PARTNERS FOR ADVANCED TRANSPORTATION TECHNOLOGY
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

# Connected Corridors: I-210 Pilot Integrated Corridor Management System

## System Requirements

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Partners for Advanced Transportation Technology works with researchers, practitioners, and industry to implement transportation research and innovation, including products and services that improve the efficiency, safety, and security of the transportation system.

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# 1. INTRODUCTION

This document presents the system requirements developed by project stakeholders for the proposed implementation of a Pilot Integrated Corridor Management (ICM) System. The system, to be piloted along a section of the I-210 corridor in the San Gabriel Valley area of Los Angeles County, aims to improve overall corridor performance during incidents, unscheduled events, and planned events. This is to be achieved by more efficiently managing existing systems and infrastructures, promoting cross-jurisdictional operations, and using multi-modal traffic and demand management strategies that consider all relevant modes of transportation.

## 1.1. PURPOSE OF DOCUMENT

This document specifies the various requirements that will both govern the development and implementation of the I-210 Pilot ICM System and serve as the basis for other Caltrans-led ICM efforts statewide. These requirements define:

- What the system is to supposed to do (functional requirements)
- How well the system is expected to perform its functions (performance requirements)
- Under what conditions the system is to be operated (environmental and institutional requirements)

The requirements usually do not state how system components will be implemented, as this information is normally defined during the design stage. However, such information is sometimes included in order to limit the development team to a specific solution.

## 1.2. RELATION TO SYSTEMS ENGINEERING PROCESS

The development of system requirements is part of the systems engineering process that the Federal Highway Administration (FHWA) requires be followed for developing Intelligent Transportation System (ITS) projects when federal funds are involved. While not required for projects only using state or local funds, use of the systems engineering process is also encouraged in such cases.

The overall systems engineering process is illustrated in Figure 1-1. Developing system requirements is the first step in the System Definition and Design phase of a project (Phase 2 in the figure). Requirements are typically derived from the user needs identified during the development of the Concept of Operations (Phase 1). The resulting requirements are in turn used to inform and guide the design of the system, as well as to establish future required system verification needs.

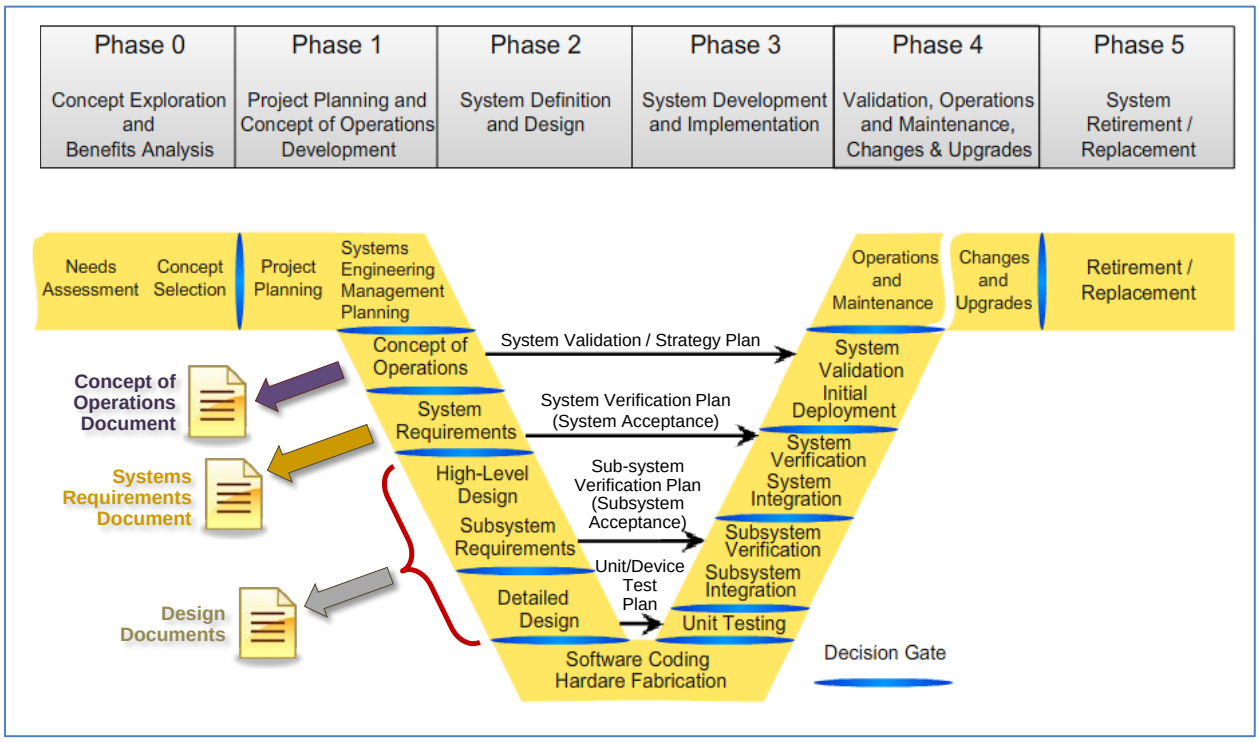


**Figure 1-1 – System Requirements Specification within Systems Engineering Process**

## 1.3. INTENDED AUDIENCE

The primary audience for the System Requirements document includes personnel responsible for designing and implementing the ICM system, as well as project stakeholders who will be committing to the requirements before the design process begins. The audience also includes individuals from Caltrans District 7, Caltrans Headquarters, and the University of California, Berkeley, tasked with project management duties.

## 1.4. DOCUMENT ORGANIZATION

The remainder of this document is organized as follows:

- **Section 2** presents a general description of the system, including project goals and objectives, technical capabilities sought, boundaries of the project corridor, transportation systems to be potentially managed by the ICM system, key corridor stakeholders, and problems to be addressed. The section also presents the institutional and control framework within which the system is expected to operate, key system components, and a preliminary system architecture.
- **Section 3** summarizes the user needs identified during the development of the Concept of Operations for the proposed system.
- **Section 4** presents the key data sources expected to support system operations.

- **Section 5** presents the primary destinations of the information the system will generate.
- **Section 6** identifies the various roles that are mentioned in the requirements and are expected to be filled by personnel from various stakeholder agencies.
- **Section 7** presents an overview of the requirements. This includes essential terminology for understanding the requirements; how the requirements are presented in three different formats and levels of detail in this document; the process followed and elements considered in developing the requirements; and a short summary of the various categories of requirements.
- **Section 8** presents generic requirements which, while developed for the I-210 Pilot ICM system, are also meant to be used as templates for other ICM efforts. These requirements provide context for understanding the detailed requirements in Section 9 but do not reference specific agencies, data sources, data formats, fully-defined metrics, or specific lower-level requirements.
- **Section 9** presents the detailed requirements that apply specifically to the I-210 Pilot ICM system.
- **Section 10** provides a list of terms used in the requirements document and their definitions.

In addition, other supporting documents are available in the Document Library of the I-210 Pilot website at http://ccdocs.berkeley.edu/content/document-library:

- **Appendix A** presents flow charts of expected operational processes.
- **Appendix B** discusses the "actors and stories" approach used in developing the requirements, including descriptions of the actors (people and system components) and stories (typical scenarios). It also includes notes from requirements-gathering meetings held with stakeholders.
- A **Data Dictionary** is also available.

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# 2. GENERAL SYSTEM DESCRIPTION

The overriding purpose of the I-210 Pilot is to reduce congestion and improve mobility along a section of the I-210 corridor in Los Angeles County through the coordinated management of its major networks: the I-210 freeway, key surrounding arterials, and local and regional transit services. The goal is to enable all corridor "actors"—transportation systems managers and operators, control systems, vehicles, and travelers—to work together in an efficient and coordinated way.

These improvements will be achieved by developing and deploying the ICM system described in this requirements document. At the heart of the proposed system will be a Decision Support System (DSS) designed to help corridor system operators manage incidents, unscheduled events, and planned events more effectively. This system will use information gathered from monitoring systems and provided by predictive analytical tools to estimate current and near-future operational performance. The information will be used to develop recommended courses of action to address problems caused by identified incidents and events. More specifically, this system is expected to:

- Improve real-time monitoring of travel conditions within the corridor
- Enable operators to better characterize travel patterns within the corridor and across systems
- Provide predictive traffic and system performance capabilities
- Evaluate alternative system management strategies and recommend desired courses of action in response to planned events, unscheduled events, and incidents
- Improve decision-making by transportation system managers
- Improve collaboration among agencies operating transportation systems in the corridor
- Improve the utilization of existing infrastructures and systems
- More efficiently use spare capacity to address non-recurring congestion
- Reduce delays and travel times along freeways and arterials
- Improve travel time reliability
- Help reduce the number of accidents occurring along the corridor
- Reduce the period during which the congestion resulting from an incident or event affects corridor operations
- Reduce greenhouse gas emissions
- Generate higher traveler satisfaction rates
- Increase the overall livability of communities in and around the I-210 corridor

While development of the proposed system is under the financial sponsorship of Caltrans Headquarters, the system will be developed primarily by the local transportation agencies that have agreed to participate in its operation, in coordination with UC Berkeley's Partners for Advanced Transportation Technology (PATH). Project activities will include the design, development, installation, testing, and operation of various components of the ICM system, as well as the development of interfaces with existing monitoring systems. For example, the ICM Core System (defined in section 7.1) will be interfaced with traffic management systems owned by Caltrans, such as the Advanced Traffic Management System (ATMS).

## 2.1. PROJECT GOALS AND OBJECTIVES

The primary goal of the I-210 Pilot ICM project is to improve overall corridor performance along a section of the I-210 corridor. This translates into the following specific goals:

1. Improve operational situational awareness
2. Promote collaboration among corridor stakeholders
3. Improve response to incidents and events
4. Improve travel reliability
5. Improve overall corridor mobility
6. Empower travelers to make informed travel decisions
7. Facilitate multi-modal movements across the region
8. Promote transportation sustainability by reducing impacts on the environment
9. Improve corridor safety

For each of these goals, Table 2-1 further identifies the main operational objectives. Many of the objectives are similar to those of traditional transportation improvement projects. Many, however, also focus on implementing more comprehensive travel and system status monitoring systems, improved operational forecasting, improved information dissemination to travelers, enhanced data-sharing capabilities, novel demand management approaches, and improved collaboration among transportation system operators.

**Table 2-1 – ICM System Goals and Objectives**

| Goals | Objectives |
|---|---|
| **1. Improve situational awareness** | • Establish minimum requirements for data collection to support system management<br>• Increase data collection opportunities from arterials and local roads<br>• Improve the collection of real-time operational data from non-traditional sources, such as probe vehicles<br>• Develop a comprehensive corridor informational database covering all relevant travel modes within the corridor<br>• Improve the quality, accuracy, and validation process of collected data<br>• Increase the ability to estimate travel demand patterns in a multi-modal environment<br>• Improve the ability to forecast near-future travel conditions based on known incidents, road conditions, weather, and local events<br>• Develop performance metrics considering all available travel modes |
| **2. Promote collaboration among corridor stakeholders** | • Strengthen existing communication channels among the corridor's institutional stakeholders<br>• Explore opportunities for new communication links between corridor stakeholders<br>• Improve cooperation and collaboration among corridor stakeholders<br>• Develop regional/joint operations concepts<br>• Identify new methods of collaboration<br>• Extend corridor performance metrics to the network level<br>• Investigate new types of agreements between participating agencies |

| Goals | Objectives |
|---|---|
| **3. Improve response to incidents and unexpected events** | • Reduce the time needed to identify the existence of an incident or unexpected situation<br>• Reduce the time needed to respond to incidents or unscheduled events<br>• Enhance the coordination of activities among first responders, traffic management agencies, and transit agencies to minimize impacts on system operations<br>• Reduce the time needed to implement control actions to address congestion resulting from an incident or event<br>• Reduce the time needed to disseminate recommended detours around an incident or event |
| **4. Improve travel reliability** | • Improve travel time predictability along the corridor<br>• Reduce the impacts of incidents and events on network operations<br>• Improve incident/event notification for first responders and network operators<br>• Improve incident/event notification to travelers and fleet operators<br>• Provide travelers and commercial vehicle operators affected by an incident or event an enhanced ability to seek alternate routes or mode of transportation |
| **5. Improve overall corridor mobility** | • Reduce delays incurred by travelers<br>• Reduce the impacts of incidents and events on network operations<br>• Efficiently use spare capacity along corridor roadways to plan necessary detours around incidents or events<br>• Promote strategies to induce desirable travel demand patterns<br>• Coordinate the management of freeway and arterial bottlenecks<br>• Promote increases in vehicle occupancy<br>• Promote increases in transit ridership |
| **6. Empower system users to make informed travel decisions** | • Improve the dissemination of real-time, multi-modal travel information<br>• Enhance the use of infrastructure-based informational devices (freeway CMS, arterial trailblazer signs, kiosks, etc.) to provide en-route information to travelers<br>• Enable individuals to receive travel information on connected mobile devices<br>• Make archived historical data available to 511 services and information service providers<br>• Support the dissemination of travel information by 511 services and third-party providers |
| **7. Facilitate regional multi-modal movements** | • Promote the integration of commuter rail and bus services with corridor operations<br>• Facilitate transfers across modes during incidents and events<br>• Provide relevant regional travel information to travelers<br>• Direct travelers to park-and-ride facilities with available spaces |
| **8. Promote transportation sustainability** | • Reduce fuel consumption<br>• Reduce vehicle emissions<br>• Identify financially sustainable solutions for long-term system operations and maintenance<br>• Encourage the use of transit, walking, and bicycling where appropriate<br>• Support locally preferred alternatives compatible with corridor objectives<br>• Develop and implement performance metrics reflecting environmental goals |
| **9. Improve corridor safety** | • Reduce collision rates<br>• Reduce the severity of collisions<br>• Reduce the number of fatalities<br>• Reduce the impacts of primary and secondary incidents on network operations through improved incident management<br>• Improve safety for bicycles, pedestrians, and transit |

## 2.2. TECHNICAL CAPABILITIES SOUGHT

To help manage travel activities within the corridor during incidents, unscheduled events, and planned events, the project is seeking the following technical capabilities to support the goals and objectives identified in Section 2.1:

- Gather and archive information characterizing traffic operations, transit operations, and the operational status of relevant control devices within the I-210 corridor.
- Identify unusual travel conditions on the I-210 freeway or nearby arterials based on monitoring data provided by various traffic, transit, and travel monitoring systems.
- Identify situations in which an incident on roadways or transit facilities significantly affects travel conditions within the corridor.
- Provide corridor-wide operational evaluations to traffic managers, transit field supervisors, and other relevant system managers, including projected assessments of near-future system operations under current and alternate control scenarios.
- Identify recommended detours around incidents or routes leading to the site of an event, considering observed travel conditions within the corridor. Depending on the need, and final system capabilities, specific detours may be recommended for motorists and transit vehicles.
- Identify recommended signal timing plans to use at signalized intersections to improve and/or accommodate traffic flow influx during incidents and events and improve overall corridor mobility.
- Identify recommended ramp metering rates to use on individual I-210 freeway on-ramps and connectors to maintain overall corridor mobility.
- Identify messages to post on available freeway and arterial changeable message signs (CMSs) to inform motorists of incidents and events.
- Provide guidance to motorists on the I-210 freeway and surrounding arterials using available freeway CMSs, arterial CMSs, and arterial trailblazer signs regarding which detour to take to go around an incident or which route to follow to reach the site of an event.
- Provide information to motorists about the availability of parking and transit services to help travelers make alternate mode-choice decisions.
- Provide uniform traffic management strategies across jurisdictional boundaries during incidents and events.
- Provide information to motorists through third-party outlets, such as 511 services, navigation application providers, etc.

## 2.3. CORRIDOR BOUNDARIES

The corridor is located approximately nine miles from downtown Los Angeles and covers a 25-mile section of the I-210 freeway running through the cities of Pasadena, Arcadia, Monrovia, Duarte, Irwindale, Azusa, Glendora, San Dimas, and La Verne. It extends from the Arroyo Boulevard interchange in Pasadena (Exit 22B) northwest of the SR-134 interchange to the Foothill Boulevard/SR-66 interchange in La Verne (Exit 47) east of the SR-57 interchange.

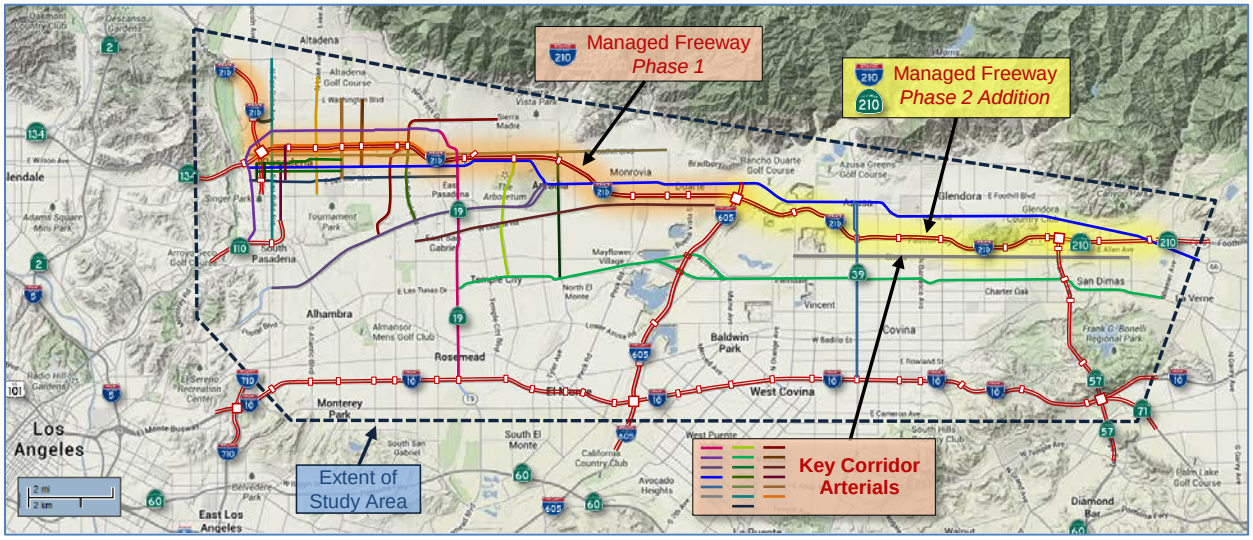


**Figure 2-1 – I-210 ICM Corridor Study Area**

As Figure 2-1 shows, deployment of the ICM system is planned to occur in two phases. Phase 1 extends from Pasadena to just east of the I-605 freeway. Phase 2, which will occur after Phase 1 is deployed, will extend from the I-605 to the SR-57 interchange.

South of the I-210, the study area is shown to extend to the I-10 freeway. While the proposed ICM system explicitly focuses on improving operations along I-210, the close proximity of the I-10 and the presence of two interconnecting freeways, I-605 and SR-57, create some operational interdependencies between I-210 and I-10. Incidents or events affecting operations along the I-10 often affect operations along the I-210, and vice versa. Even though the project does not aim to develop traffic and travel management strategies for the I-10, the operational interdependency between the two freeways creates a need to consider what may be happening on I-10 when developing operational strategies for the I-210 freeway.

## 2.4. TRANSPORTATION NETWORKS UNDER CONSIDERATION

The transportation networks under consideration for the first deployment phase of the I-210 Pilot include the following freeway, arterial, and transit system elements:

- **Freeway.** The core freeway section to be managed by the proposed ICM system is the section of I-210 extending from the Arroyo Boulevard interchange in Pasadena to the I-605 freeway interchange in Duarte. Short sections of the SR-134 and I-605 freeways are also considered for inclusion.
- **Arterials.** Figure 2-2 identifies the arterial segments that may potentially be recommended as detours around freeway or arterial incidents or events. The segments considered are locally important travel routes and, in some cases, segments that are already often used by motorists as alternate routes to the I-210 freeway.
- **Rail.** Figure 2-3 maps the primary rail systems serving the corridor. These include the light-rail Gold Line operated by Metro along the I-210 freeway and the San Bernardino commuter rail line operated by Metrolink further south.
- **Bus.** Figure 2-4 maps the express bus routes of potential interest. While not shown in the figure, various local fixed bus routes operated by Metro, Pasadena Transit, and Foothill Transit may also potentially be included in the development of responses to incidents and events.

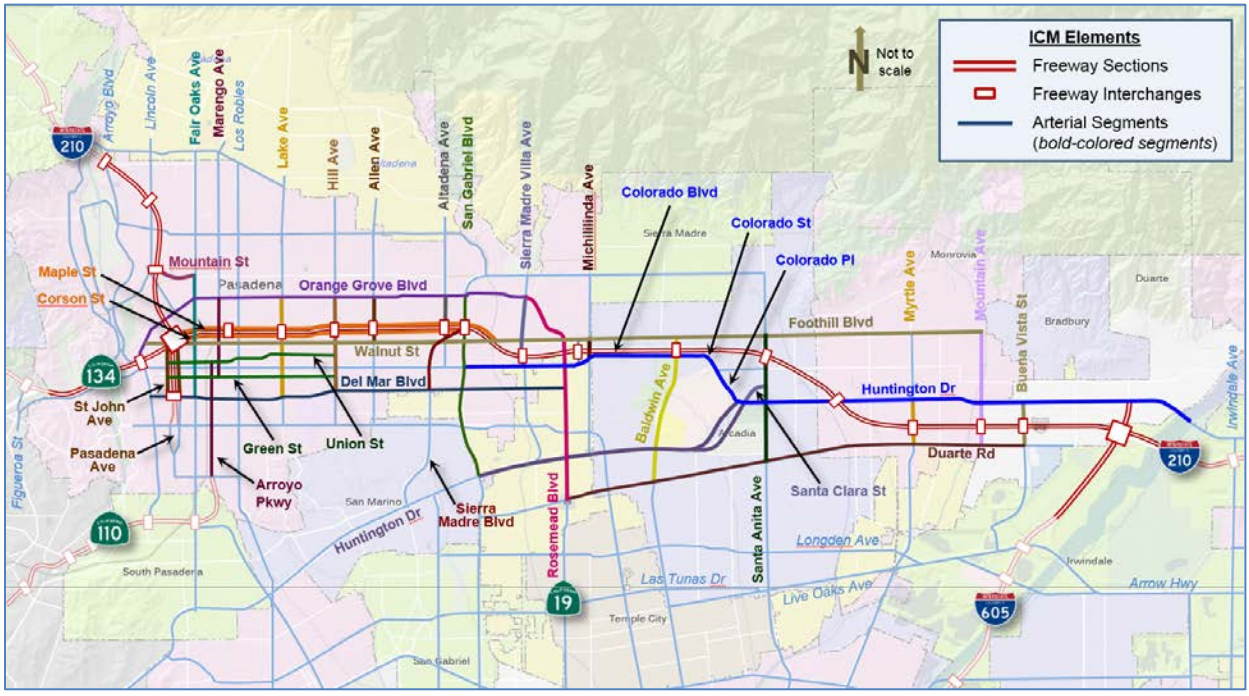


**Figure 2-2 – Candidate Freeway and Arterial Segments**

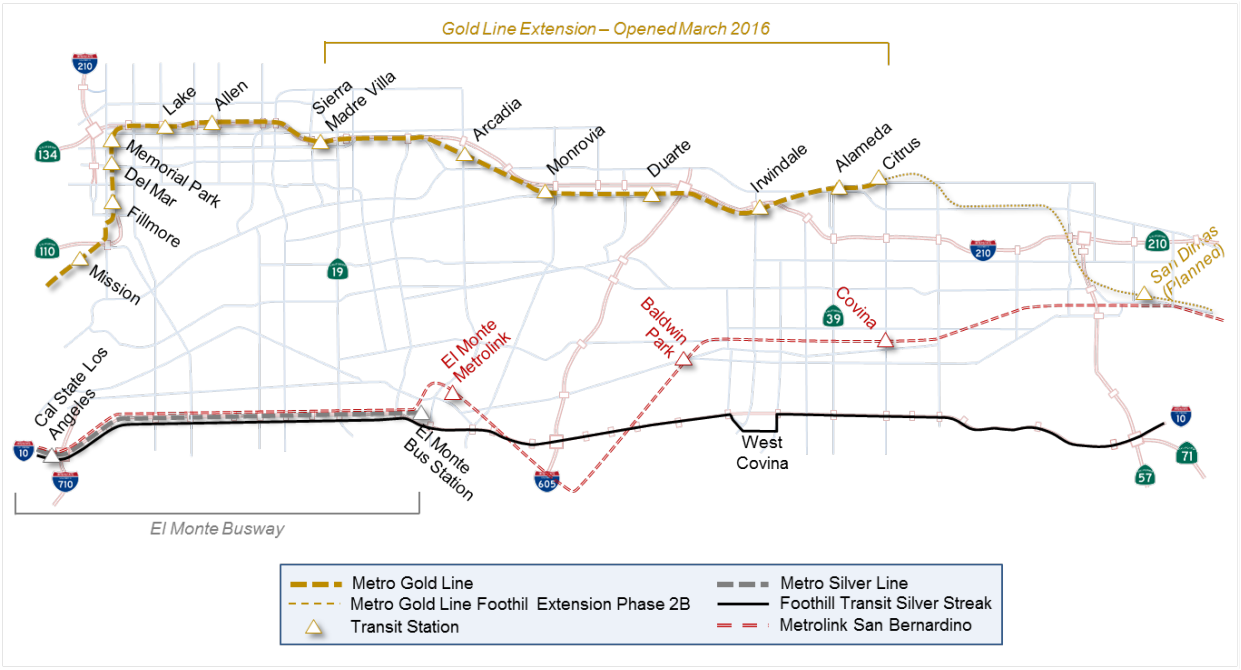


**Figure 2-3 – Light-Rail and Commuter Rail Transit Services**

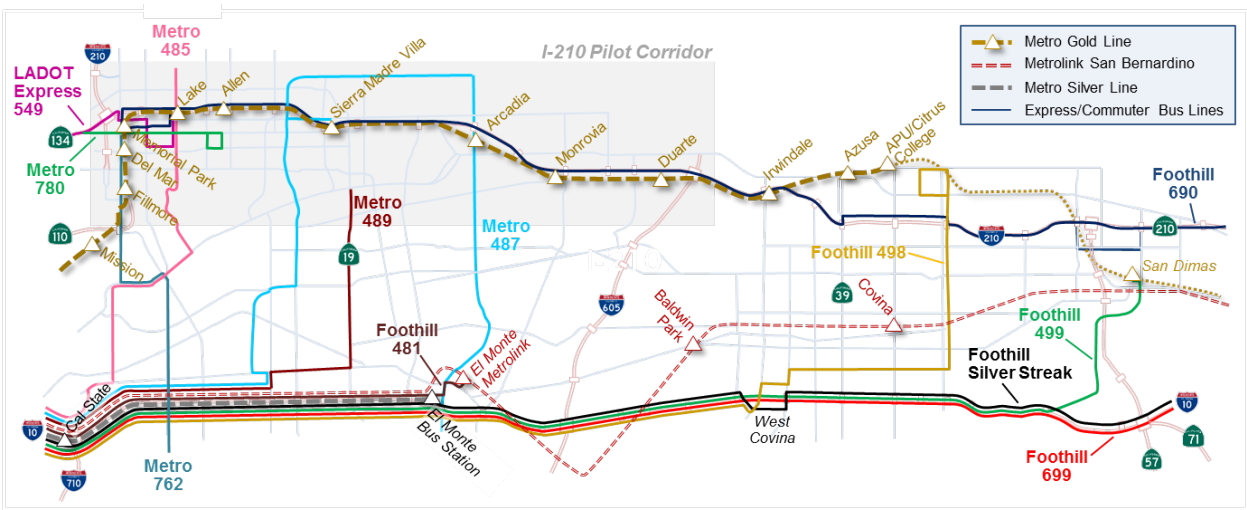


**Figure 2-4 – Express Bus Services**

## 2.5. SYSTEM STAKEHOLDERS

Stakeholders in the I-210 Pilot include agencies and groups having a direct interest in system operations and in how the proposed system might affect travel conditions in the corridor. Participation by and coordination among the stakeholders is vital to the project's success. Stakeholders, listed alphabetically, include:

- California Highway Patrol (CHP)
- Caltrans District 7 and Headquarters
- City of Arcadia
- City of Duarte
- City of Monrovia
- City of Pasadena
- Foothill Transit
- Los Angeles County Service Authority for Freeway Emergencies (LA SAFE)
- Los Angeles County Department of Public Works (LADPW)
- Los Angeles County Metropolitan Transportation Authority (Metro), including Metro Bus and Metro Rail
- Pasadena Transit
- San Gabriel Valley Council of Governments (SGVCOG)
- Southern California Association of Governments (SCAG)
- University of California, Berkeley – PATH
- US Department of Transportation (USDOT)

This list constitutes the core project partners. As the project moves forward, it is likely that additional stakeholders will be identified and engaged in the project.

Table 2-2 identifies the key roles the various project stakeholders play in the management and operations of the corridor. These roles are defined as:

- **Freeway operators** – Entities managing freeway traffic
- **Roadway operators** – Entities managing local arterials and regional highways
- **Rail transit operators** – Entities providing commuter rail and light-rail transit services
- **Bus transit operators** – Entities providing fixed-route transit services
- **Paratransit operators** – Entities providing on-demand transit services
- **Parking operators** – Entities managing parking garages and parking lots within the corridor
- **Park-and-ride lot operators –** Entities managing park-and-ride facilities within the corridor
- **Motorist aid services** – Entities responsible for providing aid to stranded motorists
- **Emergency responders** – Entities tasked with responding to incidents and emergency situations
- **511/Information providers** – Entities using information produced by the ICM system to generate and distribute value-added travel information to corridor travelers
- **Information consumers** – Entities using information produced by the ICM system to help plan their movements within the corridor
- **Local transportation planning** – Agencies planning transportation system development at a local level (e.g., city transportation planning department)
- **Regional planning** – Agencies forecasting regional travel demand patterns and developing long-

range transportation improvement plans

- **Technical/policy advisor –** Entities involved in developing and applying regional standards and policies
- **Application developer and system integrators** – Entities responsible for developing, and possibly operating, devices and systems used within the corridor

**Table 2-2 – Roles of I-210 Pilot Stakeholders**

| Stakeholders | Roles | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Freeway Operator | Roadway Operator | Rail Transit Operator | Bus Transit Operator | Paratransit Operator | Parking Operator | Motorist Aid Services | Emergency Responder | 511/Information Provider | Information Consumer | Local Transportation Planning | Regional Planning | Technical/Policy Advisor | Application Developer/Integrator |
| Caltrans – District 7 | ● | ● | | | | ● | | | ● | ● | ● | ● | ● | |
| Caltrans – Headquarters | | | | | | | | | | | | | ● | |
| Los Angeles County Metropolitan Transportation Authority | | | ● | ● | | ● | | | ● | ● | | ● | ● | |
| Los Angeles County | | ● | | | ● | ● | | ● | ● | ● | ● | ● | ● | |
| City of Pasadena | | ● | | ● | ● | ● | | ● | ● | ● | ● | | | |
| City of Arcadia | | ● | | | ● | ● | | ● | ● | ● | ● | | | |
| City of Monrovia | | ● | | | ● | ● | | ● | ● | ● | ● | | | |
| City of Duarte | | ● | | ● | | ● | | | ● | ● | ● | | | |
| Foothill Transit | | | | ● | | | | | ● | ● | | | | |
| Pasadena Transit | | | | ● | | | | | ● | ● | | | | |
| LA County Service Authority for Freeway Emergencies (LA SAFE) | | | | | | | ● | ● | ● | ● | | | | |
| California Highway Patrol (CHP) | ● | ● | | | | | ● | ● | ● | ● | | | | |
| Southern California Association of Governments (SCAG) | | | | | | | | | | | | ● | ● | |
| San Gabriel Valley Council of Governments (SGVCOG) | | | | | | | | | | | | ● | ● | |
| University of California, Berkeley – PATH Program | | | | | | | | | | | | | ● | ● |
| US Department of Transportation (USDOT) | | | | | | | | | | | | | ● | |

## 2.6. PROBLEMS TO BE ADDRESSED

The intent of the I-210 Pilot is to coordinate the various transportation networks and control systems currently in use so they can operate in a cohesive and integrated manner. This presents a unique set of technical, procedural, and organizational challenges. It means investigating tools and technologies and developing processes that will help the various corridor agencies improve their real-time collaborative decision-making.

Figure 2-5 maps various issues that were identified early in the project as important to the development of an ICM system for the I-210 corridor.

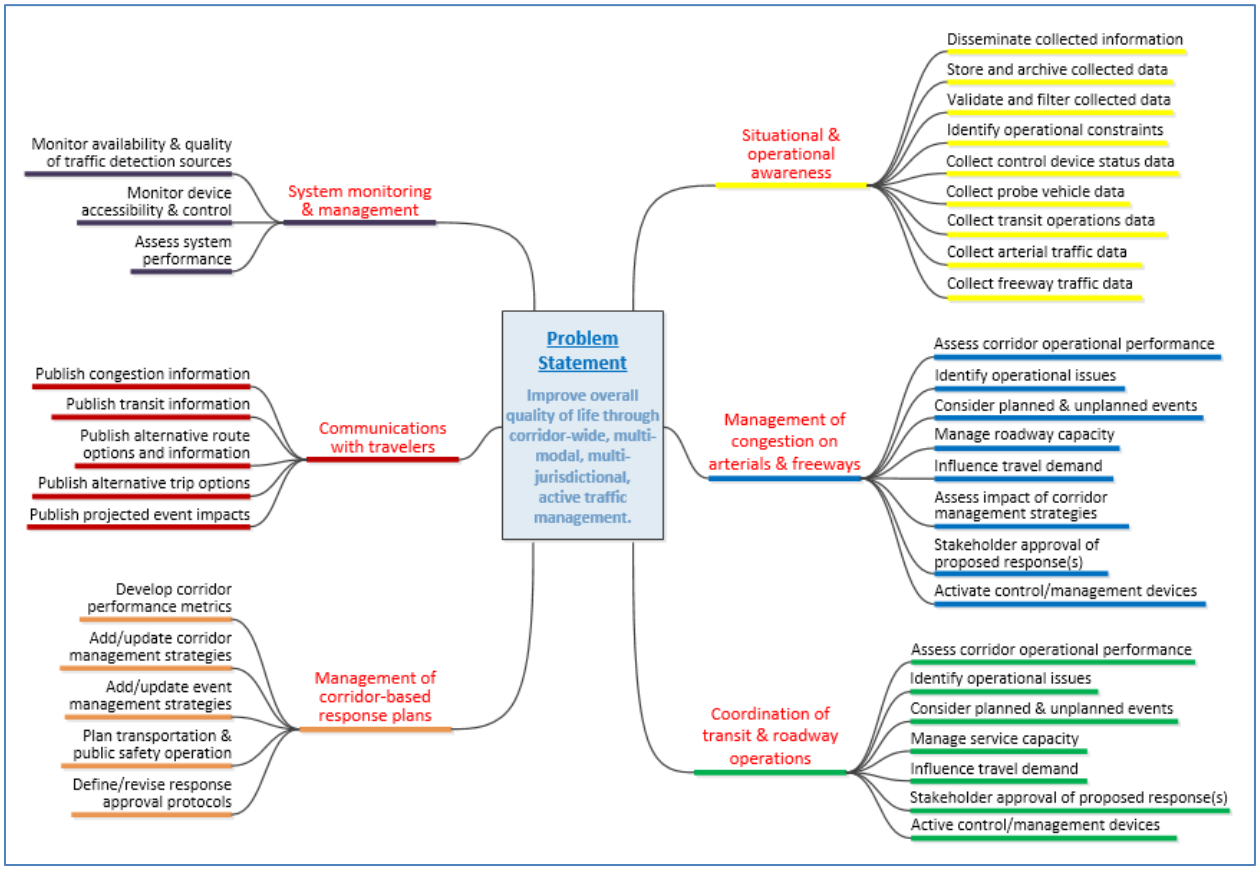


**Figure 2-5 – Mapping of User Issues to General Corridor Management Needs**

The figure lists six general operational issues to be addressed:

- Enhancement of situational and operational awareness for system operators and managers
- Management of congestion spanning freeway and arterials
- Coordination of transit and roadway operations
- Management of corridor-based response plans
- Enhancement of communication with system users
- Monitoring and management of the deployed ICM system

### 2.6.1. ENHANCEMENT OF SITUATIONAL AND OPERATIONAL AWARENESS

Both the capacity of transportation systems and the travel demand placed on them are somewhat dynamic. This dynamic quality underscores the need for adequate monitoring. For example:

- **Capacity.** Arterial capacity, for instance, is strongly affected by the operation of traffic signals at intersections. Roadway capacity is also impacted by driver behavior, inclement weather, construction activities, maintenance activities, traffic incidents, fires, natural disasters, and terror threats. For transit services, capacity is also a function of service frequency and type of vehicles used.
- **Travel demand.** While travel demand is somewhat repetitive on a day-to-day basis, variations can occur over time. Although there are obvious differences between weekdays and weekend days, travel demand may fluctuate on a month-by-month basis and be influenced by business cycles.

Given this variability, up-to-date measurements of corridor performance and travel demand are essential, and will allow agency operators to determine appropriate corridor management strategies designed to meet specific, agreed-upon corridor performance metrics.

Achieving adequate situational and operational awareness is linked to the deployment of comprehensive supportive monitoring systems. While many agencies have devoted substantial efforts to deploying real-time monitoring systems on their transportation networks, significant gaps remain in what is needed for an ICM project in the corridor. For instance, while extensive real-time monitoring capabilities already exist along the I-210 freeway, comparable capabilities along arterials are somewhat limited, with large variations from one operating agency to the next. At many locations, traffic detectors are in place but not configured to supply real-time information. At other locations, inadequate communication bandwidth limits the ability of existing sensors to supply real-time data. Real-time information sharing among agencies is also only partially available.

Inadequate monitoring can significantly impede system operators' ability to devise optimal response strategies for operational issues. Like other aspects of this project, the development of a suitable real-time corridor monitoring system has multiple dimensions that must be considered:

- What type of data can be collected from freeway, arterial, transit, and other monitoring systems?
- How frequently can the data be retrieved?
- How should it be validated and filtered to remove erroneous data?
- How should the information be stored and disseminated for use by corridor systems and stakeholders?
- How can the information be visualized most effectively to facilitate interpretation?

### 2.6.2. MANAGEMENT OF CONGESTION SPANNING FREEWAY AND ARTERIALS

Traffic congestion across the I-210 freeway and surrounding arterials is the primary problem to be addressed. Congestion occurs when demand for travel along a roadway segment exceeds the capacity of the existing infrastructure. Congestion can happen on a recurring basis, such as during peak travel periods on weekdays; during anticipated events, such as the Rose Bowl or other special event; or because of unanticipated events causing roadway capacity reductions in an unplanned and unexpected manner, such as traffic accidents, wild fires, or other events.

While many transportation system operators already dedicate significant effort to addressing the congestion that affects their transportation systems, those efforts often remain confined to their specific network. For instance, Caltrans typically tries to resolve congestion issues along freeways, while cities along the I-210 corridor normally focus only on what happens on surface streets. However, congestion often spreads across networks: Congestion on the freeway often spreads onto local streets; on local street networks, congestion also often spreads across jurisdictional boundaries.

The problem of addressing congestion has multiple aspects. It first involves identifying the extent and potential cause of the problem based on performance assessments of individual transportation links or nodes. This evaluation must also take into consideration planned and unplanned events that may influence system operations. Once operational issues have been identified, actions may be taken to adjust the capacity of roadway elements and influence, to the extent possible, travel demand within the corridor to maximize system performance. The actions to be taken will depend on previously identified and approved response strategies, as well as on the ability to activate the related control devices.

### 2.6.3. COORDINATION OF TRANSIT AND ROADWAY OPERATIONS

While local transit operators are already devoting significant effort to providing efficient services to the I-210 corridor, further improvements could be achieved by coordinating transit and roadway operations. For instance, transit agencies could alter bus routes or offer additional rides in response to major roadway incidents or events. Another strategy could be to provide comprehensive information to travelers about available transit options, such as comparative travel times to key destinations using car or transit.

The major value proposition of the I-210 Pilot for transit agencies is increased travel time reliability and improved transit ridership within the corridor through the coordinated use of existing assets and infrastructure. One of the effects of congestion along the corridor is the inability to provide transit services with desired travel time reliability. This has a significant effect on customer service, as travel time reliability is a major factor in how travelers choose a particular mode of transportation.

The ability to use transit service effectively to support corridor operations will depend on several factors, including:

- Availability of adequate parking near transit stations
- Ability of existing transit vehicles to accommodate additional passengers
- Ability to put additional transit vehicles into service
- Availability of other first-mile or last-mile services
- Ability to monitor transit operations in near real-time
- Ability of transit operators to coordinate their operations
- Ability to communicate information to motorists and transit riders effectively

### 2.6.4. DEVELOPMENT OF COORDINATED CORRIDOR-BASED RESPONSE PLANS

Once the situational awareness issues have been addressed, the problem of defining what to do under different operational environments arises. This is crucial, as a lack of coordination among corridor stakeholders can result in the implementation of less effective solutions than what might be achievable through coordinated control. In some cases, a lack of coordinated control may also be responsible for degrading corridor operations.

Current operations along the I-210 corridor are typically fragmented. Each transportation system is usually managed as an independent system, with only occasional considerations given to cross-system or cross-jurisdictional issues. This prevents implementation of synergistic strategies that could be implemented through a coordinated ICM system.

Regional transportation partners need to be able to define, select, communicate, and implement jointly developed response plans and strategies that address operational issues from a corridor-based perspective. Effective coordination of different operational systems will require the establishment of agreed-upon processes and corridor performance metrics based on common operational philosophies and corridor management objectives.

### 2.6.5. ENHANCEMENT OF COMMUNICATION WITH SYSTEM USERS

The central problem statement in Figure 2-5 is to improve overall quality of life. That involves, in part, consistently meeting system users' reasonable expectations. This means first meeting corridor performance metrics and then communicating reliable information to travelers. Depending on the extent of the traffic management system developed, the information provided to travelers may include the location and severity of congestion hotspots, data for transit services, routing options around problem areas, and data for alternate trip options. For instance, the last option may include providing comparative statistics for trips by car or transit, or for trips delayed by a certain amount of time. Information about the projected impacts of incidents or events may also be published to provide travelers advance information about future traffic conditions and enable them to respond well ahead of time to a given situation.

### 2.6.6. MANAGEMENT AND MONITORING OF DEPLOYED ICM SYSTEM

The effectiveness of traffic management is highly dependent on:

- Information gathering—the quality and completeness of the information used to monitor the operations and performance of individual systems
- System control—the ability to implement desired control actions

While suitable field equipment may be deployed for adequate information gathering and system control, such devices can degrade over time due to exposure to weather, traffic, construction activities, vandalism, or other causes. To maintain an appropriate level of operations, it is imperative to monitor deployed equipment continuously and advise system operators about equipment health. This may require developing methods and metrics for assessing equipment and overall system health based on the equipment status and the monitoring information.

## 2.7. INSTITUTIONAL FRAMEWORK

Figure 2-6 shows the institutional framework supporting the operation of the I-210 Pilot ICM system. This framework includes the following groups or individuals:

- **Corridor Manager** – The person principally responsible for ensuring that the ICM process is successful. This is the most important role described in this document and requires organizational, managerial, and technical skills and awareness. For the I-210 corridor, it is expected that this individual will be a Caltrans staff member. While this person may have authority to approve/reject control changes affecting Caltrans-operated devices, this authority will not extend to the local agencies. Traffic managers from each agency are expected to retain decision authority over their respective systems. In this context, the Corridor Manager can be viewed as a system coordinator tasked with assessing how well the individual systems connected to the ICM system are operating together and determining whether specific issues need to be escalated for consideration by the Technical and Operational Advisory Committee or Connected Corridors Steering Committee. Another important role will be to ensure that agreed-upon action items are carried through by the individual system stakeholders.
- **Core System Operators** – Operators of the road network managed by the ICM system. These represent the individuals responsible for approving/rejecting traffic control recommendations made by the ICM system when automated control is not enabled.
- **511 Services / Information Providers / Information Consumers** – Agencies and entities predominantly providing information to the ICM system or using information generated by it to affect their decision-making process. This includes first responders, transit agencies, and information providers.

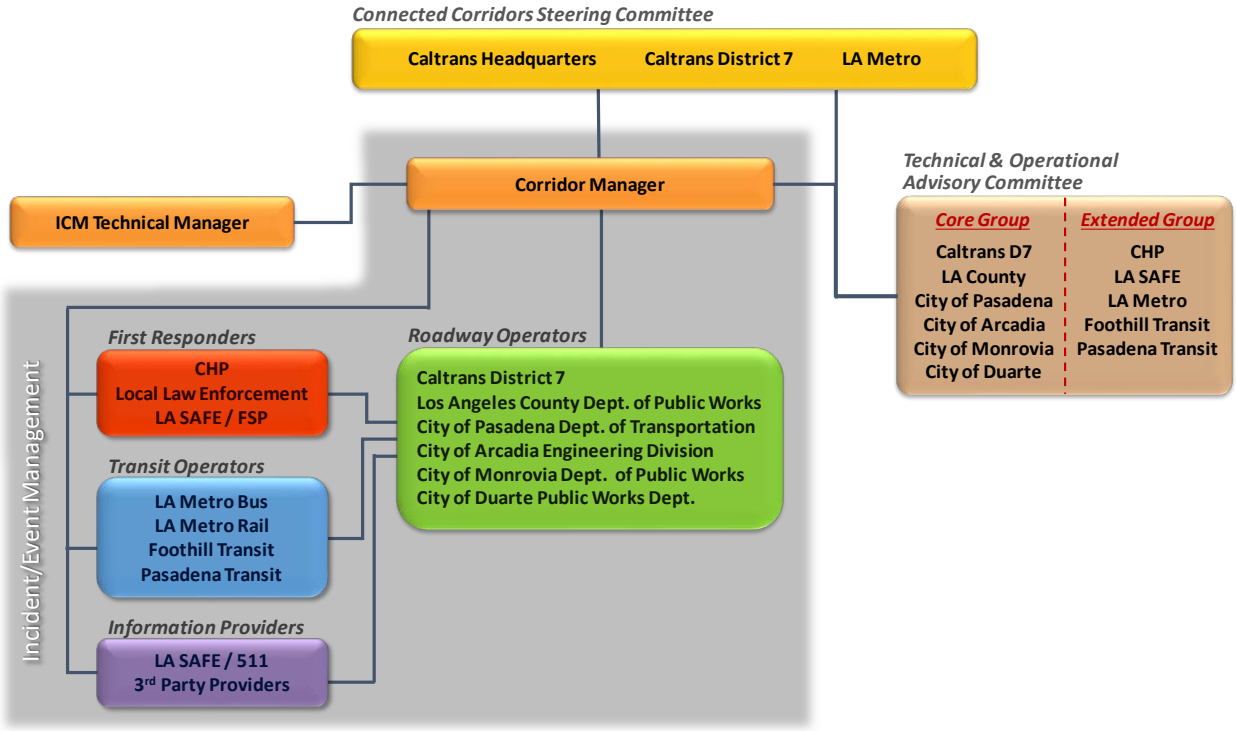


**Figure 2-6 – Institutional Framework**

- **Corridor Technical Manager** – Individual tasked with ensuring the good operation of the ICM system components. This includes managing needed system maintenance and repairs that this person, the Corridor Manager, or other system stakeholders have identified, as well as emergency repairs to address system breakdowns. Since the system is to be operated by Caltrans, the Corridor Technical Manager will be a Caltrans District 7 employee. While this role will be directly responsible for maintaining the ICM Core System, it would not be responsible for maintaining devices operated by Caltrans or other agencies. This task would fall under the responsibility of the individuals normally assigned to device maintenance. In this case, the only task assigned to the Corridor Technical Manager would be to follow up on identified maintenance and repair activities that are to be conducted, and to report on the status of those activities to the Corridor Manager.
- **Technical & Operational Advisory Committee (TOAC)** – Committee composed of a technical staff person from each of the agencies having a stake in the operation of the ICM system; tasked with addressing system operation issues that could not be resolved by the system operators and/or Corridor Manager. Roles assigned to this committee include reviewing and approving requests for changes in how the ICM system operates, advising on how to resolve operational issues affecting system operations, advising corridor stakeholders on how to resolve issues affecting multiple jurisdictions, assessing system performance against established performance metrics, identifying potential system improvements, and addressing issues related to personnel resources, maintenance, and funding. The committee core group is to include a representative from each agency operating roadways in the corridor. Depending on the issues being considered, representatives from the CHP, LA SAFE, Metro, and transit agencies are also expected to participate in the committee's activities. Expected to meet monthly.
- **Connected Corridors Steering Committee (CCSC) –** Committee composed of representatives of Caltrans District 7, Caltrans Headquarters, and Metro; tasked with resolving any issues that cannot be resolved by the TOAC and with addressing funding, legal, operational policy, and organizational issues associated with the operation of the I-210 ICM system, as well as with developing strategic vision and plans for future system enhancements and/or deployments. Would meet as needed.

## 2.8. CONTROL FRAMEWORK

Figure 2-7 illustrates the basic control framework of the I-210 Pilot ICM system. This framework involves two distinct courses of action:

- **Active incident/event** – Sequence of activities when an incident, planned event, or unplanned event is occurring.
- **Post incident/event** – Sequence of activities after a previously active incident, planned event, or unplanned event has terminated.

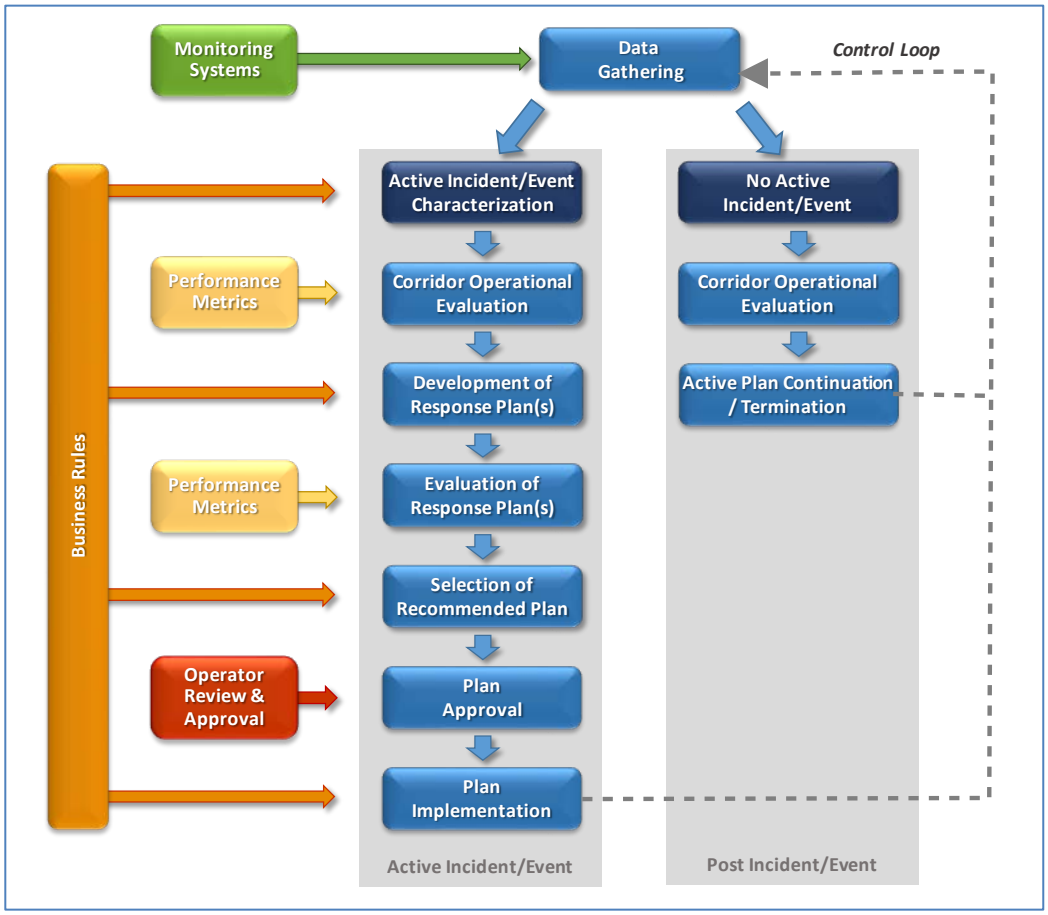


**Figure 2-7 – I-210 Pilot ICM Incident/Event Response Control Framework**

Specific control activities identified in the figure include:

- **Data gathering** – Gathering of data characterizing travel conditions within the corridor from traffic flow sensors, automated vehicle location systems used to track buses and trains, onboard and roadside travel time monitoring devices, traffic signal control systems, etc.
- **Corridor operational evaluation** – Evaluation of travel conditions within the corridor, for both passenger cars and transit travelers, based on the collected data and performance metrics of interest to system operators.

- **Development of response plan(s)** – Identification of traffic control changes, transit service adjustments, and information dissemination needs in response to incidents or events. This step potentially includes the development of both traffic and travel demand management strategies.
- **Evaluation of response plan(s)** – Use of analytical or simulation tools to assess the projected operational performance of the various response plans developed.
- **Selection of recommended plan** – Selection of a recommended course of action based on the results of the evaluations and performance thresholds agreed upon by system operators.
- **Plan approval –** Review and approval by corridor stakeholders of a recommended response plan produced by the ICM system.
- **Plan implementation** – Implementation of approved control actions.
- **Active plan continuation/termination** – Termination of active response plan after corridor operations have returned to normal following the termination of an incident or closure of an event.
- **Control loop** – Periodic re-evaluation of travel conditions within the corridor and, if necessary, generation of new response plans until the need for ICM control disappears.

## 2.9. MODE OF OPERATION

A pivotal step in the control framework shown in Figure 2-7 is the requirement for operator review and approval before a response plan can be implemented:


**Figure 2-8 – Operator Review and Approval of Recommended Response Plan**

Including this level of user oversight means the ICM system operates in a **semi-automated** mode. The basic process is:

1. The system's decision-support intelligence evaluates corridor travel conditions, develops one or more response plans to an incident or event, and recommends a preferred plan, all without intervention from the system operator.
2. At that point, one or more operators review and approve/disapprove the recommended plan.
3. With these approvals, the system then implements the plan, directly operating the control devices necessary to address the incident or event.

## 2.10. KEY SYSTEM COMPONENTS

Figure 2-9 identifies the key components of the ICM system and how they relate to each other:

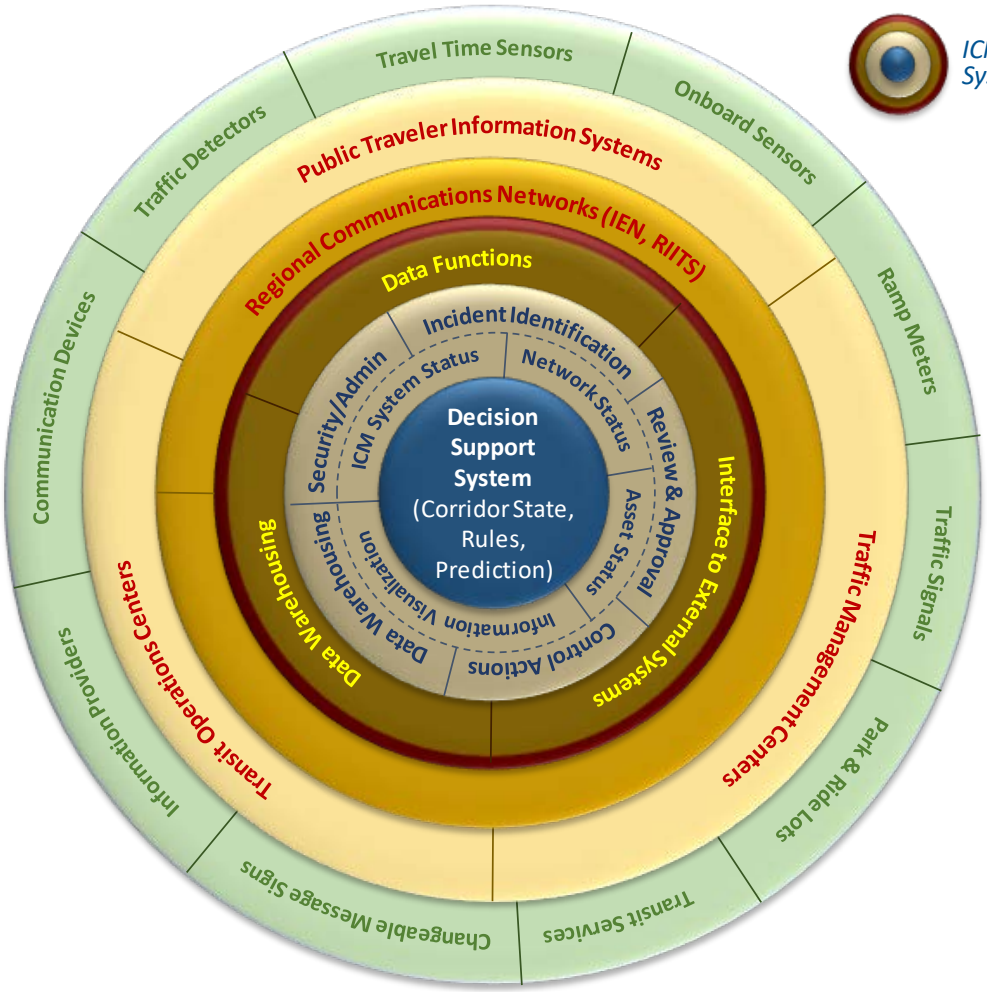


**Figure 2-9 – I-210 Pilot ICM System Key Components**

Starting from the outer ring and moving toward the center, the following categories of components are defined:

- **Field control and informational elements** – Field elements are the foundational components of the proposed system. They include devices to collect data from various systems to support ICM operations, as well as devices and services that can be used to affect traffic and travel behavior within the corridor. Key field elements include:
    - *Detectors* supplying information about traffic flows on roadway elements, such as loop detectors, video traffic detection systems, and travel time measurement devices.

  - *Onboard devices* that may be used to collect information about the movements of individual vehicles, including passenger cars, trucks, buses, and trains.
  - *Freeway on-ramp and connector metering signals* used to meter the flow of vehicles entering freeways from local arterials or connecting from one freeway to the next.
  - *Traffic signals* used to control traffic movements at intersections along arterials and supporting centralized traffic signal control systems.
  - *Transit services* operated within the corridor, such as the Metro Gold Line and bus routes operated by Metro, Foothill Transit, Pasadena Transit, and other agencies.
  - *Park-and-ride lots* available to travelers within the corridor.
  - *Changeable message signs* installed along freeways and arterials used by the different roadway operators to inform motorists of travel conditions or provide route guidance.
  - *Communication equipment* used by transit field supervisors to contact bus or train drivers.
  - *Information services* provided by 511 services and various third-party information providers.

- **Management and operations centers** – Local decision centers providing connections between the ICM system and the various field elements. Key components in this category include:
  - *Traffic management systems* used by local and regional roadway operators to control the various devices under their jurisdiction and collect data generated by the monitoring systems they are operating. Systems include those operated by Caltrans District 7, the LA County Department of Public Works, the City of Pasadena, and the City of Arcadia. Also included here are the workstations providing the cities of Monrovia and Duarte access to the centralized system controlling their traffic signals from the LA County traffic management system.
  - *Transit operations systems* used by local transit agencies to manage the services they offer. This includes the systems operated by Metro to support their bus and rail operations, Foothill Transit, Pasadena Transit, and other transit agencies that may choose to participate in the project.
  - *Traveler information systems* operated by public agencies, such as the regional 511 traveler information system operated by LA Safe, Caltrans' Quickmap real-time traffic information system, or the NextTrip information system operated by Metro.

- **Regional communication networks** – Communication networks that may be used to exchange information between system components housed at different locations. The two key networks currently considered for supporting data exchanges within the I-210 corridor are:
  - *Information Exchange Network (IEN)* – Communication network developed by the Los Angeles County Department of Public Works to enable the sharing of traffic signal data across the various systems used within the county.
  - *Regional Integration of Intelligent Transportation Systems (RIITS)* – Communication network developed by Metro to enable real-time information exchange among freeway, traffic, transit, and emergency service agencies.

- **Technical ICM system elements** – System components directly operated by the ICM server and providing support to the various decision-making processes:
    - *ICM System Status* – Processes defining how ICM components are operating.
    - *Network Status* – Processes identifying the operational status of roadway segments, transit systems, etc.
    - *Asset Status* – Processes identifying the operational status and availability of traffic control and travel management assets.
    - *Information Visualization* – Methods enabling system users to visualize the collected data and the results of evaluations conducted by the ICM system.
    - *Security/Admin* – Processes used to control who has access to the system and to ensure the security of operations.
    - *Incident/Event Identification* – Processes used to identify incidents and events, and to characterize their impacts on network operations.
    - *Review & Approval* – Processes enabling stakeholders to review, if automated approval has not been enabled, the suggestions made by the Decision Support System, make changes to the recommended actions, and ultimately approve/disapprove the recommended plans.
    - *Control Actions* – Processes converting an approved response plan into control commands to be transmitted to system assets and verifying that the requested changes have been successfully implemented. Also includes processes to terminate an implemented response plan and return control assets to normal operations.
    - *Data Warehousing* – Database holding all relevant information collected to characterize corridor operations, as well as information generated by the ICM system during corridor evaluations and the development of response plans.

- **Supporting data** – Information collected by the ICM system to support its decision-making activities. Key data elements to be potentially collected, if available, are identified in Table 2-3, together with an assessment of the importance of each data element to ICM system operations.

**Table 2-3 – Data to be Collected**

| Data | Criticality |
|---|---|
| Data characterizing traffic flow demand and patterns | High |
| Data characterizing the transit services operated within the corridor | Medium |
| Data characterizing the operational status of the various control and informational devices available for use | High |
| Data characterizing the operational performance of buses and train routes operated within the corridor, such as whether vehicles on a given route are being delayed, when an arrival is expected at a particular location, etc. | Low |
| Data characterizing various constraints that must be considered, such as school schedules, roadway closure timetables, etc. | High to Low, depending on the type of constraint |

- **Decision Support System** – Module implementing the intelligence of the ICM system. Key elements of this module include:
    - *Business rules* used to identify whether response plans should be developed to address an active incident or event, and to develop appropriate responses when needed.
    - *Simulation and analytical models* used to perform corridor performance assessments under current and possible future traffic, transit, and travel management strategies.

## 2.11. INFORMATION FLOWS

Figure 2-10 presents a preliminary view of how information is envisioned to flow between the various components of the ICM system. The diagram is not a design element; it is meant simply to illustrate envisioned system operations. Design of the actual system architecture will be conducted in a later stage of the project.

Core functionalities of the ICM system are illustrated by the two circles at the center of the figure. The inner circle, labeled DSS for Decision Support System, represents the system components that will be tasked with making decisions. Surrounding this circle, the circle labeled ICM represents various supporting functionalities of ICM system, such as data processing and communication with external systems.

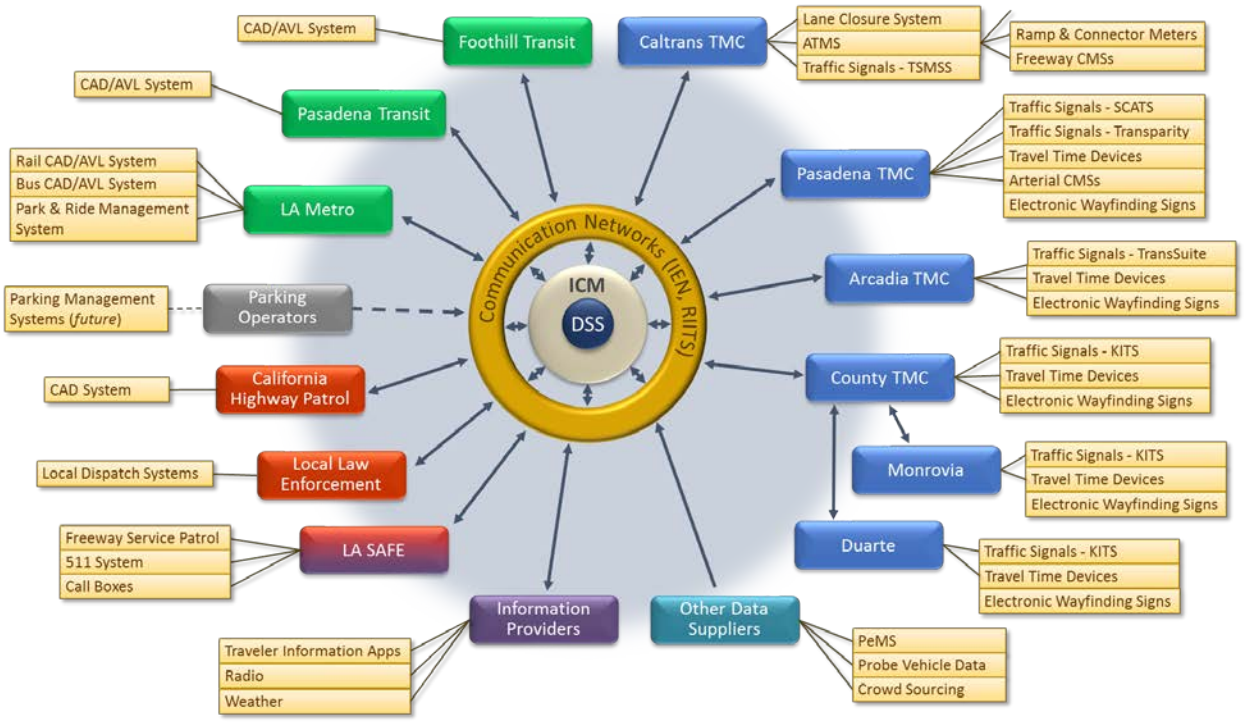


**Figure 2-10 – I-210 Pilot ICM Preliminary High-Level Architecture**

Communication between the core ICM functionalities and external components operated by project stakeholders will be conducted through various existing communication networks. This can include the IEN and RIITS networks described earlier, as well as Caltrans' existing fiber communication network along the I-210 freeway. Where no communication network exists, or where limitations of existing networks may constrain system operations, use of leased communication lines may also be considered.

Surrounding the communication ring are the various entities that will potentially contribute information to the core ICM system or receive information from it. These entities are color-coded as follows, based on their anticipated role in the operation of the ICM corridor:

- **Roadway operators**, shown in blue
- **Transit operators**, shown in green
- **Law enforcement and first responders**, shown in red
- **511 services/Information providers**, shown in purple
- **Parking operators**, shown in dark gray
- **Other data suppliers**, shown in blue-green

For each entity, the arrow shows the direction that information is exchanged between the entity and the ICM system. One-directional arrows indicate entities only supplying information to the ICM system or only receiving data from it. Two-directional arrows indicate entities both supplying information to the ICM system and receiving information from it. Dotted lines indicate communication lines that do not currently exist but are planned for the future.

The boxes attached to each entity show the systems the ICM Core System is expected to draw information from and/or provide control recommendations to.

## 2.12. KEY SYSTEM INTERFACES

Key interfaces between the ICM system and external elements must exist or be developed to support system operations. These interfaces include:

- **Interfaces with system operators**
    - Application for system administrators to manage both ICM system operations and access to the system.
    - Application for roadway operators and transit field supervisors to input information into the system, visualize the results of corridor performance evaluations, review the control actions associated with developed response plans, and assess the implementation status of a recommended response plan.
- **Interfaces to information collection systems**
    - Interface to PeMS or ATMS, which are used by Caltrans as its main systems for collecting, processing, and visualizing freeway flow data.
    - Interfaces to the traffic detection and traffic signal control systems operated by Caltrans (TransSuite), LA County (KITS), the cities of Pasadena (Transparity and SCATS), Arcadia (TransSuite), Duarte (KITS), and Monrovia (KITS).

  - Interface to the travel time data collection systems operated by local agencies, such as Arcadia's Vantage system and Pasadena's BlueMAC system.
  - Interfaces to transit operations management systems used by Metro Bus, Metro Rail, Foothill Transit, Pasadena Transit, and any other participating local transit agencies.
  - Interface to the CHP's Computer-Aided Dispatch (CAD) Mobile Traffic Application. This application has been developed by the agency to facilitate dissemination of public information about traffic hazards and collisions from the agency's CAD system to third-party application developers.
  - Interfaces to dispatch systems used by local law enforcement agencies.
  - Interface to Caltrans' Lane Closure System (either direct interface or through PeMS).
  - Interfaces to parking management systems used by operators of park-and-ride facilities participating in the project.

- **Interfaces to communication networks**
  - Functions for retrieving data being circulated within the IEN network and for sending control commands to specific devices through the network.
  - Functions for retrieving data circulated within the RIITS network.

- **Interfaces to device control systems**
  - Interfaces to traffic signal control systems operated by Caltrans (TransSuite), LA County (KITS), the cities of Pasadena (Transparity and SCATS), Arcadia (TransSuite), Duarte (KITS), and Monrovia (KITS).
  - Interface to Caltrans' ATMS, which is used by Caltrans to control ramp meters on freeway on-ramps and connectors, as well as post messages on freeway CMSs.
  - Interface to systems used by local agencies to post messages on changeable message signs operating along arterials.

- **Traveler information dissemination**
  - Application for law enforcement and first responders to access relevant information generated by the ICM system, such as recommended detour routes or information about current and projected congestion hotspots.
  - Application for the ICM system to feed relevant travel information to the regional 511 systems and/or applications operated by third-party information service providers.

## 2.13. STATES OF OPERATION

The ICM system will provide decision support and recommend courses of action for a typical range of situations faced by transportation system operators, including:

- Non-recurrent congestion due to unplanned events, such as:
  - Unexpected road closures
  - Minor roadway incidents
  - Major roadway incidents
  - Transit incidents
  - Unexpected adverse weather events, such as fog or flooding
  - Fire events near roadways
  - Natural disasters
  - Terror threats
- Non-recurrent congestion due to planned events, such as:
  - Maintenance and construction activities
  - Special events, such as concerts and sports activities
  - Forecasted weather events, such as predicted rain storms

Even when not engaged in responding to specific incidents and events, the ICM system will keep monitoring and periodically evaluating travel conditions within the corridor on a 24/7 basis.

In addition to considering the operational situations described above, the ICM system should be robust enough to keep operating in a state of partial failure. Periodic system checks should assess whether individual system components are operating as intended, as well as the health of input data feeds and the quality of input data. Following the detection of potential operational problems, such as issues with detector data or an inability to communicate with field devices, the system should inform transportation system operators of detected problems and try to continue its operation, to the extent possible, by compensating for the identified problems. Should a major failure preventing adequate system operation be detected, the system should then revert to a fail-safe operational mode allowing it to implement predetermined control strategies in response to incidents or events, or simply shut down if a certain minimal state of operation cannot be guaranteed.

# 3. IDENTIFIED USER NEEDS

This section outlines the key user needs that corridor stakeholders have identified for the ICM system. These needs were determined from a conceptual system analysis and input from corridor stakeholders and the ICM system development team. Elements presented in this section include:

- Categories of users
- User needs
- Data collection needs

## 3.1. CATEGORIES OF USERS

Table 3-1 identifies potential users of the I-210 Pilot ICM system. Two main categories of users are distinguished based on how individuals or agencies would interact with the system:

- **System Operators (Direct Users)** – Individuals actively participating in the operation of the system and having administrative access to some or all of its components
- **End Users (Indirect Users)** – Individuals who do not actively participate in the operation of the system but who may use it to view how the corridor is operating or gather information that may help them make decisions

**Table 3-1 – Categories of System Users**

| System Operators (Direct Users) | End Users (Indirect Users) |
|---|---|
| • Traffic managers<br>• TMC operators<br>• TCS operators<br>• Traffic engineers<br>• Transit field supervisors<br>• Transit dispatchers<br>• Participating parking facilities operators<br>• Participating information providers<br>• Maintenance staff | • Transit vehicle drivers<br>• Transit system managers<br>• California Highway Patrol (CHP)<br>• Local police departments<br>• Local fire departments<br>• Metro Freeway Service Patrol<br>• Parking facility operators not in system operations<br>• Transportation system planners<br>• Transportation supervisors<br>• Transportation department directors<br>• Agency/city executives and decision-makers<br>• Public information officers<br>• 511 services<br>• Third-party information service providers<br>• Commercial fleet operators/managers<br>• Travelers |

## 3.2. BASIC USER NEEDS

Table 3-2 describes the key user needs that will govern the development of the ICM system for the I-210 corridor. These needs were identified following discussions with corridor stakeholders and a review of current operational processes. These needs form the basis for the development of system and functional requirements described in this document.

**Table 3-2 – System User Needs**

| ID | Title | Description |
|---|---|---|
| **System Monitoring** | | |
| 1 | Collect and Process Multi-modal Data Characterizing Corridor Operational Performance | The ICM system needs to collect, on a real-time or near real-time basis, data characterizing the operational performance of roadways, transit systems, parking facilities, and any other relevant transportation elements within the corridor. This information will be used to identify whether incidents, planned events, or unplanned events are having an impact on corridor operations and warrant the evaluation of alternate management strategies. Satisfying this need not only implies identifying which data to collect and collecting the data, but also determining how to validate and filter data from each potential source, as well as developing suitable processing algorithms to reliably derive the information sought. |
| 2 | Collect and Process Multi-modal Corridor Travel Demand Data | The ICM system needs to collect data characterizing the demand for travel along the I-210 corridor. At the core of the system, this includes collecting data characterizing the movement of automobiles, buses, and trucks, as well as possibly individuals, along the freeways and key arterials in the corridor. Information about freight movement, as well as cyclists and pedestrian flows, should also be collected if deemed relevant to the corridor management effort. |
| 3 | Monitor Asset Availability | Agency operators need to monitor the status of all devices and facilities that may be used to control traffic, implement traffic management strategies, or disseminate information to the traveling public on a real-time basis. This means monitoring not only which devices are operational or down for maintenance, but also which operating devices may not be used because of operational constraints. It also includes monitoring available roadway and parking capacity. |
| **Decision Support** | | |
| 4 | Decision-making Assistance | The ICM system should indicate when an operational change is recommended, which systems/control devices should be modified to implement the desired change, and how these systems or devices should be modified. This includes considering both capacity and demand management strategies, where feasible. |
| 5 | Operational Forecast Capability | To assist with the selection of efficient corridor management plans, the ICM system needs to be able to forecast the effects of proposed actions, including a “no action” option, on traffic flow performance, transit system performance, and/or travel demand over near-term intervals. |

**Table 3-2 – System User Needs (cont'd)**

| ID | Title | Description |
|---|---|---|
| **Control Capabilities** | | |
| 6 | Strategy Effectiveness Assessment | Before implementing a recommended strategy, system operators should be able to assess the potential impacts of the strategy on corridor operations. Similarly, following the implementation of an approved response strategy, system operators must to be able to determine if the implemented strategy is having the intended effect. This implies identifying key performance metrics to use to conduct the assessments, developing processes to track changes in system performance over time, and providing suitable reporting capabilities. This also implies providing recommended courses of action based on the results of the strategy effectiveness assessment. |
| 7 | Multi-Agency Coordination Support | Agencies participating in the I-210 Pilot system need to coordinate how they respond to incidents, unscheduled events, or planned events to avoid situations in which two agencies would implement incompatible local response strategies. This means establishing appropriate communication capabilities and a joint operational framework among participating agencies. |
| 8 | Automated Incident Response Capability | To the extent possible and allowed, the ICM system should have the capability to operate in a fully automated mode, without user intervention, during agreed-upon periods or when specific sets of circumstances are met. |
| 9 | Manual Control Capability | Under specific sets of circumstances, system users should have the ability to change one or more components of a response plan manually to address corridor operational issues not adequately captured by the ICM system. This includes an ability to alter traffic control directives and messages disseminated by information devices. |
| 10 | Preferred Control Setup Options | System users should have the capability to identify preferred control actions that the ICM system should consider first when developing responses to specific types of incidents, unscheduled events, or planned events. An example would be the ability to define, as a first response strategy, specific detours or traffic signal control plans. |
| 11 | Device Modification and Addition Capability | The system should allow authorized users to incorporate additional locations and devices into the control environment, as well as to modify or update existing control locations and/or devices. |
| 12 | Information Visualization | To facilitate decision-making activities, information characterizing system operations should be provided to system operators in a format that is easy to read and interpret, such as maps, tables, color-coded displays, etc. |
| **Information Dissemination** | | |
| 13 | Provision of Real-Time, Multi-Modal Information to System Operators | All authorized users should receive, to the extent of their availability, real-time data enabling them to manage their transportation network. This may include observed link speeds, estimated queue sizes, project flows, and various other metrics identified as relevant by individual system users. Providing this data implies not only operating a suitable information exchange network, but also managing restrictions on certain access, features, and/or system controls that may be imposed on certain data feeds. This also includes adding new information or data to the system on a regular basis, such as expanded transit service or the opening of new light-rail lines. |

**Table 3-2 – System User Needs (cont'd)**

| ID | Title | Description |
|---|---|---|
| **Data Management** | | |
| 14 | Provision of Real-Time, Multi-Modal Information to End Users | To help motorists, transit riders, and other travelers make informed decisions during incidents, unscheduled events, and planned events, the ICM system should provide real-time or near real-time information about travel conditions within the corridor to all corridor travelers. This can be done through existing 511 and roadside information systems, third-party information providers, or the development of new mobile applications. |
| 15 | Historical Data Archiving | The data collected and information generated by the ICM system during its daily operations needs to be stored to support future offline analyses and corridor evaluations, as well as corridor modeling activities. Satisfying this need implies setting up one or more databases for storing historical data, determining the criteria governing which data will be stored and for how long, defining the protocols for archiving data, and defining the protocols for accessing and managing the database. Data output from the system should further be in a format consistent with the regional ITS architecture and be able to be utilized by other mainstream software systems. |
| **System Management and Maintenance** | | |
| 16 | ICM System Management | Administrative functions need to be developed to enable authorized users to support the management of user accounts, system configurations, and system security. |
| 17 | System Maintenance | The ICM system should have the ability to provide system diagnostics and to alert relevant authorized users to any malfunctions or inoperable devices. Authorized users should be able to identify the specific devices needing maintenance, as well as the locations of these devices. The ICM system should also be able to perform self-diagnostic checks to assess maintenance needs and recommend maintenance actions. |
| 18 | Training Support | Adequate documentation must be available to support system operations and maintenance. Adequate training must also be provided when needed. |

## 3.3. DATA COLLECTION NEEDS

In order to provide adequate system awareness and assessment of corridor operations, data will need to be continuously collected by the ICM system. This data will be used for both real-time response plan creation and the identification of historical patterns for use during planning operations. The following types of data are critical to system operation:

- **Characterization of traffic conditions on I-210 and other related freeways**
    - Traffic volumes, speeds, and density on mainline and HOV traffic lanes
    - Traffic volumes on both on-ramps and off-ramps
    - Traffic speeds along freeway segments
- **Characterization of traffic conditions on corridor arterials**
    - Traffic volumes from key intersection approaches
    - Proportion of vehicles turning left, going through, and turning right at key intersections
    - Average queue length for key intersection approaches
    - Average traffic speed between intersections along arterials of interest
    - Actual travel times between intersections along arterials of interest
- **Characterization of parking availability**
    - Occupancy of park-and-ride facilities linked to the ICM system
- **Characterization of transit operations**
    - Frequency of passage of transit vehicles along relevant transit routes
    - Average occupancy of transit vehicles operating along each relevant transit route
    - Active service deviations
- **Characterization of planned events, unscheduled events, and incidents**
    - Geographical location of incident or event
    - Time incident or event started
    - Agency responsible for managing the incident or event
    - Roadway segments and transit services affected
    - Impact on roadway and transit operations
    - Expected duration of incident or event
- **Status of devices used to monitor traffic**
    - Health status of loop detectors, video detection systems, Bluetooth devices, and any other types of monitoring devices used to collect traffic data
- **State of traffic control devices**
    - Active metering rate at each freeway on-ramp
    - Signal timing plan in operation at each intersection
    - Health status of traffic signal control equipment
- **Status of informational devices**
    - Message currently displayed on freeway changeable message signs
    - Message currently displayed on arterial trailblazer signs or changeable message signs

  - Messages being pushed or recently provided to the regional 511 System and third-party information providers
  - Health status of freeway CMSs
  - Health status of arterial CMSs or trailblazer signs

- **ICM system status**
  - Information indicating whether the ICM system is currently online
  - Health status of various ICM system components

**Data update frequency.** Information characterizing traffic conditions on freeway and arterial segments needs to be updated at least once every 15 minutes to ensure that current traffic conditions are truly being considered in the creation of response plans. To enable the ICM system to quickly detect changes in traffic conditions within the corridor, data characterizing traffic conditions should ideally be updated more frequently, typically every 5 minutes or less. However, while the use of shorter polling intervals is strongly desired, it is also understood that the ability to poll data at a high frequency will ultimately depend on the specific data collection capabilities of the traffic monitoring systems that have been set up by each stakeholder agency. This means that achieving very short sampling intervals may not be possible everywhere in the corridor.

