

CALIFORNIA DEPARTMENT OF TRANSPORTATION

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2011  
RAMP METERING  
ANNUAL REPORT

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**District 7**  
**Los Angeles and Ventura Counties**



Ramp Metering



Connector Metering

**STATE OF CALIFORNIA**  
**Governor Edmund G. Brown Jr.**

**BUSINESS, TRANSPORTATION AND HOUSING AGENCY**  
**Secretary Traci Stevens**

**DEPARTMENT OF TRANSPORTATION**  
**Director Malcolm Dougherty**



**DIVISION OF OPERATIONS**  
**Office Of Freeway Operations**  
**Ramp Metering Branch**



**2011**

**RAMP METERING ANNUAL REPORT**

**DEPARTMENT OF TRANSPORTATION  
DISTRICT 7**

**Los Angeles and Ventura Counties**

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# 2011 RAMP METERING ANNUAL REPORT

## District 7

The 2011 Ramp Metering Annual Report has been prepared by the District 7 Office of Freeway Operations Ramp Metering Branch. The information in this report encompasses all of the work performed by the Ramp Metering Branch on the metered ramps and connectors in Los Angeles and Ventura Counties.

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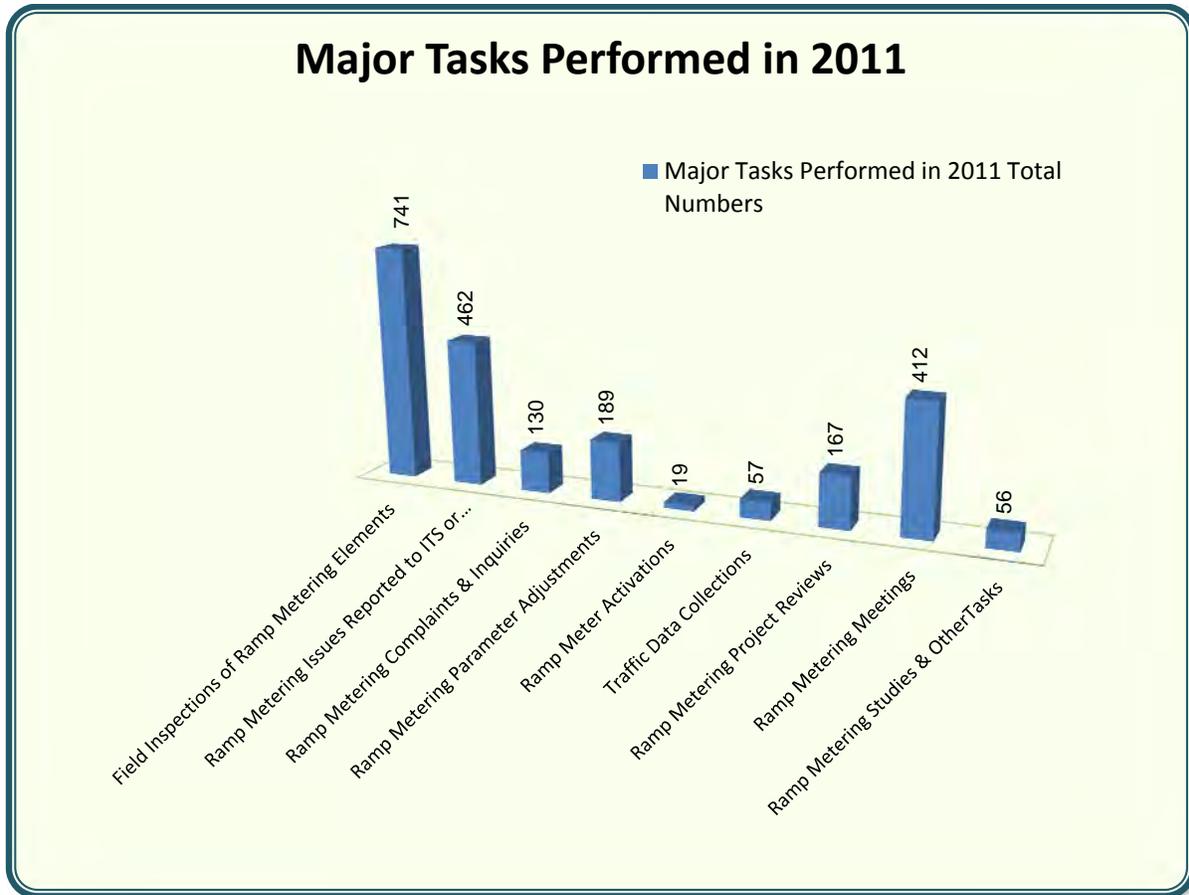
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## I. EXECUTIVE SUMMARY

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Caltrans District 7 Ramp Metering Annual Report highlights the major tasks performed and documents the accomplishments achieved by the Ramp Metering Branch during the 2011 calendar year in Los Angeles and Ventura Counties.

Some of the major tasks performed by the Ramp Metering Branch include:



The remaining responsibilities of the Ramp Metering Branch were to:

- Perform traffic engineering analyses at various ramps and connectors,
- Review and update Ramp Metering Design Manual (RMDM),
- Develop and implement statewide performance measures,
- Perform traffic engineering analyses to convert various existing ramp HOV bypass lanes to metered HOV or mix flow lanes,
- Review and update the Ramp Metering Development Plan (RMDP),
- Universal Ramp Metering System (URMS), and
- Assist in Developing District Traffic Management Plan during Design and Construction Stage.

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## II. RAMP METERING BRANCH TASKS

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Some tasks performed by the District 7 Ramp Metering Branch are routine while others are special projects. Furthermore, some tasks were performed in 2011 as well as continually while other tasks are performed as needed. These major tasks were divided into work categories as follows:

### A. SURVEILLANCE AND MONITORING OF RAMP METERING OPERATION

(Refer to pages 3 to 11):

1. Field Inspections of Ramp Meter Elements (Chart 1)
2. Ramp Metering Issues Reported to ITS or Electrical Maintenance (Chart 2)
3. Ramp Metering Complaints & Inquiries (Chart 3)
4. Ramp Meter Parameter Adjustments (Chart 4)
5. Ramp Meter Activations (Chart 5)
6. Traffic Data Collections (Chart 6)
7. Ramp Metering Project Reviews (Chart 7)
8. Ramp Metering Meetings (Chart 8)
9. Ramp Metering Studies and Other Tasks (Chart 9)

### B. RAMP METER TRAFFIC DATA COLLECTION

### C. CAPITAL PROJECT REVIEW

### D. PERMIT PROJECT REVIEW

### E. RAMP METER DEVELOPMENT PLAN (RMDP)

### F. UNIVERSAL RAMP METERING SYSTEM (URMS)

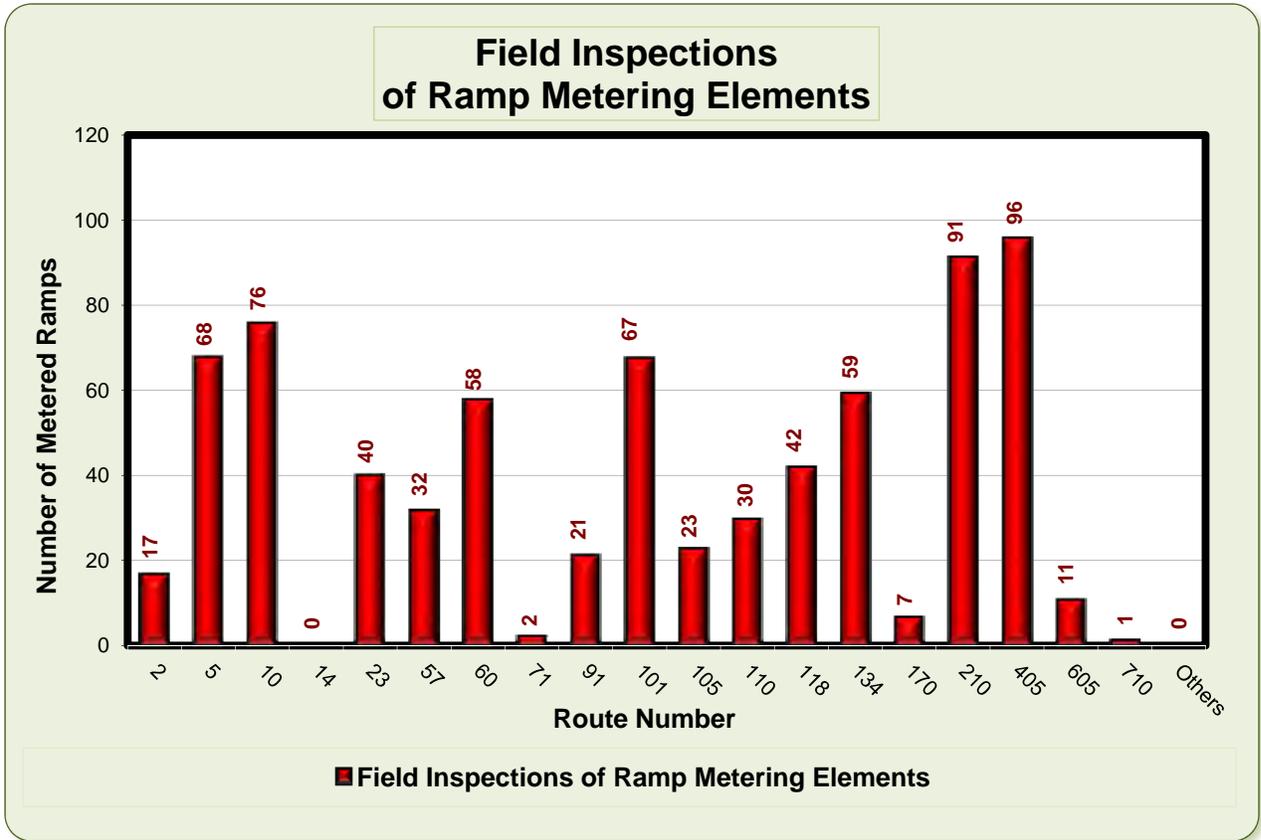
### G. STAGGERED METERING

### H. TRAFFIC MANAGEMENT PLAN

The following sections summarize in depth the amount of work performed for each of these categories. All data included in the sections below was obtained from Weekly Ramp Meter Reports filed by all Ramp Metering Engineers.

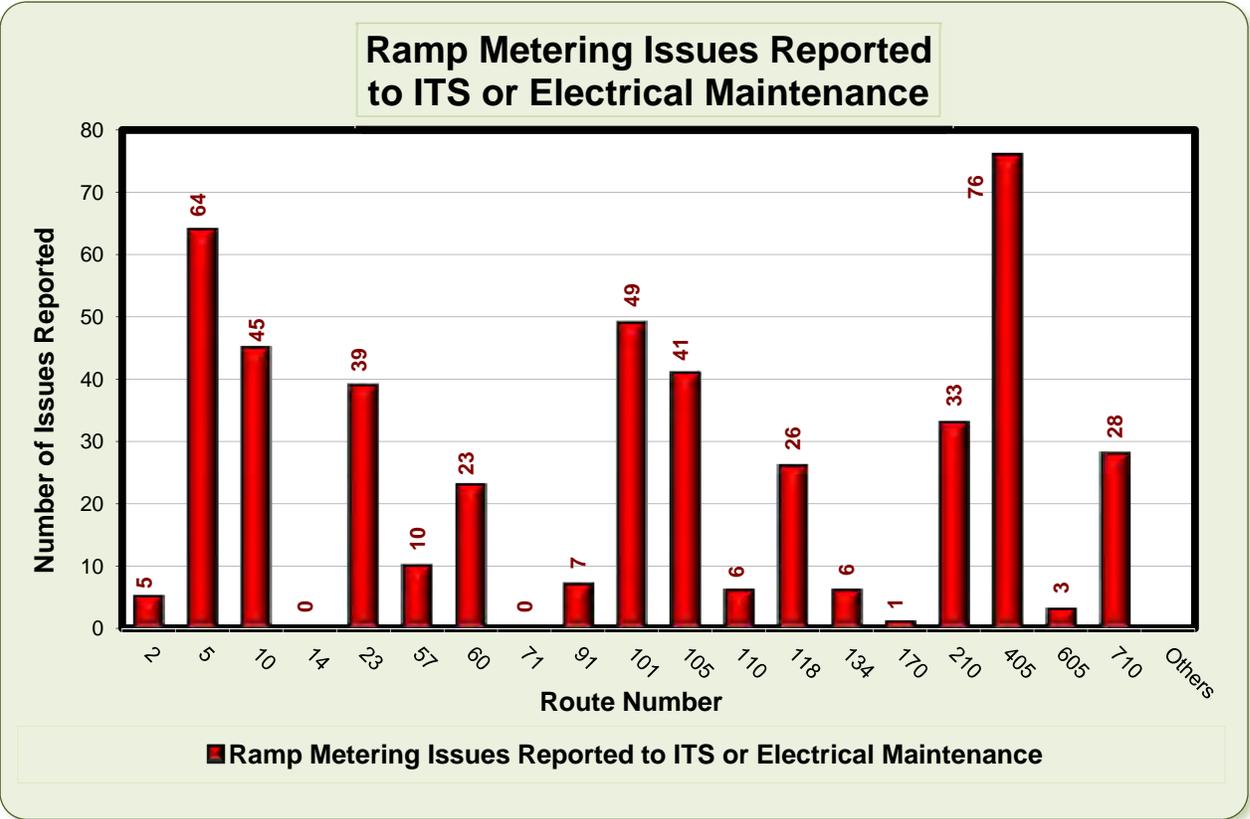
### A. SURVEILLANCE AND MONITORING OF RAMP METERING OPERATION

Currently, District 7 has 999 metered on-ramps and 28 freeway to freeway connector meters, making it the largest ramp metering district in Caltrans. The Ramp Metering Branch periodically performs field surveillance and corrects minor software and hardware problems associated with the metering operation. Staff observed traffic backups on the ramp, verify appropriate metering rates and check for any malfunctions with signal lights or advanced warning signs. If the ramp meter is off during metering hours, the controller software program and cabinet hardware will be checked in order to diagnose the problem; minor issues will be corrected, while major problems are reported to Electrical Maintenance or ITS Branch for repairs.



