# California Road Sharing (CaRS)

## Road to a Governed, Statewide California Roads Dataset

CaRS Website: https://storymaps.arcgis.com/stories/19abd0c0c16144efa53db6c75585b8f5

A graphical, georeferenced representation of California's road network is created and maintained by various government agencies, including the State Department of Transportation (Caltrans), 58 counties, and 482 cities, for different purposes—using different approaches. A single statewide road network dataset is needed that supports California government agencies to use this foundational data for highway infrastructure asset management, infrastructure projects planning and programming, emergency management, highway performance management, highway safety analysis, road user charging (RUC), etc. The Statewide roads dataset would also be used to report data to the Federal Highway Administration and could be used in the development of the National Road Network dataset, which FHWA and certain select State Departments of Transportation (State DOTs) are currently piloting. Based on a technical feasibility investigation, a plan for development and deployment of the California Roads Dataset has been developed.

**Vision**: The **California Road Sharing (CaRS) Program** will establish a process and agreement between participants that will result in a statewide road network set.. The Statewide Roads dataset will be administered and governed by a California Road Sharing (CaRS) working group, comprising members from various roads data management agencies, particularly Caltrans, local agencies (counties, cities, and municipalities), and the California Office of Emergency Services (CalOES).

### Benefits to Stakeholders

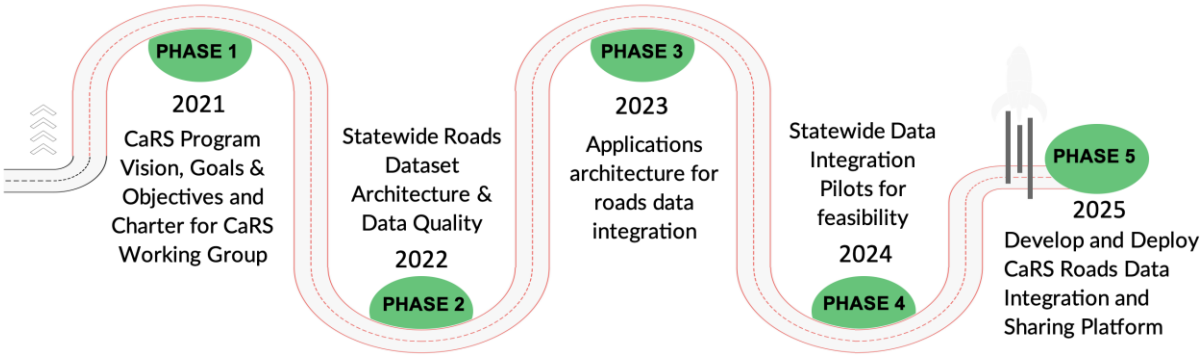
Transportation agencies in California and stakeholders of these agencies in the Federal government and private, academic, and public sectors are expected to benefit from the development of a Statewide California Roads dataset. Specifically, the following use cases for the statewide roads dataset have been identified:

- **Road Inventory Tracking:** To report roadway mileage, NG911, and ARNOLD roads data.
- **Asset Management:** To allow agency using the road network to reference the geospatial data associated with highway infrastructure assets such as the asset inventory, inspection/condition assessment, and capital and maintenance work data, thereby allowing asset data exchange and integration.
- **Highway Safety:** To enhance public safety enhancement through data-driven emergency management, preparedness and incident response, crash mapping, and statewide highway safety analysis.
- **Project Planning & Programming:** To drive transportation planning, traffic studies, and statewide capital and maintenance transportation improvement program (TIP/STIP) development,
- **Emergency Management:** To report emergencies to the Federal Emergency Management Agency, geo-locate address information (geocoding), and develop the NG911 dataset.
- **Routing & Traffic Flow Studies:** To develop a connected routable network for map-based vehicle routing and analysis of driving directions, distances, roadway mileage reporting, and freight routing.
- **California Road User Charging:** To map connected vehicles to roads to track mileage and travel to deploy RUC, and other applications that require a uniform and comprehensive statewide roads dataset.

