Integrating Weather in TMC Operations

ATTACHMENT 1

CALTRANS

DISTRICT 3

WEATHER INTEGRATION PLAN

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Version: 1.0

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GLOSSARY OF ABBREVIATIONS

AADT	Annual Average Daily Traffic
Caltrans	California Department of Transportation
CAD	Computer Aided Dispatch
CCTV	Closed Circuit Television
CHP	California Highway Patrol
CMS	Changeable Message Sign
EMS	Extinguishable Message Sign
FHWA	Federal Highway Administration
FTP	File Transfer Protocol
HAR	Highway Advisory Radio
ITS	Intelligent Transportation Systems
MDSS	Maintenance Decision Support System
NOAA	National Oceanographic Atmospheric Administration
NTCIP	National Transportation Communications for ITS Protocol
RTMC	Regional Transportation Management Center
RWIS	Road Weather Information System
RWMP	Road Weather Management Program
SACOG	Sacramento Council of Governments
SOP	Standard Operating Procedure
SSI	Surface Systems Incorporated, a Quixote company
STARNET	Sacramento Transportation Network
TI	Traveler information
TMC	Transportation Management Center
TMDD	Transportation Management Data Dictionary
WOC	Winter Operations Center
XML	Extensible Markup Language

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1. INTRODUCTION

1.1. Background

The Federal Highway Administration's (FHWA) Road Weather Management Program (RWMP) has established a programmatic road map that identifies the integration of weather information into the operations of Transportation Management Centers (TMCs) across the country as a key objective. Integrating weather information supports the capability of state and local transportation agencies to better manage their traffic, dispatch maintenance crews and respond appropriately and in a timely way to weather-induced problems affecting the transportation system. Well integrated weather information allows TMC operators to make effective and timely management and operational decisions based on quality information related to weather forecasts, the anticipated timing and intensity of weather events, and the interaction of weather conditions with the road surface. Integrated weather information positions a TMC to be proactive rather than reactive with regard to the operations and maintenance of their transportation infrastructure. The objectives of the FHWA study are to prepare a detailed self-evaluation "Guide" that will assist TMCs in identifying appropriate weather integration strategies, given their current level of weather integration and where they would like to be with regard to enhanced integration and to prepare a weather integration plan based on strategies suggested by the self-evaluation.

1.2. Purpose and Benefit

The Caltrans District 3 Regional Transportation Management Center (RTMC) was chosen by the FHWA to assist in the testing and improvement of a working draft of the self-evaluation Guide. This draft Guide was prepared in an electronic form (Microsoft Access) and walks the user through several sections to eventually result in potential weather integration strategies that a TMC may consider for future enhancements to their operations. The Caltrans RTMC was chosen because of their strong interest in improving their use of weather information in support of their operations and to better manage the diverse nature of weather events in the region. The RTMC was asked to review the Guide and provide feedback that will be used to improve the Guide. As part of this activity, Caltrans was asked to develop a weather integration plan. This document is that plan.

This plan was undertaken as part of an effort to develop a weather integration strategy for Caltrans District 3. In addition, this effort was to aid developers with the initial design of the Weather Integration Guide as part of the aforementioned FHWA study. After an initial review it was determined that this objective would be better served if only two portions of District 3 were evaluated. The first study area was comprised of approximately 100 miles of Highway 50 and Interstate 80 as they transverse the Sierra (Mountain Study Area). The second area evaluated included an area of the Sacramento Valley (Valley Study Area). The principle routes in this study region are; Interstate 5 and 80, and Highways 50, 70 and 99. The two areas selected experience most of the weather conditions possible in the Western United States at some point of the year. This allowed for extensive testing of the software's capabilities with a focus on these segments of Highway and aided in developing a plan representative of the needs of Caltrans District 3.

Weather and weather integration in both the Maintenance and the RTMC Operations environments impact the proper operation of all roadways in Caltrans District 3. Through improvements in weather integration it is envisioned that Caltrans can improve operations of the roadway resulting in increased reliability of goods movement for the State of California and its motoring public and business.

1.3. TMC Overview

Caltrans District 3 covers 11 counties with exceptionally diverse land development, geographic, roadway and weather characteristics. District 3 includes Sacramento, the State's capitol, which is the hub of a metropolitan area of over 2 million people, and Sierra County, which has a population of less than 4,000. The district stretches from the Central Sacramento Valley, a low elevation, flat, fertile agricultural area, to the Sierra Nevada Mountains, where mountain elevations are often above 7,000 feet, and includes much of the Lake Tahoe basin and numerous world class ski resorts.

A diverse mix of roadways spans the District. Interstate 5 and State Route 99 are north-south highways, which run through the valley portion of the District. Traffic volumes on both routes are high in the Sacramento metropolitan area, with annual average daily traffic (AADT) volumes over 190,000 vehicles per day (vpd) on Interstate 5 and over 220,000 vpd on State Route 99. Interstate 5 is part of a transcontinental linkage between Canada and Mexico; therefore, commercial operators and long-distance travelers are significant users of the roadway as well. Interstate 80 is one of the principal east-west trans-continental interstate routes, with significant volumes of truck traffic. It also serves as a gateway between the population centers of Sacramento and the San Francisco Bay Area, and the city of Reno as well as Lake Tahoe-area recreation areas. While segments of Interstate 80 are in the valley, the eastern portion of I-80 within District 3 runs through mountainous terrain. Interstate 80 is the highest traffic volume crossing over the Sierra Nevada Mountains, with an annual average daily traffic volume of 27,000 vehicles crossing at an elevation of over 7,200 feet. Several other state and US highways cross the district, with higher traffic volumes generally in the valley portion of the district.

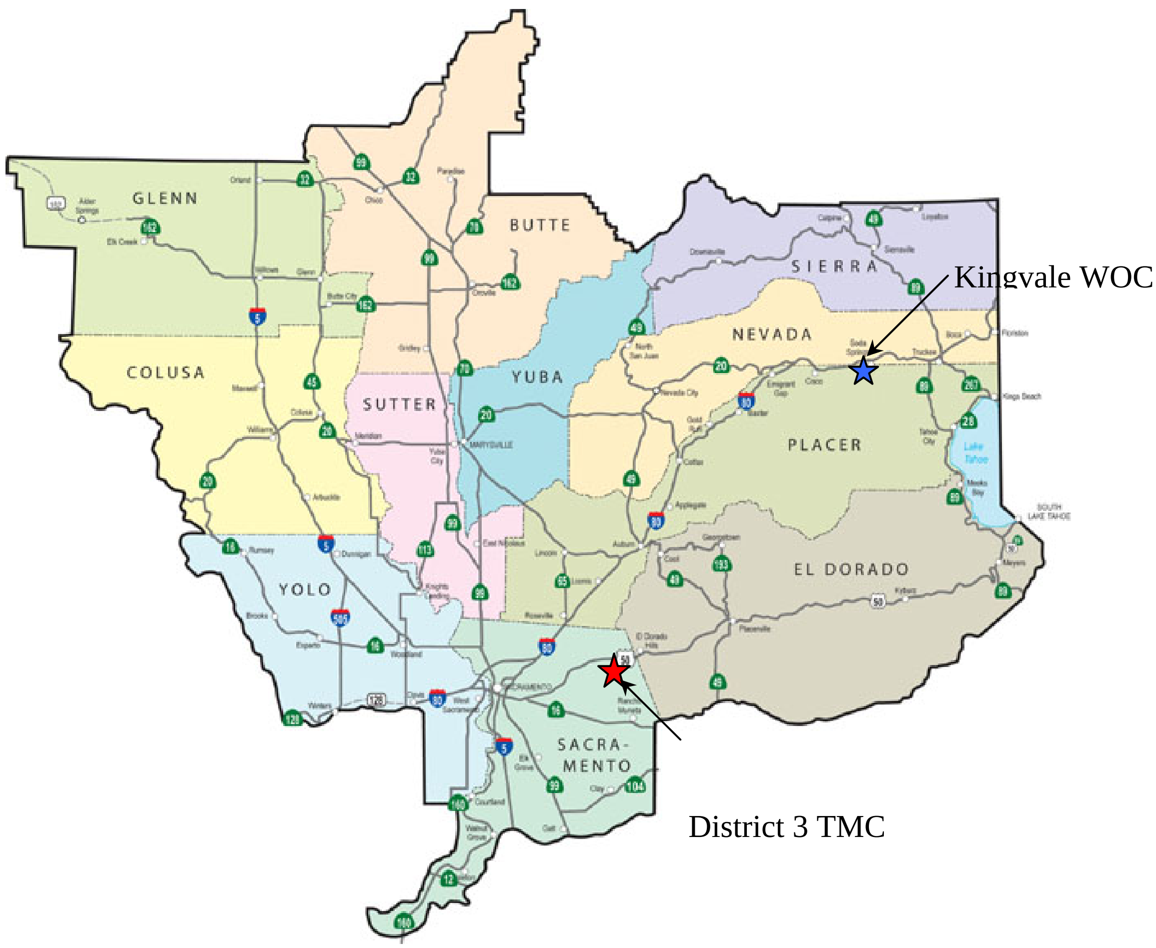
The weather patterns are as diverse as the district's geography. Fog can be a significant safety hazard in the valley, as can occasional rapid accumulations of rain. In the mountainous areas, temperature and precipitation extremes are common, with regular occurrences of heavy snow and high winds. As such, weather can have a diverse range of impacts across the highways managed by Caltrans District 3.