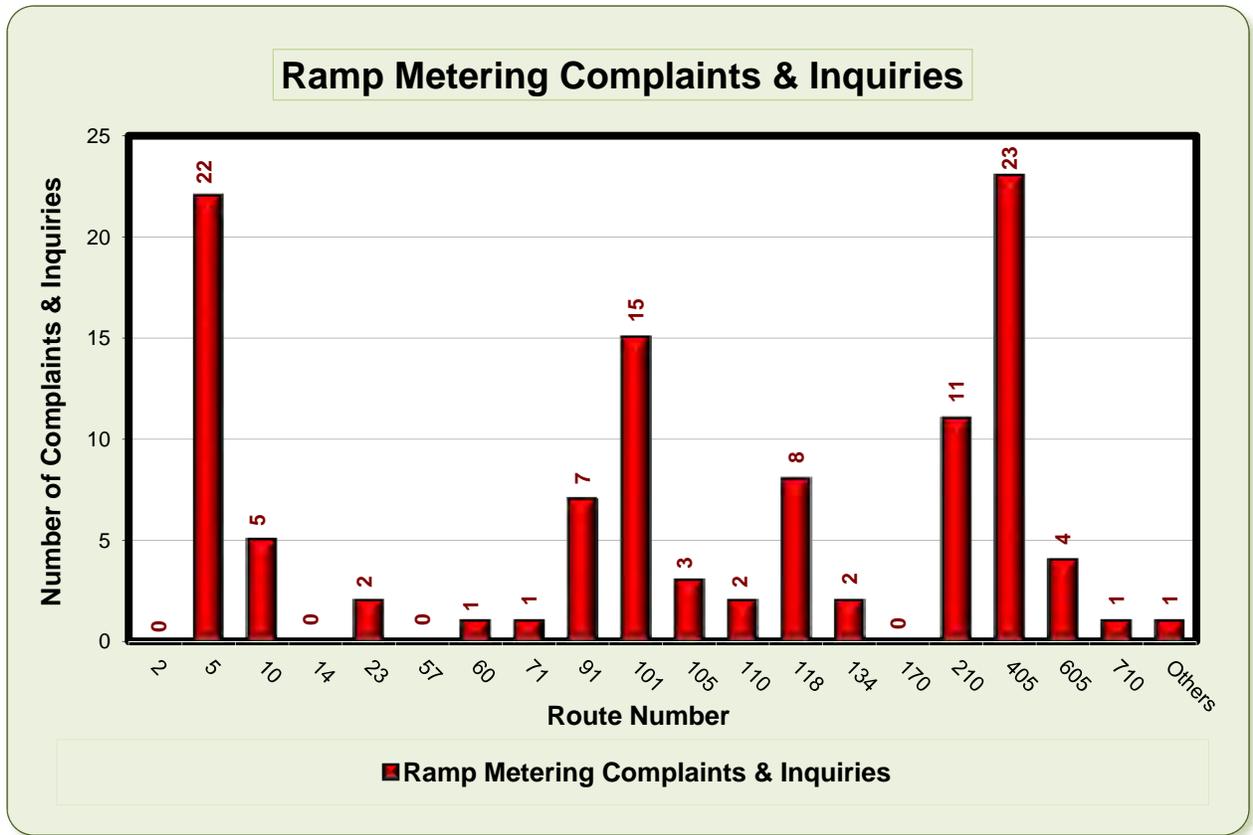
**Chart 1**

During 2011, the Ramp Metering Branch had performed numerous field inspections of Ramp Metering elements. The reasons for checking these controllers varied from simply verifying the operations of the ramp meter to performing corrections or updates to the programmed software, and in some cases, resetting or replacing controller hardware. This may involve reopening the ramp meter controllers numerous times to solve recurring problems.



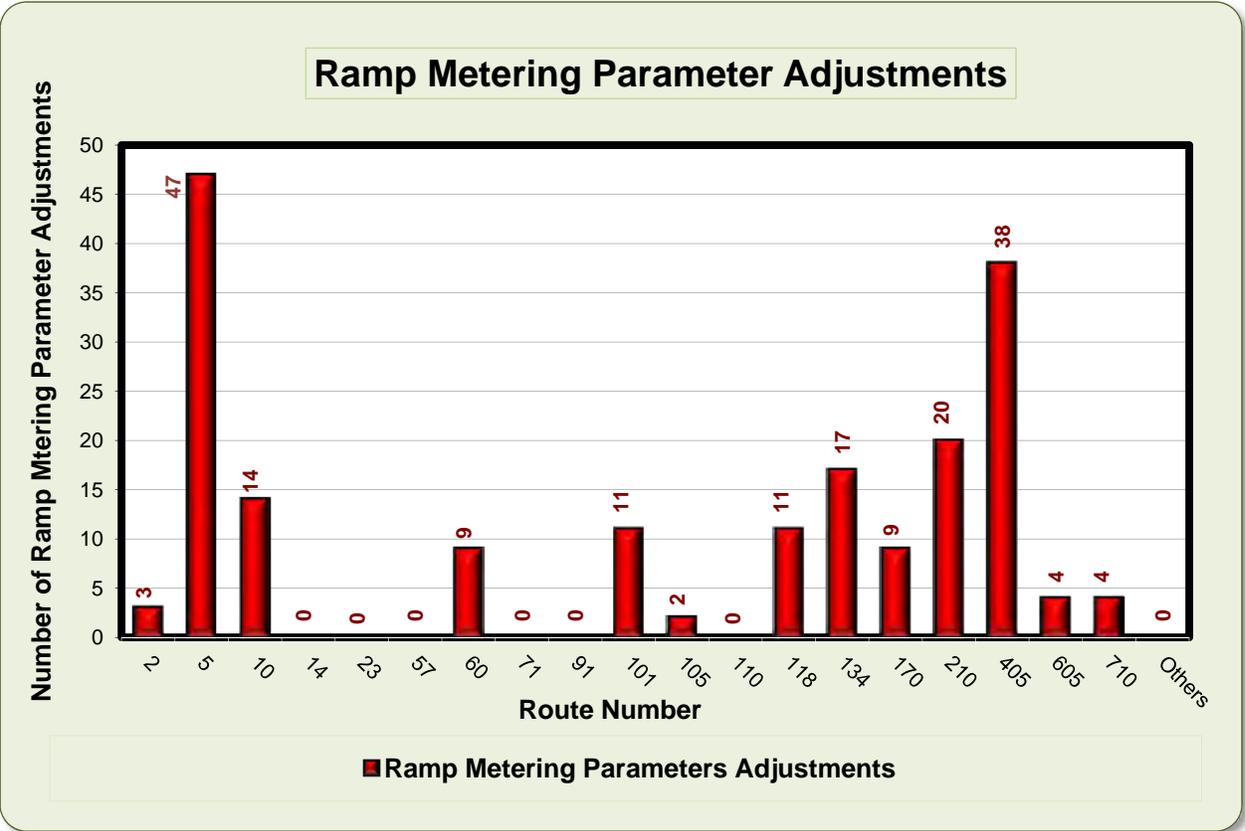
**Chart 2**

In 2011, the Ramp Metering Branch had reported numerous issues to ITS or Electrical Maintenance.



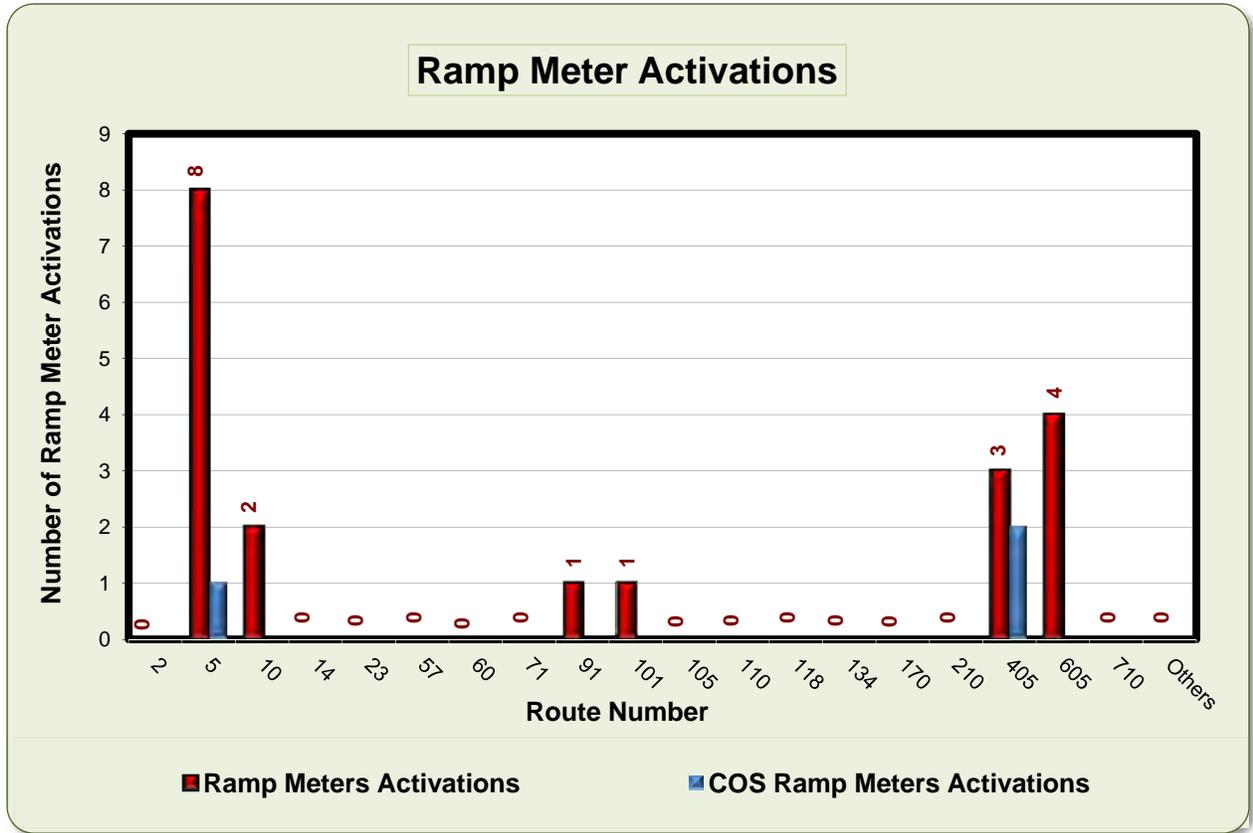
**Chart 3**

The Ramp Metering Branch had received numerous complaints and inquiries in 2011.



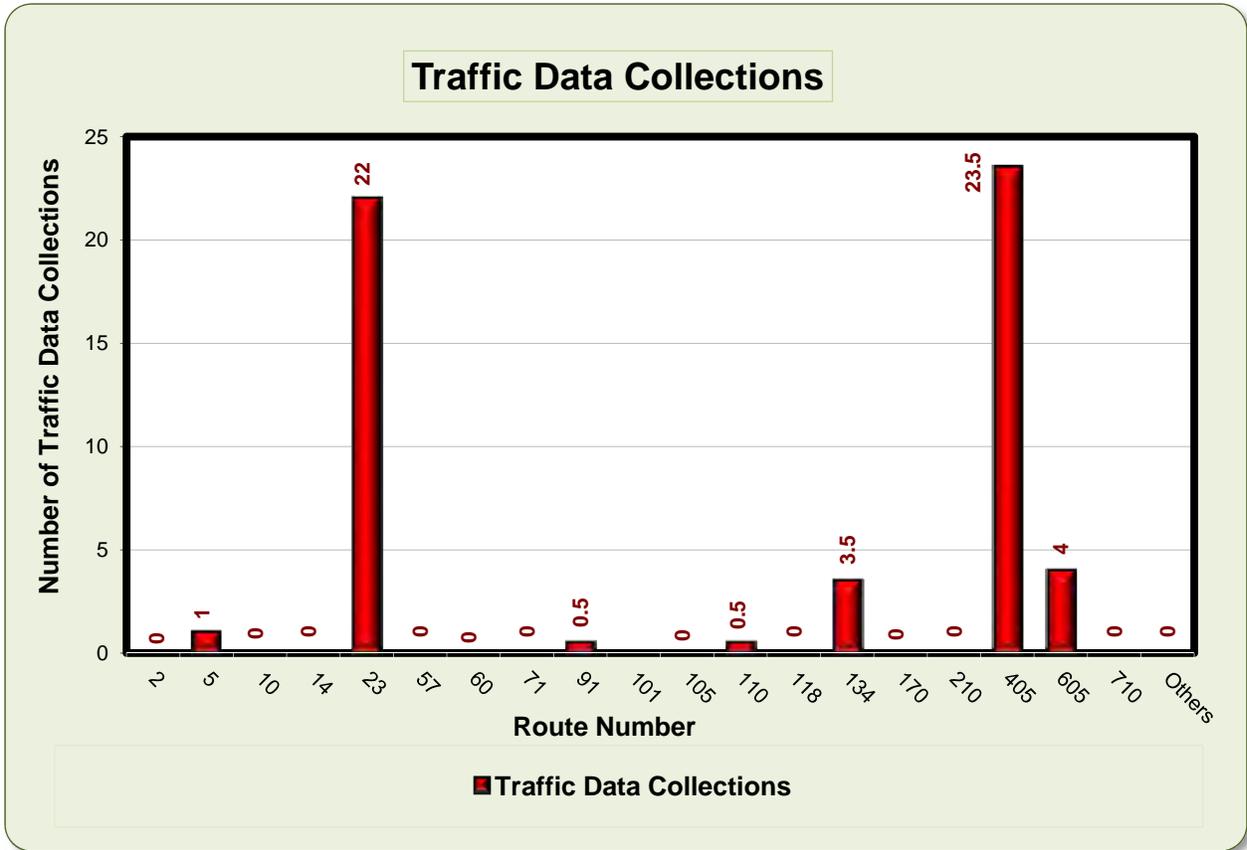
**Chart 4**

The Ramp Metering Branch had modified numerous ramp metering software parameters in 2011.