### PROGRAM GOALS

- ✓ Create a governed state-wide roads dataset to meet roads data use cases of multiple agencies in California.
- ✓ Provide mutual benefits to State and local jurisdictions, especially to business users involved in highway project planning, survey, design, construction, safety, traffic and asset management operations.
- ✓ Coordinate roadway cartographic and data model recommendations
- ✓ Support Transportation for the Nation (TFTN), which promotes a publicly available, high quality road centerline that is coordinated across all levels of government.
- ✓ Building Information Modeling (BIM) for roads and assets using standards for supporting artificial intelligence (AI) /machine learning (ML) applications, CV/autonomous vehicles (AV), and uncrewed aerial systems (UAS).

**Timeline**: Caltrans, Cal OES, and Merced County developed and proposed the CaRS program in 2021. The program is divided into five phases as shown and described below.



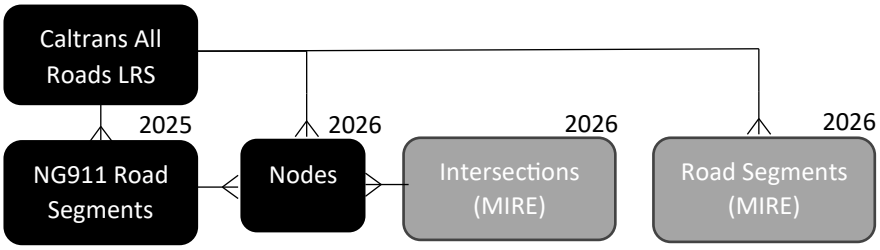

**Phase 1: Establish CaRS Program Objectives, a Statewide Working Group, and a Working Group Charter.**

As part of Phase 1, a charter has been developed for a Statewide CaRS working group. The CaRS working group includes representatives from multiple agencies in California. The working group charter established the CaRS program vision, objectives, and roles and responsibilities of the working group members.

**Phase 2: Establish Statewide Roads Data Architecture and Quality Rules with Caltrans, CalOES, and Merced County**

As part of Phase 2, Caltrans, CalOES, and Merced County conducted a pilot study to establish what road network data will be part of the Statewide Roads Dataset. The data architecture was established based on the road network data that California counties prepare and submit to CalOES for NG911. It was established that Caltrans would use the NG911 roads database to identify and add missing Interstates, US and State roads in the Caltrans All Roads database. Additionally, Caltrans will ingest following road attributes from the NG911 roads database: (a) local road unique identifier (NG911 road centerline identifier), local road name, road class, street name and directionality (one-way/two-way). These road attributes will be imported for all roads in the State and will be stored against the NG911 Road Segments in the Caltrans All Roads database. The proposed Statewide roads dataset architecture is presented below. The statewide roads dataset will establish a relationship between the "Routes" that represent the roads in the Caltrans All Roads Linear Referencing System (LRS) and the local agency maintained NG911 Road Segments. Multiple NG911 Road Segments are expected to get mapped to a Caltrans "Route," given that NG911 road segments typically break at intersections, county, Public Safety Answering Point (PSAP), and provisional boundaries. The NG911 Road Segments will be setup as "Events" in Caltrans LRS.

The Statewide Roads dataset schema will therefore include the following data entities: Caltrans All Roads LRS routes, NG911 road segments, and nodes that represent the beginning/ending of an NG911 segment. Additionally, Caltrans may add Model Inventory Road Elements (MIRE) data in the future.




The data quality assessment rules that all agencies would ensure in their respective datasets were identified. The following rules were established as the set of rules that all agencies will use to validate their data in the first year of CaRS.

- Road geometry should not be empty or self-intersecting. Agencies do not need to have z-values modeled.
- Road geometry should not have duplicate geometry or vertices, kickbacks, spikes, bifurcations, lengths less than 12 feet, or overshoots/undershoots.
- Multi-part road geometry checks will occur, but it will not be mandatory to remove multi-part geometries.
- Road Name, Street Name, Road Class, and Direction (one-way) information should be present in local roads data.