A Transportation Management Center for District 3 (see Figure 1-1) is located in the Sacramento area, in Rancho Cordova. The facility is 7 years old and remains very current in the technologies utilized in the analysis and operations of the transportation systems in District 3. From this facility the entire District's inventory of Highway Advisory Radios (HARs), Changeable Message Signs (CMS), Extinguishable Message Signs (EMS), Road Weather Information Systems (RWIS), Closed Circuit Televisions (CCTVs) and all other field elements are controlled to best manage the roadways and traveler information received by the public. Coordination is provided with the California Highway Patrol, co-located in the facility, for incident response via the Computer Aided Dispatch (CAD) system from this location.

A Winter Operations Center (WOC) is located at Kingvale, CA to aid in the centralization of control for snow removal on Interstate 80 and its connected traveler information (TI) during the winter months. This facility operates independently from the TMC, and has the ability to control all ITS field elements in its sub-region when open. This facility has been in operation since 1990.

Weather and the effects of weather on the roadway present the greatest challenges to motorists, maintenance crews and operators of the roadways in District 3. These same challenges present themselves to commercial vehicle operators as they transport goods of all nature into and out of California on Interstate 80 from the east and along Interstate 5 from the north and south. The Sacramento Valley region faces, wintertime heavy rain and hail storms, gusty and high winds, occasional frosting and freezing conditions on bridges and dense tulle fog. In warmer months, agricultural generated smoke, rain and wind are greatest challenges. The mountainous regions face the winter conditions made famous by the Donner Party. High winds, blowing and heavy snows, frozen roadways, fog, and large increases in elevation combine to make driving conditions extreme.

Figure 1-1 Caltrans District 3 Map



The District has numerous RWIS located along the Interstate and Highways of the District. Two manufactures' equipment is utilized in the collection of field data. SSI and Vaisala equipment feed the field data to the TMC where it undergoes initial processing before it is available for display or transmission to the public via a File Transfer Protocol (FTP) website. The internal data feed is processed and warnings are automatically sent out when various thresholds are reached for visibility, deck temperatures, wind speeds and gusts.

Weather forecasting information is primarily based on major media reports, National Weather Service warnings, and public Internet weather providers. No set schedule is used by operators in the TMC environment at the present time for checking these various sources.

1.4. Weather Integration Self-Evaluation Process

A panel of experts from within District 3 was assembled for the purpose of testing the self-evaluation guide and to explore the potential options for improving weather integration in the maintenance and traffic management processes. The panel was comprised of individual representatives from the two maintenance regions and the TMC. After working with the weather integration database for the District as a single unit it was determined that breaking the District into separate units, each with their own specific weather needs would produce results with a great applicability. The diversity within the District created a condition where the results of the initial evaluation were non-conclusive. The results of this analysis appeared to be effected by the high level of integration, which exists in specific portions of the District where weather related events have severely affected the transportation facilities in the past. The results indicated that the high level of integration was required throughout the District as the evaluation tool selected strategies to cover the worst case scenarios in the District. By selecting smaller portions of the District for evaluation we were able to identify areas for improvement within each of the sub-regions, and test the proposed software's output.

The first sub-region to be evaluated was mainly comprised of the two major routes over the Sierra, located on Interstate 80 between Gold Run and the California/Nevada Stateline, and on US highway 50 between Kyburz and the California/Nevada Stateline. Total mileage for these segments is approximately 100 miles, the vast majority of which is located above an elevation of 5000 feet. The time frame for analysis was year round, which allowed testing of most weather conditions experienced in the District. However the analysis is greatly over shadowed by the extreme winter weather conditions.

Definitions used in Section 1 to define the "Extent of Impact" were adopted to fit these reduced segments.

- Statewide 80-100 miles
- Regional 40-80 miles
- Area 10-40 miles
- Local/Isolated 0-10 miles

The second sub-region was selected to represent the urban environment of the Sacramento Valley and surrounding low-lying areas. This area incorporated Interstate 5 and 80, and highways 50, 99 and 70, as they traverse the Sacramento Valley and cross over the larger rivers of the region. The time frame for analysis was year round. The primary weather events in this region are related to winter rain and thunderstorms, which often drop large amounts of wind driven rain to the region. When the rain events pass they are often followed by dense fog periods near the rivers and larger bodies of water.

Use of the selected segments provided good results, which aligned with our expectations and identified needs for segments where a strong awareness for weather events existed. The results for this evaluation along with the identified potential improvements are presented in Chapters 2 and 3.

Selection of final strategies were made from the list of high and medium items of importance based on level of perceived need (selected all high rated items), and additional items were selected from the medium rate strategies based on concern for stewardship of environmental and public funds. Many items were selected for inclusion, as they appeared to be relatively inexpensive to incorporate as part the strategies selected.

The output listing of the desired strategies is contained Appendices A and B. Additional detailed discussion is included in Section 2.3 of this report. The primary needs identified are related to increased high quality information prior to the arrival of weather events and then the dissemination of this information to the public and other agencies. In addition, data gathering, which would assist Maintenance forces in the proper selection of mitigating materials and in reducing application, are of great interest both for environmental and fiscal concerns. The infilling of weather sensors to better define the existing conditions and anticipated manpower needs will be critical in resolving these identified needs.

1.5. Relationship to Other Plan Documents

This plan represents a new perspective on the evaluation of priorities of previously identified needs on the part of Caltrans District 3. The evaluation provided an opportunity to identify solutions to needs specifically related to weather integration. The analysis is being used to validate the long range ITS element planning which has been completed as part of the Tahoe Gateway Strategic Development Plan, Tahoe Basin Strategic Development Plan, and based on long range planning documents developed as part of the daily operations and needs of the TMC. The results of this study will be incorporated into the current effort to evaluate the corridor management methodology presently underway for all the major corridors in the District.

