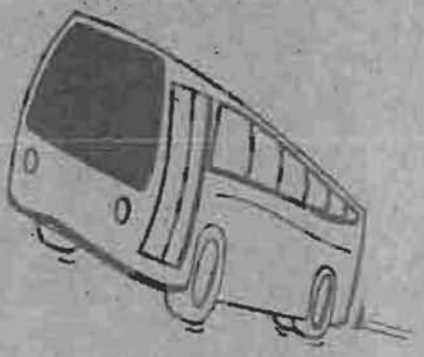
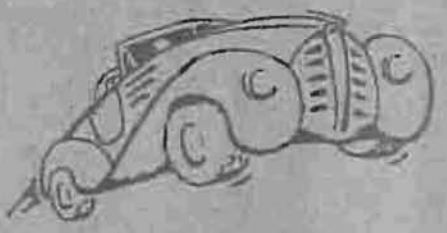
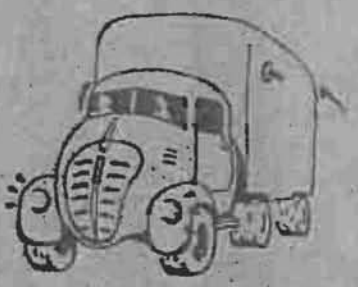
Final Report

Intelligent Transportation System Early Deployment Plan for the Kern Region



Executive Summary





Kimley-Horn and Associates, Inc.

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Executive Summary

Introduction

Intelligent Transportation Systems (ITS) (formerly called Intelligent Vehicle Highway Systems [IVHS]), is the application of advanced information processing, communications, vehicle sensing and traffic control technologies to the surface transportation system. The objective of ITS is to promote more efficient use of the existing highway and transportation network, increase safety and mobility, and decrease the environmental impacts of congestion. The Federal Highway Administration (FHWA) is sponsoring the preparation of Early Deployment Plans (EDP) in different areas to identify opportunities for ITS applications.

The primary focus of the EDP for the Kern County region is the maximization of safety, traffic flow, and efficiency in both the rural and urban areas of the Kern region. It presents an integrated, multi-modal, phased strategic plan to address the surface transportation needs and problems of the Kern region through the use of ITS. By preparing the EDP, the Kern region will be in a position to take advantage of federal and other funding opportunities and implement various components of ITS.

Kern COG is the lead agency for this study, with key participation from California Department of Transportation (Caltrans) Districts 6 and 9, Caltrans New Technology and Research Program, and major cities and transportation agencies within the Kern region. The project consultant team is headed by Kimley-Horn and Associates, Inc., with specialty sub-consultant services provided by Ronald F. Ruettgers Civil Engineer and Moore, Iacofino, and Goltsman (MIG), Inc. (public participation).

The overall goal of this ITS EDP is to develop a multi-year ITS strategic deployment plan for the Kern region which will result in a well-balanced, integrated, intermodal transportation system. Kern's transportation needs, which have the potential of being addressed by ITS technologies, have been identified and ITS elements which would be beneficial, cost-effective, and implementable have been evaluated. The strategic plan (EDP) will help facilitate the integration and coordination of ITS applications valley- and state-wide in conjunction with the other EDPs being conducted throughout California.

Study Area

Located in south central California, the Kern region, as shown in **Figure 1**, consists of an area of over 8,000 square miles. It extends from Los Angeles/Ventura counties to the south to the Kings/Inyo/Tulare counties to the north. Kern County also shares boundaries with San Bernardino County to the east and Monterey,San Luis Obispo, and Santa Barbara Counties to the west. Kern's

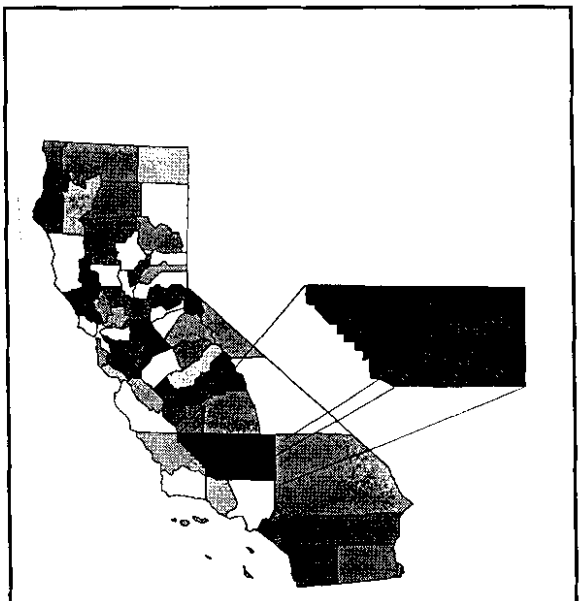


Figure 1 - Study Area

population has grown from over 400,000 in 1980 to over 617,000 in 1994 with more than half of the population residing in the Bakersfield metropolitan area.

Jurisdiction for the design, construction, and maintenance of the transportation system within the Kern region is divided among Caltrans Districts 6 and 9, the Kern County Roads Department, the transit agencies (Golden Empire Transit [GET] and Kern Regional Transit), and the Public Works Departments of the eleven incorporated cities:

- Arvin
- Bakersfield
- California City
- Delano
- Maricopa
- McFarland
- Ridgecrest
- Shafter
- Taft
- Tehachapi
- Wasco

Public Participation

A key component to the success of a long-range ITS program is the involvement and support of the public. The Kern EDP initiated an extensive, innovative public participation program with two main objectives: to educate the public about ITS and its benefits, and to solicit input from a cross-section of the region's population in determining the needs, issues, and solutions for the region's transportation system. The following activities encompass the public participation program:

- **Stakeholders Educational Workshop** — Key stakeholders from throughout the county were invited to attend this project awareness and brainstorming session at the beginning of the project (July 31, 1996).
- **Rural Community Workshops** — Three Rural Community Workshops were held in order to solicit input on concerns from a rural perspective. Two sessions were held on the east side of the region and the third on the west side.
- **Urban Community Workshops** — Two Urban Community Workshops were held in the Bakersfield metropolitan area in order to obtain valuable input about urban issues.
- **Newsletter** — A newsletter, *Kern ITS Update*, was developed and distributed which introduced and defined ITS, described the Kern EDP project, and kept stakeholders updated on the progress of the study. Three newsletters were published during the EDP development.

Needs and Issues

Poor visibility due to fog and blowing dust, large percentages of trucks, high winds in the east, steep grades, snow and ice, rockfalls, and red-light violations all contribute to the growing concerns about highway safety. The "Tule fog," a problem through the entire central valley region, has caused some of the worst accidents in the state involving dozens of vehicles and closing the main artery through the valley, I-5, for hours at a time. Blowing dust, related directly to seasonal agriculture, causes similar difficulties for travelers. In the urban

area, red-light violations are an issue. In the east county, high winds cause high profile vehicles to overturn. Snow, ice, and rockfalls make travel through the rural areas unpredictable. This EDP places traveler safety first in determining ITS solutions for Kern.