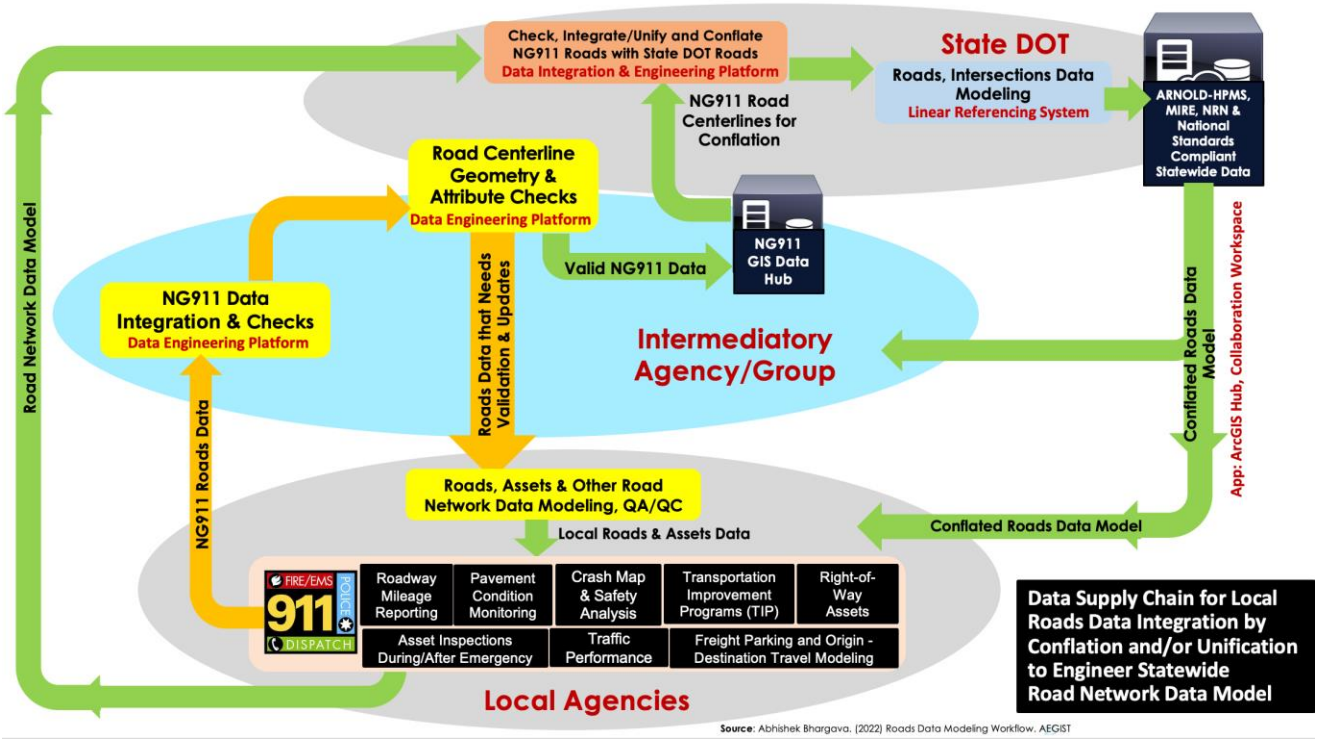
Over time, this set of rules may evolve based on the needs of the various business users and use cases in California, and the CaRS working group will facilitate administration and governance of the data quality ruleset. In addition, the CaRS working group may consider adding rules associated with modeling of following roadway features and right-of-way assets, as the program expands over time:

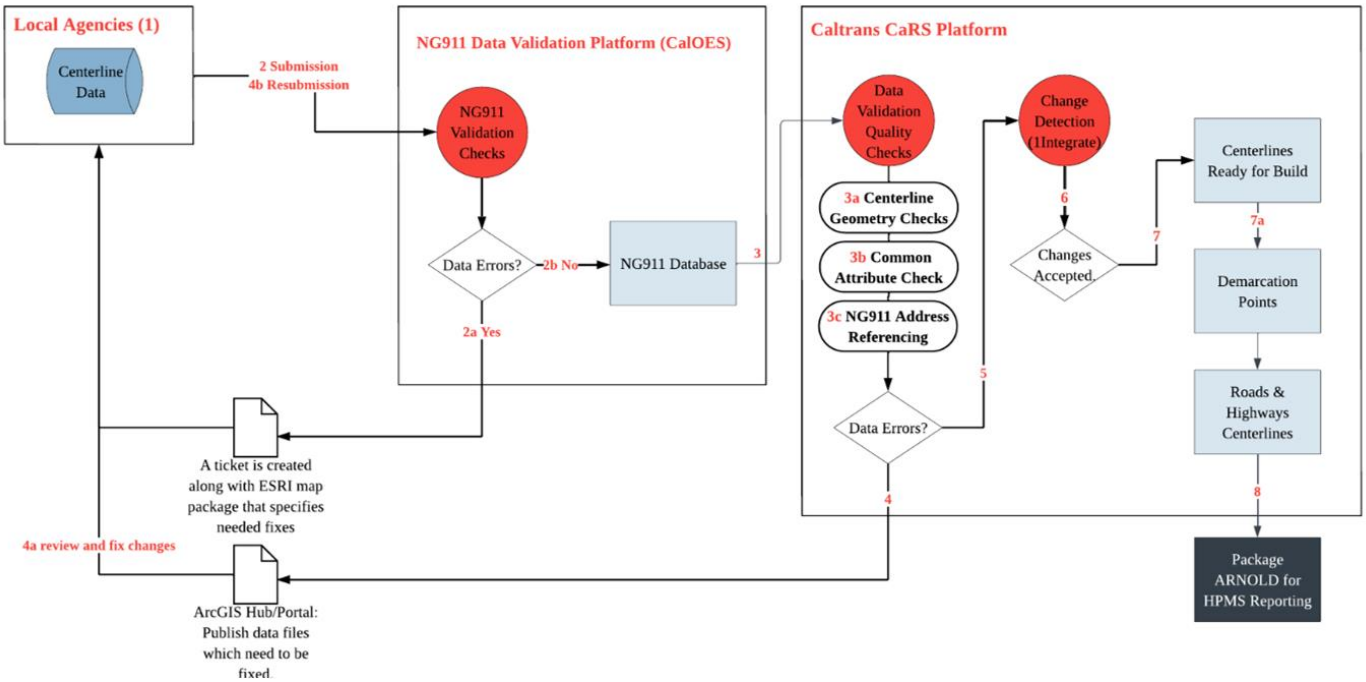
- Turn Lanes, Interchanges, Ramps
- Emergency/Median Crossovers
- Sidewalks, Crosswalks, Bike Routes
- Road Breaks at Administrative Boundaries
- Overlapping/Concurrent Roads
- Dual-Geometry Roads (Divided/Undivided)
- HOV/HOT Lanes
- Railroad Crossings
- Traffic Circles/Roundabouts

**Phase 3: Establish Applications Architecture for Data Integration Using Pilot with Caltrans, CalOES, and Merced County**

Phase 3 involved establishing an architecture to identify the different web-based software applications that will be used in the Statewide road network data integration, exchange, quality assessment and subsequent management, and determining how the data will flow between these applications. The envisioned architecture is shown below. Data flow would involve following steps:

- Step 1: Local agencies (counties) will create a road network dataset and submit to CalOES as required by NG911 program.
- Step 2: CalOES will conduct NG911 data checks and integrate data from all counties into the NG911 database.
- Step 3: Caltrans will pull local roads data from the NG911 database and conduct additional data quality checks.
- Step 4: Caltrans will share data errors with local agencies based on agreed-upon data quality validation rules.
- Step 5: Caltrans will use the local road network data that does not have errors to detect differences with its All Roads database.
- Step 6: Caltrans will prepare NG911 road segments data for integration with its All Roads LRS routes.
- Step 7: Caltrans will use the NG911 roads data to create demarcation points at county boundaries and stitch roads together.
- Step 8: Caltrans will integrate the NG911 road segments and demarcation points data into its LRS and publish the dataset.