Existing planning documents either in design, construction or waiting on funding include:

- Tahoe Area Intelligent Transportation System EA: 03-1C111: This project includes one additional RWIS station and provides for improved traveler information with the installation of numerous CMS and HARs in the Tahoe Basin. (Funded, Designed, Construction 2008)

- Tahoe Area Intelligent Transportation System, Non-Tahoe Basin EA: 03-1C112: This project provides for improved traveler information with the installation of numerous CMS and CCTVs in the Sierra North and West of the Tahoe Basin. (Designed)

- Comprehensive CMS and CCTV Installation Plan for District 3 (Sacramento Metro Area) EA: 03-0C2811. This project provides for improved traveler information (via CMS) and CCTV installation through out the Sacramento Metropolitan Area. (Funded, Designed, Construction late 2008)

- Comprehensive CMS and CCTV Installation Plan for District 3 (Outside Sacramento Metro Area) EA: 03-0C282K. This project provides for improved traveler information (via CMS) and CCTV installation through out District 3. (Partial Design)

Once complete these projects should greatly increase the TMC's ability to gather and provide traveler information related to weather events.

An additional project underway in the District 3 region is being run by the Sacramento Council of Governments (SACOG) and is generally referred to as the Sacramento Transportation Network (STARNET). This is a project which has been funded by SACOG and the local partner agencies aimed at providing communications between the transportation management centers, transit and planning agencies. The STARNET partnership has reached the point in the systems engineering process of high level design moving towards implementation. As of the writing of this document the final developer is being selected and implementation should begin to roll out in the middle of 2008. Perhaps the most important feature for the purposes of weather integration will be the parallel development of a 511 traveler information website and phone system.

Caltrans District 3 is also considering formal entrance into the FHWA sponsored *Clarus* project. Through this project we would be able access additional information related to weather forecasting and gain the experience of NOAA in weather forecasting. Depending on developments, this project alone may meet many of our weather forecasting needs.

2. TMC WEATHER INTEGRATION PLAN

This chapter provides the framework for how weather information can be integrated into the RTMC operation to improve safety and mobility under inclement weather conditions. The first section provides an inventory of existing weather and transportation management systems in the district. After this, concepts of operations are provided for several types of weather events and their impacts. Based on these concepts of operations, integration needs and solutions are identified.

2.1. Inventory Existing Weather and Transportation Management Systems

The existing inventory of weather related transportation management systems are used in conjunction with Standard Operating Procedures (SOPs) in the TMC environment to provide useful traveler information to the media and motorists. The SOPs direct the Operators in the TMC to utilize transportation management system elements for communicating this information to the public via HARs, EMS, CMS and working directly with the media by issuing SIGALERTs and traffic advisories. The increasing number of CCTVs throughout the District will continue to improve the real-time weather knowledge in the TMC.

2.1.1. Weather Stations

The use of public Internet based weather prediction websites such as www.weather.com, www.accuweather.com, www.localweather.com, and www.nws.noaa.gov are the normal methods of receiving hourly weather forecast data. These data have proven to be reasonably accurate in the short term with long range forecasting still needing additional support. TMC operators can access Doppler radar through many of these websites and learn about the speed and intensity of approaching storm events.

Our maintenance field crews and CHP Officers function as field probes and often report observations directly into the TMC. Data from these sources are often used as the initial notification of changing real-time weather conditions.

At the present time our procedures do not implement actions beyond internal preparation for weather events until events take place on the roadway. The exceptions to these procedures exist for high winds, gusty winds, reduced visibility due to fog and inspection of commercial vehicles for adequate traction chain devices in advance of winter storm events.

RWIS are used in District 3 for the collection of data associated with weather events (wind speed, direction, precipitation, visibility, temperature, relative humidity, etc.) and pavement temperatures. The actual number and variety of sensors varies by location based on likely applicability of each sensor at the given location. The following tables present the RWIS locations for sites located in District 3.

Table 2-1 Existing RWIS Infrastructure

County	Route	Post Mile	Location
El Dorado	50	66.80	Echo Summit
Nevada	80	R5.10	Castle Peak UC
Nevada	80	R9.10	Donner Lake UC
Nevada	80	19.30	Truckee CHP Truck Inspection Station
Nevada	80	27.30	Truckee River BB
Placer	28	3.00	Dollar Point (Tahoe City)
Placer	28	8.90	Rampart Dr. (Tahoe City)
Placer	80	53.30	Blue Canyon
Placer	80	R63.50	Cisco
Placer	80	R69.40	Kingvale maintenance station
Placer	89	10.42	Rampart Dr. (Tahoe City)
Placer	267	6.67	Brockway Summit
Sacramento	5	24.80	North of American River Br.
Sacramento	51	3.00	North of American River Br.
Sacramento	80	M0.40	East of Sacramento River Br.
Sacramento	99	8.80	McConnell OH
Yolo	5	0.40	West of Sacramento River
Yolo	50	2.40	Jefferson Blvd.
Yolo	80	5.70	Webster UC
Yolo	80	8.90	East end of Yolo Causeway

Table 2-2 Planned RWIS Infrastructure

County	Route	Post Mile	Location
El Dorado	50	38.70	Riverton Bridge
Nevada	80	1.70	State Line
Nevada	80	R8.00	Power Line
Nevada	80	R8.70	Windy Point
Placer	80	33.50	Colfax
Placer	80	40.00	Gold Run
Placer	80	R58.70	Yuba Gap - Pla/Nev County line

2.1.2. Autonomous Weather Warning Systems

In the TMC environment, Vaisala IceCast software is used to process raw data and send out email alerts to operators when predefined thresholds are reached for wind, fog and bridge deck temperatures. This system is then used to implement various response plans based on the type of event being reported. SOPs define actions for events such as, gust or high winds or reduced visibility due historically to fog. This system is non-operational at the present time due to failure of a computer server. In addition only Vaisala RWIS data were available on this system.

The web based Scan Cast system by SSI, is utilized for summary information from our RWIS and is available to operators in both Kingvale and the TMC; however, this site does not have an alert system or forecasting.

2.1.3. Decision Support Systems

TMC Operators use defined SOPs for activities and notifications to the public. Predefined operations exist for winter operations, fog and wind conditions.

Caltrans is a participant in the Maintenance Decision Support System (MDSS) pooled fund study, led by the South Dakota Department of Transportation. Caltrans is currently testing the MDSS on Interstate 80 over the Sierra Nevada Mountains, a key link on a transcontinental interstate that can experience significant winter weather challenges.

2.1.4. Transportation Management Centers

A standalone TMC facility is located in Rancho Cordova. This facility is co-located with the CHP Valley Division's Communication Center and is the primary interface between roadway data and the motorists on the roadway. This facility is operated 24 hours/day, 7 days/week, 52 weeks/year. Caltrans staffing for direct interaction with weather data and traveler information is typically between 2 - 4 staff/shift.

A Winter Operations Center is located in Kingvale and functions as a base of operations for maintenance crews associated with the removal of snow from Interstate 80 during the winter months. Many of the same systems are accessible to staff at the Kingvale Center, and in addition historically a contract with Meterologix's weather forecasting services has been in place. As of this season the price of this contract has exceeded budget and thus this service is no longer available.

2.2. Concepts of Operations

This section provides two scenarios to help illustrate how District 3 envisions weather information being integrated into transportation operations. While it is anticipated that there will be routine weather monitoring activities on an ongoing basis, integration is most important when major weather incidents occur which could have significant impacts on the traveling public and the road system. Therefore, concepts of operations are developed around two scenarios which are typical for District 3: a winter storm which will cause heavy snow in the mountainous areas of the district; and a winter fog event which causes significant decreases in visibility in the valley.