Additional issues were related to:

- Improved information sharing among agencies
- Improved traffic progression across jurisdictional boundaries
- Reduction in delays due to incidents
- More informed traveler decision making through improved traveler information systems
- Improved data collection through expanded coverage of information sources
- Increase transit ridership
- Enhance transit coverage and efficiency
- Improved air quality analysis
- Improved commercial vehicle operations

Kern ITS Programs

Six programs were developed for Kern which integrate the existing ITS efforts underway in the Kern region and will incrementally develop a sound base for future expansion of ITS in the region. These programs are:

- Communication Network Development Program
- Traffic and Incident Management Program
- Kern Traveler Safety Program
- Kern Informed Traveler Program (TravelKIT)
- Kern Smart Transit Program
- Enhanced Emergency Response Program

The implementation of these programs as recommended in the EDP will make transportation throughout Kern safer, more efficient, and noticeably more pleasant for travelers. The Kern ITS Programs are summarized in **Table 1**.

These programs were developed specifically for the Kern region, but each was developed as a part of an open, expandable plan, in order to provide a starting point for valley-wide integration of ITS. This means that other counties in central California which have similar problems and needs as Kern will benefit from this plan and combine ITS programs for different regions. This region-wide integration will provide further opportunities for cost sharing and funding and ultimately result in cost savings to all agencies involved. The broader goal is to facilitate a seamless, statewide ITS network.

Table 1 - Kern ITS Program Summary

Communication Network Development Program

- Communication Links with Bakersfield SONET Network:
  - Caltrans District 6 TMC
  - Kern County traveler information workstation
  - Each rural city traveler information workstation
  - Kern COG traveler information workstation (for ITS Planning data)
  - Control 5 (emergency services)
  - GET
  - Kern Regional Transit
- Smart Call Boxes for Communication
- Links to Other Regions:
  - to Fresno and other Central Valley TMCs
  - to Southern California Showcase
  - to other TMCs and traveler information systems throughout CA
  - to I-40 traveler information systems in AZ and CA

Traffic and Incident Management Program

- Census Stations, System Detectors and Incident Detection
- Decision Support System (DSS) Shared among All Agencies
- Coordinated Incident Management Procedures
- Urban Smart Corridors
- Freeway Field Elements
  - Changeable Message Signs (CMS) / Trailblazers
  - Highway Advisory Radio (HAR)
  - Closed Circuit Television (CCTV) Cameras

Kern Traveler Safety Program

- Weather Stations
- Photo Radar for Red Light Enforcement
- RR Grade Crossing Technology
- Road Closure Enforcement during Flooding
- Smart Studs
- Rockfall Detection System

Kern Informed Traveler Program

- Development of an Advanced Traveler Information System (ATIS)
- Workstations for Traveler Information
- Upgrade of Bakersfield TOC
- Interactive and Commuter Kiosks
- Live Video Feeds to the Media
- Community Access Television (CATV)
- Highway Advisory Telephone (HAT)
- WWW Site

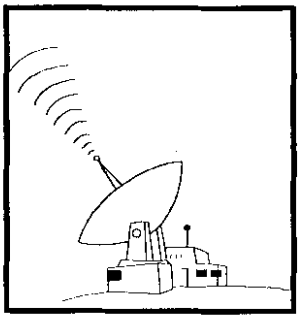
Transit Operation Program

- Upgrade of Golden Empire Transit (GET) and Kern Regional Transit Systems
- Demand Responsive Service for GET (Kern Smart Shuttles)
- Coordination of GET and Kern Regional Transit Schedules

Enhanced Emergency Response Program

- Traveler Information Workstations for Emergency Response Providers
- Establishment of Emergency Corridor Routes

Communication Network Development Program



The communication network is the most important and often the most expensive component of an ITS. Communication links are needed to connect different agencies within the region to allow coordination and cooperation in operating and managing the transportation system. Each field element requires a means of communication for receiving data, consisting of controls or display messages and for sending data, consisting of weather, traffic, or equipment condition information. There are three major components to the communication network development program:

Communication Links with Bakersfield SONET Ring:

The Bakersfield Communication Master Plan defined a fiber optic, Synchronous Optical NETwork (SONET) backbone for the City of Bakersfield, dedicated to signal communication, video, and limited ITS applications. This backbone will need to be enhanced to be used as the network for Kern ITS as well. Links to the SONET network will allow any connected agency to communicate with any other agency. Physical communication links will be either fiber, hardwire, or wireless. The microwave network owned and operated by the Office of the Superintendent of Schools in Kern should be analyzed and strongly considered to be used as the communication medium wherever possible. The cost effective use of the Internet (specifically the world wide web) should be considered as well. An extranet, or private internet (as opposed to intranets) could be easily utilized to provide the links between the different jurisdictions and agencies. Communication will allow operators from different agencies to share information and discuss strategies, to exchange weather and traffic information through the advanced traveler information system (to be described later), and, potentially, to share field elements, such as dynamic freeway signs and CCTV cameras. Cooperative agreements will be necessary among all agencies in order to address control issues. Since the SONET is currently sized only for the City of Bakersfield needs, upgrades will be necessary and included as a part of this Communication Network Development Program. This means that any additional fibers which are needed for Kern ITS over and above the current SONET design, which accommodates only the City of Bakersfield projected future needs, will be funded as a part of this Kern Communication Network Development Plan.

Communication links should be installed between the Bakersfield SONET network and following facilities or locations:

- Caltrans District 6 Traffic Management Center (TMC)
- Kern County traveler information workstation
- Each rural city traveler information workstation
- Kern COG traveler information workstation (primarily for ITS Planning data)
- Control 5 (emergency services)
- GET
- Kern Regional Transit

Smart Call Boxes for Communication

The objective of Smart Call Boxes is to enhance the functionality of a number of the existing Kern Motorist Aid Authority call boxes so that they serve as communication nodes for communication to ITS field devices. The call boxes, located throughout the Kern region, can be upgraded to provide a cost-effective communication infrastructure for ITS field elements in the rural areas. Field elements on rural highways

can be connected to the call boxes, so that the data can be transferred to and from Caltrans via cellular phone technology.

An operational test was recently implemented in San Diego to test the application of this type of technology. The evaluation of Smart Call Boxes via the operational test should be closely monitored and conclusions for implementation in Kern should be based on the results. Dedicated cellular communications should be considered for field element communications if the evaluation proves that Smart Call Boxes are ineffective.

Links to Other Regions

The objective of the statewide/regional communication links is to enable travelers to receive information from areas outside of the immediate Kern region and to facilitate incident management and traffic control activities by sharing information among agencies.

Communication links are recommended:

- to Fresno and other Central Valley TMCs/TOCs
- to Southern California Showcase (the Southern California ITS program)
- to other TMCs and traveler information systems throughout CA
- to I-40 traveler information systems in AZ and CA

Figure 2 provides an overview of Kern ITS in terms of a functional architecture. **Figure 3** depicts all of the components of the communication network.

