Traffic Management Plan Study for State Route 91 During Construction of HOV Lanes

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California State Route 91 is slated for median reconstruction to provide high-occupancy vehicle (HOV) lanes in the corridor. On the basis of national experience, construction in the median of a highway can cause a 5 to 10 percent decrease in throughput. Because Route 91 is one of the ten most congested corridors in the state, some effort must be made to mitigate this throughput reduction. During the past few years, a number of construction traffic management measures have been implemented in Southern California and around the country. The success of these isolated attempts at relieving congestion caused by construction activities has spawned the development of Traffic Management Plans (TMPs). Local transportation officials requested that these types of measures be evaluated to determine which could be used in this corridor. Because there have been few before-and-after studies to quantify the effectiveness of TMP measures and because of the singular characteristics of the corridor, the background data that was collected had to be subjectively interpreted for its relevance in this evaluation. The purpose of this study is to evaluate possible TMP measures for their applicability to the Route 91 corridor, their ability to mitigate construction impacts, and their cost-effectiveness of implementation during HOV lane construction. Also considered were the benefits derived from the interdependent nature of many of the measures and their relative advantages and disadvantages.

Throughout California, many state highways are undergoing major reconstruction to provide additional capacity. Unfortunately, the highways most in need of reconstruction are usually operating at or near their existing capacity. This condition creates a special challenge to find ways to accommodate traffic at an acceptable level of service during the period of reconstruction.

During construction, additional demands are placed upon the freeway. Vehicle throughput—a measure of the number of vehicles that travel past a given point—often decreases because of narrowed lanes, elimination of medians or shoulders, the presence of gawk screens, k-rail barriers, heavy equipment, and resulting changes in driver behavior as motorists react to the reconfigured facility. This decrease in throughput may result in significant delays for motorists. Major construction activity can also disrupt adjoining neighborhoods and businesses and alter traffic patterns on nearby streets.

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PURPOSE OF TRAFFIC MANAGEMENT PLANS

A traffic management plan (TMP) is a specialized program to mitigate some of the impacts of an urban freeway construction project by applying several techniques including contractor controls, traffic management, transportation demand management, and public awareness measures. The measures that ultimately constitute a TMP are specific to the corridor in which they are applied and are designed to address the unique traffic, topographical, demographic, and political considerations of the area. The basic objectives of a TMP are to

- Develop a high level of awareness of potential impacts among residents, motorists, and the media and keep them informed about the project as it is implemented;
- Optimize person-carrying capacity through the project area by increasing vehicle occupancy;
- Maintain level of service through the reconstruction zone; and
- Provide affected residents and motorists with clear and understandable travel and routing alternatives to the affected area, where possible.

PURPOSE OF TMP STUDY

Parsons Brinckerhoff Quade & Douglas (PBQ&D) in association with Frank Wilson & Associates (FW&A) was selected to develop a process to review and evaluate various TMP measures and assess their applicability to the Route 91 high-occupancy vehicle (HOV) construction project (Figure 1). The process developed can be applied to other TMPs considered for other corridors.

TMPs are being implemented throughout California and the United States with the knowledge that they have been effective when applied in other corridors. However, not all TMP measures are applicable or effective in every case. The utility and effectiveness of a specific measure are dependent on the characteristics of the corridor and the needs of the project. Because few TMPs have been implemented in Southern California, there is little data to defend a particular type of TMP. However, an adequate data base of experience exists for each of the individual measures studied.

This study seeks to evaluate TMP measures to design a TMP that is responsive to the specific needs of the Route 91 corridor and provide the most effective means of mitigating construction-related traffic congestion. This study provides