The following are examples of the vision of our concept of operations after a complete analysis of District 3 systems is complete. While the selected roadway segments are focusing on the winter storm events, the segments selected do experience many of the weather events experienced throughout the District.

2.2.1. Winter Storm Event

The first scenario involves a major winter storm, which is coming from the Pacific Ocean toward the Sierra Nevada Mountains. Precipitation is highest during the winter months across the entire district; however, temperatures are comparatively mild in the valley so there are rarely problems with snow or ice on valley roadways. Rain volumes can be significant, however. The impact of the precipitation is felt most strongly in the Sierra Nevada Mountains. Temperatures for this particular storm are such that the snow level is around 4,000 feet, meaning much of Interstate 80 and US Route 50 across the Sierra Nevada Mountains will experience snowfall.

The storm is predicted to start bringing precipitation into the valley starting around noon on a Friday. The storm will continue on an eastward progression into the mountains, where forecasters predict that it will produce snow at rates of 2-3 inches per hour. Total accumulations in the mountains are predicted to be between 6 and 18 inches before the storm winds down after dark on Friday.

The timing of the storm is challenging for metropolitan Sacramento as well as for the mountains. It will likely make the Friday afternoon commute more challenging, with slower travel speeds and a higher possibility of accidents. In addition, while the snow will make traveling through the mountains more challenging, the snow is also alluring for many Bay Area and Sacramento-area residents who enjoy skiing and winter recreation. Hearing about the weather forecast, some people leave work early to try to beat the rush to the ski slopes.

Anticipated Impacts

The storm will start its path across the district in the valley section. While rain volumes are not expected to cause flooding-related road closures, standing water will be present on many area roadways. Since it had not rained for a few days prior to the storm, the rain will mix with oil residue on the roads to create very slick pavement conditions. TMC staff predicts that there will be more frequent accidents on the expressways and at signalized intersections as well. The timing of the storm is bad in this regard, because many travelers during mid-day are not expecting slower travel conditions. In addition, the accidents will need to be cleared quickly so that there will not be a system-wide breakdown in traffic as the afternoon peak traffic period commences.

As the storm moves into the foothills, cooler weather in recent days means that there is a possibility that the rain will freeze on the roadways, creating potentially treacherous conditions. Travelers coming from the valley into the mountains may be surprised by the slick pavement, and therefore TMC personnel are concerned that they be warned well in advance.

In the mountains, maintenance personnel recognize that it will take a full effort to stay on top of the storm. Roadway pre-treatment is usually not a viable option with this amount of snow. Therefore, maintenance personnel are getting equipment positioned and ready for roadway clearing operations once the snow hits the hills. However, they recognize the forecast has a wide range of snowfall estimates, and snow patterns in the mountains are notoriously hard to predict. It could be that the heavy snow passes to the south of the highway corridors, meaning that they will be able to keep Interstate 80 open through the storm. Alternatively, the storm could go down the roadway corridor and dump more inches of snow than personnel are able to clear. Therefore, they are prepared for the possibility of requiring motorists to put chains on their vehicles' tires. Snow volumes will probably not be bad enough to require a road closure in itself, but chain inspection-related delays, along with the consequences of "flatlanders" driving in conditions they are not accustomed to, could mean that the road will need to be closed anyway. Road closure is a last resort, however, because the economic impacts of even one hour's closure on Interstate 80 are staggering.

The District has discouraged trucks from using Interstate 80 on Friday evenings and Sunday afternoons during winter season inclement weather, partly to help manage the roadway better when recreational traffic is going from one side of the mountains to the other. It is necessary to communicate this information on a regular basis to ensure all commercial vehicles are aware of it. This is especially true given the magnitude of the approaching storm.

In summary, the following impacts are anticipated:

- Reduced capacity on metropolitan-area roadways and at signalized intersections, increasing delay

- Reduced pavement friction on roadways in valley and foothills, increasing likelihood of accidents

- Reduction in travel speed throughout the district, with especially pronounced drops expected in the foothills and mountains

- Potential delays and/or road closure in the mountains, depending on the storm's track and severity, along with the occurrence of weather-related accidents

- Secondary accidents, because of increasing stopping distance requirements, could be a major problem throughout the district

2.2.2. Valley Fog Event

This type of an event typically follows wet winter storms in the Sacramento valley. The soaked soils and standing water maintain the high relative humidity necessary for the formation of dense fog. When combined with the typical temperature patterns the result is dense fog primarily in the areas surrounding water ways. The fog can be very spotty and yet very dense. The National Weather Service (NWS) often issues dense fog advisories; however, the ability to predict the locations of formation and patterns of disbursement has been difficult. This often results in poor predictions.

Motorist behavior in the areas around fog has been difficult to predict as well. With the extreme density of the region's fog, motorists need to travel at steady speeds and not abruptly slow once in the dense fog. The message Caltrans has tired to push is to slow down in advance of fog and maintain speed or exit the roadway and keep your foot off the brake pedal. Unfortunately the motoring public operates at speeds which seem to be unsafe for the conditions and have created major chain reaction accidents as a result.

The goal of the NWS, CHP and Caltrans is to gain a better understanding of fog and the conditions which contribute to the formation of dense fog. We can then target select segments of roadway for increased speed pacing and TI.

2.3. Integration Needs

The needs identified as part of the initial examinations for the two sub-regions resulted in many of the same requirements. It has been observed that after addressing many of the High Level needs that have been identified, the remaining less critical needs are almost completely addressed.

2.3.1. Specific Needs Identified from Analysis

After examination the following needs were identified as being the highest level of need. These high level needs have been presented as identified in each sub-region and then as a combined set of needs in the following tables.

Table 2-3 Selected Needs for Mountain Sub-Region

Mountain Sub Regional Needs	Definition of need	Need Level
Advisory Operations		
MN-1	Provide better en-route information on weather conditions to aid travelers in their decision-making	High
Treatment Operations		
MN-2	Improve the timeliness of weather management response including deployment of field personnel and equipment	High
MN-3	Reduce the time required to restore pre-event level of service operation after a weather event	High
Weather Information Processing and Gathering		
MN-4	Better short-term forecasts of arrival time. duration, and intensity of specific weather events at specific locations	High
MN-5	Assistance in interpreting weather information and how best to adjust operations in light of that information	High
MN-6	Improve the coverage and granularity of weather information in the region	High

Table 2-4 Selected Needs for Valley Sub-Region

Valley Sub Regional Needs	Definition of need	Need Level
Advisory Operations		
VN-1	Improve targeting of weather messages (site-specific; user group specific) to more effectively convey road weather information	High
VN-2	Provide better pre-trip weather condition information to aid travelers in their decision-making	High
VN-3	Provide better en-route information on weather conditions to aid travelers in their decision-making	High
Traffic Control Operations		
VN-4	Improve management of emergency routing and evacuation for large-scale weather events.	High
Weather Information Processing and Gathering		
VN-5	Better short-term forecasts of arrival time. duration, and intensity of specific weather events at specific locations	High
VN-6	Assistance in interpreting weather information and how best to adjust operations in light of that information	High
VN-7	Better real-time information on road conditions during weather events	High

Table 2-5 Combined Needs for Both Sub-Regions

Combined Regional Need	Definition of need	Need Level
Advisory Operations		
CN-1	Improve targeting of weather messages (site-specific; user group specific) to more effectively convey road weather information	High
CN-2	Provide better pre-trip weather condition information to aid travelers in their decision-making	High
CN-3	Provide better en-route information on weather conditions to aid travelers in their decision-making	High
Traffic Control Operations		
CN-4	Improve management of emergency routing and evacuation for large-scale weather events.	High
Treatment Operations		
CN-5	Improve the timeliness of weather management response including deployment of field personnel and equipment	High
CN-6	Reduce the time required to restore pre-event level of service operation after a weather event	High
Weather Information Processing and Gathering		
CN-7	Better short-term forecasts of arrival time. duration, and intensity of specific weather events at specific locations	High
CN-8	Assistance in interpreting weather information and how best to adjust operations in light of that information	High
CN-9	Better real-time information on road conditions during weather events	High