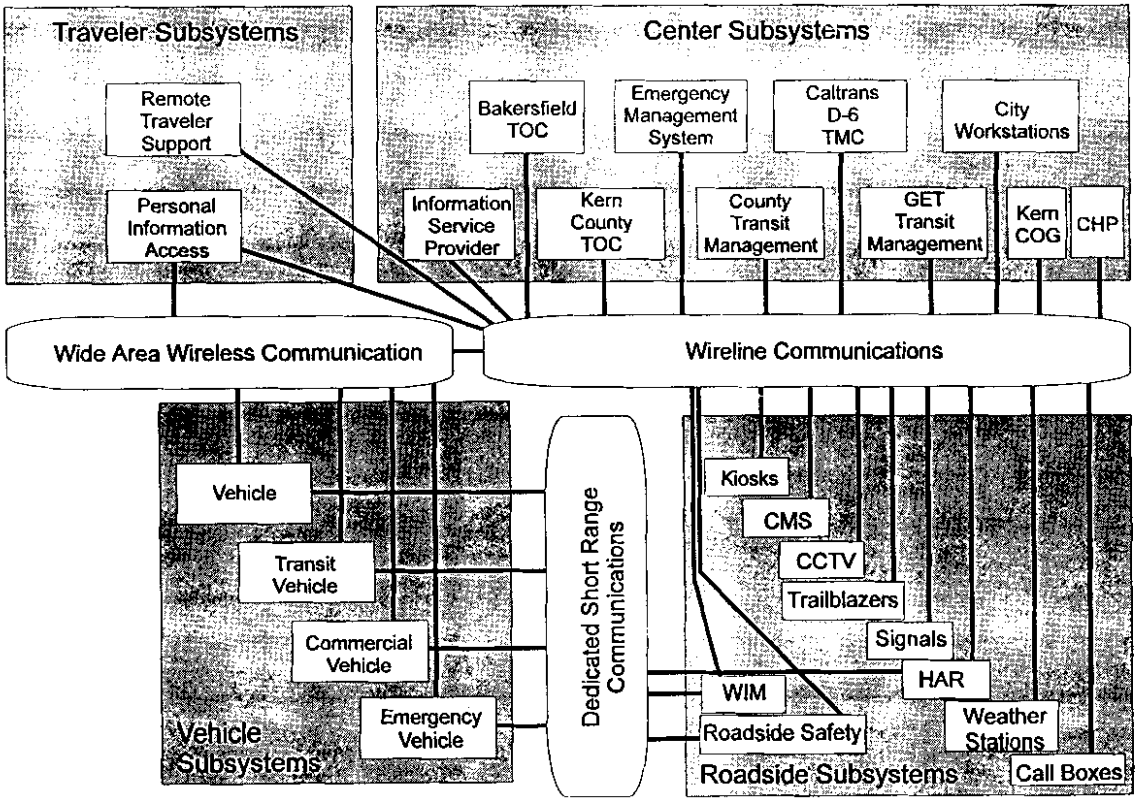
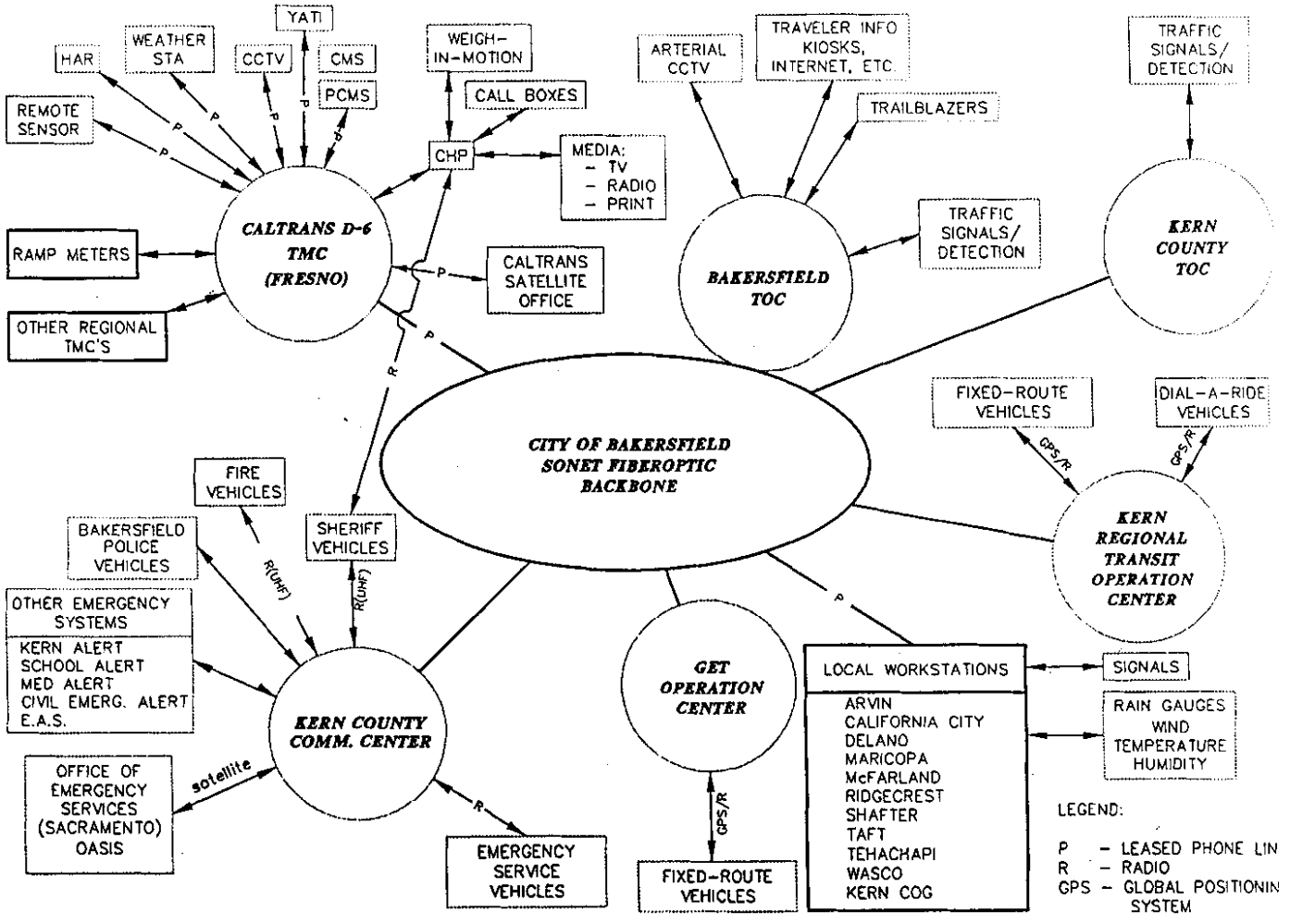
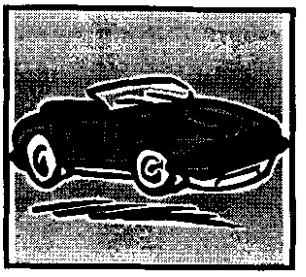


Figure 2 - Kern Functional Architecture

Figure 3 - Kern ITS Communication Network



Traffic and Incident Management Program



Traffic and incident management is already well established in Kern. Two traffic management centers[1] (Caltrans District 6 and 9) are in operation serving the Kern region. Field elements including CCTV cameras, Changeable Message Signs (CMS), and Highway Advisory Radio (HAR) are in place on various freeways. Plans for improved traffic management in the urban area of Kern are underway, with the City of Bakersfield Traffic Operations Center (TOC) under construction and plans already established for signal coordination and traveler information. The Traffic and Incident Management Program has been developed in order to meet the current and future demands of Kern's transportation network in terms of safety and congestion. This program integrates the current efforts of the various state, regional and local agencies serving Kern into a comprehensive, region-wide approach to traffic and incident management. It also expands upon current efforts to better achieve the objective of a safer, more efficient transportation network. Components of the program include:

Census Stations, System Detectors and Incident Detection

System detectors provide real-time traffic information to the TMC in the form of vehicle volume, speed, and/or occupancy. System detector coverage should be expanded to cover I-5 and SR 99, and portions of SR 58 and SR 204 through the urban area. Processes are needed for collecting and processing the raw data from the system detectors. A computer program is then needed to determine when an incident has occurred and alert TMC operators. The census stations on the east side of the region (Caltrans District 9) should be expanded to cover the entire county. These stations will provide real-time planning data for agencies such as Kern COG and Caltrans. Smart Call Boxes should be used wherever possible to send the data to Caltrans.