**Information on demand.** Information characterizing the status of devices used to support ICM operations also needs to be available on an on-demand basis. For instance, information indicating which signal timing plan is currently being run at a given intersection must be available to assess corridor operations or determine needed responses to incidents or events. In many cases, information availability is facilitated by the use of control systems that provide feedback on a real-time basis, such as traffic signal control systems that monitor signal indications every second or compile signal operational statistics on a cycle-by-cycle basis. Where such monitoring capability does not exist, appropriate remedial actions will need to be considered.

**Contingency planning.** In addition to the data collection needs listed above, contingency plans also need to be developed to address situations in which data collection devices start providing questionable data or become inoperable. These plans should specify what replacement data may be used, such as the use of historical data in place of faulty real-time data. Data imputation methods should also be considered to fill data gaps.

# 4. DATA SOURCES

This section identifies the data sources that may be used to support the operation of the ICM system.

**Table 4-1 – Potential Data Sources**

| Data Category | Data Type | Source Agency | Source System(s)/Individual(s) |
|---|---|---|---|
| Incidents and Events | Incident reports | California Highway Patrol | • Mobile Traffic Application (*application disseminating public-domain data from the agency's Computer Aided Dispatch system*)<br>• Traffic Incident Information Webpage (*website where SigAlerts are posted*) |
| | | County Sheriff | • Agency dispatcher |
| | | Pasadena PD | • Agency dispatcher<br>• Pasadena Traffic Record System |
| | | Arcadia PD | • Agency dispatcher |
| | | Monrovia PD | • Agency dispatcher |
| | | Duarte PD | • Agency dispatcher |
| | | Verdugo Fire Communications | • Verdugo Fire Communications Center dispatcher<br>• Computer-Aided Dispatch system |
| | | Caltrans | • TMC operators |
| | | Third-party data providers | • Crowdsourcing applications allowing access to user-generated data |
| | Lane closures/ Special events | Caltrans | • Lane Closure System (LCS) |
| | | LA County | • LA County Road Closures website |
| | | Pasadena | • *None* |
| | | Arcadia | • *None* |
| | | Monrovia | • *None* |
| | | Duarte | • *None* |
| Traffic Counts | Freeway traffic counts | Caltrans | • Advanced Traffic Management System (ATMS)<br>• Traffic Management Center's Front-End Protocol Translator (FEPT)<br>• Performance Measurement System (PeMS) |
| | Intersection approach flows & turning counts | Caltrans | • Traffic Signal Management & Surveillance System (TSMSS) |
| | | LA County | • KITS Traffic Management System |
| | | Pasadena | • Transparity Traffic Management System<br>• SCATS Traffic Management System |
| | | Arcadia | • TransSuite Traffic Management System |
| | | Monrovia | • LA County's KITS Traffic Management System |
| | | Duarte | • LA County's KITS Traffic Management System |
| Speed | Point measurements | Caltrans | • PeMS (*estimated speeds*) |
| | | Probe Data Providers | • Real-time and/or historical speed measurements from probe vehicles (*potentially from HERE, INRIX, Google, or other entity electing to participate in the project*) |
| | Average link speeds | Probe Data Providers | • Calculated average link speeds from probe vehicle data (*potentially from HERE, INRIX, Google, or other entity participating in the project*) |

**Table 4-1 – Potential Data Sources (cont'd)**

| Data Category | Data Type | Source Agency | Source System(s)/Individual(s) |
|---|---|---|---|
| Travel Times | Travel time measurements | LA County | • Digiwest BlueMAC Bluetooth sensor network |
| | | Pasadena | • Digiwest BlueMAC Bluetooth sensor network<br>• SMART system |
| | | Arcadia | • Iteris Vantage Velocity Bluetooth sensor network |
| | | Monrovia | • LA County's Digiwest BlueMAC Bluetooth sensor network |
| | | Duarte | • LA County's Digiwest BlueMAC Bluetooth sensor network |
| | | Probe Data Providers | • Calculated segment speeds from real-time or historical probe data (*potentially from HERE, INRIX, Google, or other entity participating in the project*) |
| | Travel time estimates | Caltrans | • Performance Measurement System (PeMS)<br>• Advanced Traffic Management System (ATMS) |
| Route Patterns | Vehicle tracking | Probe Data Providers | • Real-time or historical vehicle tracking data (*potentially from HERE, INRIX, Google, or other entity participating in the project*) |
| Traffic Signals | Signal operational status (active plan/phase, cycle length, offset, etc.) | Caltrans | • Traffic Signal Management and Surveillance System (TSMSS) |
| | | LA County | • KITS Traffic Management System |
| | | Pasadena | • Transparity Traffic Management System<br>• SCATS Traffic Management System |
| | | Arcadia | • TransSuite Traffic Management System |
| | | Monrovia | • Los Angeles County's KITS Traffic Management System |
| | | Duarte | • Los Angeles County's KITS Traffic Management System |
| | Ramp metering plan/rates | Caltrans | • Advanced Traffic Management System (ATMS) |
| Video Data | CCTV feeds | Caltrans | • Advanced Traffic Management System (ATMS) |
| | | LA County | • System used to manage video feeds |
| | | Pasadena | • COHU Videowise Management Software |
| | | Arcadia | • TransCore video web application |
| | | Monrovia | • System used by Los Angeles County to manage video feeds |
| | | Duarte | • *None* |
| Messaging | Messages posted on changeable message signs | Caltrans | • Advanced Traffic Management System (ATMS) |
| | | LA County | • *None (no device in use in corridor)* |
| | | Pasadena | • System used to manage existing arterial CMS signs |
| | | Arcadia | • *None (no device in use)* |
| | | Monrovia | • *None (no device in use)* |
| | | Duarte | • *None (no device in use)* |
| | Highway Advisory Radio broadcasts | Caltrans | • Highway Advisory Radio stations |
| Transit Data | Transit operations | Metro | • Metro Bus CAD/AVL<br>• Metro Rail CAD/AVL |
| | | Foothill Transit | • Foothill Transit CAD/AVL |
| | | Pasadena Transit | • Pasadena Transit CAD/AVL |

**Table 4-1 – Potential Data Sources (cont'd)**

| Data Category | Data Type | Source Agency | Source System(s)/Individual(s) |
|---|---|---|---|
| Parking Data | Parking occupancy | Metro | • Systems used to monitor parking availability at park-and-ride facilities along the Metro Gold Line (*planned future system*) |
| | | Private parking operators | • Systems used to monitor parking availability at facilities operated by third-party private operators participating in the operations of the ICM system |
| Weather Data | Weather information | ICM System | • Data from weather stations to be installed along I-210 corridor |
| | | Caltrans | • RWIS stations operated by Caltrans<br>• Data from MesoWest weather stations |
| | | Weather information providers | • Data disseminated by weather information services (National Weather Service, Weatherbug, Google WeatherBug, AccuWeather, others) |

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# 5. DATA DESTINATIONS

This section identifies the data destinations that may be used to support operation of the ICM system.

**Table 5-1 – Potential Data Destinations**

| Data Category | Data Type | Destination Agency | Destination System(s) |
|---|---|---|---|
| Traffic Signal Control Actions | Recommended timing plans | Caltrans | • Traffic Signal Management & Surveillance System (TSMSS) |
| | | LA County | • KITS Traffic Management System |
| | | Pasadena | • Transparity Management System<br>• SCATS Traffic Management System |
| | | Arcadia | • TransSuite Traffic Management System |
| | | Monrovia | • LA County's KITS Traffic Management System |
| | | Duarte | • LA County's KITS Traffic Management System |
| | Recommended ramp metering | Caltrans | • Advanced Traffic Management System (ATMS) |
| Information Dissemination to Travelers | CMS message requests | Caltrans | • Advanced Traffic Management System (ATMS) |
| | | LA County | • Future system(s) used to manage city-operated signs (*if deployed*) |
| | | Pasadena | • Existing system(s) used to manage city-operated signs |
| | | Arcadia | • Future system(s) used to manage city-operated signs (*if deployed*) |
| | | Monrovia | • Future system(s) used to manage city-operated signs (*if deployed*) |
| | | Duarte | • Future system(s) used to manage city-operated signs (*if deployed*) |
| | Requests to active/deactivate extinguishable trailblazer signs | LA County | • Future system used to manage signs to be deployed within County areas |
| | | Pasadena | • Future system used to manage signs deployed within city's jurisdiction |
| | | Arcadia | • Future system used to manage signs deployed within city's jurisdiction |
| | | Monrovia | • Future system used to manage signs deployed within city's jurisdiction |
| | | Duarte | • Future system used to manage signs deployed within city's jurisdiction |
| | Information to travelers information systems | LA SAFE | • 511 System |
| | | Caltrans | • Highway Advisory Radio stations operated in the vicinity of the I-210 corridor<br>• QuickMap<br>• Caltrans Highway Information Network (CHIN)<br>• Caltrans Commercial Wholesale Web Portal |
| | | Third-Party Information Providers | • News media (radio, television)<br>• Web-based traveler information systems<br>• In-vehicle real-time navigation applications<br>• Mobile navigation applications |

**Table 5-1 – Potential Data Destinations (cont'd)**

| Data Category | Data Type | Destination Agency | Destination System(s) |
|---|---|---|---|
| Stakeholder Communications | Messages to dispatch centers | Metro Rail | • Metro Bus CAD/AVL |
| | | Metro Bus | • Metro Rail CAD/AVL |
| | | Foothill Transit | • Foothill Transit CAD/AVL |
| | | Pasadena Transit | • Foothill Transit CAD/AVL |
| | | Verdugo Fire Communications Center | • Verdugo Fire Communications CAD |
| | Interagency communication networks | LA County | • Information Exchange Network (IEN) |
| | | Metro | • Regional Integration of ITS (RIITS) network<br>• Everbridge mass notification platform |
| | | LA County Sheriff's Department | • NIXLE communications platform |

# 6. SUPPORTING ROLES

The following roles are referenced in the requirements and are expected to be filled by personnel from various stakeholder agencies. Not every agency will have every role, and specific job titles may vary from agency to agency.

**Table 6-1 – Supporting Roles for the I-210 Pilot**

| Role | Description |
|---|---|
| Corridor Champions | Individuals responsible for leading the program, securing mind share, and acquiring resources within the major organizations participating in the ICM process. |
| Corridor Manager | The person principally responsible for ensuring that the ICM process is successful. This is the most important role described in this document and requires organizational, managerial, and technical skills and awareness. |
| Corridor Technical Manager | This person is responsible for ensuring the software and hardware components of the ICM system are maintained, upgraded, and working to expectations. |
| Corridor Data Analyst | This is an extremely important role. This person is responsible for analyzing corridor data, setting quality standards, ensuring data meets these standards, and identifying when it does not. |
| Traffic Engineers | These personnel fill an essential role in the ICM process. They provide the knowledge required to create and maintain response plans, rules, and the models contained in the Decision Support System. |
| Data Analysts | These personnel are responsible for day-to-day implementation of the data quality standards, ongoing review of ICM environment data quality, and initiation of corrective actions. |
| Software Engineers | These personnel are responsible for tracking down and remedying software-related problems (“bugs”) and for providing upgrades as required. |
| Electrical Engineers | These personnel are responsible for tracking down and remedying hardware- and communication-related problems and for providing upgrades as required. |
| Database Administrators | This role is responsible for ensuring access and proper storage of all corridor data. |
| Maintenance Staff | These personnel are responsible for ensuring all ICM hardware and communication components are maintained and in working order. |
| IT Support | These personnel are responsible for ensuring the day-to-day operation and maintenance of workstations, internet access, and software configuration information. |
| IT Security | These personnel are responsible for ensuring that all ICM components (software, hardware, and personnel) are safe and secure. |
| Transportation Management Center (TMC) Operators | These personnel are responsible for day-to-day interaction with the ICM system, providing incident information and approving response plans. |
| Local Traffic Control System (TCS) Operators | Similar to TMC operators, these personnel are responsible for day-to-day interaction with the ICM system. |
| Transit Field Supervisors (Rail, Bus) | These personnel are responsible for day-to-day interaction with the ICM system, providing incident information to the system and relaying response plan recommendations to operators. |

| | |
|---|---|
| Public Information Officers | These personnel are responsible for public and media relations during major incidents or major changes to the ICM system. |
| First Responders | Law enforcement, fire, and other emergency response personnel along the corridor. |
| Outreach and Communications Manager | This person is responsible for ensuring an ongoing flow of information among all ICM stakeholders both during incidents and as part of planning and general PR efforts. |
| Stakeholder Governing Bodies | These personnel are responsible for major policy decisions and the resolution of significant disputes. |
| Oversight Committees | These committees are responsible for ensuring the overall success and proper operation of the ICM system. |

# 7. REQUIREMENTS OVERVIEW

This section presents an overview of the requirements for the I-210 Pilot ICM system. It includes:

- Terms you need to know to understand the requirements
- How the requirements are presented
- Information about the process and considerations involved in developing requirements
- A short summary of the categories of requirements (presented in more detail in sections 8 and 9)

## 7.1. ESSENTIAL TERMS YOU NEED TO KNOW

As described in section 2.10 and shown again in Figure 7-1, the components of the ICM system can be illustrated as concentric layers:

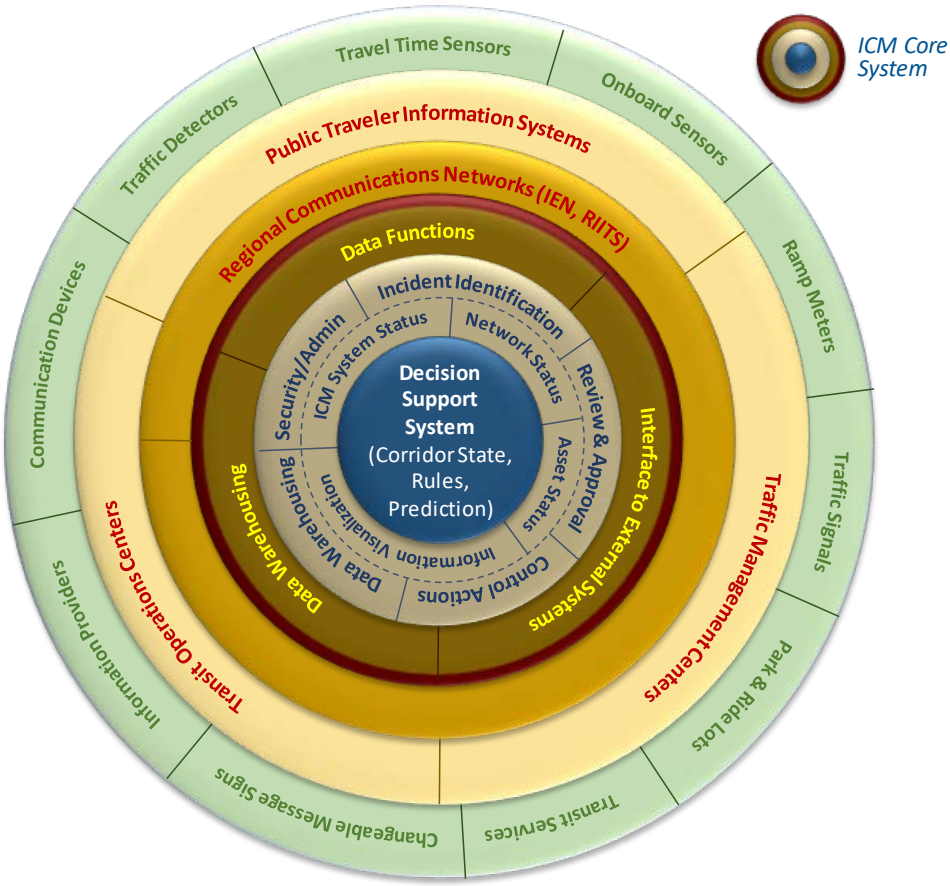


**Figure 7-1 – I-210 Pilot ICM System Key Components**

It is important to remember, however, that ICM is not solely a technical approach to traffic management. It requires, above all, the ongoing engagement and collaboration of people and organizations, as well as hardware and software, in order to succeed.

Consequently, this document uses two terms that are essential for understanding the system requirements:

- **ICM Core System**: The core technical functionalities identified in Figure 7-1 (the three innermost circles) and described in section 2.10
- **ICM Environment**: *All* the components—including people, organizations, hardware, and software—involved in the functioning ICM system

## 7.2. HOW THE REQUIREMENTS ARE PRESENTED

To make the requirements accessible to a range of users, they are presented in this document in three different formats and increasing levels of detail. As summarized in Table 7-1, this includes brief summaries for management overview and presentations, generic descriptions for management and stakeholders, and standard detailed requirements to support forthcoming design and implementation activities.

**Table 7-1 – Supporting Roles for the I-210 Pilot**

| Format | Suitable for | Location |
|---|---|---|
| Brief summaries | Management overview and presentations | Section 7.4 |
| Generic descriptions that include metrics and context, without mentioning specific agencies, local data sources, data formats, detailed metric values, or lower-level requirements | Management and other stakeholders wanting a fuller and more contextual understanding of the requirements, as well as the general KSAs (knowledge, skills, and abilities) needed for the project, but without the details specific to the I-210 Pilot. Also useful for stakeholders of other corridors, as a starting point or template for generating their own detailed requirements. | Section 8 |
| Standard detailed requirement lists, including corridor specifics, actual agencies, and particular systems | Generating implementation plans and test cases specific to the I-210 corridor | Section 9 |

In addition to the requirements themselves:

- A glossary of terms used in the requirements can be found in section 10.
- Additional materials are available in the Document Library of the I-210 Pilot website at http://ccdocs.berkeley.edu/content/document-library:
    - Appendix A contains flow charts illustrating expected operational processes.
    - Appendix B describes the "actors and stories" approach used in developing the requirements. It also includes notes from requirements-gathering meetings with stakeholders, where needs and objectives for the requirements were discussed.
    - An associated data dictionary is also available.

Taken together, these materials:

- Provide generic guidelines for developing ICM system requirements, to help ensure that every important functional requirement has been uncovered

- Define a system that mobilizes people, organizations, hardware, and software working together to improve traffic conditions during an incident, unscheduled event, or planned event on the I-210 corridor in Los Angeles County

## 7.3. DEVELOPING THE REQUIREMENTS

### 7.3.1. INTRODUCTION

The generation of requirements is a process focused on ensuring that stakeholders, implementers, users, and future reviewers of the system understand what it must do to function effectively. This means specifying not only the required system functions but also the metrics and metric values to be used in measuring the performance of these functions, as well as the necessary human and institutional elements to support system operations.

Anecdotal evidence suggests that standard methods of listing requirements do not necessarily lead to success, i.e., to the development of systems that meet the needs they were built to address. This assessment led the project team to carefully consider the approach that would be used to develop requirements for the proposed ICM system.

#### *7.3.1.1. Sources of Information*

The requirements are based primarily on information gathered from system stakeholders on the purpose and desired functionalities of the system. Specific sources of information that were considered include:

1) User Needs for the I-210 Pilot that were collaboratively identified by system stakeholders
2) The Concept of Operations for the I-210 Pilot that was previously developed by the PATH Connected Corridors project based on the identified user needs
3) Comments gathered from approximately 75 interviews with individuals and more than 20 meetings focused on requirements gathering
4) Transportation Systems Management and Operations (TSM&O) success criteria
5) ICM Capability Maturity Matrix developed by Caltrans
6) Review of system requirements developed for both the Dallas and San Diego ICM systems
7) Review of various technical documents, websites, and presentations related to ICM
8) Advice from informed personnel from other ICM sites
9) Advice from knowledgeable consultants
10) Personnel with knowledge of real-life constraints
11) Management judgment

#### *7.3.1.2. Goals*

By collecting a range of information, the project team was also able to define multiple goals for the requirements generation process. These goals were to:

1) Educate stakeholders on what functions are needed for successful ICM
2) Reduce risk by refining the scope of the system
3) Obtain agreement among stakeholders on the requirements for the system
4) Ensure that all requirements needed for ICM are listed and that none are overlooked

5) Provide guidance to funders of the system
6) Provide direction to implementers of the system
7) Ensure the system can be tested
8) Provide a template for future ICM efforts

#### *7.3.1.3. Transportation Systems Management and Operations (TSM&O)*

The development of requirements was further guided by the goals of the Transportation Systems Management and Operations (TSM&O) program at Caltrans. This program seeks to use real-time traffic management to improve safety, optimize flow, and minimize the impacts of transportation activities on the environment while adhering to statewide standards and consistency with federal rules and regulations. Success of the program is based on the following concepts:

1) Collaboration – Multiple jurisdictions, organizations, and people working together
2) Work force organization and preparation – Proper organizational structure, work processes, and training
3) Performance measurement – Decisions based on applying measured data to measurable metrics

### 7.3.2. GENERAL THEMES

Throughout the information-gathering activities, several themes were identified that have guided the development of requirements:

- **Change must be supported:** Support of change was a very important and deeply-felt concern to a number of stakeholders. For example, several individuals mentioned that there was currently no way to improve or fix broken or antiquated processes or systems. Others also mentioned that in the case of some existing systems the initial requirements did not take into account the need to support change, which has resulted in the deployment of systems that everyone knows are ineffective but are still presented as working.

  The corridor is very much alive and changing. The road network and related infrastructure, data, tools, vehicles, organizations, processes, and technology are in a constant state of change. Some would say that the system requires continual maintenance, but it is more than that. There must be processes and associated resources by which these needed changes are actively identified, managed, and implemented into the ICM environment to address new opportunities or required updates at appropriate and timely intervals. These requirements are included as people-centric non-automatable requirements, with the goal of achieving a system that can adapt to change within the corridor, extending its system life and increasing its impact on the corridor and the people who live and travel within its boundaries.

- **Simplicity:** The need for simplicity was commonly mentioned. This included such desires as reducing the number of moving parts, providing as few interfaces as possible, or ensuring the system is understandable and usable.

- **Leverage existing system assets:** While there was a general consensus that new functionalities are needed to implement the envisioned ICM system, it was also recognized that replacing existing systems used to monitor and control traffic would be cost-prohibitive. Therefore, the conclusion was to try to use, as much as possible, existing systems operated by stakeholder agencies.

- **Integrate, but not too much:** While the need to integrate functions and processes was recognized, it was also emphasized that this need should not lead to the development of homogeneous systems or to the removal of individuality where it is both useful and required. This was interpreted to mean that the system should appear as a coherent set of working and predictable functions while allowing sub-functions to be unique in how they accomplish tasks.
- **Single sources for processing methods:** The system should use common functional elements, algorithms, and design elements. For example, the system would be difficult to manage if one function determines data quality or calculates metrics differently from another function. If the same data results in different processed information, it is also difficult to isolate and resolve problems.
- **Specify measurable metrics or data:** Rather than simply requiring functional results, it was seen as important to link requirements to success metrics and the use of data. Thus, where appropriate, requirements are written specifying that data be collected, that data be of a certain quality, that data quality be maintained over time, that it is clearly traceable how data is used in decision-making, and that there are appropriately trained and motivated personnel to ensure that these data needs are met on an ongoing basis. The intent was to define a system that includes everything necessary for its successful operation and maintenance.

### 7.3.3. WHAT IS AND IS NOT IN SCOPE FOR THE REQUIREMENTS

In many of the requirements-gathering discussions, there was confusion over what is in scope and out of scope for the requirements. This confusion needed to be addressed, since readers may find the resulting requirements confusing and incomplete should they not clearly understand their scope.

#### *7.3.3.1. In Scope*

From a general standpoint, the scope of the requirements is to improve **corridor-wide** traffic conditions **during an incident, unscheduled event, or planned event.** This means the requirements are focused on:

1. **Helping traffic get *around* an incident or event**—This document defines a system that will divert traffic and people around an incident scene or the location of an event. The details of this diversion are commonly called an "*incident response plan*" but could also be called a "*traffic/traveler management around an incident or event*" plan. It is not focused on managing the incident or event itself.
2. **Freeways, arterials, and mass transit operations**—Rather than focusing on freeways alone, the requirements define a system that uses multiple roadways and modes in a coordinated way to get traffic/travelers around an incident or event.

#### *7.3.3.2. Not in Scope*

The requirements are **not** focused on:

1. **Managing normal daily traffic**—This document does not seek to define a system that will improve day-to-day traffic on an ongoing basis.

2. **Managing the *scene* of an incident/event**—While the system would divert traffic around an incident or event, it is not intended to manage what happens at the incident/event itself. That remains under the control of emergency responders. For example, the proposed system:

    a. Does not expect first responders to change their processes or priorities at the actual incident scene or event location. It will request improved communication from first responders as part of the ICM process, but it will not alter responders' internal methods already in place for incident/event scene management.

    b. Does not suggest road or lane closures. Safety officers on the scene determine which lanes to close and for how long. The ICM system only requires input on which lanes are closed, how long the closures will last, and when the lanes are to be reopened.

    c. Does not explicitly suggest or enable routes for first responders to reach an incident or event location.

This becomes clearer when we look at the Traffic Incident Management (TIM) timeline in Figure 7-2, which shows the typical stages of incident management from detection to recovery:

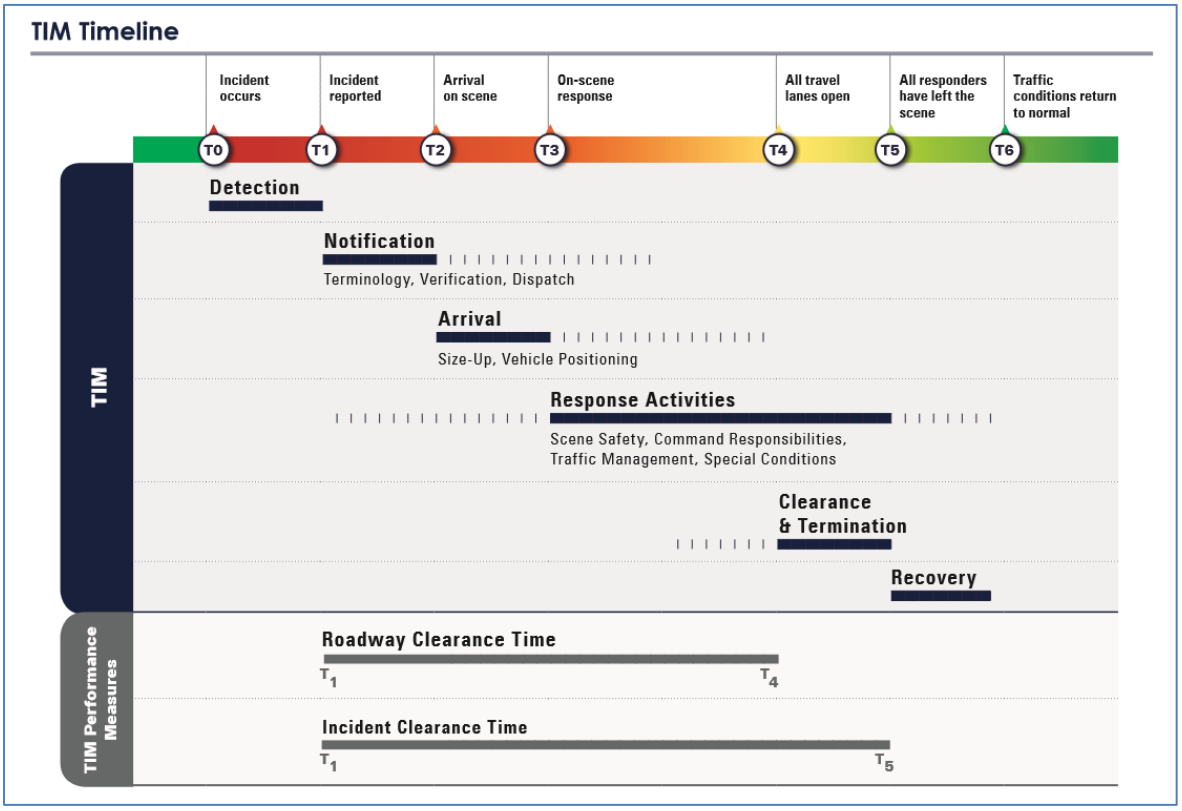


**Figure 7-2 – Typical Traffic Incident Management (TIM) Timeline**

The activities in the figure are carried out mainly by first responders and others whose job is to secure the scene, assess the situation, help victims, clear blockages, etc. The ICM requirements, in contrast, focus on addressing the impact outside the incident scene itself:

1) The ICM system needs to know about the incident and its characterization in order to develop an adequate traffic management response.

2) The ICM system will suggest and enable reroutes around the incident area.

3) The ICM system needs to know when the incident has been cleared.

4) The overall goal of the proposed system is delay reduction across the corridor:

    a. One statistic states that one minute of lane blockage results in four minutes of delay. The ICM system is focused on reducing this delay.

    b. Another statistic states that for every minute that a traffic incident is blocking a roadway or creating a distraction, the risk of a motorist being involved in a secondary accident increases 2.8%. The goal of the system is to reduce queues and thus the potential for secondary crashes.

    c. The system also seeks to reduce recovery time.

### 7.3.4. STRENGTHS AND CHALLENGES IN DEVELOPING THE REQUIREMENTS

Both strengths and challenges were encountered when developing the requirements.

#### *7.3.4.1. Strengths*

The development process revealed the following strengths:

- **Broad experience** – The people providing input into the requirements cover a broad base of experience and work function, and their contributions and insights were invaluable for defining what the system should do, how the communications channels should work, etc.
- **Interest and motivation** – Participants were interested and motivated, and their engagement added energy and momentum to carrying out this complex task.

#### *7.3.4.2. Challenges*

The key challenges were:

1) **What level of requirements, in both depth and breadth, are needed before the project team can proceed to design**?

    a) *Breadth* – The project team has taken the view that requirements should address people, organizations, software, and hardware. This is an alternative to the view that requirements should focus mainly on software. Many of the requirements are based on an assumption that the largest challenges of ICM are not in the software but in the successful integration of people and processes. Many essential requirements would be missed if they were to include only software elements.

    b) *Depth* – It is believed that requirements should be specified to the level that identifies and resolves significant differences in opinion or belief, particularly before design of the proposed system is initiated, where we would prefer not to discover fundamental differences among our stakeholders. One of the purposes of requirements-gathering is to ensure that the project team has educated personnel on ICM and arrives at real agreement. This can require in-depth discussions on who or what will perform a function.

2) **What is the difference between a requirement, a design constraint, and a design decision?** A traditional answer is that requirements define what the system must do to meet the user needs, design constraints limit the possible implementation methods, and design decisions determine how to implement the requirements. In practice, it can be difficult to distinguish between a low-level requirement, a design constraint, and a high-level design decision. By its definition, a requirement is something that a person believes is required for the system to function correctly. One person's beliefs are frequently different from another's and often related to how a function will be implemented. For example, if an ICM requirement is to improve traffic in a corridor during an incident:

    a) One person may state that maintenance is required in order to ensure that traffic control elements function during a response to an incident. Another may state that whoever designs the solution must determine if maintenance is important in improving traffic conditions.

    b) One person may state that communication between first responders is needed to manage traffic, while another may state that who communicates information is a design decision related to how information is obtained.

    c) One person may state that a decision support system should model traffic. Another may state that the DSS must only ensure that the best response plan is chosen.

    So how do we determine what is a requirement and what should be left as a design decision? We have chosen to apply the following rule: If a specific item that could reasonably be considered a design decision was mentioned by more than one person, this item was then listed as a potential requirement.

3) **Missing Requirements**. Several areas where requirements were missing were identified throughout the information-gathering process. To address these missing elements, the following actions were taken:

    a) If, when looking across the process flows we discussed in the user meetings, we saw a missing piece that was at the same level as other requirements, we included it as a requirement.

    b) If a requirement was so high-level that we didn't know how or who we might ask to implement it, then we broke it down into smaller requirements.

    c) As we brought together source material from different areas, we noted that we did not discuss certain items in our interviews. We used judgment in adding in requirements from other sources.

4) **Unfamiliarity with the ICM concept.** The concept of ICM is new to many people who were being asked to provide requirements. As such, they looked to us to help define the requirements. We have used our own experiences combined with previous efforts and the opinions of experts to help guide us.

### 7.3.5. CATEGORIES OF REQUIREMENTS

The requirements have been organized into categories that match the major functions in the corridor management workflow, as illustrated in Figure 7-3:

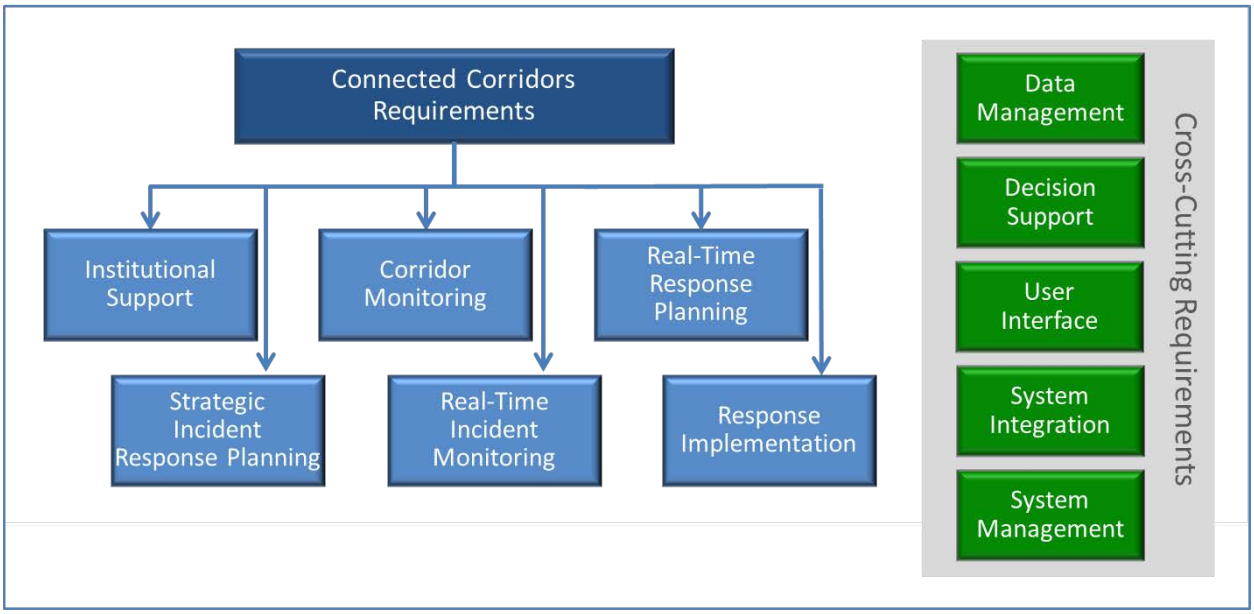


**Figure 7-3 – High-Level Requirement Categories**

Table 7-2 outlines the basic workflow functions and the six categories of requirements they correspond to (shown in blue in Figure 7-3):

**Table 7-2 – Basic Requirement Categories**

| Function | Related Category of Requirements |
|---|---|
| People and organizations work together to manage, resource, fund, and maintain a working ICM system that is accepted by all stakeholders. | Institutional Support |
| Stakeholders routinely plan, review, and update responses to incidents and events. | Strategic Incident Response Planning |
| Real-time corridor status information is continually monitored. | Corridor Monitoring |
| An incident or event is identified and characterized. | Real-Time Incident/Event Monitoring |
| Predefined response plan components and the current corridor state suggest tailored response plans. | Real-Time Response Planning |
| Once a response plan is chosen, it will then be implemented by corridor resources. | Response Plan Implementation |

As detailed in Table 7-3, the basic requirements are further supported by five categories of crossing-cutting requirements (shown in green in Figure 7-3):

**Table 7-3 – Cross-Cutting Requirement Categories**

| Function | Requirements |
|---|---|
| Day-to-day management of data used to support system operations | Data Management |
| Use of common algorithms and rules | Decision Support |
| User interfaces for accessing system functions | User Interface |
| Link systems and processes to enhance coordination; common presentation and use of data | System Integration |
| Ensuring the overall availability of a safe, secure working environment | System Management |

The requirements can also be viewed by time frame—how often certain actions would occur. Figure 7-4 illustrates this alternate breakdown of requirements, showing to the left actions that would typically be conducted once a year and to the right actions that are expected to occur continuously:

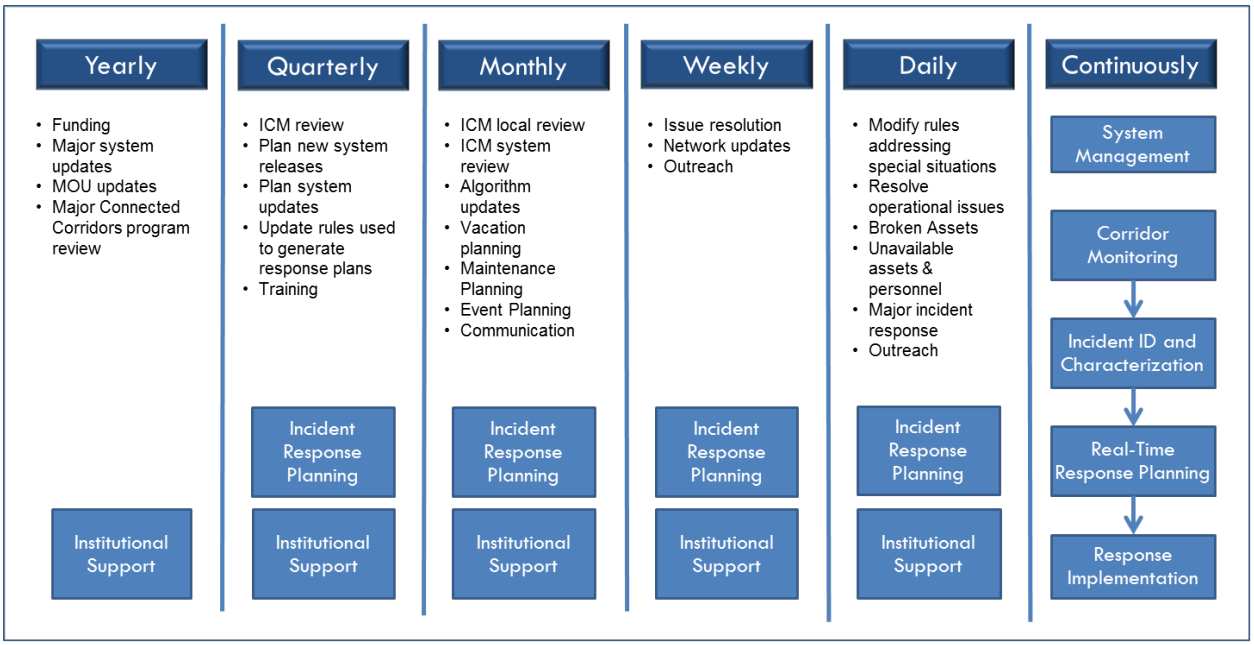


**Figure 7-4 – Requirements by Time Frame**

While the requirements have different time horizons, it is important that those vital to effective system functioning (such as issue resolution or network and algorithm updates) be addressed quickly to ensure that stakeholder interest and use of the system remain high.

## 7.4. SUMMARIZED REQUIREMENTS

This section presents high-level summaries of the requirements, intended for upper management and for use in presentations. (The requirements are presented in greater detail in sections 8 and 9.) The summaries correspond to the requirement categories shown in Figure 7-3 and include:

1. Institutional support
2. Corridor monitoring
3. Strategic incident/event response planning
4. Real-time incident/event monitoring
5. Real-time response planning
6. Response plan implementation
7. Data management
8. Decision support
9. Core System User Interface
10. System integration
11. System management

### 7.4.1. INSTITUTIONAL SUPPORT

Institutional requirements generally focus on strategic planning and on the organizations and people needed to execute those plans. They focus on how people and organizations are structured, funded, motivated, and informed. These requirements are based on the premise that active collaboration among people and organizations is the cornerstone on which an ICM effort is built. In most of the stakeholder and expert interviews, these institutional requirements were identified as the requirements most affecting the success of an ICM effort, and it is why they are listed first. They include:

- Maintaining and executing a corridor strategic plan for data collection, corridor control, and performance metric calculation
- Ensuring that assets defined in the strategic plan are in existence
- Maintaining project champions
- Defining and implementing a solid management infrastructure, associated business processes, and corresponding KSAs (knowledge, skills, and abilities)
- Ensuring all stakeholders are included and engaged in corridor decision-making and that these decisions are made within a culture of trust and communication
- Ensuring required resources are committed to corridor day-to-day operations
- Providing a properly skilled, educated, organized, trained, and motivated work force
- Establishing and maintaining communications channels with all stakeholders and agencies throughout the life of the ICM project
- Locating, securing, and monitoring funding opportunities
- Ensuring sufficient funding is available for day-to-day operations
- Managing Memoranda of Understanding (MOUs) and other agreements with stakeholders, organizations, agencies, and/or private companies and ensuring that they remain updated

### 7.4.2. CORRIDOR MONITORING

This function is tasked with determining the state of the corridor and using this state to accurately calculate and report corridor performance measures. This includes:

- Maintaining the definition of the corridor transportation network and its assets
- Measuring and recording the status and state of all assets in real time
- Receiving measurement values from corridor sensor assets
- Determining the real-time state of the corridor
- Defining performance metrics in the context of available sensor and engineering data
- Calculating performance metrics over user-selected time and space

### 7.4.3. STRATEGIC INCIDENT/EVENT RESPONSE PLANNING

Designing response plans is a core requirement for an ICM system. Response Planning encompasses a set of related functions:

- Define/maintain individual plan elements that may be selected as part of a response plan, such as preferred detours around incidents/events occurring at specific locations, signal plans to be used to manage increased traffic along possible detour routes, and specific messages to post or broadcast
- Define/maintain rules for:
    - determining when an incident, unscheduled event, or planned event is occurring
    - determining the severity of an incident or event
    - determining the level of impact of an incident, unscheduled event, or planned event on corridor performance
    - selecting control actions to take in response to an incident or event, including determining whether the response should follow a set of predefined response actions provided by system users based on past experience (as may be the case for Rose Bowl events) or should be determined by the ICM system based on current and predicted corridor state
    - combining various control actions, chosen to address an incident or event, into internally consistent response plans
    - determining when a response plan is no longer needed following the termination of an incident, unscheduled event, or planned event
    - considering the need for unique responses at certain times and locations (such as school zone restrictions based on time of day and time of year)
    - selecting one response plan for implementation from a group of potential plans
    - determining the order with which instructions in a selected response plan should be sent to individual field elements
- Test response plan components and rules prior to releasing them for use
- Hold a quarterly corridor-wide review of response plan results, as well as ad hoc reviews which may be required after major incidents

### 7.4.4. REAL-TIME INCIDENT/EVENT MONITORING

The ICM environment is principally focused on responding to changes in either transportation system capacity or demand. These changes may be caused by:

1) **Incidents –** An unplanned reduction in capacity caused by accidents, road/lane closures, or mass transit service disruptions
2) **Unscheduled Events** – Events unexpectedly affecting travel conditions or corridor operations, such as a natural disaster or a bomb threat
3) **Planned Events** – Planned changes to demand and possibly localized reductions in capacity

Being able to determine that an incident or unscheduled event has occurred, or that a scheduled event has started or is about to occur, is central to the ICM system's ability to determine appropriate responses to the situation at hand. Knowing the reason for an observed or upcoming change in traffic demand or roadway capacity is important in choosing a suitable response plan. For example, responding to a Rose Bowl event as if it were a simple accident would not properly address the transportation challenges created by the event.

A challenge remains in the identification of incidents and events affecting corridor operations. The automated identification of incidents has proven to be relatively difficult, as traffic patterns that resemble an incident can occur spontaneously without apparent cause. This can lead automated detection systems to produce frequent false positives and, thus, to be ignored by traffic managers. Furthermore, while planning can be done for scheduled events, this can only occur if all important information about the event's potential or projected impact on corridor travel is available. Without proper identification of incidents and events, the ICM environment may not meet its performance goals. A lack of adequate information may even make a bad situation worse.

The Real-Time Incident/Event Monitoring function includes the following sub-functions:

- Receiving information about incidents or events
- Automated incident detection capability
- Incident/event validation and characterization by stakeholders
- Notifying stakeholders of incidents/events
- Initiating real-time response planning
- Updating incident/event information as needed
- Determining end-of-response actions when corridor operations have returned to normal

### 7.4.5. REAL-TIME RESPONSE PLANNING

Once it has been determined that an incident or event will significantly affect corridor operations, a suitable response plan, designed to minimize the incident's impacts on corridor operations, must be assembled and selected for implementation. Assuming than an existing predefined response plan is not already associated with the type of incident or event identified, the ICM system will assemble one or more possible response plans. These plans will be based on the description of the incident or event, the transportation network configuration, the ITS elements in the network, and rules limiting or guiding the use of the network and associated assets. The likely effects on corridor performance of each developed response plan will then be evaluated by the DSS prediction function and the results used to recommend a response plan for implementation.

Figure 7-5 illustrates the basic components of a response plan. These include:

- Identification of suitable detours

- Signal timing changes at intersections along the identified detours and around the detours

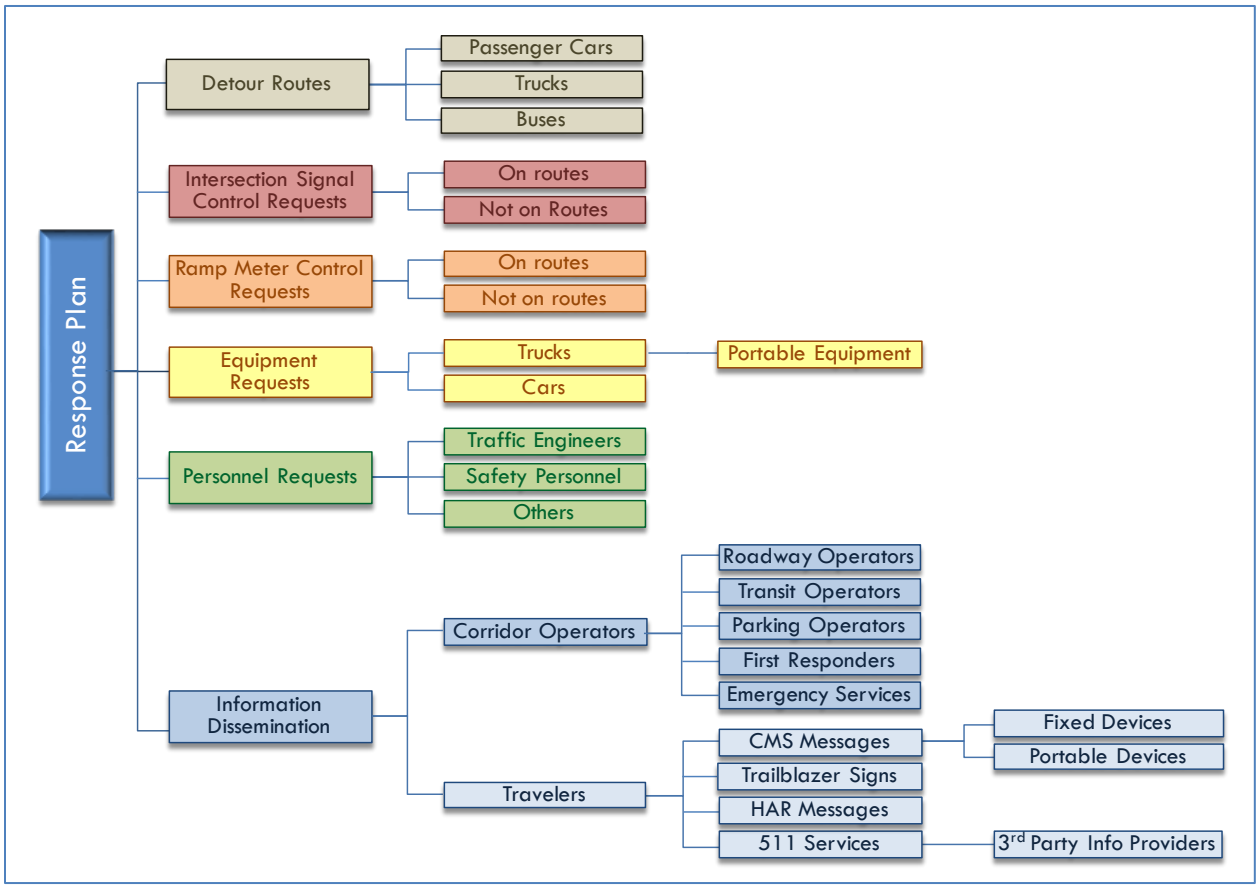


**Figure 7-5 – Response Plan Elements**

- Ramp metering changes at freeway on-ramps and freeway-to-freeway connectors to manage traffic coming on and off the freeway
- Equipment to be used to support implementation of the plan, such as trucks and cars that individuals may need to access a given field element or bring portable devices to a specific location in the corridor
- Personnel required for the implementation of specific elements of the response plan
- Information to disseminate to corridor operators and travelers

Accomplishing those tasks requires the following functions:

- Build response plans
- Evaluate response plans
- Choose a recommended response plan
- Approve a recommended response plan
- Forward approved response plan for implementation
- Periodically review and update implemented response plans
- Off-line analysis

### 7.4.6. RESPONSE PLAN IMPLEMENTATION

Once a response plan is chosen, assets selected to implement the plan must be given instructions and told to execute them in the proper sequence. At a high level, this requires the following functions:

- Determine what assets to send instructions to and in what order
- Notify stakeholders of response plan implementation
- Send instructions to response plan assets and verify they can be executed
- Monitor assets to note any unexpected changes and notify stakeholders
- When signaled by incident/event characterization, return assets to normal status

### 7.4.7. DATA MANAGEMENT

Data is at the heart of TSM&O performance-managed processes. In the context of the proposed ICM environment, data is needed for understanding the corridor, determining how to manage the corridor, instructing assets to manage travel within the corridor, determining how well the system has succeeded in transportation management tasks, and reviewing all aspects of the system in order to improve it.

Figure 7-6 illustrates the various data elements that are to be processed and stored by the ICM system. The diagram organizes the data based on their dynamic characteristics. At the bottom of the pyramid are static data describing geographic and institutional elements of the corridor. The upper layers gradually involve the handling of more dynamic data. This includes asset inventory data, data characterizing asset capabilities and states, real-time asset data, traffic states and traffic forecasts, proposed response plans, and the implemented response plan. On the right side of the pyramid are three additional data categories capturing the need to archive and warehouse collected data, access historical patterns derived from analyzing past data, and access user-defined performance metrics and past evaluation results.

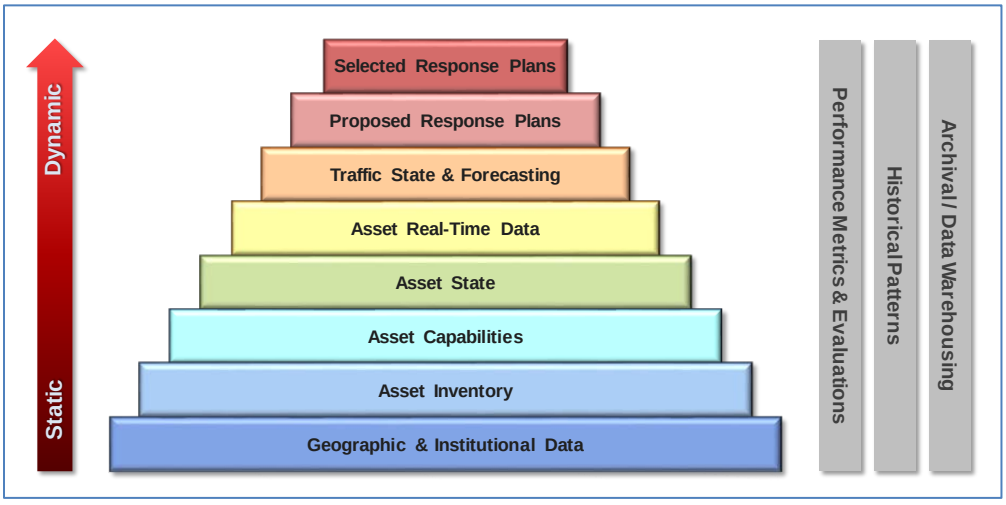


**Figure 7-6 – Data Elements**

While the general operational goal for the ICM system is to handle electronic data, the system may also be required to handle data existing on paper documents and in the minds of people working on the ICM effort.

In order to be used and useful, ICM system components must be able to:

- Understand the purpose and format of the data available to them and ensure others understand the data they are providing
- Understand the metrics used to determine data quality and the actual quality of the data they are using
- Create, read, update, delete, transmit, and receive the data using standard protocols (such as TMDD, NTCIP, and GTFS) where such standards exist. Where standard protocols do not exist, use protocols agreed to during system design.
- Add new types of data to the system; remove deprecated data types
- Have Extract, Transform, and Load (ETL) functionalities available as needed

Data Management functional requirements do not require nor expect that all data will be stored in a single data hub, only that system components will be provided with a simple, consistent way to access the data they need. Thus, local caching of data for performance is expected and supported; however, there must be only one system of record.

It should be noted that the requirements included in this section do not discuss individual data elements. For further details on the various data elements presented in Figure 7-6, please refer to the Data Dictionary document.

Another important note relates to data quality. Data is at the heart of data-driven performance management. However, the quality of the data is what determines success or failure. If one truly manages to data, then the data must be accurate, thorough, and timely. Degradations in data quality can result from many causes, and the maintenance of data quality is a system-wide responsibility and concern. A reasonable number of sensors must work at any given time. Similarly, communication networks that are relied upon must work, storage functions must work, etc.

Data management also involves maintaining relationships with third-party vendors. Commercial organizations may be used to provide data/services or as consumers of the data or response plans. These might include third-party travel information providers, mobile travel application developers, probe data providers (INRIX, HERE, or others), 511 systems, or HAR services.

### 7.4.8. DECISION SUPPORT

Decision Support is defined as a set of automated processes that assist human operators in making decisions involving large amounts of data, multiple solution sets, and knowledge captured as rules. Decision support functions are meant to be used in multiple places by other ICM system components and include the following reusable functions:

- Rules capture and evaluation
- Determination of the current state of the corridor based on limited data. When evaluating response plans, it is important that analysis starts with knowledge of the current conditions and state of the corridor.
- Prediction of the future state of the corridor based on limited data. When evaluating response plans, it is important to take the likely future state of the road into account.

### 7.4.9. CORE SYSTEM USER INTERFACE

While much of this document defines requirements for hardware, software, individuals, and organizations, the Core System UI requirements focus on the software-based user interfaces used for data manipulation and process control. This includes interface requirements for creating, viewing, updating, deleting, and reporting on data. It also includes interface requirements for managing the process of incident identification, response plan generation, and response plan implementation.

Core System User Interface requirements include:

- Asset Information Management user interface
- Incident/Event Information Management user interface
- Mock Incident Creation and Testing user interface
- Response Plan Management user interface
- ICM Core System user interface
- Geospatial visualization of data
- Reporting, charting, and graphing functions
- Post incident/event analysis reports
- Interagency Communication

### 7.4.10. SYSTEM INTEGRATION

One requirement mentioned in many meetings is that the ICM System shall operate as an integrated whole in its visual and operational presentation to stakeholders. Presentation is an important word here, as the requirement does not mean that the system (people, software, hardware) shall all be part of the same organization, sourced from the same hardware supplier, or composed of one monolithic software application.

What system integration does mean is that users should be able to view, analyze, make, and implement decisions by interfacing with a single system. That is, they should be able to access ICM system functions and complete workflow processes without switching between systems or user interfaces.

For the core ICM system, this is an understandable requirement. However, when expanded to the overall ICM system (including all supporting systems, such as ATMS), it is not possible for all software components to be part of one user interface, as each existing system has its own predefined UI. For example, Caltrans ATMS users have requested that all functions be accessible through the ATMS software. This requirement is taken to mean that all functions that an ATMS operator will be asked to perform are interfaced to the ATMS—not that every function of the ICM system is provided as part of the ATMS user interface itself.

System Integration requirements include:

- Integration requirements
- Integrated visualization and reporting
- Integrated control functions
- Integrated data definition, capture, and processing
- Ownership of corridor assets including software, hardware, data, and algorithms
- System/location of record for data

### 7.4.11. SYSTEM MANAGEMENT

System management functions ensure that the ICM system is maintained and operated in a reliable manner. These include:

- Security
- Service Level Agreements
- Maintenance requirements
- Trained personnel able to maintain the system
- Management of system failures
- System upgrades

# 8. GENERIC REQUIREMENTS

As discussed in section 7.2, this section presents generic, more holistic descriptions of the requirements detailed in the tables in section 9 of this document. The generic requirements are designed to be used as templates by other ICM efforts and for use in defining the basic knowledge, skills, and abilities (KSAs) required by personnel participating in an ICM effort.

In addition to basic functional requirements, this section discusses additional requirements and the associated personnel needed for problem identification, maintenance, and automation of system functions. Meeting these requirements is considered essential for ensuring the ICM system can respond to normal problems ("bugs") encountered in complex sociotechnical systems and adapt to changing technology and institutional conditions. Personnel interviewed felt that these support requirements were more important than some of the basic functional requirements delineated in the tables.

Like the summarized requirements in section 7.4, the generic requirements are presented for the following categories:

1. Institutional support
2. Corridor monitoring
3. Strategic incident/event response planning
4. Real-time incident/event monitoring
5. Real-time response planning
6. Response plan implementation
7. Data management
8. Decision support
9. Core System User Interfaces
10. System integration
11. System management

Each generic requirement includes the following characteristics:

- **Description:** A description/statement of the requirement
- **Quality Metrics:** One or more performance/quality metrics. These may see further refinement in the detailed requirements.
- **Metric Values:** The level of performance required. These may also see further refinement in the detailed requirements.
- **Problem Identification and Resolution:** Each requirement will generally experience challenges in the form of unexpected events, underperforming hardware, communications, and/or personnel. This characteristic looks at responsibilities and skill sets required to identify and resolve these day-to-day challenges. These are included because, in discussions with stakeholders, issues were raised regarding the differences in skill sets between personnel able to utilize functions versus those with the abilities to diagnose and fix problems.
- **Maintenance:** Each function generally requires some degree of maintenance in order to meet its quality metrics. In many cases, during our interview process, participants focused on the importance of maintenance and again on the different skill sets and resources required to maintain as opposed to utilize a given function.

- **Automation:** The user needs stated that ICM functions should be automated to the extent possible. In practice, depending on the operational situation, some functions must be performed by humans, some by hardware/software, and some by both. Software will not be able to handle all incidents or events that may occur on the corridor. The number of possible locations, unexpected complications, and unpredictable changes to asset status are too large to devise algorithms and methods that can automatically handle every situation.

  Each requirement thus specifies what must be automated. This is often the tracking and presentation of information, the suggestion of choices in well controlled circumstances, and the generation of reports where information is likely to be available and reliable. One should only automate reliable repeatable processes. More complex processing requiring experience or judgment will not be recommended for automation.

  A distinction is also made between process automation and the use of simple, readily available tools that are normally used by personnel as part of their work function. There are no discussions on the need for calculators, computers, spreadsheets, word processors, etc. Which type of tools or where they should be used is not part of the requirement specifications. It is assumed that this knowledge is part of the basic job skills of assigned personnel.

**Summary of Caltrans' and cities' requirements.** In addition to this breakdown of requirement categories and characteristics, an extra section (8.12) has been added that summarizes requirements for Caltrans and the cities. Assembled at stakeholders' request, the information is drawn from the detailed tables in section 9 but is presented in a condensed, generic form so as to be useful for ICM efforts beyond the I-210 Pilot as well.

## 8.1. INSTITUTIONAL SUPPORT

Institutional requirements generally focus on strategic planning and on the organizations and people needed to execute those plans. They focus on how people and organizations are structured, funded, motivated, and informed. These requirements are based on the premise that active collaboration among people and organizations is the cornerstone on which an ICM effort is built. In most of the stakeholder and expert interviews, these institutional requirements were identified as the requirements most affecting the success of an ICM effort, and it is why they are listed first. They include:

- Maintaining and executing a corridor strategic plan for data collection, corridor control, and performance metric calculation
- Ensuring that assets defined in the strategic plan are in existence
- Maintaining project champions
- Defining and implementing a solid management infrastructure, associated business processes, and corresponding KSAs (knowledge, skills, and abilities)
- Ensuring all stakeholders are included and engaged in corridor decision-making and that these decisions are made within a culture of trust and communication
- Ensuring required resources are committed to corridor day-to- day operations
- Providing a properly skilled, educated, organized, trained, and motivated work force
- Establishing and maintaining communications channels with all stakeholders and agencies throughout the life of the I-210 Pilot
- Locating, securing, and monitoring funding opportunities
- Ensuring sufficient funding is available for day-to-day operations

- Managing Memoranda of Understanding (MOUs) and other agreements with stakeholders, organizations, agencies, and/or private companies and ensuring that they remain updated

Below is a more detailed description of the generic requirements.

**1) Corridor Strategic Planning:**

- *Description* – The Corridor Manager, in consultation with stakeholders, shall oversee the drafting, review, approval, and maintenance of the corridor strategic plan. The Corridor Manager will review corridor transportation network changes, new technologies, and new governmental requirements in order to determine appropriate changes to the data collection, control, and performance metric calculation processes.
- *Metric* – The Corridor Manager, Corridor Technical Manager, and Corridor Data Analyst will determine if the strategic plan is completed. The plan will be approved by stakeholders.
- *Metric Value* – 100% complete.
- *Problem Identification and Resolution* – The document should be reviewed by stakeholders and by consultants who are not direct stakeholders. Deficiencies should be resolved by the Corridor Manager with appropriate assistance.
- *Maintenance* – Not applicable.
- *Automation* – This cannot be automated.

**2) Ensuring the Existence of Assets Defined in the Corridor Strategic Plan:**

- *Description* – The Corridor Manager, working with stakeholders, shall ensure the existence of assets and data defined in the strategic plan. This may involve purchasing or upgrading of assets and/or data. This is not meant to be a maintenance requirement.
- *Metric* – The Corridor Technical Manager and Corridor Data Analyst will determine the percentage of required assets and data, as defined in the strategic plan, in place in the corridor.
- *Metric Value* – 85%.
- *Problem Identification and Resolution* – The Corridor Technical Manager and Corridor Data Analyst will determine the most important missing assets or data and work with stakeholders to provide the missing items.
- *Maintenance* – Not applicable.
- *Automation* – This cannot be automated.

**3) Maintenance of Corridor Champions:**

- *Description* –Champions who have the dedication, seniority, authority, and will to overcome obstacles and ensure requirements are met, processes are followed, and the ICM effort is an ongoing success.
- *Metric* – Stakeholders can name and identify champions.

- *Metric Value* – 90% of managers can name the champions.
- *Problem Identification and Resolution* – Stakeholders must identify the absence of champions and replace them. If Senior Management is not a champion, other stakeholders will need to get involved to gain trust and/or another Senior Manager to be involved with the program.
- *Maintenance* – Champions must be replaced when they are no longer associated with the project or with a key agency.
- *Automation* – The selection and existence of champions cannot be automated.

**4) Organizational Composition and Structure:**

- *Description* – The definition of the roles, responsibilities, and reporting structures required for ICM and the identification of individuals within each organization who will fill the role. At a minimum, the following roles shall be defined:

  i. Corridor Champions
  ii. Corridor Managers
  iii. Corridor Technical Managers
  iv. Corridor Data Analysts
  v. Traffic Engineers
  vi. Maintenance Staff
  vii. Electrical Engineers
  viii. Software Engineers
  ix. IT Support
  x. IT Security
  xi. Traffic Management Center (TMC) Operators
  xii. Traffic Control System (TCS) Operators
  xiii. Transit Field supervisors
  xiv. Public Information Officers
  xv. First Responders
  xvi. Outreach and Communications Managers
  xvii. Data Analysts
  xviii. Database Administrators
  xix. Stakeholder Governing Bodies
  xx. Oversight Committee(s)

  Stakeholders shall identify how these roles will be filled among the various corridor agencies. **Note:** Not every agency is required to have these roles in place, and job titles may vary. For a description of these roles, see Table 6-1.

- *Metric* – Percentage for which up-to-date job descriptions exist and are placed in an organizational chart and a funding chart.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – The Corridor Manager must review current staff versus needed staff and work with stakeholders to resolve discrepancies.
- *Maintenance* – Stakeholders must continually ensure the accuracy and completeness of organizational needs.

- *Automation* – This cannot be automated.

**5) Management Structure and Processes:**

- *Description* – Resource allocation and management is a basic requirement for any set of sustainable processes. It involves ensuring that these requirements are met through the daily application of management skills. This includes planning, resource acquisition, resource allocation, problem identification, problem resolution, and risk management.
- *Metric* – Preparation and approval of an organization chart showing the management structure and reporting responsibilities; a survey of stakeholders asking for feedback on the management team, structure, and processes; standard management processes and skills in place, including budgets, plans, etc.
- *Metric Value* – All stakeholders concur that management is in place and working.
- *Problem Identification and Resolution* – Management must use business analysis skills to understand why problems are occurring, plan for management personnel changes, and have the flexibility to adapt to changes in the program to add/decrease management functions. If the problems are particularly difficult, then champions are required to bring resolution.
- *Maintenance* – Management must be responsible for ongoing management requirements, functions, and personnel of the ICM effort. This may require the assistance of senior management and champions.
- *Automation* – This cannot be automated.

**6) Interagency Trust and Communication:**

- *Description* - A culture of clear, consistent trust and communication must be established between the stakeholders and the organizations they represent, among the stakeholder agencies themselves, and among all the other personnel in the ICM environment (elected officials, travelers, the press, etc.).
- *Metric* – The results of surveys and after-incident/event reviews asking stakeholders and others how well we are communicating and how often there has been a communication breakdown. These survey and review efforts would be under the direction of the Outreach and Communications Manager and would include input from agency PIOs and other stakeholders.
- *Metric Value* – Less than three complaints per quarter, where complaints are written or documented verbal comments/feedback made to a member of the team expressing dissatisfaction with an aspect of the ICM program.
- *Problem Identification and Resolution* – Stakeholders must analyze why communication is not working or where the breakdown occurred and involve senior management and champions in resolving the issues.
- *Maintenance* – Ongoing communication training—including items such as conflict resolution, customer service, facilitation, speaking skills, etc., as needed and determined by the stakeholders throughout the life of the program—is critical.

- *Automation* – Facilitation by contact management software, i.e., software that stores contact information and tracks communication activities linked to contacts, in addition to providing calendar sharing and meeting scheduling functions, as well as customizable fields. This cannot fundamentally be automated.

**7) Interagency Agreements:**

- *Description* – The creation, approval, and maintenance of Project Charters, Cooperative Agreements, Letter Agreements, Memoranda of Understanding, contracts, and stakeholder-approved systems engineering documents.
- *Metric* – The percentage of agreements that are executed and followed, percentage of highly important agreements executed and followed.
- *Metric Value* – 90%, 100%.
- *Problem Identification and Resolution* – Stakeholders must analyze why and how communication failed and involve proper champions to ensure agreements are signed and followed.
- *Maintenance* – The Outreach and Communications Manager must ensure documents are drafted, approved, and current.
- *Automation* – This process cannot fundamentally be automated.

**8) Funding for the ICM System:**

- *Description* – Locate and ensure funding for ongoing operations, maintenance, day-to-day system improvements, and year-to-year system enhancements.
- *Metric* – Ratio of available funds to the minimum funding level that has been identified as necessary to design, deploy, and operate the intended system.
- *Problem Identification and Resolution* – Stakeholders must continually review budgets and identify existing funding gaps and needs for new funds.
- *Maintenance* – Stakeholders must continually review budgets, identify existing funding gaps and needs, and notify the Outreach & Communications Manager of identified needs. The Outreach & Communications Manager is responsible for researching and tracking funding opportunities, as well as preparing and submitting funding applications.

**9) Education:**

- *Description* – ICM is a new concept both operationally and culturally. Culture change requires education as opposed to training. Education will be provided as needed for specific roles and responsibilities.
- *Metric* – A survey of stakeholders and system users, to be executed by the Corridor Manager, Outreach and Communications Manager, or individual designated by them, asking if personnel understand ICM and the cultural changes required.
- *Metric Value* – 90% of surveyed individuals indicating that they understand what is expected from them and the ICM project.

- *Problem Identification and Resolution* – Management must use business analysis skills to understand when cultural issues are the result of lack of proper education and determine how to improve the education.
- *Maintenance* – Management must ensure that education programs are updated as required by designated agency staff.
- *Automation* – It is difficult to automate the planning, design, and presentation of educational material.

**10) Communication and Outreach:**

- *Description* – Information creation/ dissemination, ongoing communication strategies, and PR events with a goal of ensuring that excellent relationships and program knowledge exist among the many people and organizations involved in an ICM effort. A person in each stakeholder agency shall be responsible for outreach and communications.
- *Metric* – A survey among stakeholders regarding the outreach and communication efforts, and the effective handling of inquiries.
- *Metric Value* – Survey reports 90% positive, and 90% of inquiries are effectively handled.
- *Problem Identification and Resolution* – Management must use business analysis skills to understand why there are deficiencies or lapses in outreach and communications and involve both stakeholders and champions in the resolution of issues.
- *Maintenance* – Outreach material must be periodically updated by corridor-level staff and relationships maintained.
- *Automation* – The use of the Internet, the web, and social media tools is encouraged, but the creation of communication materials and often their presentation cannot be automated.

**11) Management of Third-Party Relationships:**

- *Description* – Determining when and how (contractually) to utilize third-party organizations. Organizations may be utilized to provide data/services or as consumers of the system's data or response plans. Individual stakeholder agencies will be responsible for contracting and relationships in coordination with the Corridor Manager.
- *Metric* – Percentage of time senior management believes that third parties are used effectively and contracts are efficiently managed.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Personnel must use business analysis skills and data quality reports to understand where there are deficiencies.
- *Maintenance* – Periodic review and renewal of purchasing choices and contracts by the stakeholder agencies is required.
- *Automation* – This cannot be automated.

## 8.2. CORRIDOR MONITORING

This function is tasked with determining the state of the corridor and using this state to accurately calculate and report corridor performance measures. This includes:

- Maintaining the definition of the corridor transportation network and its assets
- Measuring and recording the status and state of all assets in real time
- Receiving measurement values from corridor sensor assets
- Determining the real-time state of the corridor
- Defining performance metrics in the context of available sensor and engineering data
- Calculating performance metrics over user-selected time and space

Below is a more detailed description of these requirements.

**1) Static Transportation Network Definitions:**

- *Description* – The Corridor Manager will work with Traffic Engineers to ensure that the transportation network is well defined and up to date.
    - Freeways – Road geometry, speed limits, shoulder width, bridge clearance, presence of median barrier
    - Arterials – Road geometries, speed limits, bridge clearance
    - Transit – Bus and train routes, headways, travel time, connections
    - Parking – Parking facilities and number of available spaces
- *Metric* – Traffic Engineers determine the accuracy of the transportation network definition.
- *Metric Value* – 95% overall, 100% for all possible detour routes.
- *Problem Identification and Resolution* – Traffic Engineers will review the network to see where discrepancies exist, particularly if there are issues with the accuracy of response plan predictions. If discrepancies are found, then Traffic Engineers will update the transportation network definitions.
- *Maintenance* – The network undergoes steady changes; Traffic Engineers will be responsible for maintaining an accurate state of the network.
- *Automation* – This cannot be fully automated, although the use of third-party providers may provide a small amount of automation in network maintenance.

**2) Asset Inventory and Health Management:**

- *Description*: The system shall ensure that real-time status of corridor assets is available to all stakeholders. This includes status of:
    - Transportation network
    - ITS hardware elements
    - Personnel
    - Vehicles and signage
    - Software and supporting servers
    - Communications

- *Metric* – The Corridor Technical Manager shall determine/review the availability of status for corridor assets.
- *Metric Value* – 100% of assets that can provide status should be providing status.
- *Problem Identification and Resolution* – The Corridor Technical Manager will track the availability of asset status and work with Electrical Engineers and Software Engineers to determine the reason asset statuses are not available and work to bring them back online.
- *Maintenance* – Where this status is provided through automation, Software Engineers and Electrical Engineers will ensure status is available. Where status is provided through human processes, stakeholders will maintain the methods used to provide this data.
- *Automation* – This can be partially but not completely automated.

**3) Asset State Monitoring:**

- *Description* – Real-time state of corridor assets will be available to all stakeholders. State differs from health and basic availability. State represents the current configuration of information on devices. These include:
  - **i.** *Signal Plans*
  - **ii.** *Ramp Metering Plans*
  - **iii.** *CMS Messages*
- *Metric* – The Corridor Technical Manager shall determine percentage availability of asset state.
- *Metric Value* – Real-time state of corridor assets will be available 99% of the time.
- *Problem Identification and Resolution* – The Corridor Technical Manager will work with Software Engineers and Electrical Engineers to determine the reason asset state is not available and resolve the issue.
- *Maintenance* – Software Engineers and Electrical Engineers will maintain software and hardware.
- *Automation* – This function will be automated.

**4) Corridor Traffic Monitoring:**

- *Description* – The system shall measure/record at predetermined locations and time frames and make available to all stakeholders the following high-quality traffic data:
  - Freeways and ramps – Counts and flows (High Priority)
  - Arterials – Through counts and turning counts (High Priority)
  - Transit – Bus and train locations, bus and train delays and ridership (Medium and Low Priority)
  - Park and ride information – Parking space availability (Low Priority)
  - Video data (High Priority)
- *Metric* – The Corridor Data Analyst will determine the percentage of time that high-quality data is available.