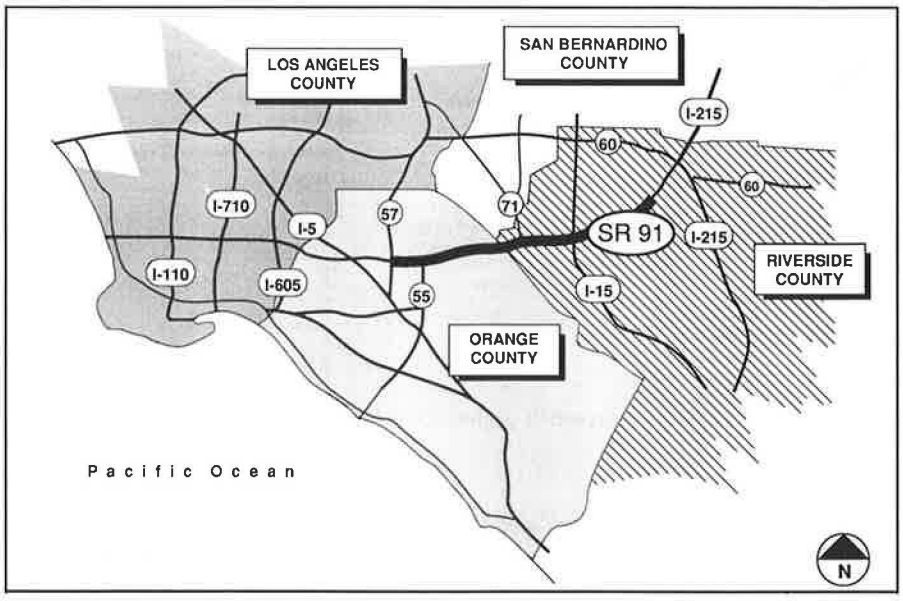


FIGURE 1 Route 91 TMP study limits and corridor location in Southern California.

the sponsoring agencies with information about various TMP measures found to be applicable to the Route 91 project, evaluates each measure with respect to its relative effectiveness, and recommends a TMP for this project.

PROJECT BACKGROUND

Description

The Riverside County Transportation Commission (RCTC), the Orange County Transportation Commission (OCTC), and California Department of Transportation (Caltrans) have embarked on a program that addresses the traffic congestion along Route 91 between the 23.8 mile project limits of Magnolia Avenue in Riverside County and State Route 57 in Orange County. Current levels of service range between D and F in the peak periods. The program includes construction of HOV lanes, installation of ramp meters and HOV bypass lanes, and implementation of other auxiliary features to augment the throughput of the facility.

The Route 91 HOV construction activities are segregated into five basic projects, each being designed by a separate consultant team. In addition, overcrossing replacements in the city of Corona are under design by a sixth consultant team. The designers were contacted to provide the TMP evaluation team with information about construction impacts and phasing and construction and implementation schedules (Figure 2).

In general, disruption of mainline traffic during daylight hours is not proposed by any of the section designers. Some temporary lane and ramp closures will occur because of specific construction tasks (i.e., placement of temporary k-railing and construction striping), but most of these closures are planned to occur at night and only for short periods (from 11 p.m. to 4 a.m.). Some ramp closures will extend around the clock for several days. Only one section designer proposes to detour the mainline traffic to local streets. All of the designers plan to restrict some mainline lane widths to 11 feet during construction.

Coordination with Cities and Other Local Agencies

Within the project limits of this study, Route 91 traverses two counties (Riverside County and Orange County) and four cities (Riverside, Corona, Yorba Linda, and Anaheim) and directly influences two others (Orange and Placentia). There is also a variety of utility companies as well as other local and regional authorities with some vested interest in the corridor. These include the California Highway Patrol (CHP), the Automobile Club of Southern California, the Orange County Transit District (OCTD), the Riverside Transit Agency, the Rapid Transit District, the Orange County Environmental Management Agency, the South Coast Air Quality Management District, and the Army Corps of Engineers.

Each of these jurisdictions was contacted and asked to provide input into the TMP planning process. The resulting study was a combination of the project needs of governing agencies.