Decision Support System (DSS) Shared among All Agencies

A Decision Support System (DSS) is a software program which receives real-time data from field devices (e.g., weather stations and system detectors), analyzes the data, and suggests strategies for incident management. The objective of the DSS is to assist transportation management agencies (Kern County, City of Bakersfield, Caltrans, and rural cities) in the coordination and implementation of traffic and incident management strategies. The strategies include the text to be displayed on CMSs and Trailblazers, the locations of the signs to be used, ramp metering (when applicable) and/or signal timing changes, detour routes, HAR messages, and which agencies should be involved. Strategies are developed and agreed upon by all agencies involved in transportation and incident management in Kern prior to inclusion in the DSS. Cooperative agreements and standard operating procedures will be drafted prior to DSS implementation. Only one DSS is designed for the Kern region, and the various agencies will share the use and cost of the system.

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[1] *Traffic Management Center* is used in this report to describe any location which centralizes the remote control of ITS elements for traffic operations and management.

Coordinated Incident Management Procedures

Whether the incident management within Kern is done manually or automatically (with the assistance of a DSS described above) coordinated incident management procedures will be necessary. Since there will be several agencies involved in the incident management in Kern, it will be most efficient and beneficial to all if strategies are coordinated among the agencies. Strategies will include signal and ramp meter timing plans (when applicable), text for display on CMSs and Trailblazers (see description below), messages to be recorded on HARs, and other responses to incidents. Emergency response teams and, potentially, commuter services (similar to the Freeway Service Patrol in other regions) for different geographic areas of the region should be established as a part of this component.

Policies should also be developed which outline the responsibilities and limits of each agency under different scenarios. If field devices are to be shared as a part of traffic and incident management, details of the control agreements (standard operating procedures) should be logged along with the cooperative agreements. These procedures would outline details such as which field elements may be controlled by which agencies, and under what circumstances. Standard operating procedures also define after-hours operations of entire systems by other agencies (e.g. Caltrans District 6 operating the County of Kern's system after hours to enable monitoring on a 24-hour basis).

Freeway Field Elements

The objectives of the freeway field elements are to collect information about the status of weather or incidents and provide the general incident, weather, and congestion information to travelers during trips to allow them to make informed decisions.

A Changeable Message Sign (CMS) is a dynamic sign, located on the roadway, that allows two to three programmable lines of communication, entered remotely from a TMC. The actual wording of the message displayed on the CMS is determined by the traffic control and information needs at the time.

A Trailblazer sign is a limited-capability CMS used primarily for relaying detour information to travelers on city streets. Each sign can display two lines of variable text (approximately ten characters per line) and either a left, through, or right arrow on the bottom line.

A highway advisory radio (HAR) system advises travelers by roadside signs to tune to a designated AM radio frequency to hear the traveler messages. The messages are short (30 - 60 seconds), and are pre-recorded and programmed to repeat end-to-end throughout the day.

Closed Circuit Television (CCTV) cameras are valuable tools for incident verification. Assessment of the incident and the associated impacts are equally critical. CCTV will be used to obtain remote video of large intersections, high accident and adverse weather areas, and to monitor special event activity. CCTV should be used in the rural areas of Kern for verification of data from weather stations, system detectors, and dynamic CMSs. **Figure 4** shows the locations of the freeway field elements recommended for deployment.

Urban Smart Corridors

A smart corridor is a roadway which focuses the deployment of advanced technologies on a particular route to provide better progression on a daily basis as well as during incidents. The objective of Urban Smart Corridors is to provide a higher level of efficiency and traffic flow quality on corridors which provide alternate routes to freeways and which facilitate the movement of "through traffic" in the urban area of

Kern. Technologies include signal coordination, detection and communication, and ITS elements (CCTV, CMS, and Trailblazers). Signal coordination will require communications to link individual local controllers. Since many corridors will span several jurisdictional boundaries, multi-jurisdictional signal coordination and general cooperation will be necessary. Dynamic timing plans should be programmed for the length of each corridor as well, in order to better accommodate fluctuations in traffic due to recurring and non-recurring congestion. **Figure 5** shows the recommended Urban Smart Corridors and locations of ITS elements.