**Chart 5**

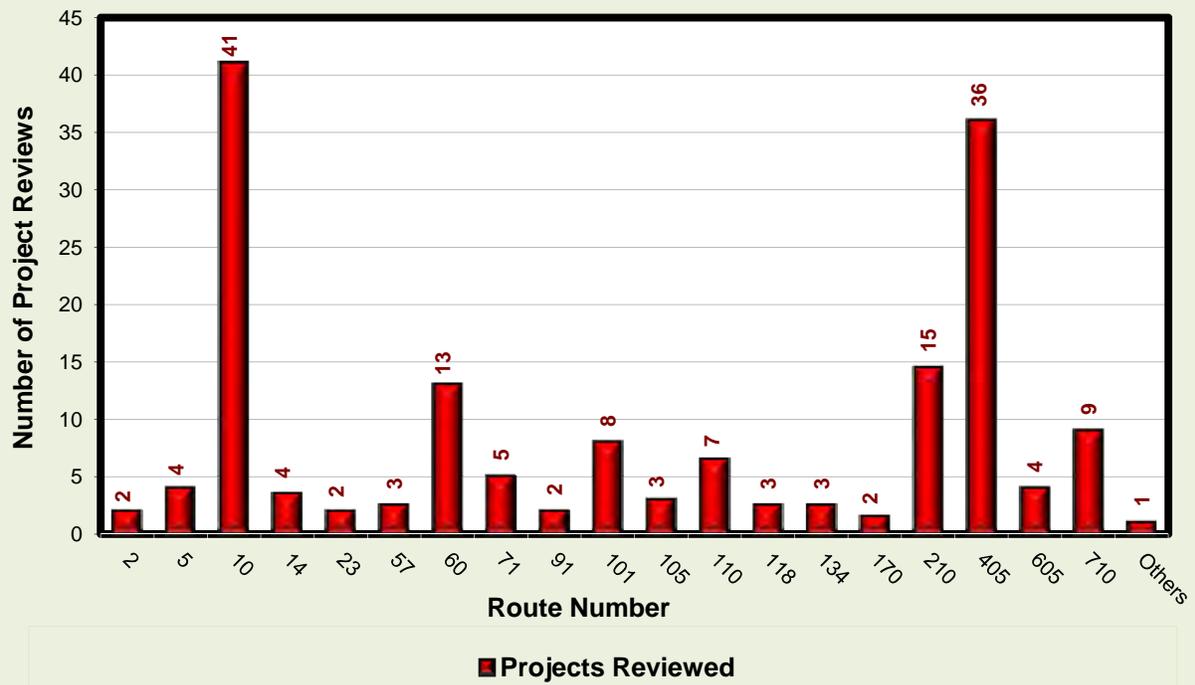
The Ramp Metering Branch had performed numerous ramp meter activations in 2011.



**Chart 6**

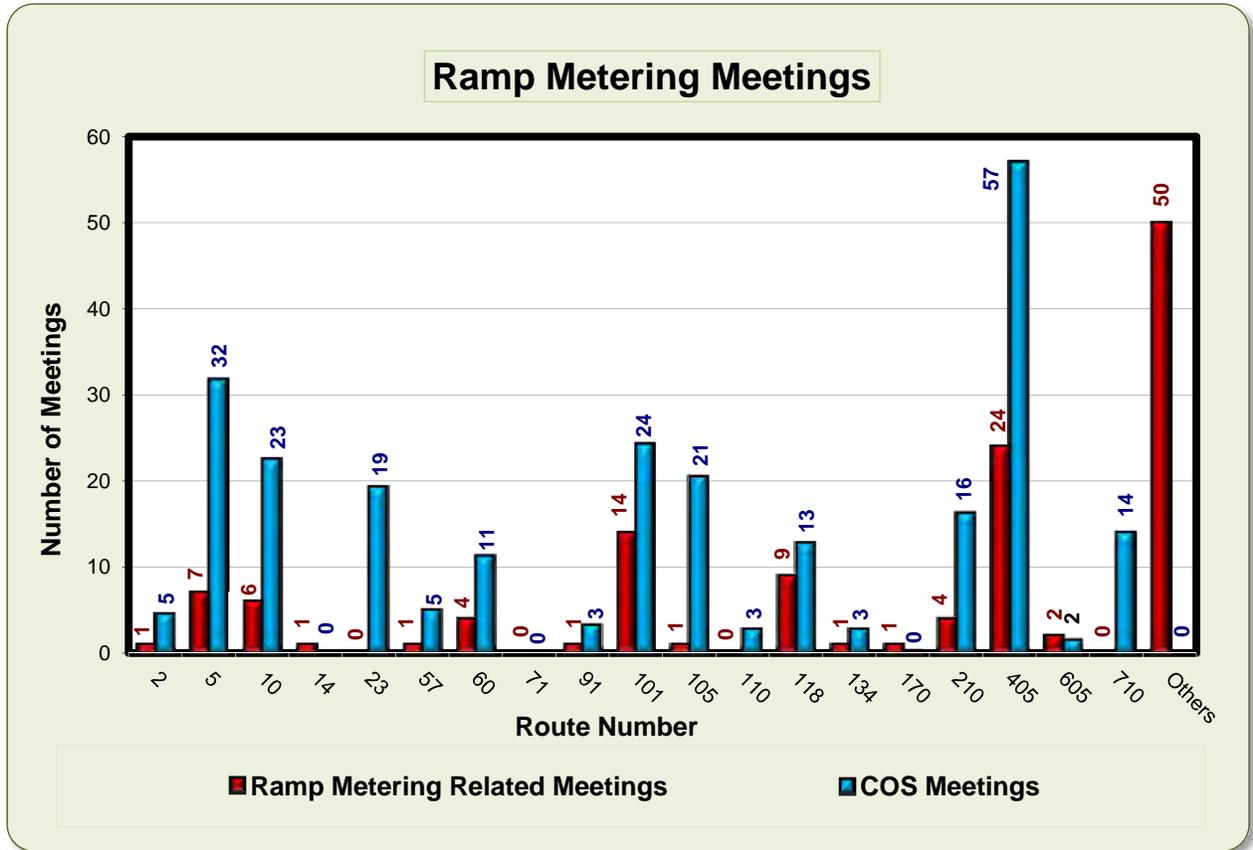
In 2011, the Ramp Metering Branch had performed numerous traffic data collections. The Ramp Metering Branch provided traffic data, which may include manual queue and demand data collections, ATMS generated reports, and various other data to various District 7 Offices, Public Agencies, and the general public.

### Ramp Metering Project Reviews



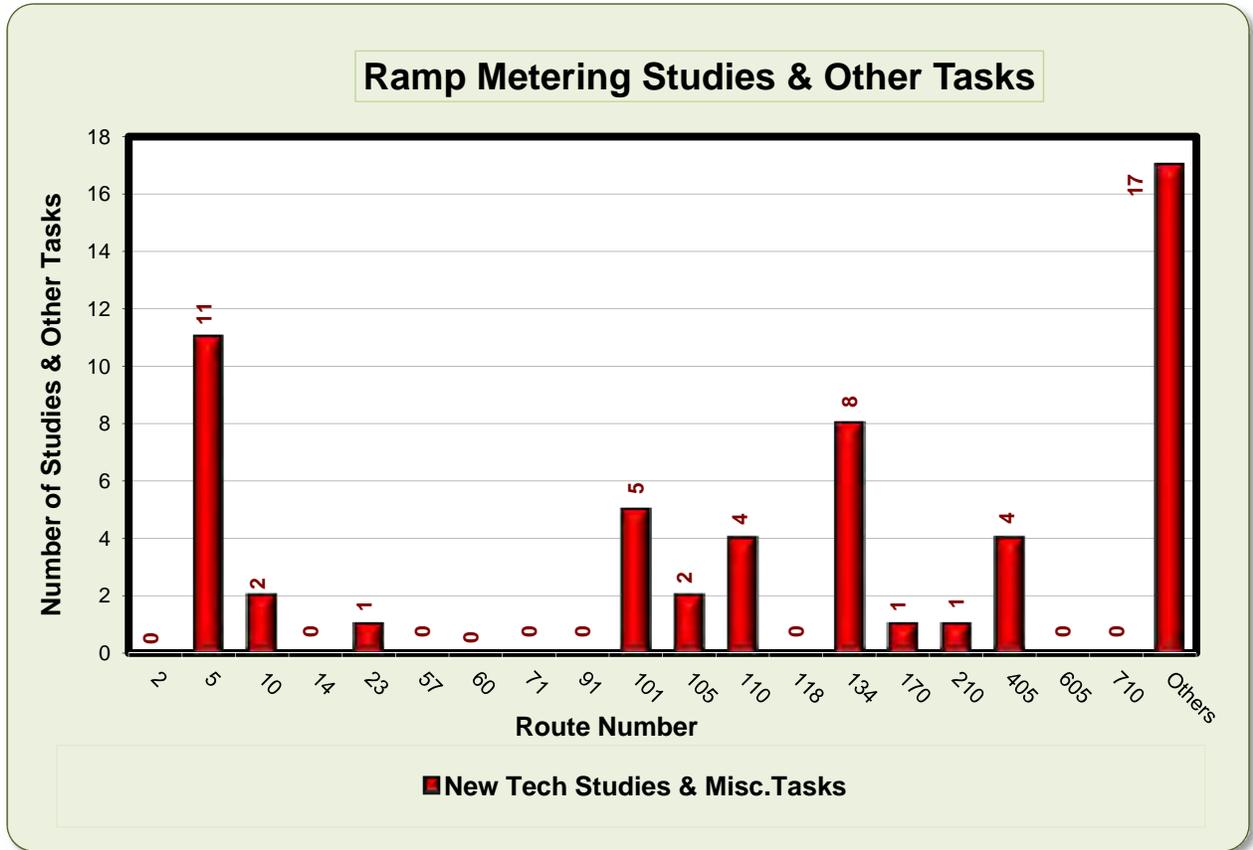
**Chart 7**

The Ramp Metering Branch had reviewed numerous projects in different stages of design and construction in 2011. This may include reviewing the same projects at 35%, 65%, 95% and 100% submittals.



**Chart 8**

The Ramp Metering Branch had attended numerous ramp metering related meetings and COS project meetings.



**Chart 9**

The Ramp Metering Branch had performed numerous ramp metering operation related studies and other tasks in 2011.

## B. RAMP METER TRAFFIC DATA COLLECTION

There are three types of traffic data collections conducted by the Ramp Metering Branch:

1. Queue and Demand (Q & D)
2. High Occupancy Vehicle (HOV)
3. Violation Rates

"Queue and Demand" traffic data collection are performed to study the operation of metered ramps, which include time and extent of traffic backup (Queue) due to ramp metering. In addition to measuring the peak and total traffic demand at the ramp, the types of vehicles using the ramp are also recorded.

Queue and Demand information helps to implement an effective ramp metering strategy. Metering rates are implemented according to type and volume of traffic demand at the on-ramp in relation to mainline traffic conditions, and to the traffic queued up behind the meter.

"HOV" traffic data collection is conducted at metered on-ramps with an HOV lane. The purpose of this data collection is to determine time intervals, types of vehicles (truck, buses, and motorcycles), peak and total HOV traffic demand, vehicle occupancy (2, 3 ...persons per vehicle). The percentage of usage of the HOV lane, in relation to the metered mix-flow lane, is calculated with this information. In addition, the number of HOV lane violations is recorded. If the violation rate is determined to be high, this information is forwarded to the California Highway Patrol for enforcement.

These three types of traffic data collection should be conducted, on a yearly basis at all active ramp meter locations. However, due to time constraints and limited resource allocations, these traffic data collection activities are currently performed as a result of public complaints, upcoming projects and developments impacting the operation of the ramp meter. See Chart 6 for detail. Thus, if a public complaint related to excessive back-up on the ramp is received, a field review and a "Q and D" data collection might be conducted to properly investigate the problem and adjust the metering rate if needed. In addition, if a project to construct a new ramp or modify an existing one is being proposed, then a traffic data collection will be conducted, in order to assist in the new design. On-ramp traffic data collections might also be conducted during major studies or large-scale projects such as the Route 5 Widening and HOV project.