**Phase 4: Investigate the Feasibility of Statewide Roads Data Integration with Caltrans, CalOES and Five to Seven Counties**
Phase 4 will be executed in 2023-2024 in coordination with Caltrans, CalOES, Merced County, and five to seven additional counties to ensure that the CaRS working group charter, data integration, and application architectures that were created in Phases 1-3 can be further validated and refined using an enhanced pilot with more agencies. The work in this phase will involve the following activities:

1. Present the CaRS architecture and process that has been developed as part of this report to contributing public agency stakeholders in California. Based on the presentation, the CaRS team will identify five to seven volunteer local agencies willing to participate in integrating their NG911 roads datasets into the Caltrans LRS and want to evaluate the use of the resulting integrated roads dataset at their agency (for supporting various business processes).

2. Caltrans, CalOES, and the identified counties in step 1 will form the CaRS working group to oversee the CaRS program and socialize the CaRS program based on the findings of the enhanced pilot. The CaRS charter will be edited/updated and adopted, and volunteer representatives will assume the roles and responsibilities outlined in the charter.

3. Conduct pilots with the identified local agencies to assess how their road centerline data validates and aligns with Caltrans' road network data model. This assessment would involve developing a more comprehensive local roads data integration algorithm that (a) unifies datasets from multiple local agencies, and (b) uses conflation algorithms and geometry check rules that have been designed specifically for California that allow for improved conflation results using 1Integrate and ArcGIS geoprocessing tools.

4. Develop a CaRS website or "story board" on an ArcGIS enterprise platform (similar Arizona's story board created for the Arizona Data Supply Chain program) to communicate the findings of the data integration, unification, and conflation results as well as the benefits of integrating data that the volunteering local agencies realized.

5. Discuss changes that should be made to the proposed data and application architecture for CaRS in this document and develop an updated version of the data and application architecture, based on the findings from data integration, unification, and the conflation pilot with other agencies.

6. Assess feasibility, desirability, and a timeline for implementing the CaRS architecture by developing and deploying a CaRS data sharing hub that allows local agencies to submit their data; validate against the rules for data integration, unification, and conflation that have been established for CaRS; and retrieve the integrated Statewide roads dataset for use in local agency business processes. Additionally, investigate the benefits and value of the integrated roads dataset (with data from five to seven local agencies) in the preparation of the ARNOLD submission, as well as in the Caltrans business processes that rely on availability of an authoritative Statewide road network dataset.

7. Review and update the plan for Phase 5 and establish a workplan for CaRS platform development and deployment activities. Propose next steps for starting Phase 5 to accomplish goals outlined in Chapter 1, based on Phase 4 findings.

[1] CaRS Presentation to Counties &

[2] CaRS Working Group Formation and Operationalizing CaRS Charter

[3] CaRS Data Integration Pilots with 5-7 Counties

[4] CaRS Website (Story Board)

[5] CaRS Data & Application Architecture Review/Updates

[6] Statewide Roads Data Integration Feasibility Assessment

[7] Phase 5 CaRS Data Portal Deployment Work Plan

**Phase 5: Develop and Deploy CaRS Data Sharing and Provisioning Platform.**
Phase 5 will involve development and deployment of the CaRS web application that roads data management agencies in California can use to share, validate, and integrate their roads datasets with the Caltrans All Roads dataset that is managed in the Caltrans LRS. This phase will involve deploying the development, testing, and production environments for the CaRS application and operationalizing the roads sharing program as envisioned in CaRS. The work in this phase will involve reviewing and selecting a geospatial web application platform that can host the CaRS web application and integrating the platform with the various applications that conduct submitted roads data validation (e.g., Esri Data Reviewer, 1Integrate). The platform will be deployed to accept the roads datasets from local agencies, conduct the data validations, report the results of the validation back to the submitting agencies, and allow for an updated file to be uploaded back (with fixes). Furthermore, the platform will allow for a data pipeline into the Caltrans Esri Roads & Highways LRS for integration of select local roads data into Caltrans All Roads LRS. Finally, the web platform will allow roads data management agencies to download the integrated "All Roads" data created by Caltrans, (using data from various local agencies, for use in their roads data management and transportation business applications.