MEASURES STUDIED

The project team convened several meetings with RCTC, OCTC, Caltrans Districts 8 and 12, OCTD, and Commuter Transportation Services Riverside staff to review and discuss the TMP measures evaluated in this study. The project team and agencies identified a comprehensive list of TMP measures

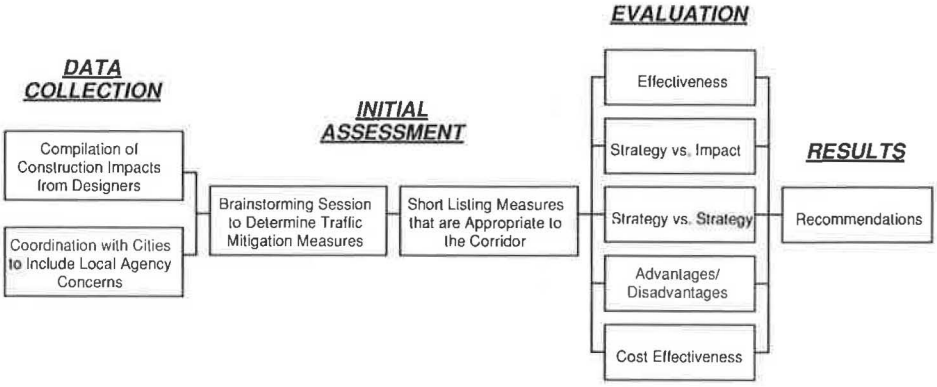


FIGURE 2 Route 91-HOV construction project TMP evaluation process.

that would be applicable to the Route 91 corridor. The measures were grouped as follows:

- Public awareness measures: TMP measures that communicate project information to residents, employers, commuters, the media, or public officials;
- On-site measures: TMP measures implemented on the freeway itself to improve throughput on the mainline during the project; and
- Off-site measures: TMP measures implemented off the mainline of the freeway but contribute to decreasing mainline vehicle demand or assist in increasing average vehicle ridership (AVR).

The project team developed a list of 37 TMP measures that applied to the three classes. TMP elements that were similar were combined. The project team then identified a shortlist for each class on the basis of estimated cost, probability of implementation, and applicability to the Route 91 corridor.

A list of TMP measures studied follows.

Public Awareness Measures

News Bureau

A news bureau is an information clearinghouse through which all project-related information is gathered, formatted, and ultimately communicated to the public. A news bureau is organized to receive, translate, and disseminate information in a consistent, timely manner. News bureaus are responsible for both initiating contact with, and responding to, inquiries from the media.

Fact Sheets and Brochures

Collateral material, such as fact sheets and brochures, is developed and produced to communicate specific messages to targeted audiences. For example, the media may require detailed fact sheets about project segments, including contractor information, cost, project limits, and traffic mitigation measures. Residents and local businesses, on the other hand, may not need as much detailed information and would be primarily concerned with construction duration and effects on local streets. Employers and commuters would want to know the impact of construction on their daily commutes as well as receive park-and-ride, carpool, and vanpool promotional information. To meet these different information needs, several types of collateral pieces with varying quantities might be developed.

Highway Advisory Radio

Highway Advisory Radio (HAR) is a low-range broadcast station that provides construction and traffic information to the motoring public in a specific area. HAR stations usually have a reach of 2½ miles from the transmitter location. Transportation agencies, such as Caltrans, airport authorities, cities, and counties use HAR to communicate traffic and parking information or to handle special traffic situations.

Because HAR stations are licensed by the FCC for traffic information only, the broadcasts can take on true public service features. Messages are usually prepared at a broadcast station and then transmitted by data phone lines to the transmitter. Broadcasts may be simple or sophisticated, but the most successful HAR stations have daily updated broadcasts, with a professional radio voice, and use feature segments that are pertinent to a particular construction corridor.

Project Information Telephone Helpline

A project information telephone helpline can provide an important link between the agencies and the public. A TMP helpline is usually established to answer specific questions about a construction project. Typical questions concern construction timetables and information on ramp closures. The helpline also serves as a means of responding to complaints about the construction project or various TMP elements.

Project Briefings to Public Officials

Project briefings to public officials and staff can be critical to the success of a TMP. Regular project briefings can help

involve opinion leaders in the project and lend credibility to and extend the reach of the public awareness effort.

On-Site Measures

Roving Tow Service

Roving contract tow services have proven to be a quick and efficient means of clearing disabled vehicles from freeways when median and shoulder access is limited. Services such as the Orange Angels in Orange County and the Ventura Improvement Program Tow Service in Los Angeles County perform minor repairs to remove stranded vehicles and motorists from the freeway at no charge. Roving tow services usually operate in the most heavily congested portion of the construction zone from the beginning of the morning peak to the end of the evening peak.

