, guaranteeing smooth project implementation. Caltrans' districts and headquarters Subject Matter Experts will be used to lead the change to the business processes and assist with the implementation of the new system. The staffing for these Caltrans Business Programs is shown in the attached Financial Analysis Worksheet, TSNR Planning Effort and Cost, and TSNR Implementation Effort and Cost spreadsheets.

2.12.3 Information Technology (IT)

Caltrans is staffing this project with experienced IT staff and will be adding to the team as the project moves forward. In addition to storing and processing data from the various program users, this project will serve to put more information directly in the hands of users. The staffing and implementation effort for IT, for Caltrans and the various vendor contracts are shown in the attached Financial Analysis Worksheet, TSNR Planning Effort and Cost, and TSNR Implementation Effort and Cost spreadsheets.

2.12.4 Testing

Caltrans is dedicating both TSN business and IT staff, as well as users and vendor staff to testing. Testing is critical to ensure the State gets the product it expected for its expenditure of resources, and to ensure the best transition because TSNR project affects Caltrans core operations statewide. The staffing for testing is Financial Analysis Worksheet, TSNR Planning Effort and Cost, and TSNR Implementation Effort and Cost spreadsheets.

2.12.5 Data Conversion/Migration

Caltrans will utilize a System Integration (SI) vendor to address Data Conversion and Migration needs. Staffing needs will be addressed by the SI vendor.

2.12.6 Training and Organizational Change Management

Training and OCM for system and business process changes are critical to TSNR Project's success. OCM and Training will be addressed within multiple vendor contracts. It is anticipated that the SI vendor will perform training activities and that OCM activities will be addressed by a separate contract.

2.12.7 Resource Capacity/Skills/Knowledge for Stage 3 Solution Development

TSNR staff have extensive experience with Caltrans' contract procurement, management, the business programs and processes. IT has extensive technical knowledge to support the project and systems. The team has already conducted a written industry survey, a literature survey, surveyed other states' agencies facing similar operations and data mandates, and hosted a three day vendor demonstration conference to collect information on industry offerings. The team has worked closely with CDT staff to ensure these activities have been appropriate and comprehensive. Caltrans will be working with the CDT State Technology Procurement (STP) division on this project. CDT sets the standard for precision, experience, skill, and accuracy for IT procurement in state government. The staffing for Stage 3 is shown in the attached FAW and TSNR Planning Effort and Cost spreadsheets and are identified in the planning phase of the project.

2.12.8 Project Management

2.12.8.1 Project Management Risk Assessment

Project Management Risk Score:	0.9
Attachment: Attach file to email submission.	Attachment #13_Project_Management_Risk_Assessment

2.12.8.2 Project Management Planning

Are the following project management plans or project artifacts complete, approved by the designated Agency/state entity authority, and available for Department of Technology review?

Project Charter	Yes	Attachment #14_Project_Management_Plans
Scope Management Plan	Yes	Attachment #14_Project_Management_Plans
Risk Management Plan	Yes	Attachment #14_Project_Management_Plans
Issue and Action Item Management Plan	Yes	Attachment #14_Project_Management_Plans
Communication Management Plan	Yes	Attachment #14_Project_Management_Plans
Schedule Management Plan	No	**In Progress**
Human Resource Management Plan	Yes	Attachment #14_Project_Management_Plans
Staff Management Plan	Yes	Attachment #14_Project_Management_Plans
Stakeholder Management Plan	No	**In Progress**
Governance Plan	No	Attachment #14_Project_Management_Plans

2.12.9 Organization Charts

Attachment #15_Organization_Chart

EXECUTIVE STEERING COMMITTEE

Coco Briseno
Planning and Modal Programs

Steve Takigawa
Maintenance & Operations

Jesse Bhullar
Traffic Opera ions Division

Karl Kopper
IT Security Services Division

Mike Nguyen
IT Infrastructure Management Division

Dara Wheeler
Division of Research, Innovation and System Information

Chad Baker
GeoSpa ial Data Officer

Luc Sou
IT Project & Business Mgmnt Division

Rihui Zhang
Local Assistance Division & Support

George Akiyama
Chief Information Officer

Saeed Bakhshi
IT Applica ion Development

PROJECT SPONSORS

Coco Briseno
Planning and Modal Programs
Deputy Director

Steve Takigawa
Maintenance & Opera ions
Deputy Director

PROJECT MANAGEMENT TEAM

Ryan Mak
Senior Engineer
Office of Highway System Informa ion and Performance

Dale Minatoya
IT Project Manager
IT Project Management Office

BUSINESS LEADS

Nick Compin
Traffic Census

Dean Samuelson
Safety Analysis

David Ly
Collision Coding

Mandy Chu
Highway System Informa ion and Performance

Aaron Truong
Traffic Accident Surveillance and Analysis System

Thomas Schriber
Traffic Opera ions
Local Assistance

Andy Richardson
Linear Ref. System

Mark Samuelson
Local Assistance

IT LEADS

Mehrdad Shahamatdoust
IT Applications and Support

Brahmjot Hanjra
Infrastructure Mngmt

Chitra Chitturi
IT Applications and Support

Ala Yousefi
Infrastructure Mngmt

Bob Acrea
IT Business Analysis Unit

Russell Watts
Infrastructure Mngmt

Terry Snyder
IT Applications and Support

Robert Traversi
IT Security Services

Solution Implemention Vendor
TBD

2.13 Data Conversion/Migration

Identify the status of each of the following data conversion/migration activities:

Data Conversion/Migration Planning	Not Started	Data Quality Assessment	Not Started
Data Conversion/Migration Requirements	Not Started	Data Quality Business Rules	Not Started
Current Environment Analysis	In Progress	Data Dictionaries	In Progress
Data Profiling	Not Started	Data Cleansing and Correction	Not Started

Data Conversion/Migration Planning and Data Conversion/Migration requirements will be addressed by the System Integration vendor.
Current Environment Analysis is in progress and is represented in the Architecture Diagram (Attachment #5).
Data Profiling/Data Quality Assessment/Data Quality Business Rules/Data Cleansing and Correction are all being addressed by State staff under a separate broader effort.
Data Dictionaries also attached but are expected to be updated and further refined throughout the remainder of project planning and the project execution phases.

Attachment #16_Data_Conversion_Data_Dictionaries

2.14 Financial Analysis Worksheets

Attachment #17_FAWs

Preliminary Assessment – Department of Technology Use Only	
Original "New Submission" Date	10/2/2018
Form Received Date	8/15/2019
Form Accepted Date	8/15/2019
Form Status	Completed
Form Status Date	1/10/2020

Main Form – Department of Technology Use Only	
Original "New Submission" Date	8/15/2019
Form Received Date	8/15/2019
Form Accepted Date	8/15/2019
Form Status	Completed
Form Status Date	01/10/2020
Form Disposition	Approved
Form Disposition Date	1/10/2020