2.3.1.1. Combined Advisory Operations Needs

The combined needs grouping of CN-1, CN-2 and CN-3 all point to the perceived need to improve the dissemination of improved forecasting integration into our traveler information. The ability to provide weather information to the public is critical in allowing the motoring public the ability to make good modal and departure decisions. Once en-route good TI can assist in preparing motorists for conditions they will encounter as their trip proceeds. If TI is used properly it can assist motorist in being prepared for conditions which may not be readily apparent to a new visitor. A prime example would be the requirement for traction devices (chains) which may not be available once a motorist is in the mountainous region where such devices are required. Unprepared motorists often find themselves delayed beyond the "norm" as they must adjust their plans to meet the conditions and preparedness.

2.3.1.2. Combined Traffic Control Needs

The need for "Improve management of emergency routing and evacuation for large-scale weather events" (CN-4) was only identified as part of the Valley Sub-regional study area; however, lessons learned in the Valley would likely translate into the Mountainous sub-region as well.

Planning is underway for the development of the concept of contraflow for use in extremely critical evacuation planning. Reliable weather information has been identified as being critical for proper route selection for both evacuation and emergency response planning. The need to predict the effects of weather with a high degree of accuracy is necessary in order to avoid creating a system where the evacuees are placed in greater harm through decreasingly poor weather or road conditions. The ability to maintain an access route for response personnel or public transit vehicles to reenter an area being evacuated must be considered in the decision process of trying up roads with contraflow.

2.3.1.3. Combined Treatment Operations Needs

The two needs CN-5 (deployment of personnel and equipment) and CN-6 (restoring capacity after an event) were identified as part of the mountainous sub-region and likely have been identified to aid in the recovery after a winter storm event. These needs also exist in the Valley sub-region, but the types of events experienced in the Valley may not lend themselves to finding a solution as easily.

By deploying personnel and equipment closer to the time they need to be on station, additional savings can be realized in both labor and equipment costs. The present concern is with accuracy of weather prediction and the potential for court-induced liability associated with a delayed response, has motivated Caltrans into early deployment of personnel and equipment. In addition advances in chemical and environmental concerns have affected our ability to recover from extreme winter events.

2.3.1.4. Combined Weather Information Processing and Gathering Needs

The needs identified as CN-7, CN-8 and CN-9 are part of the needs identified above. These needs identify the data required to make the decisions for forecasting, treatment options or for dissemination as part of the traveler information package. Improvements or development of partnerships to provide this information are required throughout District 3 to reach the level of service we would like to provide to the motoring public.

Once data are gathered and predictions have been made, mechanisms are in place to disseminate the information to the public and other outside agencies. This information will be distributed through our web-based server networks, CMS, HARs and via traveler/media advisories. The addition of a web-based email subscription service has been under consideration for deployment. It is envisioned that this service would allow subscribers to select routes, segments, and event types, as well as specify the delivery point (email, pager, etc.) for the information.

2.3.2. Institutional Coordination

The response to weather-related events is very similar to incident-driven events. In the Sacramento region the majority of interagency coordination is constrained by the tools available in each management center. The present communication tools are generally limited to phone calls and emails for advance planning. The County 800 MHz trunk radio system is available in the TMC; however, it is not widely used for incident coordination between the Management Centers. The short-term future holds great promise for improved interagency coordination through the use of STARNET. This project is discussed in greater detail in the Sections 1.5 and 2.4.3 of this report.

The notable exception, to the limited coordination, is the interaction and coordination between the CHP and Caltrans. While these agencies are co-located at the Transportation Management Center, they are unique in the way they share the communication tools and dispatch tools owned by the CHP. This allows the Caltrans staff to access the Computer Aided Dispatch (CAD) system where incoming 911 phone calls and incident information are recorded. The TMC staff can also query the CHP for information related to events. This has allowed the CHP to make rapid requests for warning messages to be displayed for weather-related hazardous conditions (wind, heavy rain, fog, etc.). TMC staff can respond quickly to these requests, as the information provided by CHP has proven to be generally creditable, as opposed to field observations provided by the public, which generally are confirmed before action is implemented.

Additional coordination between CHP and Caltrans takes place through use of a Caltrans sponsored CCTV that has been installed on CHP’s fixed wing aircraft. This CCTV has proven critical in confirming the nature of events and the appropriate response. While extreme weather conditions can ground the aircraft, CCTV is often able to observe and provide valuable information as storms are tapering off, and it has been especially valuable in determining the extent of minor flooding and areas of high likelihood for inundation of floodwaters.

Additional needs exist in the form of high quality weather prediction data. It is not envisioned that Caltrans would desire to enter into the weather prediction field. Caltrans would prefer to contract for these services or, by working through a program like *Clarus*, leverage the existing investment in predictive services.

2.4. Integration Solutions

While the needs might initially vary for the two selected sub-regions of the District, once standardized into the defined needs, they have become very similar. After exploring the output from the self-evaluation guide the selected high level strategies were compared and are presented in Tables 2-6, 2-7 and combined into Table 2-8.

Table 2-6 Identified Deficient Valley area Integration Strategies

Deficient Valley Integration Identifier	Integration Strategy	Current Integration Level	Required level to meet needs
DVI-1	Use of External Weather Information Sources	3	4
DVI-2	Availability of Weather Information	3	4
DVI-3	Frequency of Weather /Road Weather Observations	1	3
DVI-4	Weather Information Coordination	0	3
DVI-5	Extent of Coverage	2	5
DVI-6	Interaction with Meteorologists	0	3
DVI-7	Alert Notification	1	4
DVI-8	Decision Support	0	3
DVI-9	Weather/Road Weather Data Acquisition	2	3

Table 2-7 Identified Deficient Mountain Area Integration Strategies

Deficient Mountain Integration Identifier	Integration Strategy	Current Integration Level	Required level to meet needs
DMI-1	Frequency of Weather Forecasts	0	3
DMI-2	Frequency of Weather/Road Weather Observations	2	3
DMI-3	Weather Information Coordination	2	3
DMI-4	Extent of Coverage	2	5
DMI-5	Alert Notification	2	4
DMI-6	Decision Support	2	3
DMI-7	Weather/Road Weather Data Acquisition	0	3

Table 2-8 Combined Integration Strategies

Common Integration Strategies	Integration Strategy	DVI Number	DMI Number
CIS-1	Frequency of Weather/Road Weather Observations	DVI-3	DMI-2
CIS-2	Weather Information Coordination	DVI-4	DMI-3
CIS-3	Extent of Coverage	DVI-5	DMI-4
CIS-4	Alert Notification	DVI-7	DMI-5
CIS-5	Decision Support	DVI-8	DMI-6
CIS-6	Weather/Road Weather Data Acquisition	DVI-9	DMI-7
DVI-1	Use of External Weather Information Sources	DVI-1	
DVI-2	Availability of Weather Information	DVI-2	
DVI-6	Interaction with Meteorologists	DVI-6	
DMI-1	Frequency of Weather Forecasts		DMI-1

Each of the identified "combined identified deficient integration strategies" and remaining mountain and valley deficient integration strategies require plans to address them. The range of options runs from:

- SOP additions, modifications, or elimination in the TMC.
- New or improved interaction/data exchange between vendors, allied agencies.
- New infrastructure to be identified and installed.
- Development of new partnership and agreements between agencies.
- Development of new performance measurements to determine effect of implementation.