Ramp Metering

Ramp meters can be used during construction to restrict the flow of vehicles entering the freeway during an incident or in the rush hour. This function can be controlled either by detector loops in the mainline (in addition to the standard ramp meter loop installation) or through a Traffic Operations Center.

Immediate operation of the ramp meters, before beginning median construction, will help maintain throughput on the freeway. Aggressive and timely use of ramp meters will provide a smoother flow of traffic on the mainline. Ramp meters have the added effect of providing long-term benefits well after the construction is completed.

Mobile Changeable Message Signs and Incident Response

Coordination between the CHP and the various transportation agencies can ensure that traffic handling procedures are in place and equipment and personnel are allocated to handle major incidents and planned lane closures. Both Caltrans districts 12 and 8 have incident response units with mobile changeable message signs available to handle such events.

Traffic Operations Center, Mainline Loop Detectors, and Closed Circuit Television

A traffic operations center (TOC) works in conjunction with mainline loop detectors and closed circuit television to collect traffic information and data and provide a real-time response to changing traffic conditions. It monitors mainline flow, provides dispatch service to send emergency vehicles to an incident, or utilizes ramp meters to regulate the flow entering the freeway. A TOC is a command and control center that oversees the operation of a facility. To be fully effective, a TOC should monitor an entire region, not just one freeway.

Controls on Contractor Operations

The objectives of a TMP may be enhanced by specifying and enforcing controls on contractor operations. The most basic control is a restriction on the hours of construction operations. A typical control prohibits lane closures during daylight hours, during legal holidays, or during special events expected to generate above average traffic congestion. Another control might restrict contractors from consecutive ramp closures on the mainline. Contract provisions can also be included to require advance notification of closures to a traffic information center. In addition, contracts can be structured to include cost reduction incentive proposals that encourage early completion under budget.

Off-Site Measures

Rideshare Promotion and Employer Outreach

Linking people with similar origins and destinations through a commuter survey and public awareness and incentive program can foster ridesharing both during and after a construction project. Use of a commuter matching service has been an effective method of providing these services.

Vanpool Incentive Program

Vanpools provide commuters with another way to get to work. The vanpooling concept can best be applied in cases where several employees of a company or office building live near each other. Subsidizing a vanpool start-up or seed fleet or offering cash incentives to riders can make vanpooling attractive to more commuters. If fifteen vanpools—each carrying an average of 12 people between work and home each day—are subsidized by the TMP, 165 vehicles can be removed from the freeway during the peak periods. Alhough this is only 1 to 1.5 percent of the current peak-hour volume on Route 91, the vanpool incentive program in combination with other measures could make a difference in the level of service experienced on the facility.

Leased Park-and-Ride Lots

The availability of adequate park-and-ride lots or rideshare staging areas help support carpooling, vanpooling, and transit programs. There is a strong commitment to developing park-and-ride lots in both Riverside and Orange counties. On the basis of existing and projected number of carpools and vanpools, there is a current need for 1,000 spaces, and that number is expected to increase after construction and implementation of the HOV lanes. The project team estimates that at least 2,000 to 2,500 spaces will be needed to have a significant impact on congestion.

Alternate Routes and Local Street Improvements

Rerouting freeway traffic off the facility to avoid construction congestion will have an impact on the surrounding surface arterial network. Relatively simple and inexpensive roadway improvements such as restriping can sometimes solve localized traffic bottleneck problems. In other cases, increased street traffic may require upgrading an intersection with a

traffic signal or adding left, right, or both left and right turn lanes or, in the extreme case, adding additional lanes to the street.

Project Information Center

A Project Information Center (PIC) is used as an information gathering and processing center. A PIC can collect construction and maintenance schedules and relay this information to affected agencies such as CHP, Caltrans, paramedics, and so on. PIC can also function as a public information center where a helpline is manned to answer questions regarding construction on the freeway.