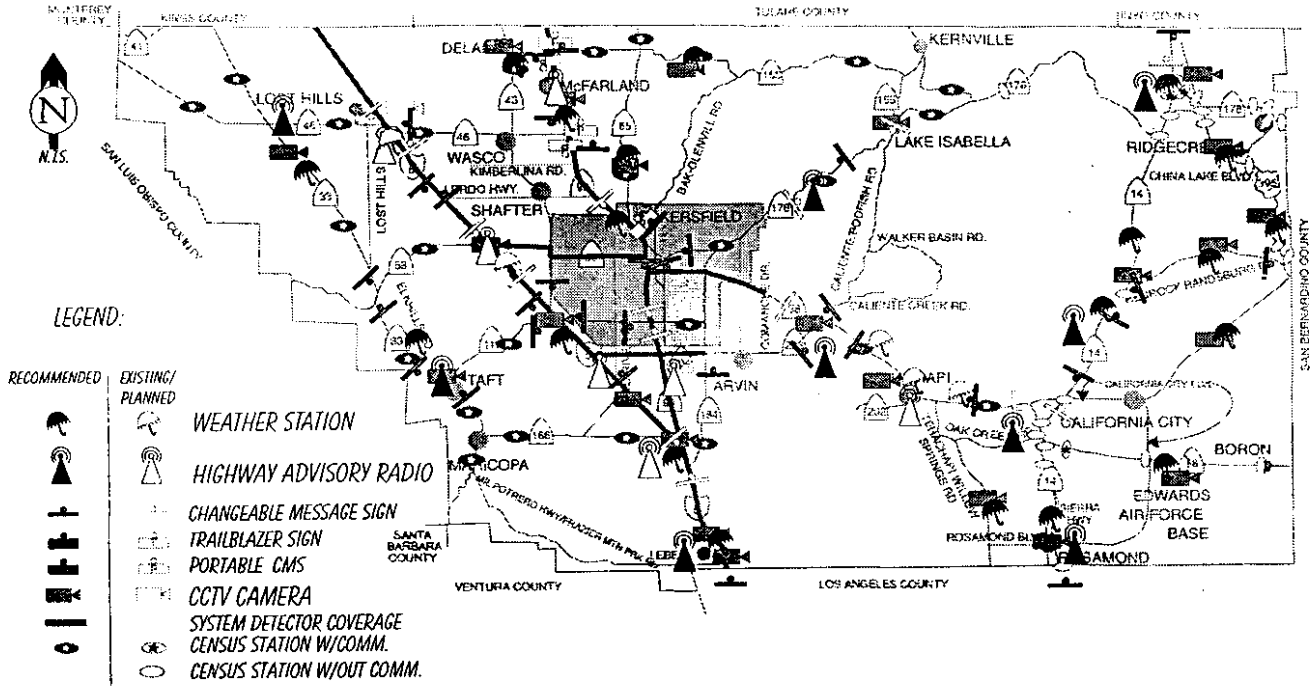


Figure 4 - Freeway Field Elements

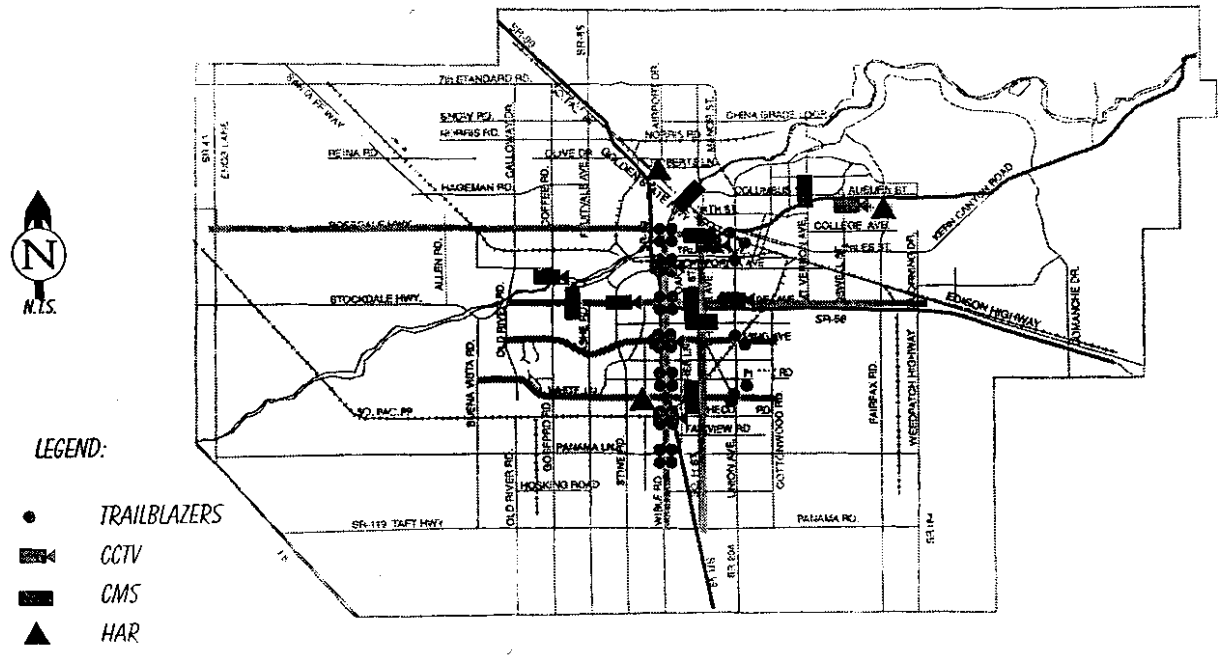


Figure 5 - Urban Smart Corridors

Kern Traveler Safety Program

The Kern Traveler Safety Program combines established, proven technologies with newer, less proven applications to provide Kern with an aggressive, "cutting edge" approach to safety. Problems vary from adverse weather conditions to red light violators (in both rural and urban settings). The following components encompass the Kern Traveler Safety Program:

Weather Stations

Weather stations, which combine a variety of technologies, coupled with CCTV cameras for verification (especially in rural areas), will provide an accurate picture of weather conditions region-wide in real-time. Available technologies include visibility sensors, precipitation intensity and type sensors, humidity/air temperature sensors, wind speed/direction sensors, and pressure transducer sensors to detect water levels in flood channels.

Extended coverage of weather stations for the entire Kern region is needed. Existing weather stations which are not within sight of the monitoring agency, should be outfitted with CCTV cameras for verification of weather conditions.

Photo Radar for Red Light Enforcement

At high accident intersections, photo enforcement systems will automatically record red-light violations. The system consists of a camera, communications with the traffic signal controller to determine when the light is red, and detectors to determine when a violation has occurred. The company which supplies the technology will also be responsible for retrieving the exposed film from the system, processing the film and issuing warnings or tickets to the violator depending on the issuing agency. The objective of the photo radar system is to improve public compliance (and therefore, safety) through behavioral modification. It is not a tool for raising revenues; an effective system will reduce the incidence of violations and in fact, decrease revenues.

RR Grade Crossing Technology

Photo enforcement can also be employed to improve railroad crossing safety. This strategy would reduce the number of vehicles which drive around the barrier arms. The same photo-enforcement systems described for red-light enforcement can be utilized at the RR grade crossings.

Video technology, placed at highway-rail intersections, relays a view of the intersection to the approaching train. This provides the train operator with the information necessary to make a decision as to whether or not the train needs to be stopped. This technology is helpful in instances where barriers are stuck in the raised position, or when a vehicle is stalled or broken down on the tracks. The driver of the train receives information early enough to make a determination while there is still enough distance to stop the train. This video technology should be deployed as a test project.

Road Closure Enforcement During Flooding

Installing automatic barriers on routes which experience annual flooding will enable County staff to efficiently close flooded roads from a remote location. CCTV cameras will be installed at these locations (with adequate weatherproof housings) to enable staff to visually confirm the flooding and roadway safety conditions remotely.

Several portable systems, involving static or automatic barriers and CCTV cameras should be developed for use in areas which experience less frequent flooding and for flooding in unpredictable locations. These systems will still require placement by maintenance staff, but, once in the field, will provide a valuable tool for confirmation of flooding status and roadway safety.

A potential additional module of this Kern Traveler Safety Program component is photo enforcement. Portable photo enforcement systems would be effective at reducing the number of vehicles which ignore the barriers. Initially the systems may be used to issue warnings, and eventually should issue tickets to violators. Since the photo enforcement systems are portable, one can be purchased and rotated among the locations with the most violations.

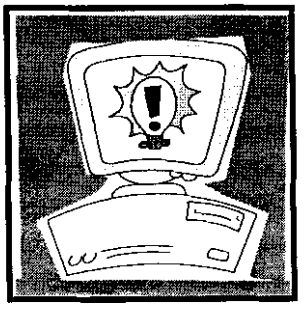
Smart Studs

Smart Studs are an upgrade of the traditional, reflective road studs used on most roads for delineating lanes. The Studs are solar powered and use a microprocessor for hazard sensing and processing. They can sense fog, blowing dust, surface water, ice, or any number of obstacles. The Studs will be used to provide weather warnings, lane guidance, and proximity warnings through colored, flashing lights within the reflectors. They will be mounted on the pavement (lane delineation) or on hazard posts (on shoulders). An operational test should be developed to initially outfit portions of I-5 with these reflectors. Eventually the program should be expanded to cover SR 99, SR 14, and SR 58.

Rockfall Detection System

The rockfall problems are isolated on a fifteen-mile stretch of SR 178. Video detection will be set up in the problem areas to detect the movement of the falling rocks. The information would be transmitted to the Kern County system for dispatching maintenance personnel to clear the road if necessary. CMS, either static or dynamic, placed on the roadway upstream from the rockfall system would enable traveler information system operators at the City of Bakersfield TOC to disseminate information to travelers. The southern three miles of the route is the most problematic area with respect to rockfalls. This three-mile stretch should be outfitted first, and eventually the system should be expanded to cover the entire fifteen miles.