- *Metric Value* – 85%; certain essential data will be required to be available at 99%.
- *Problem Identification and Resolution* – The Corridor Data Analyst must determine when data quality has degraded and when data is not available. The resolution may require many of the roles described in Institutional Support.
- *Maintenance* – Maintenance staff must ensure that hardware and communication systems are working.
- *Automation* – Measurement and transmission of this data shall be automated.

**5) Performance Metric Calculations:**

- *Description* – Determine and maintain the rules and algorithms required for performance metric calculations. These include but are not limited to VMT, delay, travel time index, buffer time.
- *Metric* – Data Analysts and Traffic Engineers determine the percentage of time that metrics are calculated correctly.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Once a year the metrics should be reviewed by stakeholders and consultants. Data Analysts must watch for unusual results and work with Traffic Engineers and Software Engineers to uncover any issues. When issues are identified, Software Engineers must either implement updated requirements or fix bugs in the software.
- *Maintenance* – As new data sources and sensor types become available, Data Analysts, Traffic Engineers, and Software Engineers must work together to update the metric calculation algorithms.
- *Automation* – This cannot be automated.

**6) Corridor Traffic State Determination:**

- *Description* – The system shall continuously determine corridor traffic state for locations that have state measurement devices and, more important to this requirement, those that do not. The DSS function Corridor State Determination will be used to provide this information.
- *Metric* – Traffic Engineers will determine the accuracy of the results.
- *Metric Value* – 90% accurate for freeways and 85% accurate for arterials.
- *Problem Identification and Resolution* – Traffic Engineers will use observation, statistical analysis, and periodic external evaluations to identify inaccuracies. As these may be caused by data, hardware, or algorithm issues, the resolution may require many of the roles described in Institutional Support.
- *Maintenance* – As the network and the data sources change, adjustments may need to be made to the algorithms and rules that perform the determination. These would be done by Traffic Engineers and Software Engineers.
- *Automation* – This process will be automated.

7) **Historical Patterns**:

- *Description* – The system shall utilize traffic data to create and maintain historical patterns based on time of day, day of week, and holidays.
- *Metric* – Data Analysts and Traffic Engineers shall determine the accuracy of historical traffic patterns.
- *Metric Value* – Estimated means and variance within values determined at design time.
- *Problem Identification and Resolution* – Data Analysts and Traffic Engineers must use observation and statistical analysis to determine the accuracy of the historical patterns. Traffic engineers and Software Engineers will resolve issues.
- *Maintenance* – As new data sources/sensors and new algorithms become available, Data Analysts, Traffic Engineers, and Software Engineers must work together to maintain and upgrade the algorithms used to create historical data.
- *Automation* – This function should be automated.

## 8.3. STRATEGIC INCIDENT/EVENT RESPONSE PLANNING

Designing response plans is a core requirement for an ICM system. Response Planning encompasses a set of related functions:

- Define/maintain individual plan elements that may be selected as part of a response plan, such as preferred detours around incidents/events occurring at specific locations, signal plans to be used to manage increased traffic along possible detour routes, and specific messages to post or broadcast
- Define/maintain rules for:
  - Determining when an incident, unscheduled event, or planned event is occurring
  - Determining the severity of an incident or event
  - Determining the level of impact of an incident, unscheduled event, or planned event on corridor performance
  - Selecting control actions to take in response to an incident or event, including determining whether the response should follow a set of predefined response actions provided by system users based on past experience (as may be the case for Rose Bowl events) or should be determined by the ICM system based on current and predicted corridor state
  - Combining various control actions, chosen to address an incident or event, into internally consistent response plans
  - Determining when a response plan is no longer needed following the termination of an incident, unscheduled event, or planned event
  - Considering the need for unique responses at certain times and locations (such as school zone restrictions based on time of day and time of year)
  - Selecting one response plan for implementation from a group of potential plans
  - Determining the order in which instructions in a selected response plan should be sent to individual field elements
- Test response plan components and rules prior to releasing them for use

- Hold a quarterly corridor-wide review of response plan results, as well as ad hoc reviews which may be required after major incidents

Below is a more detailed description of these generic requirements.

**1) Traffic Engineers Available for Response Planning:**

- *Description* – Response plans for transportation-related incidents and events should be developed by local traffic experts. These are generally Traffic Engineers. One or more Traffic Engineers or appropriate representatives must participate in the creation of response plans.
- *Metric* – The Corridor Manager determines the percentage of time that appropriate personnel are present for response planning sessions.
- *Metric Value* – 90% of the time.
- *Problem Identification and Resolution* – The Corridor Manager determines if proper personnel are absent from response planning meetings and determines the reasons why. The Corridor Manager works with stakeholders to resolve attendance issues.
- *Maintenance* – Traffic Engineers and other response planning personnel must be replaced when they are no longer available.
- *Automation* – Not automatable.

**2) Create and Maintain Rules for Incident Detection:**

- *Description* – Traffic Engineers will define the rules (metrics and the values of those metrics) to be used in determining the existence of an incident.
- *Metric* – Corridor Manager determines if incident detection rules exist.
- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the rules to determine if the application of the rules resulted in the correct identification of an incident. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process. They will be stored in a rules engine.

**3) Create and Maintain Rules for Determining Incident Severity:**

- *Description* – Traffic Engineers will define the rules (metrics and the values of those metrics) to be used in determining the severity of an incident or event (e.g., small-, medium-, and large-severity values).
- *Metric* – Corridor Manager determines if incident severity rules exist.

- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the rules during incidents or events to determine if the application of the rules resulted in the correct severity determination. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process. They will be stored in a rules engine.

**4) Create and Maintain Rules for Determining the Zone of Influence of an Incident:**

- *Description* – Traffic Engineers will define the rules (metrics and the values of those metrics) to be used in determining the zone of influence of an incident.
- *Metric* – Corridor Manager determines if zone of influence rules exist.
- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the rules during incidents or events to determine if the application of the rules resulted in the correct zone of influence determination. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process. They will be stored in a rules engine.

**5) Determine Response Plan Components:**

- *Description* – Traffic Engineers will define and list all response plan components needed to manage incidents and events. The components are shown in Figure 7-5.
- *Metric* – Corridor Manager and Traffic Engineers determine through observation, simulation, and analysis the percentage of required components that are defined and listed.
- *Metric Value – 95%.*
- *Problem Identification and Resolution* – After each incident, unscheduled event, or planned event, the Corridor Manager, in combination with Traffic Engineers and stakeholders, will review the selected response plan components and determine if any

are missing or inappropriate. If missing/inappropriate components are found, then the Corridor Manager and Traffic Engineers will update the component list.

- *Maintenance* – As the transportation network changes, the Corridor Manager and Traffic Engineers will need to update the list of response plan components.
- *Automation* – The definition of the plan components is manual. Plan components should be stored in a rules engine and, where appropriate, tied to physical items tracked in the corridor.

**6) Create and Distribute Signal Timing Plans:**

- *Description* – Traffic signal timing plans will be created, maintained, tested, and distributed to devices listed in the response plan component list. This will be done by Traffic Engineers.
- *Metric* – The Corridor Manager and Corridor Technical Manager will determine the percentage of required timing plans developed and deployed.
- *Metric Value – 100%*.
- *Problem Identification and Resolution* – After each incident, unscheduled event, or planned event, the Corridor Manager and Traffic Engineers will review the timing plans to determine any changes needed. Traffic Engineers will make these changes.
- *Maintenance* – As traffic conditions change, signal timing plans will need updating and reverification. This will be done by Traffic Engineers.
- *Automation* – The creation of the signal timing plans is a manual process (potentially assisted by tools such as Synchro); however, they should be stored on the devices and referenced in the rules.

**7) Determine Rules for Handing Special Situations:**

- *Description* – Traffic Engineers will define the special rules to be applied during an incident, unscheduled event, or planned event. For example, “Do not use this route during school hours unless the severity is high.”
- *Metric* – Corridor Manager determines if the rules exist.
- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the rules applied during incidents or events to determine if the application of special situation rules resulted in the correct response plan component selection. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process; however, they should be stored in a rules engine.

**8) Create and Maintain Rules for Building Response Plans from Components:**

- *Description* – Traffic Engineers will define the rules to be used in building response plans from components. These rules will likely include references to incident severity, location, zone of influence, and expected impacts on corridor operations.
- *Metric* – Corridor Manager determines if the rules exist.
- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the rules during incidents or events to determine if the application of the rules resulted in the generation of appropriate response plans. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process; however, they should be stored in a rules engine.

**9) Determine Rules for Selecting a Response Plan for Implementation:**

- *Description* – Traffic Engineers will define the rules to be applied for real-time response plan selection. Choices are:
    - Select a particular response plan.
    - Recommend no response plan be used.
    - Determine that the system could not make a recommendation due to data quality or system errors.
- *Metric* – Corridor Manager determines if the rules exist.
- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the response plans selected during incidents or events to determine if the application of the rules resulted in the correct selections. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process; however, they should be stored in a rules engine.

**10) Determine Rules for Sending Response Plan Instructions to Corridor Assets:**

- *Description* – Traffic Engineers will define the rules to be applied to determine what order and with what schedule instructions should be sent to response plan assets.
- *Metric* – Corridor Manager determines if the rules exist.
- *Metric Value* – The rules exist.
- *Problem Identification and Resolution* – Traffic Engineers will review the execution order of instructions sent to corridor assets to determine if the application of the rules resulted in the correct ordering. If not, they will determine whether the error lies with the rules themselves or with data or software problems. If the rules are inaccurate, then Traffic Engineers will update the rules. If the rules are correct, then a Data Analyst or a Software Engineer will diagnose the problem and work with appropriate ICM personnel to resolve the issues.
- *Maintenance* – As the corridor changes, the rules will need to be reviewed and updated by Traffic Engineers.
- *Automation* – The creation of the rules is a manual process; however, they should be stored in a rules engine.

**11) Enable Building of Mock Incidents:**

- *Description* – The ICM Core System will enable the creation of mock incidents or events for use in testing.
- *Metric* – Corridor Technical Manager determines the percentage of time that the system is able to correctly build mock incidents and events.
- *Metric Value – 100%*.
- *Problem Identification and Resolution* – Stakeholders building mock incidents will determine if there is a problem; Software Engineers will diagnose and fix the problems.
- *Maintenance* – Standard software maintenance.
- *Automation* – This process should be automated.

**12) Test the Effectiveness of Created Response Plans, Using Analytical and/or Prediction Tools:**

- *Description* – Traffic Engineers will create mock incidents and events and review the resulting response plans generated by the ICM Core system. They will then run these response plans through the prediction system and analyze the results to determine the likely effectiveness of those plans.
- *Metric* – The Corridor Manager working with Traffic Engineers will determine the proper amount of testing needed and ensure the testing takes place.
- *Metric Value* – 100% of designated tests are run.
- *Problem Identification and Resolution* – Problems for this function could exist in the ability to create and execute a mock incident or in the prediction system itself. Problems will be identified and resolved by Traffic Engineers, Software Engineers, Data Analysts, and

Database Administrators. Problems could also exist if Traffic Engineers do not create and run the mock incidents. This problem will be addressed by the Corridor Manager.

- *Maintenance* – Ensure Traffic Engineers are available to test the response plans and that the ICM system is capable of running them.
- *Automation* – Defining the inputs to the simulated incident or event is manual; running the prediction engine is automated; reviewing the results is manual.

**13) After-Incident/Event Reports:**

- *Description* – The ICM Core System will generate after-incident or after-event reports summarizing the results of the incident response plan and its effects on corridor performance.
- *Metric* – Corridor Manager will ensure that reports are generated after each incident or event for which a response plan was generated.
- *Metric Value* – 100% of reports are generated.
- *Problem Identification and Resolution* – There are a number of problems which could arise in the generation of after-incident or after-event reports. They will be identified by users and resolved by Data Analysts, Database Administrators, and Software Engineers.
- *Maintenance* – It is very likely that the format and content of these reports will change as users gain experience and knowledge of what is most useful in an after-incident or after-event report. Software Engineers and Database Administrators will upgrade and maintain the reports.
- *Automation* – The generation of reports will be automated.

**14) Quarterly Analysis of Responses to Incidents and Events:**

- *Description* – Each quarter, as well as following each major incident, stakeholders will meet to discuss and review the results of the application of response plans to the corridor.
- *Metric* – Corridor Manager will ensure the meetings occur and that all appropriate stakeholders attend the meeting.
- *Metric Value* – 100% on holding meetings and 90% on all relevant stakeholders attending.
- *Problem Identification and Resolution* – If meetings are not being held or attendance is low, the Corridor Manager will work with stakeholders and Corridor Champion(s) to determine and remedy the causes.
- *Maintenance* – The Corridor Manager must keep an updated list of who will attend these meetings.
- *Automation* – This cannot be automated.

## 8.4. REAL-TIME INCIDENT/EVENT MONITORING

The ICM environment is principally focused on responding to changes in either transportation system capacity or demand. These changes may be caused by:

1) **Incidents –** An unplanned reduction in capacity caused by accidents, road/lane closures, or mass transit service disruptions
2) **Unscheduled Events** – Events unexpectedly affecting travel conditions or corridor operations, such as a natural disaster or a bomb threat
3) **Planned Events** – Planned changes to demand and possibly localized reductions in capacity

Being able to determine that an incident or unscheduled event has occurred, or that a scheduled event has started or is about to occur, is central to the ICM system's ability to determine appropriate responses to the situation at hand. Knowing the reason for an observed or upcoming change in traffic demand or roadway capacity is important in choosing a suitable response plan. For example, responding to a Rose Bowl event as if it were a simple accident would not properly address the transportation challenges created by the event.

A challenge remains in the identification of incidents and events affecting corridor operations. The automated identification of incidents has proven to be relatively difficult, as traffic patterns that resemble an incident can occur spontaneously without apparent cause. This can lead automated detection systems to produce frequent false positives and, thus, to be ignored by traffic managers. Furthermore, while planning can be done for scheduled events, this can only occur if all important information about the event's potential or projected impact on corridor travel is available. Without proper identification of incidents and events, the ICM environment may not meet its performance goals. A lack of adequate information may even make a bad situation worse.

The Real-Time Incident/Event Monitoring function includes the following sub-functions:

- Receiving information about incidents or events
- Automated incident detection capability
- Incident/event validation and characterization by stakeholders
- Notifying stakeholders of incidents/events
- Initiating real-time response planning
- Updating incident/event information as needed
- Determining end-of-response actions when corridor operations have returned to normal

Below is a more detailed description of these requirements.

**1) Providing Information Characterizing an Incident/Event:**

- *Description* – Stakeholders will provide information characterizing an incident/event to the ICM Core System. This information includes:
    i. Location
    ii. Start time
    iii. Type
    iv. Severity
    v. Agency responsible for managing the incident or event
    vi. Lanes, routes, or tracks affected
    vii. Anticipated duration
    viii. Is a special response plan required and, if so, what is that response plan?

- *Metric* – Corridor Manager determines the percentage of time incident information is properly provided.
- *Metric Value* – All of the information is present 90% of the time. Information for maintenance and events is available an hour before-hand. Incident information is available within 15 minutes of an incident occurring.
- *Problem Identification and Resolution* – The Corridor Manager will review all incidents and events and determine when information was not provided. Stakeholders, First Responders, and Public Information Officers must work together to resolve the issues.
- *Maintenance* – Stakeholders must review all incident/event information communication processes periodically and ensure that personnel are aware of and follow these processes.
- *Automation* – Some information may be provided through automation, but it is likely that the process will require human intervention.

**2) Automated Incident Detection**

- *Description* – The ICM software will use rules and traffic measurements to identify potential incidents.
- *Metric* – Traffic Engineers will determine the percentage of time that incidents are properly identified.
- *Metric Value* – False positives only 10%, false negatives only 5%.
- *Problem Identification and Resolution* – The Corridor Manager and Traffic Engineers will review incident detection and determine if the system is working correctly.
- *Maintenance* – Incident detection algorithms and rules will need to be tuned by Traffic Engineers and Software Engineers.
- *Automation* – This process will be automated.

**3) Validation of Incidents/Events:**

- *Description* – Stakeholders must validate that an incident or event exists before a response plan is applied.
- *Metric* – Corridor Manager reports percentage of incidents and events that are validated.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – If an incident or event is characterized but not validated, the Corridor Manager must determine why and work with stakeholders to determine a remedy.
- *Maintenance* – The Corridor Manager will maintain the validation processes.
- *Automation* – Validation of an event will require human interaction.

**4) Incident/Event Characterization Required:**

- *Description* – The ICM system will not generate a response plan without a fully characterized incident/event.
- *Metric* – The Corridor Manager will track the percentage of incidents or events that are not fully characterized and result in the generation of a response plan.
- *Metric Value* – 0%.
- *Problem Identification and Resolution* – Corridor Manager will review cases where an incident or event that was not fully characterized resulted in the generation of a response plan. The Corridor Manager will work with Software Engineers to diagnose and fix the problem.
- *Maintenance* – No maintenance required.
- *Automation* – This process should be automated.

**5) Notify Stakeholders of Incidents/Events:**

- *Description* – The ICM system shall notify stakeholders that an incident or event has occurred.
- *Metric* – The Corridor Manager will determine the percentage of proper personnel are notified.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – When a stakeholder determines that they were not notified, they will tell the Corridor Manager. The Corridor Manager will work with stakeholders to ensure the "who to contact" rule set is properly updated.
- *Maintenance* – Stakeholders must maintain the "who to contact" list.
- *Automation* – This process will be automated.

**6) Initiate Real-Time Response Planning:**

- *Description* – Once an event is characterized, the real-time response planning function will be initiated.
- *Metric* – The Corridor Technical Manager will determine the percentage of time that the real-time response planning function is correctly initiated.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Software Engineers will determine why the response planning function was not initiated and resolve the problem.
- *Maintenance* – Normal software maintenance by Software Engineers.
- *Automation* – This process will be automated.

**7) Providing Updated Incident/Event Information:**

- *Description* – Stakeholders will provide updated event information (for example, end-of-incident network changes) to the ICM Core System.

- *Metric* – Percentage of incidents where the updated event information is communicated.
- *Metric Value* – 95%.
- *Problem Identification and Resolution* – Corridor Manager to determine when incident information was not properly updated and resolve issues with stakeholders.
- *Maintenance* – Processes to be updated as needed by Corridor Manager.
- *Automation* – This process will not be automated.

**8) Determine End of Residual Incident/Event-Related Disruptions:**

- *Description* – The ICM system shall determine when travel conditions within the corridor return to normal or near-normal conditions following the end of an incident or event.
- *Metric* – Percentage of time when the system properly determined the incident/event was over.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – The Corridor Manager, in conjunction with Traffic Engineers, reviews all termination recommendations for errors. If errors are found, the Corridor Manager and Traffic Engineers will identify the reason and resolve the issues.
- *Maintenance* – Normal software maintenance.
- *Automation* – This process will be automated.

## 8.5. REAL-TIME RESPONSE PLANNING

Once it has been determined that an incident or event will significantly affect corridor operations, a suitable response plan, designed to minimize the incident's impacts on corridor operations, must be assembled and selected for implementation. Assuming than an existing predefined response plan is not already associated with the type of incident or event identified, the ICM system will assemble one or more possible response plans. These plans will be based on the description of the incident or event, the transportation network configuration, the ITS elements in the network, and rules limiting or guiding the use of the network and associated assets. The likely effects on corridor performance of each developed response plan will then be evaluated by the DSS prediction function and the results used to recommend a response plan for implementation.

Accomplishing these tasks requires the following functions:

- Build response plans
- Evaluate response plans
- Choose a recommended response plan
- Approve a recommended response plan
- Forward approved response plan for implementation
- Periodically review and update implemented response plans
- Off-line analysis

Below is a more detailed description of these generic requirements.

1) **Build Response Plans:**

- *Description* – The ICM system shall use the current corridor state, predefined ITS elements, and predefined rules to build response plans.
- *Metric* – Corridor Manager and Traffic Engineers, through observation and analysis, shall determine the percentage of response plans that are correctly generated.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Corridor Manager and Traffic Engineers shall determine when response plans are not reasonable and why. Response plans are complex, and there may be a number of reasons they are not generated correctly. Resolution may require personnel from all areas of the ICM function.
- *Maintenance* – The process of building response plans involves application of a number of rules and the proper inclusion of corridor data. Software Engineers will need to ensure changes in rules and data are properly handled by the response plan building function.
- *Automation* – This process will be automated.

2) **Correctly Evaluate Individual Response Plans:**

- *Description* – The ICM system shall predict the effect on appropriate metrics (to include but not limited to corridor delay) of each of the response plans in comparison to a "do nothing" response.
- *Metric* – Percentage of response plans that are correctly evaluated.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – The Corridor Manager and Traffic Engineers shall determine when prediction results are not correct. Determining why may be difficult, as prediction accuracy is subject to random unpredictable events. Resolution may require personnel from all areas of the ICM function.
- *Maintenance* – The process of running predictions should require little maintenance, as most of the functionality resides in the DSS function. Software Engineers will be required for bug fixing and updates to interfaces, such as changes to the generic response plan components.
- *Automation* – This function will be automated.

3) **Determine Recommended Response Plan:**

- *Description* – The ICM system shall use predefined rules to choose between response plans. Choices are:
    - Suggest a response plan for implementation
    - Suggest a response plan not be implemented
    - Indicate that it could not make a recommendation due to data or system errors

- *Metric* – Corridor Manager will determine the percentage of time the system makes a recommendation based on the specified rules.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – The Corridor Manager shall review the response plan chosen and see if the choice was accurate. If not, the rules and rules engine should be reviewed by the Corridor Manager and the Traffic Engineers.
- *Maintenance* – Normal software maintenance.
- *Automation* – This process should be automated.

**4) Review of Recommended Response Plan:**

- *Description* – Based on the rules in place at the time of an incident or event, stakeholders will review and, where appropriate, modify response plans.
- *Metric* – Corridor Manager determines percentage of appropriate stakeholders who reviewed and modified plans.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – The Corridor Manager will determine when reviews are not taking place and will work with stakeholders to identify and resolve issues with the review process.
- *Maintenance* – Modifications to the review process.
- *Automation* – This process cannot be automated.

**5) Approval Process:**

- *Description* – The ICM system shall follow predefined rules to determine how plan approval is accomplished.
- *Metric* – The Corridor Manager determines percentage of time the approval rules are followed.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Corridor Manager and stakeholders note when approval rules are not followed and determine whether the problem is with the rules or the software. Depending on the problem, either the Corridor Manager or Software Engineers will fix the problem.
- *Maintenance* – Normal software maintenance.
- *Automation* – This process should be automated.

**6) Stakeholder Approval of Recommended Response Plan:**

- *Description* – Stakeholders who are part of the plan approval process approve, or disapprove, the response plan.
- *Metric* – Corridor Manager notes percentage of stakeholders who fulfill their role as approvers of the plan.

- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Corridor Manager contacts stakeholders to determine if the problem is one of human process, software, or rules. Depending on the problem, stakeholders, Software Engineers, or the Corridor Manager resolves the problems.
- *Maintenance* – Approvers who leave or are absent need to be replaced; normal software maintenance.
- *Automation* – Approval is a manual process, but tracking of the approval is automated.

**7) Initiate Response Plan Implementation:**

- *Description* – Once a response plan is approved, its implementation will be initiated.
- *Metric* – The Corridor Manager shall note the percentage of time response plan implementation is correctly initiated.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Software Engineers will determine why response plan implementation was not properly initiated and resolve issues.
- *Maintenance* – Normal software maintenance.
- *Automation* – This process should be automated.

**8) Review and Update Active Response Plan:**

- *Description* – As long as traffic conditions warrant, the system will periodically build new response plans and determine if they should be submitted for approval to stakeholders.
- *Metric* – Corridor Manager determines the percentage of time new response plans are generated during an incident or event.
- *Metric Value* – 100% of the time every 15 minutes.
- *Problem Identification and Resolution* – Corridor Manager notes when new response plans are not being generated. Software Engineers will track down and resolve issues.
- *Maintenance* – Normal software maintenance.
- *Automation* – This process should be automated.

**9) Permit Off-line Analysis:**

- *Description* – The ICM system shall permit non-real-time analysis of each step in the response planning workflow, permitting an understanding of how predictions were performed, recommendations made, and plans chosen. Note that this requires all data used in the decision to be stored and available.
- *Metric* – Corridor Manager determines the percentage of incident/event response plans that were able to be reviewed and analyzed by stakeholders.
- *Metric Value* – 100%.

- *Problem Identification and Resolution* – Corridor Manager works with Software Engineers, Data Analysts, and Database Administrators to identify and resolve possible issues.
- *Maintenance* – Normal software and database maintenance.
- *Automation* – This review process is performed by humans.

## 8.6. RESPONSE PLAN IMPLEMENTATION

Once a response plan is chosen, assets selected to implement the plan must, with the proper order and timing, be given instructions. This requires:

- Determining which assets to send instructions to and in what order to send the instructions
- Notifying stakeholders of response plan implementation
- Sending instructions to response plan assets and verifying their execution
- Monitoring assets for any unexpected changes
- Returning assets to normal status

Below is a more detailed description of these requirements.

**1) Determine Instruction Order and Schedule:**

- *Description* – The system shall send instructions to corridor assets in the proper order and at the proper times. This requires an understanding of how long it will take each asset to implement instructions.
- *Metric* – Corridor Manager and Traffic Engineers will determine the percentage of time instructions are sent correctly.
- *Metric Value* – 95%.
- *Problem Identification and Resolution* – The Corridor Manager and Traffic Engineers will determine in post-incident/event analysis where issues related to asset instructions arose. Resolution of these issues, which may be simple timing issues or problems with estimating deployment time for trucks/signs, could require resources from multiple stakeholders.
- *Maintenance* – As assets and equipment change, the order and time they receive instructions may need to be modified by the Corridor Manager and Traffic Engineers.
- *Automation* – This process will be automated.

**2) Notify Stakeholders of Response Plan Implementation:**

- *Description* – The ICM system shall notify stakeholders that a response plan is being deployed.
- *Metric* – The Corridor Manager will determine the percentage of time proper personnel are notified.
- *Metric Value* – 100%.

- *Problem Identification and Resolution* – When a stakeholder determines that they were not appropriately notified, they need to inform the Corridor Manager. The Corridor Manager will work with stakeholders to ensure the "who to contact" rule set is updated.
- *Maintenance* – Normal software maintenance by Software Engineers and rule set maintenance by stakeholders.
- *Automation* – This process will be automated.

**3) Implementation Override:**

- *Description* – The system shall determine, just before plan implementation, if the corridor has changed such that the plan should not be implemented. If so, then implementation of the plan should be canceled and stakeholders notified.
- *Metric* – Corridor Manager to determine percentage of time that plan is correctly canceled.
- *Metric Value* – 80%.
- *Problem Identification and Resolution* – Corridor Manager and Traffic Engineers will determine in post-incident/event analysis where plans were inappropriately implemented. Resolution of these issues will require updating of rules by Traffic Engineers.
- *Maintenance* – As corridor assets change, the rules may need to be updated by Traffic Engineers.
- *Automation* – This process should be automated.

**4) Send Response Plan Instructions to Assets:**

- *Description* – The ICM system shall send response plan instructions to assets. This includes both ITS and human elements in the response plan.
- *Metric* –Corridor Manager to determine percentage of time instructions are sent.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Corridor Manager and Traffic Engineers will determine in post-incident/event analysis where issues arose. Resolution of these issues, which may be simple communication issues or more complex policy issues, could require resources from multiple stakeholders.
- *Maintenance* – As assets and equipment change, the manner in which instructions are sent to assets may require modification. These modifications will need to be made by Software Engineers for hardware and software and by stakeholders for human assets.
- *Automation* – This process will be automated.

**5) Verify that Assets Have Accepted Instructions:**

- *Description* – The system shall verify, where possible, that assets have received instructions.
- *Metric* – Corridor Manager to determine percentage of time that verification occurs.

- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Corridor Manager and Traffic Engineers will determine in post-incident/event analysis where issues arose. Resolution of these issues could require resources from the entire organization.
- *Maintenance* – As assets and equipment change, the manner in which verification occurs may require modification to system components and policies. These modifications will be made by Software Engineers and stakeholders.
- *Automation* – This process should be automated for ITS elements but may be manual for personnel.

**6) Monitor and Communicate Changes in Asset Status:**

- *Description* – While a response plan is in place, the system should monitor, and assets should communicate, any changes in status. If status changes occur, stakeholders should be notified.
- *Metric* – Corridor Manager to determine percentage of time that asset changes have occurred and stakeholders have been notified.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Corridor Manager and Traffic Engineers will determine in post-incident/event analysis where status changes occurred and the proper processes were not followed. Resolution of these issues could require resources from multiple stakeholders depending on the cause of the problem.
- *Maintenance* – As corridor assets change, software may need to be updated. Stakeholders to ensure contact information is accurate.
- *Automation* – This process should be automated for hardware, manual for personnel.

**7) Assets Returned to Normal Operational Status:**

- *Description* – The ICM system shall ensure assets return to normal status when an incident or event ends.
- *Metric* – Corridor Manager to determine percentage of time that assets returned to normal status.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Corridor Manager and Traffic Engineers will determine in post-incident/event analysis where assets did not return to normal status. Resolution of these issues could require resources from multiple stakeholders.
- *Maintenance* – As corridor assets and policies change, software may need to be updated by Software Engineers.
- *Automation* – This function can be partially automated; however, some assets may not have a normal mode to return to, and these will need to be handled manually.

**8) Maintain Historical Record of Incidents/Events and Incident/Event's Responses:**

- *Description* – The ICM system shall ensure that all information relevant to response plan implementation is saved and available for review.
- *Metric* – The Corridor Manager will determine percentage of time that proper information has been retained.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – During post-incident/event review, the Corridor Manager and Traffic Engineers note issues and determine why there was difficulty. Resolution may involve Software Engineers and Database Administrators.
- *Maintenance* – As new data is used, Software Engineers and Database Administrators may need to update the ICM Core System.
- *Automation* – This process should be automated.

## 8.7. DATA MANAGEMENT

Data is at the heart of TSM&O performance-managed processes. In the context of the proposed ICM environment, data is needed for understanding the corridor, determining how to manage the corridor, instructing assets to manage travel within the corridor, determining how well the system has succeeded in transportation management tasks, and reviewing all aspects of the system in order to improve it.

While the general operational goal for the ICM system is to handle electronic data, the system may also be required to handle data existing on paper documents and in the minds of people working on the ICM effort.

Data and data quality is at the heart of data-driven performance management. If one truly manages to data, then the data must be accurate, thorough, and timely. Degradations in the quality of the data can result from many causes, and the maintenance of data quality is a system-wide responsibility and concern. A reasonable number of roadway sensors must work at any given time. Similarly, communication networks must reliably transfer data, storage functions must work, etc.

In order to be used and useful, ICM system components must be able to:

- Understand the purpose and format of the data available to them and ensure others understand the data they are providing
- Understand the data quality metrics and know the desired values for those metrics
- Create, read, update, delete, transmit, and receive the data using standard protocols (such as TMDD, NTCIP, and GTFS) where such standards exist. Where standard protocols do not exist, use protocols agreed to during the design phase.
- Add new types of data to the system; remove deprecated data types
- Extract, Transform, and Load (ETL) functionalities available as needed

Data Management functional requirements do not require nor expect that all data will be stored in a single data hub, only that system components will be provided with a simple, consistent way to access the data they need. Thus, local caching of data for performance is expected and supported; however, there must be only one system of record.

Data management also involves utilizing data from third-party vendors. Commercial organizations may provide data/services or may consume the ICM system's data or response plans. These might include third-party travel information providers, mobile travel application developers, probe data providers (INRIX, HERE, or others), or 511 systems.

The requirements included in this section do not discuss individual data elements. For further details on the various data elements, please refer to the Data Dictionary.

Below is a more detailed description of these requirements.

1) **Maintain a Data Dictionary:**

    - *Description* – A document containing up-to-date descriptions of data will be maintained. This document will include information on data:
        - Format

    - Access methods
    - Quality specifications
    - Heritage – Raw, processed, fused, or summarized
    - Source/Ownership
    - Security restrictions

- *Metric* – The Corridor Data Analyst will determine if the document is complete and up to date.
- *Metric Value* – The document is complete and up to date.
- *Problem Identification* – Data Analysts and Database Administrators must note any discrepancies between this document and the actual data and resolve them.
- *Maintenance* – Data is constantly changing. The Corridor Data Analyst must ensure the document is accurate and up to date.
- *Automation* – The maintenance of a data dictionary cannot be automated.

**2) Maintain Data Quality Specifications:**

- *Description* – All data must include an indication of its quality. Quality requirements and methods for calculating the quality must be defined and maintained by the Corridor Data Analyst. Data quality characteristics include:
    - Accuracy
    - Validity
    - Reliability
    - Timeliness
    - Completeness
- *Metric* – The Corridor Data Analyst will determine the percentage of data that has appropriate quality metrics.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Once a year, stakeholders and consultants should review the requirements and the calculation methods. The Corridor Data Analyst is responsible for identifying problems and working with stakeholders and third-party providers to refine and update the specifications.
- *Maintenance* – The Corridor Data Analyst is responsible for updating specifications and calculation methods as data sources and formats change.
- *Automation* – This cannot be automated.

**3) Maintain Data Quality:**

- *Description*: The actual quality of data, as determined by defined metrics, must be maintained.
- *Metric* – The Corridor Data Analyst will determine if data quality is being maintained.
- *Metric Value* – Quality review – Daily to Monthly based on the data, 90% of metrics met each month.

- *Problem Identification and Resolution* – Data Analysts must review the quality of data and determine the reasons for any deviations from data quality requirements. Tracking down the causes of data quality issues will be led by Data Analysts, but isolating the problems and fixing them will require resources from the entire organization.
- *Maintenance* – As data and personnel change, the Corridor Data Analyst must ensure that data quality measurement procedures are in place and that Data Analysts are available and trained.
- *Automation* – The maintenance of data quality cannot be automated.

**4) Data Will Be Stored in Electronic Format:**

- *Description* – All data defined in the Data Dictionary will be stored in electronic format. Where the data is stored either on paper or in people's minds, there will be an effort to migrate this data into electronic format.
- *Metric* – The Corridor Technical Manager, with the assistance of Data Analysts, will determine the percentage of data stored in electronic format.
- *Metric Value* – 95%.
- *Problem Identification and Resolution* – Data Analysts should note when data is not being stored in electronic format and work with stakeholders, Software Engineers, and Database Administrators to store the data.
- *Maintenance* – Over time, the types and formats of data change. Methods must be devised to store this data. Data Analysts should work with stakeholders, Software Engineers, and Database Administrators to ensure this occurs.
- *Automation* – The storage should be automated, while the process of ensuring that this occurs is manual.

**5) Use Standard Protocols for Data Access – TMDD, NTCIP, GTFS:**

- *Description* – All data, where possible, will be transmitted using TMDD/NTCIP/GTFS formats. Where data elements are not defined in the TMDD/NTCIP/GTFS formats, specifications will be extended.
- *Metric* – Database Administrators and Software Engineers determine percentage of time that data is transmitted using TMDD/NTCIP/GTFS format.
- *Metric Value* – 90% of the time.
- *Problem Identification and Resolution* – The Corridor Technical Manager working with Database Administrators and Software Engineers must identify when other formats are being used and work to replace them.
- *Maintenance* – As the TMDD/NTCIP/GTFS specification is updated, Database Administrators and Software Engineers must modify the system to stay in compliance.
- *Automation* – The use of the protocols is automated; ensuring they are used is manual.

**6) Extract, Transform, and Load (ETL):**

- *Description* – ETL will be required for interfacing with external systems. This functionality should be available in a semi-automated interface, and Database Administrators should be available to assist as needed.
- *Metric* – The Corridor Technical Manager and Database Administrators will determine the percentage of time ETL-provided functions can be used.
- *Metric Value* – 90% of the time.
- *Problem Identification and Resolution* – Careful analysis by Data Analysts and Database Administrators is needed to ensure ETL operations continue to work when external data formats change.
- *Maintenance* – Continual maintenance by Database Administrators is needed, as external and internal formats may change at any time.
- *Automation* – ETL should be automated.

**7) Data Maintenance:**

- *Description* – Stakeholders shall be able to request data additions, removals, or format changes to Data Analysts, who will determine the appropriateness of the changes. Examples include: Vehicle-to-Infrastructure data or probe data from third-party vendors.
- *Metric* – The Corridor Technical Manager will determine the percentage of time requests are responded to promptly.
- *Metric Value* – 90% of requests are handled within 1 month.
- *Problem Identification and Resolution* – Not all requests are appropriate. The Corridor Data Analyst must carefully analyze requests and determine that the request can be accommodated by resources and will enhance the ICM function.
- *Maintenance* – Data Analysts must be available to review requests. Fulfilling the requests will require Database Administrators and Software Engineers.
- *Automation* – This cannot be automated.

**8) Technology, Storage, and Performance:**

- *Description* – Data will be stored, accessed, and selected using state-of-the-art technology and processed in acceptable response times. Technology functions include:
    - Data warehousing
    - Data storage using both SQL and non-SQL data stores
    - Data storage using extensible and scalable storage paradigms
- *Metric* – Database Administrators will review technology and determine the percentage of time that state-of-the-art technologies are used and queries executed with appropriate response times.
- *Metric Value* – 90% of the time for technology, 90% for queries.

- *Problem Identification and Resolution* – Database Administrators must review query logs to determine when performance is not meeting requirements and resolve issues.
- *Maintenance* – Data storage technologies require constant maintenance to ensure performance, currency, and data security.
- *Automation* – The technologies listed above can be automated, but the maintenance, problem identification, and problem resolution cannot be automated.

**9) Data Management:**

- *Description* – The Corridor Technical Manager will develop and follow standards for data archiving, warehousing, and deletion.
- *Metric* – Database Administrators and the Corridor Technical Manager shall determine completeness of policies and percentage of time policies are being followed.
- *Metric Value* – 100% for completeness, 90% for being followed.
- *Problem Identification and Resolution* – Data logs must be reviewed to ensure required actions occur. Stakeholders must determine why policies are not being followed and ensure proper data management occurs.
- *Maintenance* – As data changes and volumes grow, the policies and methods must be updated by the Corridor Technical Manager.
- *Automation* – The warehousing, archiving, or deletion of data can be automated, but the policies cannot be.

## 8.8. DECISION SUPPORT

Decision Support is a set of automated processes that assist stakeholders in making decisions. Decision support functions are used in multiple places within the ICM system. Decision support functions include:

- Rules capture and evaluation.
- Determination of the current state of the corridor based on limited data. When evaluating response plans, it is important that analysis start with knowledge of the current conditions and state of the corridor.
- Prediction of the future state of the corridor based on limited data. When evaluating response plans, it is important to consider the likely future state of the corridor.
- Rules to determine whether corridor travel conditions are within normal expectations.

A point deserving discussion is the use of traffic models in the prediction decision support function. There has been some confusion in this area between requirements and design.

There are several implementation methods that may be used to predict the outcome of applying incident/event response plans. They are all based on a "model," a model being defined as the relationships between capacity and control mechanisms combined with anticipated demand. However, the ways in which this model may be implemented can vary and include:

1) Use of mathematical models utilizing real-time and historical data
2) Use of rule-based models utilizing real-time and historical data

3) Use of both types of models in combination
4) Use of rule-based models that use smaller amounts of real-time and historical data, relying instead on historical traffic patterns

From a requirements perspective, what is important is that the Decision Support System provide forecasts of the corridor state within the degree of accuracy specified in these requirements. The way this is accomplished is a design decision.

Below is a more detailed description of these requirements.

**1) Capture Rules:**

- *Description* – Ensure that best practices developed by stakeholder agencies for responding to incidents and events are captured in the form of rules that can be used in the development of response plans.
    i. Rules will be of the form
        1. When
            a. A hardcoded value
            b. A Data Value read from the data hub
            c. A Data Value retrieved from calling a function
            d. Reference to the result of executing another rule
        2. Is
            a. True or False
            b. Related to: (equals, greater than, etc.)
        3. Another value
        4. Then
            a. Return a value
            b. Return a Boolean
    ii. Simple rules will be able to be created by stakeholders with no software experience. More complex rules will require programming capabilities.
- *Metric* – The Corridor Manager and the Corridor Technical Manager determine the percentage of desired rules that have been captured by the rules engine.
- *Metric Value* – 95%.
- *Problem Identification and Resolution* – The Corridor Manager is responsible for reviewing rules during post-incident response plan review. Inconsistent or inaccurate rules should be corrected by whoever created or manages the rule.
- *Maintenance* – Normal maintenance by Software Engineers and Database Administrators of the rules system. Note should be taken of rules that have not been used for a long period of time and their existence discussed.
- *Automation* – Rules creation is a manual process which will be assisted by a rules engine. Rules execution is an automated process. The knowledge and experience required to define rules must be sourced from humans, and the providing of this information cannot be automated.

**2) Evaluate Rules:**

- *Description* – Rules must be correctly evaluated by a rules engine.
- *Metric* – The Corridor Technical Manager, working with Traffic Engineers, determines the percentage of time rules are evaluated correctly.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – During post-incident response plan review, the Corridor Manager will determine if rules were not evaluated correctly. Incorrect evaluation of rules would be the result of issues with the rules engine itself (as opposed to incorrect rules having been provided to the rules engine). Fixes to the rules engine must be made by Software Engineers.
- *Maintenance* – As data and rules change, any changes which cannot be done by stakeholders using the basic rules engine capabilities must be done by a Software Engineer.
- *Automation* – Rules execution will be automated.

**3) Corridor State Determination:**

- *Description* – Determine the state of the corridor transportation network every 60 seconds, both in areas where data exists and where it does not exist.
- *Metric* – Percentage of traffic sensors included in the evaluation for which the estimated traffic state deviates by more than 10% from the observed state. In this case, the assessed traffic state may refer to traffic flow, density, or other parameters of interest to system users. This assessment has to be conducted separately for the AM and PM peak periods, using a dataset covering three days without incidents.
- *Metric Value* – 90% of traffic sensors included in the evaluation with an estimated traffic state differing by no more than 10% from the observed state.
- *Problem Identification and Resolution* – Observation, measurement, and statistical analysis by Traffic Engineers should be used to determine if the results are correct. If the results are incorrect, then problem resolution may involve multiple project personnel.
- *Maintenance* – The algorithms and data used to determine corridor state will need to be updated and maintained based on changes in the corridor. Traffic Engineers and Software Engineers may be required for this task.
- *Automation* – This task should be automated.

**4) Future Corridor State Prediction:**

- *Description* – Using current corridor state, historical data, and a response plan, determine the likely evolution of corridor state over time. The maximum future prediction time is 1 hour.
- *Metric* – Required time to perform a prediction; number of predictions able to be run in parallel; and prediction error from the forecasting tool less than a similar prediction conducted without using a calibrated traffic model (i.e., resulting from simple data trend analyses), depending on underlying data quality.

- *Metric Value* – Execution of a 1-hour prediction in no more than 5 minutes. Ability to run 10 predictions in parallel. Statistical test with a 95% probability (0.05 p-value) that the prediction error from the forecasting tool is less than a similar prediction based on simple data trend analyses.
- *Problem Identification and Resolution* – Observation, measurement, and statistical analysis by Traffic Engineers should be used to determine if the results are correct. If the results are incorrect, then problem resolution may involve multiple project personnel.
- *Maintenance* – The algorithms and data used to predict corridor state will need to be updated and maintained based on changes in the corridor. Traffic Engineers with skills in modeling will be required for this task. Software Engineers may also be required for this task.
- *Automation* – This task should be automated

5) **Determine if Traffic Characteristics Are within Normal Variability**:

- Description – Using historical patterns and existing corridor state, determine if traffic is within normal variability for this date and time.
- *Metric* – Traffic Engineers determine the percentage of time that the result is accurate.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Observation, measurement, and statistical analysis by Traffic Engineers should be used to determine if the results are correct. If the results are incorrect, then problem resolution may involve multiple project personnel.
- *Maintenance* – Software Engineers and Database Administrators will be needed for ongoing maintenance.
- *Automation* – This function should be automated.

## 8.9. CORE SYSTEM USER INTERFACE

While much of this document defines requirements for hardware, software, individuals, and organizations, the Core System User Interface requirements focus on the software-based user interfaces used for data manipulation and process control. This includes interface requirements for creating, viewing, updating, deleting, and reporting on data. It also includes interface requirements for managing the process of incident identification, response plan generation, response plan implementation, and Core System management.

Core System User Interface requirements include:

- Asset Information Management user interface
- Incident/Event Information Management user interface
- Mock Incident Creation and Testing user interface
- Response Plan Management user interface
- ICM Core System user interface
- Geospatial visualization of data
- Reporting, charting, and graphing functions

- Post-incident/event analysis reports
- Software system parameters
- Interagency communication

Below is a more detailed description of the generic requirements.

**1) Asset Information Management User Interface:**

- *Description* – The ICM Core System shall include a user interface to create, view, update, and delete asset inventory, health, availability, and state.
- *Metric* – Percentage of functions accessible through one common interface as determined by the Corridor Technical Manager.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Corridor Technical Manager tracks functionality and notes issues. Software Engineers and Database Administrators may be needed to resolve issues.
- *Maintenance* – Software Engineers and Database Administrators are required for maintenance.
- *Automation* – This user interface will be automated.

**2) Incident/Event Information Management User Interface:**

- *Description* – The ICM Core System shall include a user interface to create, view, update, and delete incident/event information.
- *Metric* – Percentage of functions accessible through one common interface as determined by the Corridor Technical Manager.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Corridor Technical Manager tracks functionality and notes issues. Software Engineers and Database Administrators may be needed to resolve issues.
- *Maintenance* – Software Engineers and Database Administrators are required for maintenance.
- *Automation* – This user interface will be automated.

**3) Mock Incident Creation and Testing User Interface:**

- *Description* – The ICM Core System shall include a user interface permitting users to create and test mock incidents.
- *Metric* – Percentage of time that mock interfaces can be successfully created using this interface.
- *Metric Value* – 95%.

- *Problem Identification and Resolution* – The Corridor Technical Manager will note when the user interface is either not functioning or needs to be changed because of the need for new rules, etc. Software Engineers will be required to modify the user interface.
- *Maintenance* – As new features are added, Software Engineers will be needed to update the user interface.
- *Automation* – This user interface will be automated.

**4) Response Plan Management User Interface:**

- *Description* – The ICM Core System shall include a user interface to create, view, update, and delete response plans and rules and set the parameters for response plan approval.
- *Metric* – Percentage of time that response plan management user interface can successfully be used.
- *Metric Value* – 95% (95% because certain rules may be needed that cannot be handled).
- *Problem Identification and Resolution* – The Corridor Technical Manager will note when the user interface is either not functioning or needs to be changed because of the need for new rules, etc. Software Engineers will be required to modify the user interface.
- *Maintenance* – As new features are added, Software Engineers will be needed to update the user interface.
- *Automation* – This user interface will be automated.

**5) ICM Core System User Interface:**

- *Description* – The ICM Core System shall include a user interface to permit start and shut-down of Core System components and to manually input/edit system and user administration information.
- *Metric* – Percentage of time that the core system management user interface functions correctly.
- *Metric Value* – 100%
- *Problem Identification and Resolution* – The Corridor Technical Manager will note when the Core System Management user interface is not functioning. Software Engineers will be required to modify the user interface.
- *Maintenance* – As new features are added, Software Engineers will be needed to update the user interface.
- *Automation* – This user interface will be automated.

**6) Geospatial Visualization of Data:**

- *Description* – The ICM Core System shall display geospatial-based visualizations of corridor information. Visualizations shall be layered and customizable by users.
- *Metric* – Corridor Technical Manager determines percentage of appropriate data that can be shown on the interface and the percentage of users that are pleased with the interface.

- *Metric Value* – 90% of appropriate data, 90% of users pleased with interface.
- *Problem Identification and Resolution* – The Corridor Technical Manager and users note data when is not displayed correctly. Software Engineers and Database Administrators are needed to resolve the problem.
- *Maintenance* – As data and data presentation needs change and bugs are found, Software Engineers and Database Administrators are needed to update the user interface.
- *Automation* – This user interface will be automated.

**7) Reporting, Charting, and Graphing Functions:**

- *Description* – The ICM Core System shall include functions for standard and customized reports, plot-based (2d, 3d, heat map) visualizations of corridor information, multiple types of graphs, and tabular display of information.
- *Metric* – Corridor Technical Manager determines percentage of appropriate data that can be shown on the interface and the percentage of users that are pleased with the interface.
- *Metric Value* – 90% of appropriate data, 90% of users pleased with interface.
- *Problem Identification and Resolution* – The Corridor Technical Manager and users note data that is not displayed correctly. Software Engineers and Database Administrators are needed to resolve the problem.
- *Maintenance* – As data and data presentation needs change and bugs are found, Software Engineers and Database Administrators are needed to update the user interface.
- *Automation* – These functions will be automated.

**8) Post-Incident/Event Analysis Reports:**

- *Description* – The ICM Core System shall create post-incident/event analysis reports for incidents and events for which response plans were generated.
- *Metric* – Percentage of time that reports are properly generated.
- *Metric Value* – 100%
- *Problem Identification and Resolution* – The Corridor Technical Manager will note when the reports are not generated and work with Software Engineers to diagnose and resolve issues.
- *Maintenance* – As new features are added to reports, Software Engineers will be needed to update them.
- *Automation* – This reporting process will be automated.

**9) System Parameters:**

- *Description* – There shall be a central interface to permit review and modification of software system parameters and processes.

- *Metric* – Corridor Technical Manager determines what percentage of parameters can be reviewed and modified.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Users will report when this interface is not functioning.
- *Maintenance* – As the system undergoes planned modifications, Software Engineers and Database Administrators will be needed to maintain this functionality.
- *Automation* – This can be automated.

**10) Interagency Communication**

- *Description* – The ICM Core System shall provide stakeholders and, in particular, first responders with methods to easily exchange information during incidents.
- *Metric* – Corridor Manager determines, through interviews, ease of exchange of information.
- *Metric Value* – 80% of interviewees agree that information is easily exchanged.
- *Problem Identification and Resolution* – The Corridor Manager will observe communication during incidents and determine if communication issues exist. If so, the Corridor Manager will work with stakeholders to resolve issues.
- *Automation* – Communication methods should be automated.

## 8.10. SYSTEM INTEGRATION

This section requires that the ICM Core System be composed of one integrated set of data definitions, data values, processes, and user interfaces. Users should be able to manipulate data and manage processes by interfacing with one integrated user interface. Data should be stored in only one location, and all data of a given type should conform to the same format and quality standards.

One requirement mentioned in many meetings is that the ICM System shall operate as an integrated whole in its visual presentation to stakeholders. Presentation is an important word here, as the requirement does not mean that the system (people, software, hardware) shall all be part of the same organization, sourced from the same hardware supplier, or composed of one monolithic software application.

System integration does mean that users should be able to manage data and implement decisions through one interface. That is, they should be able to access ICM functions and complete workflow processes without switching between systems or user interfaces.

For the core ICM system this is an understandable requirement. However, when expanded to the overall ICM system (including all supporting systems, such as the ATMS), it is not possible for all software components to be part of one user interface, as each existing system has its own predefined UI. For example, Caltrans ATMS users have requested that all functions be accessible through the ATMS software. This requirement is taken to mean that all functions that an ATMS operator will be asked to perform are

interfaced to the ATMS—not that every function of the ICM system is provided as part of the ATMS user interface itself.

System Integration requirements include:

- Basic integration requirements
- Integrated visualization and reporting
- Integrated control functions
- Integrated data definition, capture, and processing
- Ownership of corridor assets including software, hardware, data, and algorithms
- System/location of record for data

Below is a more detailed description of the generic requirements.

1) **Integration Requirements:**
    - *Description* –The ICM Core System shall be a single integrated system capable of directing all corridor operations. It shall include functionality for users to view, analyze, and control corridor performance and operations from a single integrated user interface.
    - *Metric* – Percentage of functions accessible through one integrated system as determined by the Corridor Technical Manager.
    - *Metric Value* – 90%.
    - *Problem Identification and Resolution* – The Corridor Technical Manager tracks functionality, notes issues, and works with project personnel to resolve issues.
    - *Maintenance* – The Corridor Technical Manager ensures that system modifications are designed and implemented to meet these integration requirements.
    - *Automation* – Ensuring this requirement is met cannot be automated.
2) **Integrated Visualization and Reporting:**
    - *Description* – The ICM Core System shall provide a single visualization and reporting user interface for all ICM Core System operations.
    - *Metric* – Percentage of visualization and reporting functions where this interface is used.
    - *Metric Value* – 80%.
    - *Problem Identification and Resolution* – The Corridor Technical Manager will note where this does not occur. Software Engineers will be required to bring the system to compliance.
    - *Maintenance* – As new features are added, bugs are fixed, etc., these standards will need to be followed by Software Engineers.
    - *Automation* – The user interfaces are automated; ensuring integration occurs is not.

**3) Integrated Control Functions:**

- *Description* – The ICM Core System shall provide a single well-defined user interface for accessing major ICM Core System functionality.
- *Metric* – Percentage of functions accessible through one common interface as determined by the Corridor Technical Manager.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – The Corridor Technical Manager will note where this does not occur. Software Engineers will be required to bring the system to compliance.
- *Maintenance* – As new features are added, bugs are fixed, etc., these standards will need to be followed by Software Engineers.
- *Automation* – The user interfaces are automated; ensuring integration occurs is not.

**4) Integrated Data Definition, Capture, and Processing:**

- *Description* – The ICM Environment shall use a common set of data definitions and shall provide consistent data processing and management across all ICM components. Data shall be presented to users consistently across all ICM Core System components.
- *Metric* – The Corridor Data Analyst determines percentage of appropriate data that meet these requirements.
- *Metric Value* – 90% of appropriate data.
- *Problem Identification and Resolution* – The Corridor Data Analyst notes when standards are not being followed and works with Software Engineers and Database Administrators as needed to resolve the problems.
- *Maintenance* – As data needs change and bugs are found, Software Engineers and Database Administrators are needed to update the user and programming interfaces.
- *Automation* – This cannot be automated.

**5) Ownership of Corridor Assets including Software, Hardware, Data, and Algorithms:**

- *Description* – All corridor assets (excepting personnel) will have an owner/manager. This includes data definitions, algorithms, and workflows, as well as hardware and software systems. An owner is responsible for understanding the item and approving changes. This may be an organization or an individual. This ownership will be tracked by the Corridor Manager and the Corridor Technical Manager.
- *Metric* – Corridor Manager and Corridor Technical Manager determine percentage of items that have owners.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – A person who tries to change an asset and who does not know who to speak with must report this to the Corridor Manager who will determine who will work with stakeholders to determine who the owner is.

- *Maintenance* – As assets change, the Corridor Manager and Corridor Technical Manager will ensure each has an owner.
- *Automation* – Enforcement of this cannot be automated.

**6) System/Location of Record for Data:**

- *Description* – All data will have one and only one system/access protocol of record. This is a place/process where the ICM system can access accurate, up-to-date, valid data. It does not mean there will be only one way to access data, but that there will be only one authoritative data source for a given data element or unit of information.
- *Metric* – Corridor Data Analyst will determine percentage of data meeting this requirement.
- *Metric Value* – 90%.
- *Problem Identification and Resolution* – Data is duplicated for many reasons. Data Analysts must continually be on the lookout for copies of data that are being erroneously used as systems of record. The Corridor Data Analyst will work with Data Analysts, Database Administrators, and Software Engineers to identify and resolve issues.
- *Maintenance* – As new data elements are created and old ones retired, the Corridor Data Manager must ensure this requirement is met.
- *Automation* – Enforcement of this cannot be automated.

## 8.11. SYSTEM MANAGEMENT

System Management functions ensure that the ICM system is maintained and operated in a reliable manner. These include:

- Security
- Service Level Agreements
- Maintenance requirements
- Trained personnel able to maintain the system
- Management of system failures
- System upgrades

Below is a more detailed description of these requirements.

**1) Security:**

- *Description* – Processes shall be defined and implemented to protect data, hardware, software, and personnel from unauthorized access.
- *Metric* – Corridor Technical Manager ensures only authorized personnel can access system assets.
- *Metric Value* – 100% protection from unauthorized access.

- *Problem Identification and Resolution* – An access log shall be maintained and reviewed by IT Security personnel for evidence of unauthorized use. Stakeholders and consultants should review the system yearly. Stakeholders will be required to resolve issues.
- *Maintenance* – IT Security personnel will ensure security protocols are maintained.
- *Automation* – These processes can be partly automated, but security must always be managed by appropriate personnel.

**2) ICM Service Level Agreement:**

- *Description* – The ICM Environment (people, hardware, software) shall function an agreed-upon percentage of the time.
- *Metric* – Percentage of time the system is available and working. There is a need to define when the system would no longer be able to function adequately as a result of component degradation. Catastrophic failures aside, the system is required to function as data quality degrades; however, at some point the response plan recommendations become the equivalent of guesses. At this point the system is no longer functional.
- *Metric Value* – The system will be available and functioning correctly 85% of the time.
- *Problem Identification and Resolution* – The Corridor Technical Manager is responsible for reviewing system logs and up-time reports to determine problems. Depending on the problem, multiple project personnel may be required to resolve issues.
- *Maintenance* – Each year, stakeholders must determine the desired service level agreement metrics and provide resources to ensure these can be met.
- *Automation* – Ensuring that a system meets a certain service level agreement cannot be automated.

**3) Maintain Activity Logs:**

- *Description* – The ICM system shall maintain health, status, and other logs as determined during design. There may be activities where logs are manually generated.
- *Metric* – Corridor Technical Manager determines percentage of logs that are properly maintained.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – Stakeholders report inaccurate or missing logging activity. Software Engineers resolve issues.
- *Maintenance* – Corridor Technical Manager and Software Engineers must ensure new functionality is attached to viewable logs.
- *Automation* – Logging should be automated.

**4) Track Maintenance, Improvement, and Bug Fix Requests**

- *Description* – The ICM system shall maintain and stakeholders shall use a system for tracking maintenance requests, improvement requests, and bug fix requests.

- *Metric* – Corridor Technical Manager determines the percentage of time that requests are properly entered.
- *Metric Value* – 95%.
- *Problem Identification and Resolution* – Stakeholders report problems with the ability to use the system. Software Engineers resolve them.
- *Maintenance* – Normal system maintenance is required by Software Engineers and the Corridor Technical Manager.
- *Automation* – Entering of data cannot be automated, but there should be an automated request-tracking system in place.

**5) Maintenance and Asset Management:**

- *Description* – ICM stakeholders shall be responsible for maintenance (both repair and preventative) of all system components (ITS components, vehicles, people, software, hardware, use approvals, etc.).
- *Metric* – Corridor Technical Manager tracks assets being maintained.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – There are many ways that problems will be identified. The Corridor Technical Manager will work with stakeholders to resolve issues.
- *Maintenance* – Appropriate maintenance staff will be assigned to perform maintenance.
- *Automation* – Repair and maintenance cannot be automated.

**6) Software Non-Catastrophic Bug Fixing:**

- *Description* – Bugs found in software will be fixed.
- *Metric* – Percentage of bugs fixed, time it takes to fix bugs.
- *Metric Value* – 80% of bugs will be fixed within 3 months. A priority system will be established during design to refine this number based on the severity of the bug.
- *Problem Identification and Resolution* – Stakeholders will report bugs, and the Corridor Technical Manager will validate them.
- *Maintenance* – Corridor Technical Manager will ensure Software Engineers are available to fix bugs.
- *Automation* – Bug fixing cannot be automated.

**7) Maintenance Reporting:**

- *Description* – Stakeholders will be responsible for reporting maintenance activities (both repair and preventative).
- *Metric* – Corridor Manager will track percentage of maintenance activities that are properly tracked.
- *Metric Value* – The system will track 95% of all activities.

- *Problem Identification and Resolution* – The Corridor Technical Manager will note when maintenance reporting is not occurring and work with stakeholders to resolve any problems.
- *Maintenance* – Processes and systems used to manage and report this information will require normal maintenance by appropriate personnel.
- *Automation* – Where software systems exist, reporting can be automated; otherwise, manual tracking of data will be required.

**8) Training:**

- *Description* – Stakeholders will be responsible for ensuring that appropriate training and training materials are provided for all aspects of the ICM system. Areas that are new to stakeholder organizations will require more effort in this area than existing areas. This is distinguished from education, which is discussed in Institutional Support requirements.
- *Metric* – It is difficult to know if personnel are appropriately trained. Our metric will be a survey of personnel asking "Have you been adequately trained to use the ICM system functionality needed for your role?"
- *Metric Value* – 80% of responders state they are adequately trained.
- *Problem Identification and Resolution* – The Corridor Technical Manager will note when individuals do not know how to operate software/hardware systems or are not aware of proper procedures.
- *Maintenance* – Processes and systems are always changing, and training material must be updated as appropriate.
- *Automation* – The generation of training materials cannot be automated. However, some of the presentation of the material may be automated.

**9) Documentation:**

- *Description* – Stakeholders will be responsible for ensuring that appropriate documentation is available for all functions. Documentation includes both user manuals and workflow descriptions.
- *Metric* – A survey of personnel asking if they feel appropriate documentation is in place.
- *Metric Value* – 80% of responders state they have adequate documentation.
- *Problem Identification and Resolution* – The Corridor Technical Manager will note when individuals do not know how to perform their functions due to lack of documentation and work with stakeholders to improve documentation.
- *Maintenance* – Processes and systems are always changing, and documentation must be updated as appropriate.
- *Automation* – The generation of documentation materials cannot be automated. However, all documents should be available on the web.

**10) ICM Core System Recovery:**

- *Description* – The Corridor Technical Manager shall ensure the ICM Core System can recover from critical failures or disasters.
- *Metric* – Elapsed time before the system is back up and running.
- *Metric Value* – 2 days for 90% of functionality. Recovery point shall be 6 hours. Once a year, a dry run will be made to ensure system recovery functionality is working.
- *Problem Identification and Resolution* – Stakeholders and consultants should periodically review disaster preparedness, and the Corridor Technical Manager works with stakeholders to resolve issues.
- *Maintenance* – As processes and tools change, system recovery policies and procedures must be updated.
- *Automation* – The generation of policies cannot be automated.

**11) System Upgrades:**

- *Description* – The Corridor Technical Manager shall create and maintain a 5-year system upgrade plan including:
    - ICM Core System software
    - Infrastructure element upgrades, including sensors, intersection signals, ramp meters, road network characterizations, CMS, and mobile messaging systems
    - New and updated data feeds and data feed mechanisms
    - Organizational and personnel upgrades
    - Networking, communication, and communication infrastructure upgrades
    - Decision support component upgrades
- *Metric* – An approved plan exists.
- *Metric Value* – 100%.
- *Problem Identification and Resolution* – The Corridor Technical Manager determines that the plan is inadequate or not approved by the stakeholders. The Corridor Technical Manager works with the stakeholders to resolve issues.
- *Maintenance* – The Corridor Technical Manager, in concert with corridor stakeholders, will maintain the plan.
- *Automation* – The process is not automatable.

## 8.12. SUMMARY OF CITIES' AND CALTRANS' REQUIREMENTS

Table 8-1 and Table 8-2 summarize the requirements that apply to the cities and Caltrans, respectively. The information is drawn from the detailed requirements in section 9 but has been condensed into a generic form so as to be useful for ICM efforts beyond the I-210 Pilot as well.

**Table 8-1 – Summary of Cities' Requirements**

| Sensing and Data | Incident/Event Response Plans | Road Network Management | Outreach, Agreements, Funding, Personnel |
|---|---|---|---|
| To the extent possible, cities shall communicate special events, street closures, and recommended reroute information to the Corridor Manager that may affect traffic operations on identified reroutes. Caltrans shall disseminate information. | Cities will assist the Corridor Manager in defining and maintaining rules for building response plans, handling special situations, messages to be displayed on CMS signs, selecting response plans, and sending response plans to corridor assets. | Cities shall permit the ICM Core System, using the cities' signal control software, to select and implement preapproved signal plans for intersections on preapproved reroutes. | Cities shall remain engaged, attend meetings and/or teleconferences, and meet quarterly or as needed regarding incident/event responses. |
| Cities shall maintain up-to-date definitions/inventory of arterial network elements. | County, in consultation with cities and Caltrans, will create and maintain coordination timing plans for use during incidents. Cities and/or county shall load the timing plans onto the controller for use during an incident. | The cities shall permit the ICM Core System, using the CMS control software, to select and implement preapproved messages for display on preapproved reroutes. Cities shall be allowed access to the CMS control software to make changes within their jurisdiction. | Cities shall assist with editing, reviewing, and executing documents and agreements. |
| Cities shall communicate forthcoming approved/pending changes in roadway geometry and operations affecting traffic conditions, restrictions, and traffic control devices on designated arterials to the Corridor Manager. | Where possible, the ICM system shall determine the end-time of a city-initiated incident/event. Where not possible, the cities shall indicate when an incident/event has terminated or is expected to terminate. The ICM system determination may be over-ridden by the city. | The cities shall permit the ICM Core System to contact designated city personnel with requests for performing preapproved actions. | Cities shall provide updated information on city contacts. Caltrans shall disseminate information. |
| Caltrans and cities shall work together to assist in resolving data, hardware, and software issues in a timely manner (the definition of timely manner will be determined at design time). | Caltrans Corridor Manager, as necessary, will request meetings with cities in order to review rules used during incidents/events to determine if they worked correctly and, if they did not, resolve any issues. | Overall ICM system will function correctly 85% of the time.<br>• Signals 99%<br>• Detection 85%<br>• Communication 85% (70%-75%)<br>• Software 95% | Cities will work with Caltrans to apply for federal, state, regional, and local funding sources. |
| Caltrans and cities shall ensure that system detection at key ICM arterial locations will be given priority maintenance. (Response time to be determined during design). | | Stakeholder agreed to share video feeds as long as videos are not stored. | ICM Steering Committee shall define roles, responsibilities, and reporting structures for the ICM system. Cities shall ensure key personnel and support personnel are in place and trained. |

**Table 8-2 – Summary of Caltrans' Requirements**

| Corridor Management | ICM Core System Functions | Sensing and Data |
|---|---|---|
| Caltrans shall be responsible for overall ongoing management and success of the I-210 corridor management function. | Caltrans shall be responsible for operating and maintaining the ICM Core Software and Hardware System:<br>1) Security<br>2) Maintenance<br>3) Working with stakeholders to implement upgrades | Caltrans shall communicate special events/road closures and recommended reroute information to the CM that may affect traffic operations on identified reroutes. Caltrans shall disseminate information. |
| Caltrans shall fill the following leadership roles:<br>**Corridor Manager** – Responsible for overall corridor management success, stakeholder relationships, and response planning (rules, models, and analysis)<br>**Corridor Technical Manager** – Responsible for ensuring all hardware and software are operational and maintained<br>**Corridor Data Analyst** – Responsible for ensuring and encouraging data quality, data availability, and performance analysis | Caltrans shall be responsible for operating and maintaining corridor and asset monitoring and display capabilities:<br>1) Corridor Asset Inventory and Heath<br>2) Corridor Asset State<br>3) Corridor Measured and Estimated State<br>4) Calculation and Display of Corridor Metrics<br>5) Calculation of Historical Patterns | Caltrans shall maintain up-to-date definitions/inventory of freeway network elements. |
| Caltrans shall be responsible for maintaining:<br>1) Corridor TMS Strategic Plan<br>2) Corridor Data Strategic Plan<br>3) Data Dictionary<br>4) Data Quality Specs | Caltrans shall be responsible for operation and maintenance of Response Plan capabilities:<br>1) Incident creation and validation<br>2) Response plan creation<br>3) Response plan implementation | Caltrans shall communicate forthcoming approved/pending changes in roadway geometry and operations affecting traffic conditions, restrictions, and traffic control devices on the freeway to the CM. |
| Caltrans shall be responsible for guiding system integration:<br>1) Integrated Reporting, Visualization, and Control functions<br>2) Single point of ownership for data and control functions within the Core ICM System | Caltrans shall be responsible for operation and maintenance of all data management capabilities:<br>1) Storage of data<br>2) Standard access to data<br>3) Management of data | Caltrans and cities shall work together to assist in resolving data, hardware, and software issues in a timely manner (the definition of timely manner will be determined at design time). |
| Caltrans shall be responsible for Training and Documentation. | Caltrans shall be responsible for operation and maintenance of the Decision Support System capabilities:<br>1) Rules Capture and Execution<br>2) Estimation<br>3) Prediction | Caltrans and cities shall ensure that system detection at key ICM freeway and arterial locations in their jurisdiction meets system reliability goals. (Response time to be determined during design). |

| Incident/Event Response Plans | Road Network Management | Outreach, Agreements, Funding, Personnel |
|---|---|---|
| Caltrans will work with CM in defining and maintaining rules for building response plans, handling special situations, messages to be displayed on CMS signs, selecting response plans, and sending response plans to corridor assets. | Caltrans shall permit the Core ICM System to select and implement preapproved signal plans for intersections on preapproved reroutes. | Caltrans shall attend and lead meetings and/or teleconferences, and meet quarterly or as needed regarding incident/event responses. |
| LA County, in consultation with cities and Caltrans, will create and maintain coordination timing plans for use during incidents for all signals on agreed-upon reroutes (including Caltrans signals). Caltrans shall load the timing plans onto their controllers for use during an incident. | Caltrans shall permit the Core ICM System, using the CMS control software, to select and implement preapproved messages for display on preapproved freeway CMS signs. Caltrans shall be allowed access to the CMS control software to make changes within their jurisdiction. | Caltrans shall assist with editing, reviewing, and executing documents and agreements. |
| Where possible, the ICM system shall determine the end-time of a Caltrans-initiated incident/event. Where not possible, Caltrans shall indicate when an incident/event has terminated or is expected to terminate. The ICM system determination may be over-ridden by Caltrans. | Caltrans shall permit the Core ICM System to contact designated Caltrans personnel with requests for performing preapproved actions. | Caltrans shall provide updated information on Caltrans contacts. Caltrans shall disseminate information. |
| Caltrans CM, as necessary, will request meetings with Caltrans and city personnel in order to review rules used during incidents/events to determine if they worked correctly and, if they did not, resolve any issues. | The overall ICM system goal is to function correctly 85% of the time.<br>• Signals 99%<br>• Detection 85%<br>• Communication 85% (70%-75%)<br>• Software 95% | Caltrans will work with Cities and County to apply for federal, state, regional, and local funding sources. |
| | Caltrans and stakeholder agree to share video feeds as long as videos are not stored. | ICM Steering Committee shall define roles, responsibilities, and reporting structures for the ICM system. Caltrans shall ensure key personnel and support personnel are in place and trained. |
| | Caltrans shall permit the Core ICM System, through requests to the Caltrans' ramp metering software, to select and implement preapproved ramp metering plans on ramps on preapproved reroutes. | |

# 9. SPECIFIC REQUIREMENTS FOR THE I-210 PILOT

This section lists the detailed requirements that are specific to the I-210 Pilot. They will be used in building the design, implementation plans, and test cases for the ICM system. Together with the generic requirements in section 8 (which address problem identification, maintenance, and automation of ICM functions), these requirements specify what the system (hardware, software, people, and organizations) must do.

## 9.1. INSTITUTIONAL REQUIREMENTS

This section details requirements focusing on strategic planning and on how organizations and people are structured, funded, motivated, and informed in order to execute strategic plans. These requirements are based on the premise that active collaboration among people and organizations is the cornerstone on which an ICM effort is built.