Telecommuting Pilot Project

Modern technology can eliminate much of the need for daily face-to-face contact with co-workers. Telephones, computer modems, and fax machines have all increased the accessibility of information from remote locations. Telecommuting uses this technology to reduce commuter traffic on the freeways. A pilot telecommuting project for the Route 91 corridor can serve to remove vehicles from the mainline. Opportunities for a public-private partnership exist where seed monies could be provided for project implementation.

EVALUATION

The evaluation of the shortlist of TMP measures was performed by a team composed of PBQ&D and FW&A staff with relevant and specific experience in TMPs and related experience in transportation planning, traffic management, engineering and public awareness, and media relations.

A concise description of each TMP measure was prepared and customized to the unique characteristics of the Route 91 corridor. The evaluation team then subjected each measure to a multistage evaluation process that ranked the measures into three groups:

- Essential components: 1st priority—measures that should be implemented immediately upon adoption of a TMP;
- Beneficial components: 2nd priority—important, would enhance the effectiveness of the TMP; and
- Desirable components: 3rd priority—important, but not critical to meeting the TMP objectives.

Each TMP measure was evaluated against criteria established by the evaluation team and given a numerical score. Each measure was arrayed in five different tables as follows:

- Effectiveness of TMP measures: evaluated the measure against the six key TMP objectives;
- Strategy versus construction impacts matrix: evaluated the measure in light of facility operational conditions and considerations;
- Strategy versus strategy matrix: evaluated the measure in its relationship with other measures, especially its ability to enhance, complement, or reinforce other measures;
- Advantages and disadvantages of TMP measures: evaluated the relative pros and cons of each measure; and
- Summary of cost-effectiveness for recommended TMP measures: evaluated the relative cost-effectiveness of each TMP.

The results and scores from each evaluation stage were compiled into a final summary table, from which this report's recommendations were formulated.

Effectiveness of TMP Measures

Quantitatively determining the effectiveness of TMP measures was a several step process. First, a list of objectives was developed against which the measures could be compared. From this list, each measure was scored and given a weight that indicated the overall effectiveness of the measure in the Route 91 corridor.

Objectives

The TMP measures were grouped according to public awareness, on-site measures, and off-site measures and then evaluated against six objectives that, if achieved, would result in an effective TMP. The weightings developed were site specific.

- Objective 1: Public Awareness—Weighted 5. This objective is intended to measure the ability of a TMP measure to inform and educate the public of the HOV construction project. The benchmark for this objective is a public opinion survey, which indicated that 50 percent of survey respondents had an awareness of the project.

1. Public Awareness/Understanding/Acceptance

Weight	Description
1	Basic project awareness
2	Greater project awareness, lacks specific details
3	Understanding of project specifics—enough information to make choices
4	Specific details for project segments. Cooperation with/acceptance of project
5	In depth knowledge/acceptance of the project—could serve as project advocate

2. Frequency of Message

Weight	Description
1	Communicates message as needed
2	Communicates message less frequently—quarterly
3	Communicates message monthly
4	Communicates message weekly
5	Communicates message daily

3. Reach of Message/Number of People

Weight	Description
1	Communicates message to few people
2	Communicates message to targeted groups or organizations
3	Communicates message to specific audience segments

4 Communicates message to most of the audience
5 Communicates message to all of the audience

4. Message Life
Weight Description
1 One day message life
2 Several days message life
3 One week message life
4 Several weeks message life
5 Thirty days or more message life

5. Route 91 HOV Construction Project Visibility
Weight Description
1 Provides little or no project visibility—no direct connection to the project
2 Visible some of the time—has limited connection to the project
3 Moderately visible—may or may not be connected with the project
4 Moderate visibility with direct connection to the project
5 Direct connection with the project—high visibility

• Objective 2: Mainline Throughput—Weighted 5. This objective is aimed at addressing operational impacts on the facility that can affect throughput. It is estimated that throughput will be decreased 5 to 10 percent as a result of the construction. This objective will help determine the applicability of the TMP measures to maintaining a high level of operation.