## C. CAPITAL PROJECT REVIEW

The Ramp Metering Branch reviews numerous projects and gets involved in ramp meter related issues, during the following stages of a project (see Chart 7):

1. PID (Project Initiation Document)
2. PSR (Project Study Report)
3. PR (Project Report)

4. All stages of PS&E (Plans, Specifications and Estimate)

In addition, the Ramp Metering engineers also keep track of the project's progress throughout the construction stage.

**D. PERMIT PROJECT REVIEW**

The Ramp Metering engineers review and comment on ramp meter related issues involved in permit projects, and oversight projects, which are usually prepared by consultants on behalf of local cities, counties or other agencies.

**E. RAMP METER DEVELOPMENT PLAN (RMDP)**

The first 10-year RMDP report was completed in 1997 and was due to be updated by 2008. However, an updated RMDP report was initiated in 2004 and published in July of 2005. This 10-year report contained an inventory of all on-ramps (metered and non-metered), metered connectors, in addition to a listing of on-ramps proposed or funded to be metered, within the next 10 years. The last District 7 RMDP was published in January of 2009. For detailed information, please refer to REFERENCES, Item No. 2.

**F. UNIVERSAL RAMP METERING SYSTEM (URMS)**

Caltrans strives to unify the ramp metering operating software systems to minimize the operations and maintenance costs. A software package, called Universal Ramp Metering System (URMS), was therefore developed and is currently being evaluated statewide. URMS is deemed the future of ramp metering operations software.

District 7 has been successfully implementing the URMS at 2 on-ramp locations (San Rafael to WB Rte 134 and Holy to NB Rte 2). In addition, over 20 URMS will be installed at all ramp meter locations along Rte 405, between Rte 10 and Rte 101, as part Rte 405 HOV project, EA 120303. Currently efforts are being made to incorporate the URMS, operating on the 2070 controller hardware, with the ATMS software so that remote integration between the field and the TMC could be achieved.

**G. STAGGERED METERING**

In June of 2011, District 7 for the first time implemented staggered metering operation at Harvey Ave to WB Rte 134. The hardware at this on-ramp was upgraded to accommodate such application. The upper and lower ramp meter signals, at both sides of the ramp, were changed to 3 section 12 inch heads and the 170 controller using SATMS was changed to 2070 controller running the URMS software.

## H. TRAFFIC MANAGEMENT PLAN

Every now and then, the Ramp Metering Branch provides assistance with the Traffic Management Plan during the design and construction stages. In 2011, the Ramp Metering Branch had assisted with the highly publicized LA-405 Carmageddon Freeway Closure Project.

# **APPENDIX**

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## III. DISTRICT 7 RAMP METERING HISTORY

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Old LATMC

In 1965, the Freeway Operations Department, as it was called, was created in District 7 to locate, analyze and solve operational deficiencies on the existing freeway system. The first experimentation with ramp metering in District 7 occurred on the Labor Day weekend in the midst of 1960's on the Southbound Route 14 to the Southbound Route 5 Freeway connector. The connector was manually metered with temporary signals to prevent the Southbound Route 5 freeway from breaking down. The metering operation was a complete, instant success.

On April 11, 1967, the District's first two permanent fixed-time ramp meters were installed on the northbound Hollywood Freeway (Route 101) at Sunset Boulevard and Hollywood Boulevard. The project was successful in relieving congestion on the freeway mainline without seriously affecting surface street operations. Freeway delay was reduced by about 75%.

In the early 1970's, District 7 created the Los Angeles Area Freeway Surveillance and Control Project (LAAFSCP). The Harbor Freeway (Route 110), Santa Monica Freeway (Route 10) and the San Diego Freeway (Route 405) highlighted this experimental project, known as the 42-mile loop. The system had two objectives. The first objective was to test and evaluate various techniques for improving movement of people and goods on the freeway system by reducing traffic delay and increasing traffic safety. The second objective was to integrate those techniques that can show a great promise into an effective traffic management system.

The LAAFSCP consisted of a vast network of traffic sensors, telemetry equipment, and a computer workstation. The computer workstation was merely a map display and an operator's console. 24-hour real-time traffic data, including freeway mainline volumes, speeds, occupancies, ramp volumes, travel time and traffic delay. From this humble beginning, the current high tech Los Angeles Regional Transportation Management Center (LARTMC) was completed in 2006 and has evolved to be on the right track for success. District 7 is vigorously and continually working to further improve the system.

Traffic responsive ramp metering was also tested in the LAAFSCP project. The traffic responsive logic showed a great improvement over the existing fixed-time ramp metering software.

Also in the early 1970's, District 7 had developed a "Program to Upgrade and Control the Los Angeles Freeway Network". This program monitored sections of freeways that needed to be widened due to very heavy traffic demand. It was noted that as projects were completed, freeway congestion disappeared. However, as time went on, congestion returned since many motorists that were formerly taking city streets discovered the faster-moving freeways. Ramp meters were then installed to control the tremendous inflow of traffic into the freeway system and to discourage local short trips.

In 1992, the first connector meter in District 7 was installed on the Southbound Route 5 connector to the Southbound Route 110 Freeway. In 1994, Route 105 (Glenn Anderson Freeway) was opened to traffic. Design and construction of the Route 105 included on-ramp meters and freeway-to-freeway connector meters. Implementation of connector metering was possible on Route 105, due to long and wide connectors providing adequate storage and sufficient sight distance for fast approaching vehicles, especially on heavy volume connectors.

Today, ramp metering represents an important element of the Traffic Management System (TMS). The focal point of TMS is maximizing traffic flow on the freeway system by reducing congestion. Other elements of TMS include:

- Freeway Surveillance Equipment – Provides essential traffic data to the LARTMC for early detection of incidents and locates areas of traffic congestion. Freeway surveillance equipment is part of the ramp meter detection system and is installed and maintained by the Ramp Metering Branch, the ITS (Intelligent Transportation Systems) Branch and the Electrical Maintenance Branch.
- Closed Circuit Television (CCTV) – Cameras with pan, tilt and zoom capabilities are used to confirm the exact location, nature and severity of freeway incidents.
- Changeable Message Signs (CMS) – As of June of 2013, the LARTMC manages 128 CMS in District 7, located at strategic points on the freeway system. This number will most likely increase year over year. The LARTMC updates the display of CMS messages to provide major incident information affecting traffic conditions and severe weather advisories. Estimated travel times are now displayed on selected CMSs district wide. In the event of child abduction, CMSs are used by law enforcement to display Amber Alert messages.
- Highway Advisory Radio (HAR) – A short-range broadcast radio with transmitters located within the freeway right-of-way to provide motorists with updated informational messages such as directional advisories, traffic control restrictions as well as general information. As of June of 2013, the LARTMC manages 22 HARS in



**Close Circuit TV**  
**(CCTV)**

District 7. This number will most likely increase year over year. HAR messages are remotely activated from the LARTMC.

- Freeway Service Patrol (FSP) – FSP is responsible to provide assistance to stranded motorists and quickly repair or remove disabled vehicles to relieve freeway congestion. Typical hours of operation are Monday through Friday between 6:00 AM and 7:00 PM, Saturday and Sunday from 10:00 AM until 6:30 PM.

District 7 is committed to using numerous traffic management strategies to maintain an efficient freeway system by keeping it operating at, or at least near, capacity. Ramp Metering is an integral part of the system management concept that focuses on implementing operational strategies to reduce congestion and increase safety on California's state highway system with the help of advanced technologies.



**New LARTMC**

The Advanced Transportation Management System (ATMS), located in the new Los Angeles Regional Transportation Management Center (LARTMC), has been an important tool for the ramp metering operation. ATMS provides both historical and real-time traffic data for on-ramps, off-ramps, freeway-to-freeway connectors, and freeway mainline. Such data constitutes a vital and often is the primary source in determining the appropriate metering rates that are unique to each and every ramp meter location. In addition, District 7 ramp-metering engineers, using the ATMS display map and field video cameras, can quickly and effectively modify numerous ramp meter parameters including, but not limited to, and time of metering. This feature is often used when responding to a scheduled construction project, a major traffic incident, or an emergency lane closure due to an unforeseen event. Thus, the use of ATMS in District 7 results in an increase in traffic flow efficiency by allowing faster response to dynamic field conditions. Furthermore, the Media and various private and public organizations currently use the ATMS real-time traffic data and display map to report traffic conditions via Radio, Television, and the Internet.

### **Traffic Operations Management Information System (TOMIS)**

Traffic Operations Management Information System (TOMIS) is a data reporting system that captures work expenditures for Traffic Operations Program activities. TOMIS enables production of a monthly report comparing workload output (production) to work effort (expenditure). Ramp Metering Branches throughout Caltrans in all 12 districts have adopted TOMIS. Examples of subjobs are tabulated in the attached Table 3. Expenditure Authorizations (EA) and subjobs change from time to time. On a monthly basis, production units for each subjob are reported to Headquarters. These production units are also defined in Table 3. Currently, the workload standard (See Attachment 7) for 3RSUR,

3RPNT is 49 and 15 hours per widget, respectively. The workload standards for other subjobs are under development.

### Ramp Metering Procedure Manual and Addendum

The 2005 Ramp Metering Procedure Manual and Addendum can currently be found at <http://www.dot.ca.gov/dist07/news/reports/docs/RAMP%20METERING%20PROCEDURE%20MANUAL%20ADDENDUM.pdf>.

### Convert Existing Ramp HOV Bypass Lane to a Metered HOV OR Mix Flow Lane

As part of Route 210 Congestion Relief project, 26 non-metered HOV by-pass lanes along various on-ramps were converted to metered mix flow lanes, while 10 other HOV by-pass lanes were transformed to metered on-ramp HOV lanes as of 2011.

### Major Ramp Metering Operational Studies

- **I-405 Sepulveda Pass Widening Project**  
Ramp metering personnel was involved in preparation of technical specifications and in reviewing design plans at the various stages of this design build project. This 10 mile long project from Route 10 to Route 101 will improve ramps, bridges and sound walls on San Diego freeway. This \$1.03 billion dollar project will reduce commuter time, improve safety, reduce air pollution and improve the links with the state and regional transportation network.

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## IV. RAMP METERING BASICS

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Ramp meters are traffic signals placed on freeway entrance ramps or freeway connectors to control the flow of vehicles entering the freeway or moving from one freeway to another. They are designed to decrease congestion and improve the average speed of vehicles traveling on the freeway, by controlling vehicular flow at most inputs onto the mainline. By installing a traffic signal at the on-ramp, Caltrans can control the rate at which vehicles enter the freeway. Vehicles entering at short intervals are less likely to slow down flowing traffic and can merge onto the freeway without causing the traditional bottlenecks, associated with heavy unmeted on-ramp traffic volumes. In addition, metering has been proven to reduce rear end and sideswipe traffic collisions, especially during congestion periods.



**Ramp Meter Signal Lights**

The capacity of a freeway, in free-flow conditions, could easily reach 2000 vehicles per hour per lane (v/h/l). However, during congestion periods, this number often drops below 1500 v/h/l. Thus, a free-flowing traffic lane can carry 33% more cars than a congested lane. It is in the public interest to maintain the freeways moving at near capacity; therefore, by dispersing vehicular platoons entering the mainline, ramp metering helps to decrease traffic delays.

Vehicles with two or more occupants may use the High Occupancy Vehicle (HOV) by-pass lane (where available) to access the freeway mainline without stopping at the ramp meter. This practice promotes carpooling that reduces the overall number of vehicles on the freeway. On the other hand, since the freeway traffic demand continues to rise, the need to meter the carpool by-pass lane is anticipated. Currently, District 7 is proposing to meter the existing HOV by-pass lanes, where viable.



**Ramp Meter Controller Cabinet**

Additionally, ramp meters are used to discourage short distance travelers from using the freeway, especially, during the congestion periods where many parallel arterial streets can be utilized. Thus, the option to use local arterials might be better than waiting

at ramp meters. As a result, mainline traffic congestion will improve due to less freeway demand.

The following documents were prepared by Caltrans as a guide in implementing ramp metering policy throughout the State:

- Deputy Directive DD-35 defines Caltrans' policy on Ramp Metering. See Attachment 2.
- Ramp Metering Policy Procedures, dated August 1997, provides guidelines for implementing the Department's Ramp Metering Policy (DD-35). See Attachment 3.
- Design of Ramp Metering Facilities is governed by the "Ramp Meter Design Manual", also part of Highway Design Manual. Refer to REFERENCES, Item No. 1.

## A. RAMP METERING BENEFITS

The effectiveness of ramp meter systems has always been called into question. It is difficult to quantify ramp metering benefits, without conducting a detailed study to compare with and without effects of ramp metering implementation.

In 2000, Minnesota Legislature passed a bill that required the Minnesota Department of Transportation (MnDOT) to study ramp metering effects in their state. Thus, MnDOT, responsible for managing freeway access in the Twin Cities (Minneapolis and St. Paul) metropolitan area, conducted a four-month study aimed towards capturing these benefits. Data was collected during two different time periods; ramp meters were turned on in the first period then turned off in the second. After analyzing the data from both periods, it was concluded that ramp metering was a cost-effective investment. The study revealed the following ramp metering benefits:

- 21% reduction in accidents
- 8% increase in speed
- 22% reduction in travel time
- 16.3% increase in throughput capacity

For detailed information, please refer to REFERENCES, Item No. 11.