### 9.1.1. CORRIDOR STRATEGIC PLANNING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-1.1** | **The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the ICM corridor's roadway network.** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.1.1 | The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the number of lanes or lane assignments along arterials that may be used as incident/event detours. | M | 4, 5 | |
| IN-1.1.2 | The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to freeway ramps within the boundaries of the ICM corridor. | M | 4, 5 | |
| IN-1.1.3 | The Corridor Manager, in coordination with stakeholders, shall track anticipated geometrical changes to intersections along routes that may be used as incident/event detours. | M | 4, 5 | |
| IN-1.1.4 | The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to major origin-destination centers within the ICM corridor. | M | 4, 5 | |
| **IN-1.2** | **The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the ICM corridor's transit networks of interest.** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.2.1 | The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the Metro Gold Line. | M | 4, 5 | |
| IN-1.2.2 | The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to express/commuter bus lines that may affect or be affected by ICM system operations. | M | 4, 5 | |
| IN-1.2.3 | The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to local bus lines that may affect or be affected by ICM system operations. | L | 4, 5 | |
| **IN-1.3** | **The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the corridor's traffic control devices (traffic signals, ramp meters, others).** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.3.1 | The Corridor Manager, in coordination with stakeholders, shall track required maintenance for traffic management devices in operation within the ICM corridor. | M | 4, 5 | |

| | | | | |
|---|---|---|---|---|
| IN-1.3.2 | The Corridor Manager, in coordination with stakeholders, shall determine when and where traffic management devices would be needed to adequately support ICM system operations. | M | 4, 5 | |
| IN-1.3.2 | The Corridor Manager, in coordination with stakeholders, shall track proposed response plan component additions and determine whether new or modified traffic management devices are needed to fulfill these additions. | M | 4, 5 | |
| **IN-1.4** | **The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the corridor's traveler information devices (CMS, extinguishable trailblazer signs, etc.).** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.4.1 | The Corridor Manager, in coordination with stakeholders, shall track required maintenance for traveler information devices in operation within the ICM corridor. | M | 4, 5 | |
| IN-1.4.2 | The Corridor Manager, in coordination with stakeholders, shall determine when and where traveler information devices would be needed to adequately support ICM system operations. | M | 4, 5 | |
| IN-1.4.3 | The Corridor Manager, in coordination with stakeholders, shall track proposed response plan component additions and determine whether new traveler information devices are needed to fulfill these additions. | M | 4, 5 | |
| **IN-1.5** | **The Corridor Manager, in coordination with stakeholders, shall track required changes to existing sensors and sensor locations.** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.5.1 | The Corridor Manager, in coordination with stakeholders, shall track required maintenance for sensors. | M | 4, 5 | |
| IN-1.5.2 | The Corridor Manager, in coordination with stakeholders, shall determine when and where new sensors are needed to adequately support ICM system operations. | M | 4, 5 | |
| IN-1.5.3 | The Corridor Manager, in coordination with stakeholders, shall track proposed response plan component additions and determine sensing and data requirements needed to fulfill these additions. | M | 4, 5 | |
| **IN-1.6** | **The Corridor Manager, in coordination with stakeholders, shall track anticipated changes to the metrics that must be provided by the ICM system.** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.6.1 | The Corridor Manager, in coordination with stakeholders, shall track anticipated governmental requirements for collecting performance metrics. | M | 4, 5 | |
| IN-1.6.2 | The Corridor Manager, in coordination with stakeholders, shall track proposed new or updated user requirements for the ICM system. | M | 4, 5 | |
| IN-1.6.3 | The Corridor Manager, in coordination with stakeholders, shall review the acceptability and usefulness of existing metrics and determine changes needed to the metrics produced. | M | 4, 5 | |
| **IN-1.7** | **The Corridor Manager, in coordination with stakeholders, shall determine requirements for new metrics.** | **M** | **4, 5** | **Institutional Job Tasks** |
| IN-1.7.1 | The Corridor Manager, in coordination with stakeholders, shall determine existing or new data needed for proposed new metrics. | M | 4, 5 | |
| IN-1.7.2 | The Corridor Manager, in coordination with stakeholders, shall determine existing or new sensing needed for proposed new metrics. | M | 4, 5 | |
| IN-1.7.3 | The Corridor Manager, in coordination with stakeholders, shall determine existing or new algorithms needed for proposed new metrics. | M | 4, 5 | |
| **IN-1.8** | **The Corridor Manager, in coordination with stakeholders, shall maintain a strategic plan for performance metric calculation.** | **H** | **4, 5** | **Institutional Job Tasks** |

| | | | | |
|---|---|---|---|---|
| IN-1.8.1 | The Corridor Manager, in coordination with stakeholders, shall maintain a document detailing the metrics to be calculated by the ICM system and the requirements supporting the calculation of these metrics. | H | 4, 5 | |
| IN-1.8.2 | The Metric Calculation Strategic Plan shall detail any new metrics that are anticipated or proposed to be calculated by the ICM system. | H | 4, 5 | |
| IN-1.8.3 | For each proposed new metric, the Metric Calculation Strategic Plan shall detail possible sensing technologies that may be used to collect supporting data. | M | 4, 5 | |
| IN-1.8.4 | For each proposed new metric, the Metric Calculation Strategic Plan shall provide a realistic implementation plan for the metric, including the identification of potential supporting funding sources. | H | 4, 5 | |
| IN-1.8.5 | The Metric Calculation Strategic Plan shall be updated every year. | H | 4, 5 | |
| **IN-1.9** | **The Corridor Manager, in coordination with stakeholders, shall maintain a strategic plan for data collection.** | **H** | **4, 5** | **Institutional Job Tasks** |
| IN-1.9.1 | The Corridor Manager, in coordination with stakeholders, shall maintain a document detailing the data needed for system operations and the calculation of performance metrics. | H | 4, 5 | |
| IN-1.9.2 | The Data Collection Strategic Plan shall detail any new data that are anticipated or proposed to be collected to support ICM system operations. | H | 4, 5 | |
| IN-1.9.3 | For any proposed new data to be collected, the Data Collection Strategic Plan shall detail possible sensing technologies that may be used to collect the data. | M | 4, 5 | |
| IN-1.9.4 | For any proposed new data to be collected, the Data Collection Strategic Plan shall detail the system requirements associated with the data collection. | M | 4, 5 | |
| IN-1.9.5 | For any proposed new data to be collected, the Data Collection Strategic Plan shall provide a realistic implementation plan for the data collection, including the identification of potential supporting funding sources. | M | 4, 5 | |
| IN-1.9.6 | The Data Collection Strategic Plan shall be updated every six months. | H | 4, 5 | |
| **IN-1.10** | **The Corridor Manager, in coordination with stakeholders, shall maintain a strategic plan for corridor control.** | **H** | **4, 5** | **Institutional Job Tasks** |

### 9.1.2. ASSET EXISTENCE

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-2.1** | **Stakeholders shall ensure sensing assets required by the corridor strategic plan are available.** | **H** | **17** | **Institutional Job Tasks** |
| IN-2.1.1 | Traffic sensors required by the strategic plan shall be available. | H | 17 | |
| IN-2.1.2 | Travel time monitoring devices required by the strategic plan shall be available. | H | 17 | |
| IN-2.1.3 | Maintenance of traffic sensors shall be the responsibility of the agency/agencies owning/operating the devices. | H | 17 | |
| IN-2.1.4 | Maintenance of travel time monitoring devices shall be the responsibility of the agency/agencies owning/operating the devices. | H | 17 | |
| **IN-2.2** | **Stakeholders shall ensure traffic control assets required by the corridor strategic plan are available.** | **H** | **17** | **Institutional Job Tasks** |
| IN-2.1.1 | Traffic signals required by the strategic plan shall be available. | H | 17 | |
| IN-2.1.2 | Ramp meters required by the strategic plan shall be available. | H | 17 | |

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| IN-2.2.3 | Maintenance of traffic signal control equipment shall be the responsibility of the agency/agencies owning/operating the equipment. | H | 17 | |
| IN-2.2.4 | Maintenance of ramp metering control equipment shall be the responsibility of Caltrans. | H | 17 | |
| **IN-2.3** | **Stakeholders shall ensure traveler information assets required by the corridor strategic plan are available.** | **H** | **17** | **Institutional Job Tasks** |
| IN-2.3.1 | Fixed CMS devices required by the strategic plan shall be available. | H | 17 | |
| IN-2.3.2 | Portable CMS devices required by the strategic plan shall be available. | H | 17 | |
| IN-2.3.3 | Extinguishable trailblazer signs required by the strategic plan shall be available. | H | 17 | |
| IN-2.3.4 | Maintenance of fixed CMS devices shall be the responsibility of the agency owning/operating the devices. | H | 17 | |
| IN-2.3.5 | Maintenance of portable CMS devices shall be the responsibility of the agency owning/operating the devices. | H | 17 | |
| IN-2.3.6 | Maintenance of extinguishable trailblazer signs shall be the responsibility of the agency owning/operating the devices. | H | 17 | |
| **IN-2.4** | **Stakeholders shall ensure transit assets required by the corridor strategic plan are available.** | **H** | **17** | **Institutional Job Tasks** |
| IN-2.4.1 | Maintenance of equipment on transit vehicles shall be the responsibility of the agency operating the vehicles. | H | 17 | |

### 9.1.3. CORRIDOR CHAMPIONS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-3.1** | **Corridor Champions shall be high-level staff persons or elected officials with interest in transportation/transit issues.** | **H** | **7** | **Institutional Job Tasks** |
| **IN-3.2** | **Corridor Champions shall have longevity (for example, if an elected official, someone who is not termed out in the next year or so, if possible).** | **M** | **7** | **Institutional Job Tasks** |
| **IN-3.3** | **A list of current Corridor Champions from each stakeholder agency shall be developed and maintained by the Outreach and Communications Manager.** | **H** | **7** | **Institutional Job Tasks** |
| **IN-3.4** | **The list of current Corridor Champions shall be distributed to all project stakeholders.** | **H** | **7** | **Institutional Job Tasks** |
| **IN-3.5** | **Corridor Champion(s) shall be replaced if previous champion(s) leave.** | **H** | **7** | **Institutional Job Tasks** |
| IN-3.5.1 | Previously identified Corridor Champion(s) no longer associated with the project or a stakeholder agency shall be replaced as soon as possible. | H | 7 | |
| IN-3.5.2 | The Outreach and Communications Manager shall update the list of current Corridor Champions each time a change occurs with the designated champions. | H | 7 | |

### 9.1.4. ORGANIZATIONAL COMPOSITION AND STRUCTURE

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-4.1** | **The Connected Corridors Steering Committee shall define roles, responsibilities, and reporting structures for the ICM system.** | **H** | **7, 16** | **Institutional Job Tasks** |
| **IN-4.2** | **Job descriptions shall be written for supporting ICM roles.** | **H** | **7, 16** | **Institutional Job Tasks** |
| IN-4.2.1 | Job descriptions for supporting ICM roles shall be written by the stakeholder agency providing individuals filling the roles, in coordination with the Corridor Manager. | H | 7, 16 | |
| IN-4.2.2 | Stakeholder agencies shall communicate changes made to job descriptions to the Corridor Manager. | H | 7, 16 | |
| IN-4.2.3 | The Corridor Manager shall keep an up-to-date inventory of job descriptions related to the ICM operations. | H | 7, 16 | |
| **IN-4.3** | **Stakeholder agencies shall ensure that ICM staff are in place and trained.** | **H** | **7, 16** | **Institutional Job Tasks** |
| IN-4.3.1 | Participating roadway agencies shall ensure that ICM support personnel are in place and trained. | H | 7, 16 | |
| *IN-4.3.1.1* | *Caltrans shall ensure that ICM support personnel are in place and trained.* | H | 7, 16 | |
| *IN-4.3.1.2* | *LA County Department of Public Works shall ensure that ICM support personnel are in place and trained.* | H | 7, 16 | |
| *IN-4.3.1.3* | *The City of Pasadena shall ensure that ICM support personnel are in place and trained.* | H | 7, 16 | |
| *IN-4.3.1.4* | *The City of Arcadia shall ensure that ICM support personnel are in place and trained.* | H | 7, 16 | |
| *IN-4.3.1.5* | *The City of Monrovia shall ensure that ICM support personnel are in place and trained.* | H | 7, 16 | |
| *IN-4.3.1.6* | *The City of Duarte shall ensure that ICM support personnel are in place and trained.* | H | 7, 16 | |
| IN-4.3.2 | Participating transit agencies shall ensure that ICM support personnel are in place and trained. | M | 7, 16 | |
| *IN-4.3.2.1* | *Metro Rail shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.2.2* | *Metro Bus shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.2.3* | *Foothill Transit shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.2.4* | *Pasadena Transit shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| IN-4.3.3 | Participating parking management agencies shall ensure that ICM support personnel are in place and trained. | L | 7, 16 | |
| IN-4.3.4 | Participating first responding agencies shall ensure that ICM support personnel are in place and trained. | M | 7, 16 | |
| *IN-4.3.4.1* | *CHP shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.4.2* | *The LA County Sheriff's Department shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.4.3* | *The Pasadena Police Department shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.4.4* | *The Arcadia Police Department shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |

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| *IN-4.3.4.5* | *The Monrovia Police Department shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| IN-4.3.5 | Participating information providers shall ensure that ICM support personnel are in place and trained. | M | 7, 16 | |
| *IN-4.3.5.1* | *LA SAFE shall ensure that ICM support personnel are in place and trained with respect to how the system will interface with the regional 511 System.* | M | 7, 16 | |
| IN-4.3.6 | Participating regional transportation planning agencies shall ensure that ICM support personnel are in place and trained. | M | 7, 16 | |
| *IN-4.3.6.1* | *Metro Highway Program shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.6.2* | *SCAG shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| *IN-4.3.6.3* | *SGVCOG shall ensure that ICM support personnel are in place and trained.* | M | 7, 16 | |
| IN-4.3.7 | The Corridor Manager shall determine whether personnel in other corridor agencies shall be added to the list of ICM support personnel. | H | 7, 16 | |
| IN-4.3.8 | The Corridor Manager shall determine, in coordination with involved agencies, whether ICM support personnel at other agencies shall receive training on ICM operations. | H | 7, 16 | |
| **IN-4.4** | **Oversight and advisory committees shall be set up and maintained.** | **H** | **7, 16** | **Institutional Job Tasks** |
| IN-4.4.1 | A Connected Corridors Steering Committee shall be jointly set up and maintained by the Corridor Manager and Outreach and Communications Manager. | H | 7, 16 | |
| *IN-4.4.1.1* | *The Connected Corridors Steering Committee shall include a representative from Caltrans District 7.* | H | 7, 16 | |
| *IN-4.4.1.2* | *The Connected Corridors Steering Committee shall include a representative from Caltrans Headquarters.* | H | 7, 16 | |
| *IN-4.4.1.3* | *The Connected Corridors Steering Committee shall include a representative from Metro.* | H | 7, 16 | |
| IN-4.4.2 | A Technical and Operational Advisory Committee shall be jointly set up and maintained by the Corridor Manager and Outreach and Communications Manager. | H | 7, 16 | |
| *IN-4.4.2.1* | *The Technical and Operational Advisory Committee shall include a representative from Caltrans District 7.* | H | 7, 16 | |
| *IN-4.4.2.2* | *The Technical and Operational Advisory Committee shall include a representative from Los Angeles County.* | H | 7, 16 | |
| *IN-4.4.2.3* | *The Technical and Operational Advisory Committee shall include a representative from the City of Pasadena.* | H | 7, 16 | |
| *IN-4.4.2.4* | *The Technical and Operational Advisory Committee shall include a representative from the City of Arcadia.* | H | 7, 16 | |
| *IN-4.4.2.5* | *The Technical and Operational Advisory Committee shall include a representative from the City of Monrovia.* | H | 7, 16 | |
| *IN-4.4.2.6* | *The Technical and Operational Advisory Committee shall include a representative from the City of Duarte.* | H | 7, 16 | |
| IN-4.4.3 | Other committees, to be determined as needed, shall be jointly set up and maintained by the Corridor Manager and Outreach and Communications Manager. | M | 7, 16 | |

### 9.1.5. MANAGEMENT STRUCTURE AND PROCESSES

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-5.1** | **Processes shall be established to manage the ICM corridor.** | **H** | **7, 16** | **Institutional Job Tasks** |
| **IN-5.2** | **Managers shall be identified to manage the ICM corridor.** | **H** | **7, 16** | **Institutional Job Tasks** |
| IN-5.2.1 | A management-level organization chart of all project stakeholders shall be created and maintained by the Corridor Manager. | H | 7, 16 | |
| IN-5.2.2 | Designated ICM managers for each participating agency shall engage in daily planning, resource acquisition, resource allocation, problem identification, problem resolution, risk management. | H | 7, 16 | |
| IN-5.2.3 | The Corridor Manager shall be kept apprised of key changes in personnel availability (sick, vacationing, retired, laid off, etc.). | H | 7, 16 | |
| **IN-5.3** | **Stakeholders shall develop new procedures and practices supporting ICM corridor management objectives.** | **H** | **7, 16** | **Institutional Job Tasks** |
| IN-5.3.1 | New job classifications, job descriptions, and hiring practices shall be identified and implemented by participating stakeholder agencies. | H | 7, 16 | |
| IN-5.3.2 | Stakeholder agencies shall hire or make available personnel responsible for ICM needs. | H | 7, 16 | |
| *IN-5.3.2.1* | *Caltrans District 7 shall hire or make available personnel responsible for ICM needs.* | H | 7, 16 | |
| *IN-5.3.2.2* | *LA County Department of Public Works shall hire or make available personnel responsible for ICM needs.* | H | 7, 16 | |
| *IN-5.3.2.3* | *The City of Pasadena shall hire or make available personnel responsible for ICM needs.* | H | 7, 16 | |
| *IN-5.3.2.4* | *The City of Arcadia shall hire or make available personnel responsible for ICM needs.* | H | 7, 16 | |
| *IN-5.3.2.5* | *The City of Monrovia shall hire or make available personnel responsible for ICM needs.* | H | 7, 16 | |
| *IN-5.3.2.6* | *The City of Duarte shall hire or make available personnel responsible for ICM needs.* | H | 7, 16 | |
| IN-5.3.3 | Caltrans District management shall have support from Caltrans Headquarters on personnel required for ICM operations. | M | 7, 16 | |
| **IN-5.4** | **Caltrans, in consultation with system stakeholders, shall maintain a Risk Register.** | **H** | **7** | **Institutional Job Tasks** |
| IN-5.4.1 | The Corridor Manager shall be responsible for managing the risks defined in the Risk Register. | H | 7 | |
| IN-5.4.2 | The Corridor Manager shall ensure that the Risk Register is discussed in the monthly meetings and/or conference calls. | H | 7 | |
| IN-5.4.3 | The Corridor Manager shall be responsible for keeping the Risk Register up to date. | H | 7 | |

### 9.1.6. INTERAGENCY TRUST AND COMMUNICATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-6.1** | **All agencies having a potential interest in ICM corridor operations shall be engaged in development, implementation, and operational ICM activities.** | **H** | **7** | **Institutional Job Tasks** |
| IN-6.1.1 | Participating roadway agencies are key stakeholders in the ICM system and shall be continuously engaged in ICM corridor activities. | H | 7 | |
| *IN-6.1.1.1* | *Caltrans is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.1.2* | *LA County Department of Public Works is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.1.3* | *The City of Pasadena is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.1.4* | *The City of Arcadia is a key stakeholder and shall be continuously engaged and engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.1.5* | *The City of Monrovia is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.1.6* | *The City of Duarte is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| IN-6.1.2 | Participating transit agencies are key stakeholders in the ICM system and shall be continuously engaged in ICM corridor activities. | H | 7 | |
| *IN-6.1.2.1* | *Metro Rail is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.2.2* | *Metro Bus is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.2.3* | *Foothill Transit is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.2.4* | *Pasadena Transit is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| IN-6.1.3 | Participating parking management agencies shall be continuously engaged in ICM corridor activities. | H | 7 | |
| IN-6.1.4 | Participating first responding agencies are key stakeholders in the ICM system and shall be continuously engaged in ICM corridor activities. | H | 7 | |
| *IN-6.1.4.1* | *CHP is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.4.2* | *LA County Sheriff's Department is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.4.3* | *The Pasadena Police Department is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.4.4* | *The Arcadia Police Department is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.4.5* | *The Monrovia Police Department is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| IN-6.1.5 | Participating information providers shall be continuously engaged in ICM corridor activities. | H | 7 | |
| *IN-6.1.5.1* | *LA SAFE, which operates the 511 regional system, is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| IN-6.1.6 | Participating regional transportation planning agencies are key stakeholders in the ICM system and shall be continuously engaged in ICM corridor activities. | H | 7 | |

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| *IN-6.1.6.1* | *Metro Highway Program is a key stakeholder and shall be continuously engaged in ICM corridor activities.* | H | 7 | |
| *IN-6.1.6.2* | *The Southern California Association of Governments (SCAG) shall be continuously engaged in ICM activities.* | H | 7 | |
| *IN-6.1.6.3* | *The San Gabriel Valley Council of Governments (SGVCOG) shall be continuously engaged in ICM activities.* | H | 7 | |
| IN-6.1.7 | Other stakeholder agencies having an interest in ICM corridor operations shall be identified and engaged on an as-needed basis. | H | 7 | |
| **IN-6.2** | **Clear, consistent communication mechanisms shall be established among the corridor stakeholders.** | **H** | **7** | **Institutional Job Tasks** |
| **IN-6.3** | **Quarterly meetings shall be held to keep ICM system stakeholders updated on system and corridor activities.** | **H** | **7** | **Institutional Job Tasks** |
| IN-6.3.1 | Quarterly meetings shall be established by the Corridor Manager to keep all stakeholders informed of progress on the project. | H | 7 | |
| IN-6.3.2 | Participating roadway agencies shall be expected to attend quarterly ICM corridor update meetings. | H | 7 | |
| *IN-6.3.2.1* | *Caltrans shall be expected to attend all ICM corridor quarterly update meetings.* | H | 7 | |
| *IN-6.3.2.2* | *LA County Department of Public Works shall be expected to attend all ICM corridor quarterly update meetings.* | H | 7 | |
| *IN-6.3.2.3* | *The City of Pasadena shall be expected to attend all quarterly ICM corridor update meetings.* | H | 7 | |
| *IN-6.3.2.4* | *The City of Arcadia shall be expected to attend all quarterly ICM corridor update meetings.* | H | 7 | |
| *IN-6.3.2.5* | *The City of Monrovia shall be expected to attend all quarterly ICM corridor update meetings.* | H | 7 | |
| *IN-6.3.2.6* | *The City of Duarte shall be expected to attend all quarterly ICM corridor update meetings.* | H | 7 | |
| IN-6.3.3 | Participating transit agencies shall be expected to attend quarterly ICM corridor update meetings where transit-related elements are on the agenda. | H | 7 | |
| *IN-6.3.3.1* | *Metro Rail shall be expected to attend quarterly ICM corridor update meetings where transit-related elements are discussed.* | H | 7 | |
| *IN-6.3.3.2* | *Metro Bus shall be expected to attend quarterly ICM corridor update meetings where transit-related elements are discussed.* | H | 7 | |
| *IN-6.3.3.3* | *Foothill Transit shall be expected to attend quarterly ICM corridor update meetings where transit-related elements are discussed.* | H | 7 | |
| *IN-6.3.3.4* | *Pasadena Transit shall be expected to attend quarterly ICM corridor update meetings where transit elements are on the agenda.* | H | 7 | |
| IN-6.3.4 | Participating parking management agencies shall be expected to attend quarterly ICM corridor update meetings where parking operations are on the agenda. | H | 7 | |
| IN-6.3.5 | Participating information providers shall be expected to attend quarterly ICM corridor update meetings where traveler information dissemination topics are on the agenda. | H | 7 | |
| *IN-6.3.5.1* | *LA SAFE shall be expected to attend quarterly ICM corridor update meetings where 511 systems elements are on the agenda.* | H | 7 | |
| IN-6.3.6 | Participating first responding agencies shall be expected to attend quarterly ICM corridor update meetings where first response procedures are on the agenda. | H | 7 | |
| *IN-6.3.6.1* | *CHP representatives shall be expected to attend quarterly ICM corridor update meetings where first response procedures involving the agency are on the agenda.* | H | 7 | |

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| *IN-6.3.6.2* | *Representatives from LA County Sheriff's Department shall be expected to attend quarterly ICM corridor update meetings where first response procedures involving the agency are on the agenda.* | H | 7 | |
| *IN-6.3.6.3* | *Pasadena Police Department representatives shall be expected to attend quarterly ICM corridor update meetings where first response procedures involving the department are on the agenda.* | H | 7 | |
| *IN-6.3.6.4* | *Arcadia Police Department representatives shall be expected to attend quarterly ICM corridor update meetings where first response procedures involving the department are on the agenda.* | H | 7 | |
| *IN-6.3.6.5* | *Monrovia Police Department representatives shall be expected to attend quarterly ICM corridor update meetings where first response procedures involving the department are on the agenda.* | H | 7 | |
| IN-6.3.7 | Participating regional transportation planning agencies shall be expected to attend quarterly ICM corridor update meetings where first response procedures are on the agenda. | H | 7 | |
| IN-6.3.7.1 | *Metro Highway Program shall be expected to attend ICM corridor quarterly meetings where first response procedures are on the agenda.* | H | 7 | |
| IN-6.3.8 | Other stakeholders may be invited by the Corridor Manager to attend quarterly ICM review meetings based on expected discussion topics. | H | 7 | |
| **IN-6.4** | **Stakeholder agencies shall establish and maintain communications mechanisms with other stakeholder agencies.** | **H** | **7** | **Institutional Job Tasks** |
| IN-6.4.1 | Regular meetings or teleconferences shall be held to keep corridor stakeholders up to date. | H | 7 | |
| IN-6.4.2 | The Corridor Manager (or his delegate) shall lead the update meetings or teleconferences. | H | 7 | |
| IN-6.4.3 | Participating roadway management agencies shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed. | H | 7 | |
| *IN-6.4.3.1* | *Caltrans shall attend regular corridor update meetings or teleconferences where Caltrans operations may be discussed.* | H | 7 | |
| *IN-6.4.3.2* | *LA County Department of Public Works shall attend regular corridor update meetings or teleconferences where the County matters may be discussed.* | H | 7 | |
| *IN-6.4.3.3* | *The City of Pasadena shall attend regular corridor update meetings or teleconferences where city matters may be discussed.* | H | 7 | |
| *IN-6.4.3.4* | *The City of Arcadia shall attend regular corridor update meetings or teleconferences where city matters may be discussed.* | H | 7 | |
| *IN-6.4.3.5* | *The City of Monrovia shall attend regular corridor update meetings or teleconferences where city matters may be discussed.* | H | 7 | |
| *IN-6.4.3.6* | *The City of Duarte shall attend regular corridor update meetings or teleconferences where city matters may be discussed.* | H | 7 | |
| IN-6.4.4 | Participating transit agencies shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed. | H | 7 | |
| *IN-6.4.4.1* | *Metro Rail shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed.* | H | 7 | |
| *IN-6.4.4.2* | *Metro Bus shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed.* | H | 7 | |
| *IN-6.4.4.3* | *Foothill Transit shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed.* | H | 7 | |
| *IN-6.4.4.4* | *Pasadena Transit shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed.* | H | 7 | |

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| IN-6.4.5 | Participating parking management agencies shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed. | H | 7 | |
| IN-6.4.6 | Participating first responding agencies shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed. | H | 7 | |
| IN-6.4.7 | Participating information providers shall attend regular corridor update meetings or teleconferences where agency-related matters may be discussed. | H | 7 | |
| **IN-6.5** | **Information requests about the ICM system shall be appropriately followed up.** | **H** | **7** | **Institutional Job Tasks** |
| IN-6.5.1 | The Outreach and Communications Manager and Corridor Manager shall follow up on information requests. | H | 7 | |
| IN-6.5.2 | The Outreach and Communications Manager and Corridor Manager shall, when needed, forward requests to other stakeholders for comment or response. | H | 7 | |

### 9.1.7. INTERAGENCY AGREEMENTS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-7.1** | **A Project Charter shall be drafted to get stakeholder agencies to agree on initial roles and responsibilities.** | **H** | **7** | **Institutional Job Tasks** |
| IN-7.1.1 | The initial draft of the Project Charter shall be written by the Outreach and Communications Manager. | H | 7 | |
| IN-7.1.2 | The process leading to the adoption of a Project Charter shall be managed by the Outreach and Communications Manager. | H | 7 | |
| IN-7.1.3 | Caltrans shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to Caltrans staff. | H | 7 | |
| IN-7.1.4 | LA County shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to County staff. | H | 7 | |
| IN-7.1.5 | Metro Highway Program shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to Metro staff. | H | 7 | |
| IN-7.1.6 | The City of Arcadia shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to City staff. | H | 7 | |
| IN-7.1.7 | The City of Duarte shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to City staff. | H | 7 | |
| IN-7.1.8 | The City of Monrovia shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to City staff. | H | 7 | |
| IN-7.1.9 | The City of Pasadena shall assist with refining the Project Charter language, making sure that the correct logo is used, ensuring full review, obtaining signatures, and distributing a fully-executed copy to City staff. | H | 7 | |
| **IN-7.2** | **A Memorandum of Understanding (MOU) shall be signed by project stakeholders to get formal agreement on expected roles and responsibilities.** | **H** | **7** | **Institutional Job Tasks** |

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| IN-7.2.1 | The MOU shall include details on the roles, responsibilities, dispute resolution, and decision-making process (including funding responsibilities). | H | 7 | |
| IN-7.2.2 | Caltrans shall draft and maintain the MOU, with support from other stakeholders. | H | 7 | |
| **IN-7.3** | **An Operations & Maintenance (O&M) Plan shall be signed by corridor stakeholders.** | **H** | **7** | **Institutional Job Tasks** |
| IN-7.3.1 | The O&M Plan shall include details on the ICM system that is to be operated and maintained by the corridor stakeholders. | H | 7 | |
| IN-7.3.2 | Caltrans, with assistance from corridor stakeholders, shall draft and maintain the O&M Plan. | H | 7 | |
| **IN-7.4** | **The Outreach and Communications Manager, with assistance from corridor stakeholders, shall determine whether additional agreements may be needed to support system operations.** | **M** | **7** | **Institutional Job Tasks** |
| **IN-7.5** | **Management of agreements shall be the responsibility of the Outreach and Communications Manager.** | **H** | **7** | **Institutional Job Tasks** |
| IN-7.5.1 | Required other agreements/document(s) shall be drafted, terms negotiated, and signatures secured by the Outreach and Communications Manager, with assistance from corridor stakeholders. | H | 7 | |
| IN-7.5.2 | The Outreach and Communications Manager shall determine, in collaboration with corridor stakeholders, which agencies shall sign required documents. | H | 7 | |
| IN-7.5.3 | The Outreach and Communications Manager shall follow up on the status of documents submitted for signing. | H | 7 | |
| **IN-7.6** | **Stakeholder agencies shall sign in a timely manner agreements submitted for their approval.** | **H** | **7** | **Institutional Job Tasks** |
| **IN-7.7** | **Developed agreements shall be maintained, updated, and/or amended throughout the life of the project.** | **H** | **7** | **Institutional Job Tasks** |
| IN-7.7.1 | The Outreach and Communications Manager shall track when current agreements are set to expire. | H | 7 | |
| IN-7.7.2 | The Outreach and Communications Manager shall track whether current agreements need to be updated or amended. | H | 7 | |
| IN-7.7.3 | The Outreach and Communications Manager shall inform corridor stakeholders of agreements that are set to expire and need renewal. | H | 7 | |
| IN-7.7.4 | The Outreach and Communications Manager shall inform corridor stakeholders of agreements that may need to be updated or amended. | H | 7 | |
| IN-7.7.5 | The Outreach and Communications Manager shall lead discussions on the renewal, updating, or amending of existing agreements. | H | 7 | |
| **IN-7.8** | **Stakeholder agencies shall participate in the review and updating of documents related to the operation of the ICM system.** | **H** | **7** | **Institutional Job Tasks** |

### 9.1.8. FUNDING FOR ICM SYSTEM

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-8.1** | **Potential funding sources shall be researched on an ongoing basis.** | **H** | **7** | **Institutional Job Tasks** |
| IN-8.1.1 | Stakeholders shall work with Caltrans to identify federal, state, regional, and local funding sources that may be applied to the development, operations, and enhancement of ICM system components operated by the agencies. | H | 7 | |

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| IN-8.1.2 | A spreadsheet detailing possible funding sources and upcoming funding opportunities shall be developed and maintained by the Outreach and Communications Manager. | M | 7 | |
| IN-8.1.3 | A list of agency personnel responsible for tracking potential funding sources shall be developed by the Outreach and Communications Manager. | H | 7 | |
| **IN-8.2** | **Adequate support shall be provided for the development and submission of funding applications.** | **H** | **7** | **Institutional Job Tasks** |
| IN-8.2.1 | The Outreach and Communications Manager and Corridor Manager shall oversee the development of applications for funding. | H | 7 | |
| IN-8.2.2 | The Outreach and Communications Manager and Corridor Manager shall track the progress of submitted funding applications. | H | 7 | |
| IN-8.2.3 | Agency personnel to help with the development, submission, and tracking of funding applications shall be identified. | H | 7 | |
| IN-8.2.4 | Stakeholders shall write, when needed, Letters of Support for funding applications throughout the life of the project. | H | 7 | |
| IN-8.2.5 | The Outreach and Communications Manager shall determine other corridor agencies that may be willing to write Letters of Support and secure them. | H | 7 | |
| **IN-8.3** | **Approved funding sources shall be managed, and necessary reports completed and submitted.** | **H** | **7** | **Institutional Job Tasks** |
| IN-8.3.1 | A tracking system shall be developed by the Corridor Manager, in collaboration with the Outreach and Communications Manager, to manage approved funding sources. | M | 7 | |
| IN-8.3.2 | Funding reports requested by funding agencies shall be written and submitted by the Outreach and Communications Manager on an agreed-upon schedule. | H | 7 | |

### 9.1.9. TRAINING AND EDUCATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-9.1** | **Adequate training shall be provided to individuals responsible for ICM operations.** | **H** | **18** | **Institutional Job Tasks** |
| IN-9.1.1 | Stakeholder agencies shall ensure that adequate training is provided to individuals assigned or hired to positions related to ICM corridor operations. | H | 18 | |
| IN-9.1.2 | Caltrans shall develop and maintain a training plan/manual for individuals to be assigned to ICM operations. | H | 18 | |

### 9.1.10. PUBLIC OUTREACH AND COMMUNICATIONS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-10.1** | **An Outreach and Communications Manager shall be a Caltrans role responsible for handling general outreach and communication activities pertaining to the ICM system.** | **H** | **7** | **Institutional Job Tasks** |
| IN-10.1.1 | The Outreach and Communications Manager shall be responsible for developing a communications strategy. | H | 7 | |

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| IN-10.1.2 | The Outreach and Communications Manager shall be responsible for drafting, maintaining, and updating (as needed) the communications strategy, including two-way communications with businesses, transportation agencies, corridor elected officials, stakeholder agencies, travelers, etc. | M | 7 | |
| IN-10.1.3 | The Outreach and Communications Manager shall be responsible for organizing regular meetings with stakeholders, PIOs, and first responders. | H | 7 | |
| IN-10.1.4 | The Outreach and Communications Manager shall partner with management on key outreach and communications efforts to ensure that ICM is understood and accepted by all stakeholders (particularly when there is staff or elected official turnover). | H | 7 | |
| IN-10.1.5 | The Outreach and Communications Manager shall be responsible for continually researching and adding new stakeholders throughout the life of the I-210 Pilot. | H | 7 | |
| IN-10.1.6 | The Outreach and Communications Manager shall be responsible for maintaining an agency contact database for the corridor and a document library. | M | 7 | |
| IN-10.1.7 | The Outreach and Communications Manager shall be responsible for writing and distributing a quarterly newsletter. | L | 7 | |
| IN-10.1.8 | The Outreach and Communications Manager shall be responsible for drafting and distributing fact sheets and brochures, updated as necessary. | M | 7 | |
| IN-10.1.9 | The Outreach and Communications Manager shall be responsible for writing and posting Digest (a compendium of information on ICM) on the website. | M | 7 | |
| IN-10.1.10 | The Outreach and Communications Manager shall be responsible for monitoring elections, funding opportunities, and the political environment which may affect the I-210 Pilot or ICM in general. | H | 7 | |
| IN-10.1.11 | The Outreach and Communications Manager shall be responsible for maintaining the website and plan/implement a social media strategy. | H | 7 | |
| IN-10.1.12 | The Outreach and Communications Manager shall be responsible for updating outreach materials periodically. | M | 7 | |
| IN-10.1.13 | The Outreach and Communications Manager shall be responsible for maintaining relationships on an ongoing basis. | H | 7 | |
| **IN-10.2** | **Information on stakeholder agencies shall be collected and updated on an ongoing basis by the Outreach and Communications Manager.** | **H** | **7, 13, 14** | **Institutional Job Tasks** |
| IN-10.2.1 | Participating roadway agencies shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager. | H | 7, 13, 14 | |
| *IN-10.2.1.1* | *Caltrans shall provide an organizational chart, names of office chiefs and directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.1.2* | *LA County Department of Public Works shall provide an organizational chart, names of board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.1.3* | *The City of Pasadena shall provide an organizational chart, names of elected officials and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |

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| *IN-10.2.1.4* | *The City of Arcadia shall provide an organizational chart, names of elected officials and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.1.5* | *The City of Duarte shall provide an organizational chart, names of elected officials and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.1.6* | *The City of Monrovia shall provide an organizational chart, names of elected officials and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| IN-10.2.2 | Participating transit agencies shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager. | H | 7, 13, 14 | |
| *IN-10.2.2.1* | *Metro Rail shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.2.2* | *Metro Bus shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.2.3* | *Foothill Transit shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.2.4* | *Pasadena Transit shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| IN-10.2.3 | Participating parking management agencies shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager. | H | 7, 13, 14 | |
| IN-10.2.4 | Participating regional transportation planning organizations shall provide an organizational chart, names of Board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager. | H | 7, 13, 14 | |
| *IN-10.2.4.1* | *Metro Highway Program shall provide an organizational chart, names of board members and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.4.2* | *SGVCOG shall provide an organizational chart, names of elected officials and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |
| *IN-10.2.4.3* | *SCAG shall provide an organizational chart, names of elected officials and office directors, key contact persons, and other relevant institutional information to the Outreach and Communications Manager.* | H | 7, 13, 14 | |

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| IN-10.2.5 | The Outreach and Communications Manager shall collect organizational charts, names of elected officials and office directors, key contact persons, and other relevant institutional information from the CHP and local first responding agencies involved in the operations of the ICM system where such information is not provided by other stakeholders. | H | 7, 13, 14 | |
| IN-10.2.6 | The Outreach and Communications Manager shall ensure on a quarterly basis that the information that has been submitted by corridor stakeholders is up to date. | H | 7, 13, 14 | |
| IN-10.2.7 | The Outreach and Communications Manager shall make available to the ICM operational team any relevant institutional information received from stakeholders. | H | 7, 13, 14 | |
| **IN-10.3** | **Key corridor stakeholders shall review documents submitted to them by agreed-upon deadlines.** | **H** | **7** | **Institutional Job Tasks** |
| IN-10.3.1 | The Corridor Manager shall determine which participating agencies need to review project documents and provide comments on them. | H | 7 | |
| IN-10.3.2 | The Corridor Manager shall determine if other agencies need to review project documents and provide comments on them. | H | 7 | |
| IN-10.3.3 | Caltrans shall submit by agreed-upon deadlines comments on key project documents submitted for review. | H | 7 | |
| IN-10.3.4 | Metro Highway Program shall submit by agreed-upon deadlines comments on key project documents submitted to them for review. | H | 7 | |
| IN-10.3.5 | LA County shall submit by agreed-upon deadlines comments on key project documents submitted to them for review. | H | 7 | |
| IN-10.3.6 | The City of Arcadia shall submit by agreed-upon deadlines comments on key project documents submitted to them for review. | H | 7 | |
| IN-10.3.7 | The City of Duarte shall submit by agreed-upon deadlines comments on key project documents submitted to them for review. | H | 7 | |
| IN-10.3.8 | The City of Monrovia shall submit by agreed-upon deadlines comments on key project documents submitted to them for review. | H | 7 | |
| IN-10.3.9 | The City of Pasadena shall submit by agreed-upon deadlines comments on key project documents submitted to them for review. | H | 7 | |
| **IN-10.4** | **Agencies participating in the operation of the ICM system shall identify a PIO (or PIO role) who shall be actively involved in ICM outreach and communications activities, such as press events, announcements, briefings on incidents/events, etc.** | **M** | **7** | **Institutional Job Tasks** |
| **IN-10.5** | **Ongoing, inclusive communication shall be established among corridor PIOs.** | **H** | **7** | **Institutional Job Tasks** |
| IN-10.5.1 | Corridor stakeholders shall collaboratively maintain ongoing communications concerning ICM-related activities so that all agencies have the same information. | H | 7 | |
| IN-10.5.2 | An organizational chart identifying communication contacts shall be developed by the Corridor Manager and Outreach and Communications Manager. | H | 7 | |
| **IN-10.6** | **Corridor stakeholders shall keep the Corridor Manager informed of scheduled events anticipated to have a noticeable impact on travel conditions along corridor arterials that may be used as detours by the ICM system.** | **H** | **7, 14** | **Institutional Job Tasks** |
| IN-10.6.1 | LA County shall communicate to the Corridor Manager and local PIO information about street closures and recommended detours associated with scheduled events held in unincorporated county areas within the corridor. | H | 7, 14 | |
| IN-10.6.2 | The City of Pasadena shall communicate to the Corridor Manager and local PIO information about street closures and recommended detours associated with scheduled events held within the city. | H | 7, 14 | |

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| IN-10.6.3 | The City of Arcadia shall communicate to the Corridor Manager and local PIO information about street closures and recommended detours associated with scheduled events to be held within the city. | H | 7, 14 | |
| IN-10.6.4 | The City of Monrovia shall communicate to the Corridor Manager and local PIO information about street closures and recommended detours associated with scheduled events to be held within the city. | H | 7, 14 | |
| IN-10.6.5 | The City of Duarte shall communicate to the Corridor Manager and local PIO information about street closures and recommended detours associated with scheduled events to be held within the city. | H | 7, 14 | |

### 9.1.11. MANAGEMENT OF THIRD-PARTY RELATIONSHIPS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IN-11.1** | **The Corridor Manager in coordination with stakeholders shall manage third-party relationships.** | **H** | **14** | **Institutional Job Tasks** |
| IN-11.1.1 | The Corridor Manager in coordination with stakeholders shall develop a strategy for acquiring real-time and/or historical data from third-party probe data providers (INRIX, HERE, or others). | H | 14 | |
| IN-11.1.2 | The Corridor Manager in coordination with stakeholders shall develop a strategy to share data with Waze and other travel information providers. | H | 14 | |
| IN-11.1.3 | The Corridor Manager in coordination with stakeholders shall purchase or develop contracts related to third-party data. | H | 14 | |
| IN-11.1.4 | The Corridor Manager in coordination with stakeholders shall determine which functions shall be outsourced to contractors. | H | 14 | |
| IN-11.1.5 | The Corridor Manager in coordination with stakeholders shall develop contracts with contractors. | H | 14 | |
| IN-11.1.6 | The Corridor Manager in coordination with stakeholders shall maintain contracts with contractors. | H | 14 | |
| IN-11.1.7 | The Corridor Manager in coordination with stakeholders shall draft contracts for providing data generated by the ICM Environment to third-party entities. | H | 14 | |
| IN-11.1.8 | The Corridor Manager in coordination with stakeholders shall maintain positive relationships with vendors and contractors. | H | 14 | |
| **IN-11.2** | **Third-party purchasing choices and contracts shall be reviewed periodically under the direction of the Corridor Manager.** | **M** | **14** | **Institutional Job Tasks** |

## 9.2. CORRIDOR MONITORING

This section defines requirements associated with the need to continuously monitor travel activities and device operations within the corridor, assess trends, and calculate performance metrics in order to develop an accurate depiction of existing corridor operations.

### 9.2.1. STATIC TRANSPORTATION NETWORK CHARACTERISTICS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-3.1** | **Roadway operators shall maintain and communicate to the Corridor Manager up-to-date definitions of roadway facilities connected to the ICM Environment** | **H** | **4, 5** | **Institutional Job Tasks** |
| CM-3.1.1 | Caltrans shall maintain up-to-date definitions of freeway network elements | H | 4, 5 | |
| *CM-3.1.1.1* | *Caltrans shall communicate to the ICM Corridor Manager any changes in roadway geometry affecting traffic conditions within the I-210 corridor, such as:*<br>• *Addition of auxiliary lanes on freeway*<br>• *Permitted use of shoulder lanes on freeway or ramps*<br>• *Changes in number or width of traffic lanes*<br>• *Changes in lane striping at intersections*<br>• *Intersection reconfigurations, including turn radius changes* | H | 4, 5 | |
| *CM-3.1.1.2* | *Caltrans shall communicate to the ICM Corridor Manager any changes to roadway restrictions, such as:*<br>• *Changes in bridge clearance*<br>• *Changes in permitted truck routes*<br>• *Changes in HOV restrictions (time of day, occupancy threshold)* | H | 4, 5 | |
| *CM-3.1.1.3* | *Caltrans shall communicate to the ICM Corridor Manager any changes to traffic control devices, such as:*<br>• *Speed limit changes*<br>• *Addition/removal of ramp meters*<br>• *Installation of new traffic signals*<br>• *Installation of new stop signs*<br>• *Changes in ramp metering control algorithm*<br>• *Signal timing plan changes* | H | 4, 5 | |
| CM-3.1.2 | Los Angeles County shall maintain up-to-date definitions of arterial network elements | H | 4, 5 | |
| *CM-3.1.2.1* | *Los Angeles County shall communicate to the ICM Corridor Manager any changes in roadway geometry affecting traffic conditions on reroute arterials, such as:*<br>• *Changes in number or width of traffic lanes*<br>• *Changes in lane striping at intersections*<br>• *Intersection reconfigurations, including turn radius changes*<br>• *Implementation/removal of one-way streets*<br>• *Long-term road closures*<br>• *Known physical bottleneck locations* | H | 4, 5 | |

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| *CM-3.1.2.2* | *Los Angeles County shall communicate to the ICM Corridor Manager any changes to traffic control devices on reroute arterials, such as:*<br>• *Location of new signalized intersections*<br>• *Location of new stop signs*<br>• *Implementation of new signal timing plans* | H | 4, 5 | |
| CM-3.1.3 | Pasadena shall maintain up-to-date definitions of arterial network elements | H | 4, 5 | |
| *CM-3.1.3.1* | *Pasadena shall communicate to the ICM Corridor Manager any changes in roadway geometry affecting traffic conditions on reroute arterials, such as:*<br>• *Changes in number or width of traffic lanes*<br>• *Changes in lane striping at intersections*<br>• *Intersection reconfigurations, including turn radius changes*<br>• *Implementation/removal of one-way streets*<br>• *Long-term road closures*<br>• *Known physical bottleneck locations* | H | 4, 5 | |
| *CM-3.1.3.2* | *Pasadena shall communicate to the ICM Corridor Manager any changes to roadway restrictions on reroute arterials, such as:*<br>• *Changes in permitted truck routes* | H | 4, 5 | |
| *CM-3.1.3.3* | *Pasadena shall communicate to the ICM Corridor Manager any changes to traffic control devices on reroute arterials, such as:*<br>• *Location of new signalized intersections*<br>• *Location of new stop signs*<br>• *Implementation of new signal timing plans* | H | 4, 5 | |
| CM-3.1.4 | Arcadia shall maintain up-to-date definitions of arterial network elements | H | 4, 5 | |
| *CM-3.1.4.1* | *Arcadia shall communicate to the ICM Corridor Manager any changes in roadway geometry affecting traffic conditions on reroute arterials, such as:*<br>• *Changes in number or width of traffic lanes*<br>• *Changes in lane striping at intersections*<br>• *Intersection reconfigurations, including turn radius changes*<br>• *Implementation/removal of one-way streets*<br>• *Long-term road closures*<br>• *Known physical bottleneck locations* | H | 4, 5 | |
| *CM-3.1.4.2* | *Arcadia shall communicate to the ICM Corridor Manager any changes to roadway restrictions on reroute arterials, such as:*<br>• *Changes in permitted truck routes* | H | 4, 5 | |
| *CM-3.1.4.3* | *Arcadia shall communicate to the ICM Corridor Manager any changes to traffic control devices on reroute arterials, such as:*<br>• *Location of new signalized intersections*<br>• *Location of new stop signs*<br>• *Implementation of new signal timing plans* | H | 4, 5 | |
| CM-3.1.5 | Monrovia shall maintain up-to-date definitions of arterial network elements | H | 4, 5 | |

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| *CM-3.1.5.1* | *Monrovia shall communicate to the ICM Corridor Manager any changes in roadway geometry affecting traffic conditions on reroute arterials, such as:*<br>• *Changes in number or width of traffic lanes*<br>• *Changes in lane striping at intersections*<br>• *Intersection reconfigurations, including turn radius changes*<br>• *Implementation/removal of one-way streets*<br>• *Long-term road closures*<br>• *Known physical bottleneck locations* | H | 4, 5 | |
| *CM-3.1.5.2* | *Monrovia shall communicate to the ICM Corridor Manager any changes to roadway restrictions on reroute arterials, such as:*<br>• *Changes in permitted truck routes* | H | 4, 5 | |
| *CM-3.1.5.3* | *Monrovia shall communicate to the ICM Corridor Manager any changes to traffic control devices on reroute arterials, such as:*<br>• *Location of new signalized intersections*<br>• *Location of new stop signs*<br>• *Implementation of new signal timing plans* | H | 4, 5 | |
| CM-3.1.6 | Duarte shall maintain up-to-date definitions of arterial network elements | H | 4, 5 | |
| *CM-3.1.6.1* | *Duarte shall communicate to the ICM Corridor Manager any changes in roadway geometry affecting traffic conditions on reroute arterials, such as:*<br>• *Changes in number or width of traffic lanes*<br>• *Changes in lane striping at intersections*<br>• *Intersection reconfigurations, including turn radius changes*<br>• *Implementation/removal of one-way streets*<br>• *Long-term road closures*<br>• *Known physical bottleneck locations* | H | 4, 5 | |
| *CM-3.1.6.2* | *Duarte shall communicate to the ICM Corridor Manager any changes to roadway restrictions on reroute arterials, such as:*<br>• *Changes in permitted truck routes* | H | 4, 5 | |
| *CM-3.1.6.3* | *Duarte shall communicate to the ICM Corridor Manager any changes to traffic control devices on reroute arterials, such as:*<br>• *Location of new signalized intersections*<br>• *Location of new stop signs*<br>• *Implementation of new signal timing plans* | H | 4, 5 | |
| **CM-3.2** | **Parking facility operators shall maintain up-to-date definitions of park-and-ride facilities connected to the ICM Environment** | **L** | **4, 5** | **Institutional Job Tasks** |
| CM-3.2.1 | Metro shall maintain up-to-date definitions of park-and-ride facilities operated by the agency | L | 4, 5 | |
| *CM-3.2.1.1* | *Metro shall communicate to the ICM Corridor Manager changes in the capacity of existing park-and-ride lots operated by the agency within the I-210 corridor* | L | 4, 5 | |
| *CM-3.2.1.2* | *Metro shall communicate to the ICM Corridor Manager information about the location and capacity of any new park-and-ride facility within the I-210 corridor* | L | 4, 5 | |
| CM-3.2.2 | Los Angeles County shall maintain up-to-date definitions of park-and-ride facilities operated by the agency | L | 4, 5 | |
| *CM-3.2.2.1* | *Los Angeles County shall communicate to the ICM Corridor Manager changes in the capacity of existing park-and-ride lots operated by the agency within the I-210 corridor* | L | 4, 5 | |

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| *CM-3.2.2.2* | *Los Angeles County shall communicate to the ICM Corridor Manager information about the location and capacity of any new park-and-ride facility within the I-210 corridor* | L | 4, 5 | |
| CM-3.2.3 | Caltrans shall maintain up-to-date definitions of park-and-ride facilities operated by the agency | L | 4, 5 | |
| *CM-3.2.3.1* | *Caltrans shall communicate to the ICM Corridor Manager changes in the capacity of existing park-and-ride lots operated by the agency within the I-210 corridor* | L | 4, 5 | |
| *CM-3.2.3.2* | *Caltrans shall communicate to the ICM Corridor Manager information about the location and capacity of any new park-and-ride facility within the I-210 corridor* | L | 4, 5 | |
| CM-3.2.4 | Private parking operators participating in the operation of the ICM Environment shall maintain up-to-date definitions of park-and-ride facilities operated by the agency | L | 4, 5 | |
| *CM-3.2.4.1* | *Private parking operators participating in the operation of the ICM Environment shall communicate to the ICM Corridor Manager changes in the capacity of existing park-and-ride lots operated by the agency within the I-210 corridor* | L | 4, 5 | |
| *CM-3.2.4.2* | *Private parking operators participating in the operation of the ICM Environment shall communicate to the ICM Corridor Manager information about the location and capacity of any new park-and-ride facility within the I-210 corridor* | L | 4, 5 | |
| **CM-3.3** | **Transit operators shall maintain up-to-date definitions of transit elements connected to the ICM Environment** | **M** | **4, 5** | **Institutional Job Tasks** |
| CM-3.3.1 | Metro Rail shall maintain up-to-date definitions of rail services that may affect or be affected by ICM system operations | M | 4, 5 | |
| *CM-3.3.1.1* | *Metro Rail shall communicate to the ICM Corridor Manager any changes to train operations within the I-210 corridor that may affect the carrying capacity of the service (e.g., increase in train frequency, use of longer/shorter trains, etc.)* | M | 4, 5 | |
| *CM-3.3.1.2* | *Metro Rail shall communicate to the ICM Corridor Manager any changes to train stations within the I-210 corridor that may affect the time needed by transit riders to board trains* | M | 4, 5 | |
| CM-3.3.2 | Metro Bus shall maintain up-to-date definitions of bus services that may affect or be affected by ICM system operations | M | 4, 5 | |
| *CM-3.3.2.1* | *Metro Bus shall communicate to the ICM Corridor Manager any changes to bus services on arterial reroutes that may affect available transit carrying capacity (e.g., increase in bus frequency, use of higher-capacity buses, route modifications, etc.)* | M | 4, 5 | |
| *CM-3.3.2.2* | *Metro Bus shall communicate to the ICM Corridor Manager any changes to bus services on arterial reroutes that may affect bus/traffic interactions (e.g., new bus bays at bus stops)* | M | 4, 5 | |
| *CM-3.3.2.3* | *Metro Bus shall communicate to the ICM Corridor Manager any changes in bus stop location on arterial reroutes that may affect the planning and implementation of response plans* | M | 4, 5 | |
| CM-3.3.3 | Pasadena Transit shall maintain up-to-date definitions of bus services that may affect or be affected by ICM system operations | M | 4, 5 | |
| *CM-3.3.3.1* | *Pasadena Transit shall communicate to the ICM Corridor Manager any changes to bus services on arterial reroutes that may affect available transit carrying capacity (e.g., increase in bus frequency, use of higher-capacity buses, route modifications, etc.)* | M | 4, 5 | |

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| *CM-3.3.3.2* | *Pasadena Transit shall communicate to the ICM Corridor Manager any changes to bus services on arterial reroutes that may affect bus/traffic interactions (e.g., new bus bays at bus stops)* | M | 4, 5 | |
| *CM-3.3.3.3* | *Pasadena Transit shall communicate to the ICM Corridor Manager any changes in bus stop location on arterial reroutes that may affect the planning and implementation of response plans* | M | 4, 5 | |
| CM-3.3.4 | Foothill Transit Line shall maintain up-to-date definitions of bus services that may affect or be affected by ICM system operations | M | 4, 5 | |
| *CM-3.3.4.1* | *Foothill Transit shall communicate to the ICM Corridor Manager any changes to bus services on arterial reroutes that may affect available transit carrying capacity (e.g., increase in bus frequency, use of higher-capacity buses, route modifications, etc.)* | M | 4, 5 | |
| *CM-3.3.4.2* | *Foothill Transit shall communicate to the ICM Corridor Manager any changes to bus services on arterial reroutes that may affect bus/traffic interactions (e.g., new bus bays at bus stops)* | M | 4, 5 | |
| *CM-3.3.4.3* | *Foothill Transit shall communicate to the ICM Corridor Manager any changes in bus stop location on arterial reroutes that may affect the planning and implementation of response plans* | M | 4, 5 | |
| **CM-3.4** | **The Corridor Manager shall ensure that network definitions are up to date in all locations within the ICM Core system** | **H** | **4, 5** | **Institutional Job Tasks** |
| CM-3.4.1 | The Corridor Manager shall ensure the estimation function has updated network descriptions | H | 4, 5 | |
| CM-3.4.2 | The Corridor Manager shall ensure the prediction function has updated network descriptions | H | 4, 5 | |
| CM-3.4.3 | The Corridor Manager shall ensure all rules that may reference network configuration are reviewed and updated as needed | H | 4, 5 | |
| CM-3.4.4 | The Corridor Manager shall ensure all user interface maps have updated network representations | H | 4, 5 | |
| CM-3.4.5 | The Corridor Manager shall ensure the network anomaly functions have updated network descriptions | H | 4, 5 | |
| CM-3.4.6 | The Corridor Manager shall ensure all metrics that may have constants based on network configuration are updated | H | 4, 5 | |
| **CM-3.5** | **The Corridor Manager shall ensure any changes to designated reroutes around incidents or events are communicated to all system stakeholders** | **H** | **4, 5** | **Institutional Job Tasks** |

### 9.2.2. ASSET INVENTORY AND HEALTH MANAGEMENT

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-4.1** | **The ICM Core System shall continuously assess the health status of devices used to monitor traffic conditions** | **H** | **3** | **Data Hub/DSS** |
| CM-4.1.1 | The ICM Core System shall monitor for fault and error messages that may be sent by individual traffic detection devices. | H | 3 | |
| CM-4.1.2 | The ICM Core System shall monitor for fault and error messages that may be sent by individual travel time measurement devices. | H | 3 | |
| CM-4.1.3 | The ICM Core System shall check whether CCTV cameras are providing video feeds. | H | 3 | |

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| CM-4.1.4 | The ICM Core System shall check whether tilt and pan functions of CCTV cameras are working as intended. | M | 3 | |
| CM-4.1.5 | The ICM Core System shall assess whether the data sent by individual traffic detection devices present anomalies or abnormalities. | H | 3 | |
| CM-4.1.6 | The ICM Core System shall assess whether the data sent by travel time measurement devices present anomalies or abnormalities. | H | 3 | |
| **CM-4.2** | **The ICM Core System shall continuously assess the health status of devices used to control traffic within the corridor** | **H** | **3** | **Data Hub/DSS** |
| CM-4.2.1 | The ICM Core System shall monitor for fault and error messages that may be sent by individual traffic signal controllers. | H | 3 | |
| CM-4.2.2 | The ICM Core System shall monitor for fault and error messages that may be sent by individual ramp meter controllers. | H | 3 | |
| **CM-4.3** | **The ICM Core System shall continuously assess the health status of devices used to inform travelers** | **H** | **3** | **Data Hub/DSS** |
| CM-4.3.1 | The ICM Core System shall monitor for fault or error messages that may be sent by fixed CMSs. | H | 3 | |
| CM-4.3.2 | The ICM Core System shall monitor for fault or error messages that may be sent by deployed mobile CMSs. | H | 3 | |
| CM-4.3.3 | The ICM Core System shall monitor for fault or error messages that may be sent by deployed extinguishable trailblazer signs. | H | 3 | |
| CM-4.3.3 | The ICM Core System shall monitor for fault or error messages that may be sent by HARs that have been activated to broadcast messages. | L | 3 | |
| **CM-4.4** | **The ICM Core System shall continuously assess the health status of communication networks used by participating agencies to exchange information** | **H** | **3** | **Data Hub/DSS** |
| CM-4.4.1 | The ICM Core System shall monitor and record fault or error messages that may be sent by the IEN communication network | H | 3 | |
| CM-4.4.2 | The ICM Core System shall monitor and record fault or error messages that may be sent by the RIITS communication network | H | 3 | |
| **CM-4.5** | **The ICM Core System shall report on identified operational problems with devices used to monitor and manage travel within the corridor.** | **H** | **3, 13, 17** | **Corridor Managemt** |
| CM-4.5.1 | The ICM Core System shall maintain an inventory of devices for which operational problems have been identified or reported. | L | 3, 13, 17 | |
| CM-4.5.2 | For each device with an identified or reported problem, the ICM Core System shall store the following information:<br>• Date record was created or last updated<br>• Date problem was first identified<br>• Type of device affected<br>• Location of device<br>• Agency responsible for device operation and maintenance<br>• Reported problem with device | H | 3, 13, 17 | |
| CM-4.5.3 | To the extent possible, the ICM Core System shall attempt to auto-generate device problem reports based on status information received from device monitoring systems. | M | 3, 13, 17 | |
| CM-4.5.4 | The ICM Core System shall include a function for system users to create and edit device problem reports. | M | 3, 13, 17 | |
| *CM-4.5.4.1* | *Stakeholders shall create and edit device problem reports, where reports are not generated automatically by the ICM Core System.* | M | 3, 13, 17 | |
| CM-4.5.5 | The ICM Core System shall notify immediately the respective agency and the Corridor Manager of any identified problem with a traffic control device operated by the agency. | H | 3, 13, 17 | |

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| CM-4.5.6 | The ICM Core System shall notify daily the designated TMC or TCS operator of each stakeholder agency of identified problems with a traffic monitoring device operated by the agency. | H | 3, 13, 17 | |
| CM-4.5.7 | The ICM Core System shall include a function for authorized users to access upon request the inventory of devices with operational problems. | L | 3, 13, 17 | |
| CM-4.5.8 | ICM Core System shall produce upon request reports summarizing the operational status of the devices used to monitor and manage travel within the corridor | M | 3, 13, 17 | |
| *CM-4.5.8.1* | *ICM Core System shall include a function for system users to specify the frequency with which reports are to be produced (e.g., hourly, daily, weekly, monthly, one-time, etc.)* | M | 3, 13, 17 | |
| *CM-4.5.8.2* | *ICM Core System shall include a function for system users to specify the type of devices for which a report is to be created (e.g., devices used to monitor traffic conditions, control traffic, inform travelers, etc.)* | M | 3, 13, 17 | |

### 9.2.3. CONTROL ASSET STATE MONITORING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-5.2** | **The ICM Core System shall monitor in real time the operational state of traffic control devices used along roadways under ICM management.** | **H** | **3, 4** | **Decision Support** |
| CM-5.2.1 | The ICM Core System shall monitor in real time the active timing plan in operation at signalized intersections along corridor arterials under ICM management | H | 3, 4 | |
| CM-5.2.2 | The ICM Core System shall monitor in real time ramp metering control parameters at on-ramps along freeway sections under ICM management. | H | 3, 4 | |
| *CM-5.2.2.1* | *The ICM Core System shall monitor in real time the ramp metering plan or control strategy in effect at on-ramps along freeway sections under ICM management.* | H | 3, 4 | |
| *CM-5.2.2.2* | *The ICM Core System shall monitor in real time the ramp metering rate in effect at freeway-to-freeway connectors along freeway sections under ICM management.* | H | 3, 4 | |
| **CM-5.3** | **The ICM Core System shall monitor in real time the operational state of traveler information devices under ICM management.** | **H** | **3, 4** | **Decision Support** |
| CM-5.3.1 | The ICM Core System shall monitor in real time the messages displayed on fixed changeable message signs operated within the corridor. | H | 3, 4 | |
| *CM-5.3.1.1* | *The ICM Core System shall monitor in real time the messages displayed on fixed changeable message signs operated along freeway sections under ICM management* | H | 3, 4 | |
| *CM-5.3.1.2* | *The ICM Core System shall monitor in real time the messages displayed on fixed changeable message signs operated along corridor arterials under ICM management* | H | 3, 4 | |
| CM-5.3.2 | The ICM Core System shall monitor in real time the operational status of portable message signs operated within the corridor. | H | 3, 4 | |
| CM-5.3.3 | The ICM Core System shall monitor in real time the operational status of extinguishable trailblazer signs operated within the corridor. | H | 3, 4 | |

### 9.2.4. TRAFFIC MONITORING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-6.1** | **The ICM Core System shall monitor in real time traffic conditions on freeway segments within the ICM corridor.** | **H** | **1, 2, 6** | **Data Hub** |
| CM-6.1.1 | The ICM Core System shall receive traffic volume measurements with a latency of no more than 1 minute from the following freeway traffic sensors within the ICM corridor:<br>• Sensors on mainline general purpose traffic lanes<br>• Sensors on mainline HOV lanes<br>• Sensors on freeway on-ramps<br>• Sensors on freeway off-ramps<br>• Sensors on freeway-to-freeway connectors | H | 1, 2, 6 | |
| CM-6.1.2 | The ICM Core System shall receive sensor occupancy measurements with a latency of no more than 1 minute from the following freeway traffic sensors within the ICM corridor:<br>• Sensors on mainline general purpose traffic lanes<br>• Sensors on mainline HOV lanes | H | 1, 6 | |
| CM-6.1.3 | The ICM Core System shall receive speed measurements with a latency of no more than 1 minute from the following freeway traffic sensors within the ICM corridor:<br>• Sensors on mainline general purpose traffic lanes<br>• Sensors on mainline HOV lanes | H | 1, 6 | |
| CM-6.1.4 | The ICM Core System shall receive with a latency of no more than 1 minute the travel time measurements from travel time measurement systems operated by Caltrans along freeways within the ICM corridor. | L | 1, 6 | |
| **CM-6.2** | **The ICM Core System shall monitor in real time traffic conditions on key corridor arterials.** | **H** | **1, 2, 6** | **Data Hub** |
| CM-6.2.1 | The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors along key corridor arterials. | H | 1, 2, 6 | |
| *CM-6.2.1.1* | *The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors operated by Caltrans along key corridor arterials* | H | 1, 2, 6 | |
| *CM-6.2.1.2* | *The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors operated by Los Angeles County along key corridor arterials* | H | 1, 2, 6 | |
| *CM-6.2.1.3* | *The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors operated by the City of Pasadena along key corridor arterials* | H | 1, 2, 6 | |
| *CM-6.2.1.4* | *The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors operated by the City of Arcadia along key corridor arterials* | H | 1, 2, 6 | |
| *CM-6.2.1.5* | *The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors operated by the City of Monrovia along key corridor arterials* | H | 1, 2, 6 | |
| *CM-6.2.1.6* | *The ICM Core System shall receive with a latency of one minute or less traffic flow measurements from sensors operated by the City of Duarte along key corridor arterials* | H | 1, 2, 6 | |

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| CM-6.2.2 | The ICM Core System shall receive with a latency of one minute or less data collected by travel time measurement systems operated by local agencies along key corridor arterials. | L | 1, 6 | |
| *CM-6.2.2.1* | *The ICM Core System shall receive with a latency of one minute or less data collected by the travel time measurement system operated by Los Angeles County* | L | 1, 6 | |
| *CM-6.2.2.* | *The ICM Core System shall receive with a latency of one minute or less data collected by the travel time measurement system operated by the City of Pasadena.* | L | 1, 6 | |
| *CM-6.2.2.3* | *The ICM Core System shall receive with a latency of one minute or less data collected by the travel time measurement system operated by the City of Arcadia* | L | 1, 6 | |
| *CM-6.2.2.4* | *If a separate system is used, the ICM Core System shall receive with a latency of one minute or less data collected by the travel time measurement system operated by the City of Monrovia.* | L | 1, 6 | |
| *CM-6.2.2.5* | *If a separate system is used, the ICM Core System shall receive with a latency of one minute or less collected by the travel time measurement system operated by the City of Duarte.* | L | 1, 6 | |

### 9.2.5. TRANSIT MONITORING

| ID | Description | Criticality | Related User Need(s) | Related Susbystem |
|---|---|---|---|---|
| **CM-7.1** | **The ICM Core System shall monitor for significant transit service disruptions along relevant transit routes within the corridor.** | **M** | **1, 2, 4, 6** | **Data Hub** |
| CM-7.1.1 | The ICM Core System shall receive as soon as available information about transit service disruptions that may influence traffic demand within the corridor or influence the development or implementation of response plans | M | 1, 4, 6 | |
| *CM-7.1.1.1* | *The ICM Core System shall receive as soon as possible information about service disruptions on the Gold Line reported by Metro Rail* | M | 1, 4, 6 | |
| *CM-7.1.1.2* | *The ICM Core System shall receive as soon as possible information about service disruptions along relevant commuter and express lines reported by Metro Bus.* | M | 1, 4, 6 | |
| *CM-7.1.1.3* | *The ICM Core System shall receive as soon as possible information about service disruptions along relevant commuter and express lines reported by Foothill Transit* | M | 1, 4, 6 | |
| *CM-7.1.1.4* | *The ICM Core System shall receive as soon as possible information about service disruptions along relevant local bus lines reported by Pasadena Transit.* | M | 1, 4, 6 | |
| **CM-7.2** | **The ICM Core System shall monitor average ridership along transit services of interest within the corridor** | **L** | **1, 2, 4, 6** | **Data Hub** |
| CM-7.2.1 | The ICM Core System shall receive once a quarter or less average ridership data along transit routes of interest operated by participating transit agencies. | L | 1, 2, 4, 6 | |
| *CM-7.2.1.1* | *The ICM Core System shall receive once a quarter ridership data from the Metro Gold Line.* | L | 1, 2, 4, 6 | |
| *CM-7. 2.1.2* | *The ICM Core System shall receive once a quarter ridership data from corridor commuter and express lines operated by Metro Bus.* | L | 1, 2, 4, 6 | |

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| *CM-7. 2.1.3* | *The ICM Core System shall receive once a quarter ridership data from corridor commuter and express lines operated by Foothill Transit.* | L | 1, 2, 4, 6 | |
| *CM-7. 2.1.4* | *The ICM Core System shall receive once a quarter ridership data from corridor commuter and express lines operated by Pasadena Transit.* | L | 1, 2, 4, 6 | |
| **CM-7.3** | **The ICM Core System shall report on monitored transit operations within the ICM corridor.** | **M** | **4, 6** | **Corridor Managemt** |
| CM-7.3.1 | The ICM Core System shall produce daily reports summarizing reported service disruptions of interest along each transit route monitored by the ICM system. | M | 4, 6 | |
| CM-7.3.2 | The ICM Core System shall only report on disruptions potentially affecting traffic demand on corridor roadways or the implementation of a response plan. | M | 4, 6 | |

### 9.2.6. PARK-AND-RIDE MONITORING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-8.1** | **The ICM Core System shall monitor in real time park-and-ride availability at facilities operated by participating agencies within the corridor.** | **L** | **1, 2, 4, 6** | **Data Hub** |
| CM-8.1.1 | The ICM Core System shall receive every 15 minutes or less parking availability data from park-and-ride facilities operated by Metro within the corridor. | L | 1, 2, 4, 6 | |
| CM-8.1.2 | The ICM Core System shall receive every 15 minutes or less parking availability data from park-and-ride facilities operated by LA County within the corridor. | L | 1, 2, 4, 6 | |
| CM-8.1.3 | The ICM Core System shall receive every 15 minutes or less parking availability data from park-and-ride facilities operated by Caltrans within the corridor. | L | 1, 2, 4, 6 | |
| **CM-8.2** | **The ICM Core System shall report on parking availability at facilities under ICM surveillance.** | **L** | **4, 6** | **Corridor Managemt** |
| CM-8.2.1 | The ICM Core System shall produce hourly and daily reports summarizing parking availability within individual park-and-ride facilities for the reporting period. | L | 4, 6 | |

### 9.2.7. CORRIDOR PERFORMANCE METRICS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-9.1** | **The ICM Core System shall calculate and store metrics summarizing overall corridor performance** | **H** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.1.1 | The ICM Core System shall calculate and store the following vehicle-based productivity metrics for the entire corridor:<br>• Vehicle-miles traveled (VMT)<br>• Vehicle-hours traveled (VHT) | H | 1, 2, 4, 6 | |
| CM-9.1.2 | The ICM Core System shall calculate and store the following vehicle-based mobility metrics for the entire corridor:<br>• Vehicle-hours of delay | H | 1, 4, 6 | |

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| CM-9.1.3 | The ICM Core System shall estimate and store the following person-based productivity metrics for the entire corridor based on available average regional vehicle occupancy factors:<br>• Person-miles traveled (PMT)<br>• Person-hours traveled (PHT) | M | 1, 2, 4, 6 | |
| CM-9.1.4 | The ICM Core System shall estimate and store the following person-based mobility metrics for the entire corridor based on available average regional vehicle occupancy factors:<br>• Person-hours of delay | M | 1, 4, 6 | |
| **CM-9.2** | **The ICM Core System shall calculate and store metrics summarizing the performance of mainline freeway operations.** | **H** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.2.1 | For each mainline freeway segment, the ICM Core System shall calculate and store the following vehicle-based productivity metrics:<br>• Total vehicle flow<br>• Vehicle-miles traveled (VMT)<br>• Vehicle-hours traveled (VHT) | H | 1, 2, 4, 6 | |
| CM-9.2.2 | For each mainline freeway segment, the ICM Core System shall calculate and store the following vehicle-based mobility metrics:<br>• Average travel time across segment<br>• Average speed across segment<br>• Vehicle-hours of delay (VHD)<br>• Average delay per vehicle | H | 1, 4, 6 | |
| CM-9.2.3 | For each mainline freeway segment, the ICM Core System shall estimate and store the following person-based productivity metrics based on available average regional vehicle occupancy factors:<br>• Total person flow<br>• Person-miles traveled (PMT)<br>• Person-hours traveled (PHT) | M | 1, 2, 4, 6 | |
| CM-9.2.4 | For each mainline freeway segment, the ICM Core System shall estimate and store the following person-based mobility metrics based on available average regional vehicle occupancy factors:<br>• Person-hours of delay (PHD)<br>• Average delay per person | M | 1, 4, 6 | |
| CM-9.2.5 | For each mainline freeway segment, the ICM Core System shall calculate and store the following reliability metrics:<br>• Travel time index<br>• Buffer index (extra time that travelers must add to their average travel time when planning trips to ensure on-time arrival) | H | 1, 4, 6 | |
| CM-9.2.6 | Where HOV lanes exist, the ICM Core System shall calculate and store separately segment metrics for the general-purpose and HOV lanes | H | 1, 2, 4, 6 | |
| **CM-9.3** | **The ICM Core System shall calculate and store metrics summarizing the performance of freeway ramp operations.** | **H** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.3.1 | For each freeway on-ramp and off-ramp, the ICM Core System shall calculate and store the following vehicle-based productivity metrics:<br>• Total vehicle flow<br>• Vehicle-miles traveled (VMT)<br>• Vehicle-hours traveled (VHT) | H | 1, 2, 4, 6 | |
| CM-9.3.2 | For each freeway on-ramp and off-ramp, the ICM Core System shall calculate and store the following vehicle-based mobility metrics:<br>• Vehicle-hours of delay (VHD)<br>• Average delay per vehicle | H | 1, 4, 6 | |

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| CM-9.3.3 | For each freeway on-ramp and off-ramp, the ICM Core System shall estimate and store the following person-based productivity metrics based on available average regional vehicle occupancy factors:<br>• Total person flow<br>• Person-miles traveled (PMT)<br>• Person-hours traveled (PHT) | M | 1, 2, 4, 6 | |
| CM-9.3.4 | For each freeway on-ramp and off-ramp, the ICM Core System shall estimate and store the following person-based mobility metrics based on available average regional vehicle occupancy factors:<br>• Person-hours of delay (PHD)<br>• Average delay per person | M | 1, 4, 6 | |
| **CM-9.4** | **The ICM Core System shall calculate and store metrics summarizing the performance of arterial traffic operations.** | **H** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.4.1 | For each arterial segment, the ICM Core System shall calculate and store the following vehicle-based productivity metrics:<br>• Total vehicle flow<br>• Vehicle-miles traveled (VMT)<br>• Vehicle-hours traveled (VHT) | H | 1, 2, 4, 6 | |
| CM-9.4.2 | For each arterial segment, the ICM Core System shall estimate and store the following person-based productivity metrics based on available average regional vehicle occupancy factors:<br>• Total person flow<br>• Person-miles traveled (PMT)<br>• Person-hours traveled (PHT) | H | 1, 2, 4, 6 | |
| CM-9.4.3 | For each arterial segment, the ICM Core System shall calculate and store the following vehicle-based mobility metrics:<br>• Vehicle-hours of delay (VHD)<br>• Average delay per vehicle | M | 1, 4, 6 | |
| CM-9.4.4 | For each arterial segment, the ICM Core System shall estimate and store the following person-based mobility metrics based on available average regional vehicle occupancy factors:<br>• Person-hours of delay (PHD)<br>• Average delay per person | M | 1, 4, 6 | |
| CM-9.4.5 | For key signalized intersections, the ICM Core System shall calculate and store the following vehicle-based productivity metrics:<br>• Vehicle flow (each approach)<br>• Average delay per vehicle (each approach and overall intersection) | H | 1, 2, 4, 6 | |
| CM-9.4.6 | For key signalized intersections, the ICM Core System shall calculate and store the following person-based productivity metrics:<br>• Person flow (each approach)<br>• Average delay per person (each approach and overall intersection) | M | 1, 2, 4, 6 | |
| CM-9.4.7 | For key signalized intersections, the ICM Core System shall calculate and store the following productivity metrics summarizing traffic signal operations:<br>• Vehicle flow capacity (each approach and overall intersection)<br>• Volume-to-capacity ratio (each approach and overall intersection)<br>• Average queue length (each approach) | H | 1, 4, 6 | |

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| CM-9.4.8 | For key signalized intersections, the ICM Core System shall calculate and store the following vehicle-based mobility metrics:<br>• Vehicle-hours of delay (each approach and overall intersection)<br>• Average delay per vehicle (each approach and overall intersection) | H | 1, 4, 6 | |
| CM-9.4.9 | For key signalized intersections, the ICM Core System shall estimate and store the following person-based mobility metrics based on available average regional vehicle occupancy factors:<br>• Person-hours of delay (each approach and overall intersection)<br>• Average delay per person (each approach and overall intersection) | M | 1, 4, 6 | |
| **CM-9.5** | **The ICM Core System shall calculate and store metrics summarizing the performance along user-defined routes.** | **H** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.5.1 | For each user-defined route, the ICM Core System shall calculate and store the following vehicle-based productivity measures:<br>• Maximum vehicle flow along each segment of the route<br>• Vehicle-miles traveled along the route (VMT)<br>• Vehicle-hours traveled along the route (VHT) | H | 1, 2, 4, 6 | |
| CM-9.5.2 | For each user-defined route, the ICM Core System shall estimate and store the following person-based productivity measures based on available average regional vehicle occupancy factors:<br>• Maximum person flow along each segment of the route<br>• Person-miles traveled along the route (PMT)<br>• Person-hours traveled along the route (PHT) | H | 1, 2, 4, 6 | |
| CM-9.5.3 | For each user-defined route, the ICM Core System shall calculate and store the following mobility measures:<br>• Overall travel time along the route<br>• Speed contour plot | H | 1, 2, 4, 6 | |
| CM-9.5.4 | For each user-defined route, the ICM Core System shall calculate and store the following reliability measures:<br>• Observed travel time variability along the route within the defined time period<br>• Observed flow variability along the route within the defined time period<br>• Travel time index for the route<br>• Buffer index for the route (extra time that travelers must add to their average travel time when planning trips to ensure on-time arrival) | H | 1, 2, 4, 6 | |
| **CM-9.6** | **Decision Support shall compile performance metrics for each roadway management agency participating in the operation of the ICM system.** | **H** | **6** | **Decision Support** |
| CM-9.6.1 | The ICM Core System shall compile metrics calculated for freeway elements (mainline sections, on-ramps, off-ramps, freeway-to-freeway connectors) managed by Caltrans. | H | 6 | |
| CM-9.6.2 | The ICM Core System shall compile metrics calculated for arterial segments managed by Los Angeles County. | H | 6 | |
| CM-9.6.3 | The ICM Core System shall compile metrics calculated for arterial segments managed by Pasadena. | H | 6 | |
| CM-9.6.4 | The ICM Core System shall compile metrics calculated for arterial segments managed by Arcadia. | H | 6 | |
| CM-9.6.5 | The ICM Core System shall compile metrics calculated for arterial segments managed by Monrovia. | H | 6 | |

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| CM-9.6.6 | The ICM Core System shall compile metrics calculated for arterial segments managed by Duarte. | H | 6 | |
| **CM-9.7** | **The ICM Core System shall compile metrics summarizing the performance of monitored transit services.** | **M** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.7.1 | The system shall compile, based on data provided by the Gold Line, the following performance metrics for the Metro Gold Line light-rail service:<br>• Train ridership<br>• Average train occupancy along each segment<br>• Average travel times along key route segments<br>• Reported service delays of more than 15 minutes | M | 1, 2, 4, 6 | |
| CM-9.7.2 | The system shall compile the following performance metrics for each express bus route and commuter bus route being monitored:<br>• On-time arrivals<br>Additional metrics (such as route ridership, average vehicle occupancy along specific route segments, average travel times along key route segments, and reported service delays of more than 15 minutes) will be determined during design. | M | 1, 2, 4, 6 | |
| **CM-9.8** | **The ICM Core System shall compile metrics summarizing the performance of parking facilities.** | **L** | **1, 2, 4, 6** | **Decision Support** |
| CM-9.8.1 | For each monitored parking facility, the ICM Core System shall compile the following performance metrics:<br>• Facility occupancy rate<br>• Number of available parking spaces | L | 1, 2, 4, 6 | |

### 9.2.8. TRAFFIC STATE DETERMINATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-10.1** | **The ICM Core System shall use available sensor data to determine the state of traffic along roadways of interest within the ICM corridor.** | **H** | **4, 5, 6, 13** | **Decision Support** |
| CM-10.1.1 | The ICM Core System shall use available sensor data to estimate the prevailing average traffic flow rate on sections of roadways of interest to the system. | H | 4, 5, 6, 13 | |
| *CM-10.1.1.1* | *The ICM Core System shall use available sensor data to estimate the prevailing average traffic flow rate between successive on-ramps along the sections of I-210, I-605, and SR-134 within the ICM corridor.* | H | 4, 5, 6, 13 | |
| *CM-10.1.1.2* | *The ICM Core System shall use available sensor data to estimate the prevailing average traffic flow rate on HOV lanes between successive on-ramps along the section of I-210 within the ICM corridor.* | H | 4, 5, 6, 13 | |
| *CM-10.1.1.3* | *The ICM Core System shall use available sensor data to estimate prevailing average traffic flow rates on on-ramps along the sections of I-210, SR-134, and I-605 within the ICM corridor.* | H | 4, 5, 6, 13 | |
| *CM-10.1.1.3* | *The ICM Core System shall use available sensor data to estimate prevailing average traffic flow rates on off-ramps along the sections of I-210, SR-134, and I-605 within the ICM corridor.* | H | 4, 5, 6, 13 | |

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| *CM-10.1.1.4* | *The ICM Core System shall use available sensor data to estimate prevailing average traffic flow rates on arterial segments along potential detour routes.* | H | 4, 5, 6, 13 | |
| *CM-10.1.1.5* | *The ICM Core System shall use available sensor data to estimate prevailing average traffic flow rates on arterial segments outside potential detour routes that may influence decision-making activities.* | H | 4, 5, 6, 13 | |
| CM-10.1.2 | The ICM Core System shall use available sensor data to estimate prevailing average traffic speeds on sections of roadways of interest to the system. | H | 4, 5, 6, 13 | |
| *CM-10.1.2.1* | *The ICM Core System shall use available sensor data to estimate the prevailing average traffic speed on the general-purpose traffic lanes between successive on-ramps along the sections of I-210, SR-134, and I-605 within the ICM corridor.* | H | 4, 5, 6 13 | |
| *CM-10.1.2.2* | *The ICM Core System shall use available sensor data to estimate the average traffic speed on the HOV lanes between successive on-ramps along the sections of I-210 and SR-134 within the ICM corridor.* | H | 4, 5, 6, 13 | |
| *CM-10.1.2.3* | *The ICM Core System shall use available sensor data to estimate prevailing average traffic speeds on arterial segments along potential detour routes.* | H | 4, 5, 6, 13 | |
| *CM-10.1.2.4* | *The ICM Core System shall use available sensor data to estimate prevailing average traffic speeds on arterial segments outside potential detour routes that may influence decision-making activities.* | H | 4, 5, 6, 13 | |
| CM-10.1.3 | The ICM Core System shall use available sensor data to estimate prevailing average travel times along sections of roadways of interest to the system. | M | 4, 5, 6, 13 | |
| *CM-10.1.3.1* | *The ICM Core System shall use available sensor data to estimate prevailing average travel times on general-purpose traffic lanes between key interchanges along the section of I-210 within the ICM corridor.* | M | 4, 5, 6, 13 | |
| *CM-10.1.3.2* | *The ICM Core System shall use available sensor data to estimate prevailing average HOV-lane travel times between key interchanges along the section of I-210 within the ICM corridor.* | M | 4, 5, 6, 13 | |
| *CM-10.1.3.3* | *The ICM Core System shall use available sensor data to estimate prevailing average travel times along arterial segments that may be part of a detour route.* | M | 4, 5, 6, 13 | |
| CM-10.1.4 | The ICM Core System shall use available sensor data to estimate, where possible, average queue lengths along sections of roadways of interest to the system. | M | 4, 5, 6, 13 | |
| *CM-10.1.4.1* | *The ICM Core System shall use available sensor data to estimate prevailing average queue length on freeway on-ramps along the section of I-210 within the ICM corridor.* | M | 4, 5, 6, 13 | |
| *CM-10.1.4.2* | *The ICM Core System shall use available sensor data to estimate prevailing average queue length on approaches to signalized intersections along potential detour routes.* | M | 4, 5, 6, 13 | |
| CM-10.1.5 | The ICM Core System shall use available sensor data to determine the level of congestion on sections of roadways of interest to the system. | M | 4, 5, 6, 13 | |
| *CM-10.1.5.1* | *The ICM Core System shall use available sensor data to estimate the level of congestion between successive on-ramps along the sections of I-210, SR-134, and I-605 within the ICM corridor.* | M | 4, 5, 6, 13 | |

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| *CM-10.1.5.2* | *The ICM Core System shall use available sensor data to estimate the level of congestion on HOV lanes between successive on-ramps along the I-210, SR-134, and I-605 freeways.* | M | 4, 5, 6, 13 | |
| *CM-10.1.5.3* | *The ICM Core System shall use available sensor data to estimate the level of congestion between key intersections on arterial segments along potential detour routes.* | M | 4, 5, 6, 13 | |
| **CM-10.2** | **The ICM Core System shall attempt to use available sensor data to estimate traffic conditions on roadway sections of interest without instrumentation.** | **H** | **4, 5, 6, 13** | **Decision Support** |

### 9.2.9. HISTORICAL PATTERN DETERMINATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **CM-11.1** | **The ICM Core System shall determine historical traffic patterns from available traffic data** | **H** | **4, 5** | **Decision Support** |
| CM-11.1.1 | For each traffic detector, the ICM Core System shall determine upon request the following statistics over a specified period:<br>• Average flow measurement<br>• Average sensor occupancy<br>• Average speed measurement (if available)<br>• Flow variance<br>• Sensor occupancy variance | H | 4, 5 | |
| CM-11.1.2 | For each intersection for which turn movements are available, the ICM Core System shall determine upon request the following statistics over a specified period:<br>• Average measured volumes for right-turn, thru, and left-turn movements<br>• Volume variance for each movement | H | 4, 5 | |
| CM-11.1.3 | For each roadway segment for which travel time measurements are available, the ICM Core System shall determine the following statistics over a user- or system-specified period:<br>• Average measured travel time<br>• Travel time variance | H | 4, 5 | |
| **CM-11.2** | **The ICM Core System shall determine historical patterns from available traffic control data** | **H** | **4, 5** | **Decision Support** |
| CM-11.2.1 | For each metered freeway on-ramp, the ICM Core System shall determine the following operational statistics over a specified period:<br>• Average period during which the ramp meter was in operation<br>• Average start time of metering operation<br>• Average end time of metering operation<br>• Average metering rate during active period<br>• Proportion of time that each defined metering rate within the controller has been used | H | 4, 5 | |

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| CM-11.2.2 | For each signalized intersection, the ICM Core System shall determine the following operational statistics over a specified period:<br>• List of activated signal timing plans<br>• Total time during which each activated timing plan was operational<br>• Average observed cycle length<br>• Minimum and maximum observed cycle length<br>• Average duration of each signal phase<br>• Minimum and maximum duration of each signal phase<br>• Average signal offset | M | 4, 5 | |
| **CM-11.3** | **The ICM Core system shall calculate variability statistics associated with real-time traffic data over a given interval** | **H** | **1, 2** | **Decision Support** |
| CM-11.3.1 | Data Management shall include a function to obtain or calculate across days, weeks, months, or years the mean value of flow, speed, and travel time data provided to the ICM system by a given sensor or system for a given interval. | H | 1, 2 | |
| CM-11.3.2 | Data Management shall include a function to obtain or calculate across days, weeks, months, or years the standard deviation of flow, speed, and travel time data provided to the ICM system by a given sensor or system for a given interval. | H | 1, 2 | |
| **CM-11.4** | **The ICM Core System shall include a function to analyze historical data over time periods** | **H** | **4, 5** | **Decision Support** |
| CM-11.4.1 | The ICM Core System shall include a function to analyze historical data over a range of dates. | H | 4, 5 | |
| CM-11.4.2 | The ICM Core System shall include a function to analyze historical data within one day of the collection of the historical data being collected. | H | 4, 5 | |
| CM-11.4.3 | The ICM Core System shall include a function to analyze historical data over specific weekdays within a given date range. | H | 4, 5 | |
| CM-11.4.4 | The ICM Core System shall include a function to analyze historical data over an interval (for instance, every 15 minutes, 1 hour, day, month, etc.) | H | 4, 5 | |
| **CM-11.5** | **The ICM Core System shall notify system users whether a requested historical data compilation is feasible for the specified period and reporting interval based on available data and the characteristics of the available data** | **H** | **4, 5** | **Corridor Managemt** |
| CM-11.5.1 | The ICM Core System shall assess whether a requested historical data compilation is feasible for the specified period and reporting interval based on available data and the characteristics of the available data | M | 4, 5 | |
| CM-11.5.2 | The ICM Core System shall notify system users when requested historical data compilation cannot be executed | M | 4, 5 | |

## 9.3. STRATEGIC INCIDENT/EVENT RESPONSE PLANNING (CORRIDOR PLANNING)

This section details requirements for defining response plan components and for capturing the rules that will be used to assemble these components into specific response plans for use during a particular incident or event. The section also defines requirements for the ability to test response plans and review the results of applying these plans.