1. Obstructions/Bottlenecks
Weight Description
1 Does not apply—no impacts on obstructions or bottlenecks
2 Responds to obstructions or bottlenecks within a week
3 Responds to obstructions or bottlenecks within a day
4 Responds to obstructions or bottlenecks within an hour
5 Responds to obstructions or bottlenecks immediately

2. On-line Operational Communications
Weight Description
1 Does not provide operational communication
2 Regular transmission of on-line operational information
3 Provides on-line operational information feedback and transmission
4 Provides immediate operational information
5 Provides on-line operational command and control

• Objective 3: Mainline Vehicle Demand—Weighted 5. This objective is intended to gauge the impact the TMP measures will have on demand. Decreased demand can be achieved either by reducing the number of person trips that need to be made through the corridor or by increasing the average vehicle ridership. This objective addresses an overall reduction of vehicle trips.

1. Mainline Vehicle Demand Management
Weight Description
1 No impact on mainline demand management
2 Slight impact on demand reduction
3 Occasionally reduces demand (incident related, no regularity of impact)
4 Reduces demand on a regular basis (2–3 times per week)
5 Reduces demand daily

• Objective 4: Ease of Implementation—Weighted 2. This objective addresses the ease with which the TMP measures can be implemented. It indicates the degree to which funds, equipment, personnel, or all of these are already dedicated to each of the measures and provides an indication of the amount of lead time needed to implement that measure.

1. Degree to which it is currently implemented
Weight Description
1 Not programmed—not funded
2 Resources exist—not programmed specific to Route 91
3 Programmed—needs additional funding specific to Route 91
4 Programmed—majority of funding secured
5 Already programmed and fully funded

2. Time to Implement
Weight Description
1 1+ year lead time to implement
2 9 months to implement
3 6 months to implement
4 3 months to implement
5 Immediate project implementation (within 30 days)

• Objective 5: Project Responsiveness—Weighted 3. This objective evaluates the flexibility of the TMP element to changing project conditions.

1. Response during peak and off-peak periods
Weight Description
1 Nonresponsive to changing conditions
2 Marginally responsive to changing conditions
3 Responsive to changing conditions during daylight business hours only
4 Responsive from beginning AM peak to the end of the PM peak
5 Responsive to changing conditions peak and off-peak periods

2. Ease of use by motorists
Weight Description
1 Requires a change in behavior/lifestyle for user
2 Not easily adaptable—requires education, persuasion, or both
3 User friendly—requires education and time to adapt
4 User friendly—requires time to adapt
5 User friendly—requires no change in behavior or education

• Objective 6: Facility Safety—Weighted 3. Safety is an important consideration of a TMP. As such, this objective addresses the ability of a TMP element to improve safety for the work force and the motoring public. This objective was designed to measure TMP elements that go beyond the usual and required safety precautions implemented in all construction projects.

1. Safety for the workforce and motoring public
Weight Description
1 Does not contribute to worker or motorist safety

2 Heightens awareness of safety issues
3 Promotes safe driving habits and worker safety
4 Monitors on-line conditions—improves off-line operating conditions
5 Creates safe operating conditions

The six objectives were given weights based on their presumed level of significance in the overall evaluation. Although each of the objectives is important to the TMP, some of the objectives carry a greater significance in the evaluation process than do others and as such are more heavily weighted. That is to say that public awareness and mainline throughput (both weighted 5) were deemed more significant in the overall weighting than was ease of implementation (weighted 2).

Scoring

An average score for each of the objectives was found on the basis of the score given for each of the criteria. This average was then multiplied by the weight given to the objective and added to give a total weight. A maximum of 110 points and a minimum of 22 points was possible for each measure.

A "percentage of criteria met" was calculated to provide a clearer indication of the degree to which each measure addressed the needs of the TMP. The maximum score, 110 points, was considered to meet 100 percent of the criteria and the minimum score, 22 points, met 0 percent of the criteria. A score of 66 points (halfway between 110 and 22) was considered to have met 50 percent of the criteria.

It is important to note that few of the TMP measures garnered even half of the 110 possible points. This indicates that no one measure can, by itself, serve as the TMP. A network of several measures should be put in place to ensure adequate attention to all of the impacts to the corridor.