## B. TYPES OF RAMP METERING

There are three types of ramp meter operations in District 7:

1. Type 1 – Fixed Time/Time of Day (TOD)
2. Type 2 – Local Mainline Responsive (LMR)
3. Type 3 – System Wide Adaptive Ramp Metering (SWARM)

It should be noted that all three types of metering operation could be implemented according to the following two modes:

- One Car per Cycle Metering - One vehicle per cycle per lane is permitted to enter the freeway. Assuming that green time is typically 2 seconds, the remaining cycle is red time, varying from 2 to 18 seconds. In District 7, the typical maximum metering cycle (Red + Green) time does not exceed 10 seconds or 360 vehicles per hour per lane (v/h/l), in order to minimize meter violations and to minimize vehicle back-up onto local city streets.
- Platoon Metering - Two to three vehicles per cycle per lane are permitted to enter the freeway. Theoretically, it is possible to meter up to 1,200 v/h/l for two vehicles per cycle and 1,320 v/h/l for three vehicles per cycle. Typically, platoon metering is used at freeway connectors or high-traffic ramps, where traffic volumes exceed 900 v/h/l. However when feasible, widening is the better option.

### 1. Fixed Time/Time of Day (TOD) Metering

Fixed time ramp metering is the simplest form of ramp metering that disperses platoons of vehicles entering the freeway. The ramp meter is programmed to operate based on a single or multiple fixed metering rates, for a pre-set metering period, based on historically averaged traffic conditions. Thus, the primary drawback of this metering type is that the cycle length is “fixed” and does not change or respond to real-time freeway mainline traffic conditions. In addition, if the on-ramp gets congested, vehicle backup (Queue) reaches near city street, the Queue loop, usually located at the entrance of the ramp, will be triggered and the meter rate will increase to the maximum rate of 15 vehicles/minute/lane until traffic back-up at the ramp is relieved. Fixed metering rates can be programmed from 180 to 900 v/h/l for single-vehicle metering and 600 to 1320 v/h/l for platoon metering. This practice allows more vehicles to enter the freeway mainline regardless of what the freeway traffic conditions are. Therefore, this type of ramp metering is used only on a limited basis when mainline detection is malfunctioning or during construction.

### 2. Local Mainline Responsive (LMR) Metering

In addition to all the features of fixed time metering, local mainline traffic-responsive metering is directly influenced by the dynamic traffic conditions at the on-ramp and on the freeway mainline lanes adjacent to the on-ramp. If the traffic volume and occupancy on the mainline freeway drop below a set critical volume and critical occupancy, the ramp meter software would override the programmed meter rates to allow more vehicles to enter onto the freeway; thus relieving traffic congestion on local streets. Local mainline responsive metering is widely used in District 7.

The primary drawback of this type of local mainline responsive metering operation is that it reacts only to local mainline traffic conditions immediately adjacent to the ramp and does not take into account the conditions of the rest of the freeway corridor. Thus, the

need to improve the Local Mainline Responsive (LMR) Metering had brought the concept of System Wide Adaptive Ramp Metering (SWARM).

### **3. System Wide Adaptive Ramp Metering (SWARM)**

System Wide Adaptive Ramp Metering (SWARM) seeks to optimize traffic flow on the mainline by being responsive to a whole freeway corridor. For additional information, please refer to the Section V Subsection B “SYSTEM WIDE ADAPTIVE RAMP METERING” section of this Ramp Metering Annual Report. This type of technology is still under development.

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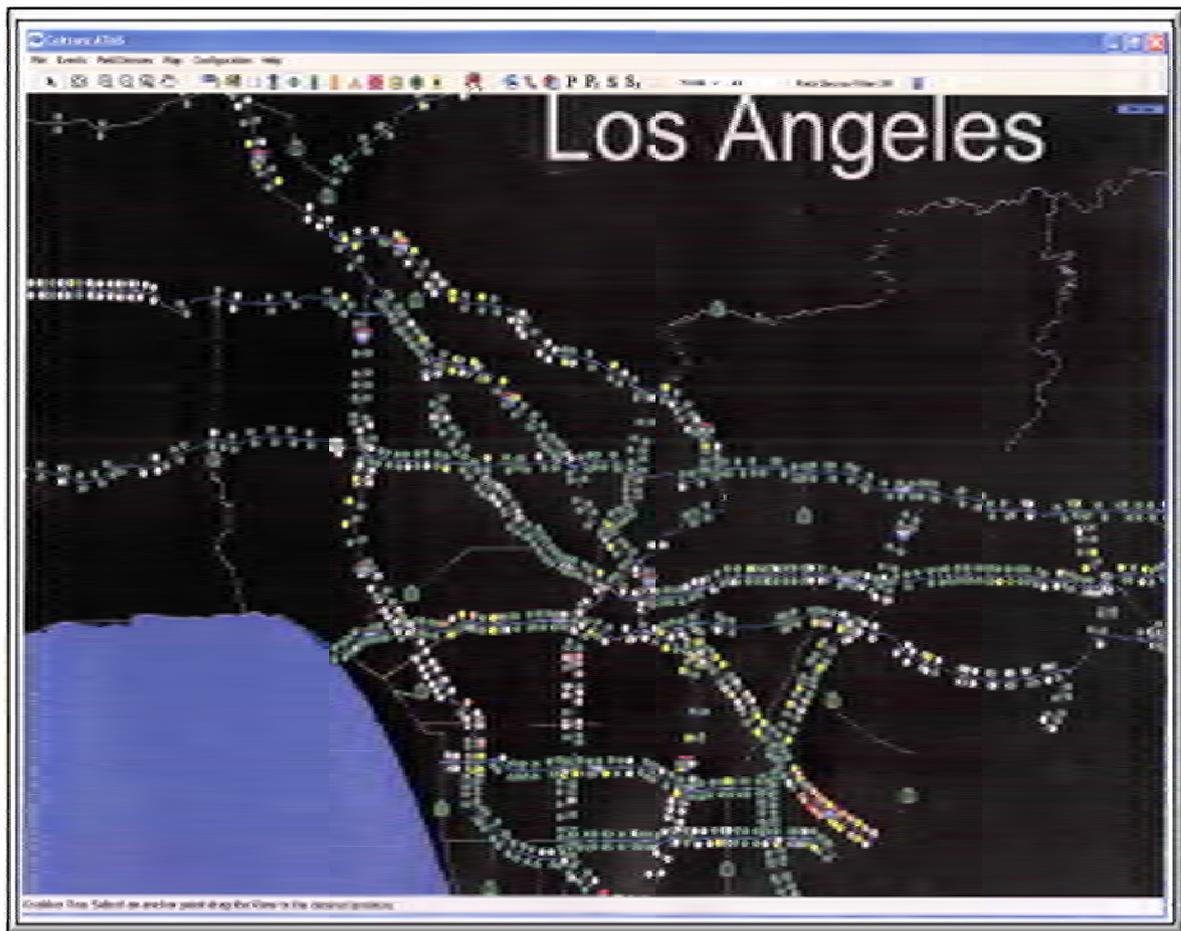
## V. RAMP METERING TECHNOLOGY DEVELOPMENT

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### A. ADVANCED TRANSPORTATION MANAGEMENT SYSTEM (ATMS)

The Advanced Transportation Management System (ATMS), located in the new Los Angeles Regional Transportation Management Center (LARTMC), is a computer system that was designed to assist in the collection and dissemination of traffic information in order to effectively manage the existing District 7 Transportation System. Refer to REFERENCES, Items No. 6, 7, and 14 for more detail. The LARTMC was designed with the intention to reduce congestion and increase safety through the rapid detection of, response to, and removal of incidents on the freeway. Using ATMS, Ramp Metering engineers manage recurring congestion by remotely controlling the ramp meter operation



**ATMS Map Display**

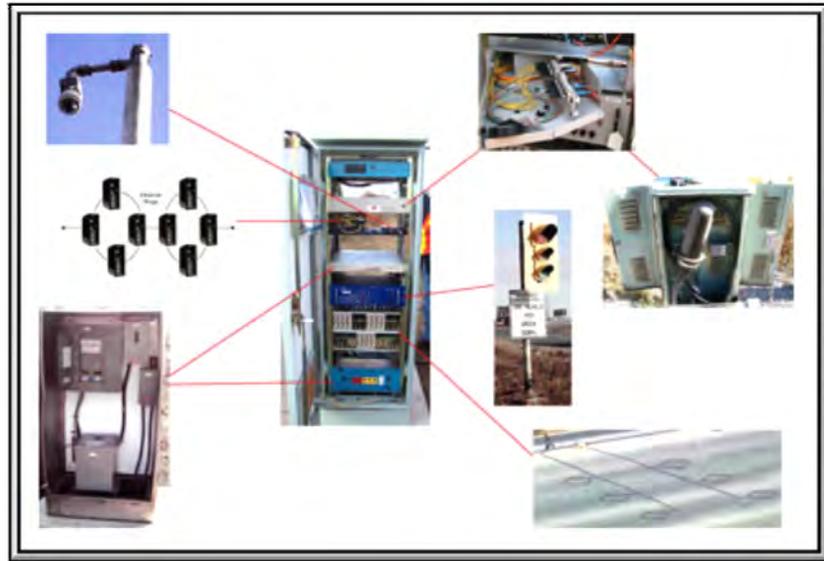
and analyzing freeway system efficiency.

Another ATMS enhanced feature includes incident detection, which is integrated with the closed circuit television (CCTV) cameras to view dynamic traffic conditions, and

changeable message signs (CMS) and highway advisory radio (HAR) to inform motorists of existing freeway conditions and estimated travel times.

ATMS gets its data from field hardware. The vehicle loop detector system, located on freeway mainline lanes, on-ramps, off-ramps, connectors, etc., is connected to traffic controllers enabling data to be sent to the ATMS.

Ramp Metering, Intelligent Transportation Systems (ITS) and Electrical Maintenance personnel are responsible for new installations as well as maintaining, operating, and upgrading or modifying existing field elements.



**ATMS Communications System**

In October 2006, Caltrans District 7 Ramp Metering Branch and ITS Branch entered into a contract with Delcan Technologies to modify the existing ATMS software. The goal of the modification was to improve the ATMS to be more user-friendly and to be able to easily deploy the SWARM algorithm.

## **B. SYSTEM WIDE ADAPTIVE RAMP METERING (SWARM)**

System Wide Adaptive Ramp Metering (SWARM) is a ramp meter operating system, developed by National Engineering Technology (NET) Corporation (Currently known as DELCAN TECHNOLOGIES), based on the recommendations and input of District 7 Ramp Metering Branch. This technology is still under development.

SWARM seeks to optimize traffic flow on the mainline by being responsive to actual and future forecasted traffic conditions throughout the system and to recurrent and non-recurrent congestion.

SWARM was originally tested in 2001 and 2002 on Routes 210 and 405. Results of the Route 210 study were published in the "PRELIMINARY SWARM STUDY REPORT" dated November 2001 and the "SWARM STUDY FINAL REPORT" dated October 2002. A brief summary was prepared following the Route 405 study in 2002. Please refer to REFERENCES, Item Nos. 4, 5 and 16.

In 2008 and 2009, SWARM was tested and implemented along the eastbound and westbound directions of Route 210, from Baseline Road at the Los Angeles / San Bernardino County line (PM 52.00) to Marengo Avenue in the City of Pasadena, just east of the Route 134 Interchange (PM 26.00). This SWARM implementation was the first since the Route 405 study in January 2002 and was part of Route 210 Growth Plan – Congestion Relief Project. Following this study a final report outlining the benefits was published on July 21, 2009. Based on the report recommendation, SWARM was again implemented along the same limits of Rte 210, between March and August 2011. This time SWARM application was during the hours before and after the AM and PM peak periods, while Local Traffic Responsive (LMR) was implemented during the peaks. However, due to ongoing sudden communication failures and lack of resources for monitoring the progress and benefits of such application, SWARM implementation was suspended at the end of August 2011.

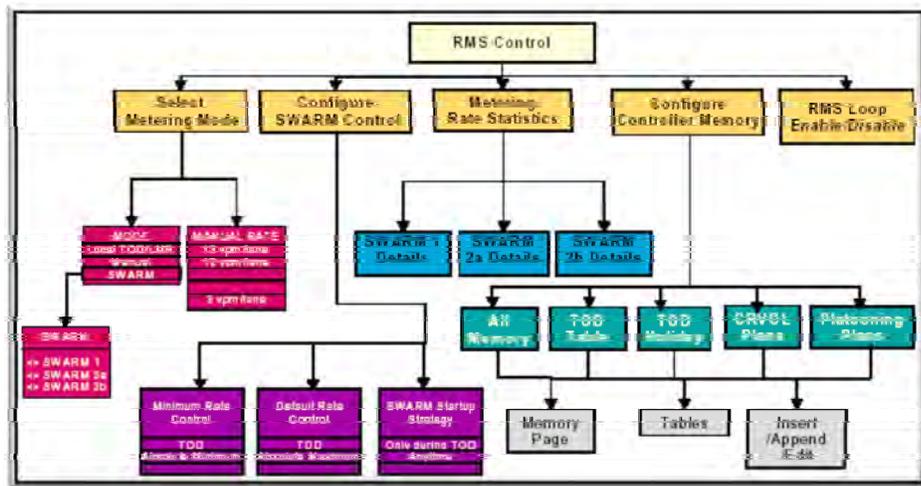
## Types of SWARM

There are three basic types of SWARM: SWARM 1 operates system wide to predict congestion, SWARM 2a and SWARM 2b operate locally and are based on headway and storage capacity respectively.