### 9.3.1. STAKEHOLDER INVOLVEMENT

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-1.1** | **Stakeholders shall participate in incident/event response planning activities.** | **H** | **7** | **Institutional Job Tasks** |
| SP-1.1.1 | The Corridor Manager shall lead incident/event response planning. | H | 7 | |
| SP-1.1.2 | Traffic engineers from stakeholder agencies managing roadways within the ICM corridor shall participate in incident/event response planning. | H | 7 | |
| *SP-1.1.2.1* | *A traffic engineer from the City of Pasadena shall participate in response planning.* | H | 7 | |
| *SP-1.1.2.2* | *A traffic engineer from the City of Arcadia shall participate in response planning* | H | 7 | |
| *SP-1.1.2.3* | *A traffic engineer from the City of Monrovia shall participate in response planning.* | H | 7 | |
| *SP-1.1.2.4* | *A traffic engineer from the City of Duarte shall participate in response planning.* | H | 7 | |
| *SP-1.1.2.5* | *A traffic engineer from Los Angeles County shall participate in response planning.* | H | 7 | |
| *SP-1.1.2.6* | *A traffic engineer from Caltrans shall participate in response planning.* | H | 7 | |
| SP-1.1.3 | First Responders operating within the ICM corridor shall participate in incident/event response planning | H | 7 | |
| *SP-1.1.3.1* | *California Highway Patrol officers shall participate in response planning.* | H | 7 | |
| *SP-1.1.3.2* | *Los Angeles County Sheriff's officers shall participate in response planning.* | H | 7 | |
| *SP-1.1.3.3* | *Police officers from the City of Pasadena shall participate in response planning.* | H | 7 | |
| *SP-1.1.3.4* | *Police officers from the City of Arcadia shall participate in response planning.* | H | 7 | |
| *SP-1.1.3.5* | *Police officers from the City of Monrovia shall participate in response planning.* | H | 7 | |
| SP-1.1.4 | Transit Field Supervisors from agencies providing transit services within the ICM corridor shall participate in event response planning | M | 7 | |
| *SP-1.1.4.1* | *Transit Field Supervisors from Metro Rail shall participate in response planning activities potentially affecting services provided by the agency.* | M | 7 | |
| *SP-1.1.4.2* | *Transit Field Supervisors from Metro Bus shall participate in response planning activities potentially affecting services provided by the agency.* | M | 7 | |

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| *SP-1.1.4.3* | *Transit Field Supervisors from Foothill Transit shall participate in response planning activities potentially affecting services provided by the agency.* | M | 7 | |
| *SP-1.1.4.4* | *Transit Field Supervisors from Pasadena Transit shall participate in response planning activities potentially affecting services provided by the agency.* | M | 7 | |

### 9.3.2. MANAGEMENT OF RESPONSE PLAN COMPONENTS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-2.1** | **System stakeholders shall determine and maintain desired routes to be used as detours for incidents and events.** | **H** | **7, 8, 10** | **Institutional Job Tasks** |
| SP-2.1.1 | Detour route determination shall be done in consultation with the California Highway Patrol. | H | 7, 8, 10 | |
| SP-2.1.2 | Caltrans traffic engineers shall determine detour routes for passenger cars on state highways. | H | 7, 8, 10 | |
| SP-2.1.3 | Los Angeles County traffic engineers and representatives from the Sheriff's office shall determine detour routes for passenger cars in areas controlled by County. | H | 7, 8, 10 | |
| SP-2.1.4 | Arcadia traffic engineers and first responders shall determine detour routes for passenger cars in Arcadia. | H | 7, 8, 10 | |
| SP-2.1.5 | Pasadena traffic engineers and first responders shall determine detour routes for passenger cars in Pasadena. | H | 7, 8, 10 | |
| SP-2.1.6 | Monrovia traffic engineers and first responders shall determine detour routes for passenger cars in Monrovia. | H | 7, 8, 10 | |
| SP-2.1.7 | Duarte traffic engineers and first responders shall determine detour routes for passenger cars in Duarte. | H | 7, 8, 10 | |
| SP-2.1.8 | Caltrans traffic engineers shall determine detour routes for trucks on the state highways. | H | 7, 8, 10 | |
| SP-2.1.9 | Los Angeles County traffic engineers shall determine detour routes for trucks in areas controlled by County. | H | 7, 8, 10 | |
| SP-2.1.10 | Pasadena traffic engineers and first responders shall determine detour routes for trucks in Pasadena. | H | 7, 8, 10 | |
| SP-2.1.11 | Arcadia traffic engineers and first responders shall determine detour routes for trucks in Arcadia. | H | 7, 8, 10 | |
| SP-2.1.12 | Monrovia traffic engineers and first responders shall determine detour routes for trucks in Monrovia. | H | 7, 8, 10 | |
| SP-2.1.13 | Duarte traffic engineers and first responders shall determine detour routes for trucks in Duarte. | H | 7, 8, 10 | |
| SP-2.1.14 | Metro Bus field supervisors shall determine, if needed, detour routes that may be used by buses during incidents and events impacting transit operations. | M | 7, 8, 10 | |
| SP-2.1.15 | Metro rail field supervisors shall determine, if needed, detour routes that may be used by buses during incidents and events impacting transit operations. | M | 7, 8, 10 | |
| SP-2.1.16 | Pasadena Transit field supervisors shall determine, if needed, detour routes that may be used by buses during incidents and events impacting transit operations. | M | 7, 8, 10 | |
| SP-2.1.17 | Foothill transit field supervisors shall determine, if needed, detour routes that may be used by buses during incidents and events impacting transit operations. | M | 7, 8, 10 | |

| **SP-2.2** | **System stakeholders shall be able to influence the selection of suitable detours around incidents or events.** | **H** | **10** | **Institutional Job Tasks** |
|---|---|---|---|---|
| SP-2.2.1 | The ICM Core System shall include a function for traffic engineers from stakeholder agencies, in coordination with first responders, to define preferred detours that should be considered as first potential solutions in the identification of suitable detours around incidents or events. | H | 10 | |
| SP-2.2.2 | The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define preferred roadway segments to be used by the ICM Core System if tasked to assemble proposed detours around an incident or event. | L | 10 | |
| SP-2.2.3 | The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define temporary restrictions on the use of specific roadway segments. | H | 10 | |
| SP-2.2.4 | The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define a minimal percentage of control devices (traffic signals, ramp meters, changeable message signs) that should be available along a detour routes for the route to be considered viable. | M | 10 | |
| *SP-2.2.4.1* | *The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define a minimal percentage of traffic signals that should be available along a detour for it to be considered viable.* | M | 10 | |
| *SP-2.2.4.2* | *The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define a minimal percentage of ramps meters that should be available along a detour for it to be considered viable.* | M | 10 | |
| *SP-2.2.4.3* | *The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define a minimal percentage of fixed changeable message signs that should be available along a detour for it to be considered viable.* | M | 10 | |
| *SP-2.2.4.4* | *The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define a minimal percentage of extinguishable trailblazer signs that should be available along a detour for it to be considered viable.* | M | 10 | |
| SP-2.2.5 | The ICM Core System shall include a function for traffic engineers from stakeholder agencies to define the relative importance of the following parameters used to assess the suitability of potential detour routes:<br>• Overall length of detour route<br>• Current average travel time along route<br>• Available spare capacity along route<br>• Percentage of control assets available along route | L | 10 | |
| **SP-2.3** | **System stakeholders shall determine the signalized intersections in their jurisdictions whose traffic signal timing plans may be changed during an incident or event.** | **H** | **7, 8, 10** | **Institutional Job Tasks** |
| SP-2.3.1 | Caltrans traffic engineers shall determine intersections in their jurisdiction, both on detour routes and elsewhere, whose traffic signal timing plans may be changed during an incident or event. | H | 7, 8, 10 | |
| SP-2.3.2 | Los Angeles County traffic engineers shall determine intersections in their jurisdiction, both on detour routes and elsewhere, whose traffic signal timing plans may be changed during an incident or event. | H | 7, 8, 10 | |

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| SP-2.3.3 | Pasadena traffic engineers shall determine intersections in their jurisdiction, both on detour routes and elsewhere, whose traffic signal timing plans may be changed during an incident or event. | H | 7, 8, 10 | |
| SP-2.3.4 | Arcadia traffic engineers shall determine intersections in their jurisdiction, both on detour routes and elsewhere, whose traffic signal timing plans may be changed during an incident or event. | H | 7, 8, 10 | |
| SP-2.3.5 | Monrovia traffic engineers shall determine intersections in their jurisdiction, both on detour routes and elsewhere, whose traffic signal timing plans may be changed during an incident or event. | H | 7, 8, 10 | |
| SP-2.3.6 | Duarte traffic engineers shall determine intersections in their jurisdiction, both on detour routes and elsewhere, whose traffic signal timing plans may be changed during an incident or event. | H | 7, 8, 10 | |
| **SP-2.4** | **System stakeholders shall determine which freeway ramps shall have their metering rate changed during an incident or event.** | **H** | **7, 8, 10** | **Institutional Job Tasks** |
| SP-2.4.1 | Caltrans traffic engineers shall determine ramp meter locations where rates may be changed during an incident. | H | 7, 8, 10 | |
| SP-2.4.2 | The determination of which ramps should have their metering rate altered during an incident or event shall be done in consultation with traffic engineers from Los Angeles County and the cities of Pasadena, Arcadia, Duarte, Monrovia. | H | 7, 8, 10 | |
| **SP-2.5** | **System stakeholders shall identify or create, maintain, and distribute signal timing plans to be used along corridor arterials during incidents and events.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| SP-2.5.1 | Traffic engineers from individual roadway management agencies shall identify which existing timing plans may be used for responding to incidents and events. | H | 7, 8 ,10 | |
| *SP-2.5.1.1* | *Caltrans traffic engineers shall identify, in consultation with Los Angeles County and local cities, which existing timing plans at Caltrans-operated intersections may be used for responding to incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.1.2* | *Los Angeles County traffic engineers shall identify, in consultation with Caltrans and local cities, which existing timing plans at County-operated intersections may be used for responding to incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.1.3* | *Pasadena traffic engineers shall identify, in consultation with Caltrans, Los Angeles County, and neighboring cities, which existing timing plans at city-operated intersections may be used for responding to incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.1.4* | *Arcadia traffic engineers shall identify, in consultation with Caltrans, Los Angeles County, and neighboring cities, which existing timing plans at city-operated intersections may be used for responding to incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.1.5* | *Monrovia traffic engineers shall identify, in consultation with Caltrans, Los Angeles County, and neighboring cities, which existing timing plans at city-operated intersections maybe used for responding to incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.1.6* | *Duarte traffic engineers shall identify, in consultation with Caltrans, Los Angeles County, and neighboring cities, which existing timing plans at city-operated intersections may be used for responding to incidents and events.* | H | 7, 8 ,10 | |
| SP-2.5.2 | Where needed, traffic engineers from individual roadway management agencies shall create and manage timing plans to be used to respond to specific types of incidents or events. | H | 7, 8 ,10 | |

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| *SP-2.5.2.1* | *Where needed, Caltrans shall create, in consultation with Los Angeles County and adjacent local cities, new timing plans to be used at Caltrans-operated signals during incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.2.2* | *Where needed, Los Angeles County shall create, in consultation with Caltrans and adjacent local cities, new timing plans to be used at county-operated intersections during incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.2.3* | *Where needed, Pasadena shall create, in consultation with Caltrans, Los Angeles County, and Arcadia, new timing plans to be used at city-operated intersections during incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.2.4* | *Where needed, Arcadia shall create, in consultation with Caltrans, Los Angeles County, Pasadena, and Monrovia, new timing plans to be used at city-operated intersections during incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.2.5* | *Where needed, Monrovia shall create, in consultation with Caltrans, Los Angeles County, Arcadia, and Duarte, new timing plans to be used at city-operated intersections during incidents and events.* | H | 7, 8 ,10 | |
| *SP-2.5.2.6* | *Where needed, Duarte shall create, in consultation with Caltrans, Los Angeles County, and Monrovia, new timing plans to be used at city-operated intersections during incidents and events.* | H | 7, 8 ,10 | |
| SP-2.5.3 | Traffic engineers from individual roadway management agencies shall be responsible for loading developed signal timing plans into the controllers of agency-operated traffic signals. | H | 7, 8 ,10 | |
| *SP-2.5.3.1* | *Caltrans traffic engineers shall load timing plans for their jurisdiction onto signal controllers for use during an incident.* | H | 7, 8 ,10 | |
| *SP-2.5.3.2* | *Los Angeles County traffic engineers shall load timing plans for their jurisdiction onto signal controllers for use during an incident* | H | 7, 8 ,10 | |
| *SP-2.5.3.3* | *Pasadena traffic engineers shall load timing plans for their jurisdiction onto signal controllers for use during an incident.* | H | 7, 8 ,10 | |
| *SP-2.5.3.4* | *Arcadia traffic engineers shall load timing plans for their jurisdiction onto signal controllers for use during an incident.* | H | 7, 8 ,10 | |
| *SP-2.5.3.5* | *Monrovia traffic engineers shall load timing plans for their jurisdiction onto signal controllers for use during an incident.* | H | 7, 8 ,10 | |
| *SP-2.5.3.6* | *Duarte traffic engineers shall load timing plans for their jurisdiction onto signal controllers for use during an incident.* | H | 7, 8 ,10 | |
| **SP-2.6** | **System stakeholders shall identify or create, maintain, and distribute ramp metering plans to be used during incidents and events.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| SP-2.6.1 | Caltrans traffic engineers shall create and maintain ramp metering plans, in consultation with Pasadena, Arcadia, Duarte, Monrovia, and LA County traffic engineers. | H | 7, 8 ,10 | |
| SP-2.6.2 | Traffic engineers from Caltrans shall be responsible for loading, if necessary, developed ramp metering plans onto ramp controllers operated on freeway on-ramps and freeway-to-freeway connectors. | H | 7, 8 ,10 | |
| **SP-2.7** | **System stakeholders shall determine messaging equipment that may be used to support the implementation of response plans** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| SP-2.7.1 | Caltrans traffic engineers shall determine messaging equipment available for use during an incident or event (HAR, fixed CMSs, portable CMSs, others). | H | 7, 8 ,10 | |

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| SP-2.7.2 | Los Angeles County traffic engineers shall determine messaging equipment available for use during an incident or event (fixed CMSs, portable CMSs, extinguishable trailblazer signs, others). | H | 7, 8 ,10 | |
| SP-2.7.3 | Pasadena traffic engineers shall determine messaging equipment available for use during an incident or event (fixed CMSs, portable CMSs, extinguishable trailblazer signs, others). | H | 7, 8 ,10 | |
| SP-2.7.4 | Arcadia traffic engineers shall determine messaging equipment available for use during an incident or event (fixed CMSs, portable CMSs, extinguishable trailblazer signs, others). | H | 7, 8 ,10 | |
| SP-2.7.5 | Monrovia traffic engineers shall determine messaging equipment available for use during an incident or event (fixed CMSs, portable CMSs, extinguishable trailblazer signs, others). | H | 7, 8 ,10 | |
| SP-2.7.6 | Duarte traffic engineers shall determine messaging equipment available for use during an incident or event (fixed CMSs, portable CMSs, extinguishable trailblazer signs, others). | H | 7, 8 ,10 | |
| **SP-2.8** | **System stakeholders shall determine equipment (vehicles and other portables) that may be used to support the implementation of response plans** | **M** | **7, 8, 10** | **Institutional Job Tasks** |
| *SP-2.8.1* | Pasadena traffic engineers shall determine what vehicles are available for use to implement a response to an incident or event. | M | 7, 8, 10 | |
| *SP-2.8.2* | Arcadia traffic engineers shall determine what vehicles are available for use to implement a response to an incident or event. | M | 7, 8, 10 | |
| *SP-2.8.3* | Los Angeles County traffic engineers shall determine what vehicles are available for use to implement a response to an incident or event. | M | 7, 8, 10 | |
| *SP-2.8.4* | Monrovia traffic engineers shall determine what vehicles are available for use to implement a response to an incident or event. | M | 7, 8, 10 | |
| *SP-2.8.5* | Duarte traffic engineers shall determine what vehicles are available for use to implement a response to an incident or event. | M | 7, 8, 10 | |
| *SP-2.8.6* | Caltrans traffic engineers shall determine what vehicles are available for use to implement a response to an incident or event. | M | 7, 8, 10 | |
| **SP-2.9** | **System stakeholders shall determine personnel available for deployment during an incident or event.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| SP-2.9.1 | Caltrans traffic engineers shall determine personnel available for deployment during an incident or event. | H | 7, 8 ,10 | |
| SP-2.9.2 | Los Angeles County traffic engineers shall determine personnel available for deployment during an incident or event. | H | 7, 8 ,10 | |
| SP-2.9.3 | Pasadena traffic engineers shall determine personnel available for deployment during an incident or event. | H | 7, 8 ,10 | |
| SP-2.9.4 | Arcadia traffic engineers shall determine personnel available for deployment during an incident or event. | H | 7, 8 ,10 | |
| SP-2.9.5 | Monrovia traffic engineers shall determine personnel available for deployment during an incident or event. | H | 7, 8 ,10 | |
| SP-2.9.6 | Duarte traffic engineers shall determine personnel available for deployment during an incident or event. | H | 7, 8 ,10 | |
| SP-2.9.7 | California Highway Patrol managing officers shall determine personnel available for deployment during an incident or event. | M | 7, 8 ,10 | |
| SP-2.9.8 | Los Angeles County Sherriff's office shall determine first responders available for deployment during an incident or event. | M | 7, 8 ,10 | |
| SP-2.9.9 | Pasadena first responders shall determine individuals available for deployment during an incident or event. | M | 7, 8 ,10 | |
| SP-2.9.10 | Arcadia first responders shall determine individuals available for deployment during an incident or event. | M | 7, 8 ,10 | |

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| SP-2.9.11 | Monrovia first responders shall determine individuals available for deployment during an incident or event. | M | 7, 8 ,10 | |
| SP-2.9.12 | Duarte first responders shall determine individuals available for deployment during an incident or event. | M | 7, 8 ,10 | |
| **SP-2.10** | **System stakeholders shall determine typical information to be sent to agency personnel when responding to an incident or event.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| SP-2.10.1 | Caltrans traffic engineers shall determine information to be sent to Caltrans personnel. | H | 7, 8 ,10 | |
| SP-2.10.2 | Los Angeles County traffic engineers shall determine information to be sent to LA County personnel. | H | 7, 8 ,10 | |
| SP-2.10.3 | Arcadia traffic engineers shall determine information to be sent to Arcadia personnel. | H | 7, 8 ,10 | |
| SP-2.10.4 | Pasadena traffic engineers shall determine information to be sent to Pasadena personnel. | H | 7, 8 ,10 | |
| SP-2.10.5 | Monrovia traffic engineers shall determine information to be sent to Monrovia personnel. | H | 7, 8 ,10 | |
| SP-2.10.6 | Duarte traffic engineers shall determine information to be sent to Duarte personnel. | H | 7, 8 ,10 | |
| SP-2.10.7 | Metro Rail field supervisors shall determine, if needed, information to be sent to Metro Rail personnel during an incident or event. | M | 7, 8 ,10 | |
| SP-2.10.8 | Metro Bus Transit field supervisors shall determine, if needed, information to be sent to Metro Bus personnel during an incident or event. | M | 7, 8 ,10 | |
| SP-2.10.9 | Foothill Transit field supervisors shall determine, if needed, information to be sent to Foothill Transit personnel during an incident or event. | M | 7, 8 ,10 | |
| SP-2.10.10 | Pasadena Transit field supervisors shall determine, if needed, information to be sent to Pasadena Transit personnel during an incident or event. | M | 7, 8 ,10 | |
| SP-2.10.11 | California Highway Patrol managing officers shall determine information to be sent to California Highway Patrol personnel. | M | 7, 8 ,10 | |
| SP-2.10.12 | Los Angeles County Sherriff's office shall determine information to be sent to Sheriff's personnel. | M | 7, 8 ,10 | |
| SP-2.10.13 | Pasadena first responders shall determine information to be sent to Pasadena first responders. | M | 7, 8 ,10 | |
| SP-2.10.14 | Arcadia first responders shall determine information to be sent to Arcadia first responders. | M | 7, 8 ,10 | |
| SP-2.10.15 | Monrovia first responders shall determine information to be sent to Monrovia first responders. | M | 7, 8 ,10 | |
| SP-2.10.16 | Duarte first responders shall determine information to be sent to Duarte first responders. | M | 7, 8 ,10 | |
| **SP-2.11** | **System stakeholders shall determine messages to be posted on fixed and/or portable CMS devices when responding to an incident or event.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| SP-2.11.1 | Caltrans traffic engineers shall determine information to be displayed on Caltrans fixed and portable CMS devices. | H | 7, 8 ,10 | |
| SP-2.11.2 | Los Angeles County traffic engineers shall determine information to be displayed on County fixed and portable CMS devices, if any. | H | 7, 8 ,10 | |
| SP-2.11.3 | Pasadena traffic engineers shall determine information to be displayed on Pasadena fixed and portable CMS devices, if any. | H | 7, 8 ,10 | |
| SP-2.11.4 | Arcadia traffic engineers shall determine information to be displayed on Arcadia fixed and portable CMS devices, if any. | H | 7, 8 ,10 | |

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| SP-2.11.5 | Monrovia traffic engineers shall determine information to be displayed on Monrovia fixed and portable CMS devices, if any. | H | 7, 8 ,10 | |
| SP-2.11.6 | Duarte traffic engineers shall determine information to be displayed on Duarte fixed and portable CMS devices, if any. | H | 7, 8 ,10 | |
| **SP-2.12** | **The Corridor Manager, in consultation with all relevant stakeholders, shall determine the information to be sent to 511 services.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| **SP-2.13** | **The Corridor Manager, in consultation with all relevant stakeholders, shall determine the information to be sent to HAR stations used as part of response plans.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| **SP-2.14** | **The Corridor Manager, in consultation with all relevant stakeholders, shall determine the information to be sent to third-party providers.** | **H** | **7, 8 ,10** | **Institutional Job Tasks** |
| **SP-2.15** | **The ICM Core System shall include a function for stakeholders to specify predefined response plans, i.e., specific sets of response actions that may be considered as responses to an incident or event.** | **H** | **7, 8 ,10** | **Corridor Managemt** |

### 9.3.3. INCIDENT RESPONSE TESTING CAPABILITIES

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-3.1** | **The ICM Core System shall include a function for traffic engineers to create mock incidents.** | **H** | **6** | **Corridor Managemt** |
| **SP-3.2** | **The ICM Core System shall include functionality permitting mock incidents to be used to test the effectiveness of created or proposed response plans.** | **H** | **6** | **Corridor Managemt** |
| SP-3.2.2 | The ICM Core System shall allow user-created mock incidents to be submitted as real incidents for testing purposes. | H | 6 | |
| SP-3.2.3 | Upon receiving a mock incident, the ICM Core System shall perform Real-Time Incident Planning and generate response plans addressing the mock incident as if it were a real incident. | H | 6 | |
| SP-3.2.4 | Upon receiving a mock incident, the ICM Core System shall identify a recommended response plan as if the mock incident were a real incident | H | 6 | |
| SP-3.2.5 | Upon receiving a mock incident, the Implementation Function shall recognize that a response plan is being generated for a mock incident and stop response activities at the identification of required field control actions. No field commands are to be issued. | H | 6 | |
| SP-3.2.6 | Upon the execution of a mock incident, the ICM Core System shall store information permitting the generation of a post-incident report. | H | 6 | |

### 9.3.4. RULE CREATION AND MANAGEMENT

#### *9.3.4.1. Decision Support Rules*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-4.1** | **The ICM Core System shall include a function for users to define rules to be used in the development, evaluation, selection, and implementation of response plans** | **H** | **4,8,10,16** | **Corridor Managemt** |

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| SP-4.1.1 | Decision Support shall include a function for users to define single-condition rules. | H | 4,8,10,16 | |
| SP-4.1.2 | Decision Support shall include a function for users to define multiple-condition rules. | H | 4,8,10,16 | |
| SP-4.1.3 | Decision Support shall include a function for users to define single-action rules. | H | 4,8,10,16 | |
| SP-4.1.4 | Decision Support shall include a function for users to define multiple-action rules. | H | 4,8,10,16 | |
| SP-4.1.5 | Decision Support shall include a function for users to define decision tree-based rules. | H | 4,8,10,16 | |
| SP-4.1.6 | Decision Support shall include a function for users to define dependencies and relationships between rules. | H | 4,8,10,16 | |
| SP-4.1.7 | Decision Support shall provide a means for users to input rules into the system. | H | 4,10,16 | |
| SP-4.1.8 | Decision Support shall provide a means for users to edit rules in the system. | H | 4,10,16 | |
| SP-4.1.9 | Decision Support rules engine shall allow for multiple unbound rule arguments – variable conditions and responses | H | 4,8,10,16 | |
| SP-4.1.10 | Decision Support rules engine shall include a function for users to specify rule groups and rules priority to determine rules execution order | H | 4,8,10,16 | |
| SP-4.1.11 | Decision Support rules engine shall include a function for external process execution and results to be included within a rule. | H | 4,8,10,16 | |
| **SP-4.2** | **Rules for determining the existence of an incident shall be defined and maintained.** | **M** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.2.1 | Rules for determining the existence of an incident shall be developed by traffic engineers from stakeholder agencies involved in the implementation of response plans. | M | 4, 8, 10 | |
| SP-4.2.2 | Rules for determining the existence of an incident shall consider current traffic conditions. | M | 4, 8, 10 | |
| SP-4.2.3 | Rules for determining the existence of an incident shall consider historical patterns. | M | 4, 8, 10 | |
| SP-4.2.4 | Rules for determining the existence of an incident shall be based on average estimated traffic conditions over a user-defined interval. | M | 4, 8, 10 | |
| SP-4.2.5 | Rules for determining the existence of an incident shall be accepted by Caltrans ATMS operators and stakeholder traffic engineers before being used in production. | M | 4, 8, 10 | |
| **SP-4.3** | **Rules for determining the severity of an incident shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.3.1 | Rules for determining the severity of an incident shall be defined by Traffic Engineers or other operational personnel from stakeholder agencies having adequate knowledge of corridor operations and incident response processes. | H | 4, 8, 10 | |
| SP-4.3.2 | Rules for determining the severity of an incident shall consider current traffic conditions. | H | 4, 8, 10 | |
| SP-4.3.3 | Rules for determining the severity of an incident shall consider, where feasible, predictions of traffic conditions with the incident. | H | 4, 8, 10 | |
| **SP-4.4** | **Rules for determining the zone of influence of an incident or event shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.4.1 | Rules for determining the zone of influence of an incident shall be defined by traffic engineers from stakeholder agencies involved in the implementation of response plans. | H | 4, 8, 10 | |

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| SP-4.4.2 | Rules for determining the zone of influence of an incident shall be based on current traffic conditions. | H | 4, 8, 10 | |
| SP-4.4.3 | Rules for determining the zone of influence of an incident shall consider, where feasible, predictions of traffic conditions with the incident. | H | 4, 8, 10 | |
| **SP-4.5** | **Rules for assessing the level of impact of an incident or event on corridor operations shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.5.1 | Rules for assessing the level of impact of an incident shall be defined by traffic engineers from stakeholder agencies involved in the implementation of response plans. | H | 4, 8, 10 | |
| SP-4.5.2 | Rules for assessing the level of impact of an incident shall be based on current traffic conditions. | H | 4, 8, 10 | |
| SP-4.5.3 | Rules for assessing the level of impact of an incident shall be based on prediction of traffic conditions. | H | 4, 8, 10 | |
| **SP-4.6** | **Rules for building response plans from a set of possible individual response actions shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.6.1 | Rules for building response plans from a set of possible response actions shall be defined by traffic engineers from stakeholder agencies involved in the implementation of response plans. | H | 4, 8, 10 | |
| SP-4.6.2 | Transit Field Supervisors from stakeholder agencies shall participate in defining or validating rules for building response plans that may potentially affect transit services within the ICM corridor. | H | 4, 8, 10 | |
| SP-4.6.3 | First Responders shall be given the opportunity to comment on proposed rules for building response plans. | H | 4, 8, 10 | |
| SP-4.6.4 | Rules for building response plans shall use incident/event location as a core decision factor. | H | 4, 8, 10 | |
| SP-4.6.5 | Rules for building response plans shall use the expected duration of an incident/event as a core decision factor. | H | 4, 8, 10 | |
| SP-4.6.6 | Rules for building response plans shall use incident/event severity as a core decision factor. | H | 4, 8, 10 | |
| *SP-4.6.6.1* | *The ICM Core System shall include a function for users to specify a maximum number of response plans to be developed based on the severity of the incident or event.* | H | 10 | |
| SP-4.6.7 | Rules for building response plans shall use the projected impact of an incident/event on corridor operations as a core decision factor. | H | 4, 8, 10 | |
| SP-4.6.8 | The ICM Core System shall include a function for users to specify a maximum number of response plans to be developed for each incident or event. | H | 10 | |
| **SP-4.7** | **Rules for handling special management or operational situations shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.7.1 | Rules limiting the use of specific roadway elements based on specific situations shall be defined and maintained. | H | 4, 8, 10 | |
| *SP-4.7.1.1* | *Rules limiting the use of specific roadway elements based on time-of-day restrictions shall be defined and maintained.* | H | 4, 8, 10 | |
| *SP-4.7.1.2* | *Rules limiting the use of specific roadway elements based on day-of-year restrictions shall be defined and maintained.* | H | 4, 8, 10 | |
| *SP-4.7.1.3* | *Rules limiting the use of specific roadway elements based on restrictions defined by local/regional agencies (such as school zones or vehicle restrictions) shall be defined and maintained.* | H | 4, 8, 10 | |
| *SP-4.7.1.4* | *Rules limiting the use of specific roadway elements based on event-related restrictions shall be defined and maintained.* | H | 4, 8, 10 | |
| SP-4.7.2 | Rules limiting the use of specific roadway elements without sufficient capacity shall be defined and maintained. | H | 4, 8, 10 | |

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| SP-4.7.3 | Rules limiting the use of specific roadway elements based on the operational status of traffic management devices on these elements shall be defined and maintained. | H | 4, 8, 10 | |
| *SP-4.7.3.1* | *Rules to limit potential reroutes based on asset capability restrictions shall be defined and maintained.* | H | 4, 8, 10 | |
| *SP-4.7.3.2* | *Rules to limit potential reroutes based on asset state restrictions shall be defined and maintained.* | H | 4, 8, 10 | |
| SP-4.7.4 | Rules for handling special situations shall be defined by traffic engineers from stakeholder agencies. | H | 4, 8, 10 | |
| SP-4.7.5 | Transit Field Supervisors from stakeholder agencies shall participate in defining or validating rules for handling special situations that may affect transit services within the ICM corridor. | H | 4, 8, 10 | |
| SP-4.7.5 | First Responders shall participate in defining rules for handling special situations. | H | 4, 8, 10 | |
| **SP-4.8** | **Rules for selecting a recommended response plan among a set of alternate plans shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.8.1 | Rules for selecting a recommended response plan among a set of alternatives shall be defined by traffic engineers from stakeholder agencies involved in the implementation of response plans. | H | 4, 8, 10 | |
| SP-4.8.2 | Rules for selecting a recommended response plan among a set of alternatives shall use current traffic conditions as a starting point for the evaluation of response alternatives. | H | 4, 8, 10 | |
| SP-4.8.3 | Rules for selecting a recommended response plan among a set of alternatives shall consider the potential effect on near-future corridor operations of each alternative. | H | 4, 8, 10 | |
| SP-4.8.3 | Rules for selecting a recommended response plan among a set of alternatives shall allow system users to select the time horizon to which near-future corridor operations is to be evaluated. | H | 4, 8, 10 | |
| SP-4.8.2 | Rules for selecting a recommended response plan among a set of alternatives shall always consider the current traffic management strategy (“Do Nothing Scenario”) as a viable alternative. | H | 4, 8, 10 | |
| SP-4.8.2 | Rules for selecting a recommended response plan among a set of alternatives shall evaluate alternatives against the current traffic management strategy (“Do Nothing Scenario”). | H | 4, 8, 10 | |
| SP-4.8.3 | Rules for selecting a recommended response plan among a set of alternatives shall allow users to specify the performance metrics to be used for the comparative evaluation of response plans | H | 4, 8, 10 | |
| *SP-4.8.3.1* | *System users shall be allowed to select change in incurred delays as an evaluation criterion.* | H | 4, 8, 10 | |
| *SP-4.8.3.2* | *System users shall be allowed to select change in throughput as an evaluation criterion.* | H | 4, 8, 10 | |
| *SP-4.8.3.3* | *System users shall be allowed to specify whether evaluations shall consider person-based or vehicle-based metrics.* | H | 4, 8, 10 | |
| *SP-4.8.3.4* | *Rules for selecting a recommended response plan shall allow users to specify the relative weight between the various selected evaluation criteria.* | H | 4, 8, 10 | |
| *SP-4.8.3.5* | *System users shall be able to specify weights to be applied to forecasted metrics pertaining to different intervals into the future (for instance, applying lower weights to metrics focusing on corridor conditions 45 minutes into the future than metrics focusing on conditions 15 minutes into the future).* | H | 4, 8, 10 | |

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| SP-4.8.4 | Rules for selecting a recommended response plan among a set of alternatives shall determine the corridor area over which performance metrics are to be compiled based on the location, severity, and projected impact of an incident or event. | H | 4, 8, 10 | |
| SP-4.8.5 | Rules for selecting a recommended response plan among a set of alternatives shall allow users to set minimum impact thresholds for a proposed response plan to be considered for potential implementation. | H | 4, 8, 10 | |
| **SP-4.9** | **Rules for sending response plan instructions to corridor assets shall be defined and maintained.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.9.1 | Rules for converting an approved response plan into a schedule of field commands shall be developed and maintained. | M | 4, 8, 10 | |
| SP-4.9.2 | TMC and TCS operators shall be able to specify the level of automation desired for the termination of response activities. | H | 8, 9, 10 | |
| *SP-4.9.2.1* | *The ICM Environment shall provide a means for individual stakeholder agencies to specify whether active response plans involving agency assets can be automatically terminated by the ICM Core System.* | H | 8, 9, 10 | |
| *SP-4.9.2.2* | *The ICM Environment shall provide a means for stakeholder agencies to define periods during which manual approval is required and periods during which automated approval is possible.* | H | 8, 9, 10 | |
| SP-4.9.3 | Rules for returning affected corridor assets to normal operations following the termination of a response shall be developed and maintained. | M | 4, 8, 10 | |
| *SP-4.9.3.1* | *The ICM Core System shall include a function for users to define the thresholds or criteria to be used to determine when corridor travel conditions are assumed to have returned to a normal or near-normal situation for the given day of week and time of day.* | M | 1, 4 | |
| SP-4.9.4 | Rules for sending response plan instructions to corridor assets shall be defined by traffic engineers from stakeholder agencies. | H | 4, 8, 10 | |
| SP-4.9.5 | Rules for sending response plan instructions to corridor assets shall be based on current traffic conditions. | H | 4, 8, 10 | |
| SP-4.9.6 | Rules for sending response plan instructions to corridor assets may be based on prediction of traffic conditions. | H | 4, 8, 10 | |
| **SP-4.10** | **Rules for determining agency personnel who should be notified of a response planning action shall be defined and maintained** | **H** | **4, 8, 10** | **Corridor Managemt** |
| SP-4.10.1 | Rules for determining agency personnel who should be notified of a response planning action shall be defined by traffic engineers from stakeholder agencies. | H | 4, 8, 10 | |
| **SP-4.11** | **The ICM Core System shall include a function for Traffic Engineers to specify the conditions under which the implementation of an approved response plan can be canceled.** | **L** | **10** | **Corridor Managemt** |
| **SP-4.12** | **System users shall specify the level of automation required for the approval of submitted modifications to active response plans.** | **L** | **8, 9, 10** | **Corridor Managemt** |
| SP-4.12.1 | The ICM Core System shall include a function for authorized users from each agency to specify whether proposed changes submitted to an active response plan shall require manual approval from all agencies involved in the plan or whether they can be approved automatically. | L | 8, 9, 10 | |
| SP-4.12.2 | The ICM Core System shall include a function for authorized users to define periods during which manual approval of proposed changes to response plans is required and periods during which automated approval is possible. | L | 8, 9, 10 | |

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| SP-4.12.3 | The ICM Core System shall include a function for system users to customize manual/automated approval setup based on the type of control action requested. | L | 8, 9, 10 | |
| **SP-4.13** | **Decision Support shall provide a means for users to group and categorize rules.** | **M** | **12** | **Corridor Managemt** |

*9.3.4.2. Rules Testing and Evaluation*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-4.11** | **Proposed modification to existing rules shall be validated over a user-defined period prior to being introduced into the production system.** | **M** | **4, 8, 10** | **Corridor Managemt** |
| **SP-4.12** | **The ICM Core System shall provide an environment allowing proposed new rules or rule modifications to be tested and validated prior to their implementation.** | **H** | **4, 8, 10, 16** | **Corridor Managemt** |
| **SP-4.13** | **The ICM Core System shall conduct a rules test, exercising the rules using test data on a regular basis and providing a pass/fail check for the results of each rule execution.** | **H** | **16** | **Corridor Managemt** |
| SP-4.13.1 | The ICM Core System shall have a set of test facts with known desired outcomes for specific tasks. | H | 16 | |
| SP-4.13.2 | The ICM Core System shall execute a test with the test facts and with the current rule set on a user-determined schedule that shall verify the outcome of the rule set execution. | H | 16 | |
| SP-4.13.3 | The ICM Core System shall provide a pass/fail report indicating each test that passed and each test that failed. | H | 16 | |
| SP-4.13.4 | The ICM Core System shall include in the pass/fail report the specific facts and rules involved in each failed test execution. | H | 16 | |
| **SP-4.14** | **The Corridor Technical Manager shall conduct weekly and quarterly evaluations of the rules and their execution.** | **M** | **16** | **Institutional Job Tasks** |

*9.3.4.3. Rule Documenting and Archiving*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-4.15** | **The ICM Core System shall provide a means for users to archive rules within the system.** | **H** | **10,11,15, 16** | **Corridor Managemt** |
| **SP-4.16** | **All developed rules shall be stored in a format usable by the DSS rules engine.** | **H** | **4, 8, 10** | **Data Hub** |
| **SP-4.17** | **The ICM Core System shall utilize a configuration management system to manage rules.** | **M** | **15,16** | **Corridor Managemt** |

### 9.3.5. POST-INCIDENT/EVENT ANALYSES

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-5.1** | **The Corridor Manager shall conduct a post-incident analysis review with all affected agencies within one week of each significant event** | **H** | **6** | **Institutional Job Tasks** |

### 9.3.6. QUARTERLY OPERATIONAL REVIEWS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SP-6.1** | **The Corridor Manager shall conduct a quarterly review of the operational effectiveness of the ICM Environment.** | **H** | **6** | **Institutional Job Tasks** |
| **SP-6.2** | **As part of the quarterly effectiveness evaluation, the Corridor Manager shall assign a score to the observed effectiveness of response planning activities.** | **M** | **6** | **Institutional Job Tasks** |
| SP-6.2.1 | The Corridor Manager shall score corridor performance based on the observed corridor improvements over time | M | 6 | |
| SP-6.2.1.1 | *The Corridor Manager shall score corridor performance based on the ability of implemented response plans to reduce delay incurred by travelers within the corridor on a quarter-to-quarter basis* | M | 6 | |
| SP-6.2.1.2 | *The Corridor Manager shall score corridor performance based on the ability of implemented response plans to reduce delay incurred by travelers within the corridor on a year-to-year basis* | M | 6 | |
| SP-6.2.2 | The Corridor Manager shall score the performance of the Decision Support module based on its ability to select plans that improve corridor response to incidents and events. | M | 6 | |
| SP-6.2.2.1 | *For cases in which no action was taken, Decision Support evaluation shall be based on a comparison of actual corridor performance against the forecasted corridor performance under the existing traffic management plan.* | M | 6 | |
| SP-6.2.2.2 | *For cases in which a response plan was implemented, Decision Support evaluation shall be based on a comparison of actual corridor performance against the forecasted corridor performance had no plan been implemented.* | M | 6 | |
| SP-6.2.2.3 | *Decision Support evaluation shall be based on an aggregated assessment of incidents and events occurring during a quarter* | M | 6 | |
| SP-6.2.3 | System performance is to be scored on a scale of 1 to 10, with the following template:<br>• Score < 5 – Deterioration in corridor performance<br>• Score = 5 – No improvement or deterioration<br>• Score > 5 – Improvement in corridor performance | M | 6 | |
| SP-6.2.4 | The Corridor Manager shall support each published score evaluation with adequate field data. | M | 6 | |
| **SP-6.3** | **The Corridor Manager shall use results from quarterly operational assessments of decision support operations to influence corridor planning decisions.** | **H** | **4, 5, 6, 7, 10** | **Institutional Job Tasks** |
| SP-6.3.1 | The quarterly decision support operational analysis report shall be used to influence corridor planning. | H | 4, 5, 6, 7, 10 | |
| SP-6.3.2 | The quarterly decision support operational analysis report shall be used to create a list of potential corridor improvements, with impact, cost, and success probability assessments to assist in corridor planning. | H | 4, 5, 6, 7, 10 | |

## 9.4. REAL-TIME INCIDENT/EVENT MONITORING

This section details the requirements associated with the need to identify, characterize, and track incidents and events occurring within the corridor.

### 9.4.1. INCIDENT/EVENT IDENTIFICATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IM-1.1.5** | **The ICM Core System shall maintain a list of active incidents and events affecting corridor operations.** | **H** | **1, 4** | **Data Hub/DSS** |
| **IM-1.1** | **The ICM Core System shall be aware of when traffic incidents occur on corridor roadways of interest.** | **H** | **1, 4** | **Data Hub/DSS** |
| IM-1.1.1 | Law enforcement agencies shall inform the ICM Core System about new active incidents as soon as the incidents have been verified. ***Note:*** *The system shall be able to operate without this requirement being met.* | M | 1,4 | |
| IM-1.1.2 | The ICM Core System shall receive from first responding agencies information about active incidents or events affecting corridor operations being managed by these agencies. ***Note:*** *The system shall be able to operate without these requirements being met.* | M | 1, 4 | |
| IM-1.1.2.1 | *The ICM Core System shall receive from the California Highway Patrol information about major active incidents on the ICM corridor being managed by the agency.* | H | 1, 4 | |
| IM-1.1.2.2 | *The ICM Core System shall receive from the Los Angeles County Sheriff's Department information about major active incidents on main corridor arterials in Duarte.* | H | 1, 4 | |
| IM-1.1.2.3 | *The ICM Core System shall receive from the Pasadena Police Department information about major active incidents on main corridor arterials being managed by the agency.* | H | 1, 4 | |
| IM-1.1.2.4 | *The ICM Core System shall receive from the Arcadia Police Department information about major active incidents on main corridor arterials being managed by the agency.* | H | 1, 4 | |
| IM-1.1.2.5 | *The ICM Core System shall receive from the Monrovia Police Department information about major active incidents on main corridor arterials being managed by the agency.* | H | 1, 4 | |
| IM-1.1.2.6 | *The Verdugo Fire Communications dispatch system shall send to the ICM Core System information about fire incidents expected to significantly affect roadway operations within the ICM corridor being managed by the agency.* | H | 1, 4 | |
| IM-1.1.2.7 | *The ICM Core System shall receive from LA SAFE information about incidents being responded to by the agency.* | L | 1, 4 | |
| IM-1.1.3 | The ICM Core System shall retrieve incidents reported by travelers on social media applications. | M | 1, 4 | |
| IM-1.1.4 | The ICM Core System shall include a function for system users to manually define new traffic incidents that should be considered by the response planning activities. | H | 1, 4 | |
| **IM-1.2** | **The ICM Core System shall be aware of major transit incidents occurring within the corridor** | **M** | **1, 4** | **Data Hub/DSS** |

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|---|---|---|---|---|
| IM-1.2.1 | The ICM Core System shall monitor for transit service disruptions or interruptions that have the potential to increase traffic demand on corridor roadways of interest or affect the development or implementation of response plans. | M | 1, 4 | |
| *IM-1.2.1.1* | *The ICM Core System shall flag service interruptions reported by Metro Rail along the Gold Line.* | M | 1, 4 | |
| *IM-1.2.1.2* | *The ICM Core System shall flag service disruptions reported by Metro Bus on relevant commuter and express routes.* | M | 1, 4 | |
| *IM-1.2.1.3* | *The ICM Core System shall flag significant service disruptions reported by Foothill Transit on relevant commuter and express routes.* | M | 1, 4 | |
| *IM-1.2.1.4* | *The ICM Core System shall flag significant service disruptions reported by Pasadena Transit of transit routes of interest.* | M | 1, 4 | |
| IM-1.2.2 | The ICM Core System shall include a function for users to manually define new transit incidents that should be considered by the response planning activities. | M | 1, 4 | |
| *IM-1.2.2.1* | *Transit Field Supervisors shall enter into the ICM Core System information about transit incidents or service disruptions.* | M | 1, 4 | |
| **IM-1.3** | **The ICM Core System shall be aware of when scheduled events may affect corridor operations.** | **H** | **1, 4** | **Data Hub/DSS** |
| IM-1.3.1 | The ICM Core System shall maintain a list of major scheduled events expected to have a significant impact on corridor operations. | H | 1, 4 | |
| IM-1.3.2 | The ICM Core System shall extract information about scheduled events from information systems used by stakeholder agencies | H | 1, 4 | |
| *IM-1.3.2.1* | *The ICM Core System shall extract from the Caltrans Lane Closure System (LCS) information about planned roadway closures that may affect corridor operations* | H | 1, 4 | |
| *IM-1.3.2.2* | *The ICM Core System shall extract from the Los Angeles County Lane Closure Website information about planned roadway closures that may affect corridor operations* | H | 1, 4 | |
| IM-1.3.3 | The ICM Core System shall accept information about planned lane/roadway closures manually entered into the system by system users | H | 1, 4 | |
| IM-1.3.4 | The ICM Core System shall include a function for users to manually define new events that should be considered by the response planning activities. | H | 1, 4 | |
| *IM-1.3.4.1* | *Stakeholders shall enter into the ICM Core System information about scheduled events or planned lane or roadway closures.* | H | 1, 4 | |
| **IM-1.4** | **The ICM Core System shall be aware of when major weather events may affect travel conditions within the corridor.** | **L** | **1, 4** | **Data Hub/DSS** |
| IM-1.4.1 | The ICM Core System shall monitor weather bulletins issued by weather information services for weather events that can significantly affect road and travel conditions within the corridor, such as dense fog, heavy rain, or icy roads. | L | 1, 4 | |
| IM-1.4.1 | The ICM Core System shall treat as planned events forecasted weather events for which alerts have existed for at least 24 hours. | L | 1, 4 | |
| IM-1.4.1 | The ICM Core System shall treat as unplanned events unexpected weather events affecting travel conditions within the corridor or events that have been forecasted for less than 24 hours. | L | 1, 4 | |
| **IM-1.5** | **The ICM Core System shall determine when unusual traffic conditions exist within the corridor.** | **H** | **1, 4** | **Decision Support** |
| IM-1.5.1 | The ICM Core System shall use comparisons with historical average traffic conditions to determine whether unusual conditions may exist within the corridor. | H | 1, 4 | |

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| IM-1.5.2 | The ICM Core System shall monitor traffic congestion reported on social media applications (Waze, etc.) by travelers. | L | 1, 4 | |
| **IM-1.6** | **The ICM Core System shall alert relevant TMC or TCS operators when unusual traffic volumes or speeds are detected.** | **H** | **4, 13** | **Corridor Managemt** |
| IM-1.6.1 | The ICM Core System shall alert Traffic Engineers at the Caltrans TMC when traffic volumes or speeds that do not match historical patterns are detected on freeways within the corridor. | H | 4, 13 | |
| IM-1.6.2 | The ICM Core System shall alert the Traffic Engineer on duty at the Los Angeles County TMC when traffic conditions that do not match historical patterns are detected on arterials managed by the agency. | H | 4, 13 | |
| IM-1.6.3 | The ICM Core System shall alert the Traffic Engineer on duty at the Pasadena TMC when traffic conditions that do not match historical patterns are detected on arterials managed by the agency. | H | 4, 13 | |
| IM-1.6.4 | The ICM Core System shall alert the Traffic Engineer on duty at the Arcadia TMC when traffic conditions that do not match historical patterns are detected on arterials managed by the agency. | H | 4, 13 | |
| IM-1.6.5 | The ICM Core System shall alert the Traffic Engineer on duty at the City of Monrovia when traffic conditions that do not match historical patterns are detected on arterials managed by the agency. | H | 4, 13 | |
| IM-1.6.6 | The ICM Core System shall alert the Traffic Engineer on duty at the City of Duarte when traffic conditions that do not match historical patterns are detected on arterials managed by the agency. | H | 4, 13 | |
| IM-1.6.7 | The ICM Core System shall display upon request the traffic alerts that have been generated for all roadways within the I-210 ICM corridor. | H | 4, 13 | |
| **IM-1.7** | **The ICM Core System shall have rules and parameters for incident detection that can be adjusted ("fine-tuned") to minimize false alerts and effectively deliver useful warnings to the operator.** | **H** | **4, 13** | **Corridor Managemt** |
| **IM-1.8** | **The ICM Core System shall ensure that duplicate incidents or events are not created when processing data from various sources.** | **M** | **1, 4, 13** | **DSS/Data Hub** |
| IM-1.8.1 | The ICM Core System shall verify that each newly identified incident or event has not already been defined. | M | 1, 4, 13 | |
| IM-1.8.2 | The ICM Core System shall merge into a single item duplicate incident or event definitions. | L | 1, 4, 13 | |

### 9.4.2. INCIDENT/EVENT VERIFICATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IM-2.1** | **All incidents shall be verified before initiating response planning.** | **H** | **1** | **Decision Support** |
| IM-2.1.1 | The ICM Core System shall only develop response plans for incidents that have been verified to exist. | H | 1 | |
| IM-2.1.2 | The ICM Core System shall only develop response plans for scheduled events that have been verified to occur as planned. | H | 1 | |
| **IM-2.3** | **The ICM Core System shall remove from consideration any identified incident or event that has not been verified within a reasonable amount of time.** | **H** | **1** | **Decision Support** |
| IM-2.3.1 | The ICM Core System shall automatically remove from consideration incidents and events that have not been verified within a prescribed threshold. | H | 1 | |
| IM-2.3.3 | The ICM Core System shall log for future review all unverified incidents and events that have been removed from consideration. | M | 1 | |

### 9.4.3. INCIDENT/EVENT CHARACTERIZATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IM-3.1** | **The ICM Core System shall obtain or be provided with information allowing it to assess the impact of an incident or event on corridor operations.** | **H** | **1, 4** | **Decision Support** |
| IM-3.1.1 | Following the verification of an active incident, the ICM Core System shall use the following information to assess the impact of the incident.<br>• Type of incident<br>• Time incident occurred<br>• Expected duration of incident<br>• Roadway segment on which incident is located<br>• Location of incident along roadway segment<br>• Lane(s) affected by the incident<br>• Agency responsible for managing the incident | H | 1, 4 | |
| IM-3.1.2 | Following the verification of an active incident, the ICM Core System shall use the following information to assess the impact of the event.<br>• Type of event<br>• Location of event<br>• Time event started<br>• Expected duration of event<br>• Roadway segment(s) affected by the event<br>• Traffic lanes affected by the event on each affected roadway segment<br>• Agency response for managing traffic event | H | 1, 4 | |
| IM-3.1.3 | Wherever possible, the ICM Core System shall attempt to gather and store incident or event characteristics in advance from available data feeds. | H | 1, 4 | |
| **IM-3.4** | **The ICM Core System shall not develop response plans for incidents or events for which critical information is missing.** | **H** | **1, 4** | **Decision Support** |
| IM-3.4.1 | The ICM Core System shall not develop a response plan for an incident or event that has not been located on a specific roadway segment. | H | 1, 4 | |
| IM-3.4.1 | The ICM Core System shall not develop a response plan for an incident or event for which there is no information about the number of lanes closed on the affected roadway. | H | 1, 4 | |
| IM-3.4.2 | The ICM Core System shall not develop a response plan for an incident or event for which an expected duration has not been provided. | H | 1, 4 | |
| **IM-3.5** | **The ICM Core System shall log for future review any non-verified incident or event that has been removed from consideration.** | **M** | **1, 4** | **Decision Support** |

### 9.4.4. INCIDENT/EVENT INFORMATION DISSEMINATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IM-4.1** | **The ICM Core System shall notify the system's Real-Time Response Planning function of any new active incident, unscheduled event, or planned event occurring within the ICM corridor.** | **H** | **4** | **Corridor Managemt** |

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| **IM-4.2** | **The ICM Core System shall include functionality to inform stakeholders, travelers, and industry partners of incidents and events.** | **H** | **13** | **Corridor Managemt** |
| **IM-4.3** | **The ICM Core System shall notify TMC/TCS operators of active incidents and events affecting travel conditions with the ICM corridor.** | **H** | **13** | **Corridor Managemt** |
| IM-4.3.1 | The ICM Core System shall notify the designated TMC/TCS operator of all roadway management agencies within the ICM corridor of major incidents and events occurring within the corridor. | H | 13 | |
| IM-4.3.2 | The ICM Core System shall notify relevant TMC/TCS operators of minor/medium incidents or unscheduled events expected to have only a local impact on corridor operations. This includes operators from all agencies within the zone of influence of an incident or event, as well as operators from agencies that may be affected by the implementation of a detour around the incident or event. | H | 13 | |
| IM-4.3.3 | The ICM Core System shall notify the designated TMC/TCS operator of all roadway management agencies of all major planned events scheduled to occur within the next 24 hours. | H | 13 | |
| IM-4.3.4 | The ICM Core System shall notify relevant TMC/TCS operators of planned events expected to have a minor or moderate impact on corridor operations. This includes operators from all agencies within the zone of influence of the event and operators from agencies that may be affected by the implementation of a detour around the event. | H | 13 | |
| **IM-4.4** | **The ICM Core System shall inform first responders of active incidents and events affecting travel conditions with the corridor.** | **H** | **13** | **Corridor Managemt** |
| IM-4.4.1 | The ICM Core System shall inform Caltrans' Traffic Management Team of freeway incidents and corridor events that may require its deployment. | H | 13 | |
| IM-4.4.2 | The ICM Core System shall inform LA SAFE of identified freeway incidents. | H | 13 | |
| IM-4.4.3 | The ICM Core System shall inform the CHP of identified freeway incidents and major arterial incidents that may affect freeway operations. | H | 13 | |
| IM-4.4.4 | The ICM Core System shall inform local first responding agencies of incidents and events that may affect travel conditions within their jurisdiction. | H | 13 | |
| *IM-4.4.4.1* | *The ICM Core System shall inform the Los Angeles County Sheriff's Department of incidents and events expected to affect roadways managed by the City of Duarte.* | H | 13 | |
| *IM-4.4.4.2* | *The ICM Core System shall inform the Pasadena Police Department of incidents and events expected to affect roadways managed by the City of Pasadena.* | H | 13 | |
| *IM-4.4.4.3* | *The ICM Core System shall inform the Arcadia Police Department of incidents and incidents expected to affect roadways managed by the City of Arcadia.* | H | 13 | |
| *IM-4.4.4.4* | *The ICM Core System shall inform the City of Monrovia Public Safety Manager of incidents and events expected to affect roadways managed by the city.* | H | 13 | |
| *IM-4.4.4.5* | *The ICM Core System shall inform the City of Duarte Public Safety Officer of incidents and events expected to affect roadways managed by the city.* | H | 13 | |
| *IM-4.4.4.6* | *The ICM Core System shall inform Verdugo Fire Communication dispatchers of incidents and events expected to affect roadways within the ICM corridor* | H | 13 | |

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|---|---|---|---|---|
| *IM-4.4.4.7* | *The Corridor Management Subsystem shall inform the Los Angeles County Sheriff's Department of corridor incidents and events expected to affect roadways managed by Los Angeles County.* | H | 13 | |
| **IM-4.5** | **The ICM Core System shall inform transit field supervisors of active incidents and events affecting travel conditions with the corridor.** | **H** | **13** | **Corridor Managemt** |
| IM-4.5.1 | The ICM Core System shall alert Metro Rail field supervisors about incidents/events affecting travel conditions within the I-210 corridor. | H | 13 | |
| IM-4.5.2 | The ICM Core System shall alert Metro Bus field supervisors about incidents/events affecting travel conditions within the I-210 corridor. | H | 13 | |
| IM-4.5.3 | The ICM Core System shall alert Foothill Transit field supervisors about incidents/events affecting travel conditions within the I-210 corridor. | H | 13 | |
| IM-4.5.4 | The ICM Core System shall alert Pasadena Transit field supervisors about medium/major incidents affecting travel conditions within the City of Pasadena. | H | 13 | |
| IM-4.5.5 | The ICM Core System shall alert Arcadia Transit field supervisors about medium/major incidents affecting travel conditions within the City of Arcadia. | H | 13 | |
| **IM-4.6** | **The ICM Core System shall inform corridor travelers, by multiple channels, of active incidents and events affecting travel conditions with the corridor.** | **H** | **14** | **Corridor Managemt** |
| IM-4.6.1 | The ICM Core System shall send incident/event alerts to the regional 511 System. | H | 14 | |
| IM-4.6.2 | The ICM Core System shall send notifications about major incidents/events to the Nixle communication system. | M | 14 | |
| IM-4.6.3 | The ICM Core System shall send incident/event alerts to third-party navigation application providers. | H | 14 | |
| IM-4.6.4 | The ICM Core System shall send incident/event alerts to social media applications supporting ICM operations. | M | 14 | |
| **IM-4.7** | **The ICM Core System shall include a function for sending incident information directly to first responders or agency staff in the field (i.e., via smartphone, tablet, or onboard vehicle device).** | **M** | **13** | **Corridor Managemt** |
| **IM-4.8** | **The ICM Core System shall disseminate information about incidents and events that enables the information recipients to assess how the incident or event may impact their activities.** | **H** | **4, 13, 14** | **Corridor Managemt** |
| IM-4.8.1 | The ICM Core System shall disseminate the following information when notifying TMC/TCS operators, transit field supervisors, and first responders of active incidents and events:<br>• Jurisdiction where incident/event is occurring<br>• Roadway segment(s) affected by the incident/event<br>• Agency(ies) managing affected roadway segment(s)<br>• Number of lanes closed on each identified roadway segment<br>• Number of lanes remaining open on each identified roadway segment<br>• Location of affected lanes within each identified roadway (e.g., curb lane, center lane, lane 3, lanes 1 and 2, etc.)<br>• Anticipated duration of incident/event<br>• Anticipated zone of influence of incident/event | H | 4, 13 | |

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| IM-4.8.2 | The ICM Core System shall disseminate the following information when notifying corridor travelers of active incidents and events:<br>• Jurisdiction where incident/event is occurring<br>• Roadway segment(s) affected by the incident/event<br>• Affected traffic lanes<br>• Anticipated duration of incident/event<br>• Anticipated zone of influence of incident/event | H | 4, 14 | |
| **IM-4.9** | **The ICM Core System shall disseminate information about how identified incidents and events are expected to impact corridor travel conditions** | **M** | **4, 13** | **Corridor Managemt** |
| IM-4.9.1 | For each incident or event, the ICM Core System shall provide TMC/TCS operators with estimates of current travel times or travel delays within the corridor. | M | 4, 13 | |
| IM-4.9.2 | For each incident or event, the ICM Core System shall provide TMC/TCS operators with estimates of projected travel times or travel delays within the corridor for each 15-minute interval over the next hour. | M | 4, 13 | |

### 9.4.5. INCIDENT/EVENT TERMINATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IM-5.1** | **The ICM Core System shall attempt to determine when an active incident or event has terminated.** | **L** | **1, 4** | **Corridor Managemt/DSS** |
| IM-5.1.1 | The ICM Core System shall keep track of the expected end time of active incidents. | L | 1, 4 | |
| IM-5.1.2 | The ICM Core System shall keep track of when a scheduled event is planned to terminate. | L | 1, 4 | |
| IM-5.1.3 | The ICM Core System shall attempt to identify from first responder dispatch communications when an incident or unscheduled event has terminated. | L | 1, 4 | |
| **IM-5.2** | **The ICM Core System shall permit event/incident termination** | **H** | **1, 4** | **Corridor Managemt** |
| IM-5.2.1 | Only personnel from the agency associated with an incident or event shall be authorized to terminate an event. | H | 1, 4 | |
| IM-5.2.2 | When informed that an incident or event has terminated, the ICM Core System shall label the incident or event as having terminated. | H | 4 | |
| IM-5.2.3 | The ICM Core System shall not terminate an incident or event without stakeholder approval. | H | 10 | |
| IM-5.2.4 | Before marking an active incident or event as having terminated, the ICM Core System shall seek confirmation from relevant TMC/TCS operators that the incident or event has effectively been terminated. | H | 4, 7 | |
| *IM-5.2.4.1* | *TMC/TCS operators shall confirm that the incident or event has effectively been terminated before the ICM Core System identifies it as such.* | H | 4, 7 | |
| IM-5.2.5 | The ICM Core System shall notify stakeholders if an incident or event has not been terminated within a user-defined time past the expected duration. | H | 10 | |

### 9.4.6. INCIDENT/EVENT ARCHIVING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **IM-6.1** | **The ICM Core System shall log all identified incidents/events.** | **M** | **15** | **Corridor Managemt/ DSS/Data Hub** |

## 9.5. REAL-TIME RESPONSE PLANNING

This section details the requirements associated with the need to develop suitable response plans to minimize the impact of a verified incident or event on corridor operations.