Kern Informed Traveler Program (TravelKIT)



Making Kern travelers *informed* travelers, will reduce unnecessary accidents and congestion when advanced warnings are available. When adverse weather conditions prohibit safe travel on certain routes, or flooding makes segments of roadways unsafe, warranting closure of the segment, the best way to keep the transportation system working safely and efficiently is to get the information to travelers immediately. Prior knowledge of driving conditions allows travelers to select different routes, modes, or departure times. The base system, the ATIS, is described as the first component of the Kern Informed Traveler Program. The various dissemination media are subsequently described as individual components. The following components will work together to provide Kern with a safer, more efficient transportation system.

Development of an Advanced Traveler Information System (ATIS)

The ATIS will require a basic system for collecting, processing, and disseminating the information to the various components, which include two types of kiosks, a WWW site, workstations for transportation agencies, community access television (CATV), and an automated highway advisory telephone (HAT) system. **Figure 6** shows the ATIS with four basic subsystems, collection elements, and dissemination elements. The base system will need to be catered to Kern, in that it will need to collect information from the rural workstations (for rain, weather and manually input incident information), from the Caltrans TMCs, from the City of Bakersfield system, and from other sources. Since the City of Bakersfield TOC will (once built) be the only TOC in the immediate Kern region (others serving Kern are located in other counties), the ATIS should be located at the City of Bakersfield TOC.

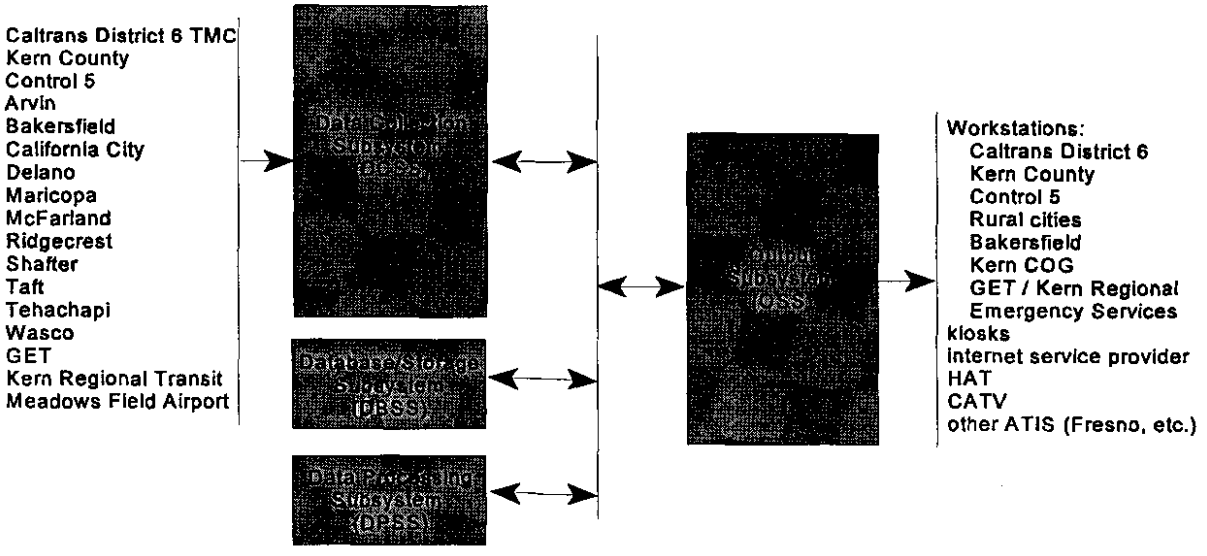


Figure 6 - General ATIS Diagram

Standard ATIS messages, as defined by the standardization efforts of the National Architecture, should be used in order to allow for coordination among jurisdictions throughout the region and the nation. Interfaces should also be provided for Value Added Resellers (VARs) in order to allow for full or partial privatization of the Kern Informed Traveler Program.

Workstations for Traveler Information

The physical communication links from the different agencies to the Kern ITS network (Bakersfield SONET) were described as a component of the Communication Network Development Program. Given that these links are established, each incorporated rural city should have a workstation connected with the ATIS. Workstations should also be developed for Caltrans District 6, Kern COG, the County of Kern, GET and Kern Regional Transit. The workstations should have the capability of not only retrieving information from field elements and from the ATIS server, but also sending information such as field element data from that area and operator inputs for information such as incidents, detours, etc., back to

the server. The workstations should be developed for all agencies involved in traffic and incident management and data collection including the following:

- Arvin
- Bakersfield
- California City
- Delano
- Maricopa
- McFarland
- Ridgecrest
- Shafter
- Taft
- Tehachapi
- Wasco
- Kern COG
- County of Kern
- Caltrans District 6
- GET
- Kern Regional Transit
- Control 5

Upgrade of Bakersfield TOC

In order to accommodate Kern ITS with the City of Bakersfield TOC acting as the regional TOC (particularly for traveler information) certain aspects and elements will require improvements. Spatial requirements will include additional racks for the ATIS server; a workstation for the traveler information system operator, including furniture; and all additional associated hardware, such as additional monitors. Future expansion plans of the TOC should consider region-wide ITS needs, especially the traveler information system, in addition to City of Bakersfield needs.

The upgrade can be achieved through one of the following alternatives:

- expanding the existing TOC if space is available
- moving the TOC to Control 5
- moving the TOC to the Superintendent of Schools building in downtown Bakersfield
- moving the TOC to a new, dedicated building at a site to be determined at a later date

Interactive and Commuter Kiosks

Placement of kiosks at major tourist attractions and traffic generators, would provide travelers with easy-to-access, real-time information and travel aids. This type of kiosk should be interactive, providing the inquiring traveler with the ability to choose which type of information is to be displayed. Equipment would include a touch-screen monitor, computer, modem and a cabinet which conceals and protects all but the touch-screen. Examples of information to be provided are:

- real-time weather and traffic information
- continuously updated road closure reports
- scheduled roadway maintenance and construction schedules
- transit schedules and real-time schedule adherence
- community events
- maps and trip planning program
- local points of interest
- traveler service listings such as hospitals, police stations, gas stations, etc.
- business yellow pages to offset program costs and provide local information

Placement of smaller kiosks at major business centers which only provide quickly-accessible, important information for familiar travelers such as real-time weather and traffic information (familiar commuters will be less likely to request tourist information) would allow for maximum information dissemination at a minimum cost. This type of kiosk would be non-interactive, and display only real-time traffic and weather information which would update automatically on a pre-timed basis. Equipment would include standard monitors and a single server located at the Bakersfield TOC (with the traveler information system) to display information on the remote monitors. Weather- and vandal-proof cabinets will be necessary as well. The capital cost per unit of this type of kiosk will average 1/5 of the cost of the "traditional" kiosks described above.

Live Video Feeds to the Media

Once CCTV cameras are in place throughout the region, live feeds of the video images to the media will be established. This component of the traveler information system will provide an "early start" opportunity for real-time information dissemination. This type of feed is valuable to the media, gets the information to the traveler, and helps to establish a positive public opinion of the CCTV cameras (and ITS in general) which, very often, are initially frowned upon by the community. Any video feeds originating from Caltrans will involve full-time, active monitoring by TMC operators as per the active policy regarding such feeds.