### 1. SWARM 1

SWARM 1 is system wide adaptive and based on a freeway network divided into SWARM sections. Each section begins and ends at a mainline vehicle detection station (VDS) identified as a bottleneck. SWARM 1 algorithm operates at designated and dynamic bottleneck locations and controls vehicle flow of all upstream on-ramp locations linked to that bottleneck.

Since it is directly related to congestion, density is monitored at each bottleneck location. The algorithm requires a nominal saturation density threshold for each mainline VDS in the network.



**Ramp Meter Station (RMS) Control Diagram**

The algorithm attempts to estimate the density  $n$  minutes (user settable) in the future based on real time traffic data. When estimated density, at the bottleneck, exceeds saturation density, ramp meter rates will be computed in an attempt to proactively react to the predicted onset of congestion. Starting at the bottleneck and working upstream, the software calculates new metering rates based on the required volume reductions. Actual metering rates vary between maximum and minimum rates. Since rate adjustments may be positive or negative, excess or reduction values are propagated upstream (user settable).

## 2. SWARM 2a

SWARM 2a is local responsive based on headway (time between consecutive vehicles). It uses the density function to compute local metering rates and attempts to maintain headway such that the maximum flow can be obtained.

## 3. SWARM 2b

SWARM 2b is local responsive based on storage. It computes the number of vehicles stored between two VDS stations and compares it to a maximum storage value. Metering rates are computed to maintain level of service (LOS) D as long as possible.

## 4. SWARM Combinations

SWARM can be used in combinations, i.e., SWARM 1 and 2b. The controller uses the more restrictive rates of those recommended. Within a bottleneck segment, some controllers can be programmed to be on local Time of Day (TOD) mode while others are programmed to be on one of the SWARM modes. The use of the local Time of Day mode is especially useful at on-ramps that are experiencing heavy traffic volumes and cannot be further restricted.

## 5. Advantages of SWARM

- It predicts future traffic conditions.
- It maximizes traffic flow on the mainline.
- It is responsive to actual traffic conditions throughout the freeway corridor.
- It is responsive to recurring and non-recurring congestion.

## 6. Disadvantages of SWARM

- Ramp control and traffic surveillance devices must be connected to a central computerized communications center.
- Communication lines have to be operating at all times in order for SWARM to operate properly.
- SWARM requires accurate data from mainline and on and off-ramp detectors in order to work effectively.

- It is more complicated than local traffic responsive metering.
- SWARM software is too big to easily troubleshoot problems.

### C. SATMS 3.0

SATMS (Semi-Automatic Traffic Management System) 3.0 is the latest computer processor chip developed by the Caltrans ITS Branch to upgrade the existing ramp metering software. The previous versions were SATMS 1, used only at on-ramps, and SATMS C, used for both connector and on-ramp locations.

The primary goal of the SATMS 3.0 upgrade was to improve the compatibility with the new ramp metering SWARM algorithm. Furthermore, other features were also added in order to enhance the overall ramp meter operation.

In 2002, the SATMS 3.0 chip was tested at several locations in District 7. Once the testing phase was successfully completed, the updated chip was installed at all on-ramp controller cabinets. By the end of 2003, ramp meter operation was universal district wide as the SATMS 3.0 chip replaced the obsolete model.

The new features in the SATMS 3.0 chip are:

- The controller 170 initiation reset time following a power failure to reduce the watchdog black out problem is sped up. Thus, variation or brief interruption in power voltage level will have less effect on the operation of the ramp meter.
- The loss of communication Cycle Time is increased from one cycle (approximately 30 seconds) to ten cycles (around five minutes) in order to minimize frequent changes between SWARM and local Time of Day modes. Thus, communication losses lasting no more than ten cycles would not affect the implementation of SWARM in the field; the controller would meter for up to five minutes, according to the last SWARM rate before communication failure occurred.
- The Queue override maximum rate can be set by a ramp meter engineer to be lower than 15 vehicles per minute per lane. In addition, the new chip provides the ability of linking the activation of the Queue override mode to mainline traffic condition by settable threshold critical speed level (normally 35 mph) to control Queue activation.
- The Queue override mode, created to speed up the metering rate when vehicular back up reaches the entrance of the on-ramp, can be used with the SWARM mode. If activated, the Queue override mode will gradually increase the metering rate, dictated by SWARM, up to the maximum rate of 15 vehicles per minute per lane; thus, reducing the overflow of vehicles onto city streets.
- Whenever metering is initiated or terminated by SWARM or loss of communication cycle time exceeds ten cycles, the controller will apply one-minute “Green” light at the beginning and at the end of each metering phase.

- Set default values for the SATMS 3.0 chip are improved over the older versions.
- The traffic responsive feature is improved.
- Q2 loop operation (for connectors only) is enhanced as follows:
  1. Q2 can be programmed to operate independently of Q1 to trigger “Green” light when backup occurs.
  2. Similarly to on-ramps, the Queue 1 Override maximum rate can be set at a rate lower than 15 vehicles per minute per lane. In addition, the Queue 1 and 2 activation modes can be controlled by mainline threshold critical speed level set by the engineer.

#### D. STATEWIDE RAMP METERING SYSTEMS

Several ramp metering software packages have been used by different districts within Caltrans. They include the San Diego Ramp Metering System (SDRMS), which was deployed in Districts 3, 6, 8, 10, and 11, the Semi-Automatic Traffic Management System (SATMS), which was deployed in District 7, and the Traffic Operations System (TOS), which was deployed in District 4. District 8 deploys Revision 8 of the SDRMS. District 11 uses a dynamic ramp metering system. A variation of SATMS, named Orange County Ramp Metering System (OCRMS), District 12 allows staggered ramp metering.

#### E. ROUTE 210 STRATEGIC GROWTH PLAN – CONGESTION RELIEF PROJECT (2009)

Route 210 Congestion Relief Projects primarily focused on the development and implementation of enhanced on-ramp and freeway-to-freeway connector metering strategies designed to improve the ability for effective traffic management along Route 210 corridor.

Route 210 Strategic Growth Plan consists of 2 congestion relief projects. The first project, EA 257404, extends over the eastern segment of Route 210 corridor from post mile 26.00 (City of Pasadena) to post mile 52.00 (San Bernardino County Line), while the second, EA 258004, covers the western segment from post mile 0.31 (Route 5) to post mile 24.92 (Route 134).

The deployment and testing of these strategies should provide the opportunity to evaluate the potential impacts of different aspects of the improvements. These main aspects are highlighted below:

1. The installation of 41 new traffic responsive ramp meters at existing non-metered on-ramp locations, bringing the total to 107 ramp metering stations throughout the corridor.

2. Addition of 24 microwave vehicle detection stations, along brief remote sections in the western end of Route 210 corridor: This new technology was installed within a rural section along the western segment of the corridor.
3. Installation of 9 freeway-to-freeway connector meters along five major interchanges (Routes 2, 57, 118, 134 and 605 with Route 210 corridor): The purpose of this strategy is to regulate the flow of vehicles, from connecting freeways, onto Route 210.
4. Introducing High Occupancy Vehicle (HOV) bypass lane metering at 9 existing and 20 new ramp metering locations. This strategy is intended to better manage the previously uncontrolled flow of HOV vehicles onto the Freeway mainline.
5. Conversion of 23 existing non-metered HOV by-pass lane to metered on-ramp mix flow lanes: This conversion was required in order to provide additional vehicular storage capacity needed to effectively implement ramp metering operation.
6. System Wide Adaptive Ramp Metering (SWARM): This advanced metering strategy works by evaluating real-time traffic situations at dynamic bottlenecks throughout the corridor, in order to predict future congestion and properly set upstream ramp metering rates helping to reduce congestion. This methodology improves the ability to maximize and maintain efficiency of traffic flow throughout the corridor. It represents an innovation over current metering capabilities, by implementing ramp metering on a system wide basis, thus, responding to both recurring and non-recurring traffic congestion.

The addition of these strategies also required many supporting implementations including the addition of signage (both extinguishable and static), re-striping, the addition or repositioning of traffic detectors, and ramp reconfiguration.

Early in 2008, and following the completion of Construction in 2007, all ramp meters along the eastern segment of Route 210, in addition to four connector meters, between Route 210 and Routes 57 and 605 within the same limits of the corridor, were activated. Traffic data was collected, analyzed and compared to the before condition in 2006. The evaluation revealed positive impact due to the ramp and connector metering installation. A detailed report highlighting the overall benefits and detailing all the positive improvements was released on July 31, 2009.

In June 2009, all ramp meters along the western segment of Route 210 corridor were activated; however the five connector meters from Routes 2, 118 and 134 onto Route 210, remain inactive awaiting a detailed traffic study and observation of the overall traffic condition in the area.

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## VI. RESPONSIBILITIES

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Ramp Metering Branch, Intelligent Transportation System (ITS), and Electrical Maintenance Branch work as a team in respect to ramp metering issues and development. Ramp Metering Branch is responsible for the operation of ramp meters district-wide. ITS Branch provides technical support for the LARTMC. Electrical Maintenance Branch is responsible for the maintenance of hardware and electrical equipment deployed in the field. To maintain and to improve the cooperation, these groups meet on a quarterly basis.

### A. RAMP METERING BRANCH

The ramp metering system in the District is inspected and regularly observed through routine field surveillance and frequent ATMS observation. Ramp Metering Engineers are responsible for the ramp meter programmed software as well as the proper operation of ramp meters district-wide. Ramp Metering operation software consists of a “RAM (Random Access Memory) Map” package which includes a program sheet, time of day (TOD) table and a detailed loop detector (sensor) diagram layout, in addition to an electrical as-built plan showing all of the hardware. Ramp Meter hardware includes signals, controllers, loop detectors, signing, striping and advance warning devices. Area Engineers (lead workers) are assigned ramp meters by routes or segments of routes. Other engineers within the Ramp Metering Branch assist the Area Engineers.

### B. ELECTRICAL MAINTENANCE BRANCH

Electrical Maintenance responds to ramp meter malfunctions reported by CHP, Ramp Metering Branch, ITS Branch and the general public, if related to hardware and electrical problems. Electrical Maintenance performs routine checks of all ramp-metering equipment. The following main actions are performed by the Electrical Maintenance technician during this check:

- Maintenance of Freeway Meter Signals

Meter signals should be checked for damage, proper operation, and timing every 120 days. This check should include the following items as a minimum:

#### (A) Field Inspection

- (1) Visual check of indications.
- (2) Signal indication alignment.
- (3) Hardware (signs, poles, back plates, etc.).
- (4) Pull box covers (broken, missing, and clear of dirt or debris).
- (5) Visual check of service cabinet and equipment locks.
  
- (6) Visual check of loops in roadway (if possible).

(B) Cabinet Interior

- (1) Controller unit indicator lights and display.
- (2) Function and timing.
- (3) Detector indicator lights and operation.
- (4) Check output devices, including interconnect systems.
- (5) Thermostat and ventilation system including filter.
- (6) Clean cabinet and interior components.
- (7) Check documentation (timing sheets, schematics, wiring plans, etc, and inspection noted on cabinet login card).

(C) Cabinet Exterior

- (1) Condition of surface (paint, damage, graffiti).
- (2) Condition of locks and handles.
- (3) Operation of Police panel switches.

▪ Meter Timing and Operation

Initial timing of ramp meter signals and any subsequent changes in timing are the sole responsibility of the Ramp Metering Branch.

Maintaining the meters is the responsibility of the Electrical Maintenance Branch.

**C. INTELLIGENT TRANSPORTATION SYSTEMS (ITS) BRANCH**

ITS Branch provides technical support for the LARTMC. This includes ramp metering and ATMS. ITS main duties are:

1. Test and develop new software related to metering operation.
2. Set up the configuration of ATMS.
3. Review electrical design plans for new projects.
4. Monitor and correct any discrepancies found on the ATMS data reports such as icons, loop configuration, etc.
5. Check system electrical operation and final compliance in accordance to the contract documents or as-built plans on all new and replacement equipment.
6. Test and maintain communication lines between field equipment and LARTMC.

**D. RAMP METERING WORKLOAD TRACKING SYSTEM**

The Office of System Management Operations tracks the activities of Ramp Metering staff throughout the State. It is the responsibility of each District to provide charging activities to the Office of System Management Operations.

A spreadsheet for tracking ramp metering surveillance widgets was created by Ramp Metering Statewide Committee. A workload standard is defined as the number of hours spent per widget production. The ramp metering workload standard was developed following three basic steps. First, the statewide team focused on developing a comprehensive ramp metering activity list. This list provides a basic understanding of what the ramp metering program does and what the discrepancies are among the districts. The activities were further categorized into three categories, namely Critical, Essential, and Preventive. Critical activities are defined as the must-do activities to operate ramp meters; essential activities are those to reduce operational problems; while activities to prevent operational problems are defined as preventive.