### 9.5.1. DETERMINATION OF REFERENCE DATA FOR RESPONSE PLANNING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-1.1** | **At the onset of a response planning activity, the ICM Core System shall identify the set of data that will be used to assist in the evaluation of current corridor operations and the development of traffic forecasts.** | **H** | **5, 6** | **Decision Support** |

### 9.5.2. INCIDENT/EVENT IMPACT ASSESSMENT

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-2.1** | **Prior to developing a response plan, the ICM Core System shall assess the near-future impacts of identified incidents on corridor operations.** | **H** | **5** | **Decision Support** |
| RP-2.1.1 | Following the identification of an active incident or event, the ICM Core System shall assess the potential impact of the incident or event on overall corridor operations over the next hour. | H | 5 | |
| RP-2.1.2 | When evaluating the impact of a new active incident or event, the ICM Core System shall determine the extent of the zone of influence of the incident or event. | H | 5 | |
| RP-2.1.3 | When evaluating the impact of a new active incident or event, the ICM Core System shall consider the cumulative effect of all other active incidents and events within the corridor, as well as future events scheduled to start during the evaluation period. | H | 5 | |
| **RP-2.2** | **The ICM Core System shall only conduct operational assessments of incidents and events that have been confirmed to exist.** | **H** | **5** | **Decision Support** |
| **RP-2.3** | **Based on the results of the incident impact assessment, active incidents or events shall be categorized using rules specified in response planning as having a minor, medium, or major impact on corridor operations.** | **H** | **4** | **Decision Support** |

### 9.5.3. RESPONSE PLAN GENERATION

#### *9.5.3.1. Response Triggers*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-3.1** | **The ICM Core System shall assemble response plans for all incidents, unscheduled events, and planned events expected to generate average delays of 5 minutes or greater to travelers.** | **H** | **4** | **Decision Support** |

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| RP-3.1.1 | The ICM Core System shall assemble response plans for freeway incidents expected to last longer than the number of minutes defined in the response plan trigger rules and expected to generate average delays of 5 minutes or greater to travelers. | H | 4 | |
| RP-3.1.2 | The ICM Core System shall assemble response plans for arterial incidents expected to last longer than the number of minutes defined in the response plan trigger rules and expected to generate average delays of 5 minutes or greater to travelers. | H | 4 | |
| RP-3.1.3 | The ICM Core System shall assemble response plans for planned road closures anticipated to last longer than the number of minutes defined in the response plan trigger rules and expected to generate average delays of 5 minutes or greater to travelers. | H | 4 | |
| RP-3.1.4 | The ICM Core System shall assemble response plans for planned events affecting roadway operations expected to last longer than the number of minutes defined in the response plan trigger rules and expected to generate average delays of 5 minutes or greater to travelers. | H | 4 | |
| RP-3.1.5 | The ICM Core System shall assemble response plans for unexpected events anticipated to last longer than the number of minutes defined in the response plan trigger rules and expected to generate delays of 5 minutes or greater. | H | 4 | |

### *9.5.3.2. Identification of Available Field Elements*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-3.2** | **When assembling a response plan, the ICM Core System shall only consider modifying available, working assets.** | **H** | **4** | **Decision Support** |
| RP-3.2.1 | The ICM Core System shall use status data collected from individual traffic signal controllers to determine whether changes to the operation of specific signalized intersections would be authorized. | H | 4 | |
| RP-3.2.3 | The ICM Core System shall use status data collected from individual ramp controllers to determine whether metering changes can be implemented at specific freeway on-ramps or freeway-to-freeway connectors. | H | 4 | |
| RP-3.2.4 | The ICM Core System shall use status data collected from fixed CMSs to determine whether desired information messages can be displayed on specific devices. | H | 4 | |
| RP-3.2.5 | The ICM Core System shall use status data collected from extinguishable trailblazer signs to determine whether the signs can be used to provide route guidance. | H | 4 | |
| RP-3.2.6 | The ICM Core System shall check the availability of portable CMSs to determine whether such devices can be deployed. | H | 4 | |
| RP-3.2.7 | The ICM Core System shall use status data collected from individual Highway Advisory Radios (HARs) to determine whether the stations could be used to broadcast incident/event-related messages. | H | 4 | |
| RP-3.2.8 | The ICM Core System shall remove from consideration any control element determined to be currently unavailable. | H | 4 | |
| RP-3.2.9 | The ICM Core System shall remove from consideration any control element projected to become unavailable within the anticipated period of application of the response plan to be developed. | M | 4 | |

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| **RP-3.3** | **When assembling a response plan, the ICM Core System shall only consider management resources available within each agency at the time of day a response plan is developed.** | **H** | 4 | **Decision Support** |
| **RP-3.4** | **The ICM Core System shall include the capability to include or exclude a particular control asset from modification by response plans.** | **L** | **4** | **Decision Support** |
| RP-3.4.1 | The ICM Core System shall include a function to include or exclude particular traffic signals from modification by response plans. | L | 4 | |
| RP-3.4.2 | The ICM Core System shall include a function to include or exclude particular ramp meters from modification by response plans. | L | 4 | |
| RP-3.4.2 | The ICM Core System shall include a function to include or exclude particular CMS signs from modification by response plans. | L | 4 | |

*9.5.3.3. Identification of Suitable Detours*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-3.5** | **When responding to an incident or event, the ICM Core System shall first assess the usability of user-defined predefined detours before attempting to assemble new detour routes.** | **L** | **4** | **Decision Support** |
| **RP-3.6** | **If no predefined detour route is available, the ICM Core System shall conduct network searches to try to identify potential detours around incidents and events within a set of allowable roadway segments.** | **L** | **4** | **Decision Support** |
| **RP-3.7** | **The ICM Core System shall be able to identify suitable detours for various types of vehicles.** | **M** | **4** | **Decision Support** |
| RP-3.7.1 | The ICM Core System shall identify suitable detours for regular passenger car traffic. | H | 4 | |
| RP-3.7.2 | The ICM Core System shall identify suitable detours for heavy vehicles. | H | 4 | |
| RP-3.7.3 | The ICM Core System shall identify suitable detours for bus transit vehicles. | L | 4 | |
| **RP-3.8** | **The ICM Core System shall consider all applicable roadway geometrical restrictions when searching for suitable detours around an incident or event.** | **H** | **4** | **Decision Support** |
| RP-3.8.1 | The ICM Core System shall refrain from sending trucks along roadway segments for which there may be insufficient height clearance under bridges or structures. | H | 4 | |
| RP-3.8.2 | The ICM Core System shall refrain from sending trucks along roadway segments where there is insufficient turning radius to allow the vehicles to make intended right or left turns | H | 4 | |
| RP-3.8.3 | The ICM Core System shall refrain from sending buses along roadway segments where there is insufficient turning radius to allow the vehicles to make intended right or left turns. | H | 4 | |
| **RP-3.9** | **The ICM Core System shall consider all applicable active traffic restrictions when searching for suitable detours around an incident or event.** | **H** | **4** | **Decision Support** |
| RP-3.9.1 | The ICM Core System shall not send traffic into school zones when children are walking to and from schools. | H | 4 | |
| RP-3.9.2 | The ICM Core System shall not send heavy vehicles on local arterials with active truck restrictions. | H | 4 | |
| RP-3.9.3 | To the extent possible, the ICM Core System shall refrain from sending traffic along arterial segments heavily traveled by buses (e.g., Colorado Blvd in Pasadena). | H | 4 | |

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| **RP-3.10** | **The ICM Core System shall consider the availability of traffic management devices along individual detours** | **H** | **4** | **Decision Support** |
| RP-3.10.1 | The ICM Core System shall exclude from consideration identified detours where the proportion of traffic control signals that can be modified by the ICM Core System is below a user-defined threshold. | H | 4 | |
| RP-3.10.2 | The ICM Core System shall exclude from consideration identified detours where the proportion of devices that can be used to provide guidance along the identified route (such as CMSs and extinguishable trailblazer signs) is below a user-defined threshold. | H | 4 | |
| **RP-3.11** | **Unless necessary, the ICM Core System shall avoid sending traffic towards stop-controlled intersections.** | **H** | **4** | **Decision Support** |
| **RP-3.12** | **The ICM Core System shall consider the congestion developing upstream and around an incident or event when searching for suitable detours around an incident or event.** | **H** | **4, 5** | **Decision Support** |
| RP-3.12.1 | Wherever possible, the ICM Core System shall select or develop detours starting from a point upstream of the congestion developing on the approach to an incident. | H | 4, 5 | |
| RP-3.12.2 | Wherever possible, the ICM Core System shall select or develop detour routes avoiding heavily congested roadway segments. | H | 4, 5 | |
| **RP-3.13** | **The ICM Core System shall be robust enough to incorporate projected traffic conditions on the freeways and arterials, if available, in determining the best detour(s) around incidents and events.** | **H** | **4, 5** | **Decision Support** |
| **RP-3.14** | **The ICM Core System shall include a function to identify and accommodate more than one detour being implemented simultaneously as a response to a given incident/event.** | **H** | **4** | **Decision Support** |
| **RP-3.15** | **The ICM Core System shall rank potential detour routes around an incident or event based on their attractiveness relative to the incident or event. (Note: This requirement is ranked low, as the initial requirements state that response plan routes will be selected in advance. This requirement is in anticipation that at some point in the future the system will generate routes in real time.)** | **L** | **4, 5** | **Decision Support** |
| RP-3.15.1 | The ICM Core System shall give a higher priority to detours located close to the incident or event. | L | 4 | |
| RP-3.15.2 | The ICM Core System shall give a higher priority to detours offering shorter travel distance. | L | 4 | |
| RP-3.15.3 | The ICM Core System shall give a higher priority to detours offering shorter overall travel times. | L | 4, 5 | |
| RP-3.15.4 | The ICM Core System shall give a higher priority to detours with higher spare capacity. | L | 4, 5 | |
| RP-3.15.5 | The ICM Core System shall give a higher priority to detours that do not include at-grade crossings with the Metro Gold Line. | L | 4 | |
| RP-3.15.6 | The ICM Core System shall eliminate from consideration roadway segments or routes without adequate spare capacity. | L | 4, 5 | |
| **RP-3.16** | **The ICM Core System shall include a function to remove routes from consideration based on control asset availability** | **H** | **4** | **Decision Support** |
| RP-3.16.1 | The ICM Core System shall eliminate from consideration roadway segments or routes along which the number of unavailable control assets exceeds a user-defined threshold. | M | 4 | |
| RP-3.16.2 | The ICM Core System shall eliminate from consideration roadway segments or routes where control assets critical to the implementation of a response plan (such as a traffic signal at a key intersection) are unavailable. | M | 4 | |

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| **RP-3.17** | **The ICM Core System shall include a function to return a "no existing detour" solution as a suitable solution to the search of detour routes around an incident or event.** | **H** | **4** | **Decision Support** |

### 9.5.4. IDENTIFICATION OF SUITABLE CONTROL ACTIONS (RESPONSE PLAN DEVELOPMENT)

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-3.18** | **The ICM Core System shall develop response plans seeking to minimize the anticipated impacts of identified active incidents/events on near-future corridor operations.** | **H** | **4, 5, 6** | **Decision Support** |
| RP-3.18.1 | When developing a response plan, the ICM Core System shall promote actions seeking to minimize overall travel times/delays within the zone of influence of the related incident/event. | H | 4, 5, 6 | |
| RP-3.18.2 | When developing a response plan, the ICM Core System shall consider the effects on corridor operations of all identified active incidents/events within the corridor. | H | 4, 5, 6 | |
| RP-3.18.3 | When developing a response plan, the ICM Core System shall consider the effects of all future road/lane closures and events scheduled to occur within the zone of influence of the related incident/event during the incident's projected duration. | H | 4, 5, 6 | |
| **RP-3.19** | **Developed response plans shall be comprised of pre-approved control and management actions.** | **H** | **4, 8, 10** | **Decision Support** |
| RP-3.19.1 | Developed response plans shall be comprised, at a minimum, of one or more of the following control actions:<br>• Individuals to be contacted at each agency about the incident being responded to.<br>• Recommended alternate routes around an incident or event:<br>- Recommended route(s) for passenger cars<br>- Recommended route(s) for trucks<br>- Recommended route(s) for buses<br>• Ramp metering control actions:<br>- Turning ramp meters to green ("Green-ball" operation)<br>- Activation of a specific metering rate (0 to 15)<br>• Intersection control:<br>- Change in traffic signal control plan in operation<br>• Personnel deployment requests:<br>- Full ramp closure<br>- Locations where portable CMSs are to be deployed<br>• Information dissemination:<br>- Messages to post on fixed CMSs<br>- Messages to post on portable CMSs to be deployed along the corridor<br>- Extinguishable trailblazer signs to be activated<br>- Messages to broadcast on HARs<br>- Information to disseminate to 511 systems, third-party information providers, and mobile travel application developers | H | 4, 8, 10 | |
| **RP-3.20** | **When developing a response plan, the ICM Core System shall favor the implementation of pre-approved response actions.** | **H** | **4, 8, 10** | **Decision Support** |
| RP-3.20.1 | When developing a response plan, the ICM Core System shall first consider typical detour routes that have been identified by stakeholder agencies before attempting to develop new routes. | H | 4, 8, 10 | |

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| RP-3.20.2 | When developing a response plan, the ICM Core System shall first consider whether a pre-assembled set of response actions (i.e., a predefined response plan) has already been defined by system users for responding to the type of incident or event being considered. | H | 4, 8, 10 | |
| RP-3.20.3 | When developing a response plan, the ICM Core System shall only consider the traffic signal control plans that have already been created and loaded within each signal controller. | H | 4, 8, 10 | |
| RP-3.20.4 | When developing a response plan, the ICM Core System shall only consider the specific metering rates or control algorithms defined within each ramp meter controller. | H | 4, 8, 10 | |
| RP-3.20.5 | When developing a response plan, the ICM Core System shall rely on a library of pre-approved message templates to determine which messages to display on fixed CMSs. | H | 4, 8, 10 | |
| **RP-3.21** | **When developing response plans, the ICM Core System shall consider, if possible, the historical performance of previously developed combinations of response actions for past incidents or events of similar magnitude occurring at similar locations.** | **L** | **4, 5, 6** | **Decision Support** |
| **RP-3.22** | **The ICM Core System shall only develop response plans that can be implemented if recommended.** | **M** | **4** | **Decision Support** |
| RP-3.22.1 | The ICM Core System shall eliminate from consideration response plans for which a proportion of critical assets above a user-defined threshold is not available for control. | M | 4 | |
| **RP-3.23** | **The ICM Core System shall include a function to develop multiple potential response plans in response to a given incident or event.** | **H** | **4, 10** | **Decision Support** |
| RP-3.23.1 | The ICM Core System shall be able to develop multiple response plans as a response to an incident or event. | H | 4 | |
| **RP-3.25** | **The ICM Environment shall inform transit field supervisors as soon as possible of the response actions being considered to help them make decisions regarding potential transit service adjustments.** | **M** | **4, 13** | **Corridor Managemt** |
| RP-3.25.1 | Following the development of a response plan, the ICM Core System shall disseminate the following information to transit field supervisors:<br>• Location of incident<br>• Time incident occurred<br>• Expected duration of incident<br>• Agency responsible for managing the incident<br>• Recommended detour(s) for the passenger cars<br>• Recommended detour(s) for buses<br>• Messages to be passed along regarding the incident or detour | M | 4, 13 | |
| RP-3.25.2 | Following the identification of a medium or major incident, the ICM Core System shall inform transit field supervisors of recommended detour(s) for buses within the zone of influence of the incident. | M | 4, 13 | |
| RP-3.25.3 | Transit field supervisors shall use information from the response actions to make potential transit service adjustments. | M | 4, 13 | |

### 9.5.5. EVALUATION OF INDIVIDUAL RESPONSE PLANS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-3.26** | **The ICM Core System shall evaluate all developed valid response plans.** | **H** | **4** | **Decision Support** |

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| RP-3.26.1 | The ICM Core System shall always consider a "do nothing" scenario (scenario in which no action is taken) as one of the potential response plans to be evaluated. | H | 4 | |
| RP-3.26.2 | The ICM Core System shall evaluate all response plans developed by Decision Support. | H | 4 | |
| **RP-3.27** | **The ICM Core System shall produce a traffic forecast for each response plan being evaluated.** | **H** | **5** | **Decision Support** |
| RP-3.27.1 | The traffic forecast for each response plan shall use the corridor's current traffic state as its initial state. | H | 5 | |
| RP-3.27.2 | The traffic forecast for each response plan shall take into account expected changes in traffic patterns from known road closures, other incidents or events, etc. | H | 5 | |
| RP-3.27.3 | The traffic forecast for each response plan shall implement all the plan elements (intersection signal plan changes, ramp meter changes, road/lane changes, communication elements, manual interventions) associated with the response plan being evaluated. | H | 5 | |
| **RP-3.28** | **The ICM Core System shall evaluate the extent to which each developed response plan would improve/deteriorate corridor operations over a "Do Nothing" scenario.** | **H** | **4,5,6** | **Decision Support** |
| RP-3.28.1 | Evaluation of the potential impacts of individual response plans on corridor operations shall be conducted over one-hour forecasts of corridor operations using the current time as a starting point. | H | 4, 5, 6 | |
| RP-3.28.2 | For each evaluated response plan, the ICM Core System shall provide the forecasted increase/decrease in vehicle-delay incurred within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario. | H | 4,5,6 | |
| *RP-3.28.2.1* | *For each evaluated response plan, the ICM Core System shall provide the forecasted nominal increase/decrease in vehicle-delay incurred within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario*. | H | 4,5,6 | |
| *RP-3.28.2.2* | *For each evaluated response plan, the ICM Core System shall provide the forecasted percent increase in vehicle-delay incurred within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario*. | H | 4,5,6 | |
| RP-3.28.3 | For each evaluated response plan, the ICM Core System shall provide the forecasted increase/decrease in person-delay incurred within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario. | M | 4,5,6 | |
| *RP-3.28.3.1* | *For each evaluated response plan, the ICM Core System shall provide the forecasted nominal increase/decrease in person-delay incurred within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario.* | M | 4,5,6 | |
| *RP-3.28.3.2* | *For each evaluated response plan, the ICM Core System shall provide the forecasted percent increase in person-delay incurred within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario.* | M | 4,5,6 | |
| RP-3.28.4 | For each evaluated response plan, the ICM Core System shall provide the forecasted increase /decrease in travel demand resulting from the implementation of the response plan | H | 4,5,6 | |
| *RP-3.28.4.1* | *For each evaluated response plan, the ICM Core System shall provide the forecasted percent increase/decrease in vehicle-miles traveled within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario.* | H | 4,5,6 | |

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| *RP-3.28.4.2* | *For each evaluated response plan, the ICM Core System shall provide the forecasted percent increase/decrease in person-miles traveled within the zone of influence of the associated incident or event when compared to the "Do Nothing" scenario.* | M | 4,5,6 | |
| RP-3.28.5 | For each developed response plan, the ICM Core System shall provide a map showing the location of congested roadway segments associated with the response plan. | H | 4,5,6, 12 | |
| **RP-3.29** | **For each evaluated response plan, the ICM Core System shall produce a confidence index reflecting the potential ability of the proposed actions to positively affect corridor operations.** | **M** | **4,8** | **Decision Support** |
| RP-3.29.1 | When assessing confidence in a response plan, the ICM Core System shall consider the accuracy and reliability of the traffic forecasts supporting the development of the plan. | M | 4,8 | |
| RP-3.29.2 | When assessing confidence in a response plan, the ICM Core System shall consider the number of manual actions required in the response plan. | L | 4,8 | |
| RP-3.29.3 | When assessing confidence in a response plan, the ICM Core System shall consider the historical success of previous response plans using similar detours. | L | 4,8 | |
| RP-3.29.4 | When assessing confidence in a response plan, the ICM Core System shall consider the number of control actions (signal plan changes, ramp meter changes, CMS sign modifications) associated with the plan. | L | 4,8 | |
| RP-3.29.5 | The ICM Core System shall determine an overall response plan confidence index based on the considerations described in RP 3.29.1-3.29.4. | M | 4,8 | |

### *9.5.5.1. Selection of Recommended Response Plan*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-3.32** | **The ICM Core System shall always consider a "Do Nothing" scenario as a potential recommendation.** | **H** | **4** | **Decision Support** |
| **RP-3.33** | **The ICM Core System shall rank all developed response plans based on their ability to improve corridor operations within the identified zone of influence of the incident or event that triggered the response planning.** | **H** | **4** | **Decision Support** |
| RP-3.33.1 | Response plan ranking shall be made against the "Do Nothing" scenario. | H | 4 | |
| RP-3.33.2 | The ICM Core System shall assign a higher ranking to response plans reducing incurred delays within the zone of influence of the incident or event. | H | 4 | |
| RP-3.33.3 | The ICM Core System shall assign a higher ranking to response plans increasing the number of vehicles or travelers able to travel through the zone of influence of the incident or event. | H | 4 | |
| RP-3.33.4 | The ICM Core System shall assign a higher ranking to response plans where all involved corridor assets are available and in good operating condition. | H | 4,8 | |
| RP-3.33.5 | The ICM Core System shall assign a higher ranking to response plans having a higher confidence index. | H | 4 | |

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| RP-3.33.6 | The ICM Core System shall rank a response plan as "Unacceptable – Jurisdictional Restricted" if implementation of the plan would violate a mandatory jurisdictional restriction (such as a school zone restriction, a truck restriction, etc.). | H | 4,8 | |
| RP-3.33.7 | The ICM Core System ranking shall rank a response plan as "Unacceptable" if its implementation would result in a worse outcome than the "Do Nothing" scenario. | H | 4,8 | |
| **RP-3.34** | **The ICM Core System shall only recommend for implementation response plans with forecasted benefits exceeding given user-defined thresholds.** | **H** | **4** | **Decision Support** |
| RP-3.34.1 | The ICM Core System shall only recommend for implementation response plans for which the forecasted total delay reduction over the "Do Nothing" scenario exceeds a given user-defined threshold. | H | 4 | |
| *RP-3.34.1.1* | *The ICM Core System shall only recommend for implementation response plans for which the forecasted total vehicle-delay reduction over the "Do Nothing" scenario exceeds a given user-defined threshold.* | H | 4 | |
| *RP-3.34.1.1* | *The ICM Core System shall only recommend for implementation response plans for which the forecasted total person-delay reduction over the "Do Nothing" scenario exceeds a given user-defined threshold.* | M | 4 | |
| RP-3.34.2 | The ICM Core System shall only recommend for implementation response plans for which the corridor throughput increase over the "Do Nothing" scenario exceeds a given user-defined threshold. | H | 4 | |
| **RP-3.35** | **The ICM Core System shall recommend for implementation the response plan with the highest positive ranking.** | **H** | **4** | **Decision Support** |
| RP-3.36.1 | The ICM Core System shall recommend the "Do Nothing" scenario should no alternative response plan with a positive ranking remain | H | 4 | |
| **RP-3.36** | **The ICM Core System shall permit manual selection of a response plan from a list of recommended response plans.** | **H** | **4** | **Corridor Managemt** |
| RP-3.36.1 | The ICM Core System shall permit manual selection of response plans. | H | 4 | |
| RP-3.36.2 | The TMC/TCS operator shall be able to manually select a response plan from a list of recommended response plans. | H | 4 | |
| RP-3.36.3 | The ICM Core System shall not allow selection of a plan estimated to have a negative impact on corridor operations. | H | 4 | |
| RP-3.36.4 | The ICM Core System shall not allow selection of a plan having a low confidence index. | H | 4 | |

### 9.5.6. RESPONSE PLAN REVIEW AND APPROVAL

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-4.1** | **The ICM Core System shall submit for approval all the response plans that are recommended for implementation by the Decision Support module.** | **H** | **7** | **Corridor Managemt** |
| RP-4.1.1 | Approval of recommended response plans shall be required from all agencies having a role to play in the implementation of the plan or being affected by its implementation. | H | 7 | |
| RP-4.1.2 | For each recommended response plan, the ICM Core System shall identify the individuals within each agency responsible for reviewing and approving the plan. | H | 7 | |

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| RP-4.1.3 | The ICM Core System shall notify all individuals responsible for reviewing/approving response plans when an agency has approved or rejected a recommended plan that has been submitted for review. | H | 7 | |
| RP-4.1.4 | The ICM Core System shall only consider as approved a recommended plan that has received approval for its implementation from all agencies affected by its implementation. | H | 7 | |
| **RP-4.2** | **Individuals tasked with reviewing recommended response plans shall provide a review decision within a prescribed interval.** | **H** | **8, 9, 10** | **Corridor Managemt** |
| RP-4.2.1 | The ICM Core System shall inform agency representatives of the interval allowed to make a decision on the approval/rejection of a submitted response plan whenever this interval is changed. | H | 8, 9, 10 | |
| **RP-4.3** | **The ICM Core System shall permit minor modifications to recommended plans submitted for stakeholder approval before final plan approval is obtained.** | **L** | **9** | **Corridor Managemt** |
| RP-4.3.1 | Unless automated approval is granted, the ICM Core System shall re-submit for approval all submitted changes to pending response plans. | L | 9 | |
| RP-4.3.2 | The ICM Core System shall only allow one round of re-review to address modifications submitted by TMC/TCS operators. | L | 9 | |
| RP-4.3.3 | The ICM Core System shall only permit modification requests for response plan components that have received prior approval for change. | L | 9 | |
| **RP-4.4** | **Following approval of a response plan, the ICM Core System shall immediately notify the response plan implementation functions of the need to implement a new response plan.** | **M** | **8** | **Corridor Managemt** |

### 9.5.7. PERIODIC RESPONSE PLAN UPDATES

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-5.1** | **The ICM Core System shall continue to monitor, evaluate, and update the recommended response plan (e.g., suggest changes to messages, timing plans, meter rates, etc.) as an incident/event unfolds.** | **H** | **4** | **Decision Support** |
| **RP-5.2** | **The ICM Core System shall automatically reassess every 5-15 minutes (depending on user configuration) the adequacy of the previously recommended plan and propose, if necessary, modifications to the existing plan.** | **H** | **4, 5, 6** | **Decision Support** |
| **RP-5.3** | **The ICM Core System shall automatically reassess the adequacy of the previously recommended response plan if there are changes to important characteristics of the incident or event being responded to.** | **H** | **4, 5, 6** | **Decision Support** |
| RP-5.3.1 | The ICM Core System shall automatically reassess the adequacy of the previously recommended response plan if there is a change in the number of lanes affected. | H | 4, 5, 6 | |
| RP-5.3.1 | The ICM Core System shall automatically reassess the adequacy of the previously recommended response plan if the expected duration of the incident or event being responded to changes by more than 15 minutes. | H | 4, 5, 6 | |
| **RP-5.4** | **The ICM Core System shall include a function for TMC and TCS operators to propose changes to an implemented response plan.** | **L** | **9** | **Corridor Managemt** |
| **RP-5.5** | **The ICM Core System shall submit for review and approval all proposed modifications to an active response plan.** | **L** | **7** | **Corridor Managemt** |

### 9.5.8. RESPONSE TERMINATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-6.1** | **Following the termination of an incident or event, the ICM Core System shall continue to monitor, evaluate, and update the active response plan until travel conditions within the corridor have returned to an historical average.** | **H** | **4** | **Decision Support** |
| RP-6.1.1 | Following the closure of an incident or event, the ICM Core System shall continue assessing travel conditions within the corridor every 5 minutes to determine whether travel conditions have returned to historical average. | H | 1, 4 | |
| RP-6.1.2 | Traffic conditions shall be assumed to have returned to historical average when observed conditions are within the range of conditions typically observed for the given time of week and time of day in the absence of incidents or events. | H | 1, 4 | |
| **RP-6.2** | **Following the termination of an incident or event, active response planning shall continue until travel conditions within the corridor have returned to a an historical average.** | **H** | **1, 4** | **Decision Support** |
| RP-6.2.1 | Following the closure of an incident or event, normal asset operations shall only be resumed once travel conditions within the corridor have returned to a normal state for the given time of day and day of week. | H | 1, 4 | |
| RP-6.2.3 | Following the identification of a need to continue response planning activities past the termination an incident or event, the ICM Core System shall assign the “Post-Incident/Event Response” label to the active response plan until response activities can formally be terminated. | H | 4 | |
| **RP-6.3** | **The ICM Core System shall return corridor assets to normal operations when corridor operations have returned to normal.** | **H** | **4** | **Corridor Managemt** |
| RP-6.3.1 | Upon determining that corridor operations have returned to normal after the closure of an incident or event, the ICM Core System shall instruct all control devices for which operation has been altered during the incident/event response to return to their defined normal operations for the time of day and day of week. | H | 4 | |
| RP-6.3.2 | Prior to terminating response planning activities, the ICM Core System shall check that all control devices for which operation has been altered during the incident/event response have effectively returned to normal operation. | H | 4 | |
| **RP-6.4** | **Before terminating a response activity, the ICM Core System shall seek appropriate approval from TMC/TCS operators that the response planning activity can be terminated.** | **H** | **7** | **Corridor Managemt** |
| RP-6.4.1 | TMC/TCS operators shall approve termination of response plans. | H | 7 | |
| **RP-6.6** | **The ICM Corridor Manager shall have the authority to command the ICM Core System to terminate a response planning activity.** | **H** | **9** | **Institutional Job Tasks** |
| **RP-6.7** | **The ICM Core System shall inform relevant system operators when traffic conditions within the corridor are deemed to have returned to normal.** | **H** | **4, 13** | **Corridor Managemt** |
| RP-6.7.1 | The ICM Core System shall notify the Corridor Manager when traffic conditions within the corridor have returned to normal state. | H | 4, 13 | |

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| RP-6.7.2 | The ICM Core System shall notify the TMC/TCS operators of all agencies involved in the implementation of a response plan when traffic conditions within the corridor have returned to normal and that regular corridor operations are to resume. | H | 4, 13 | |
| RP-6.7.3 | The ICM Core System shall notify first responders involved in the implementation of a response plan that traffic conditions within the corridor have returned to normal and that regular corridor operations are to resume. | M | 4, 13 | |
| RP-6.7.4 | The ICM Core System shall notify transit agencies involved in the implementation of a response plan that traffic conditions within the corridor have returned to normal and that regular corridor operations are to resume. | M | 4, 13 | |
| RP-6.7.5 | The ICM Core System shall notify parking operators involved in the implementation of a response plan that traffic conditions within the corridor have returned to normal and that regular corridor operations are to resume. | L | 4, 13 | |
| RP-6.7.6 | The ICM Core System shall notify information providers involved in the implementation of a response plan that traffic conditions within the corridor have returned to normal and that regular corridor operations are to resume. | M | 4, 13 | |
| **RP-6.8** | **The ICM Core System shall inform relevant system operators when a response planning activity has been terminated.** | **H** | **13** | **Corridor Managemt** |
| RP-6.8.1 | The ICM Core System shall inform affected TMC/TCS operators when a decision has been made to terminate a response planning activity. | H | 13 | |
| RP-6.8.2 | The ICM Core System shall inform the owner of each field device (e.g., traffic signal controllers, fixed CMS, etc.) used in the implementation of a response plan when a decision has been made to return the device to normal operation. | H | 13 | |
| RP-6.8.3 | The ICM Core System shall inform field supervisors of affected transit agencies when a decision has been made to terminate a response plan. | H | 13 | |
| RP-6.8.4 | The ICM Core System shall inform affected first responders when a decision has been made to terminate a response planning activity. | H | 13 | |
| RP-6.8.5 | The ICM Core System shall inform affected parking operators when a decision has been made to terminate a response planning activity. | M | 13 | |
| RP-6.8.6 | The ICM Core System shall inform affected information providers when a decision has been made to terminate a response planning activity. | M | 13 | |
| RP-6.8.7 | The ICM Core System shall inform all system stakeholders when all response planning activities have officially concluded. | H | 13 | |

### 9.5.9. RESPONSE PLANNING ARCHIVING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-7.1** | **The ICM Core System shall log all response planning activities.** | **M** | **15** | **Corridor Managemt** |
| **RP-7.2** | **The ICM Core System shall archive developed response plans.** | **M** | **15** | **Data Hub** |

### 9.5.10. RESPONSE PLANNING PERFORMANCE ASSESSMENT

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **RP-8.1** | **The ICM Core System shall generate a response plan within 5 minutes of the verification of an active incident or event.** | **H** | **4** | **Decision Support** |
| **RP-8.2** | **The simulation software shall be able to evaluate within a 5-minute interval the impacts of at least three candidate response plans over at least the next projected hour of operation.** | **H** | **4** | **Decision Support** |

## 9.6. RESPONSE PLAN IMPLEMENTATION

This section details requirements defining how a recommended response plan is implemented in the field after being approved by all relevant stakeholder agencies. These requirements essentially deal with the instructions that must be given to individual devices to implement specific control actions and inform travelers, as well as with the need to keep corridor operators appropriately informed of the actions being undertaken within the transportation networks under their management.

### 9.6.1. RESPONSE PLAN FIELD IMPLEMENTATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **PI-2.1** | **Upon receiving a new approved response plan, the ICM Core System shall determine the order and proper time at which control actions should be sent to individual control elements.** | **H** | **4, 8** | **Decision Support** |
| **PI-2.2** | **The ICM Core System shall send response plan instructions to individual corridor assets.** | **H** | **3, 4, 8** | **Corridor Managemt** |
| PI-2.2.1 | The ICM Core System shall send instructions to individual traffic control devices involved in the implementation of the plan. | H | 3, 4, 8 | |
| *PI-2.2.1.1* | *The ICM Core System shall send commands to individual traffic signal controllers specifying which timing plan to use at the corresponding intersection.* | H | 3, 4, 8 | |
| *PI-2.2.1.2* | *The ICM Core System shall send commands to individual ramp meter controllers specifying which metering algorithm/rate to use at the corresponding on-ramp or freeway-to-freeway connector.* | H | 3, 4, 8 | |
| PI-2.2.2 | The ICM Core System shall send instructions to traveler information devices involved in the implementation of a response plan. | H | 3, 4, 8 | |
| *PI-2.2.2.1* | *The ICM Core System shall send commands to individual fixed CMS devices specifying what message is to be posted on the device.* | H | 3, 4, 8 | |
| *PI-2.2.2.2* | *The ICM Core System shall send commands to individual portable CMS devices with remote communication capability specifying what message is to be posted on the device.* | H | 3, 4, 8 | |
| *PI-2.2.2.3* | *The ICM Core System shall send activation commands to individual extinguishable trailblazer signs along the selected detour(s).* | H | 3, 4, 8 | |
| PI-2.2.3 | The ICM Core System shall send deployment requests to agency personnel having a role to play in implementing the plan. | H | 3, 4, 8 | |
| *PI-2.2.3.1* | *Stakeholders shall permit the Core ICM System to contact designated agency personnel with requests for performing preapproved actions.* | H | 3, 4, 8 | |
| *PI-2.2.3.2* | *The ICM Core System shall send task requests to agency staff responsible for the deployment of portable CMSs, specifying how many signs are to be deployed and where.* | H | 3, 4, 8 | |
| *PI-2.2.3.3* | *The ICM Core System shall send deployment requests to field operation staff from each participating agency specifying where they should deploy and what task is to be accomplished.* | H | 3, 4, 8 | |
| *PI-2.2.3.4* | *The ICM Core System shall send traffic management requests to first responders from each participating agency.* | H | 3, 4, 8 | |

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| **PI-2.3** | **The ICM Core System shall verify, to the extent possible, that field assets have the correct plan components.** | **H** | **3, 4** | **Corridor Managemt** |
| PI-2.3.1 | Traffic control devices involved in the implementation of a response plan shall acknowledge receiving instructions sent by the ICM Core System. | H | 3, 4 | |
| *PI-2.3.1.1* | *Traffic signal controllers shall acknowledge receiving instructions on when to start a specific signal plan.* | H | 3, 4 | |
| *PI-2.3.1.2* | *Ramp controllers shall acknowledge receiving instructions on when to start a particular ramp metering plan.* | H | 3, 4 | |
| PI-2.3.2 | Traveler information devices involved in the implementation of a response plan shall acknowledge receiving instructions sent by the ICM Core System | H | 3, 4 | |
| *PI-2.3.2.1* | *Fixed CMS devices shall acknowledge receiving instructions on when to display a particular message.* | H | 3, 4 | |
| *PI-2.3.2.2* | *Portable CMS devices with remote communication capability shall acknowledge receiving instructions on when to display a particular message.* | H | 3, 4 | |
| *PI-2.3.2.3* | *Extinguishable trailblazer signs shall acknowledge receiving activation instructions.* | H | 3, 4 | |
| *PI-2.3.2.4* | *HAR systems shall acknowledge receiving instructions on when to broadcast a particular message.* | H | 3, 4 | |
| **PI-2.4** | **Assets failing to acknowledge in a timely manner receipt of instructions from the ICM Core System shall, to the extent possible, be checked to determine whether they have received the information.** | **H** | **3, 4** | **Corridor Managemt** |
| PI-2.4.1 | Traffic control devices failing to acknowledge within one minute the receipt of response plan implementation instructions shall be checked to see if they have received the instructions. | H | 3, 4 | |
| *PI-2.4.1.1* | *In the absence of timely acknowledgment, ramp controllers shall be checked to ensure that the metering change information sent by the ICM Core System has been received by the device.* | H | 3, 4 | |
| *PI-2.4.1.2* | *In the absence of timely acknowledgment, traffic signal controllers shall be checked to ensure that the timing plan change information sent by the ICM Core System has been received by the device.* | H | 3, 4 | |
| PI-2.4.2 | Traveler information devices failing to acknowledge within one minute receipt of messaging instructions shall be checked to see if they have received the instructions. | H | 3, 4 | |
| *PI-2.4.2.1* | *In the absence of timely acknowledgment, fixed CMS signs shall be checked to ensure that the messaging information sent by the ICM Core System has been received.* | H | 3, 4 | |
| *PI-2.4.2.2* | *In the absence of timely acknowledgment, portable CMS signs shall be checked to ensure that the messaging information sent by the ICM Core System has been received.* | H | 3, 4 | |
| *PI-2.4.2.3* | *In the absence of timely acknowledgment, extinguishable trailblazer signs shall be checked to ensure that the activation information sent by the ICM Core System has been received.* | H | 3, 4 | |
| *PI-2.4.2.4* | *In the absence of timely acknowledgment, HAR systems shall be checked to ensure that the messaging information sent by the ICM Core System has been received.* | H | 3, 4 | |
| **PI-2.5** | **The ICM Core System shall be responsible for performing initial checks on instruction receipt acknowledgments from corridor assets.** | **H** | **3, 4** | **Corridor Managemt** |

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| PI-2.5.1 | To the extent possible, the ICM Core System shall provide an automated way to check whether instruction receipt acknowledgments have been received from corridor assets. | H | 3, 4 | |
| PI-2.5.2 | Human assets shall only be involved in verifying instruction receipt where automation is not possible or after automation verification has failed. | H | 3, 4 | |
| PI-2.5.3 | Asset acknowledgments and lack of acknowledgments shall be tracked in electronic format. | H | 3, 4 | |
| PI-2.5.4 | Asset checks and results shall be tracked in electronic format. | H | 3, 4 | |

### 9.6.2. INFORMATION DISSEMINATION TO TRAVELERS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **PI-3.1** | **The ICM Core System shall inform corridor travelers of incidents, unscheduled events, and planned events occurring within the corridor.** | **H** | **14** | **Corridor Managemt** |
| PI-3.1.1 | The ICM Core System shall inform travelers and fleet operators of roadway incidents, unscheduled events, and planned events occurring along corridor freeways and arterials that may be used as detours. | H | 14 | |
| PI-3.1.2 | The ICM Core System shall inform travelers and fleet operators of planned roadway closures occurring along corridor freeways and arterials that may be used as detours. | H | 14 | |
| PI-3.1.3 | The ICM Core System shall inform travelers and fleet operators of unscheduled roadway closures due to maintenance or other reasons occurring along corridor freeways and arterials that may be used as detours. | H | 14 | |
| PI-3.1.4 | The ICM Core System shall inform travelers of major transit incidents occurring within the corridor. | M | 14 | |
| PI-3.1.5 | The ICM Core System shall inform travelers and fleet operators of major events held within the corridor. | M | 14 | |
| PI-3.1.6 | For each incident or event, the ICM Core System shall provide travelers and fleet operators with an assessment of travel conditions within the corridor. | L | 14 | |
| *PI-3.1.6.1* | *For each incident or event, the ICM Core System shall provide travelers and fleet operators with estimates of current travel times or travel delays within the corridor.* | L | 14 | |
| *PI-3.1.6.2* | *For each incident or event, the ICM Core System shall provide travelers and fleet operators with estimates of projected travel times or travel delays within the corridor at 15-minute intervals.* | L | 14 | |
| **PI-3.2** | **The ICM Core System shall inform corridor travelers, by multiple channels, of recommended detours around incidents.** | **H** | **14** | **Corridor Managemt** |
| PI-3.2.1 | The ICM Core System shall display information about recommended detour(s) on relevant CMSs within and around the corridor. | H | 14 | |
| *PI-3.2.1.1* | *The ICM Core System shall display, when needed, detour information on fixed CMSs operated by Caltrans along the I-210 freeway.* | H | 14 | |
| *PI-3.2.1.2* | *The ICM Core System shall display, when needed, detour information on fixed CMSs operated by Caltrans on relevant regional freeways.* | H | 14 | |

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| *PI-3.2.1.3* | *The ICM Core System shall display, when needed, relevant detour information on fixed CMSs operated along corridor arterials by local agencies.* | H | 14 | |
| *PI-3.2.1.4* | *The ICM Core System shall display, when needed, relevant detour information on mobile CMSs operated by local agencies.* | H | 14 | |
| *PI-3.2.1.5* | *The ICM Core System shall display, when needed, relevant detour information on extinguishable trailblazer signs operated along corridor arterials by local agencies.* | H | 14 | |
| PI-3.2.2 | The ICM Core System shall send information about recommended detour(s) to the regional 511 System. | H | 14 | |
| PI-3.2.3 | The ICM Core System shall send information about recommended detour(s) to participating third-party information providers. | H | 14 | |
| PI-3.2.4 | The ICM Core System shall make detour information available to navigation application providers (Waze, Google, etc.). | M | 14 | |
| **PI-3.3** | **The ICM Core System shall send mode-specific detour information to corridor travelers.** | **H** | **14** | **Corridor Managemt** |
| PI-3.3.1 | The ICM Core System shall send suitable detours around incidents and events to passenger cars. | H | 14 | |
| PI-3.3.2 | The ICM Core System shall send suitable detours around incidents and events to truck fleet dispatchers and/or truck operators. | H | 14 | |
| PI-3.3.3 | The ICM Core System shall send suitable detours around incidents and events to transit bus field supervisors and/or bus drivers. | M | 14 | |
| **PI-3.4** | **The ICM Core System shall guide vehicle operators along recommended detours.** | **H** | **14** | **Corridor Managemt** |
| PI-3.4.1 | The ICM Core System shall guide detouring traffic along recommended detours, using various channels that may include fixed CMSs, mobile CMSs, fixed extinguishable trailblazer signs, fixed static signs, hands-free mobile applications, and/or radio broadcasts. | H | 14 | |
| **PI-3.5** | **The ICM Environment shall send corridor travelers information on alternate transportation modes.** | **L** | **14** | **Corridor Managemt** |
| **PI-3.6** | **The ICM Environment shall provide travelers information about incidents and events occurring within the corridor in a consistent format.** | **H** | **14** | **Corridor Managemt** |

### 9.6.3. IMPLEMENTATION OVERRIDE

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **PI-4.1** | **Prior to initiating the implementation of an approved response plan, the ICM Core System shall check whether changes in corridor operations may warrant the development of a new response plan.** | **M** | **4** | **Decision Support** |
| PI-4.1.1 | Prior to initiating the implementation of an approved response plan, the ICM Core System shall check whether additional major incidents potentially requiring the development of an alternate response plan have occurred. | M | 4 | |
| PI-4.1.2 | Prior to initiating the implementation of an approved response plan, the ICM Core System shall check whether control assets set to be modified by the response plan are still available. | M | 4 | |
| **PI-4.2** | **The ICM Core System shall initiate the development of a new response plan if changes in corridor operations render the currently approved response plan obsolete before its implementation.** | **L** | **4** | **Decision Support** |

### 9.6.4. RESPONSE PLAN IMPLEMENTATION TRACKING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **PI-6.1** | **The ICM Core System shall track the implementation progress of approved response plans.** | **H** | **4** | **Corridor Managemt** |
| PI-6.1.1 | The ICM Core System shall track the implementation status of all programmed changes associated with an approved response plan. | H | 4 | |
| PI-6.1.2 | The ICM Core System shall log the time at which each recommended action has been implemented. | H | 4 | |
| PI-6.1.3 | The ICM Core System shall log any failure to implement a change request. | H | 4 | |
| **PI-6.2** | **Upon termination of an incident or event response plan, the ICM Core System shall ensure that all assets are returned to the state of operation that would have been in in effect had an incident or event not occurred.** | **H** | **4** | **Corridor Managemt** |
| **PI-6.3** | **The ICM Core System shall inform all TMC/TCS operators and transit field supervisors whether a recommended response has been successfully implemented.** | **H** | **4, 13** | **Corridor Managemt** |
| PI-6.3.1 | The ICM Core System shall inform TMC/TCS operators and transit field supervisors when a response plan has been successfully implemented in its entirety. | H | 4, 13 | |
| PI-6.3.2 | The ICM Core System shall inform individual TMC/TCS operators and transit field supervisors of all implemented changes within their jurisdiction. | H | 4, 13 | |
| PI-6.3.3 | The ICM Core System shall inform the Corridor Manager and relevant TMC operators and transit field supervisors if a recommended response plan cannot be implemented. | H | 4, 13 | |
| PI-6.3.4 | In the case of implementation failure, the ICM Core System shall indicate why a recommended response plan could not be implemented. | H | 4, 13 | |
| **PI-6.4** | **The ICM Core System shall inform all TMC/TCS operators and transit field supervisors when all corridor assets have been returned to normal operations.** | **H** | **4, 13** | **Corridor Managemt** |

### 9.6.5. RESPONSE PLANNING ARCHIVING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **PI-7.1** | **The ICM Core System shall log all control activities related to the implementation of an approved response plan.** | **H** | **15** | **Corridor Managemt** |
| **PI-7.2** | **The ICM Core System shall archive implemented response plans.** | **H** | **15** | **Data Hub** |

## 9.7. DATA MANAGEMENT

This section specifies the tasks that must be carried out by the Data Management function of the proposed ICM system, and many of the requirements listed here take the form of "Data Management shall..." The Data Management function is responsible for managing all types of data supporting the operation of the system, including functions that may be required to capture non-electronic data.

### 9.7.1. DATA QUALITY

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-1.1** | **The Corridor Technical Manager and Corridor Data Analyst shall develop a data quality management program for the ICM Environment.** | **H** | **1, 2** | **Institutional Job Tasks** |
| DM-1.1.1 | The data quality management program shall be guided by a Data Quality Management Guide, developed by the Corridor Technical Manager and Corridor Data Analyst. | H | 1, 2 | |
| DM-1.1.2 | The Corridor Data Analyst shall conduct a quarterly data quality assessment for all ICM Environment data elements and sources. | H | 1, 2 | |
| DM-1.1.3 | The data quality management program shall include a data governance board. At a minimum, the Corridor Technical Manager, Corridor Data Analyst, and a representative from each major stakeholder and provider of data shall be members of the data governance board. | H | 1, 2 | |
| DM-1.1.4 | The Corridor Data Analyst shall be responsible for ensuring data quality within the ICM environment. | H | 1, 2 | |
| DM-1.1.5 | The Corridor Technical Manager and Corridor Data Analyst shall ensure a data quality management plan is in place to specify processes, procedures, responsibilities, metrics, and best practices for measuring, monitoring, and correcting data issues within the ICM environment. | H | 1, 2 | |
| **DM-1.2** | **For the ICM Environment, data quality requirements shall be specified for all data sources and system data elements.** | **H** | **1, 2** | **Institutional Job Tasks** |
| DM-1.2.1 | Data quality indicators, requirements, and methods for calculating the quality must be defined and maintained for the system. Data quality characteristics shall be specified for each data element and source and shall include:<br>• Minimum and mean accuracy requirements<br>• Precision<br>• Validity checks and procedures<br>• Reliability (minimum MTBF)<br>• Timeliness<br>• Completeness<br>• Transaction integrity<br>• Required actions should data quality metrics not be met | H | 1, 2 | |
| DM-1.2.2 | Data quality requirements shall be specified based on the design and practical needs of the system consumers of each specific data element and data source. When there is more than one consumer of the data, data requirements shall meet the needs of all consumers of the data element or source. | H | 1, 2 | |

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| DM-1.2.3 | Data quality shall be monitored for each data element and data source. This includes calculating metrics for accuracy, validity, reliability, timeliness, and completeness. | H | 1, 2 | |
| DM-1.2.4 | Data quality monitoring shall be used to determine system component reliability and data quality over time. | H | 1, 2 | |
| DM-1.2.5 | Data quality monitoring statistics and trends shall be maintained and shall be used by the Corridor Manager to improve system performance. | H | 1, 2 | |
| DM-1.2.6 | The Corridor Data Analyst shall ensure the data quality measures and system calculation methods are reviewed on an annual basis. | H | 1, 2 | |
| **DM-1.3** | **Data quality shall be maintained.** | **H** | **1, 2** | **Institutional Job Tasks** |
| DM-1.3.1 | The actual quality of data, as determined by defined metrics, must be reviewed, and any deviations from data quality requirements must be corrected. 90% of data quality issues shall be corrected within 30 days of identification. | H | 1, 2 | |
| DM-1.3.2 | Data Analysts shall be responsible for day-to-day implementation of the data quality standards, ongoing review of ICM environment data quality, and initiation of corrective actions. | H | 1, 2 | |
| DM-1.3.3 | The Corridor Manager shall be responsible for ensuring adequate funding for the data quality management program and for funding and execution of any corrective actions required from data quality management actions. | H | 1, 2 | |

## 9.7.2. DATA MANAGEMENT NEEDS

### *9.7.2.1. Geographic and Institutional Data*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.1** | **Data Management shall store and provide access to information characterizing the corridor's institutional environment.** | **M** | **4, 7, 15** | **Data Hub** |
| DM-2.1.1 | Data Management shall store and provide institutional and organizational geographic boundaries. | L | 7, 15 | |
| DM-2.1.2 | Data Management shall store and provide organizational ownership and control geographic boundaries. | L | 7, 15 | |
| DM-2.1.3 | Data Management shall store and provide institutional and organizational department information and key staffing information. | L | 7, 15 | |
| DM-2.1.4 | Data management shall store and provide organization asset ownership information. | M | 4, 7, 15 | |

### *9.7.2.2. Asset Inventory*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.2** | **Data Management shall store or provide access to information characterizing freeway segments.** | **H** | **4, 5, 6, 15** | **Data Hub** |
| DM-2.2.1 | For each freeway segment, Data Management shall store or provide access to the following information:<br>• General characteristics | H | 4, 5, 6, 15 | |

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| | - Number of general-purpose traffic lanes<br>- Posted speed limit<br>- Upstream mainline freeway segments, on-ramps, and connectors feeding traffic to the segment<br>- Downstream mainline freeway segments, off-ramps, and connectors receiving traffic from the segment<br>- Left and right shoulder widths<br>- Median barrier height, if any<br>• HOV treatment<br>- Number of HOV lanes<br>- Type of HOV restriction (2+ or 3+ occupants)<br>- Periods during which HOV restriction is in effect<br>• Restrictions<br>- Vehicle height clearance under bridges or structures<br>- Truck use restrictions | | | |
| DM-2.2.2 | For each on-ramp or freeway-to-freeway connector, Data Management shall store or provide access to the following information:<br>• General characteristics:<br>- Number of general-purpose traffic lanes<br>- Posted speed limit<br>- Roadway link(s) feeding traffic to the ramp<br>- Mainline freeway segment(s) receiving traffic from the ramp<br>• HOV treatment:<br>- Number of HOV lanes<br>- Type of HOV restriction (2+ or 3+ occupants)<br>- Periods during which HOV restriction is in effect<br>• Ramp metering:<br>- Ramp meter present<br>- Type of ramp metering (fixed, adaptive, etc.)<br>- HOV vehicles allowed bypassing the ramp meter<br>• Restrictions:<br>- Vehicle height clearance under bridges or structures<br>- Truck use restriction | H | 4, 5, 6, 15 | |
| DM-2.2.3 | For each off-ramp, Data Management shall store or provide access to the following information:<br>• General characteristics:<br>- Number of general-purpose traffic lanes<br>- Posted speed limit<br>- Freeway segment(s) feeding traffic to the off-ramp<br>- Roadway segment(s) receiving left-turning, thru, and right-turning traffic from the off-ramp<br>• Restrictions:<br>- Vehicle height clearance under bridges or structures<br>- Truck use restriction | H | 4, 5, 6, 15 | |
| **DM-2.3** | **Data Management shall store or provide access to information characterizing arterial segments.** | **H** | **4, 5, 6, 15** | **Data Hub** |
| DM-2.3.1 | For each arterial segment, Data Management shall store or provide access to the following information:<br>• General characteristics:<br>- Number of through traffic lanes<br>- Posted speed limit<br>- Roadway segment(s) feeding traffic to the arterial segment<br>- Roadway segments receiving left-turning, thru and right-turning traffic from the arterial segment | H | 4, 5, 6, 15 | |

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| | - Presence of hard median barrier<br>• Restrictions:<br>- Left-turn restrictions<br>- Vehicle height clearance under bridges or structures<br>- Truck use restrictions<br>- Parking restrictions | | | |
| **DM-2.4** | **Data Management shall store or provide access to information characterizing relevant transit services operated within the corridor (rail lines, transit routes, etc.).** | **M** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.4.1 | Data Management shall maintain an inventory of commuter and express bus routes operated by Metro Bus within the corridor. | M | 4, 5, 6, 15 | |
| DM-2.4.2 | Data Management shall maintain an inventory of commuter and express bus routes operated by Foothill Transit within the corridor. | M | 4, 5, 6, 15 | |
| DM-2.4.3 | Data Management shall maintain an inventory of bus routes operated by Pasadena Transit. | M | 4, 5, 6, 15 | |
| DM-2.4.4 | Data Management shall store or provide access to the following information regarding the Metro Gold line:<br>• Hours of operation<br>• Frequency of service (by time of day and day of week)<br>• Location of stations<br>• Presence of park-and-ride facility at each station<br>• Total number of parking spaces in park-and-ride facility | M | 4, 5, 6, 15 | |
| DM-2.4.5 | Data Management shall store or provide access to the following information regarding commuter and express bus routes operated within the corridor:<br>• Route number<br>• Route operator<br>• Route followed<br>• Location of bus stops along route<br>• Hours of operation<br>• Frequency of service (by time of day and day of week) | M | 4, 5, 6, 15 | |
| **DM-2.5** | **Data Management shall store or provide access to information characterizing park-and-ride facilities operated within the corridor.** | **L** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.5.1 | Data Management shall maintain an inventory of park-and-ride facilities operated within the corridor. | L | 4, 5, 6, 15 | |
| DM-2.5.2 | Data Management shall store or provide access to the following information about park-and-ride facilities in operation within the corridor:<br>• Location of facility<br>• Facility operator<br>• Number of parking spaces available<br>• Whether a parking availability monitoring system is used | L | 4, 5, 6, 15 | |
| DM-2.5.3 | Data Management shall maintain an inventory of peak/non-peak curb parking restrictions along arterials that may be used as detours | L | 4, 5, 6, 15 | |
| **DM-2.6** | **Data Management shall store or provide access to information characterizing devices used to monitor traffic.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.6.1 | Data Management shall maintain an inventory of devices used to collect traffic flow data. | H | 4, 5, 6, 15 | |
| DM-2.6.2 | Data Management shall store or provide access to the following information for each device used to collect traffic flow data:<br>• Sensor location<br>• Sensor type<br>• Device owner<br>• Sensor identification number | H | 4, 5, 6, 15 | |

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| | • Reporting system to which the sensor is connected<br>• Movements covered by the sensor (through, left-turn, right-turn, combinations) | | | |
| DM-2.6.3 | Data Management shall maintain an inventory of devices used to monitor travel times. | H | 4, 5, 6, 15 | |
| DM-2.6.4 | Data Management shall store or provide access to the following information for each device used to collect travel times:<br>• Sensor location<br>• Sensor type<br>• Device owner<br>• Sensor identification number<br>• Reporting system to which the sensor is connected | H | 4, 5, 6, 15 | |
| **DM-2.7** | **Data Management shall store or provide access to information characterizing devices used to monitor weather conditions.** | **L** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.7.1 | Data Management shall maintain an inventory of field weather stations from which the ICM Environment draws weather information. | L | 4, 5, 6, 15 | |
| DM-2.7.2 | For each weather station set to supply information to the ICM Environment, Data Management shall store or provide access to the following information:<br>• Station location<br>• Station owner<br>• Inventory of measurement devices | L | 4, 5, 6, 15 | |
| **DM-2.8** | **Data Management shall store or provide access to information characterizing signalized intersections.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.8.1 | Data Management shall maintain an inventory of signalized intersections under ICM management. | H | 4, 5, 6, 15 | |
| DM-2.8.2 | For each signalized intersection under ICM management, Data Management shall store or provide access to the following information:<br>• Agency/Agencies owning the intersection<br>• Agency/Agencies responsible for operation and maintenance of intersection<br>• Type of signal controller used<br>• Controller firmware<br>• Number of approaches to the intersection | H | 4, 5, 6, 15 | |
| DM-2.8.3 | For each approach to a signalized intersection under ICM management, Data Management shall store or provide access to the following information:<br>• Lane assignments (number of left, thru, right lanes)<br>• Distance to upstream intersection<br>• Posted speed limit<br>• Length of left-turn bay, if any<br>• Length of right-turn bay, if any | H | 4, 5, 6, 15 | |
| **DM-2.9** | **Data Management shall store or provide access to information characterizing ramp metering operations within the corridor.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.9.1 | Data Management shall maintain an inventory of freeway ramps and freeway-to-freeway connectors equipped with ramp meters under ICM management. | H | 4, 5, 6, 15 | |
| DM-2.9.2 | For each metered on-ramp or freeway-to-freeway connector under ICM management, Data Management shall store or provide access to the following information:<br>• Location of ramp meter along the on-ramp or connector<br>• Type of signal controller used<br>• Ramp metering program installed in controller<br>• Distance of queue sensors from ramp metering stop line | H | 4, 5, 6, 15 | |

| DM-2.10 | **Data Management shall store or provide access to information characterizing devices that may be used to disseminate information to travelers.** | H | 4, 5, 6, 15 | Data Hub |
|---|---|---|---|---|
| DM-2.10.1 | Data Management shall maintain an inventory of fixed CMS devices within and outside the ICM corridor that may be used by to disseminate information to travelers. | H | 4, 5, 6, 15 | |
| DM-2.10.2 | Data Management shall maintain an inventory of portable CMS devices that may be used by to disseminate information to travelers. | H | 4, 5, 6, 15 | |
| DM-2.10.3 | Data Management shall maintain an inventory of extinguishable trailblazer signs that may be used by to disseminate information to travelers. | H | 4, 5, 6, 15 | |
| DM-2.10.4 | For each fixed CMS that may be used by the ICM Environment, Data Management shall store or provide access to the following information:<br>• Location of device<br>• Device operator<br>• Number of display lines<br>• Total number of characters that can be displayed per line | H | 4, 5, 6, 15 | |
| DM-2.10.5 | For each portable CMS that may be used by the ICM Environment, Data Management shall store or provide access to the following information:<br>• Device operator<br>• Location where device is normally stored when not used<br>• Number of display lines<br>• Total number of characters that can be displayed per line | H | 4, 5, 6, 15 | |
| DM-2.10.6 | For each extinguishable trailblazer sign that may be used by the ICM Environment, Data Management shall store or provide access to the following information:<br>• Location of device<br>• Device operator<br>• Message(s) displayed by device when lit | H | 4, 5, 6, 15 | |
| DM-2.10.7 | For each HAR that may be used by the ICM Environment, Data Management shall store or provide access to the following information:<br>• Station location<br>• Broadcast frequency<br>• Station operator | L | 4, 5, 6, 15 | |

*9.7.2.3. Asset Capabilities (Background Operational Data)*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.11** | **Data Management shall store or provide access to information characterizing typical traffic signal operations at relevant intersections within the ICM corridor.** | **H** | **4, 5, 6, 15** | **Data Hub** |
| DM-2.11.1 | For each signalized intersection under ICM management, Data Management shall store or provide access to the following information:<br>• Agency responsible for the operation of the intersection<br>• Agency responsible for maintenance<br>• Traffic control system managing the intersection<br>• Type of signal controller used<br>• Number of defined timing plans available | H | 4, 5, 6, 15 | |

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| DM-2.11.2 | For each signal timing plan, Data Management shall store or provide access to the following information:<br>• Typical times of operation<br>• Cycle length<br>• Signal offset<br>• Offset reference point within cycle<br>• Phase sequence<br>• Phase durations | H | 4, 5, 6, 15 | |
| DM-2.11.3 | For each approach to a signalized intersection, Data Management shall store or provide access to the following information:<br>• Prohibited right turn on red movements | M | 4, 5, 6, 15 | |
| **DM-2.12** | **Data Management shall store or provide access to information characterizing typical ramp metering operations within the ICM corridor.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.12.1 | For each metered on-ramp or freeway-to-freeway connector, Data Management shall store or provide access to the following information:<br>• Minimum and maximum ramp metering rates allowed<br>• Metering rate table<br>• Metering algorithm used | H | 4, 5, 6, 15 | |
| **DM-2.13** | **Data Management shall store or provide access to information identifying typical detour routes that should be considered when responding to incidents.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.13.1 | Data Management shall store or provide access to information identifying typical preferred detour routes that should be considered for passenger cars. | H | 4, 5, 6, 15 | |
| DM-2.13.2 | Data Management shall store or provide access to information identifying typical preferred detour routes that should be considered for buses. | H | 4, 5, 6, 15 | |

*9.7.2.4. Asset State Data*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.14** | **Data Management shall receive real-time data characterizing the operational status of devices supporting ICM operations.** | **H** | **4, 5, 6, 15** | **Data Hub** |
| DM-1.14.1 | For each traffic sensor, Data Management shall receive every 5 minutes or less the following device status data:<br>• Whether the device is operating normally<br>• Any error messages produced by the device or its associated management system | H | 4, 5, 6, 15 | |
| DM-2.14.2 | For each travel time measurement device, Data Management shall receive every 5 minutes or less the following status data:<br>• Whether the device is operating normally<br>• Any error messages produced by the device or its associated management system | H | 4, 5, 6, 15 | |
| DM-2.14.3 | For each signalized intersection, Data Management shall receive every 5 minutes or less the following device status data:<br>• Whether the signal is operating normally<br>• Timing plan in operation<br>• Any error messages produced by the device or its associated management system | H | 4, 5, 6, 15 | |

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| DM-2.14.4 | For each ramp meter, Data Management shall receive every 5 minutes or less the following device status data:<br>• Whether the ramp meter is operating<br>• Any error messages produced by the device or associated management system<br>• Metering rate currently in operation | H | 4, 5, 6, 15 | |
| DM-2.14.5 | For each fixed CMS, Data Management shall receive every 5 minutes or less the following device status data:<br>• Whether the sign is active<br>• Whether the sign is operating normally<br>• Any error messages produced by the device or its associated management system | H | 4, 5, 6, 15 | |
| DM-2.14.6 | For each portable CMS, Data Management shall receive every 5 minutes or less the following device status data:<br>• Whether the sign is active<br>• Whether the sign is operating normally<br>• Any error messages produced by the device or its associated management system | H | 4, 5, 6, 15 | |
| DM-2.14.7 | For each extinguishable trailblazer sign, Data Management shall receive every 5 minutes or less the following device status data:<br>• Whether the sign is active<br>• Whether the sign is operating normally<br>• Any error messages produced by the device or its associated management system | H | 4, 5, 6, 15 | |
| DM-2.14.8 | For each weather monitoring station providing data to the ICM Environment, Data Management shall receive every 15 minutes or less the following status data:<br>• Whether the weather station is operational<br>• Whether the monitoring station is operating normally<br>• Any error messages produced by the device or its associated data collection system | H | 4, 5, 6, 15 | |
| DM-2.14.9 | Data Management shall receive every 5 minutes the data indicating whether ICM Environment components are operating normally or not. | H | 4, 5, 6, 15 | |

### *9.7.2.5. Asset Real-Time Data*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.15** | **Data Management shall receive real-time traffic data from individual traffic sensors operating within the corridor.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.15.1 | Data Management shall receive every 1 minute or less the following data from each traffic sensor located on general-purpose or HOV freeway lanes:<br>• Recorded vehicle counts<br>• Measured sensor occupancy<br>• Estimated/measured speed | H | 4, 5, 6, 15 | |
| DM-2.15.2 | Data Management shall receive every 1 minute or less the following real-time data from each traffic sensor located on freeway on-ramps, off-ramps, and freeway-to-freeway connectors:<br>• Recorded vehicle counts<br>• Measured sensor occupancy | H | 4, 5, 6, 15 | |

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| DM-2.15.3 | Data Management shall receive every 5-15 minutes or less (details to be determined at design) the following real-time data from individual traffic sensors located along arterial segments:<br>• Recorded vehicle counts | H | 4, 5, 6, 15 | |
| DM-2.15.4 | Based on data received from traffic sensors located on mainline general-purpose or HOV lanes, Data Management shall calculate if necessary the following traffic statistics for each successive 5-minute interval for each sensor:<br>• Average observed vehicle flow (in vehicles per hour)<br>• Average estimated flow density (in vehicles per mile)<br>• Average observed traffic speed (in miles per hour) | H | 4, 5, 6, 15 | |
| DM-2.15.5 | Based on data received from traffic sensors located on freeway on-ramps and off-ramps, as well as freeway-to-freeway connectors, Data Management shall calculate if necessary the following traffic statistics for each successive 5-minute interval for each sensor:<br>• Average observed vehicle flow (in vehicles per hour)<br>• Average estimated flow density (in vehicles per mile)<br>• Average observed traffic speed (in miles per hour) | H | 4, 5, 6, 15 | |
| DM-2.15.6 | Based on data received from traffic sensors located on corridor arterials, Data Management shall calculate if necessary the following traffic statistics for each successive 5-minute interval for each sensor:<br>• Average observed vehicle flow (in vehicles per hour)<br>• Average estimated flow density (in vehicles per mile)<br>• Average observed traffic speed (in miles per hour) | H | 4, 5, 6, 15 | |
| **DM-2.16** | **Data Management shall receive real-time data from travel time measurement systems within the corridor.** | **M** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.16.1 | Data Management shall receive every 5 minutes or less travel time measurements from Bluetooth travel time measurement systems in operation within the corridor. | H | 4, 5, 6, 15 | |
| DM-2.16.2 | Data Management shall receive every 5 minutes or less travel time measurements from Pasadena's SMART system in operation along Orange Grove Boulevard. | H | 4, 5, 6, 15 | |
| **DM-2.17** | **Data Management shall receive real-time data from participating probe vehicle monitoring systems covering the ICM corridor.** | **L** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.17.1 | Data Management shall receive every 5 minutes or less vehicle-tracking data from participating operators of probe vehicle monitoring systems. | L | 4, 5, 6, 15 | |
| **DM-2.18** | **Data Management shall receive real-time data characterizing incidents and events occurring within the corridor.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.18.1 | Data Management shall receive every 5 minutes or less information updates about traffic incidents that have been identified to have occurred. | H | 4, 5, 6, 15 | |
| DM-2.18.2 | Data Management shall receive every 5 minutes or less information updates about active events affecting corridor operations. | H | 4, 5, 6, 15 | |
| DM-2.18.3 | Data Management shall receive every 5 minutes or less information updates about unusual traffic congestion patterns that may have been detected by the ICM Environment and Core System. | H | 4, 5, 6, 15 | |
| DM-2.18.4 | Data Management shall receive every 5 minutes or less information updates about planned lane closures scheduled to occur during the current operation day. | H | 4, 5, 6, 15 | |
| **DM-2.19** | **Data Management shall receive real-time data characterizing the operational performance of relevant transit services within the corridor.** | **M** | 4, 5, 6, 15 | **Data Hub** |

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| DM-2.19.1 | Data Management shall receive every 15 minutes or less updated information about transit service disruptions that may affect traffic demand on the corridor or the development or implementation of response plans. | M | 4, 5, 6, 15 | |
| *DM-2.19.1.1* | *Data Management shall receive from Metro Rail every 15 minutes or less updated information about major service disruptions along the Gold Line.* | M | 4, 5, 6, 15 | |
| *DM-2.19.1.2* | *Data Management shall receive from Metro Bus every 15 minutes or less updated information about major service disruptions along express buses routes of interest to ICM operations.* | M | 4, 5, 6, 15 | |
| *DM-2.19.1.3* | *Data Management shall receive from Foothill Transit every 15 minutes or less updated information about major service disruptions along express bus routes of interest to ICM operations.* | M | 4, 5, 6, 15 | |
| *DM-2.19.1.4* | *Data Management shall receive from Foothill Transit every 15 minutes or less updated information about major service disruptions along local bus routes of interest to ICM operations.* | M | 4, 5, 6, 15 | |
| *DM-2.19.1.5* | *Data Management shall receive from Pasadena Transit every 15 minutes or less updated information about major service disruptions along express bus routes of interest to ICM operations.* | M | 4, 5, 6, 15 | |
| *DM-2.19.1.6* | *Data Management shall receive from Pasadena Transit every 15 minutes or less updated information about major service disruptions along local bus routes of interest to ICM operations.* | M | 4, 5, 6, 15 | |
| **DM-2.21** | **Data Management shall receive real-time data characterizing observed ramp metering operations within the corridor.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.21.1 | For each ramp meter, Data Management shall receive the following information each time a change in metering rate is implemented within one minute of the time of the change:<br>• Time ramp metering rate was changed<br>• Metering rate that was activated | H | 4, 5, 6, 15 | |
| **DM-2.22** | **Data Management shall receive real-time data characterizing the current operational status of traffic signals in operation within the corridor.** | **H** | 4, 5, 6, 15 | **Data Hub** |
| DM-2.22.1 | For each signalized intersection under ICM surveillance, Data Management shall receive at the end of each signal cycle the following operational information:<br>• Signal timing plan in effect<br>• Start time of signal cycle<br>• Signal cycle length<br>• Signal coordination status<br>• Signal offset<br>• Offset reference phase | H | 4, 5, 6, 15 | |
| **DM-2.23** | **Data Management shall store information characterizing the typical range of values associated with the data received.** | **M** | 4, 5, 6, 15 | **Data Hub** |

### *9.7.2.6. Response Plan Data*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.24** | **Data Management shall maintain an updated list of active incidents and events affecting corridor operations.** | **H** | **4, 5, 6, 15** | **Data Hub** |

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| DM-2.24.1 | At any given time, Data Management shall maintain the following lists of active incidents and events affecting corridor operations:<br>• Active traffic incidents<br>• Active unusual congestion events reported by the ICM Environment or Core System<br>• Active transit incidents<br>• Active planned road/lane closures<br>• Active planned events<br>• Active weather events having the potential to affect travel conditions with the corridor | H | 4, 5, 6, 15 | |
| DM-2.24.2 | For each identified incident and event, Data Management shall collect and periodically update the following information characterizing the incident or event:<br>• Identification number assigned to the incident or event<br>• Location of incident or event<br>• Time incident occurred or event started<br>• Time all lanes were cleared or opened<br>• Time traffic conditions returned to normal<br>• Roadway segment(s) affected by incident or event<br>• Number of lanes closed on each affected roadway segment<br>• Location of closed lanes on each affected roadway segment<br>• Agency responsible for managing the incident / event traffic | H | 4, 5, 6, 15 | |
| **DM-2.25** | **Data Management shall maintain a log of response planning activities conducted as a result of an active incident or event.** | **H** | **6, 15** | **Data Hub** |
| DM-2.25.1 | Following the identification of an active incident or event, Data Management shall collect and periodically update the following information describing the resulting response planning activities:<br>• Identification number assigned to the incident or event<br>• Time when response planning activities were initiated<br>• Information about recommended response plans, if any:<br>- Time a recommended response plan was proposed<br>- Identification number of recommended response plan<br>- Response plan evaluation score<br>- Time response plan was approved<br>- Time response plan was implemented<br>- Time response plan was replaced by another plan or terminated<br>- Response plan element implementation schedule<br>- Response plan element implementation success or failure and time of implementation<br>• Time when response planning activities were terminated | H | 6, 15 | |
| **DM-2.26** | **Data Management shall collect and store information describing each developed response plan.** | **H** | **6, 15** | **Data Hub** |
| DM-2.26.1 | For each developed response plan, Data Management shall store or provide access to information describing the recommended control actions associated with the plan. This includes:<br>• Agencies involved in the implementation of the response plan<br>• Recommended alternate route(s) around incident/event for which the response plan was developed<br>- Recommended route(s) for passenger cars<br>- Recommended route(s) for buses<br>• Recommended metering actions at freeway on-ramp:<br>- Ramps with recommended full closure<br>- Ramps with recommended green ball operation | H | 6, 16 | |

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|---|---|---|---|---|
| | - Ramps with recommended metering change<br>- Recommended metering rate at each ramp<br>• Recommended traffic signal control actions:<br>- Intersections for which signal timing plans are to be changed<br>- Signal timing plan to activate at each identified intersection<br>• Information dissemination strategy:<br>- Messages to post on fixed CMSs<br>- Where to deploy portable CMSs and what message to post at each location<br>- Extinguishable trailblazer signs to activate<br>- Which HARs to activate and what message to broadcast on them<br>- Information to disseminate to the regional 511 System<br>- Information to make available to third-party information providers and mobile travel application developers<br>• Requested personnel deployments to specific corridor locations<br>• Implementation schedule | | | |
| **DM-2.27** | **Data Management shall collect and store information describing each implemented response plan.** | **H** | **6, 15** | **Data Hub** |
| DM-2.27.1 | For each implemented response plan, Data Management shall store or provide access to information describing the control actions taken. This includes:<br>• Time plan was activated<br>• Time plan was terminated (updated with another plan or closed)<br>• Agencies involved in the implementation of the plan<br>• Recommended alternate route(s) around the incident/event:<br>- Recommended route(s) for passenger cars<br>- Recommended route(s) for buses<br>• Recommended metering actions at freeway on-ramp:<br>- Ramps with recommended full closure<br>- Ramps with recommended green ball operation<br>- Ramps with recommended metering change<br>- Recommended metering rate at each ramp<br>• Recommended traffic signal control actions:<br>- Intersections for which signal timing plans are to be changed<br>- Signal timing plan to activate at each identified intersection<br>• Information dissemination strategy:<br>- Messages posted on fixed CMSs<br>- Locations where portable CMSs were deployed<br>- Message posted on each deployed portable CMS<br>- Extinguishable trailblazer signs activated<br>- Activated HARs, with what message broadcasted<br>- Information disseminated to the regional 511 System<br>- Information made available to third-party information providers and mobile travel application developers<br>• Requested personnel deployments to specific corridor locations<br>• Response plan element implementation times | H | 6, 16 | |

*9.7.2.7. Data Archiving*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.28** | **Data Management shall archive ICM Core System configuration elements** | **H** | **15** | **Data Hub** |
| DM-2.28.1 | Data Management shall archive road network information. | H | 15 | |
| DM-2.28.2 | Data Management shall archive ICM Core System configuration, security, error/fault, and status information. | H | 15 | |
| DM-2.28.3 | Data Management shall archive ICM Core System rules information. | H | 15 | |
| DM-2.28.4 | Data Management shall archive all asset capability data provided to the ICM Core system. | H | 15 | |
| **DM-2.29** | **Data Management shall archive data collected as part of ICM Core System operations** | **H** | **15** | **Data Hub** |
| DM-2.29.1 | Data Management shall archive all information collected about incidents and events occurring within the corridor. | H | 15 | |
| DM-2.29.2 | Data Management shall archive all real-time data collected from corridor assets. | H | 15 | |
| DM-2.29.3 | Data Management shall archive all traffic data collected from sensors that supply information to the ICM Core System. | H | 15 | |
| DM-2.29.4 | Data Management shall archive all weather data supplied to the ICM Core system. | H | 15 | |
| **DM-2.30** | **Data Management shall archive the results of decision-making activities conducted by the ICM Core System** | **H** | **15** | **Data Hub** |
| DM-2.30.1 | Data Management shall archive information detailing the response plans that were developed and implemented in response to specific incidents or events. | H | 15 | |
| DM-2.30.2 | Data Management shall archive traffic estimation and prediction information. | H | 15 | |
| **DM-2.31** | **Data Management shall provide a means for users to configure archiving functions.** | **M** | **16, 17** | **Data Hub** |
| DM-2.31.1 | Data Management shall include a function for users to specify pre-configured collections of data to be created for easy specification of archive data sets (for example, to archive one city's signal data separately from other cities'). | M | 16, 17 | |
| DM-2.31.2 | Data Management shall include a function for scheduling of data archiving tasks. | M | 16, 17 | |
| DM-2.31.3 | Data Management shall include a function for on-demand data archiving tasks. | M | 16, 17 | |
| DM-2.31.4 | Data Management shall include a function for the Corridor Data Analyst, in consultation with stakeholders, to specify the time period an archive data set will be retained. | M | 16, 17 | |
| DM-2.31.5 | Data Management shall include a function for the Corridor Data Analyst, in consultation with stakeholders, to edit the time period an archive data set will be retained. | M | 16, 17 | |
| DM-2.31.6 | Data Management shall produce a daily report of archive data sets that will expire within the next 7 days. | M | 16, 17 | |
| DM-2.31.7 | Data Management shall assign ownership of data archive sets to individuals or groups. | M | 16, 17 | |
| DM-2.31.8 | Data Management shall notify owners of data archives once/day for 7 days prior to removing an archived data set. | M | 16, 17 | |
| DM-2.31.9 | Data Management shall include a function for users to define event-based time boundaries for data sets to be archived. | M | 16, 17 | |

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| DM-2.31.10 | Data Management shall include a function for users to define geographic-based boundaries for data sets to be archived. | M | 16, 17 | |
| DM-2.31.11 | Data Management shall notify system administrators when the data maintained in the system reaches 75% of storage capacity. | M | 16, 17 | |
| DM-2.31.12 | Data Management shall notify system administrators when the data maintained in the system reaches 90% of storage capacity. | M | 16, 17 | |
| DM-2.31.13 | When the data 75% capacity threshold is exceeded, the system shall indicate the projected time to exceed the 100% storage capacity level of the system. | M | 16, 17 | |
| DM-2.31.14 | When the data 90% capacity threshold is exceeded, the system shall indicate the projected time to exceed the 100% storage capacity level of the system. | M | 16, 17 | |
| **DM-2.32** | **Data Management shall archive selected data sets for a period of 5 years.** | **M** | **6, 15** | **Data Hub** |
| DM-2.32.1 | Data Management shall archive all sensor and asset data received for a period of 5 years. | M | 6, 15 | |
| DM-2.32.2 | Data Management shall archive and maintain all archived response plans for a period of 5 years. | M | 6, 15 | |
| DM-2.32.3 | Data Management shall archive all corridor asset and roadway inventory and states for a period of 5 years. | M | 6, 15 | |
| DM-2.32.4 | Data Management shall archive all sensor and model results for a period of 5 years. | M | 6, 15 | |
| DM-2.32.5 | All archived data shall be made available through a single access point. | M | 6, 15 | |

*9.7.2.8. Maintenance Logs*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.33** | **Data Management shall collect and archive all maintenance alerts and notifications generated by the ICM Environment and Core System.** | **L** | **15** | **Data Hub** |
| **DM-2.34** | **Data Management shall collect and archive all maintenance activity logs entered by participating agencies.** | **L** | **15** | **Data Hub** |

*9.7.2.9. Administrative Logs*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-2.35** | **Data Management shall log when users access the system.** | **M** | **15** | **Corridor Managemt** |
| **DM-2.36** | **Data Management shall log ICM Core System and subsystem activities.** | **M** | **15** | **Corridor Managemt** |
| **DM-2.37** | **Data Management shall log all system changes made by system users.** | **M** | **15** | **Corridor Managemt** |

## 9.7.3. DATA COMMUNICATION INTERFACES

### *9.7.3.1. Incoming Data Communication Channels*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-3.1** | **Data Management shall include a function to retrieve data disseminated through regional communication networks.** | **H** | **1, 2, 7** | **Data Hub** |
| DM-3.1.1 | Data Management components shall include a function to retrieve data disseminated through the IEN. | H | 1, 2, 7 | |
| DM-3.1.2 | Data Management components shall include a function to retrieve data disseminated through RIITS. | H | 1, 2, 7 | |
| DM-3.1.3 | Data Management components shall include a function to retrieve data disseminated through Caltrans' Freeway Performance Measurement System (PeMS). | H | 1, 2, 7 | |
| **DM-3.2** | **Data Management shall receive traffic detection data from traffic management systems operated by local agencies.** | **H** | **1, 2** | **Data Hub** |
| DM-3.2.1 | Data Management shall receive traffic sensor data from Caltrans' freeway traffic surveillance system. | H | 1, 2 | |
| DM-3.2.2 | Data Management shall receive traffic sensor data from Caltrans' TSMSS system. | H | 1, 2 | |
| DM-3.2.3 | Data Management shall receive traffic sensor data from Pasadena's QuicNet system. | H | 1, 2 | |
| DM-3.2.4 | Data Management shall receive traffic sensor data from Pasadena's SCATS system. | H | 1, 2 | |
| DM-3.2.5 | Data Management shall receive traffic sensor data from Arcadia's TransSuite system. | H | 1, 2 | |
| DM-3.2.6 | Data Management shall receive traffic sensor data from Los Angeles County's KITS system. | H | 1, 2 | |
| DM-3.2.7 | Data Management shall receive traffic sensor data from Monrovia's KITS system hosted on the Los Angeles County KITS server. | H | 1, 2 | |
| DM-3.2.8 | Data Management shall receive traffic sensor data from Duarte's KITS system hosted on the Los Angeles County KITS server. | H | 1, 2 | |
| **DM-3.3** | **Data Management shall receive data from travel time monitoring systems installed within the corridor.** | **H** | **1** | **Data Hub** |
| DM-3.3.1 | Data Management shall receive travel time data collected by Pasadena's Digiwest BlueMAC system. | H | 1 | |
| DM-3.3.2 | Data Management shall receive travel time data collected by Pasadena's SMART Signal System deployed along Orange Grove. | M | 1 | |
| DM-3.3.3 | Data Management shall receive travel time data collected by Arcadia's Iteris Vantage system. | H | 1 | |
| DM-3.3.4 | Data Management shall receive travel time data from the travel time monitoring system used by the Los Angeles County Department of Public Works. | H | 1 | |
| DM-3.3.5 | Data Management shall receive travel time data from the system used by the City of Monrovia to monitor travel times on city arterials. | H | 1 | |
| DM-3.3.6 | Data Management shall receive travel time data from the system used by the City of Duarte to monitor travel times on city arterials, if different from Los Angeles County's system. | H | 1 | |
| DM-3.3.7 | Data Management shall receive travel time data from the system used by Caltrans to monitor travel times along the sections of I-210, SR-134, and I-605 freeways under ICM management. | M | 1 | |