Example: The News Bureau received average scores of 3.8, 1.5, 3, 3.5, 3, and 2 under each of the six objectives. These scores were multiplied by the weights of the objectives (5, 5, 5, 2, 3, and 3, respectively), then added, to give a total weight of 63.5.

$$(3.8 \times 5) + (1.5 \times 5) + (3 \times 5) + (3.5 \times 2) + (3 \times 3) + (2 \times 3) = 63.5$$

The weighting then becomes a percentage, in this case 47 percent. This percentage is an indicator of how many of the criteria are met by this measure (Table 1). However, the TMP cannot be formed by using enough of the measures to add up to 100 percent because the measures overlap in many categories. The recommended measures should cover all areas of concern.

TABLE 1 EFFECTIVENESS OF TMP MEASURES

Measures / Objectives	Public Awareness Objective Weight = 5	Mainline Throughput Objective Weight = 5	Mainline Vehicle Demand Objective Weight = 5	Ease of Implementation Objective Weight = 2	Project Responsiveness Objective Weight = 3	Facility Safety Objective Weight = 3	Total Weight	Percent Criteria Met
Group I -- Public Awareness Measures								
1 NEWS BUREAU	3.8	1.5	3.0	3.5	3.0	2.0	63.5	47%
2 FACT SHEETS/BROCHURES	3.4	1.0	2.0	2.5	2.5	3.0	53.5	36%
3 HIGHWAY ADVISORY RADIO (HAR)	3.2	3.0	3.0	2.5	4.0	3.0	72.0	57%
4 PROJECT INFORMATION LINE	2.2	2.0	1.0	4.5	3.5	1.0	48.5	30%
5 PROJECT BRIEFINGS TO PUBLIC OFFICIALS	3.0	1.0	1.0	3.5	2.0	2.0	44.0	25%
Group II -- On-Site Measures								
1 TOW SERVICES	2.6	4.5	1.0	1.5	4.5	5.0	72.0	57%
2 RAMP METERING	3.0	5.0	3.0	3.0	4.0	5.0	88.0	75%
3 MOBILE CMS/INCIDENT RESPONSE	1.2	4.0	1.0	3.0	4.5	5.0	65.5	49%
4 TOC, DETECTORS AND CLOSED CIRCUIT TV	2.4	5.0	1.0	1.0	2.0	4.0	62.0	45%
5 CONTROLS ON CONTRACTOR OPERATIONS	1.6	1.5	1.0	4.5	5.0	5.0	59.5	43%
Group III -- Off-Site Measures								
1 RIDESHARE PROMO/EMPLOYER OUTREACH	3.8	1.0	4.0	4.0	1.0	1.0	72.0	57%
2 VANPOOL INCENTIVE PROGRAM	1.6	1.0	5.0	2.5	1.0	1.0	52.0	34%
3 LEASED PARK-AND-RIDE LOTS	2.2	1.0	4.0	3.0	2.0	1.0	57.0	40%
4 ALTERNATE RTES/LOCAL STREET IMPROVE	2.8	2.5	3.0	1.5	4.0	4.0	70.0	55%
5 PROJECT INFORMATION CENTER	2.4	3.0	1.0	2.5	2.0	3.0	49.0	31%
6 TELECOMMUTING PILOT PROJECT	1.4	1.0	4.0	2.0	1.5	1.0	45.5	27%

Strategy Versus Construction Impact Matrix

From the discussions with the section designers, four construction requirements were identified as issues that would have a physical impact on the freeway.

- Selected lanes will be narrowed from 12 ft to 11 ft wherever construction was taking place.
- The left (or inside) shoulder will be lost to the construction zone. Adding HOV lanes requires removal of the existing shoulder pavement and replacing it with structural pavement. The right shoulder will only be replaced in isolated locations. It is anticipated that this will not cause severe disruptions. However, the installation of barriers and gawk screens that accompanies the removal of the shoulder will create a certain amount of friction on the mainline.
- Night detours will occur in the area of the Route 55/91 interchange during its reconstruction period. This will include mainline detours on the facility (no routing off the facility is anticipated at this time). Night detours from the mainline will be imposed during demolition activities at four overcrossings in the city of Corona.
- Lane and ramp closures will be in effect in some locations, but only during off-peak hours (between 11:00 p.m. and 4:00 a.m.).