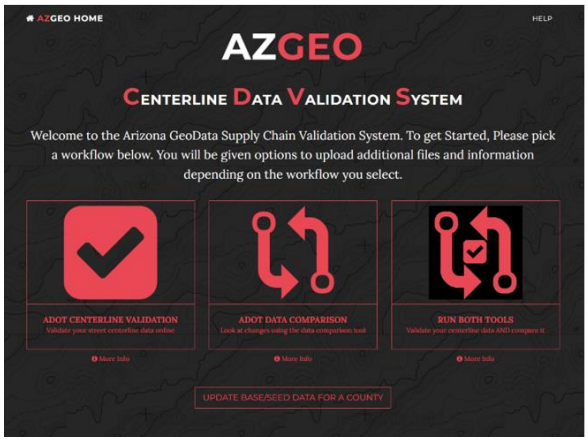
## Statewide Roads Data Implementation Programs and Success Stories in other States

Transportation agencies in states such as Arizona, Georgia, and Ohio have implemented different variations of the data supply chain between local agencies and State DOTs for the exchange of road network and roadway geometry data to be integrated into a Statewide Roads Dataset. California is drawing inspiration and has investigated the implementations in these states to develop the CaRS program vision and assess the feasibility of its implementation in California.

Integration efforts in these states around statewide road network datasets involved coordination across multiple agencies for sharing of road data. This lesson learned from the other states spurred California to create a CaRS working group with a formal charter to support the creation of its Statewide Roads dataset. The specific data exchange/sharing and integration tools, techniques, and digital process workflows varied across states, but at a high level, California has leveraged the data exchange models deployed across these states to develop the envisioned application communication architecture for CaRS data supply chain.

Across all the data supply chains between local agencies and State DOTs, an intermediate agency/group is in place to either facilitate or lead the governance of the data supply chain program in the state. For example, in Georgia, Georgia DOT launched the REVAMP program, which uses the Georgia Association of Regional Commission and University of Georgia as the intermediatory agencies that collaborate with local agencies to gather information about roadway characteristics, validate and integrate that information, and ultimately provide the data to Georgia DOT. In Arizona and Ohio, the State GIS offices are playing the role of intermediatory agency/group to facilitate the data exchange between local agencies and the State DOT. Pennsylvania and California worked with the emergency management agencies, the Pennsylvania Emergency Management Agency (PEMA) and CalOES, to investigate how the NG911 roads database compiled by these emergency management agencies and local agencies can be leveraged and integrated with the State DOT LRS routes. Both states conducted this investigation as part of the AEGIST program and developed data and application architectures associated with the NG911 road centerline data integration into the State DOTs LRS as NG911 road segments (referred to as LRS events). In Massachusetts and North Carolina, the local agencies submit GIS files of the road network to the State DOT as part of a structured workflow process ingest the roads data (including geometry). These initiatives across the states and the deployments/investigations completed to integrate and engineer a single centerline statewide road network suggest that although each state used a different implementation practice and reports a different success story, several of them had the State DOT and local agencies coordinate to create and manage the integrated Statewide road network data model (geometry and road characteristics).

California can leverage these experiences and implementation practices from other states, particularly the practice in Arizona, where a mature data supply chain program called AzGeo has been created and has evolved over the last 5 years.





## Conclusion

In California, local agencies model all roads in their county, including the higher functional class roads, to submit the data to NG911. These local agency-prepared roads datasets can be imported into the Caltrans LRS and can be conflated with the routes in the Caltrans All Roads LRM. Specifically, the missing local roads in the Caltrans LRS can be added based on the information provided in the local roads data. Additionally for all roads in the local roads dataset, information about all road names, road class, direction (one-way/two-way), and NG911 roads identifiers can be added to the Caltrans All Roads database for each NG911 road segments. The technical feasibility of this data integration was investigated and confirmed as part of the CaRS Phases 2 and 3. Using tools such as 1Integrate, ArcGIS Pro, and ArcGIS Roads and Highways, the differences in different roads datasets can be identified and used to update/add to any of the source roads datasets. The differences in roads data modeling rules among Caltrans and local agencies were also identified, and it was established that these differences were not significant and would not affect conflation of the roads datasets. Overall, it was also confirmed that it is possible to create a unified road network database that can be used to publish the unified roads dataset to all stakeholders in the state. To drive the CaRS program forward, and for governance of the road network data in the State of California across agencies, a CaRS working group will be operationalized as part of Phase 4 according to the charter created in Phase 1 of the CaRS program.