2.4.1. Frequency of Weather/Road Weather Observations

The common integration strategy of increasing the frequency of weather and road weather observations (CIS-1) has differing impacts based on the application environment. In the Valley sub-region the greatest changes will be required. The valley is presently at integration Level 1 with a goal of reaching a Level 3. This will require moving from an environment of only receiving data when requested to the level where automatic reports are generated when thresholds are exceeded.

Implementation to the proposed level will require a system capable of generating automatic feedback. The current system employed by the TMC, Scan Web by SSI, does not provide the alert service. Likely partnering with SSI could result in a user-managed threshold alert system. There is also the potential for including this feature into STARNET.

Once a solution is identified for the alert system, modifications to the SOPs in the TMC will be required to properly maintain the notification system. As the old system used at the TMC had the capability of providing alerts, thresholds have been defined and will need to be reviewed once a solution is brought online to assure current methodologies are prescribed.

The mountainous region will need to review their thresholds for notification and procedures for action once a system is made operational.

The system requirements should be developed through the systems engineering approach; however, for estimating purposes the following could be used. The system should check to assure the thresholds have not been exceeded each time the system collects data from the field stations. The current system polls for data twice every minute, and this is likely to continue. The alert system should be user-administered and take the form of either a paging or email alert system. Integration into the proposed web-based incident management system would be an optimal solution.

The time frame for this implementation is limited by both personnel prior commitments and the funding required for development. The cost for such a system implementation would likely be under $100k and should be deliverable within one year.

2.4.2. Weather Information Coordination

Common integration strategy CIS-2, weather information coordination, at the proposed Level 3 requires the assignment of a staff member to gather and disseminate information to other staff with respect to weather prediction, events and impacts. While the staff member would not be a meteorologist, this person would require additional training and must be capable of functioning as a lead person for weather reporting and coordination. The present levels of integration range from a Level 0 in the Valley sub-region to a Level 2 in the Mountainous sub-region.

This staff position would likely be an existing member of our TMC team, who with additional training could coordinate our preparedness and response to predicted weather conditions. Identification of areas requiring additional instrumentation, either by working with our maintenance crews or through observation and analysis, are the best methodologies to employ in the identification process.

This staff member would conduct meetings after events with our field crews to identify additional areas for instrumentation, or where outside sources of information could be leveraged to improve both pre-event preparedness and response coordination.

Additional duties would include improving the education of all TMC staff and maintenance field crews on the type and quality of information available for use in weather-related events. Identification and interaction with outside vendors, agencies and resources to assist in information collection and interpretation of weather-related information would be an additional responsibility of this staff member.

Staffing workload, training availability and integration into existing duties would be the limiting factors in developing this level of integration. The responsibilities associated with this workload would be seasonally dependent. Off peak season training, if available, could be accomplished as workloads generally would allow for flexibility in scheduling. The workload during peak adverse weather conditions would require senior management understanding that the increase in non-flexible time associated with weather events could be reductions in service levels in other areas from the lead person.

Costs associated with travel and the availability/costs of proper training would have impacts on the fixed budgets allocated for these activities. The magnitude of the impact could range from hundreds to thousands of dollars. The estimated impact would be under $10,000 per year initially with reduced costs once training was complete. These estimates are based on the reallocation of duties assigned to existing staff and do not include additional staff.

2.4.3. Extent of Coverage

The Common Integration Strategy (CIS-3) improving the extent of coverage to a Level 5, requires additional field element implementation for data collection, integration with other private and governmental partners, and development of an improved traveler information system (511). This 511 system can be viewed as the capstone integration strategy, as it is the face of the integration effort most likely to be seen and recognized by the public. It is dependent on the successful outcome of many of the identified integration strategies in order to gather the information necessary to provide the high quality data to support the improvements in traveler information.

The SACOG Region is currently working on an Internet-based data collection platform which will likely be implemented at Caltrans and many of our District 3 partner agencies (STARNET). The purpose of data collection within STARNET is to feed an improved regional 511 system. Weather and related events are regionally recognized as creating major impacts to our transportation system, and as such the information related to these events will be provided as part of this activity.

The costs to the region of STARNET and the related 511 system upgrades are projected to be about $5 million. The systems engineering (SE) approach has been used regionally to develop the SE documents through high level design. Currently the region is negotiating with a candidate contractor who will complete development of the detailed design and implementation of the STARNET concept. The implementation of the improved 511 system is dependent on the data collected as part of the STARNET implementation and is anticipated to follow quickly, once the data are in hand. Additional features and incremental improvements to the system are anticipated, but have not been defined at this time.

Regional Operation and Maintenance costs are anticipated to be on the order of $500,000/year for the STARNET system and may require additional staff for complete implementation. These staff will likely be employed at the regional level by SACOG. Caltrans must continue to be engaged in the development of STARNET and contribute to the matching fund requests in order to have their needs addressed as part of the regional effort. This will require approximately 5% of time for a senior engineering level position, and likely 5% from support staff. The need for monetary contributions is on the order of $50,000/year. Additionally Caltrans will need to continue supporting the use of regional funds through SACOG as the projects major funding source.

The need for additional field elements may be identified as part of this effort. Costs associated with installation of field elements can be estimated at the following values:

- Roadway Weather Information Station $50,000
- Closed Circuit Television $70,000
- Changeable Message Sign $250,000
- Highway Advisory Radio $80,000
- Extinguishable Message Sign $25,000

These values should only be used for element installation, and, while they do include traffic control and other construction costs, they do not generally include costs associated with reaching utilities which can be sizeable if the site for installation is located away from urban centers. Communication costs for high bandwidth can be especially challenging in remote locations.

2.4.4. Alert Notification

The present level of Alert Notification (CIS-4) is very basic for the Valley Region and slightly improved in the Mountainous Region. Steps necessary to reach recommended levels of integration include better dissemination of RWIS data either by phone, email alerts or paging. The final step is the integration of automatic alerts sent from the RWIS system when thresholds are exceeded. These alerts are recommended to be provided to maintenance personnel to aid in field decision making related to pre- and post-event activities. Most of these capabilities either exist or could be rapidly implemented with minor modification to our existing systems, little cost for SOPs, and only a minor investment in time in the TMC environment.

Perhaps the area of greatest challenge to implementation of this integration strategy is the identification of the proper thresholds and standard operating procedures to be implemented as each threshold is reported to be exceeded. This will require an institutional change internally for our maintenance personnel as they primarily use field observation as their tool for gauging response. Data generated from RWIS locations are generally only considered as a secondary or third source of data in the decision making process. The level of effort to implement this change could be large, and a champion will need to be identified within Upper Maintenance Management for an institutional change of this nature to be effective and implemented.

2.4.5. Decision Support

Common Implementation Strategy five (CIS-5) is reliant on field data and the development of software which would identify potential solutions based on weather and traffic modeling. The software would then point to a selection of SOPs for consideration of the field managers for application. Implementation of this strategy will once again face the same sort of intuitional barriers which presently exist for CIS-4.

The development and customization of software for the selection of SOPs should not be a major expense. Possible solutions could range from integrated solutions offered by SSI for use with their Scan Web product currently in use in District 3, to home developed systems requiring additional manual input. Costs for implementation range from $10,000 to $200,000. These software costs are independent of field device implementations which may be required for data collection. The costs associate with field element installations are provided in Section 2.4.3, and the same values can be used for planning purposes. The intuitional changes present some of the greatest challenges for implementation. The necessary strategy for implementation follows the procedure outlined in Section 2.4.4.