Community Access Television (CATV)

CATV is a medium which could broadcast real-time weather and traffic information into every home with access to cable television. The system will display real-time information (weather, traffic, etc.) in the form of a clear, concise map of the entire region. The system will be displayed during peak hours, or on a 24-hour basis. It is recommended that it be available 24-hours per day and that the system and channel be well-publicized to establish a user base. Live video can be included as well.

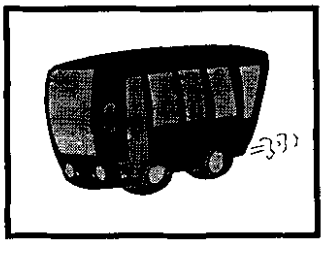
Highway Advisory Telephone (HAT)

Another component of the Kern Informed Traveler Program is to provide travelers with traffic information via a dedicated Highway Advisory Telephone (HAT) number. Similar information to the HAR messages will be accessible over the phone (though the information will not be localized as with HAR). The dial-in number should be well-publicized and the messages (recordings) should be made clear and concise.

WWW Site

A World Wide Web (WWW) site for the Kern region will be developed which is linked with other sites which provide similar information, such as Caltrans, Fresno and other central valley sites, southern California sites, and the I-40/SR 58 sites.

Kern Smart Transit Program



Advanced technologies will make transit systems "smarter" by providing increased flexibility, reliability, and efficiency. The overall objective of the Kern Smart Transit program is to increase transit's share of the commuting market by providing an alternative mode to automobiles which is flexible, convenient, and responsive to customer demand. The success of such a program will offer a range of benefits to commuters including reduced travel times, improved air

quality, cost savings, and increased mobility. The combination of the following strategies into a cohesive, region-wide program will maximize the operational efficiency of the transit throughout Kern and allow the agencies to better serve the needs of the communities through extended hours of operations, weekend operations, and reduced headways. The Kern Smart Transit program consists of three main components.

Upgrade of the Golden Empire Transit (GET) and Kern Regional Transit systems

Transit system upgrades will involve the installation of Automatic Vehicle Location (AVL) on the transit vehicles. Dispatching centers will require upgrades varying from changes to the control room layout to computer hardware to racks for housing new equipment. AVL provides the transit agency dispatcher with the capability of monitoring the location of all fixed route and demand responsive vehicles in real-time. The AVL will be integrated with digital communications to and from the vehicles and a GIS mapping system. Instructions from the dispatcher, regarding schedule corrections, will be sent directly to the vehicle. The AVL should be provided through Global Positioning System (GPS) technology.

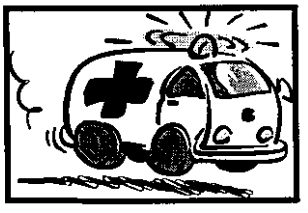
Kern Smart Shuttles

The Kern Smart Shuttle is a demand responsive service which incorporates vehicle-based and dispatching technologies to achieve more effective vehicle and fleet planning, scheduling and operations. AVL will be required for the Smart Shuttles. Computerized Scheduling and Dispatching will automate the reservation process, improve the efficiency of trip assignments, allow for the accommodation of immediate service requests, and provide real-time information for maintaining schedule integrity and rectifying schedule delays. Trips are requested by users via telephone or internet and vehicle assignment, routing and schedule are automatically generated and dispatched to the driver, based on vehicle location, the number of passengers, etc.

Coordination of GET and Kern Regional Transit Schedules

The communication link between GET and Kern Regional Transit, established as a component of the Communication Network Development Program, will enable the two agencies to communicate with each other through a distributed communication network as shown previously in **Figure 3**. Integrating the scheduling efforts of the two agencies will enable the two transit systems to be coordinated. In other words, just as within a single agency, routes for both agencies will be coordinated and optimized with respect to transfers between the two systems.

Enhanced Emergency Response Program



A multitude of agencies throughout the region provide emergency services to the general public. Whether the agency is responding to an incident related to transportation or something else, the vehicle and driver would benefit greatly from knowing which routes to take in order for responses to be timely. The Enhanced Emergency Response Program improves the safety of the surface transportation system as well as that of the general public, by providing police, sheriff, fire, ambulance, and other service providers with the tools to help them determine quickly and accurately which routes will be fastest. The components of the Enhanced Emergency Response Program are as follows.

Workstations for Emergency Response Providers

One component of the Kern Informed Traveler program provides emergency service providers located at Control 5 with workstations for traveler information. This component of the enhanced emergency response program recommends allowing any other emergency service providers in the region to obtain workstations as well. Communication links to the Kern ITS network will be required for those agencies which choose to incorporate real-time traveler information into their dispatch centers. The workstations should also allow the emergency service providers to input information regarding incidents or hazards.

Emergency Corridor Routes (Signal Pre-emption)

Primary emergency corridor routes should be established with signal pre-emption capabilities for emergency vehicles. The three candidate corridors recommended for upgrade to primary emergency corridors through enhanced pre-emption are:

- Stine Road/California Avenue
- H Street
- Brundage Lane

Budgets/Implementation Plan

The estimated budgets for the recommended Kern ITS programs are summarized in **Table 2.** Estimates were developed based on discussions with vendors, through literature review, and by referencing historical cost data for similar projects. The latter method was used only as a starting point as technology costs have decreased substantially in recent years.

Table 2 - Summary of Program Costs

	Project Description	Initial Capital Cost (in thousands)	Annual Recurring Cost (in thousands)
Communication Network Development Program			
	Communication Links with Bakersfield SONET Network	$ 6,500	$ 325
	Smart Call Boxes for Communication	(1)	
	Links to Other Regions	(2)	
Traffic and Incident Management Program			
	Census Stations, System Detectors and Incident Detection	$ 2,250	$ 112.5
	Decision Support System (DSS) Shared among All Agencies	$ 500	$ 0
	Coordinated Incident Management Procedures	$ 50	$ 0
	Urban Smart Corridors	$ 1,917	$ 174
	Freeway Field Elements	$ 4,980	$ 300
Kern Traveler Safety Program			
	Weather Stations	$ 2,000	$ 20
	Photo Radar for Red Light Enforcement	$ 600	$ 0
	RR Grade Crossing Technology	$ 600	$ 0
	Road Closure Enforcement during Flooding	$ 1,000	$ 50
	Smart Studs	$ 2,500	(3)
	Rockfall Detection System	$ 300	$ 15
Kern Informed Traveler Program		$ 4,000	$ 200
Transit Operation Program			
	Upgrade of GET and Kern Regional Transit Systems	$ 1,000	$ 100
	Demand Responsive Service for GET (Kern Smart Shuttles)	$ 750	$ 0
	Coordination of GET and Kern Regional Transit Schedules	$ 200	$ 10
Enhanced Emergency Response Program			
	Traveler Information Workstations for Emergency Response Providers	(4)	na
	Establishment of Emergency Corridor Routes	$ 500	$ 0
TOTALS		**$ 29,647**	**$ 1,307**

(1) Smart Call Boxes will be used for communication between the TMC and field devices, costs are included with each field device.
(2) Costs will be determined as projects are designed in the future.
(3) Cumulative operations and maintenance costs will be estimated during design.
(4) Each workstation will cost approximately $10,000. Each provider will fund the requested workstations.