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| **DM-3.4** | **Data Management shall receive data from participating probe data providers.** | **L** | **1, 2** | **Data Hub** |
| **DM-3.5** | **Data Management shall receive operational data from transit management systems.** | **M** | **1, 2** | **Data Hub** |
| DM-3.5.1 | Data Management shall receive operational data from Metro Rail CAD/AVL system disseminated through RIITS. | M | 1, 2 | |
| DM-3.5.2 | Data Management shall receive operational data from Metro Bus CAD/AVL system disseminated through RIITS. | M | 1, 2 | |
| DM-3.5.3 | Data Management shall receive operational data from Foothill Transit CAD/AVL system disseminated through RIITS. | M | 1, 2 | |
| DM-3.5.4 | Data Management shall receive operational data from Pasadena Transit CAD/AVL system disseminated through RIITS. | M | 1, 2 | |
| **DM-3.6** | **Data Management shall receive traffic signal operational data from traffic management systems operated by local agencies.** | **L** | **3** | **Data Hub** |
| DM-3.6.1 | Data Management shall receive traffic signal status data from Caltrans' TSMSS. | L | 3 | |
| DM-3.6.2 | Data Management shall receive ramp metering signal status data from Caltrans' ATMS. | L | 3 | |
| DM-3.6.3 | Data Management shall receive traffic signal status data from Pasadena's Transparity system. | L | 3 | |
| DM-3.6.4 | Data Management shall receive traffic signal status data from Pasadena's SCATS system. | L | 3 | |
| DM-3.6.5 | Data Management shall receive traffic signal status data from Arcadia's TransSuite system. | L | 3 | |
| DM-3.6.6 | Data Management shall receive traffic signal status data from Los Angeles County's KITS system. | L | 3 | |
| DM-3.6.7 | Data Management shall receive traffic signal status data from Monrovia's KITS system hosted on the Los Angeles County KITS server. | L | 3 | |
| DM-3.6.8 | Data Management shall receive traffic signal status data from Duarte's KITS system hosted on the Los Angeles County KITS server. | L | 3 | |
| **DM-3.7** | **Data Management shall receive operational data from electronic traveler information message signs operated along corridor roadways of interest.** | **L** | **3** | **Data Hub** |
| DM-3.7.1 | Data Management shall receive operational data on fixed CMSs operated along freeways within the corridor from Caltrans ATMS. | L | 3 | |
| DM-3.7.2 | Data Management shall receive operational data on fixed CMSs operated along roadways within Pasadena from the systems used by the city to manage the devices. | L | 3 | |
| DM-3.7.3 | Data Management shall receive operational data on fixed CMSs that may be installed by Los Angeles County, Arcadia, Monrovia, or Duarte along corridor arterials. | L | 3 | |
| DM-3.7.4 | Data Management shall receive operational data from extinguishable trailblazer signs that may be installed along corridor arterials to guide travelers along a recommended detour. | L | 3 | |
| **DM-3.8** | **Data Management shall receive operational data from HAR stations within and around the corridor used to disseminate information to travelers.** | **L** | **3** | **Data Hub** |
| **DM-3.9** | **Data Management shall receive incident information from dispatch systems used by first responders.** | **L** | **1** | **Data Hub** |
| DM-3.9.1 | Data Management shall retrieve incident data posted by the CHP on its Computer-Aided Dispatch Traffic Application. | L | 1 | |
| DM-3.9.2 | Data Management shall receive incident data from the dispatch system used by the Los Angeles County Sheriff's Department. | L | 1 | |
| DM-3.9.3 | Data Management shall receive incident data from the Verdugo Communications Center dispatch system. | L | 1 | |

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| DM-3.9.4 | Data Management shall receive incident data from the dispatch system used by the Pasadena Police Department. | L | 1 | |
| DM-3.9.5 | Data Management shall receive incident data from the dispatch system used by the Arcadia Police Department. | L | 1 | |
| DM-3.9.6 | Data Management shall receive incident data from the dispatch system used by the Monrovia Police Department. | L | 1 | |
| **DM-3.10** | **Data Management shall receive planned lane closures from systems maintained by roadway management agencies.** | **M** | **1** | **Data Hub** |
| DM-3.10.1 | Data Management shall retrieve planned lane closure information from Caltrans' Lane Closure System. | M | 1 | |
| DM-3.10.2 | Data Management shall retrieve planned lane closure information from the Los Angeles County Lane Closure Website. | M | 1 | |
| **DM-3.11** | **Data Management shall receive alerts from regional notification systems.** | **L** | **1** | **Data Hub** |
| DM-3.11.1 | Data Management shall receive incident/event alerts related to the I-210 corridor disseminated through Metro's Everbridge mass notification platform. | L | 1 | |
| DM-3.11.2 | Data Management shall receive SigAlerts messages related to the I-210 posted by the CHP on its Web Service. | L | 1 | |
| **DM-3.12** | **Data Management shall receive incident data from crowd-sourcing applications.** | **L** | **1** | **Data Hub** |
| DM-3.12.1 | Data Management shall receive incident data from participating crowd-sourcing application developers. | L | 1 | |
| **DM-3.13** | **Data Management shall use communication protocols and methods for incoming data appropriate to the design needs of the system.** | **H** | **1** | **Data Hub** |
| **DM-3.14** | **Data Management shall use data transformation methods for all incoming data appropriate to the specific data formats and communication protocols and its intended use within the system. Possible transformation methods may include ETL, streaming, service layers, or others. Specific methods shall be defined during system design.** | **H** | **1** | **Data Hub** |
| **DM-3.15** | **Data Management shall use the system of record, as defined in the System Integration requirements, as the initial source or final destination for data.** | **H** | **1** | **Data Hub** |

### *9.7.3.2. Outgoing Data Communication Channels*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-3.16** | **The ICM Core System shall include a function to disseminate data using regional communication networks.** | **H** | **7, 13** | **Corridor Managemt** |
| DM-3.16.1 | The ICM Core System components shall include a function to send data through the IEN. | H | 7, 13 | |
| DM-3.16.1 | The ICM Core System components shall include a function to send data through RIITS. | H | 7, 13 | |
| **DM-3.17** | **The ICM Core System shall include a function to send traffic signal change requests to traffic management systems operated by local agencies.** | **H** | **8** | **Corridor Managemt** |
| DM-3.17.1 | The ICM Core System shall include a function to send traffic signal change requests to Caltrans' TSMSS system. | H | 8 | |
| DM-3.17.2 | The ICM Core System shall include a function to send traffic signal change requests to Pasadena's Transparity system. | H | 8 | |
| DM-3.17.3 | The ICM Core System shall include a function to send traffic signal change requests to Pasadena's SCATS system. | H | 8 | |
| DM-3.17.4 | The ICM Core System shall include a function to send traffic signal change requests to Arcadia's TransSuite system. | H | 8 | |

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| DM-3.17.5 | The ICM Core System shall include a function to send traffic signal change requests to Los Angeles County's KITS system. | H | 8 | |
| DM-3.17.6 | The ICM Core System shall include a function to send traffic signal change requests to Monrovia's KITS system hosted on the Los Angeles County KITS server. | H | 8 | |
| DM-3.17.7 | The ICM Core System shall include a function to send traffic signal change requests to Duarte's KITS system hosted on the Los Angeles County KITS server. | H | 8 | |
| **DM-3.18** | **The ICM Core System shall include a function to change metering rates in operation at freeway on-ramps and freeway-to-freeway connectors.** | **H** | **8** | **Corridor Managemt** |
| DM-3.18.1 | The ICM Core System shall include a function to send metering rate requests to the ATMS module used by Caltrans to manage ramp-metering operations. | H | 8 | |
| **DM-3.19** | **The ICM Core System shall include a function to send message posting requests to electronic message signs used to disseminate information to travelers within the corridor.** | **M** | **8** | **Corridor Managemt** |
| DM-3.19.1 | The ICM Core System shall include a function to send message posting requests to the system used by Caltrans to manage the fixed CMSs it operates along regional freeways. | M | 8 | |
| DM-3.19.2 | The ICM Core System shall include a function to send message requests to the system used by Pasadena to manage the fixed CMSs in operation along the city's local arterial network. | M | 8 | |
| DM-3.19.3 | The ICM Core System shall include a function to send message requests to the system used to manage future fixed CMSs that may be operated by Los Angeles County, Arcadia, Monrovia, and/or Duarte. | M | 8 | |
| DM-3.19.4 | The ICM Core System shall include a function to send message posting requests to portable CMSs with wireless communication capabilities that may be deployed during an incident or event. | M | 8 | |
| DM-3.19.5 | The ICM Core System shall include a function to send activation/deactivation requests to extinguishable trailblazer signs in operation in and around the corridor. | M | 8 | |
| **DM-3.20** | **The ICM Core System shall include a function to send message broadcast requests to HAR stations used to disseminate information to travelers in and around the corridor.** | **L** | **8** | **Corridor Managemt** |
| **DM-3.21** | **The ICM Core System shall include a function to send relevant information to participating first responding agencies.** | **M** | **13** | **Corridor Managemt** |
| DM-3.21.1 | The ICM Core System shall include a function to send relevant messages/data to CHP designated dispatchers/supervisors. | M | 13 | |
| DM-3.21.2 | The ICM Core System shall include a function to send relevant messages/data to Los Angeles County Sheriff designated dispatchers/supervisors. | M | 13 | |
| DM-3.21.3 | The ICM Core System shall include a function to send relevant messages/data to Pasadena Police Department designated dispatchers/supervisors. | M | 13 | |
| DM-3.21.4 | The ICM Core System shall include a function to send relevant messages/data to Arcadia Police Department designated dispatchers/supervisors. | M | 13 | |
| DM-3.21.5 | The ICM Core System shall include a function to send relevant messages/data to Monrovia Police Department designated dispatchers/supervisors. | M | 13 | |
| DM-3.21.6 | The ICM Core System shall include a function to send relevant messages/data to Verdugo Fire Communications dispatchers. | M | 13 | |
| **DM-3.22** | **The ICM Core System shall include a function to send relevant information to participating transit agencies.** | **M** | **13** | **Corridor Managemt** |

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| DM-3.22.1 | The ICM Core System shall include a function to send relevant messages/data to Metro Rail's train dispatchers/supervisors at Metro's Rail Operations Center. | M | 13 | |
| DM-3.22.2 | The ICM Core System shall include a function to send relevant messages to Metro Bus's vehicle dispatchers/supervisors at Metro's Bus Operations Center. | M | 13 | |
| DM-3.22.3 | The ICM Core System shall include a function to send relevant messages to Foothill Transit vehicle dispatchers/supervisors. | M | 13 | |
| DM-3.22.4 | The ICM Core System shall include a function to send relevant messages/data to Pasadena Transit vehicle dispatchers/supervisors. | L | 13 | |
| DM-3.22.5 | The ICM Core System shall include a function to send relevant messages/data to Arcadia Transit vehicle dispatchers/supervisors. | L | 13 | |
| **DM-3.23** | **The ICM Core System shall include a function to send alerts to participating agencies.** | **L** | **13** | **Corridor Managemt** |
| DM-3.23.1 | The ICM Core System shall include a function to send incident alerts to agencies connected to Metro's Everbridge mass notification platform. | L | 13 | |
| **DM-3.24** | **The ICM Core System shall include a function to send information to regional traveler information systems.** | **M** | **14** | **Corridor Managemt** |
| DM-3.24.1 | The ICM Core System shall include a function to send travel information to the regional 511 System operated by Metro. | M | 14 | |
| DM-3.24.2 | The ICM Core System shall include a function for third-party information providers to access relevant travel information. | M | 14 | |
| **DM-3.25** | **The ICM Core System shall include a function to send information to traveler information systems used by truck fleet dispatchers and truck operators.** | **L** | **14** | **Corridor Managemt** |

### 9.7.4. DATA FORMATS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-4.1** | **The ICM Environment shall store or provide access to data in commonly used formats.** | **H** | **7, 15** | **Data Hub** |
| DM-4.1.1 | To the extent possible, the ICM Environment shall transmit data in the Transportation Management Data Dictionary (TMDD) or National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) format. | H | 7, 15 | |
| DM-4.1.2 | To the extent possible, the ICM Environment shall store or provide access to collected transit route data in the General Transit Feed Specification (GTFS) format. | L | 7, 15 | |
| **DM-4.2** | **Collected traffic data shall be aggregated in intervals no longer than 15 minutes. All data aggregations shall be appropriate to the intended use of the information.** | **M** | **7, 15** | **Data Hub** |
| **DM-4.3** | **All data used by the ICM Environment shall be stored in electronic format.** | **M** | **7, 15** | **Data Hub** |
| DM-4.3.1 | All data provided by external sources used by the ICM Environment shall be stored in electronic format. At a minimum it shall be stored in the Data Hub. It may also be stored internally within system components, based on the needs of the system and the components. | M | 7, 15 | |
| DM-4.3.2 | All data provided by the ICM Environment to external consumers shall be stored in electronic format. At a minimum it shall be stored in the Data Hub. | M | 7, 15 | |
| DM-4.3.3 | All data processed internally by the system that crosses an ICM Environment system or subsystem boundary, as defined by the system design documentation, shall be stored within the Data Hub. | M | 7, 15 | |

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| DM-4.3.4 | All system development documentation shall be made available in electronic format upon delivery and shall be made available for users from the system user interfaces. This includes<br>• System requirements documents<br>• System design documents<br>• Development process documents<br>• Concept of operations<br>• Test plans<br>• Standards and specifications used in development and deployment<br>• Test results and reports<br>• Deployment documentation<br>• Installation instructions | M | 7, 15 | |
| DM-4.3.5 | All ICM Environment operations documentation shall be delivered electronically and made available from the system user interface. This includes:<br>• System operator manuals<br>• Operational process and procedure documentation<br>• Traffic engineering standards for use in the corridor<br>• Maintenance manuals<br>• Hardware/software operational documentation and manuals<br>• Traffic and operating information for traffic infrastructure assets<br>• Other operations documentation | M | 7, 15 | |
| DM-4.3.6 | As part of the quarterly or annual data reviews, the Corridor Technical Manager and Corridor Data Analyst shall conduct a review of data stored both in electronic and non-electronic formats, and its availability to users of the system. A minimum of 95% of all data shall be stored in electronic format. The review shall also include for each non-electronic format data element a method for storing in electronic format and a target date for capture in electronic format. | M | 7, 15 | |

### 9.7.5. DATA VERIFICATION AND VALIDATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-5.1** | **Data Management shall validate all field measurements.** | **H** | **1, 2** | **Data Hub** |
| DM-5.1.1 | Data Management shall validate unverified traffic data obtained from traffic sensor data, using validated historical data and expected values for the period associated with the data. | H | 1, 2 | |
| *DM-5.1.1.1* | *Data Management shall validate unverified traffic volume data obtained from traffic sensor data, using validated historical data and expected values for the period associated with the data.* | H | 1, 2 | |
| *DM-5.1.1.2* | *Data Management shall validate unverified sensor occupancy data obtained from traffic sensor data, using validated historical data and expected values for the period associated with the data.* | H | 1 | |
| *DM-5.1.1.3* | *Data Management shall validate unverified traffic speed estimates obtained from traffic sensor data, using validated historical data and expected values for the period associated with the data.* | H | 1 | |

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| *DM-5.1.1.4* | *Data Management shall validate unverified travel time measurements obtained from travel time monitoring systems, using validated historical data and expected values for the period associated with the data.* | H | 1 | |
| DM-5.1.3 | Data Management shall validate received incident/event data, using validated historical data and expected values for the period associated with the data. | H | 1 | |
| DM-5.1.4 | Data Management shall validate unverified transit data received from participating transit agencies, using validated historical data and expected values for the period associated with the data. | L | 1, 2 | |
| DM-5.1.5 | Data Management shall validate unverified parking occupancy data obtained from parking management systems, using validated historical data and expected values for the period associated with the data. | L | 1, 2 | |
| DM-5.1.6 | Data Management shall validate received weather data, using validated historical data and expected values for the period associated with the data. | L | 1 | |
| **DM-5.2** | **Data Management shall validate all received control device data that have not been previously validated by the system supplying the information.** | **H** | **3** | **Data Hub** |
| DM-5.2.1 | Data Management shall validate unverified operational data received from control devices connected to the ICM system, using validated historical data and expected values for the period associated with the data. | H | 3 | |
| *DM-5.2.1.1* | *Data Management shall validate unverified received signal timing data, using validated historical data and expected values for the period associated with the data.* | H | 3 | |
| *DM-5.2.1.2* | *Data Management shall validate unverified received ramp metering data, using validated historical data and expected values for the period associated with the data.* | H | 3 | |
| *DM-5.2.1.3* | *Data Management shall validate unverified received fixed CMS operational data, using validated historical data and expected values for the period associated with the data.* | H | 3 | |
| **DM-5.4** | **Data Management shall mark as "potentially invalid" received field measurements data failing a verification or validation test.** | **H** | **1, 2, 3** | **Data Hub** |
| DM-5.4.1 | Data Management shall mark as "potentially invalid" unverified flow measurements received from field devices or systems deviating by more than two standard deviations from the historical average or falling outside a user-defined accepted range for the corresponding time period in the absence of active major incidents/events. | H | 1, 2, 3 | |
| DM-5.4.2 | Data Management shall mark as "potentially invalid" unverified intersection turning counts received from field devices or systems deviating by more than two standard deviations from the historical average or falling outside a user-defined accepted range for the corresponding time period in the absence of active major incidents/events. | H | 1, 2, 3 | |
| DM-5.4.3 | Data Management shall mark as "potentially invalid" unverified speed measurements or estimates received from field devices or systems deviating by more than two standard deviations from the historical average or falling outside a user-defined accepted range for the corresponding time period in the absence of active major incidents/events. | H | 1, 2, 3 | |
| DM-5.4.4 | Data Management shall mark as "potentially invalid" unverified travel time measurements received from field devices or systems deviating by more than two standard deviations from the historical | H | 1, 2, 3 | |

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| | average or falling outside a user-defined accepted range for the corresponding time period in the absence of active major incidents/events. | | | |
| DM-5.4.5 | Data Management shall mark as "potentially invalid" unverified parking occupancy data received from parking management systems deviating by more than two standard deviations from the historical average or falling outside a user-defined accepted range for the corresponding time period in the absence of active major incidents/events. | H | 1, 2, 3 | |
| DM-5.4.6 | Data Management shall mark as "potentially invalid" unverified data received from transit agencies deviating by more than two standard deviations or falling outside a user-defined accepted range from the historical average for the corresponding time period in the absence of active major incidents/events. | H | 1, 2, 3 | |
| DM-5.4.7 | Data Management shall mark as "potentially invalid" any weather data received from weather stations falling outside a user-defined accepted range. | H | 1, 2, 3 | |
| **DM-5.5** | **Data Management shall include a function to determine a range of typical values for the data that may be supplied by traffic management devices.** | **M** | **3** | **Data Hub** |
| DM-5.5.1 | Data Management shall include a function to determine a range of typical values for the data that may be supplied by traffic signal control systems. | M | 3 | |
| DM-5.5.2 | Data Management shall include a function to determine a range of typical values for the data that may be supplied by Caltrans' ramp metering system. | M | 3 | |
| DM-5.5.3 | Data Management shall include a function to determine a range of typical values for the data that may be supplied by CMS management systems. | M | 3 | |
| **DM-5.6** | **Data Management shall mark as "invalid" data received from traffic management devices falling outside the normal range of values associated with the device operations.** | **M** | **1, 2, 3** | **Data Hub** |
| **DM-5.7** | **The ICM Core System shall not use invalid or erroneous data in its corridor operational assessments and decision-making processes.** | **H** | **4, 5, 6** | **Data Hub** |
| DM-5.7.1 | The ICM Core System shall ignore any data marked as having failed a validity test. | H | 4, 5, 6 | |
| DM-5.7.2 | The ICM Core System shall ignore redundant data. | H | 4, 5, 6 | |
| **DM-5.8** | **The ICM Environment shall inform relevant TMC and TCS operators when data anomalies or abnormalities are identified.** | **H** | **17** | **Corridor Managemt** |
| DM-5.8.1 | The ICM Environment shall inform the designated maintenance manager of the agency operating a device when anomalies or abnormalities are identified in the data received from the device. | H | 17 | |
| DM-5.8.2 | The ICM Environment shall inform the Traffic Engineer of the agency operating a device when anomalies or abnormalities are identified in the data received from the device. | H | 17 | |
| DM-5.8.3 | The ICM Environment shall inform ICM Environment users when anomalies or abnormalities are identified in the data received from a device connected to the ICM system. | H | 17 | |
| **DM-5.9** | **The ICM Environment shall submit for review field measurement data that have been flagged as "potentially invalid".** | **H** | **17** | **Corridor Managemt** |

### 9.7.6. DATA STORAGE AND WAREHOUSING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-6.1** | **Data Management shall store in a central repository all data utilized or created by the system not being stored elsewhere.** | **H** | **7, 15** | **Data Hub** |
| **DM-6.2** | **Data Management shall store in a central repository all data characterizing the operation of the ICM Core System not stored elsewhere.** | **H** | **7, 15** | **Data Hub** |
| **DM-6.4** | **Data shall be stored using state-of-the-art technology by methods that are extensible and scalable.** | **H** | **7, 15** | **Data Hub** |
| **DM-6.5** | **Data shall be stored using technologies appropriate to the design needs of the system (performance, cost, size, etc.). Technologies shall include both SQL and Non-SQL technologies as dictated by design needs and constraints.** | **H** | **7, 15** | **Data Hub** |

### 9.7.7. DATA DOCUMENTATION AND MAINTENANCE

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DM-7.1** | **The ICM Environment shall have an ICM data dictionary.** | **H** | **18** | **Data Hub** |
| DM-7.1.1 | The Data Dictionary shall contain a listing of all Data Hub data elements, their definition, data format, and size. | H | 18 | |
| DM-7.1.2 | The Data Dictionary shall contain a listing of all data sources and their data elements, their definition, data format, and size. | H | 18 | |
| DM-7.1.3 | The Data Dictionary shall contain a listing of all externally available data provided by the system, including their data elements, their definition, data format, and size. | H | 18 | |
| DM-7.1.4 | The Data Dictionary shall contain a listing of all available system-produced, externally available interfaces and messages, documenting the data available, transmission protocols, and formats. | H | 18 | |
| DM-7.1.6 | The Data Dictionary shall describe system standards for capturing and managing data, including issues of the time value of data, data provenance, data types, data standard use and selection, and data security. | H | 18 | |
| DM-7.1.7 | The Data Dictionary shall describe data quality standards for all data elements. | H | 18 | |
| *DM-7.1.7.1* | *Data quality standards shall include standards for:*<br>• *Data accuracy*<br>• *Methods to measure and verify data quality*<br>• *Required levels of data quality (such as degraded performance vs. unable to perform function results)*<br>• *Required responses for data that does not meet data quality standards*<br>• *Required timeliness standards for each data source*<br>• *Required completeness for each data source* | H | 18 | |
| *DM-7.1.7.2* | *Data quality shall be uniquely specified for each data source and internally processed data element.* | H | 18 | |
| *DM-7.1.7.3* | *90% of all data elements must include a data quality standard.* | H | 18 | |

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| DM-7.1.8 | The Data Dictionary shall describe system standards and validation. Included will be specific data validation specifications for all incoming and processed data elements. | H | 18 | |
| DM-7.1.9 | Maintenance including updates, reviews, and accuracy of the Data Dictionary shall be the responsibility of the Corridor Data Analyst, along with assigned data analysts and database administrators. | H | 18 | |
| **DM-7.2** | **The Corridor Data Analyst shall ensure that all data has a data quality specification and that data is meeting those specifications at all times.** | **H** | **18** | **Institutional Job Tasks** |
| DM-7.2.1 | The Corridor Data Analyst shall ensure that the data quality specifications are being met within the ICM Environment and that both automated and human processes are in place and in use for ensuring and measuring the quality of data and for addressing data quality issues when they arise. | H | 18 | |
| DM-7.2.2 | The Corridor Data Analyst shall ensure that the following metrics are established, measured, and met for all data:<br>• maximum time to detect errors or problems with data quality<br>• maximum time to correct errors or problems<br>• mean time to detect errors or problems<br>• mean time to correct errors or problems | H | 18 | |
| DM-7.2.3 | The Corridor Data Analyst shall measure and report on mean time between failure for all data quality metrics. | H | 18 | |
| DM-7.2.4 | The Corridor Data Analyst shall promptly report all identified data quality failures to the Corridor Manager and stakeholders. | H | 18 | |
| DM-7.2.5 | The Corridor Data Analyst shall report on the status of corrections being executed to address data quality failures. This includes reporting on the time needed to perform the correction. | H | 18 | |
| DM-7.2.6 | The Corridor Data Analyst shall conduct a weekly corridor data review, using data quality metrics specified in the Data Dictionary. | H | 18 | |
| *DM-7.2.6.1* | *The Corridor Data Analyst shall initiate any actions required to address issues identified, either during system operation or as a result of the weekly review.* | H | 18 | |
| *DM-7.2.6.2* | *90% of all issues identified must be corrected within 30 days.* | H | 18 | |
| DM-7.2.7 | The Corridor Data Analyst and Corridor Manager shall conduct quarterly and annual reviews of the system data. Reviews shall include:<br>• Measures of the data quality for the quarter and year<br>• Status of the data dictionary<br>• A change management review of the system data sources, data processes, data hub, and externally available data elements<br>• System performance<br>• Recommended actions to improve data, data processes, and data quality | H | 18 | |
| DM-7.2.8 | Annual reviews of system data and data quality must include an independent external review. | H | 18 | |
| DM-7.2.9 | The Corridor Manager and Corridor Data Analyst are responsible to ensure that the quarterly and annual data review recommendations are funded and executed. | H | 18 | |
| **DM-7.3** | **Stakeholders shall be able to communicate needs for data additions, removals, or format changes to the system data processes and design.** | **H** | **18** | **Institutional Job Tasks** |

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| DM-7.3.1 | Corridor stakeholders shall be responsible for notifying the Corridor Data Analyst of any desired changes to data processing or externally available data elements. | H | 18 | |
| DM-7.3.2 | Corridor stakeholders shall be responsible for notifying the Corridor Data Analyst of any changes to data sources from systems owned by the stakeholder. | H | 18 | |
| DM-7.3.3 | The Corridor Data Analyst, using the approved system change management processes, shall determine the appropriateness of the changes and, if appropriate, perform the maintenance. Examples include: Vehicle-to-Infrastructure data or probe data from third-party vendors. | H | 18 | |
| DM-7.3.4 | The Corridor Data Analyst shall be responsible for any and all changes to the Data Dictionary. | H | 18 | |

## 9.8. DECISION SUPPORT

This section specifies the tasks that must be carried out by the Decision Support function of the proposed ICM system, and many of the requirements listed here take the form of "Decision Support shall..." Decision Support is defined as a set of automated processes that assist human operators in making decisions involving large amounts of data, multiple solution sets, and knowledge captured as rules.

### 9.8.1. CORRIDOR ROAD AND ASSET INFORMATION ACCESS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DS-1.1** | **Decision Support shall receive from Data Management the status of the road network, including current incident information, roadway maintenance actions, and closures.** | **H** | **3** | **Decision Support** |
| DS-1.1.1 | Decision Support shall receive all road status information from Data Management at a frequency of 30 seconds or less | H | 3 | |
| DS-1.1.2 | All road status information received from Data Management shall be processed and available to Decision Support within 1 minute of the data's time of measurement. | H | 3 | |
| **DS-1.2** | **Decision Support shall receive from Data Management current sensor data** | **H** | **1, 2** | **Decision Support** |
| DS-1.2.1 | Decision Support shall receive sensor data from Data Management at a frequency of every 30 seconds or less | H | 1, 2 | |
| DS-1.2.2 | All sensor data received from Data Management shall be processed and available to Decision Support within 1 minute of the data's time of measurement. | H | 1, 2 | |
| **DS-1.3** | **Decision Support shall receive from Data Management the operational status of the traffic control assets, including traffic sensors, environmental sensors, intersection signals, ramp meters, and CMS devices.** | **H** | **1, 2, 3** | **Decision Support** |
| DS-1.3.1 | Decision Support shall receive all operational status information from Data Management at a frequency of 30 seconds or less | H | 1, 2, 3 | |
| DS-1.3.2 | All operational status information received from Data Management shall be processed and available to Decision Support within 1 minute of the data's time of measurement. | H | 1, 2, 3 | |
| **DS-1.4** | **Decision Support shall receive from Data Management the operational status of transit assets** | **M** | **1, 2, 3** | **Decision Support** |
| DS-1.4.1 | Decision Support shall receive all relevant transit operational status information from Data Management at a frequency of 30 seconds or less | M | 1, 2, 3 | |
| DS-1.4.2 | All relevant transit operational status information received from Data Management shall be processed and available to Decision Support within 1 minute of the data's time of measurement. | M | 1, 2, 3 | |
| **DS-1.5** | **Decision Support shall use reliable data from corridor assets.** | **H** | **1, 2, 3** | **Decision Support** |
| DS-1.5.1 | All physical asset state information not received within timeframes mandated within the time period stated in these requirements shall be considered not operational in the system data uptime requirement. | H | 1, 2, 3 | |

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| DS-1.5.2 | All physical asset state information received shall be evaluated for data quality. Methods for evaluating data quality shall be determined according to the type and specific model of the physical asset being evaluated. These methods and the specific thresholds required by the system shall be defined during the system design phase.<br><br>Data from a physical asset that fails data quality checks shall cause the asset to be considered failed for the purposes of the uptime requirement. | H | 1, 2, 3 | |
| DS-1.5.3 | All sensor information received shall be evaluated for data quality. Methods for evaluating quality shall be determined according to the specific sensor type. These methods and the specific thresholds required by the system shall be defined during the system design phase.<br><br>Data from a sensor that fails data quality checks shall cause the sensor to be considered failed for the purposes of the uptime requirement. | H | 1, 2, 3 | |
| **DS-1.6** | **Decision Support shall receive from Data Management the operational status and availability of all organizational assets.** | **M** | **3** | **Decision Support** |

### 9.8.2. CORRIDOR TRAFFIC STATE ESTIMATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DS-2.1** | **Decision Support shall estimate on a continuous basis the current state of vehicle traffic on roadway links under ICM consideration.** | **H** | **1, 2** | **Decision Support** |
| DS-2.1.1 | Decision Support shall maintain a characterization of the current vehicle traffic conditions on the link for each freeway segment under ICM consideration. | H | 1, 2 | |
| *DS-2.1.1.1* | *For each freeway segment under ICM consideration, Decision support shall estimate the current average traffic density across the segment.* | H | 1, 2 | |
| *DS-2.1.1.2* | *For each freeway segment under ICM consideration, Decision support shall estimate the current average traffic flow across the segment.* | H | 1, 2 | |
| DS-2.1.2 | Decision Support shall maintain a characterization of the current vehicle traffic conditions on each arterial segment under ICM consideration. | H | 1, 2 | |
| *DS-2.1.2.1* | *For each arterial segment under ICM consideration, Decision support shall estimate the average traffic flow able to travel across the link.* | H | 1, 2 | |
| *DS-2.1.2.2* | *For each user-defined arterial route, Decision support shall estimate the current average travel time along the route.* | H | 1, 2 | |
| *DS-2.1.2.2* | *For each arterial segment under ICM consideration, Decision support shall estimate whether the segment is:*<br>• *Not congested*<br>• *Experiencing low-level congestion*<br>• *Experiencing high-level congestion*<br>• *Oversaturated* | H | 1, 2 | |
| DS-2.1.3 | Decision Support shall maintain a characterization of current vehicle traffic conditions at each intersection under ICM consideration. | H | 1, 2 | |

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|---|---|---|---|---|
| *DS-2.1.3.1* | *For each major approach to an intersection under ICM consideration, Decision Support shall determine whether the approach is:*<br>• *Undersaturated*<br>• *Oversaturated*<br>• *Spilling back across the upstream intersection* | H | 1, 2 | |
| *DS-2.1.3.2* | *For each intersection under ICM consideration, Decision Support shall determine whether the overall intersection is:*<br>• *Undersaturated*<br>• *Oversaturated*<br>• *Spilling back across upstream intersections on at least one approach* | H | 1, 2 | |
| DS-2.1.3 | Current traffic state shall be estimated on an ongoing basis, delayed no more than 5 minutes behind actual time. | H | 1, 2 | |
| DS-2.1.4 | Traffic state estimation snapshot shall be provided every 5 minutes. | H | 1, 2 | |
| DS-2.1.5 | Current traffic state estimates shall be based on the latest information available from the data hub. | H | 1, 2 | |
| **DS-2.3** | **Decision Support shall include in its current traffic state estimation effects associated with active incidents and events** | **H** | **1** | **Decision Support** |
| DS-2.3.1 | Decision Support shall identify in its current traffic state estimation lane blockages and/or capacity constraints caused by active incidents that have been verified. | H | 1 | |
| DS-2.3.2 | Decision Support shall identify in its current traffic state estimation lane blockages and/or capacity constraints caused by planned lane or roadway closures. | H | 1 | |
| **DSD-2.4** | **Decision Support shall include in its current traffic state estimation the effect of the current working state of all traffic sensors set to supply information to the ICM Core System.** | **H** | **1, 2, 3** | **Decision Support** |
| DS-2.4.1 | Decision Support shall assess the effect of the quality of incoming information on the quality of its current traffic state estimates. | H | 1, 2, 3 | |
| DS-2.4.2 | Decision Support shall assess the effect of missing information on the quality of its current traffic state estimates. | H | 1, 2, 3 | |
| DS-2.4.3 | Decision Support shall provide an overall confidence level for all current traffic estimates. | H | 1, 2, 3 | |
| **DS-2.5** | **Decision Support shall include in its current traffic state estimation effects associated with the operational status of traffic control devices** | **H** | **1, 3** | **Decision Support** |
| DS-2.5.1 | Decision Support shall include in its current traffic state estimation the effects of the traffic signal control plan currently in use at individual signalized intersections. | H | 1, 3 | |
| DS-2.5.2 | Decision Support shall include in its current traffic state estimation the effects of current ramp metering operations on freeway on-ramps and freeway-to-freeway connectors. | H | 1, 3 | |
| **DS-2.6** | **Decision Support shall provide reliable estimates of current traffic conditions within the corridor** | **H** | **1, 2, 5** | **Decision Support** |
| DS-2.6.1 | The Corridor Manager shall periodically review the accuracy of the traffic state estimates produced by Decision Support. | H | 5, 6 | |
| *DS-2.6.1.1* | *At the start of ICM System operations, the Corridor Manager shall conduct a review every 2 weeks of the accuracy of the traffic state estimates produced by Decision Support.* | H | 5, 6 | |
| *DS-2.6.1.2* | *Over time, as the accuracy of the traffic estimation process is increased, the Corridor Manager shall be allowed to space the frequency of estimation accuracy reviews to no fewer than once every 3 months.* | H | 5, 6 | |

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| DS-2.6.2 | The accuracy of state estimations produced by Decision Support shall be assessed by comparing estimated state elements to reliable corresponding field measurements. | H | 5, 6 | |
| DS-2.6.3 | The validity of the state estimations produced by Decision Support shall be determined using a test designed to assess the level of error associated with the estimations under normal corridor operations. | H | 5, 6 | |
| *DS-2.6.3.1* | *The data set to use in the validity test shall consist of 3 recent days featuring normal levels of recurrent congestion, i.e., 3 days with no extraordinary incidents or events affecting corridor operations.* | H | 5, 6 | |
| *DS-2.6.3.2* | *For each day, the data shall include one interval covering the morning peak travel period and another the afternoon peak period.* | H | 5, 6 | |
| *DS-2.6.8.3* | *For peak periods, the data to include in the test shall cover a period satisfying the following conditions:*<br>• *Data covering at least a two-hour peak congestion period*<br>• *Data covering at last one hour prior to the start of the peak congestion period*<br>• *Data covering at least one hour after the end of the peak congestion period* | H | 5, 6 | |
| *DS-2.6.8.4* | *The validity test shall be conducted by removing each freeway mainline station in sequence, and run the state estimator on the entire system at 15-minute intervals. This will result in the state estimator being run T*N times, where T is the number of time instances on a 15-minute grid, and N is the number of healthy mainline detector stations.* | H | 5, 6 | |
| *DS-2.6.8.5* | *At the end of each test, the estimation error for each mainline station "n" shall be computed as the average of the differences between the estimated and the measured density when station "n" is removed from consideration in the state estimator (MAPE).* | H | 5, 6 | |
| *DS-2.6.8.6* | *The estimator shall be considered to have passed the test if no more than 10% of the sensors included in the test dataset register an error value larger than 10%.* | H | 5, 6 | |
| **DS-2.7** | **Decision Support shall compare the current corridor traffic state to historical traffic patterns and provide a measure of variability from the normal historical traffic pattern** | **H** | **1, 2, 5** | **Decision Support** |
| DS-2.7.1 | The ICM Core System shall compute and display variability measurements comparing the current estimated traffic state to normal traffic patterns every 5 minutes. | H | 5, 6 | |
| *DS-2.7.1.1* | *The variability measurements shall be displayed to the ICM system user both for specific routes and predefined corridor geographic regions.* | H | 5, 6 | |
| *DS-2.7.1.2* | *The variability metrics shall be displayed in map-based displays, distinguishing areas or routes that are within normal variability limits and those that are outside normal variability limits.* | H | 5, 6 | |
| *DS-2.7.1.3* | *The variability metrics shall be displayed in other graphical formats for specific routes or geographic regions.* | H | 5, 6 | |

### 9.8.3. CORRIDOR TRAFFIC STATE FORECASTING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DS-3.1** | **Decision Support shall include a function to produce forecasts of future states of vehicle traffic on roadway links under ICM consideration** | **H** | **5, 6** | **Decision Support** |
| DS-3.1.1 | Decision Support forecasts shall compute and display the following basic traffic characteristics for each roadway link under ICM consideration at the end of each forecast interval:<br>• Forecasted average traffic flow rate across the link<br>• Forecasted average traffic speed across the link<br>• Forecasted average traffic density along the link | H | 5, 6 | |
| DS-3.1.2 | Decision Support forecasts shall compute and display the following vehicle-based productivity metrics for each forecast reporting interval for each roadway link under ICM consideration:<br>• Vehicle-miles traveled (VMT)<br>• Vehicle-hours traveled (VHT) | H | 5, 6 | |
| DS-3.1.3 | Decision Support forecasts shall compute and display the following vehicle-based mobility metrics for each forecast reporting interval for each roadway link under ICM consideration:<br>• Average travel time across link<br>• Average delay per vehicle traversing the link<br>• Vehicle-hours of delay (VHD) incurred on the link since start of forecast interval | H | 5, 6 | |
| DS-3.1.4 | Decision Support forecasts shall compute and display the following person-based productivity metrics for each forecast reporting interval for each roadway link under ICM consideration:<br>• Person-miles traveled (PMT)<br>• Person-hours traveled (PHT) | H | 5, 6 | |
| DS-3.1.5 | Decision Support forecasts shall compute and display the following person-based mobility metrics for each forecast reporting interval for each roadway link under ICM consideration:<br>• Average delay per person traversing the link<br>• Person-hours of delay (PHD) incurred on the link since start of forecast interval | H | 5, 6 | |
| **DS-3.2** | **Traffic forecasts shall be based on the latest traffic and demand information available for the corridor at the time the forecast is requested.** | **H** | **5, 6** | **Decision Support** |
| DS-3.2.1 | Decision Support shall conduct traffic forecasts using the latest field and estimated data available at the time the forecast is requested. | H | 5, 6 | |
| DS-3.2.2 | Decision Support shall not attempt to replace the set of field and estimated data used to conduct a forecast in the middle of a forecasting process. | H | 5, 6 | |
| **DS-3.3** | **Decision Support shall include in its traffic forecasts the effect of the current working state of all traffic sensors set to supply information to the ICM Core System.** | **H** | **5, 6** | **Decision Support** |
| DS-3.3.1 | Decision Support shall evaluate the effect of the quality of incoming information on the quality of its traffic forecasts. | H | 5, 6 | |
| DS-3.3.2 | Decision Support shall evaluate the effect of missing information on the quality of its traffic forecasts. | H | 5, 6 | |

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| DS-3.3.3 | Decision Support shall calculate and display an overall confidence level for all traffic forecasts. | H | 5, 6 | |
| **DS-3.4** | **Decision Support shall complete a traffic forecast for each response plan developed (known as a response plan forecast).** | **H** | **4, 5, 6** | **Decision Support** |
| **DS-3.5** | **Decision Support shall include a function for ICM Core System users to specify under which circumstances traffic forecasts of existing control strategies ("no change scenario") are to be executed.** | **H** | **4, 5, 6** | **Corridor Managemt** |
| **DS-3.6** | **Decision Support shall include a function for ICM Core System users to specify the time horizon to which traffic forecasts are to be executed (forecast over the next 30 minutes, 1 hour, 2 hours, etc.).** | **H** | **4, 5, 6** | **Corridor Managemt** |
| DS-3.6.1 | Decision Support shall include a function for ICM Core System users to specify forecast time horizons of up to 2 hours. | H | 4, 5, 6 | |
| DS-3.6.2 | Decision Support shall not allow ICM Core System users to specify forecast time horizons of less than 30 minutes. | H | 4, 5, 6 | |
| DS-3.6.3 | Decision Support shall include a function for ICM Core System users to specify forecast time horizons in increments of 15 minutes. | H | 4, 5, 6 | |
| **DS-3.7** | **Decision Support shall include a function for ICM Core System users to specify the data reporting interval within a traffic forecast (e.g., forecast data reported every 5 minutes, 15 minutes, 1 hour, etc.)** | **H** | **4, 5, 6** | **Corridor Managemt** |
| DS-3.7.1 | Decision Support data reporting intervals shall be a fixed length during execution of a forecast. | H | 4, 5, 6 | |
| DS-3.7.2 | Decision Support shall include a function for ICM Core System users to specify the length of the data reporting intervals in increments of 5 minutes. | H | 4, 5, 6 | |
| DS-3.7.3 | Decision Support shall have a minimum traffic forecast data reporting interval of 5 minutes. | H | 4, 5, 6 | |
| DS-3.7.4 | Decision Support shall have a maximum traffic forecast data reporting interval equal to the length of the traffic forecast horizons. | H | 4, 5, 6 | |
| DS-3.7.5 | Decision Support shall only allow ICM Core System users to specify data reporting intervals producing an integer number of intervals within the forecast horizon. | H | 4, 5, 6 | |
| **DS-3.8** | **Decision Support shall include a function for ICM Core System users to specify the interval at which Decision Support is to execute traffic forecasts (e.g., new forecast every 15 minutes).** | **H** | **4, 5, 6** | **Corridor Managemt** |
| DS-3.8.1 | Decision Support shall allow system users to specify the interval at which new traffic forecasts are to be executed by Decision Support when responding to an incident or event. | H | 4, 5, 6 | |
| DS-3.8.2 | Decision Support shall only accept forecast intervals that are specified in increments of 5 minutes (e.g., new forecast every 5, 15, 20 minutes). | H | 4, 5, 6 | |
| DS-3.8.3 | Decision Support shall not accept forecast intervals of less than 5 minutes. | H | 4, 5, 6 | |
| **DS-3.9** | **Decision Support shall be able to complete forecasts of corridor operations in a timely manner.** | **H** | **5** | **Decision Support** |
| DS-3.9.1 | Decision Support shall be able to complete a traffic forecast within 5 minutes of receiving a forecast request. | H | 5 | |
| **DS-3.10** | **The Corridor Manager shall periodically ensure the accuracy of the traffic forecasts produced by Decision Support.** | **H** | **5, 6** | **Institutional Job Tasks** |
| DS-3.10.1 | The Corridor Manager shall conduct periodic reviews of the accuracy of the traffic forecasts produced by Decision Support. | H | 5, 6 | |
| *DS-3.10.1.1* | *At the start of ICM Environment operations, the Corridor Manager shall conduct a review of the accuracy of the traffic* | H | 5, 6 | |

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| | *forecasts every 2 weeks.* | | | |
| *DS-3.10.1.2* | *Over time, as the accuracy of the traffic estimation process is increased, the Corridor Manager shall be allowed to space the forecast accuracy reviews to no fewer than once every 3 months.* | H | 5, 6 | |
| DS-3.10.2 | The validity of the traffic forecasts produced by Decision Support shall be determined using a test designed to assess an aggregate level of error associated with the forecasts. | H | 5, 6 | |
| *DS-3.10.2.1* | *The data set to use in the validity test shall consist of 3 recent days that may or may not include incidents or events.* | H | 5, 6 | |
| *DS-3.10.2.2* | *For each day, the data shall include one interval covering the morning peak travel period and another the afternoon peak period.* | H | 5, 6 | |
| *DS-3.10.2.3* | *For peak periods, the data to include in the test shall cover a period satisfying the following conditions:*<br>• *Data covering at least a two-hour peak congestion period*<br>• *Data covering at last one hour prior to the start of the peak congestion period*<br>• *Data covering at least one hour after the end of the peak congestion period* | H | 5, 6 | |
| *DS-3.10.2.4* | *The validity test shall be conducted by computing 1-hour traffic predictions, at 30-minute intervals, for each peak period considered in the test data set.* | H | 5, 6 | |
| *DS-3.10.2.5* | *For each peak period included in the test data set, two sets of computations must be made:*<br>• *Predictions from the traffic forecasting tool used by Decision Support*<br>• *Prediction from a forecasting approach based purely on historical trends, and without the aid of a calibrated physical model of traffic ("model-less" approach)* | H | 5, 6 | |
| *DS-3.10.2.6* | *A traffic forecasting tool shall be considered to have passed the test if a statistical test considering all peak periods within the test data set with a null hypothesis stating that "the prediction error of the forecasting tool is not less than the prediction error of the model-less approach" can be rejected with a 95% probability (p-value of 0.05).* | H | 5, 6 | |
| DS-3.10.3 | Decision Support comparisons between forecasted and field data shall be conducted automatically. | H | 5, 6 | |
| DS-3.10.4 | Decision Support shall provide an interface for the Corridor Manager to initiate comparative evaluations of specific traffic forecasts (for instance, traffic forecasts produced on a given day and time, or forecasts associated with a specific incident or event) | H | 5, 6 | |
| **DS-3.11** | **Decision Support shall archive the results of traffic forecasting activities for future uses of analyses.** | **H** | **4, 5, 15** | **Decision Support** |
| DS-3.11.1 | Decision Support shall archive all forecasted traffic states for use in post-incident/event analysis. | H | 4, 5, 15 | |
| DS-3.11.2 | Decision Support shall archive the results of all forecast comparisons to field data for future analyses. | H | 4, 5, 15 | |

### 9.8.4. RULES ENGINE CAPABILITIES

#### *9.8.4.1. Rule Application*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DS-4.1** | **The rules engine shall have state-of-the-art rules engine capabilities.** | **H** | **4,8** | **Decision Support** |
| DS-4.1.1 | Decision Support rules evaluation performance shall not degrade linearly with increases in the number of rules. | H | 4 | |
| DS-4.1.2 | Decision Support rules engine shall implement a Rete or similar algorithm within its inference engine. | M | 4 | |
| DS-4.1.3 | Decision Support rules engine shall implement a hybrid-chaining (forward and backward chaining) rules execution. (NOTE: Likely uses for backward chaining – constantly evaluating current traffic state looking for incident, looking for multiple possible routes) | H | 4,8 | |
| DS-4.1.4 | Decision Support rules engine shall include a function for recursive rules definition and processing. | H | 4,8 | |
| DS-4.1.5 | Decision Support rules engine shall include a function for geospatial-based rules execution. Geospatial results may be implemented as an external query process. | H | 4,8 | |
| DS-4.1.6 | Decision Support rules engine shall allow for deterministic results. | H | 4,8 | |
| DS-4.1.7 | Decision Support rules engine shall allow for non-deterministic results (NOTE: Likely usage finding routes, incidents) | H | 4,8 | |
| DS-4.1.8 | Decision Support rules engine shall include a function to react to events in the corridor, in effect listening for events and executing rules as a result (NOTE: In a manner similar to a reactive transitive query) | H | 4,8 | |
| DS-4.1.9 | Decision Support rules engine shall allow for external class/method, procedure, and service execution in rules estimations | H | 4,8 | |
| **DS-4.2** | **Decision Support shall be able to implement the rules defined in section 9.3.4.** | **H** | **4,8,10,16** | **Decision Support** |
| **DS-4.3** | **Decision Support shall include a function for Traffic Engineers to manage the rules to be applied to incident/event response** | **H** | **10,11,12, 15,16** | **Corridor Managemt** |
| DS-4.3.1 | Decision Support shall provide a means for Traffic Engineers to activate/deactivate rules to be used. | H | 10,11,16 | |
| **DS-4.4** | **Decision Support shall execute rules automatically or on demand** | **H** | **4,8** | **Decision Support** |
| DS-4.4.1 | Decision Support shall execute rule sets upon demand by users via the user functions. | H | 4,8 | |
| DS-4.4.2 | Decision Support shall include a function to execute rules automatically as a scheduled process. | M | 4,8 | |
| DS-4.4.3 | Decision Support shall include a function to execute rules automatically as an event-driven process. | M | 4,8 | |

#### *9.8.4.2. Post-Response Evaluation*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **DS-4.5** | **Decision Support shall maintain a log of rule execution for post-incident/event evaluation.** | **H** | **15** | **DSS/Corridor Managemt** |

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|---|---|---|---|---|
| **DS-4.6** | **Decision Support shall provide a post-incident/event rules evaluation and analysis.** | **M** | **6** | **Corridor Managemt** |
| DS-4.6.1 | The Decision Support post-incident/event rules evaluation shall include the current state of the data facts used in the rules engine at the time of rules execution. | M | 6 | |
| DS-4.6.2 | The Decision Support post-incident/event rules evaluation shall include the rules used in the rules engine execution during the event. | M | 6 | |
| DS-4.6.3 | The Decision Support post-incident/event rules evaluation shall include the results of the rules engine execution. | M | 6 | |
| DS-4.6.4 | The Decision Support post-incident/event rules evaluation shall include the time required for rules engine execution. | M | 6 | |
| **DS-4.7** | **Decision Support shall generate a daily operational evaluation report at the end of each day providing a summary of the rules execution and details of the specific rules operation, to be reviewed by the Corridor Technical Manager.** | **M** | **16** | **Corridor Managemt** |

## 9.9. CORE SYSTEM USER INTERFACES

This section defines user interface requirements for data manipulation and process control. This includes interface requirements for creating, viewing, updating, deleting and reporting on data. It also includes interface requirements for managing the process of incident identification, response plan generation, response plan implementation, and system control.

### 9.9.1. USER INTERFACES FOR MANAGING ASSET INFORMATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-1.1** | **The ICM Core System shall include a user interface to create, view, update, and delete asset inventory data** | **H** | **3** | **Corridor Managemnt** |
| UI-1.1.1 | The ICM Core System shall include a user interface to create, view, update, and delete the inventory of roadway links and intersections (network inventory) defining the ICM corridor. | H | 3 | |
| UI-1.1.2 | The ICM Core System shall include a user interface to create, view, update, and delete travel time measurement device inventory. | H | 3 | |
| UI-1.1.3 | The ICM Core System shall include a user interface to create, view, update, and delete weather measurement device inventory. | L | 3 | |
| UI-1.1.4 | The ICM Core System shall include a user interface to create, view, update, and delete signal inventory. | H | 3 | |
| UI-1.1.5 | The ICM Core System shall include a user interface to create, view, update, and delete ramp meter inventory. | H | 3 | |
| UI-1.1.6 | The ICM Core System shall include a user interface to create, view, update, and delete transit asset inventory. | H | 3 | |
| UI-1.1.7 | The ICM Core System shall include a user interface to create, view, update, and delete traffic sensor inventory. | H | 3 | |
| UI-1.1.8 | The ICM Core System shall include a user interface to create, view, update, and delete fixed CMS inventory. | H | 3 | |
| UI-1.1.9 | The ICM Core System shall include a user interface to create, view, update, and delete portable CMS inventory. | H | 3 | |
| UI-1.1.10 | The ICM Core System shall include a user interface to create, view, update, and delete extinguishable trailblazer sign inventory. | H | 3 | |
| UI-1.1.11 | The ICM Core System shall include a user interface to create, view, update, and delete HAR inventory. | H | 3 | |
| UI-1.1.12 | The ICM Core System shall include a user interface to create, view, update, and delete organizational asset inventory. | H | 3 | |
| UI-1.1.13 | The ICM Core System shall include a user interface to create, view, update, and delete parking asset inventory. | H | 3 | |
| UI-1.1.14 | The ICM Core System shall include a user interface to create, view, update, and delete video camera inventory. | M | 3 | |
| **UI-1.2** | **The ICM Core System shall include a user interface to view and update asset health information.** | **H** | **3** | **Corridor Managemt** |
| UI-1.2.1 | The ICM Core System shall include a user interface to view and update traffic signal health information. | H | 3 | |
| UI-1.2.2 | The ICM Core System shall include a user interface to view and update ramp meter health information. | H | 3 | |

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| UI-1.2.3 | The ICM Core System shall include a user interface to view and update parking asset health information. | H | 3 | |
| UI-1.2.4 | The ICM Core System shall include a user interface to view and update transit asset health information. | H | 3 | |
| UI-1.2.5 | The ICM Core System shall include a user interface to view and update fixed CMS health information. | H | 3 | |
| UI-1.2.6 | The ICM Core System shall include a user interface to view and update portable CMS inventory and state information. | H | 3 | |
| UI-1.2.7 | The ICM Core System shall include a user interface to view and update extinguishable trailblazer sign health information. | H | 3 | |
| UI-1.2.8 | The ICM Core System shall include a user interface to view and update HAR health information. | M | 3 | |
| UI-1.2.9 | The ICM Core System shall include a user interface to view and update organizational asset health information. | H | 3 | |
| UI-1.2.10 | The ICM Core System shall include a user interface to view and update CCTV camera health information. | M | 3 | |
| UI-1.2.11 | The ICM Core System shall include a user interface to view and update traffic sensor health information. | H | 3 | |
| UI-1.2.12 | The ICM Core System shall include a user interface to view and update travel time measurement device health information. | H | 3 | |
| UI-1.2.13 | The ICM Core System shall include a user interface to view and update weather measurement device health information. | M | 3 | |
| **UI-1.3** | **The ICM Core System shall include a user interface to view and update asset availability** | **H** | **1, 3** | **Corridor Managemt** |
| UI-1.3.1 | The ICM Core System shall include a user interface to view and update traffic signal availability. | H | 3 | |
| UI-1.3.2 | The ICM Core System shall include a user interface to view and update ramp meter availability. | H | 3 | |
| UI-1.3.3 | The ICM Core System shall include a user interface to view and update parking asset availability. | H | 3 | |
| UI-1.3.4 | The ICM Core System shall include a user interface to view and update transit asset availability. | H | 3 | |
| UI-1.3.5 | The ICM Core System shall include a user interface to view and update fixed CMS availability. | H | 3 | |
| UI-1.3.6 | The ICM Core System shall include a user interface to view and update portable CMS availability. | H | 3 | |
| UI-1.3.7 | The ICM Core System shall include a user interface to view and update extinguishable trailblazer sign availability. | H | 3 | |
| UI-1.3.8 | The ICM Core System shall include a user interface to view and update HAR availability. | M | 3 | |
| UI-1.3.9 | The ICM Core System shall include a user interface to view and update organizational asset availability. | H | 3 | |
| UI-1.3.10 | The ICM Core System shall include a user interface to view and update road network segment availability. | H | 3 | |
| UI-1.3.11 | The ICM Core System shall include a user interface to view and update CCTV camera availability. | H | 3 | |
| UI-1.3.12 | The ICM Core System shall include a user interface to view and update traffic sensor availability. | H | 3 | |
| UI-1.3.13 | The ICM Core System shall include a user interface to view and update travel time measurement device availability. | H | 3 | |
| UI-1.3.14 | The ICM Core System shall include a user interface to view and update weather measurement device availability. | M | 3 | |
| **UI-1.4** | **The ICM Core System shall include a user interface to view and update asset state** | **H** | **1, 3** | **Corridor Managemt** |

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| UI-1.4.1 | The ICM Core System shall include a user interface to view and update scheduled lane/road closures. | H | 3 | |
| UI-1.4.2 | The ICM Core System shall include a user interface to view and update traffic signal state. | H | 3 | |
| UI-1.4.3 | The ICM Core System shall include a user interface to view and update ramp meter state. | H | 3 | |
| UI-1.4.4 | The ICM Core System shall include a user interface to view and update parking asset state. | H | 3 | |
| UI-1.4.5 | The ICM Core System shall include a user interface to view and update transit asset state. | H | 3 | |
| UI-1.4.6 | The ICM Core System shall include a user interface to view and update fixed CMS state. | H | 3 | |
| UI-1.4.7 | The ICM Core System shall include a user interface to view and update portable CMS state. | H | 3 | |
| UI-1.4.8 | The ICM Core System shall include a user interface to view and update extinguishable trailblazer sign state. | H | 3 | |
| UI-1.4.9 | The ICM Core System shall include a user interface to view and update HAR state. | M | 3 | |
| UI-1.4.10 | The ICM Core System shall include a user interface to view and update organizational asset state. | H | 3 | |
| UI-1.4.11 | The ICM Core System shall include a user interface to view and update road network state. | H | 3 | |
| UI-1.4.12 | The ICM Core System shall include a user interface to view and update traffic sensor state. | H | 3 | |
| UI-1.4.13 | The ICM Core System shall include a user interface to view and update travel time measurement device state. | H | 3 | |
| UI-1.4.14 | The ICM Core System shall include a user interface to view live CCTV camera video streams. | H | 3 | |
| UI-1.4.15 | The ICM Core System shall include a user interface to pan and tilt CCTV cameras. | M | 3 | |
| UI-1.4.16 | The ICM Core System shall include a user interface to view and update weather measurement device state. | M | 3 | |
| **UI-1.5** | **The ICM corridor asset management user interface shall be capable of continuous operations in the event of any individual system failure.** | **H** | **17** | **Corridor Managemt** |

### 9.9.2. USER INTERFACES FOR MANAGING INCIDENT/EVENT INFORMATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-2.1** | **The ICM Core System shall include a user interface to create, view, update, and delete incident/event information.** | **H** | **1, 4** | **Corridor Managemt** |

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|---|---|---|---|---|
| UI-2.1.1 | The ICM Core System shall include a user interface to create, view, update, and delete the following information for an incident:<br>• Type of incident<br>• Time incident occurred<br>• Expected duration of incident<br>• Roadway/transit segment on which incident is located<br>• Location of incident along roadway/transit segment<br>• Lane(s) affected by the incident<br>• Agency responsible for managing the incident<br>• Verification status of incident | H | 1, 4 | |
| UI-2.1.2 | The ICM Core System shall include a user interface to create, view, update, and delete the following information for an event:<br>• Type of event<br>• Time event occurred<br>• Expected duration of event<br>• Roadway/transit segment(s) on which event is located<br>• Location(s) of event along roadway/transit segment(s)<br>• Lane(s) affected by the incident<br>• Agency responsible for managing the incident<br>• Verification status of event | H | 1, 4 | |
| UI-2.1.3 | The ICM Core System shall provide a function permitting users to confirm that an incident or event has been verified to exist. | H | 1 | |
| UI-2.1.4 | The ICM Core System shall include a function to set interval thresholds within which newly identified incidents or events shall be verified. | H | 1 | |

### 9.9.3. USER INTERFACE FOR MANAGING MOCK INCIDENTS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-3.1** | **The ICM Core System shall include a user interface permitting users to create mock incidents.** | **H** | **6, 12** | **Corridor Managemt** |
| UI-3.1.1 | The ICM Core System shall include a user interface permitting users to create, view, update, and delete mock incidents. | H | 6 | |
| UI-3.1.2 | The ICM Core System shall include a map-based interface enabling users to choose the location for the mock incidents to be tested. | H | 6 | |
| UI-3.1.3 | The ICM Core System shall include a user interface for setting the start time for a mock incident. | H | 6 | |
| UI-3.1.4 | The ICM Core System shall include a user interface for specifying the duration of mock incidents. | H | 6 | |
| UI-3.1.5 | The ICM Core System shall include a user interface for specifying lanes, bus routes, or tracks affected by a mock incident. | H | 6 | |
| UI-3.1.6 | The ICM Core System shall include a user interface for specifying an end time for mock incidents. | H | 6 | |

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| UI-3.1.7 | The ICM Core System shall include a user interface for specifying whether a special response plan is required as a response to a mock incident. | H | 6 | |
| UI-3.1.8 | The ICM Core System shall include a user interface permitting users to assign a name to a mock incident. | H | 6, 12 | |
| **UI-3.2** | **The ICM Core System shall include a user interface permitting the testing of mock incidents.** | **H** | **6** | **Corridor Managemt** |
| UI-3.2.1 | The ICM Core System shall include an interface permitting the submission of mock incidents to the Decision Support module for testing purposes. | H | 6 | |
| UI-3.2.2 | The ICM Core System shall include an interface permitting the generation of a post-incident report based on a submitted mock incident. | H | 6 | |
| UI-3.2.3 | The ICM Core System shall include an interface permitting the displaying on a map of the response plan elements that have been recommended for a submitted mock incident. | H | 6 | |

### 9.9.4. USER INTERFACES FOR MANAGING RESPONSE PLANS

#### *9.9.4.1. Response Plan Viewing*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-4.1** | **The ICM Core System shall include a user interface for viewing response plans.** | **H** | **4, 13** | **Corridor Managemt** |
| UI-4.1.1 | For each response plan, the ICM Core System shall display summary information about the incident or event that triggered the development of the plan. | H | 4, 13 | |
| UI-4.1.2 | For each response plan, the ICM Core System shall display a list of all the agencies involved in the implementation of the plan. | H | 4, 13 | |
| UI-4.1.3 | For each response plan, the ICM Core System shall display the recommended detour route(s) for passenger cars, trucks, and buses. | H | 4, 13 | |
| UI-4.1.4 | For each response plan, the ICM Core System shall display a list of ramp meters that are to be modified and information about the metering strategy/rate to be used at each location. | H | 4, 13 | |
| UI-4.1.5 | For each response plan, the ICM Core System shall display a list of intersections where traffic signal operations are to be altered and information about the timing plan to be activated at each intersection. | H | 4, 13 | |
| UI-4.1.6 | For each response plan, the ICM Core System shall display a list of fixed freeway/arterial CMSs where incident/detour messages are to be posted and what message is to be posted at each location. | H | 4, 13 | |
| UI-4.1.7 | For each response plan, the ICM Core System shall display the locations where extinguishable trailblazer signs are to be activated. | H | 4, 13 | |
| UI-4.1.8 | For each response plan, the ICM Core System shall display the locations where portable CMSs are to be deployed and what message is to be posted at each location. | H | 4, 13 | |

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| UI-4.1.9 | For each response plan, the ICM Core System shall display the HAR stations that are to be activated and what message is to be broadcasted at each location. | M | 4, 13 | |
| UI-4.1.10 | For each response plan, the ICM Core System shall display a summary of personnel required to implement the response plan. | H | 4, 13 | |
| UI-4.1.11 | For each response plan, the ICM Core System shall display a list of constraints that may have affected the development of the response plan. | H | 4, 13 | |
| **UI-4.2** | **The ICM Core System shall allow system users to access information about active response plans while in the field.** | **M** | **4, 13** | **Corridor Managemt** |
| UI-4.2.1 | The ICM Core System shall provide a means for first responding officers in the field to access detailed information about approved response plans from a mobile device (smartphone, tablet, laptop, etc.). | M | 4, 13 | |
| UI-4.2.2 | The ICM Core System shall provide a means for field maintenance or management staff from traffic management agencies to access recommended detour information from a mobile device (smartphone, tablet, laptop, etc.). | M | 4, 13 | |

### *9.9.4.2. Response Rules Management*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-4.3** | **The ICM Core System shall provide a user-friendly interface for managing rules used by the Decision Support module to identify, evaluate, and respond to incidents and events.** | **H** | **4, 8, 10** | **Corridor Managemt** |
| UI-4.3.1 | The ICM Core System shall include a user-friendly interface for creating, viewing, updating, and deleting rule information. | H | 4, 8, 10 | |
| UI-4.3.2 | The ICM Core System shall provide an interface permitting users to test rules. | H | 4, 10 | |
| UI-4.3.3 | The ICM Core System shall provide an interface permitting the visualization or rules and their dependencies. | H | 4, 10 | |
| **UI-4.4** | **The ICM Core System shall provide a means for users to document the requirements for specific rules and dependent rules within the system for display with the rule.** | **L** | **16** | **Corridor Managemt** |

### *9.9.4.3. Response Plan Development*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-4.5** | **The ICM Core System shall provide a user interface allowing users to submit requests for specific actions to be included in a response plan.** | **M** | **9** | **Corridor Managemt** |
| UI-4.5.1 | The ICM Core System shall provide a user interface permitting users to submit requests for control actions to be included in a response plan development. | M | 9 | |
| *UI-4.5.1.1* | *The ICM Core System shall provide a user interface permitting users to submit requests for the use of specific detours.* | M | 9 | |

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|---|---|---|---|---|
| *UI-4.5.1.2* | *The ICM Core System shall provide a user interface permitting users to submit requests for the use of specific signal control plans at specific intersections.* | M | 9 | |
| *UI-4.5.1.3* | *The ICM Core System shall provide a user interface permitting users to submit requests for the use of specific ramp metering rates at specific freeway on-ramps or freeway-to-freeway connectors.* | M | 9 | |
| *UI-4.5.1.4* | *The ICM Core System shall provide a user interface permitting users to submit requests for the posting of specific messages on fixed CMSs.* | M | 9 | |
| *UI-4.5.1.5* | *The ICM Core System shall provide a user interface permitting users to submit requests for the activation of specific extinguishable trailblazer signs.* | M | 9 | |
| *UI-4.5.1.6* | *The ICM Core System shall provide a user interface permitting users to submit requests for the broadcast of specific messages by specific HAR stations.* | M | 9 | |
| UI-4.5.2 | The ICM Core System shall include an interface permitting users to specify proposed changes to a recommended plan that is still pending approval, and whether the proposed changes shall be submitted for approval by other users or can be implemented automatically. | M | 9 | |
| **UI-4.6** | **The ICM Core System shall include a function for users to manually specify whether specific control assets can be used for the generation of a response plan.** | **H** | **4** | **Corridor Managemt** |
| UI-4.6.1 | The ICM Core System shall include a function for users to specify when the operation of specific traffic signals cannot be altered by the ICM Environment. | H | 4 | |
| UI-4.6.2 | The ICM Core System shall include a function for users to specify when the operation of specific ramp meters cannot be altered by the ICM Environment. | H | 4 | |
| UI-4.6.3 | The ICM Core System shall include a function for users to specify when the operation of specific CMS signs cannot be altered by the ICM Environment. | H | 4 | |
| **UI-4.7** | **The ICM Core System shall provide a user interface permitting modification to preferences affecting how response plans are evaluated** | **H** | **10** | **Corridor Managemt** |
| UI-4.7.1 | The ICM Core System shall include a user interface permitting the setting of weighting functions for the calculation of prediction-based performance metrics used in the evaluation of response plans | H | 10 | |
| *UI-4.7.1.1* | *The ICM Core System shall include an interface permitting users to set different weight factors to be applied to metrics associated with specific prediction intervals (e.g., 0-15 minutes, 15-30 minutes, etc.).* | H | 10 | |
| *UI-4.7.1.2* | *The ICM Core System shall include an interface permitting users to set different weight factors to be applied to various vehicle types (e.g., higher weights for buses).* | H | 10 | |
| UI-4.7.2 | The ICM Core System shall include a user interface permitting the selection of person-based or vehicle-based metrics in the evaluation of response plans. | H | 10 | |
| **UI-4.8** | **For each developed response plan, the ICM Core System shall display a list of system elements that were not selected because of operational problems, if any.** | **M** | **17** | **Corridor Managemt** |

*9.9.4.4. Response Plan Selection*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-4.9** | **The ICM Core System shall provide an interface summarizing the various response plans developed, the result of their evaluation, and the plan recommended for implementation.** | **H** | **4** | **Corridor Managemt** |
| **UI-4.10** | **The ICM Core System shall provide an interface allowing users to select the approach to be used for the evaluation of corridor impacts of each developed response plans where multiple alternatives exist (such as selection between use of user-defined rules, or specific evaluation tools or models).** | **L** | **4** | **Corridor Managemt** |
| **UI-4.11** | **The ICM Core System shall provide an interface allowing users to manually select the response plan to implement among the proposed plans developed by the system.** | **H** | **4** | **Corridor Managemt** |

*9.9.4.5. Response Plan Approval*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-4.12** | **The ICM Core System shall include a user interface permitting each stakeholder agency to specify the level of automation desired for the approval of submitted recommended response plans.** | **H** | **8, 9, 10** | **Corridor Managemt** |
| UI-4.12.1 | The ICM Core System shall include a user interface permitting users to define periods during which manual approval is required and periods during which automated approval is permitted. | H | 8, 9, 10 | |
| **UI-4.13** | **The ICM Core System shall include an interface permitting the setting of the level of automation required for the approval of submitted modifications to an active response plan.** | **M** | **8, 9, 10** | **Corridor Managemt** |
| UI-4.13.1 | The ICM Core System shall include a function for authorized users from each agency to specify whether real-time proposed changes to an active response plan should require manual approval from all agencies involved in the implementation of the plan or whether the changes can be approved automatically. | M | 8, 9, 10 | |
| UI-4.13.2 | The ICM Core System shall provide a means for users to define periods during which manual approval of proposed changes to response plans is required and periods during which automated approval is possible. | M | 8, 9, 10 | |
| UI-4.13.3 | The ICM Core System shall provide a means for users to customize manual/automated approval setup based on the type of control action requested. | M | 8, 9, 10 | |
| UI-4.13.4 | The ICM Core System shall provide an interface permitting the setting of the maximum interval allowed for agency representatives to make an approval decision on the response plans sent to them for review. | H | 8, 9, 10 | |
| **UI-4.14** | **The ICM Core System shall provide an interface allowing individuals responsible for approving response plans to review plans submitted for their approval.** | **H** | **4, 12** | **Corridor Managemt** |

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| UI-4.14.1 | The ICM Core System shall provide individuals tasked with approving a response plan an interface detailing the plan submitted for approval. | H | 4, 12 | |
| *UI-4.14.1.1* | *The response plan approval interface shall display a map showing the recommended detour(s) for each vehicle type.* | H | 4, 12 | |
| *UI-4.14.1.2* | *The response plan approval interface shall display a map showing the location of all control elements associated with a response plan.* | H | 4, 12 | |
| *UI-4.14.1.3* | *The response plan approval interface shall display a map showing the control actions associated with each control element.* | H | 4, 12 | |
| *UI-4.14.1.4* | *The response plan approval interface shall provide a comparative performance summary of the proposed response plan against the "Do Nothing" scenario (current situation).* | H | 4, 12 | |
| UI-4.14.2 | The ICM Core System shall provide individuals tasked with approving a response plan an interface allowing them to compare alternate response plans that may have been produced by the Decision Support module. | L | 4, 12 | |
| UI-4.14.3 | The ICM Core System shall provide individuals tasked with approving a response plan an interface allowing them to enter their approval decision. | L | 4, 12 | |
| UI-4.14.4 | The ICM Core System shall provide individuals tasked with approving a response plan a summary of the approval status of the plan by other agencies/individuals from which approval is sought. | H | 4, 12 | |

### *9.9.4.6. Response Plan Implementation*

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-4.15** | **The ICM Core System shall include a user interface for directing the implementation of an approved response plan.** | **H** | **7, 8, 9** | **Corridor Managemt** |
| UI-4.15.1 | The ICM Core System shall include a function for directing the implementation of road network changes (ramp closures, etc.). | H | 7, 8, 9 | |
| UI-4.15.2 | The ICM Core System shall include a function for directing the implementation of traffic signal changes. | H | 7, 8, 9 | |
| UI-4.15.3 | The ICM Core System shall include a function for directing the implementation of ramp meter changes. | H | 7, 8, 9 | |
| UI-4.15.4 | The ICM Core System shall include a function for directing the implementation of organizational asset required actions. | H | 7, 8, 9 | |
| UI-4.15.5 | The ICM Core System shall include a function for directing the implementation of transit asset required changes. | H | 7, 8, 9 | |
| UI-4.15.6 | The ICM Core System shall include a function for directing the implementation of messages on fixed CMS signs. | H | 7, 8, 9 | |
| UI-4.15.7 | The ICM Core System shall include a function for directing the deployment of portable CMS signs. | H | 7, 8, 9 | |
| UI-4.15.8 | The ICM Core System shall include a function for directing the activation of extinguishable trailblazer signs. | H | 7, 8, 9 | |
| UI-4.15.9 | The ICM Core System shall include a function for directing the activation of HAR broadcasts. | H | 7, 8, 9 | |

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|---|---|---|---|---|
| UI-4.15.10 | The ICM Core System shall include a function for directing the dissemination of information to 511 services, media, and other information outlets. | H | 7, 8, 9 | |
| **UI-4.16** | **The ICM Core system shall include an interface permitting stakeholders to specify whether they require the ICM Core System to seek confirmation from them that an incident or event has been terminated before allowing the ICM Core System to terminate the event.** | **M** | **10** | **Corridor Managemt** |
| **UI-4.17** | **The ICM Core System shall include an interface for system users to manually indicate that an incident or event has terminated.** | **H** | **1, 4** | **Corridor Managemt** |
| UI-4.17.1 | The ICM Core System shall include an interface for TMC and TCS operators to manually inform the ICM Core System that an incident or event has terminated. | H | 1, 4 | |
| UI-4.17.2 | Only TMC/TCS operators from the agency associated with an incident or event shall be authorized to inform the ICM system that a specific incident or event has terminated. | H | 1, 4 | |
| **UI-4.18** | **The ICM Core System shall include an interface indicating whether a recommended response plan has been successfully implemented in the field.** | **H** | **4, 13** | **Corridor Managemt** |
| UI-4.18.1 | The ICM Core System shall include an interface indicating when and if a response plan has been successfully implemented in its entirety. | H | 4, 13 | |
| UI-4.18.2 | The ICM Core System shall include an interface listing all implemented response plan components within a selected jurisdiction. | H | 4, 13 | |
| UI-4.18.3 | The ICM Core System shall include an interface indicating if a recommended response plan cannot be implemented. | H | 4, 13 | |
| UI-4.18.4 | In the case of implementation failure, the ICM Core System shall indicate why a recommended response plan could not be implemented. | H | 4, 13 | |
| **UI-4.19** | **The ICM Core System shall inform stakeholders of system elements that were not selected because of operational problems but that would otherwise have been part of the response plan.** | **M** | **17** | **Corridor Managemt** |
| **UI-4.20** | **The ICM Core System shall provide response plan information to stakeholders.** | **H** | **4, 13** | **Corridor Managemt** |
| UI-4.20.1 | The ICM Core System shall inform TMC/TCS operators of approved response plans that are to be implemented within the corridor. | H | 4, 13 | |
| UI-4.20.1 | The ICM Core System shall inform transit field supervisors of response plan elements that may affect bus service operations. | M | 4, 13 | |
| UI-4.20.1 | The ICM Core System shall provide detailed information to first responders about approved response plans. | H | 4, 13 | |
| UI-4.20.1 | The ICM Core System shall include a function for system users to access information about active response plans while in the field. | H | 4, 13 | |

### 9.9.5. USER INTERFACES FOR MANAGING ICM CORE SYSTEM INFORMATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-5.1** | **The ICM Core System shall include a function for viewing all ICM log activity.** | **H** | **1** | **Corridor Managemt** |
| **UI-5.2** | **The ICM Core System shall provide a means for users to customize ICM Environment operations.** | **H** | **10, 16** | **Corridor Managemt** |
| UI-5.2.1 | The ICM Core System shall provide input screens for manual input or edit of system configuration information. | H | 10, 16 | |
| UI-5.2.2 | The ICM Core System shall display input screens for manual input or edit of user administration information. | H | 10, 16 | |
| UI-5.2.3 | The ICM Core System shall display input screens for manual input or edit of user preferences. | H | 10, 16 | |
| **UI-5.3** | **The ICM Core System shall allow operational parameters to be changed without requiring a system restart.** | **M** | **16** | **Corridor Managemt** |
| **UI-5.4** | **The ICM Core System shall provide a user interface to permit start and shut-down of Core System components.** | **H** | **16** | **Corridor Managemt** |

### 9.9.6. GEOSPATIAL VISUALIZATION OF DATA

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-6.1** | **The ICM Core System shall display on a map the devices that may be used to manage traffic within the ICM corridor.** | **H** | **3, 4, 12, 13** | **Corridor Managemt** |
| UI-6.1.1 | The ICM Core System shall display on maps roadway segments under ICM management. | H | 4, 6, 12, 13 | |
| UI-6.1.1 | The ICM Core System shall display on maps the signalized intersections connected to the ICM system. | H | 4, 6, 12, 13 | |
| UI-6.1.1 | The ICM Core System shall display on maps the ramp meter controllers connected to the ICM system. | H | 4, 6, 12, 13 | |
| UI-6.1.1 | The ICM Core System shall display on maps the fixed CMS devices connected to the ICM system. | H | 4, 6, 12, 13 | |
| UI-6.1.1 | The ICM Core System shall display on maps the extinguishable trailblazer signs connected to the ICM system. | H | 4, 6, 12, 13 | |
| UI-6.1.1 | The ICM Core System shall display on maps the HAR stations connected to the ICM system. | H | 4, 6, 12, 13 | |
| UI-6.1.1 | The ICM Core System shall display on maps the park-and-ride facilities connected to the ICM system. | H | 4, 6, 12, 13 | |
| **UI-6.2** | **The ICM Core System shall display on a map information about transit services of interest to ICM operations.** | **M** | **12** | **Corridor Managemt** |
| UI-6.2.1 | The ICM Core System shall display on maps the location of the Metro Gold Line light-rail line and stations. | M | 12 | |
| UI-6.2.2 | The ICM Core System shall include an interface for users to view routes followed by commuter and express bus services of interest. | M | 12 | |
| UI-6.2.3 | The ICM Core System shall include an interface for users to view routes followed by local bus services of interest. | M | 12 | |
| UI-6.2.4 | The ICM Core System shall include an interface for users to view bus stops used by bus services of interest. | L | 12 | |