After the activities were listed and agreed upon, the group decided to aggregate them into three widgets and each widget into subtask. District 7 Ramp Metering Branch is committed to implementing the workload tracking practice. The following is General information, definitions and instructions on using ramp metering workload tracking spreadsheet. (Please see Attachment 6 for sample of spreadsheet report).

**General information and instructions on using this spreadsheet for tracking ramp metering surveillance widgets:**

1. There were 6 "main" ramp metering surveillance tasks that can be performed per the BPAC briefing package for ramp metering as summarized on the right. Each main task is weighted equally and is considered to be 1/6 of a ramp metering surveillance widget. Each main task has several "sub" tasks that when all performed, constitute the main task being completed. Each sub task is weighted according to the number of sub tasks within a given main task. For example, each sub task under Task 1 is weighted 1/8 of the task since there are 8 sub tasks within it; each sub task in Task 2 is weighted 1/10 of the task since there are 10 sub tasks within it, etc.
2. Each month has its own tab in the spreadsheet and contains each ramp meter location with boxes to track which ramp metering surveillance sub tasks have been performed for each location during the month. Each time a sub task is performed for a particular location, the individual completing the task enters it into the spreadsheet.
3. Tasks performed are tracked by ramp meter location NOT by individual(s) performing the task. In other words, if two or more people are working together on a sub task at a particular location, the sub task should be tallied only once in the spreadsheet. A particular sub task can, however, be performed multiple times at a given location in a given month, and can be counted as many times as it is completed, but again, is not multiplied by the number of individuals working on the sub task together. For example, occupancy counts can be collected (task #2, sub task #1) at a particular ramp meter location by two people 4 times in a month. On the spreadsheet, it would be reported as 4 instances of a sub task in task #2 being completed, not 8 instances (4 x 2 individuals).
4. By tallying the number of sub tasks performed in the spreadsheet, the equivalent number of widgets (shown highlighted in yellow) to be reported to HQ each month is automatically calculated based on the parameters outlined in item 1 above.

**TASK DEFINITIONS (PER BPAC BRIEFING PACKAGE FOR RAMP  
METERING DATED 2/16/10)**

**• TASK 1: CONDUCT FIELD/OFFICE ELEMENT SURVEILLANCE**

- Monitor ramp meter functionality in the field
- Monitor ramp meter functionality through a central system in the office
- Review and adjust corridor ramp metering hours (am, pm, or all day for both weekdays and weekends).
- Inspect firmware (SATMS/SDRMS/TOS) and hardware in the field.
- Report hardware or communication problems to appropriate functional units such as TMC support, electrical maintenance and TMS support.
- Investigate and respond to inquiries/complaints
- Respond to inquiries (internal and external)
- Respond to legal claims inquiries

**• TASK 2: COLLECT TRAFFIC DATA**

- Occupancy counts
- Queue and demand
- ramp geometry
- ramp volumes
- Mainline volumes
- Turning movements at the ramp termini
- meter violation rates
- HOV (Bypass) counts
- HOV (Bypass) Violation rates
- Maintain and update log of surveillance results

**• TASK 3: ANALYZE TRAFFIC DATA**

- Analyze traffic data
- HOV (Bypass) analysis
- Corridor analysis
- Analyze violation rates
- Develop recommendations and implementation plans
- Conduct before and after studies

**• TASK 4: ADJUST FIELD ELEMENTS**

- Adjust ramp meter equipment such as detector settings.
- Adjust metering parameters (rate, traffic responsive thresholds, holiday timing plans, etc.)
- Fine tune field elements and metering rates, if necessary
- Maintain log of ramp metering changes (including meter timing)

- Efforts and coordination with Maintenance and other internal/external offices To restore the knock-downs

• **TASK 5: SUPPORT OPERATIONAL IMPROVEMENT**

- Obtain data from ATMS, RMIS or other sources
- Develop ramp meter operational study for each freeway
- Develop plans for operational improvement
- Generate the improvement report
- Support ramp metering operations during construction
- Implement and evaluate the improvement
- Respond to inquiries (internal and external)
- Participate in specification development and procurement process

• **TASK 6: CONDUCT YEARLY INVENTORY**

- Conduct inventory of each RMS and VDS/TMS
- Report findings to TMC support and/or electrical maintenance, Headquarters

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## VII. REFERENCES

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For further information about ramp metering and ramp metering related subjects, you can refer to the following manuals and reports:

1. "Ramp Meter Design Manual", Caltrans, January 2000.
2. "Ramp Meter Development Plan", Reza Akramian & Rody Torchin, January 2009.
3. Amended "Ramp Metering Procedure Manual", Rafael Benitez-Lopez, November 2005.
4. "Preliminary SWARM Study Report", Hanh Pham, Caltrans District 7, November 2001.
5. "SWARM Study Final Report", Hanh Pham, Caltrans District 7, October 2002.
6. "ATMS User's Manual", National Engineering Technology Corporation, June 2000.
7. "ATMS Traffic Engineer's Manual", National Engineering Technology Corporation, June 2000.
8. "Highway Capacity Manual", Transportation Research Board, 2000.
9. "Traffic Manual", Caltrans
10. "Highway Design Manual", Caltrans
11. "Twin Cities Ramp Meter Evaluation", Cambridge Systematics Inc., November 27 2001.
12. "Traffic Bulletin No. 4 - Notes on Freeway Capacity", Karl Moskowitz and Leonard Newman, July 1962.
13. "Traffic Bulletin No. 16 – Introduction to Capacity", Leonard Newman, April 1969.
14. "Ramp Meter Operation Plan", National Engineering Technology Corporation, December 2001.
15. "Basic Ramp Control", M.K. Kim, Caltrans
16. Route 405 SWARM Study Summary, Wahib Jreij & Fady Al-Awar, Caltrans District 7, January 2003.
17. 2002 "System Wide Adaptive Ramp Metering" (SWARM) Study Final Report  
[http://www.dot.ca.gov/dist07/news/reports/docs/swarm\\_LA210\\_final.pdf](http://www.dot.ca.gov/dist07/news/reports/docs/swarm_LA210_final.pdf)

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## **IX. ATTACHMENTS**

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**ROUTE RESPONSIBILITIES**  
**Afsaneh Razavi (Ramp Metering Branch Chief)**  
**Phone (323) 259-1841**

AREA ENGINEER: Wahib Jreij

Phone: (323) 259 -1842

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-10	18.39/48.30	Route 101 to San Bernardino County	Jreij / Dumaplin	1842	81
LA-57	0.00/12.00	Orange County to Route 210	Jreij / Dumaplin	1846	20
LA-60	0.00/30.50	East LA Inter. to San Bernardino Co.	Jreij / Dumaplin	1846	65
LA-71	0.30/4.80	San Bernardino County to Route 10	Jreij / Dumaplin	1846	3
LA-210	0.00/52.00	Route 5 to San Bernardino County	Jreij / Dumaplin	1842	108
LA-210	Connector	NB Rte 57 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 57 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 605 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 605 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	EB Rte 118 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	EB Rte 118 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 2 to EB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	NB Rte 2 to WB Rte 210	Jreij / Dumaplin	1842	1
LA-210	Connector	EB Rte 134 to WB Rte 210	Jreij / Dumaplin	1842	1
Total					<b>286</b>

AREA ENGINEER: Iqbal Toorawa

Phone: (323) 259 -1858

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-91	6.01/20.74	Vermont to Orange County	Toorawa	1858	41
LA-110	0.00/20.36	Route 47 to Rte 05	Toorawa / Torchin	1859	45
LA-110	20.36/31.91	Route 05 to Glenarm St. (Pasadena)	Toorawa	1858	0
LA-110	Connector	S/B 5 to S/B 110	Toorawa	1858	1
LA-605	0.00/26.00	Orange County to Route 210	Toorawa/Masatsugu	1855	56
Total					<b>143</b>

## ROUTE RESPONSIBILITIES (Continued)

AREA ENGINEER: Rafael Benitez

Phone: (323) 259 -1856

<b>Co/Rte</b>	<b>PM Limits</b>	<b>Limits</b>	<b>Assigned</b>	<b>Ph. Ext</b>	<b>Meters</b>
LA-10	1.88/18.33	PCH to East LA Interchange	Benitez	1856	46
LA-105	0.00/18.14	Sepulveda (LAX) to Rte 605	Benitez	1856	28
LA-105	Connector	N/B 405 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 405 to E/B 105	Benitez	1856	1
LA-105	Connector	N/B 110 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 110 to W/B 105	Benitez	1856	1
LA-105	Connector	S/B 110 to E/B 105	Benitez	1856	1
LA-105	Connector	N/B 710 to W/B 105	Benitez	1856	1
LA-105	Connector	N/B 710 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 710 to E/B 105	Benitez	1856	1
LA-105	Connector	S/B 710 to W/B 105	Benitez	1856	1
LA-110	Connector	(E/W)/B 105 to N/B 110	Benitez	1856	1
LA-110	Connector	E/B 105 to S/B 110	Benitez	1856	1
LA-110	Connector	W/B 105 to S/B 110	Benitez	1856	1
LA-405	Connector	E/W 105 to S/B 405	Benitez	1856	1
LA-405	Connector	W/B 105 to N/B 405	Benitez	1856	1
LA-605	Connector	E/B 105 to N/B 605	Benitez	1856	1
LA-605	Connector	E/B 105 to S/B 605	Benitez	1856	1
LA-710	Connector	E/W 105 to S/B 710	Benitez	1856	1
LA-710	Connector	E/W 105 to N/B 710	Benitez	1856	1
Total					<b>92</b>

AREA ENGINEER: Jeff Le

Phone: (323) 259 -1850

<b>Co/Rte</b>	<b>PM Limits</b>	<b>Limits</b>	<b>Assigned</b>	<b>Ph. Ext</b>	<b>Meters</b>
LA-2	14.08/23.44	Glendale Blvd to Route 210	Le / Atefyekta	1857	7
LA-134	0.0/13.34	Route 170 to Route 210	Le / Atefyekta	1850	30
LA-170	14.57/20.55	Route 101 to Route 5	Le	1850	9
Total					<b>46</b>

## ROUTE RESPONSIBILITIES (Continued)

AREA ENGINEER: Hamid Kalkatechi

Phone: (323) 259 -1843

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-5	0.00/88.61	Orange County to Kern County	Kalkatechi/Sepanj	1843	99
Ven-33	0.00/5.66	Route 101 to Casitas Vista Road	Kalkatechi	1843	0
LA-101	11.60/16.98	Rte 101/134/170 Int. to Rte 101/405 Int.	Kalkatechi	1843	11
Ven-126	0.00/13.24	Route 101 to Hallock Drive	Kalkatechi	1843	0
LA-138	0.00/1.80	Route 5 to Gorman Post	Kalkatechi	1843	0
				Total	<b>110</b>

AREA ENGINEER: Fady Al-Awar

Phone: (323) 259 -1844

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-14	24.79/77.01	Route 5 to Kern County	Al-Awar	1844	0
LA-90	0.92/3.28	Route 1 to Slauson Ave	Al-Awar / Torchin	1859	0
LA-101	0.18/11.60	Mission Rd to 101/134/170 Inter.	Al-Awar	1844	32
LA-118	0.00/14.08	Ventura County to Route 210	Al-Awar	1844	20
Ven-118	18.20/32.60	Route 23 to Los Angeles County	Al-Awar	1844	34
LA-405	48.64/39.40	Route 05 to Route 101	Al-Awar	1844	19
LA-405	39.40/21.44	Route 101 to Route 105	Al-Awar / Torchin	1859	41
				Total	<b>146</b>

AREA ENGINEER: Nabil Eskander

Phone: (323) 259 - 1869

<u>Co/Rte</u>	<u>PM Limits</u>	<u>Limits</u>	<u>Assigned</u>	<u>Ph. Ext</u>	<u>Meters</u>
LA-405	0.00/12.95	Orange County to Route 110	Eskander/Atefyekta	1857	37
LA-405	12.95/21.44	Route 110 to Route 105	Eskander / Torchin	1859	23
LA-710	6.80/27.38	Shoreline Dr to Valley Blvd	Eskander/Masatsugu	1869	36
				Total	<b>96</b>

## ROUTE RESPONSIBILITIES (Continued)

AREA ENGINEER: Behdad Sepanj

Phone: (323) 259 - 6306

<b>Co/Rte</b>	<b>PM Limits</b>	<b>Limits</b>	<b>Assigned</b>	<b>Ph. Ext</b>	<b>Meters</b>
Ven-23	3.20/11.60	Route 101 to Route 118	Sepanj	6306	23
LA-101	16.98/38.19	Rte 101/405 int. to Ventura County	Sepanj	6306	44
Ven-101	0.00/43.62	L.A. County to Santa Barbara Co.	Sepanj	6306	13
				Total	<b>80</b>

**Total number of Meters in District 07** **999**

California Department of Transportation  
***DEPUTY DIRECTIVE***

*Number:* DD-35

*Refer to*  
*Director's Policy:* 08-Freeway System  
Management

*Effective Date:* 1-3-95

*Supersedes:* P&P 91-01

*Title:* Ramp Metering

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**POLICY**

Caltrans is committed to using ramp metering as an effective traffic management strategy to maintain an efficient freeway system and protect the investment made in constructing freeways to keeping them operating at or near capacity flow rates.

**DEFINITION/BACKGROUND**

Ramp metering is the common method of ramp entry control. It has been an effective tool in reducing congestion on California freeways since the late 1960ís. Caltrans has installed over 1300 ramp meters throughout the state and proposes their installation on all urban freeway entrance ramps where metering will improve or maintain effective operations along freeway corridors.