A summary of the Implementation Plan for the recommended Kern ITS programs is provided in **Figure 7**. Factors such as funding availability will influence the magnitude, prioritization, and timing of projects as they are defined in this report. The key to successful phased implementation is to mix and match projects relative to each time period, thereby providing the capability to adjust to changing market trends and future needs. In this sense, the implementation plan should be used as a guide to developing the specific plans for each recommended project.

The six Kern ITS programs described thus far are scheduled for early deployment over the next ten years. Commercial Vehicle Operations was addressed in the earlier stages of the planning process, and there were noted issues related to large volumes of commercial vehicles on the freeway system throughout the region. In the process of prioritizing needs, issues, benefits, and solutions, however, CVO did not rate as a high enough priority to warrant inclusion into the ten-year plan for early ITS deployment. CVO will be an issue for the future (beyond ten years), and will be readdressed in future updates of this strategic plan.

Kern Funding and Project Management Strategy

Table 3 describes a strategy by which Kern can obtain adequate funding to implement ITS over the next ten years as described in the following section.

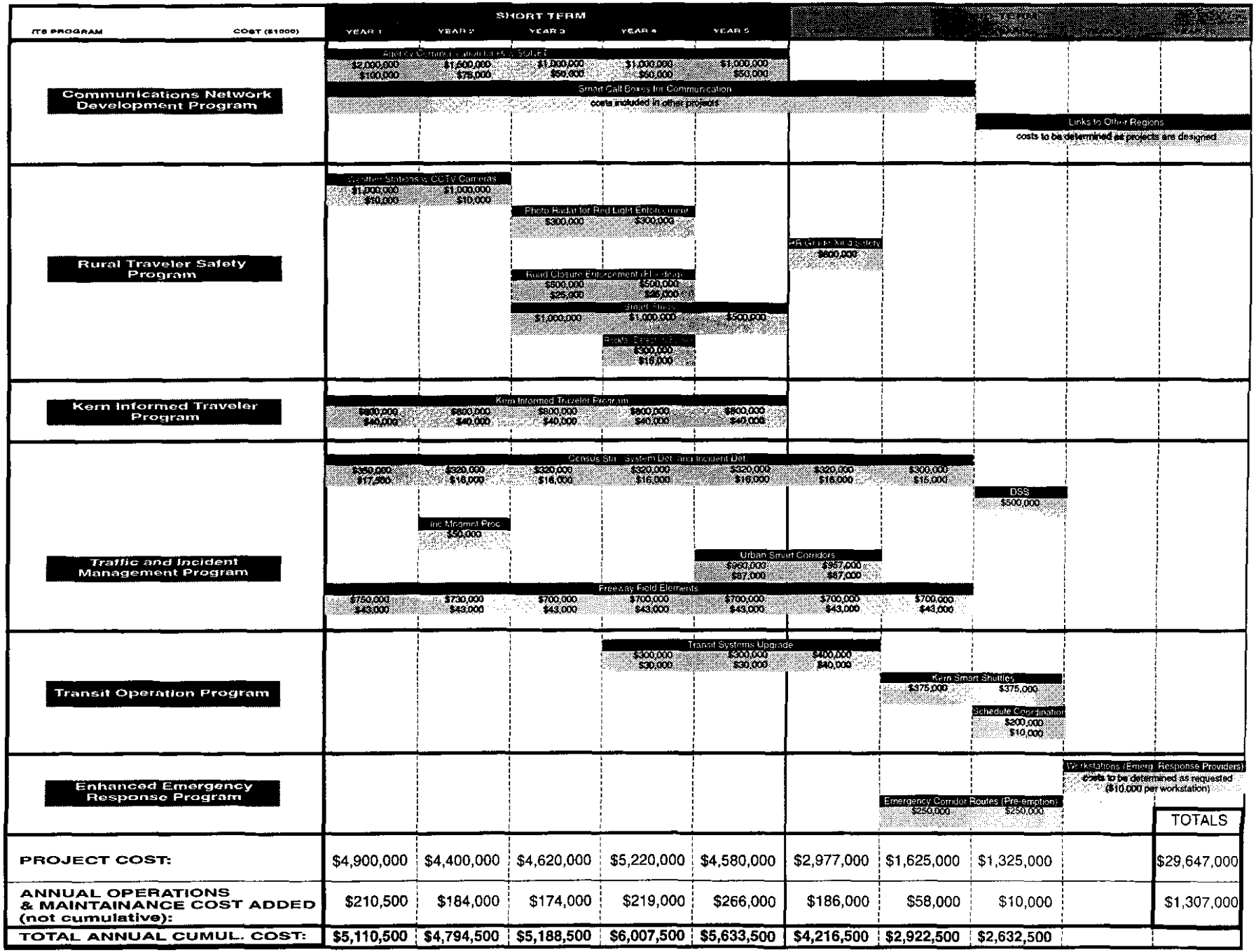
Table 3 - Kern Funding Strategy

Funding Source	Potential Funding for Kern Region
NEXTEA	
• CMAQ	$ 3 - 4 million/year
• ITI	$ 1 million/year
TSM	$ 0.2 - 0.8 million/year
Public/Private Partnerships	varies

The programs presented for implementation in Kern were organized to be consistent with inclusion into the Regional Transportation Plan (RTP) for Kern. Kern COG will incorporate projects as part of the 1998 revision of the RTP.

Program management of local projects will be provided by the corresponding local jurisdiction wherein the project is located. Regional projects, such as the Kern Informed Traveler Program will ultimately be managed by Kern COG or a delegate of the COG (e.g. the City of Bakersfield may serve as the lead agency on this project since it will be co-located with the TOC).

Kern ITS Early Deployment Plan



									TOTALS
PROJECT COST:	$4,900,000	$4,400,000	$4,620,000	$5,220,000	$4,580,000	$2,977,000	$1,625,000	$1,325,000	$29,647,000
ANNUAL OPERATIONS & MAINTAINANCE COST ADDED (not cumulative):	$210,500	$184,000	$174,000	$219,000	$266,000	$186,000	$58,000	$10,000	$1,307,000
TOTAL ANNUAL CUMUL. COST:	**$5,110,500**	**$4,794,500**	**$5,188,500**	**$6,007,500**	**$5,633,500**	**$4,216,500**	**$2,922,500**	**$2,632,500**	

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Figure 7 - Implementation Plan

ITS Benefits

Over the past decade, deployment of ITS in the United States has resulted in substantial, quantifiable benefits. Several measured benefits of ITS in different areas of the country are summarized in **Table 4** to demonstrate the potential for improvements in Kern.

Table 4 - Examples of ITS Benefits Compiled by the FHWA[2]

Freeway Management	Reduced accidents by 15% - 62% while handling 8% - 22% more traffic at 16% - 62% greater speeds compared to pre-existing congested conditions (quantified benefit coming mostly through the use of ramp metering).
Incident Management	By providing video feeds from the field into a Traffic Management Center, the responding towing concession yielded a clearance reduction of 5 - 8 minutes.
Traffic Signal Control	The implementation of a transit signal priority system yielded a 5% - 8% decrease in transit run times.
Transit Management	On-time performance yielded improvements of 12% - 28% while reducing costs to generate a positive return on investment in as little as three years.
Signal Coordination	Traffic signal coordination has resulted in an average of 20% reduction in travel times in various locations throughout California.

[2] FHWA-JPO-96-008, *Intelligent Transportation Infrastructure Benefits: Expected and Experienced*