2.4.6. Weather/Road Weather Data Acquisition

This implementation strategy (CIS-6) calls for installation and proper maintenance of field sensors throughout the regions where we experience adverse weather conditions. It includes development of procedures for checking the accuracy, functionality and reliability of our field sensors.

The identification of additional field sensor locations is a process that should be undertaken with the aid of maintenance personnel, and weather modeling/prediction/integration experts. If for the purposes of this report we assume the need for 15 additional RWIS locations, the estimated cost would be $750,000. This cost estimate does not include utility or communications costs, or professional design service fees. A planning estimate would more likely be $1 million. As no funding source has been identified or had a placeholder inserted in the past, the implementation timeframe could be extended with knowledge of the current budget projections. Implementation at this level is therefore not likely to occur within the next 5-7 years.

2.4.7. Use of External Weather Information Sources

The Mountainous Region is utilizing a weather information service as proposed in DVI-1 for the Valley Region. At the present time the subscription service is only used during the winter months and is funded through a special winter snow removal maintenance source. The present monthly fee associated with this service is $3,500. The cost to expand this service to a second location is likely to be similar in cost. Thus, the total cost for 6 winter months would be raised to $42,000. It might be possible to use the services of the *Clarus* project instead of the contract service. Further exploration into the scope and capabilities presented by the *Clarus* project is required to determine if the services provided would meet our requirements.

The cost to implement this service for the 6-month winter period would likely be between $25,000 and $50,000 per year with implementation time being very short (less than 6 months to develop and bid the contract). Staff time requirements could be intensive while preparing contract documents, and once in place the impact to personnel would be minimal.

If the option of exploring the *Clarus* project was selected to serve as the information source, staff time could be greatly increased. It is possible that the same person who takes on the leadership role for CIS-2 (Section 2.4.2) could assume the lead on this project and likely would receive some training through exposure to this effort. It is anticipated that participation in the *Clarus* project could require up to 15% of a staff position's time. This would include integration coordination and any contract oversight.

2.4.8. Availability of Weather Information

The proposed services to meet this recommendation - Availability of Weather Information (DVI-2) - would likely be met by addressing DVI-1 as discussed in Section 2.4.7. This information would be provided by an outside contract vendor who would use RWIS data to improve and provide daily (and eventually hourly) forecasts to allow the TMC and maintenance crews to respond either in advance or to be better prepared for changes in weather patterns and advancing storm fronts.

These services would likely be included in DVI-1 so no additional cost or time would be associated with this improvement of service once the contract was executed.

The ability to gain confidence in the prediction service and change field operating procedures to leverage the potential cost saving by reducing response to a just in time method will require time for acceptance and a champion for the method within our Maintenance Division management.

2.4.9. Interaction with Meteorologists

Deficient Integration Strategy Number 6 calls for increased interaction with meteorologists to discuss information needs and responses. Implementation would provide the opportunity for TMC and maintenance staff to interact with a meteorologist to discuss response methods and to allow for the introduction of new techniques used in responding in similar conditions elsewhere in the country and world.

The cost for meetings of this nature is unknown, but likely is under $5,000 per day. The selection of a meteorologist and the time required for meeting with the proper staff is minimal. The timeframe for implementation should be rather short once a service is identified.

2.4.10. Frequency of Weather Forecasts

Deficient Mountain Implementation Strategy Number 1 identifies the need to increase the frequency of general weather forecasts to multiple times per day. This proposed strategy has recently been met by the implementation of a contract weather information service in the Mountain region. The service is presently available; however, each winter as budgets get tighter and costs increase, renewal of this contract each year is becoming more difficult.

Possible long term solutions include identification of special funding sources for payment of this service, or looking into the *Clarus* project for possible assistance.

3. IMPLEMENTATION OF INTEGRATION PLAN

The largest challenge facing implementation of the identified strategies likely is not funding or manpower, though these resources are at a premium and likely will influence the timeframes, but rather is a change in methodology where we become proactive "before events take place" in the TMC and maintenance environments. The current perspective for most activities in the TMC defines our role to be reactionary as opposed to proactive. We have developed systems to let us know quickly once an event has an impact on our system (ranging from vehicle incidents to high winds). Weather integration and the ability to predict weather present a unique opportunity in the TMC and for maintenance of our roadways. This opportunity is something we have not taken a great advantage of in the past and will require modification of the methods of thinking on the part of management and operators.

3.1. Integration Schedule (Phasing and Sequencing)

3.1.1. Implementation Timeframe

It can be seen from the list of projects presently underway that movement toward an environment where weather integration plays a critical role is improving. Many of the traveler information improvement projects should enter construction in this building season and will continue to add additional capabilities.

The largest challenges exist with weather prediction data and contract-based services. The use of contract prediction services in the mountainous sub-region has been approved in the past; however, long term stable funding sources have not been identified.

The identified improvement strategies discussed in Section 2.4 of this report had the following time frames identified:

Table 3-1 Combined Integration Strategies – Implementation Time Frames

Common Integration Strategies	Integration Strategy	Implementation Time Frame
CIS-1	Frequency of Weather/Road Weather Observations	1 year
CIS-2	Weather Information Coordination	1 year
CIS-3	Extent of Coverage	2-10 years
CIS-4	Alert Notification	1 year
CIS-5	Decision Support	1-7 years
CIS-6	Weather/Road Weather Data Acquisition	5-7 years
DVI-1	Use of External Weather Information Sources	1 year
DVI-2	Availability of Weather Information	1 year
DVI-6	Interaction with Meteorologists	1 year
DMI-1	Frequency of Weather Forecasts	1 year

While many of these strategies look promising, the need for a champion in the region to raise the awareness of these solutions and to present associated needs to upper management is critical. Without support these projects will fall short of the funding line when set against other necessary projects all fighting for limited resources and budget.

The forecast for the more complex and longer term projects is even more dire. Long range high dollar projects will continue to compete against both funded and unfunded pavement and infrastructure rehabilitation projects. It is critical that these projects begin the process of funding requests at this time so that they stand a chance for funding in the future as budgets tighten and resources shrink in the public sector.

3.1.2. Sequencing of Strategy Implementation

While sequencing allows for greater utilization of each component as it relates to the system of weather integration devices, it should not be used as a reason to delay implementation if funding appears for any one element. It is possible that funded or placeholder projects already incorporate many of the identified, or need to be identified, elements. These projects should be leveraged as early winner projects and utilized to the greatest extent possible and potentially point toward other low cost projects which might complete a regional or area-wide system for acceleration.

The ordering of implementation has been considered and is presented in Table 3-2 below. For those elements with more than one component the portion of the project which can be accelerated should be completed early and followed up with additional field element installations as funding and time allows.

Table 3-2 Combined Integration Strategies – Sequencing

Common Integration Strategies	Integration Strategy	Implementation Sequencing
CIS-1	Frequency of Weather/Road Weather Observations	4
CIS-2	Weather Information Coordination	3
CIS-3	Extent of Coverage	2-5
CIS-4	Alert Notification	3
CIS-5	Decision Support	4
CIS-6	Weather/Road Weather Data Acquisition	5
DVI-1	Use of External Weather Information Sources	4
DVI-2	Availability of Weather Information	4
DVI-6	Interaction with Meteorologists	1
DMI-1	Frequency of Weather Forecasts	4

This ordering of projects should not slow the effort to begin the process of institutional change necessary for the vision of weather integration. Working on development of the indicators and thresholds for notification should continue throughout the next few years. It is anticipated that adjustments and fine tuning will be necessary before the final values and indicators can be identified.

To begin work on these indicators and thresholds, the potential for meeting with weather experts as identified in DVI-6 has been identified as one of the first priorities.