**RESPONSIBILITES**

The Traffic Operations Program Manager is responsible for the development, review and dissemination of policies, guidelines, and procedures for ramp metering (see Ramp Metering Policy Procedures).

The State and Local Project Development Program Manager is responsible for the development and review of geometric design standards for ramp metering and supports the inclusion of ramp metering in projects within freeway segments identified in the Ramp Meter Development Plan.

District Directors are responsible for developing local agency support for ramp metering; implementing ramp metering policies and procedures; and providing justification for deviation from established policy and procedures.

**APPLICABILITY**

Any employees involved with ramp metering activities.

***ORIGINAL SIGNED BY***

LEE F. DETER  
Deputy Director  
Maintenance and Operations

***RAMP  
METERING  
POLICY  
PROCEDURES***

## RAMP METERING POLICY PROCEDURES

### I. PURPOSE

The purpose of these procedures is to provide guidelines for implementing the Department's ramp metering policy (DD-35).

### II. BACKGROUND

Metering has proven to be an effective traffic operations tool to maximize the efficiency of a corridor. The primary objective of metering is to reduce congestion and the overall travel time of the total traffic stream - on both freeway and surface streets. Ramp metering reduces congestion by:

- Maintaining more consistent freeway throughput.
- Utilizing the capacity of the freeway corridor more efficiently.
- Providing incentives for increased use of carpools, vanpools, and public transit by including preferential lanes, which offer time savings to High Occupancy Vehicles (HOV) at ramp meters.

Secondary benefits include the reduction of congestion-related accidents and air pollution. Ramp meters operate most effectively when upstream mainline traffic is controlled. This control can be accomplished by installing additional ramp meters, metering freeway to freeway connectors or mainline control. These procedures focus on the implementation of ramp metering systems through a coordinated effort involving Caltrans planners, designers, operations personnel, local agency staff, the California Highway Patrol (CHP), and the public.

### III. PROCEDURES

- A. It is the District's responsibility to maintain an acceptable level of service on the freeway system, to make the most effective use of each transportation corridor, and to protect the public's investment in the system.

Each District that currently operates, or expects to operate, ramp meters within the next ten years shall prepare a Ramp Meter Development Plan (RMDP) identifying the

freeway segments, including freeway to freeway connectors, which are expected to be metered within this period. The RMDP should also identify freeway segments where upstream mainline control is necessary to maintain effective overall freeway operations. The RMDP shall be updated biennially and be included in local Congestion Management Plans.

- B. Projects, which propose the modification of an existing interchange or the construction of a new interchange within the freeway segments identified in the RMDP, regardless of funding source, should include provisions for ramp meters. This applies to all projects that have an approved Project Study Report dated July 1991 or later (the date of the original Policy and Procedure). These provisions, as defined in the Ramp Meter Design Guidelines, should include right of way, geometric to accommodate vehicle storage and HOV bypass lanes, ramp meter equipment, and CHP enforcement areas. Projects which propose additional capacity within freeway segments identified in the RMDP shall include provisions for ramp meters and shall implement the ramp meters at all entrance ramps within the project limits. In freeway segments identified in the RMDP where mainline control is necessary to maintain effective overall freeway operation, additional freeway capacity should not be constructed without an analysis of the operational impacts to downstream segments. Districts are responsible for performing appropriate environmental studies for ramp metering projects.
- C. The District will work in partnership with metropolitan planning organizations; regional transportation planning agencies, and congestion management agencies to program ramp metering projects and develop implementation plans. Coordination and consultation should be documented and concurrence may be obtained in any form the District considers appropriate.
- D. The Ramp Meter Design Guidelines prepared by the Division of Traffic Operations, in cooperation with the Division of State and Local Project Development, and the CHP shall be used when designing ramp metering facilities. This document is a compilation of design information and operational practices used statewide.
- E. HOV preferential lanes shall be considered wherever ramp meters are installed. The need for HOV bypass lanes should be included in the Project Study Report, Project Information Report, Project Report, and Environmental Document. If an HOV preferential lane is not included in a proposal to ramp meter, the reasons should be addressed in the appropriate document.

The District is responsible for consulting with the CHP on project features, which affect enforcement activities such as HOV lane violations, enforcement pads, etc. Coordination and consultation should be documented.

- F. When selecting the appropriate metering method for the HOV preferential lane, the following criteria should be used:

Control: An analysis of HOV traffic volumes shall be made to determine the impact on mainline traffic flows. Where adverse impacts exist, consideration should include metering the HOV preferential lane and/or more restrictive metering of the SOV lane(s). Consideration should be given to metering the HOV preferential lane if platoons from local signalized intersections adversely affect the operation of the freeway. Storage capacity and effects to local arterials should also be addressed.

Merge Conditions: Prior to entering the freeway, all vehicles on the on-ramp should be provided with adequate space to safely merge with each other. The safest merge condition is when the speeds of the merging vehicles are identical. When the speed differentials between HOVs and SOVs are excessive, consideration should be given to metering the HOV lane. All ramps should be designed in accordance with the Ramp Meter Design Guidelines, which detail adequate merging distances.

Enforcement: The ability to safely enforce occupancy violations of HOV lanes is essential. The CHP should be consulted for their recommendation of enforcement operations at each HOV preferential lane location.

Corridor Operations: In corridors where ramp meters are already operational, the existing metering method may be used as criteria for additional installations in the same corridor. If alternate metering methods are proposed along a corridor, local agencies should be consulted.

The criteria listed above can be applied to new and existing ramp meter installations. If it is being applied to an existing ramp meter, the following criteria should also be used:

Accident History: The accident history of the ramp needs to be investigated. If either the ramp or any portion of the freeway within 500 feet of the ramp gore has been flagged as a high accident concentration location (Table C), each accident report should be reviewed in detail to determine whether or not the HOV operation during the metered period was a contributing factor. If evidence suggests that it could have been a contributing factor to the accident, consideration should be given to metering the HOV preferential lane.

G. Districts shall provide justification for deviation from the policy and these procedures and concurrence shall be obtained from the Headquarters Traffic Operations District Liaison. Deviations from design standards require the approval of the Project Development Coordinator in the Office of Project Planning and Design.

H. The Division of Traffic Operations provides District personnel with technical assistance and support on the design and operation of ramp meter systems and assists in the preparation of the District's RMDP.

## CONTENTS OF EXCEPTION TO RAMP METERING POLICY FACT SHEET

### PROJECT DESCRIPTION

Briefly describe the project. Note the type of project and/or major elements of work to be done.

### RAMP METERING POLICY NON-COMPLIANCE FEATURES

Describe the proposed or existing ramp metering policy non-compliance feature(s). (Note: Deviations from advisory or mandatory design standards shall be addressed as required by the *Project Development Procedures Manual*, the *Highway Design Manual* and applicable District Directives.) Design exceptions to standards to be attached to Ramp Meter Policy Fact Sheet.

### REASON FOR THE EXCEPTION

Be thorough but brief. Supportive factors may include right-of-way or space constraints, environmental concerns, inordinate costs, etc. Show an estimate of the added cost above the proposed project cost that would be required to conform to the ramp metering policy for which exception is being documented. The estimate does not have to be highly developed but must be realistic.

### FUTURE CONSTRUCTION

Describe any planned future projects in the immediate vicinity of the requested ramp meter exception, but do not make any commitments (e.g., ramp metering as part of future projects) unless there is a certainty that they can be followed through.

### PROPOSED EXCEPTION REVIEWS AND CONCURRENCE

Note reviews by HQ Traffic Operations, the District Liaison and District Office of Traffic Systems. Give dates of reviews and discuss any comments that were made and their disposition.

### REMARKS

Note clarifying remarks. Discuss impacts on project delivery schedule and project costs, if any. Discuss impacts of ramp metering policy non-compliance features.

### ATTACHMENTS

Provide a locations map and/or vicinity map for the project, indicating the location of the requested exception(s) to the ramp metering policy. Also provide cross-sections and/or special details as necessary to illustrate the policy non-compliance condition. Letters, resolutions, traffic studies, etc., which help to clarify the reasons for the exception request, may be attached.

### SIGNATURE SHEET

The Fact Sheet signature page shall conform to the attached.

**FACT SHEET**

**EXCEPTION TO  
RAMP METERING POLICY**

(Insert Registered C.E. Seal)

**Prepared by:**

\_\_\_\_\_  
(Name), Registered C.E.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Telephone

**Approval recommended by:**

\_\_\_\_\_  
(Name), Project Manager

\_\_\_\_\_  
Date

\_\_\_\_\_  
Telephone

**Concurrence by:**

\_\_\_\_\_  
(Name), District Liaison  
HQ Traffic Operations

\_\_\_\_\_  
Date

\_\_\_\_\_  
Telephone

**Approved by:**

\_\_\_\_\_  
(Name), District Division Chief,  
Operations

\_\_\_\_\_  
Date

## Memorandum

**To:** DISTRICT DIVISION CHIEFS – Operations      **Date:** July 31, 2000  
DISTRICT DIVISION CHIEFS – Design  
DISTRICT DIVISION CHIEFS – Planning      **File:**

**From:** DEPARTMENT OF TRANSPORTATION  
Traffic Operations  
Mail Station 36

**Subject:** Ramp Metering Policy on High Occupancy Vehicle (HOV) Preferential Lanes

The purpose of this memorandum is to clarify and re-affirm the California Department of Transportation (Caltrans) policy on HOV preferential lanes at ramp meter locations. Caltrans is committed to its current policy: **An HOV preferential lane shall be provided at all ramp meter locations.**

The January 2000 edition of the Ramp Meter Design Manual now addresses the circumstances under which exceptions to this policy may be warranted. See ‘Modifications to Existing HOV Preferential Lanes’ located in Section ‘I’ of Chapter One:

- Underutilization of an existing lane plus the need for additional right-of-way for storage
- The availability of an alternate HOV entrance ramp within 2 Km
- The availability of a direct HOV access (drop) ramp

Exceptions shall be handled on a location-by-location basis. Conversions may require Federal Highway Administration actions or concurrence. The District Division Chief for Operations, in consultation with the Headquarters Traffic Operations Liaison, is responsible for approving and documenting decisions to remove HOV preferential lanes. These policies and exceptions also apply to new and reconstruction projects. Districts should refer to the “Exception to Ramp Metering Policy” located in the Appendix of the Ramp Meter Design Manual or contact your Headquarters Traffic Operations Liaison for assistance.

### Original Signed By

KIM NYSTROM  
Program Manager  
Traffic Operations

cc: Mr. Robert Buckley  
Program Manager  
Design and Local Programs

Ms. Joan Sollenberger  
Program Manager  
Transportation Planning

## RAMP METERING TRACKING SYSTEM

Example of a portion the spreadsheet for tracking ramp metering surveillance widgets:

DISTRICT 7					OCTOBER 2011					
# RAMP METERING SURVEILLANCE WIDGETS TO REPORT TO HQ:									90.1	
WEIGHTED # OF MAIN TASKS COMPLETED:					393.3	11.8	0.2	99.2	34.4	2.0
# OF SUB TASKS COMPLETED:					3146	118.0	1.0	496.0	275	4.0
RAMP METERING SURVEILLANCE SUB TASK COMPLETION LOG										
<i>each time a sub task is completed at a location, add 1 to the applicable main task</i>										
<b>ROUTE 405</b>										
County	Postmile	Direction	Location	Ramp Type	Tasks					
					1	2	3	4	5	6
LA	47.62	S	Rinaldi St	Diamond	2	0	0	3	0	0
LA	47.28	S	San Fernando Mission Rd	Loop	2	0	0	2	0	0
LA	46.28	S	Devonshire St WB	Hook	3	0	0	3	0	0
LA	46.10	S	Devonshire St EB	Diamond	2	0	0	2	0	0
LA	44.62	S	Nordoff St	Hook	3	0	0	2	3	0
LA	43.61	S	Roscoe Blvd	Hook	2	0	0	3	1	0
LA	42.40	S	Sherman Way WB	Loop	3	0	0	3	2	0
LA	42.25	S	Sherman Way EB	Hook	1	0	0	4	1	0
LA	41.48	S	Victory Blvd WB	Hook	2	0	0	2	2	0
LA	41.31	S	Victory Blvd EB	Loop	2	0	0	2	3	0
LA	40.08	S	Burbank Blvd	Hook	3	0	0	3	2	0
LA	39.09	S	Ventura Bl.	Loop	3	0	0	2	1	0
LA	38.42	S	Valley Vista Bl.	Angle	5	0	0	3	2	0
LA	36.25	S	Skirball/Muholland Dr.	Angle	3	0	0	2	3	0
LA	34.73	S	Getty Center Dr.	Angle	4	0	0	1	2	0
LA	33.05	S	Sunset WB/Church Ln	Loop	6	0	0	3	1	0
LA	32.90	S	Sunset Bl. EB	Angle	7	0	0	4	2	0
LA	31.66	S	Wilshire Bl. WB	Loop	7	0	0	6	3	0
LA	31.39	S	Wilshire Bl. EB	Hook	9	0	0	3	3	0
LA	30.80	S	Santa Monica Bl.	Angle	5	0	0	3	2	0
LA	29.16	S	National Bl.	Angle	7	0	0	1	1	0
LA	27.81	S	Venice Bl.	Hook	8	0	0	2	2	0