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| **UI-6.3** | **The ICM Core System shall display on a map information about the devices used to monitor corridor operations.** | **M** | **3, 4, 12, 13** | **Corridor Managemt** |
| UI-6.3.1 | The ICM Core System shall include an interface for users to view on a map the location of traffic sensors supplying information to the ICM system. | M | 4, 6, 12, 13 | |
| UI-6.3.2 | The ICM Core System shall include an interface for users to view on a map the location of travel time monitoring devices supplying information to the ICM system. | M | 4, 6, 12, 13 | |
| UI-6.3.3 | The ICM Core System shall include an interface for users to view on a map the CCTV cameras providing video feeds. | M | 4, 6, 12, 13 | |
| UI-6.3.4 | For each detection device, the ICM Core System shall display the type of data provided by the device (count, speed, occupancy, etc.) | M | 4, 6, 12, 13 | |
| **UI-6.4** | **The ICM Core System shall include a function for users to access from maps key geometric characteristics about individual roadway links under ICM management.** | **M** | **3, 4, 12, 13** | **Corridor Managemt** |
| UI-6.4.1 | The ICM Core System shall include a function for users to view for each roadway link under ICM management the number of through, left-turn, and right-turn traffic lanes at the downstream end of the link. | M | 12 | |
| UI-6.4.2 | The ICM Core System shall include a function for users to view for each roadway link under ICM management the posted speed limit. | M | 12 | |
| UI-6.4.3 | The ICM Core System shall include a function for users to display on a map geometrical elements potentially constraining response planning activities (e.g.., low bridge clearance). | M | 12 | |
| UI-6.4.4 | The ICM Core System shall include a function for users to display on a map roadway segments affected by regulations that may potentially constrain response planning activities (e.g., truck restrictions) | M | 12 | |
| **UI-6.5** | **System users shall be able to access from map displays information about the traffic management devices in the ICM inventory.** | **M** | **3, 4, 12, 13** | **Corridor Managemt** |
| UI-6.5.3 | For each signalized intersection in the ICM inventory, the ICM Core System shall include a function for users to access from map displays available configuration data and stored timing plan information | M | 12 | |
| UI-6.5.3 | For each ramp meter in the ICM inventory, the ICM Core System shall include a function for users to access from map displays available configuration data and stored metering plans. | M | 1 | |
| UI-6.5.3 | For each fixed CMS in the ICM inventory, the ICM Core System shall include a function for users to access from map displays available configuration data. | M | 12 | |
| UI-6.5.3 | For each portable CMS in the ICM inventory, the ICM Core System shall include a function for users to access from map displays available configuration data. | M | 12 | |
| UI-6.5.3 | For each extinguishable trailblazer sign in the ICM inventory, the ICM Core System shall include a function for users to access from map displays available configuration data. | M | 12 | |
| UI-6.5.3 | For each HAR station in the ICM inventory, the ICM Core System shall include a function for users to access from map displays available configuration data. | M | 12 | |

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| **UI-6.6** | **The ICM Core System shall include a function for users to access from map displays available video feeds from nearby CCTV cameras.** | **H** | **4, 6, 12, 13** | **Corridor Managemt** |
| **UI-6.7** | **The ICM Core System shall include a function for users to view on a map the current operational status of roadway segments under ICM management.** | **H** | **4, 6, 12, 13** | **Corridor Managemt** |
| UI-6.7.1 | The ICM Core System shall include a function for users to view, if available, the latest measurements from traffic detection devices displayed on map. | M | 4, 6, 12, 13 | |
| UI-6.7.2 | Maps shall be able to color roadway links based on the level of congestion on the link. | M | 4, 6, 12, 13 | |
| UI-6.7.2 | Maps shall be able to display upon request the current traffic state of a link displayed on the map for which the information is available. | M | 4, 6, 12, 13 | |
| *UI-6.7.2.1* | *For roadway links for which field data are available, maps shall be able to display traffic states determined from the field data.* | *M* | *12* | |
| *UI-6.7.2.2* | *For links for which field data are not provided, maps shall be able to display estimated traffic states produced by the ICM System, if such information is available.* | *M* | *12* | |
| *UI-6.7.2.3* | *The ICM Core System shall include a function for users to determine what current traffic state information (density, speed, flow rate, etc.) is to be displayed.* | *M* | *12* | |
| *UI-6.7.2.4* | *Maps shall indicate whether the displayed traffic states are derived from field data or an estimation process.* | *M* | *12* | |
| **UI-6.8** | **The ICM Core System shall include a function for users to view on a map the projected operational status of roadway segments under ICM management.** | **H** | **12** | **Corridor Managemt** |
| UI-6.8.1 | The ICM Core System shall be able to display on maps forecasted states for roadway links for which a forecast exists. | H | 12 | |
| UI-6.8.2 | The ICM Core System shall include a function for users to determine which available forecasted traffic states (density, speed, flow rate, etc.) are to be displayed. | H | 12 | |
| **UI-6.9** | **The ICM Core System shall include a function for users to view on a map historical status data for roadway segments under ICM management.** | **M** | **12** | **Corridor Managemt** |
| *UI-6.9.1* | The ICM Core System shall be able to display historical traffic data where such information is available. | M | 12 | |
| *UI-6.9.2* | The ICM Core System shall include a function for users to determine which available historical traffic characteristics are to be displayed (density, speed, flow rate, etc.). | M | 12 | |
| **UI-6.10** | **The ICM Core System shall include a function for users to view on a map the operational status of traffic management devices in the ICM inventory.** | **M** | **3, 4, 12, 13** | **Corridor Managemt** |
| UI-6.10.1 | The ICM Core System shall include a function for users to view on a map the current and projected operational status of traffic signals connected to the ICM Environment (operational status, current timing plan, planned timing plan). | M | 3, 4, 12, 13 | |
| UI-6.10.2 | The ICM Core System shall include a function for users to view on a map the current and projected operational status of ramp meters on freeway ramps under ICM management (meter on/off, active meter rate, planned metering rate). | M | 3, 4, 12, 13 | |

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| UI-6.10.3 | The ICM Core System shall include a function for users to view on a map the current and projected operational status of fixed CMSs connected to the ICM Environment (sign on/off, current message displayed, planned message display). | M | 3, 4, 12, 13 | |
| UI-6.10.4 | The ICM Core System shall include a function for users to view on a map, to the extent possible, the current and projected operational status of portable CMSs connected to the ICM Environment (deployment location, current message displayed, planned message display). | M | 3, 4, 12, 13 | |
| UI-6.10.5 | The ICM Core System shall include a function for users to view on a map the current and projected operational status of extinguishable trailblazer signs connected to the ICM Environment (device on/off, planned activation/termination time). | M | 3, 4, 12, 13 | |
| UI-6.10.6 | The ICM Core System shall include a function for users to view on a map the current and projected operational status of HAR stations connected to the ICM Environment (station activate or not, planned activation/termination time). | L | 3, 4, 12, 13 | |
| **UI-6.11** | **The ICM Core System shall include a function for users to view on a map the operational status of transit services of interest to the ICM System.** | **M** | **4, 6, 12, 13** | **Corridor Managemt** |
| UI-6.11.1 | The ICM Core System shall include a function for users to view on a map available ridership and operational statistics from the Metro Gold Line. | M | 4, 6, 12, 13 | |
| UI-6.11.2 | The ICM Core System shall include a function for users to view on a map available ridership and operational statistics from express and commuter bus routes under ICM surveillance. | M | 4, 6, 12, 13 | |
| UI-6.11.3 | The ICM Core System shall include a function for users to view on a map available ridership and operational statistics from local bus routes under ICM surveillance. | L | 4, 6, 12, 13 | |
| **UI-6.12** | **The ICM Core System shall include a function for users to view on a map the operational status of monitored park-and-ride facilities.** | **L** | **4, 6, 12, 13** | **Corridor Managemt** |
| UI-6.12.1 | The ICM Core System shall include a function for users to view on a map the level of occupancy of each park-and-ride facility under ICM surveillance. | L | 4, 6, 12, 13 | |
| **UI-6.13** | **The ICM Core System shall include a function to plot on a map the location of incidents and events being tracked** | **H** | **12, 13** | **Corridor Managemt** |
| UI-6.13.1 | The ICM Core System shall include a function to plot on a map the location of all active verified incidents and events. | H | 12, 13 | |
| UI-6.13.2 | The ICM Core System shall include a function to plot on a map the location of scheduled near-future events. | H | 12, 13 | |
| UI-6.13.3 | The ICM Core System shall include a function to plot on a map the location of active and near-future scheduled road closures. | H | 12, 13 | |
| UI-6.13.4 | The ICM Core System shall include a function to plot on a map the location of incidents and events awaiting verification. | H | 12, 13 | |
| UI-6.13.5 | The ICM Core System shall include a function to plot on a map the location of closed incidents or events that are still subject to response planning (until corridor conditions return to normal). | H | 12, 13 | |
| **UI-6.14** | **The ICM Core System shall include a function for users to access detailed incident or event information from map displays.** | **H** | **12, 13** | **Corridor Managemt** |

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| UI-6.14.1 | For each displayed incident, the ICM Core System shall include a function for users to access the following information:<br>• Incident status (e.g., pending verification, active, closed, etc.)<br>• Incident type<br>• Roadway segment on which the incident is located<br>• Number of lanes affected<br>• Anticipated zone of influence<br>• Expected duration (if not closed)<br>• Responsible agency | H | 12, 13 | |
| UI-6.14.2 | For each displayed event, the ICM Core System shall include a function for users to access the following information describing the event:<br>• Type of event (lane closure, special event, etc.)<br>• Event status (scheduled, active, recently terminated)<br>• Roadway segment(s) affected<br>• Number of lanes affected<br>• Anticipated zone of influence<br>• Expected start time<br>• Expected duration (if not closed)<br>• Responsible agency | H | 12, 13 | |
| UI-6.14.3 | The ICM Core System shall provide the means to access from a map incident/event information based on the active status of the incident or event. | H | 12, 13 | |
| *UI-6.14.3.1* | *The ICM Core System shall display a list of active incidents and events that have been verified.* | H | 12, 13 | |
| *UI-6.14.3.2* | *The ICM Core System shall display a list of active incidents and events with an active response plan.* | H | 12, 13 | |
| *UI-6.14.3.3* | *The ICM Core System shall display a list of active incidents and events that are pending verification.* | H | 12, 13 | |
| *UI-6.14.3.4* | *The ICM Core System shall display a list of scheduled events expected to start within the current day.* | H | 12, 13 | |
| **UI-6.15** | **The ICM Core System shall include a function for users to view on a map the availability of traffic management devices connected to the ICM Environment for the development of response plans.** | **M** | **3, 4, 12, 13** | **Corridor Managemt** |
| UI-6.15.1 | The ICM Core System shall display on a map whether traffic signals in the ICM inventory are available for response planning. | M | 3, 4, 12, 13 | |
| UI-6.15.2 | The ICM Core System shall display on a map whether ramp meters in the ICM inventory are available for response planning. | M | 3, 4, 12, 13 | |
| UI-6.15.3 | The ICM Core System shall display on a map whether fixed CMSs in the ICM inventory are available for response planning. | M | 3, 4, 12, 13 | |
| UI-6.15.4 | The ICM Core System shall display on a map, to the extent possible, whether portable CMS devices in the ICM inventory are available for response planning. | M | 3, 4, 12, 13 | |
| UI-6.15.5 | The ICM Core System shall display on a map whether extinguishable trailblazer signs on the ICM inventory are available for response planning. | M | 3, 4, 12, 13 | |

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| UI-6.15.6 | The ICM Core System shall display on a map whether HAR stations in the ICM inventory are available for response planning. | L | 3, 4, 12, 13 | |
| **UI-6.16** | **The ICM Core System shall include a function for users to view response plan elements on a map.** | **H** | **4, 12** | **Corridor Managemt** |
| UI-6.16.1 | The ICM Core System shall display on a map the recommended detour(s) for each vehicle type. | H | 4, 12 | |
| UI-6.16.2 | The ICM Core System shall display on a map the location of all field devices associated with a response plan. | H | 4, 12 | |
| *UI-6.16.2.1* | *The ICM Core System shall display on a map the location of all traffic signals associated with a response plan.* | H | 4, 12 | |
| *UI-6.16.2.2* | *The ICM Core System shall display on a map the location of all ramp meters associated with a response plan.* | H | 4, 12 | |
| *UI-6.16.2.3* | *The ICM Core System shall display on a map the location of all fixed CMS devices associated with a response plan.* | H | 4, 12 | |
| *UI-6.16.2.4* | *The ICM Core System shall display on a map the locations where portable CMS devices are recommended to be deployed.* | H | 4, 12 | |
| *UI-6.16.2.5* | *The ICM Core System shall display on a map the locations of all extinguishable trailblazer signs that are to be activated.* | H | 4, 12 | |
| *UI-6.16.2.6* | *The ICM Core System shall display on a map the locations of all HAR stations that are to be activated.* | H | 4, 12 | |
| UI-6.16.3 | The ICM Core System shall display on a map the control actions associated with each response plan element. | H | 4, 12 | |
| *UI-6.16.3.1* | *The ICM Core System shall display on a map the timing plan that is to be activated at each affected signalized intersection.* | H | 4, 12 | |
| *UI-6.16.3.2* | *The ICM Core System shall display on a map the metering strategy that is to be activated at each affected freeway on-ramp.* | H | 4, 12 | |
| *UI-6.16.3.3* | *The ICM Core System shall display on a map the message that is to be displayed at each affected fixed CMS device.* | H | 4, 12 | |
| *UI-6.16.3.4* | *The ICM Core System shall display on a map the messages that are to be posted at each location where a portable CMS device is to be deployed.* | H | 4, 12 | |
| *UI-6.16.3.5* | *The ICM Core System shall display on a map the message provided by each activated extinguishable trailblazer signs.* | H | 4, 12 | |
| **UI-6.17** | **The ICM Core System shall use a layered approach to display information on maps.** | **M** | 12 | **Corridor Managemt** |

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| UI-6.17.1 | The ICM Core System map visualizations shall organize display elements in layers so that users can easily turn on and off types of display elements. These layers should include but may not be limited to:<br>• Background maps/imagery<br>• Road network geometry<br>- Freeways<br>- Freeway ramps<br>- Arterials<br>- Local streets<br>• Organizational and jurisdictional boundaries<br>• Traffic control devices<br>- Traffic signals<br>- Ramp meters<br>• Transit networks<br>- Light-rail lines<br>- Express and commuter bus routes<br>- Local bus routes<br>- Bus stops<br>- Park-and-ride facilities<br>• Traveler information devices<br>- Fixed CMSs<br>- Extinguishable trailblazer signs<br>- Static signs<br>- HAR stations<br>• Defined detour routes for ICM decision-making<br>• Road network constraints<br>- Truck restrictions<br>- School zones (location, start/end times)<br>• Response plan elements<br>- Boundaries<br>- Control assets involved<br>- Traveler information devices involved | M | 12 | |
| UI-6.17.2 | The ICM Core System shall include a function for users to turn on and off the various device layers on the map based upon appropriate user rights. | M | 12 | |
| **UI-6.18** | **The ICM Core System shall provide a means for users to create and customize visualizations.** | **M** | **12** | **Corridor Managemt** |
| UI-6.18.1 | The ICM Core System shall include a function for users to select which display elements, corridor traffic and asset information, map, table, and plot-based elements to display. | M | 12 | |
| UI-6.18.2 | The ICM Core System shall include a function for users to customize geographic areas, pan settings, and zoom levels for display and save them as user preferences and quick access shortcuts for use in the future upon request. | M | 12 | |
| UI-6.18.3 | The ICM Core System shall include a function for users to save customized display selections as a user preference and allow them to use those preferences in the future upon request. | M | 12 | |
| **UI-6.19** | **The ICM Core System shall provide a geospatial approach to manage corridor information.** | **H** | **12** | **Corridor Managemt** |
| UI-6.19.1 | The ICM Core System shall provide a means for users to modify asset usage and state (within the parameters allowed by the owning agency) from geospatial displays. | H | 12 | |

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| UI-6.19.2 | The ICM Core System shall provide a means to initiate incident confirmation, response plan development, response plan selection, and response plan implementation from the primary geospatial displays. | H | 12 | |
| **UI-6.20** | **Geospatial displays shall include a function for animation where time-based data analysis is available.** | **H** | **12** | **Corridor Managemt** |

### 9.9.7. REPORTING, CHARTING, AND GRAPHING FUNCTIONS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-7.1** | **The ICM Core System shall provide standard and customized reporting capabilities.** | **H** | **12, 13** | **Corridor Managemt** |
| UI-7.1.1 | The ICM Core System shall provide a means to create and save reports for users to run either scheduled or on demand. | H | 12, 13 | |
| UI-7.1.2 | The ICM Core System shall provide a means to display reports on screen. | H | 12, 13 | |
| UI-7.1.3 | The ICM Core System shall provide a means to print reports. | H | 12, 13 | |
| UI-7.1.4 | The ICM Core System shall provide a means to save report output in standardized formats, including pdf and image-based formats. | H | 12, 13 | |
| **UI-7.2** | **The ICM Core System shall include a function to produce traffic summary reports for specific roadway elements.** | **M** | **4, 6** | **Corridor Managemt** |
| UI-7.2.1 | The ICM Core System shall include a function to generate traffic reports for specific traffic sensors. | M | 4, 6 | |
| UI-7.2.2 | The ICM Core System shall include a function to generate traffic reports for specific intersections. | M | 4, 6 | |
| UI-7.2.3 | The ICM Core System shall include a function to generate traffic reports for specific roadway segments. | M | 4, 6 | |
| UI-7.2.4 | The ICM Core System shall include a function to generate traffic reports for specific user-defined routes. | M | 4, 6 | |
| **UI-7.3** | **The ICM Core System shall include a function to produce operational summary reports for individual devices in operation within the ICM corridor.** | **M** | **4, 16, 17** | **Corridor Managemt** |
| UI-7.3.1 | The ICM Core System shall include a function to generate traffic signal operation reports for specific signal controllers/signalized intersections. | M | 4, 16, 17 | |
| UI-7.3.2 | The ICM Core System shall include a function to generate ramp metering operation reports for specific freeway on-ramps. | M | 4, 16, 17 | |
| UI-7.3.3 | The ICM Core System shall include a function to generate reports summarizing message displays on specified fixed CMS devices. | M | 4, 16, 17 | |
| UI-7.3.4 | The ICM Core System shall include a function to generate reports summarizing deployment locations and messages displayed for specific mobile CMS devices. | M | 4, 16, 17 | |
| UI-7.3.5 | The ICM Core System shall include a function to generate reports summarizing which extinguishable trailblazer signs were activated as part of a response plan. | M | 4, 16, 17 | |

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| UI-7.3.6 | The ICM Core System shall include a function to generate reports summarizing HAR activations and messages that were broadcast by each station. | M | 4, 16, 17 | |
| **UI-7.4** | **The ICM Core System shall include a function to produce summary reports of system activities.** | **M** | **4, 16, 17** | **Corridor Managemt** |
| UI-7.4.1 | The ICM Core System shall include a function to produce a summary of response planning activities. | M | 4, 16, 17 | |
| UI-7.4.2 | The ICM Core System shall include a function to produce a summary of system performance over a given interval. | M | 4, 16, 17 | |
| **UI-7.5** | **The ICM Core System shall display plot-based (2d, 3d, heat map) visualizations of corridor information.** | **H** | **12** | **Corridor Managemt** |
| UI-7.5.1 | The ICM Core System shall provide plot-based displays of corridor traffic density and velocity values from traffic state determinations along user-selected routes in 2d (spatial point in time) and heat map (spatial and time variant). | H | 12 | |
| UI-7.5.2 | The ICM Core System shall provide plot-based displays of corridor traffic density and velocity forecasts along user-selected routes in 2d (spatial point in time) and heat map (spatial and time variant). | H | 12 | |
| UI-7.5.3 | The ICM Core System shall provide plot-based displays of corridor asset availability (% of assets by type or geographic area out of service or degraded). | M | 12 | |
| UI-7.5.4 | The ICM Core System shall provide plot-based displays of corridor asset reliability, quality, and accuracy (asset quality metrics, asset reliability metrics vs. time by type or geographic area). | M | 12 | |
| UI-7.5.5 | The ICM Core System shall provide plot-based displays of corridor sensor data along user-selected routes in 2d (spatial point in time) and heat map (spatial and time variant). | H | 12 | |
| UI-7.5.6 | The ICM Core System shall provide plot-based displays of corridor roadway capacity. | H | 12 | |
| UI-7.5.8 | Plot displays shall include a function for animation where time-based analysis is available. | M | 12 | |
| UI-7.5.9 | Plot displays shall include drill-down capabilities to display additional detail when available. | M | 12 | |
| **UI-7.6** | **The ICM Core System shall provide multiple types of graphing displays.** | **H** | **12** | **Corridor Managemt** |
| UI-7.6.1 | The ICM Core System shall display organization information in organizational charts. | L | 12 | |
| UI-7.6.2 | The ICM Core System shall display rules in decision tree charts. | L | 12 | |
| UI-7.6.3 | The ICM Core System shall display rules in flow charts. | L | 12 | |
| UI-7.6.4 | Plots shall include pie, line, bar, and histogram charts. | H | 12 | |
| **UI-7.7** | **The ICM Core System shall include a function to display information in tables.** | **H** | **12** | **Corridor Managemt** |
| UI-7.7.1 | The ICM Core System shall include a function to display corridor asset inventories in tables. | H | 12 | |
| UI-7.7.2 | The ICM Core System shall include a function to display user-defined routes in tables. | H | 12 | |
| UI-7.7.3 | The ICM Core System shall include a function to display corridor transit routes and inventory in tables. | H | 12 | |

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| UI-7.7.4 | The ICM Core System shall include a function to display corridor transit asset state in tables. | H | 12 | |
| UI-7.7.5 | The ICM Core System shall include a function to display corridor maintenance activity and schedules in tables. | L | 12 | |
| UI-7.7.6 | The ICM Core System shall include a function to display appropriate rules-based information (i.e., location and hours of schools, event information, facility location and hours of operation information, etc.) in tables. | M | 12 | |
| **UI-7.8** | **The ICM Core system shall provide visualizations showing differences between plots.** | **H** | **12** | **Corridor Managemt** |
| UI-7.8.1 | The ICM Core System shall provide displays of corridor traffic density and velocity values identifying differences between the state of the corridor traffic at the time forecasts were initiated and the current estimated traffic state. | H | 12 | |
| **UI-7.9** | **The ICM Core System shall calculate upon request travel times or travel delays between selected points within the corridor.** | **M** | **1, 4, 6** | **Corridor Managemt** |
| UI-7.9.1 | The ICM Core System shall accept and store a user-defined library of segments along which travel time or travel delay is to be calculated and continuously updated. | M | 1, 4, 6 | |
| UI-7.9.2 | The ICM Core System shall display a map of current or projected traffic conditions, per user request, from which users can select the points between which travel time or travel delay is to be calculated. | M | 1, 4, 6 | |
| **UI-7.8** | **The ICM Core System shall report on observed traffic operations within the corridor.** | **M** | **4, 6** | **Corridor Managemt** |
| UI-7.8.1 | The ICM Core System shall produce upon request hourly and daily reports summarizing observed traffic conditions on freeway segments under ICM surveillance. | M | 4, 6 | |
| UI-7.8.2 | The ICM Core System shall produce upon request hourly and daily reports summarizing observed traffic conditions on arterial segments under ICM surveillance. | M | 4, 6 | |
| UI-7.8.3 | The ICM Core System shall produce upon request hourly and daily reports summarizing observed traffic conditions at given intersections within the corridor. | M | 4, 6 | |
| UI-7.8.4 | The ICM Core System shall produce upon request hourly and daily reports summarizing observed traffic conditions along given user-defined routes within the corridor. | M | 4, 6 | |
| UI-7.8.5 | The ICM Core System shall include a function to aggregate and summarize calculated performance metrics by commute direction. | M | 6 | |
| UI-7.8.6 | The ICM Core System shall include a function to aggregate and summarize calculated performance metrics by time of day, day of week, for a specific date or for a specified date range. | M | 6 | |
| **UI-7.9** | **The ICM Core System shall report on observed versus estimated/predicted values.** | **M** | **4, 6** | **Corridor Managemt** |
| UI-7.9.3 | Decision Support shall provide comparisons of current traffic state estimation results to measured data. | M | 6 | |
| UI-7.9.4 | Decision Support shall provide comparisons of traffic forecast results to measured data. | M | 6 | |
| **UI-7.10** | **The ICM Core System shall include a function for system users to run queries on the performance of monitored roadways.** | **M** | **4, 6** | **Corridor Managemt** |

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| UI-7.10.1 | The ICM Core System shall include a function for users to run queries on the performance of specific roadway segments. | M | 4, 6 | |
| *UI-7.10.1.1* | *The ICM Core System shall include a function for users to query average flow measurements from roadway segments from which such measurements are available.* | M | 4, 6 | |
| *UI-7.10.1.2* | *The ICM Core System shall include a function for users to query average speed measurements from roadway segments from which such measurements are available.* | M | 4, 6 | |
| *UI-7.10.1.3* | *The ICM Core System shall include a function for users to query average travel time measurements from roadway segments from which such measurements are available.* | M | 4, 6 | |
| *UI-7.10.1.4* | *The ICM Core System shall include a function for users to query average sensor occupancy measurements from roadway segments from which such measurements are available.* | M | 4, 6 | |
| UI-7.10.2 | The ICM Core System shall include a function for users to run queries on the performance of specific intersections. | M | 4, 6 | |
| *UI-7.10.2.1* | *The ICM Core System shall include a function for users to query, for each intersection approach, information about average observed traffic volumes.* | M | 4, 6 | |
| *UI-7.10.2.2* | *The ICM Core System shall include a function for users to query, for each intersection approach, information about the average delay that traffic is estimated to incur due to the traffic signal operation.* | M | 4, 6 | |
| *UI-7.10.2.3* | *The ICM Core System shall include a function for users to query for each intersection information about the average delay that traffic is estimated to incur due to the traffic signal operation.* | M | 4, 6 | |
| UI-7.10.3 | The ICM Core System shall include a function for users to run queries on the performance of specific user-defined routes. | M | 4, 6 | |
| *UI-7.10.3.1* | *The ICM Core System shall include a function for users to query information about average observed travel times along user-defined routes.* | M | 4, 6 | |
| *UI-7.10.3.2* | *The ICM Core System shall include a function for users to query observed traffic volumes along various sections of a user-defined route.* | M | 4, 6 | |
| **UI-7.11** | **The ICM Core System shall include a function for system users to specify the period over which historical data are to be analyzed.** | **H** | **4, 5** | **Corridor Managemt** |
| UI-7.11.1 | The ICM Core System shall include a function for system users to specify the range of dates for which historical data are to be analyzed. | H | 4, 5 | |
| UI-7.11.2 | The ICM Core System shall include a function for system users to specify the specific time period within a day for which historical data are to be analyzed. | H | 4, 5 | |
| UI-7.11.3 | The ICM Core System shall include a function for system users to specify the specific weekdays within a given date range for which historical data are to be analyzed. | H | 4, 5 | |

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| UI-7.11.4 | The ICM Core System shall include a function for system users to specify the interval within a given time period with which historical statistics are to be calculated (for instance, every 15 minutes, 1 hour, day, month, etc.) | H | 4, 5 | |

### 9.9.8. POST-INCIDENT/EVENT ANALYSIS REPORT

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-8.1** | **The ICM Core System shall create post-incident/event analysis reports for incidents and events for which response plans were generated.** | **H** | **6** | **Corridor Managemt** |
| UI-8.1.1 | The post-incident/event analysis report shall include a detailed description of the incident or event for which a potential response was evaluated. Minimal information to be presented includes:<br>• Type of incident/event<br>• Location where incident/event occurred<br>• Time incident occurred or event started<br>• Formal duration of incident/event (up to incident clearance or event closure)<br>• Time when travel conditions were reported to have returned to normal following termination of the incident or event<br>• Roadway segment(s) affected by the incident<br>• Reported lane closures on each affected roadway segment<br>• Agency responsible for managing the incident or event | H | 6 | |
| UI-8.1.3 | For each response plan evaluated, the post-incident/event analysis report shall identify all elements included in the response plan. | H | 6 | |
| UI-8.1.4 | The post-incident/event analysis report shall include the results of the rules analysis, including source data used in the analysis, rules evaluated, data quality evaluation, and final recommendations of the rules analysis. | M | 6 | |
| UI-8.1.7 | The post-incident/event analysis report shall identify response plan elements automatically selected by the ICM Core System and plan elements that were manually input by agency staff. | L | 6 | |
| UI-8.1.8 | For each recommended response plan, the post-incident/event analysis report shall identify any plan modifications that were made by agency staff after the initial plan development. | L | 6, 9 | |
| UI-8.1.6 | For each recommended response plan, the post-incident/event analysis report shall detail the results of any required approval actions by agencies involved in the implementation of the plan. | H | 6 | |
| UI-8.1.9 | For each recommended response plan, the post-incident/event analysis report shall identify which plan elements were successfully implemented, which elements were not fully successfully implemented, and a timeline of the response plan implementation and de-escalation. | H | 6 | |

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| UI-8.1.10 | The post-incident/event analysis report shall include an analysis of the accuracy of the traffic forecast at the base of the response recommendation ("no action" or "response plan recommendation"). | H | 6 | |
| UI-8.1.11 | The post-incident analysis report shall reference any additional events that occurred during the same impact period anywhere on the corridor. | H | 6 | |

### 9.9.9. INTERFACE TO CALTRANS' ATMS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-9.1** | **The ICM Environment shall include UI functionality within the Caltrans ATMS for use by Caltrans' operators** | **H** | **7, 16** | **Corridor Managemt** |
| UI-9.1.3 | The ICM Environment shall provide ATMS operators with an ATMS interface providing the ability to create, edit, and review incident /event information. | H | 1, 4 | |
| UI-9.1.1 | The ICM Environment shall provide ATMS operators with an ATMS interface providing the ability to review response plans. | H | 7, 16 | |
| UI-9.1.2 | The ICM Environment shall provide ATMS operators with an ATMS interface providing the ability to reject or approve response plans. | H | 7, 16 | |

### 9.9.10. INTERAGENCY COMMUNICATION

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **UI-9.1** | **The ICM Environment shall facilitate communication between staff from different agencies.** | **M** | **7, 16** | **Corridor Managemt** |
| UI-9.1.1 | The ICM Environment shall provide users with a list of contact persons from each participating agency. | M | 7, 16 | |
| UI-9.1.2 | The ICM Environment shall provide users with the means to send messages to other users. | L | 7, 16 | |
| UI-9.1.3 | The ICM Environment shall provide a means for roadway operators and first responders to exchange information about active incidents. | M | 1, 4 | |

## 9.10. SYSTEM INTEGRATION

This section requires that the ICM Core system be composed of one integrated set of data definitions, data values, processes, and user interfaces. Users should be able to manipulate data and manage processes by interfacing with one integrated user interface. Data should be stored in only one location, and all data of a given type should conform to the same format and quality standards.

### 9.10.1. INTEGRATION REQUIREMENTS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SI-1.1** | **The ICM Core System shall be a single integrated system capable of directing all corridor operations. It shall include functionality for users to view, analyze, and control corridor performance and operations from a single integrated platform and user interface.** | **H** | **4, 6, 7, 8, 16, 17** | **Corridor Managemt** |
| SI-1.1.1 | The ICM Core System shall provide integrated visualization and reporting using common reporting and visualization components. | H | 12,13 | |
| SI-1.1.2 | The ICM Core System shall have a single control interface for corridor operational functions. The control interface shall provide centralized access to the ICM functions and shall be incorporated into a single user interface for control and data presentation. | H | 4,8, 9 | |
| SI-1.1.3 | The ICM Environment shall use a common set of data definitions and shall provide consistent data processing and management across all ICM components. Data shall be presented to users consistently across all ICM Core System components. | H | 1, 2, 3, 7, 12, 13, 14, 15 | |
| SI-1.1.4 | The ICM Core system shall maintain systems of record and user-level ownership of rules, data and data definitions, algorithms, and workflows | H | 16, 17 | |
| SI-1.1.5 | All ICM Core System user interfaces shall use common user interface components and common user experience design elements. | H | 4, 6, 7, 12, 13, 17, 18 | |

### 9.10.2. INTEGRATED VISUALIZATION AND REPORTING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SI-2.1** | **The ICM Core System shall provide a single visualization and reporting user interface for all ICM Core System Operations.** | **H** | **1, 2, 3, 4, 5, 6, 7, 12, 13, 14, 17** | **Corridor Managemt** |
| SI-2.1.1 | The ICM Core System shall provide a single visualization and reporting user interface for corridor traffic state. | H | 1, 2 | |
| SI-2.1.2 | The ICM Core System shall provide a single visualization and reporting user interface for traffic forecasts. | H | 4, 5 | |
| SI-2.1.3 | The ICM Core System shall provide a single visualization and reporting user interface for corridor asset inventories. | H | 1, 3 | |

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| SI-2.1.4 | The ICM Core System shall provide a single visualization and reporting user interface for corridor asset information. | H | 1, 3, 4 | |
| SI-2.1.5 | The ICM Core System shall provide a single visualization and reporting user interface for corridor sensing data. | H | 1, 4 | |
| SI-2.1.6 | The ICM Core System shall provide a single visualization and reporting user interface for corridor analytic data and metrics. | H | 4, 5, 6, 13, 14 | |
| SI-2.1.7 | The ICM Core System shall provide a single visualization and reporting user interface for response plan information. | H | 4, 6 | |
| SI-2.1.8 | The ICM Core System shall provide a single visualization and reporting user interface for management, maintenance, and operations functions. | H | 16, 17 | |

### 9.10.3. INTEGRATED CONTROL FUNCTIONS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SI-3.1** | **The ICM Core System shall provide integrated functions for major functional areas.** | **H** | **7, 8, 9** | **Corridor Managemt** |
| SI-3.1.1 | The ICM Core System shall provide an integrated set of functions for corridor monitoring. | H | 7, 8, 9 | |
| SI-3.1.2 | The ICM Core System shall provide an integrated set of functions for incident/event management. | H | 7, 8, 9 | |
| SI-3.1.3 | The ICM Core System shall provide an integrated set of functions for response plan management. | H | 7, 8, 9 | |
| SI-3.1.3 | The ICM Core System shall provide an integrated set of functions for data management. | H | 7, 8, 9 | |
| SI-3.1.5 | The ICM Core System shall provide an integrated set of functions for decision support capabilities. | H | 4, 6 | |
| SI-3.1.5 | The ICM Core System shall provide an integrated set of functions for system management. | H | 4, 6 | |
| SI-3.1.6 | All traffic state assessment and traffic forecasting shall be accomplished within Decision Support. | H | 1,5 | |
| SI-3.1.7 | All ICM rules evaluation shall be accomplished within a common rules engine. | H | 1,5 | |
| SI-3.1.8 | ICM control functions shall be capable of continuous operations in the event of any individual system failure. | H | 17 | |

### 9.10.4. INTEGRATED DATA DEFINITION, CAPTURE, AND PROCESSING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SI-4.1** | **The ICM Core System shall have an integrated point of access with consistent data definitions and formatting for internal system data access and data processing.** | **H** | **1, 2, 3, 4, 6, 12, 16, 17** | **Corridor Managemt** |
| SI-4.1.1 | All data collected by the ICM Core System shall be available through the common ICM data access interfaces. | H | 1, 2, 3, 4, 6, 12, 16, 17 | |
| SI-4.1.2 | All data collected by the ICM Core System shall be managed through common ICM user interfaces. | H | 1, 2, 3, 4, 6, 12, 16, 17 | |

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| SI-4.1.3 | All data collected by the ICM Core System shall be defined and used in a common manner and format cross all ICM system components. | H | 1, 2, 3, 4, 6, 12, 16, 17 | |
| ***SI-4.2*** | **All data collected by the ICM Core System shall be managed within the appropriate security context.** | **H** | **1, 2, 3, 4, 6, 12, 16, 17** | **Corridor Managemt** |
| **SI-4.3** | **All ICM data shall be processed in a consistent manner, using design techniques that ensure that each data element is consistently defined, processed, and calculated to ensure the integrity and accuracy of the data element.** | **H** | **1, 2, 3, 4, 6, 12, 16, 17** | **Data Hub** |
| **SI-4.4** | **The ICM Environment corridor data processing and access shall be capable of continuous operations in the event of any individual system component failure.** | **H** | **17** | **Corridor Managemt** |

### 9.10.5. OWNERSHIP OF SOFTWARE, HARDWARE, DATA, AND ALGORITHMS

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SI-5.1** | **The ICM Environment shall maintain ownership of each data element and data record.** | **H** | **1, 2, 3, 7, 16, 17** | **Institutional Job Tasks** |
| SI-5.1.1 | The ICM Environment shall maintain a record identifying critical primary data elements and the owner of each critical primary data element. | H | 1, 2, 3, 7, 16, 17 | |
| SI-5.1.2 | The ICM Environment shall maintain a record of the owner of each data record (generally the creator of the record) and permissions for updating or deleting the data record. | H | 7, 16, 17 | |
| **SI-5.2** | **The ICM Environment shall maintain ownership of rules.** | **H** | **7, 16, 17** | **Institutional Job Tasks** |
| SI-5.2.1 | The ICM Environment shall maintain a record identifying the owner of each rule (generally its creator). | H | 7, 16, 17 | |
| SI-5.2.2 | The ICM Environment shall maintain a record identifying permissions for updating, activating, or deactivating the rule. | H | 7, 16, 17 | |
| **SI-5.3** | **The ICM Environment shall maintain ownership of algorithms and workflows.** | **H** | **7, 16, 17** | **Institutional Job Tasks** |
| SI-5.3.1 | The ICM Environment shall maintain a record of primary algorithms used by various system components. | H | 7, 16, 17 | |
| SI-5.3.2 | The ICM Environment shall maintain a record of the owner of each algorithm. | H | 7, 16, 17 | |
| **SI-5.4** | **The ICM Environment shall maintain ownership of hardware.** | **H** | **7, 16, 17** | **Institutional Job Tasks** |
| SI-5.4.1 | The ICM Environment shall maintain a record of who is responsible for the operation of each hardware asset. | H | 7, 16, 17 | |
| SI-5.4.2 | The ICM Environment shall maintain a record of who is responsible for the maintenance of each hardware asset. | H | 7, 16, 17 | |
| **SI-5.5** | **The ICM Environment shall maintain ownership of software.** | **H** | **7, 16, 17** | **Institutional Job Tasks** |
| SI-5.5.1 | The ICM Environment shall maintain a record of who is responsible for software programs. | H | 7, 16, 17 | |

### 9.10.6. SYSTEM OF RECORD/LOCATION FOR DATA

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SI-6.1** | **The ICM Environment shall define a single system of record for each data element.** | **H** | **1, 2, 3, 7, 16, 17** | **Institutional Job Tasks** |
| SI-6.1.1 | Each data element shall have a single system of record, holding single authority for the correct value of that data element. | H | 1, 2, 3, 7, 16, 17 | |
| SI-6.1.2 | The ICM environment shall track the system of record for each data element. | H | 1, 2, 3, 7, 16, 17 | |

## 9.11. SYSTEM MANAGEMENT

This section presents requirements associated with various functions that are needed to ensure that the ICM system is maintained and operated in a reliable manner. These requirements cover topics such as system security, system management, system health monitoring, system reliability and maintenance, software maintenance and updates, and supporting documentation.

### 9.11.1. SYSTEM ACCESS AND SECURITY

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-1.1** | **The ICM Environment shall grant access for system functionalities to authorized users only.** | **H** | **16** | **Corridor Managemt** |
| SM-1.1.1 | The ICM Environment shall allow only authorized users to access its functionalities. | H | 16 | |
| SM-1.1.2 | The ICM Environment shall report all unauthorized access attempts. | H | 16 | |
| **SM-1.2** | **The ICM Environment shall allow multiple users to simultaneously access system functionalities from various locations.** | **H** | **16** | **Corridor Managemt** |
| **SM-1.3** | **The ICM Environment shall provide secure access to its functionalities.** | **H** | **16** | **Corridor Managemt** |
| SM-1.3.1 | The ICM Environment shall provide a means for system users to login to access system functionalities. | H | 16 | |
| SM-1.3.2 | The ICM Environment shall implement encrypted multi-factor authentication for system access. | H | 16 | |
| **SM-1.4** | **The ICM Environment shall provide a secure means of information transmission.** | **H** | **16** | **Corridor Managemt** |
| SM-1.4.1 | The ICM Environment shall provide a means to maintain secure connections between internal system components where relevant. | H | 16 | |
| SM-1.4.2 | The ICM Environment shall provide a means to maintain secure connections between internal and external system components. | H | 16 | |
| SM-1.4.3 | The ICM Environment shall implement industry-standard point-to-point encryption for all information transmission. | H | 16 | |
| **SM-1.5** | **The ICM Environment shall provide a secure means for storing information.** | **H** | **16** | **Corridor Managemt** |
| SM-1.5.1 | The ICM Environment shall implement, at any storage point, encryption of information deemed sensitive. | H | 16 | |
| **SM-1.6** | **The ICM Environment shall track system access and usage.** | **H** | **16** | **Corridor Managemt** |
| SM-1.6.1 | The ICM Environment shall track system access history. | H | 16 | |
| SM-1.6.2 | The ICM Environment shall track authorized user action history. | M | 16 | |
| **SM-1.7** | **The ICM Environment shall allow ICM Environment users to manage access to ICM Environment components.** | **H** | **16** | **Corridor Managemt** |
| SM-1.7.1 | The ICM Environment shall provide a means for ICM Environment users to create/edit authorized user accounts. | H | 16 | |
| SM-1.7.2 | The ICM Environment shall provide a means for ICM Environment users to create/edit authorized user groups. | H | 16 | |

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| SM-1.7.3 | The ICM Environment shall provide a means for ICM Environment users to edit authorized user privileges. | H | 16 | |
| **SM-1.8** | **The ICM Environment shall provide a validated secure environment.** | **H** | **16** | **Corridor Managemt** |
| SM-1.8.1 | The ICM Environment shall implement commercial or open-source off-the-shelf security component solutions approved by the stakeholders. | H | 16 | |
| SM-1.8.2 | The ICM Environment shall implement penetration testing for developed software, certification of penetration testing for purchased software solutions. | H | 16 | |
| SM-1.8.3 | The ICM Environment shall implement security reviews of the integrated solution and each primary component. | H | 16 | |
| **SM-1.9** | **The ICM Environment shall protect the system environment from unauthorized intentional modification or unintentional modifications.** | **H** | **16** | **Corridor Managemt** |
| **SM-1.10** | **The Corridor Technical Manager shall develop and implement security protocols and processes to ensure secure operations of the ICM Environment.** | **H** | **16** | **Institutional Job Tasks** |
| SM-1.10.1 | The Corridor Technical Manager, following industry-standard security processes, shall develop security procedures. | H | 16 | |
| SM-1.10.2 | The Corridor Technical Manager shall designate an IT Security Officer for the ICM Environment who shall have responsibility for the security of the ICM Environment and its operations. | H | 16 | |
| SM-1.10.3 | The IT Security Officer shall implement security protocols and processes for the ICM Environment. | H | 16 | |
| SM-1.10.4 | The IT Security Officer shall conduct formal reviews of ICM Environment security processes at a regular frequency in accordance with the security protocols and processes, with a minimum frequency of quarterly. | H | 16 | |
| SM-1.10.5 | The IT Security Officer shall direct a formal review of ICM Environment security, led by stakeholders and consultants, at a regular frequency in accordance with the security protocols and processes, with a minimum frequency of annually. | H | 16 | |

### 9.11.2. ICM SYSTEM HEALTH MONITORING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-3.1** | **The ICM Environment shall monitor the health status of its core components.** | **H** | **17** | **Corridor Managemt** |
| SM-3.1.1 | The ICM Environment shall include a function to perform self-checks without operator assistance. | H | 17 | |
| SM-3.1.2 | The ICM Environment shall report any identified operational issue with its core components. | H | 17 | |

### 9.11.3. SYSTEM RELIABILITY

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-2.8** | **The ICM Environment shall have a service level agreement.** | **H** | **17** | **Institutional Job Tasks** |

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| SM-2.8.1 | The service level agreement shall indicate the maximum amount of scheduled system downtime per measurement period. | H | 17 | |
| *SM-2.8.1.1* | *No more than 10 minutes/day of scheduled system downtime and up to 1 additional day quarterly, shall be allowed for system upgrades and maintenance.* | H | 17 | |
| SM-2.8.2 | The service level agreement shall indicate the maximum amount of unscheduled system downtime per measurement period. | H | 17 | |
| *SM-2.8.2.1* | *Minimum performance level shall be 85% minimum system uptime at full capability (not degraded).* | H | 17 | |
| *SM-2.8.2.2* | *Minimum external system reliability shall be:*<br>• *85% uptime for total sensor inventory*<br>• *99% uptime for intersection signals*<br>• *99% uptime for ramp meters*<br>• *85% uptime for CMS*<br>• *85% uptime for CCTV cameras (video & pan, tilt, zoom)*<br>• *85% uptime for extinguishable trailblazer signs*<br>• *85% uptime for HAR*<br>• *85% uptime for network communications* | H | 17 | |
| SM-2.8.3 | The service level agreement shall indicate the minimum required traffic state estimation accuracy and the allowances for data quality and quantity degradation in the forecast accuracy measurement. | M | 17 | |
| SM-2.8.4 | The service level agreement shall indicate the minimum required traffic forecast accuracy and the allowances for data quality and quantity degradation in the forecast accuracy measurement. | M | 17 | |
| SM-2.8.5 | The service level agreement shall indicate the minimum required data quality, reporting frequency, and quantity allowed by 511 services and data providers for each data type. | H | 17 | |
| SM-2.8.6 | The service level agreement shall indicate the allowable time periods and frequency that scheduled maintenance may be performed. | H | 17 | |
| SM-2.8.7 | The service level agreement shall be developed and maintained by the Corridor Technical Manager and reviewed and approved by the Stakeholders. | H | 17 | |
| **SM-2.9** | **The ICM System shall provide a system uptime metrics report for the ICM Environment.** | **H** | **17** | **Corridor Managemt** |
| SM-2.9.1 | The ICM Environment shall produce an annual system uptime report for its performance. | H | 17 | |
| SM-2.9.2 | The ICM Environment shall produce a monthly system uptime report for its performance. | H | 17 | |
| SM-2.9.3 | The system uptime reports shall include information on the decision support system's uptime performance. | H | 17 | |
| SM-2.9.4 | The system uptime reports shall include information on the uptime performance observed for its data sources. | H | 17 | |
| SM-2.9.5 | The system uptime reports shall include information on the uptime performance it observed for its target systems. | H | 17 | |
| SM-2.9.6 | The system uptime reports shall include information on the uptime performance it observed for systems it depends upon. | H | 17 | |

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| **SM-2.10** | **The ICM Environment shall allow for degraded system performance in the event of component failure.** | **M** | **17** | **Corridor Managemt/ DSS/Data Hub** |
| SM-2.10.1 | The ICM Environment shall create a procedure and design for incremental system degradation in the event of an ICM Environment component failure. | M | 17 | |
| SM-2.10.2 | The ICM Environment shall create a procedure and design for incremental system degradation in the event of external system component failure. | M | 17 | |
| **SM-2.11** | **The ICM Core System shall have a System Recovery Plan.** | **H** | **17** | **Institutional Job Tasks** |
| SM-2.11.1 | The ICM Core System shall have a System Recovery Plan that is developed prior to implementation and reviewed quarterly. | H | 17 | |
| SM-2.11.2 | The ICM Core System design shall include an initial system recovery assessment and shall design for critical function system recovery. | H | 17 | |
| SM-2.11.3 | The System Recovery Plan shall be tested at least annually. | H | 17 | |
| SM-2.11.4 | The System Recovery Plan shall ensure the ICM Core System can recover 90% of the time from critical loss within 2 days. | H | 17 | |
| SM-2.11.5 | The Corridor Technical Manager shall develop and maintain the System Recovery Plan, in coordination with stakeholders. | H | 17 | |
| **SM-2.12** | **The ICM Environment shall implement redundant critical system component design.** | **M** | **17** | **Corridor Managemt/ DSS/Data Hub** |
| SM-2.12.1 | The ICM Environment shall use redundant components for all critical system capabilities, including data receipt and processing, traffic state estimation and forecasting, response plan development, and decision rules evaluation. | M | 17 | |
| SM-2.12.2 | The ICM Environment should use redundant hosted facilities or services. | M | 17 | |
| SM-2.12.3 | The ICM Environment should use redundant data connectivity. | M | 17 | |
| **SM-4.1** | **The ICM Environment shall be available 24 hours a day, 7 days a week.** | **H** | **17** | **Corridor Managemt/ DSS/Data Hub** |
| **SM-4.2** | **The ICM Environment shall be available 85% of the time during normal operation, not including routine maintenance and outages due to factors beyond the control of system users.** | **H** | **17** | **Corridor Managemt/ DSS/Data Hub** |
| **SM-4.3** | **All traffic monitoring devices connected to the ICM Environment shall be maintained in good operational condition.** | **H** | **17** | **Institutional Job Tasks** |
| SM-4.3.1 | The Corridor Manager shall ensure that 85% of traffic sensors feeding information to the ICM System operate correctly at any given time. | H | 17 | |
| SM-4.3.2 | The Corridor Manager shall ensure that 85% of travel time measurement devices feeding information to the ICM System operate correctly at any given time. | H | 17 | |
| **SM-4.4** | **All traveler information devices that may be used by the ICM Environment shall be maintained in good operational condition.** | **H** | **17** | **Institutional Job Tasks** |

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| SM-4.4.1 | An 85% uptime shall be maintained for fixed freeway CMSs. | H | 17 | |
| SM-4.4.2 | An 85% uptime shall be maintained for fixed arterials CMSs. | H | 17 | |
| SM-4.4.3 | An 95% uptime shall be maintained for extinguishable trailblazer signs. | H | 17 | |
| **SM-4.5** | **The ICM Environment shall allow external users to access the information it generates without degrading its performance.** | **H** | **17** | **Corridor Managemt** |

### 9.11.4. SYSTEM MAINTENANCE

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-5.1** | **The ICM Environment shall maintain a backup of its core operating parameters.** | **H** | **17** | **Corridor Managemt/ DSS/Data Hub** |
| SM-5.1.1 | The ICM Environment shall store a backup of the system inventory and configuration parameters once per day. | H | 17 | |
| SM-5.1.2 | The Corridor Technical Manager shall have the ability to specify the frequency of system backups. | H | 17 | |
| **SM-5.2** | **The ICM Environment shall not be required to run continuously without maintenance.** | **H** | **17** | **Institutional Job Tasks** |
| **SM-5.3** | **Maintenance of ICM Environment elements shall be the responsibility of the agency owning/operating each element.** | **H** | **17** | **Institutional Job Tasks** |
| SM-5.3.1 | Maintenance of common ICM Environment elements, such as the ICM Core System and Data Hub, shall be the responsibility of Caltrans. | H | 17 | |
| SM-5.3.2 | Maintenance of the IEN communication network shall be the responsibility of the Los Angeles County Department of Public Works. | H | 17 | |
| SM-5.3.3 | Maintenance of the RIITS communication network shall be the responsibility of Metro. | H | 17 | |
| SM-5.3.4 | Maintenance of traffic sensors shall be the responsibility of the agency/agencies owning/operating the equipment. | H | 17 | |
| SM-5.3.5 | Maintenance of travel time monitoring devices shall be the responsibility of the agency/agencies owning/operating the devices. | H | 17 | |
| SM-5.3.6 | Maintenance of traffic signal control equipment shall be the responsibility of the agency/agencies owning/operating the equipment. | H | 17 | |
| SM-5.3.7 | Maintenance of ramp metering control equipment shall be the responsibility of Caltrans. | H | 17 | |
| SM-5.3.8 | Maintenance of fixed CMS devices shall be the responsibility of the agency owning/operating the devices. | H | 17 | |
| SM-5.3.9 | Maintenance of portable CMS devices shall be the responsibility of the agency owning/operating the devices. | H | 17 | |
| SM-5.3.10 | Maintenance of extinguishable trailblazer signs shall be the responsibility of the agency owning/operating the devices. | H | 17 | |
| SM-5.3.11 | Maintenance of equipment on transit vehicles shall be the responsibility of the agency operating the vehicles. | H | 17 | |
| **SM-5.4** | **All traffic sensors providing information to the ICM Environment shall be maintained and calibrated according to the manufacturers' specifications.** | **H** | **17** | **Institutional Job Tasks** |

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|---|---|---|---|---|
| SM-5.4.1 | All traffic sensors shall be maintained in accordance with the manufacturers' specifications. | H | 17 | |
| SM-5.4.2 | All traffic sensors shall be calibrated in accordance with the manufacturers' specifications. | H | 17 | |
| SM-5.4.3 | All received traffic sensor information shall be checked for the reasonableness of the data upon receipt. | H | 17 | |
| SM-5.4.4 | All traffic sensors shall be calibrated before returning to service whenever maintenance is performed. | H | 17 | |
| SM-5.4.5 | All traffic sensors shall be checked for maintenance whenever sensor quality is below allowable thresholds as judged by the Data Hub. | H | 17 | |
| **SM-5.5** | **All corridor assets providing automated data feeds to Decision Support shall be maintained in accordance with the manufacturers' specifications for the assets.** | **H** | **17** | **Institutional Job Tasks** |
| **SM-5.6** | **The ICM Environment shall periodically produce summary reports of maintenance activities conducted on devices connected to the system.** | **M** | **17** | **Corridor Managemt** |
| SM-5.6.1 | The ICM Environment shall produce periodic maintenance reports covering all system elements for the corridor's ICM Environment users. | M | 17 | |
| SM-5.6.2 | The ICM Environment shall produce periodic maintenance reports covering all system elements for the designated Traffic Engineer for each participating agency. | M | 17 | |
| SM-5.6.3 | The ICM Environment shall produce periodic maintenance activity reports covering the devices owned/operated by an agency for each agency's designated maintenance staff supervisor. | M | 17 | |
| **SM-5.7** | **ICM Environment operators shall develop and maintain a list of critical elements that should receive maintenance priority should they fail.** | **H** | **17** | **Institutional Job Tasks** |
| SM-5.7.1 | The Corridor Technical Manager shall ensure that the list of critical elements is developed and maintained. | H | 17 | |
| **SM-5.9** | **The ICM Environment shall log all received alerts and notifications regarding systems operations.** | **H** | **17** | **Corridor Managemt** |
| SM-5.9.1 | The ICM Environment shall log all received faults and error messages. | H | 17 | |
| SM-5.9.2 | The ICM Environment shall log all system and subsystem failures. | H | 17 | |
| **SM-5.10** | **The ICM Environment shall log all maintenance-related activities conducted on devices connected to the system.** | **L** | **17** | **Corridor Managemt** |
| SM-5.10.1 | Upon receiving a fault and error message from a connected device, the ICM Environment shall automatically open a maintenance ticket for the device. | L | 17 | |
| SM-5.10.2 | The ICM Environment shall provide a means for designated maintenance staff supervisors within each agency to open/close/edit maintenance ticket items. | L | 17 | |
| SM-5.10.3 | The ICM Environment shall provide a means for designated maintenance staff from each participating agency to report on maintenance activities conducted on devices connected to the ICM System. | L | 17 | |

### 9.11.5. SOFTWARE MAINTENANCE AND UPDATES

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-6.1** | **The ICM Environment software shall receive regular updates.** | **H** | **17** | **Corridor Managemt/ DSS/Data Hub** |
| SM-6.1.1 | The Corridor Technical Manager shall designate a software development and update process, based on industry standards, for software updates and bug fixes. | H | 17 | |
| SM-6.1.2 | The Corridor Technical Manager shall develop a schedule for software development updates and bug fixes, and shall maintain the schedule, providing updates to the schedule on a monthly basis. | H | 17 | |
| SM-6.1.3 | The Corridor Technical Manager shall develop an annual budget for software updates and bug fixes, with quarterly updates. | H | 17 | |
| **SM-6.2** | **The Corridor Technical Manager shall produce an annual report of system software maintenance, providing a year in review of the previous year and a plan for the coming year of software maintenance and bug fix activities, schedule, and budget.** | **H** | **17** | **Institutional Job Tasks** |
| **SM-6.3** | **The ICM Environment shall maintain a managed repository of software configuration changes and activities.** | **H** | **17** | **Corridor Managemt** |
| SM-6.3.1 | The ICM Environment shall use an off-the-shelf solution(s) for software configuration management. | H | 17 | |
| SM-6.3.2 | The ICM Environment shall track all software component and configuration changes. | H | 17 | |
| SM-6.3.3 | The ICM Environment software configuration management solution shall include a function to track user change requests from user input of requests, configuration management processes, through eventual disapproval or release into production. | H | 17 | |
| SM-6.3.4 | The ICM Environment software configuration management solution shall track all identified software bugs, capturing a description of the bug, allowing for assignment of fix priority, disposition, assignment to a specific software update release as appropriate based on disposition, and resolution or closure. | H | 17 | |
| SM-6.3.5 | The ICM Environment software configuration management solution shall include a function to manage software change and release activities in accordance with industry-standard protocols. | H | 17 | |
| SM-6.3.6 | The ICM Environment software configuration management solution shall include a function to roll back software changes in the event of software bugs or release failures. | H | 17 | |

### 9.11.6. SYSTEM UPGRADES

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-7.1** | **The ICM Environment shall have a 5-year system upgrade plan.** | **H** | **18** | **Institutional Job Tasks** |

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|---|---|---|---|---|
| SM-7.1.1 | The 5-year system upgrade plan shall be developed by the Corridor Technical Manager. | H | 18 | |
| SM-7.1.2 | The 5-year upgrade plan shall provide the information required for 5-year system upgrade budgeting. | H | 18 | |
| SM-7.1.3 | The 5-year system upgrade plan shall include expected upgrades for the following elements at a minimum:<br>• Hardware, storage, operating system, and software upgrades<br>• Sensing upgrades<br>• Infrastructure element upgrades, including intersection signals, ramp meters, road network characterizations, CMS, and mobile messaging systems<br>• New and updated data feeds and data feed mechanisms<br>• Distributed and remote computing<br>• Organizational and personnel needs<br>• Networking and communication infrastructure upgrades<br>• Decision support component upgrades<br>• ICM Environment component upgrades<br>• Maintenance and system management-related upgrades | H | 18 | |
| SM-7.1.4 | The 5-year system upgrade plan shall be delivered every five years at least 12 months prior to the fiscal year in which the 5-year plan begins. | H | 18 | |
| **SM-7.2** | **The ICM Environment shall have an annual upgrade plan that identifies the system upgrades from the 5-year plan that will be implemented within the next year.** | **H** | **18** | **Institutional Job Tasks** |
| SM-7.2.1 | The Corridor Technical Manager shall deliver the annual upgrade plan a minimum of six months prior to the fiscal year start. | H | 18 | |
| SM-7.2.2 | The annual upgrade plan shall identify the upgrades to be completed in the annual cycle. | H | 18 | |
| SM-7.2.3 | The annual upgrade plan shall include a budget for all identified annual upgrades. | H | 18 | |
| SM-7.2.4 | The annual upgrade plan shall include a schedule of implementation for all system upgrades. | H | 18 | |
| SM-7.2.5 | The annual upgrade plan shall include a project plan for each system upgrade. | H | 18 | |
| **SM-7.3** | **The Corridor Technical Manager shall develop a system of governance to ensure each proposed system upgrade receives the appropriate priority and reflects the needs of all corridor stakeholders.** | **H** | **18** | **Institutional Job Tasks** |
| **SM-7.4** | **The Corridor Technical Manager shall ensure system upgrades are developed, delivered, and implemented according to the budget and planning identified in the annual upgrade plan.** | **H** | **18** | **Institutional Job Tasks** |
| **SM-7.5** | **The Corridor Technical Manager shall provide updates to the 5-year and annual upgrade plans when changes are identified and approved according to the governance system of the corridor.** | **H** | **18** | **Institutional Job Tasks** |
| **SM-7.6** | **All system upgrades shall be managed and implemented in accordance with the industry standards appropriate to the specific upgrade elements.** | **H** | **18** | **Institutional Job Tasks** |

### 9.11.7. SUPPORTING DOCUMENTATION AND TRAINING

| ID | Description | Criticality | Related User Need(s) | Related Subsystem |
|---|---|---|---|---|
| **SM-7.7** | **The ICM Environment shall have documentation of its operations and maintenance.** | **H** | **18** | **Institutional Job Tasks** |
| SM-7.7.1 | The ICM Environment shall have database documentation that addresses any database or database-related component. | H | 18 | |
| SM-7.7.2 | The ICM Environment shall have operations manuals to cover system operations, response plan operations, and systems usage. | H | 18 | |
| SM-7.7.3 | The ICM Environment shall have system administration manuals that cover the administration of all system components. | H | 18 | |
| SM-7.7.4 | The ICM Environment shall have maintenance manuals for all system components. | H | 18 | |
| SM-7.7.5 | The ICM Environment shall have presentations and material that have been developed in support of training activities. | H | 18 | |
| **SM-7.8** | **The ICM Environment shall provide a means for system users to access relevant system documentation when logged into the system.** | **H** | **18** | **Corridor Managemt** |
| SM-7.8.1 | The ICM Environment shall give users online access to the ICM data dictionary. | H | 18 | |
| SM-7.8.2 | The ICM Environment shall give users online access to a database manual. | H | 18 | |
| SM-7.8.3 | The ICM Environment shall give users online access to developed operations manuals. | H | 18 | |
| SM-7.8.4 | The ICM Environment shall give users online access to developed system administration manuals. | H | 18 | |
| SM-7.8.5 | The ICM Environment shall give users online access to developed maintenance manuals. | H | 18 | |
| SM-7.8.6 | The ICM Environment shall give users online access to presentations and material that have been developed in support of training activities. | H | 18 | |
| **SM-7.9** | **The Corridor Manager and Corridor Technical Manager shall develop a training program for the ICM Environment and ICM Core System.** | **H** | **18** | **Institutional Job Tasks** |
| SM-7.9.1 | The training program shall be based on the ICM corridor training plan. | H | 18 | |
| SM-7.9.2 | The training program shall identify critical and typical training needs, including skills and knowledge gaps, training goals, and requirements. | H | 18 | |
| SM-7.9.3 | The training program shall match identified critical and typical training skills and knowledge with individuals and roles to receive training. | H | 18 | |
| SM-7.9.4 | The training program shall identify training methods and training sources. | H | 18 | |
| SM-7.9.5 | The training program shall identify training materials required. | H | 18 | |
| SM-7.9.6 | The training program shall identify training funds required and a training budget. | H | 18 | |

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|---|---|---|---|---|
| SM-7.9.7 | The training program shall identify training staffing requirements. | H | 18 | |
| SM-7.9.8 | The training program shall identify training facility requirements. | H | 18 | |
| SM-7.9.10 | The Corridor Manager and Corridor Technical Manager shall conduct quarterly and annual training program reviews and make any necessary changes in the training program. | H | 18 | |
| SM-7.10 | The Corridor Manager and Corridor Technical Manager shall review the initial ICM training plan and shall submit a new ICM training plan on an annual basis. | H | 18 | |

# 10. DEFINITION OF TERMS

| Term | Definition |
|---|---|
| Alert | Notification sent by the ICM system to individuals or units. Alerts may be displayed on screen, sent by email, sent by text message, sent by radio message, or sent by telephone. |
| Archive | Data that has been stored for historical purposes and can be retrieved upon request, usually to a location and using a storage method that has large capacity and slower retrieval times. |
| Area of Impact (area of influence) | The road network elements impacted by an incident or event. |
| Asset | See *Corridor Asset*. |
| Asset Inventory | An inventory of corridor assets taken at any point in time. Asset inventory includes locations of fixed position assets, and types of corridor assets. Can be specified for a type of assets, such as intersection signal asset inventory. Also includes the attributes of each individual asset, such as intersection or ramp meter signal capabilities and currently available signal/ramp meter plans. |
| Asset State | The condition of a corridor asset at a point in time. This condition includes working state (usually operational, failed, or some degraded operational state), location of mobile assets, signal or ramp meter plan that is in operation at the point in time, and all most recent data received by the asset at the point in time. |
| Authentication | Verifying a user's identity. |
| Authorization | Verifying a user's permissions to view specific data elements or perform specific functions. |
| Availability | A description of whether an asset is available for use in a response plan or not. |
| Backward Chaining Rules | Rules that are defined so that a specific goal is specified, and the possible alternatives that will achieve that goal are identified by execution of the rule. A potential ICM-related example would be rules that are defined to create a list of alternative routes between two defined points and set limitations on what road links can be used at various times for the route creation. In this example, the goal is a route between the two points. The rules are executed to find all the possible alternatives, essentially working backwards to find solutions that fit the rules given to achieve the goal. |
| CMS | Changeable message sign. Includes both fixed and mobile devices. |
| Configuration Management | Maintaining a timeline of changes to an entity, ensuring traceability of changes in time, content, and author of the change. |
| Contact Details | Information for a specific individual or organizational unit, including names, phone numbers, email addresses, physical address, specific to the type of contact methods available for the individual or unit. |

| Term | Definition |
|---|---|
| Corridor Asset | Any corridor element available for use within a response plan or that provides information to the ICMS. Assets include the following types of elements:<br>• Intersection traffic signals<br>• Ramp meters<br>• Organizational units or individuals (people resources)<br>• Equipment<br>• Mobile or stationary CMS elements<br>• Traffic sensors and other measurement devices<br>• Communication elements (511, HAR, third party information providers)<br>• Parking facilities<br>• Transit elements |
| Corridor State | Information describing the state of the corridor at a specific point in time. State information includes:<br>• Corridor road network closures<br>• Corridor road network lane blockages<br>• Incident information<br>• Event information<br>• Asset inventory<br>• Asset state<br>• Sensor information<br>• Transit information<br>• Transit state<br>• Traffic conditions (density, flow, velocity) on the road network<br>• Response plans currently implemented or in the process of being implemented<br>• |
| Current Traffic State | Determining a value of traffic density, flow, and velocity for each link in the road network at the current time and with the data available at the current time. Also includes values for current turn volumes and ratios at each turn movement within the road network. |
| Data Hub | A core component of the ICM system which has primary responsibility for receiving, processing, storing, and providing data for all ICM system components. |
| Data Quality | A measure of the quality of data being received by the ICM system. Factors considered in data quality of a specific asset or type of assets include:<br>• Percent of working assets<br>• Individual asset state, including level of asset degradation<br>• Percent of time reliable data is provided by the asset<br>• Specific filtering or algorithmic verification of incoming data specific to the asset or asset type |
| Data Restoration | Restoration of data to service in the event of system or component failure. |
| Decision Support | A core component of the ICM system, providing traffic conditions, incident and event information, forecasts of traffic, proposed response plans and associated traffic forecasts, asset inventories and asset availability, maintenance information, |

| Term | Definition |
|---|---|
| | organizational information, road network conditions, and previous corridor planning and study information to users to support corridor operations and decision making. |
| Delay | A measure of the typical time a traveler would experience along a route over and above the time the traveler would experience at free-flow traffic conditions. |
| Demand | A measure of traffic demand (flow) at an entrance to the road network or between specify entry and exit points. |
| Deterministic | A solution to an algorithm or rule execution for which the execution of the algorithm or rule, given the same input data, will always provide the same answer at any point in time. |
| Device State | See *Asset State*. |
| System Recovery Plan | A plan developed that provides procedures, operations, and actions that are taken in the event of system failure or loss of capabilities, including any required system shutdown procedures, data protection actions, system and data recovery actions, procedures for restoration of the system to operational state, and post-event actions to be taken. |
| DMS | Dynamic Message Sign. This is the same as a *CMS* (see above). |
| Do Nothing Response | A response plan that includes no changes to any corridor assets' normal, preprogrammed, responses to traffic behavior. |
| Downtime | The amount of time a system is not fully operational over a specified time interval. |
| Drill Down | The ability of the user to select an element of information on a display and retrieve additional details related to the information selected. |
| ESS | Environmental Sensor Station. |
| Event | A planned or unplanned occasion or activity occurring within the corridor that is not caused by traffic activity but affects traffic conditions. Examples include road maintenance activity, a major sports event, a public event such as a parade, and a concert or arts activity. |
| Event-Driven Process | A process or action that is driven by notification or detection of a previous action or set of actions. |
| Forward Chaining Rules | Rules that are defined to be executed from a set of pre-defined inputs, to achieve an answer by executing the rule against those inputs. An ICM-related example might be a rule that states that any response plan that achieves a delay time improvement over the do-nothing response plan of 25% shall be submitted for selection by the corridor manager. |
| Geospatial | Relating to location on the earth. |
| Geospatial Display | Display of information on a map. |
| GTFS | General Transit Feed Specification. This is a data format used to represent transit routes and schedules on electronic maps. |
| HAR | Highway Advisory Radio, used for communicating to travelers. |
| ICM Core System | The core technical functionalities of the ICM system |

| Term | Definition |
|---|---|
| ICM Environment | All the components—including people, organizations, hardware, and software—involved in the functioning ICM system |
| Incident | Traffic-related incident, such as an accident or disabled vehicle. |
| Incident Confirmation | Positive confirmation within the system of an identified traffic incident. |
| Incident Identification | Identification of a traffic incident. |
| Inventory | A collection of assets. |
| Jurisdiction | Geographic and asset ownership or control by a specific organizational or governmental entity. |
| Jurisdictional Restriction | A restriction, generally on a corridor asset or road network element, imposed by an organizational or governmental agency. |
| LCS | Lane Control Signal. Same acronym is also used for Lane Closure System. |
| Link | A defined section of road. |
| Node | A point of connection between two or more links, often located at intersections, freeway ramp diversions or ends, changes in lane configuration, or changes in road attributes (such as speed limits). |
| Non-deterministic | A solution to an algorithm or rule execution for which the execution of the algorithm or rule, given the same input data, will not always provide the same answer at any point in time. |
| NTICP | National Transportation Communications for Intelligent Transportation System Protocol |
| Operational Status | The working state of a corridor asset—generally working, degraded, or not functional, depending upon the capabilities of the asset. |
| Persistence | Storage of information in a permanent store, such as a database or file system. |
| PHT | Person-Hours Traveled. The product of the number of travelers (people) and the hours traveled over a specified period of time and within a specified geographic boundary. |
| Plot-Based Display | Display of information using two- and three-dimensional graphing techniques. |
| PMT | Person Miles Traveled. The product of the number of travelers (people) and the miles traveled over a specified period of time and within a specified geographic boundary. |
| Post-event | An event or action taken after a traffic incident and removal or release of response plan elements and after the end of the response plan duration. |
| Probe Vehicle | A vehicle equipped with sensors allowing them to record the position, speed, and travel direction of the vehicle at regular intervals or when coming into proximity of roadside devices. |
| Reactive Transitive Query | A type of rules execution where the rule being executed does not find a solution but is still listening to the facts being provided and, upon a change of the facts provided, will re-evaluate automatically and provide a solution if a solution exists. A possible ICM example is a rule that is provided and checks the difference |

| Term | Definition |
|---|---|
| | between the current traffic state density and the "historical normal" density on the traffic network. At any time, the difference may not be above a threshold specified by the rule. However, when the difference is updated, the rule will evaluate again without a direction to execute, and if the threshold is exceeded, the rule action (perhaps notification of a potential incident) will be executed. |
| Real-Time Data | Real-time data denotes information that is delivered immediately after measurement. Depending on the system providing the data, this may include data that was measured a few seconds or a few minutes ago. In transportation systems, this typically means data that 15-minute old or less. |
| Recovery Point Objective | The maximum amount of time for which data may be lost in the event of a system or component failure. The time measure does not include the recovery time (see *Recovery Time Objective*). |
| Recovery Time Objective | The maximum amount of time a system or component may be out of service in the event of a system or component failure. |
| Redundant Capability | A capability of a system function or component to continue operating in the event of loss of a primary dependency or system capability by use of duplicate capacity or function. |
| Reroute | An alternative route defined within the ICM system chosen for traffic to follow in response to an event or incident. |
| Response Crew | Any organizational (human and equipment) assets that respond to an incident or event. |
| Response Plan | A collection of actions prepared and evaluated by the ICM system for implementation in response to an event or incident. Response plans may be in the following states:<br>• *Development* - The selection and assembly of response plan elements<br>• *Evaluation* - System generation of traffic forecast based on the response plan and analysis of the forecast and other response plan components<br>• *Proposed* - Recommended by the system for implementation based on the evaluation of the plan<br>• *Selection* - Selection of a plan to be submitted for approval<br>• *Active* - Approved and in implementation<br><br>Response plans may include one or more of the following deployment elements:<br>• Recommended traffic reroutes around an incident or event<br>• Intersection traffic signal changes<br>• Ramp meter changes<br>• Organizational asset deployments<br>• Equipment deployments<br>• CMS changes<br>• Communications<br><br>Required additional supporting elements of a response plan include:<br>• Approval requests and responses (if the response plan is proposed for implementation) |

| Term | Definition |
|---|---|
| | • Traffic state at the time of response plan development initiation<br>• Traffic forecast based on the response plan deployment elements<br>• Geographic area of impact (also known as area of influence)<br>• Corridor asset state at the time of response plan development initiation<br>• Initiating incident or event information<br>• Implementation results, including success or failure of each response plan action and traffic state information throughout the response plan duration (if the response plan is deployed) |
| Response Plan Development | Creation of one or more response plans in response to an incident or event by the ICM system. |
| Response Plan Implementation | Execution of response plan deployment elements. |
| Road Capacity | The maximum number of vehicles a road, road segment, or link is capable of carrying at free-flow speed over a one-hour period. |
| Route | An interconnected collection of road links that create a single continuous path between any two points in the road network. |
| Rule | A single element of logic, expressed within a format and dialog that the rules engine can understand and process. |
| Rule Action | A resulting action from execution of a rule. |
| Rule Condition | A condition that a rule checks during rule execution. |
| Rule Dependency | A dependency between two rules, usually enforced by rule categorization, grouping, or priority. |
| Rule Fact | A collection of information provided for a rule to use in its execution. |
| Rule set | A collection of rules and any instructions for their execution intended to be executed as a group within the rules engine. |
| Rules Engine | A core component of the ICM system that includes an off-the-shelf (commercial or open-source) software system that allows users to define, edit, or delete rules that govern specific logic applied to specific processes. The rules engine executes those rules at run time in the context of a process when the process is invoked. A rules engine is specified within the ICM system to allow users to define identification of traffic incidents, when response plans are to be developed, what response plan elements will be included within a response plan, and to allow the logic of these processes to be redefined by the users over the lifetime of the system. |
| Scheduled-Driven Process | An action or process that is initiated based on a pre-defined time-based schedule. |
| Sensor | A corridor asset that senses and reports to the ICMS a measurement of the state of the asset or traffic. |
| Tabular Display | Display of information in tables. |
| TMDD | Traffic Management Data Dictionary, which is a standard for communications between traffic centers. |
| Total Delay | The sum of all delay within a road network over a specified period of time. |

| Term | Definition |
|---|---|
| Traffic Forecast | A prediction of the future state of traffic density, velocity, and flow for each link in the road network. |
| Traffic State | The current traffic density, velocity, and flow for each link in the road network. |
| Transit State | The state of one or more transit providers, including the transit inventory in operation, the working state of each asset, and each asset's location. |
| Travel Time | The time it takes to travel between two defined points along a specified route on the traffic network. Three types of travel time can be distinguished:<br>• Point travel time—Travel time observed at a given point in time within the road network<br>• Predicted travel time—Expected future travel time along a given route based on a traveler or vehicle starting a trip at the current time and encountering various predicted traffic conditions along his trip<br>• Experienced travel time—Travel time obtained by measuring the time it actually took for a person or vehicle to travel along a given route. |
| Turn Movement | A split in the traffic flow at a node in the road network. Each possible link pair at the node in the direction of traffic flow is defined as a turn movement. |
| Turn Ratio | The flow from the input link to one output link of a turn movement divided by the total flow of the input link at a point in time. |
| Turn Volume | The traffic volume for a specific turn movement at a point in time. |
| Two-Factor Authentication | Authentication method that requires two forms of identification. A common two-factor authentication method is to use a username/password combination with an additional method, such as an additional hardware key device. |
| Unbound Rule Arguments | Arguments specified within a rule condition that are data-dependent. |
| Uptime | The amount of time a system is fully operational divided by the total period time over a specified time interval. For the purposes of the ICM system, fully operational is defined as reporting as working with no asset degradation and as the ICM system being unable to detect any behavior indicating asset failure or degraded operation. |
| VHT | Vehicle Hours Traveled. The product of the number of vehicles and the hours traveled over a specified period of time and within a specified geographic boundary. |
| Visualization | The collection and display of information by the system for the user. |
| VMT | Vehicle Miles Traveled. The product of the number of vehicles and the miles traveled over a specified period of time and within a specified geographic boundary. |