3.2. Cost Estimates

General cost estimate information was included in the discussion of each of the proposed integration strategies in Section 2.4. To better understand the total costs and level of fiscal commitment, these estimates are summarized in the following sections.

3.2.1. Deployment

Almost all of the individual strategies have infrastructure improvement costs associated with them. In some cases the initial effort to gain the basic capabilities of the proposed solution, while taking advantage of the present ITS element deployments, are small, and the potentially necessary deployment of field elements to complete the data collection could be very high.

Table 3-3 Combined Integration Strategies – Cost Estimates

Common Integration Strategies	Integration Strategy	Cost Estimates
CIS-1	Frequency of Weather/Road Weather Observations	$100,000
CIS-2	Weather Information Coordination	$10,000
CIS-3	Extent of Coverage	$50,000-$200,000 +
CIS-4	Alert Notification	$10,000
CIS-5	Decision Support	$10,000-$200,000 +
CIS-6	Weather/Road Weather Data Acquisition	$750,000
DVI-1	Use of External Weather Information Sources	$25,000 / year
DVI-2	Availability of Weather Information	$25,000 / year
DVI-6	Interaction with Meteorologists	$5,000 / meeting
DMI-1	Frequency of Weather Forecasts	$25,000 / year

3.2.2. Integration Life-Cycle Costs

Total life-cycle costs associated with deploying, operating, and maintaining the hardware and software components of the system are difficult to determine at this stage. Many of the projects will require further use of outside experts to aid in determining the number and placement of field elements. The lives of properly maintained field elements are in the 15-20 year range, and only require periodic calibration and electronic sensor replacement. The maintenance costs should be no more then $1,000 per year per element. As the number of elements has yet to be determined, the final costs are unknown at this time.

In addition, the software to be deployed will need to be selected and the costs associated with licensing and updates will be scoped at that time. It has been our experience that software has a shorter life than the field elements themselves, and generally the ability of software to be compatible with legacy systems is always a challenge. The requirement for software to be NTCIP compatible will hopefully address many of these concerns into the future. Advances in XML-based web interfacing have also shown themselves to be integral in the fusion of data streams for the TMC operators. Software that allows for XML data stream output in the TMDD 2.1 or 3.0 versions will be of great help in integrating the data from weather-based streams into the normal user interface in the TMC. The more integrated into the TMC user interface the greater likelihood that the users will recognize the data as normal to work with not something special.

3.3. Operations and Maintenance Requirements

Many of the required systems are additional field elements to support traveler information systems. The operations and maintenance of these elements should not create a large increase in labor required to maintain these new elements and can likely be adsorbed in the short term. As the field elements age, increased maintenance will create a demand for additional personnel and service dollars. The increase in communications costs as the elements are added to our inventory may create a larger problem in the near term.

3.3.1. Staffing

The present level of staffing in the TMC should be able to handle the increased work load, as many of the proposed integration methodologies automate the tasks presently being done manually, while increasing efforts in other areas. Once the vision is completed the level of effort indoors should remain about constant for the operators.

Electrical systems support, those who care for computer systems and field element communication networks will see an increase in workload as the new servers and communication links are activated. The initial level of effort to integrate notification systems onto our current or replacement servers will be fairly large if the providers do not have an off-the-shelf module to add to our software packages. Past experience has led this group to believe that even the best specified software generally brings with it the requirement of initially increased effort. In the long term, this effort may result in the need for an additional staff position to be added.

The impacts to maintenance field staff are the most difficult to forecast. The need for increased electrical maintenance personnel is a continuous struggle presently, and this situation will only intensify with increased inventory of field elements. This shortage is felt both in terms of qualified personnel and in dollars to purchase replacement parts and maintenance supplies. Staffing levels have been augmented in the recent past; however, these increases appear as if they are not adequate to keep up with the demand.

Maintenance response personnel for weather-related events could see a decrease in demand if we are able to gain efficiencies through weather integration; however, most likely we could see increased detection of potential weather events, and given advance notice from forecasting the demand for hours could increase. This would result in the need for increased personnel or at a minimum an increase in overtime money required.

In general the ability to quantify the staffing impacts for weather integration is difficult. It is likely that some efficiency will be discovered and off set some of the new workload both in the TMC and in the field, but in general we will see the need for increased spending for personnel and maintenance dollars as we would with the increase in inventory for any system.

3.3.2. Support

A steady funding stream to offset the cost of contracting with outside vendors for interpretation of weather data has not been identified and is critical to the success of this effort. In the past this effort has utilized winter storm funds from within our maintenance division's funding, but even this funding source has been subject to reductions. The same source of funding is likely to be utilized for the training and meetings which will be necessary as part of the implementation of many of the identified strategies. Identification of these funds will be critical, as generally the State of California can not write or fund contracts which span fiscal years. The identification of a vendor with which to work in developing the vision for field element placement, response plans and training to interpret the collected data would be of great value.

To properly maintain and operate the system additional resources will be required for software support and field maintenance. These staff and support dollars are not required initially as the systems they would be required to maintain do not exist today. The effort required to obtain legislative approval for augmenting our personnel (the budget change control process) has proven to be arduous. The budget change control process is something that we should begin to explore in the near future if we hope to have staff and service dollars ready as these systems come on line.

3.3.3. Training

The training requirements will be dependent on the systems ultimately selected for implementation as part of the integration effort. If new vendor’s equipment is added to our inventory it is possible that training would be required for field maintenance personnel. In the case where we are able to add similar equipment to our current inventory, this training would only be required for new personnel.

In the TMC and electrical systems support arena, new software will bring the potential need for increased training. In general, support staff is very flexible and unless a vendor moves in a completely new direction with software implementation very little training should be required.

The largest increase in training demand will stem from the new areas of data interpretation and understanding associated with the implementation of response procedures. Outside expertise will be required to develop training recommendations for many of these functions. Once internal champions are identified they will work with vendors and need to attend conferences associated with weather integration in order to establish contacts in the industry. These champions will then need to recommend training development plans.

3.4. Anticipated Challenges and Constraints of Integration

The challenges and constraints likely to effect our implementation of a complete weather integration system into the daily operation of the TMC have been identified elsewhere in this document. The requirement to move from a reactive to proactive management operation based on predicted data is perhaps the largest challenge. High (and continued) confidence in predictive data from other sources is critical for successful implementation.

The identification of a champion with the Maintenance Division to work with the Operations Division on weather integration is critical. Continuation of the support received in developing this report and leadership internally from the Maintenance Division will be necessary if the traveling public is to realize the results as envisioned. Staff at the TMC will work to further integrate weather information into our daily activities, decision process, and SOPs, and they will provide any and all identified information to our field personnel in a timely manner. It will be necessary for the maintenance staff to consider revising their SOPs to incorporate weather prediction data into their response plans.

Consideration must be given for the opinion our legal representation should consider regarding the impacts of exposure, if we elect to modify our methods to respond to forecasts. The concern raised is related to the possibility of being perceived as “being late” or “non-responsive” as forecast models and response methods are refined.

The TMC staff is committed to continue to improve communication with the traveling public through all means possible including standard field element activation (HAR, CMS and media), as well as continuing to lead the effort throughout the region in development of a 511 system and STARNET.

A source for funding or changes in our understanding of the proper use of Federal monies for the purpose of "Operations" either to run a center or purchase services from qualified vendors (private firms) that can provide high quality predictive estimates will be required to make the ultimate plan a reality.

APPENDIX A

Valley Study Area
Weather Integration

Self-Evaluation Guide Reports

APPENDIX B

Mountain Study Area
Weather Integration
Self-Evaluation Guide Reports