Each of the TMP measures was then compared to the anticipated impacts to determine which would be able to mitigate some or all of the negative effects these practices would have on Route 91 during construction (Table 2).

Some TMP measures will be directly involved in alleviating congestion caused by the construction impacts—detour management teams will be on the freeway directing traffic in the case of a night detour—whereas others will be educational tools that will inform residents and the motoring public of the construction situation so that there are no surprises. The news bureau, for example, could inform residents and commuters of any night detours that are planned.

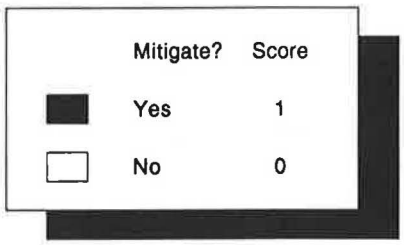
Once it was determined whether or not a particular TMP measure addressed the construction impacts, a score was given (1 point was given if the measure did address an impact and 0 if it did not). This score was then transferred to the summary chart to be used later in the analysis.

Strategy Versus Strategy Matrix

Although any one of the TMP measures could be implemented on its own and provide some benefit to the corridor during construction, many are influenced by the implementation of certain other measures. This interactive and rein-

TABLE 2 STRATEGY VERSUS CONSTRUCTION IMPACT MATRIX

Does implementation of Measure Y help mitigate the effects of Impact X? / Measure Y — Impact X	NARROWED LANES	NO INSIDE SHOULDER	NIGHT DETOURS	LANE AND RAMP CLOSURES	Total of Mitigation	Percent of Impacts Mitigated
Group I -- Public Awareness Measures						
1 NEWS BUREAU	■	■	■	■	4	100%
2 FACT SHEETS/BROCHURES	■	■	■	■	4	100%
3 HIGHWAY ADVISORY RADIO (HAR)			■	■	2	50%
4 PROJECT INFORMATION LINE			■	■	2	50%
5 PROJECT BRIEFINGS TO PUBLIC OFFICIALS	■	■	■	■	4	100%
Group II -- On-Site Measures						
1 TOW SERVICES	■	■			2	50%
2 RAMP METERING					0	0%
3 MOBILE CMS/INCIDENT RESPONSE		■	■	■	3	75%
4 TOC, DETECTORS AND CLOSED CIRCUIT TV	■	■	■	■	4	100%
5 CONTROLS ON CONTRACTOR OPERATIONS	■	■	■	■	4	100%
Group III -- Off-Site Measures						
1 RIDESHARE PROMO/EMPLOYER OUTREACH					0	0%
2 VANPOOL INCENTIVE PROGRAM					0	0%
3 LEASED PARK-AND-RIDE LOTS					0	0%
4 ALTERNATE RTES/LOCAL STREET IMPROVE			■		1	25%
5 PROJECT INFORMATION CENTER		■	■	■	3	75%
6 TELECOMMUTING PILOT PROJECT					0	0%



forcing influence underscores the TMP's utility and should be exploited.

Each of the TMP measures was compared to the rest by posing the question, "Is the success or impact of this TMP measure, measure X, enhanced or improved by the implementation of that TMP measure, measure Y?" (See Table 3.)

Again, some TMP measures will directly reinforce the impact of other measures and some measures will inform the motoring public about the existence and benefits of other measures. But in some cases, the support provided by a particular measure is only of a moderate degree or of a conditional nature. For example, park-and-ride lots do not directly enhance or support rideshare promotion activities; that is, they are not directly related to the production or distribution of promotional materials the way the news bureau is. However, the mere existence of park-and-ride lots provides an incentive to rideshare. When adequately promoted as a part of ridesharing, park-and-ride lots enhance the potency of the ridesharing message.

Once it was determined whether or not a particular TMP measure reinforced the success of another, a score was given (2 points were given if the measure did enhance another, 1 point if there was some moderate degree of enhancement, and 0 if a measure did not enhance another at all). This score was then transferred to the summary chart to be used later in the recommendation analysis.

Statement of TMP Measure Advantages and Disadvantages

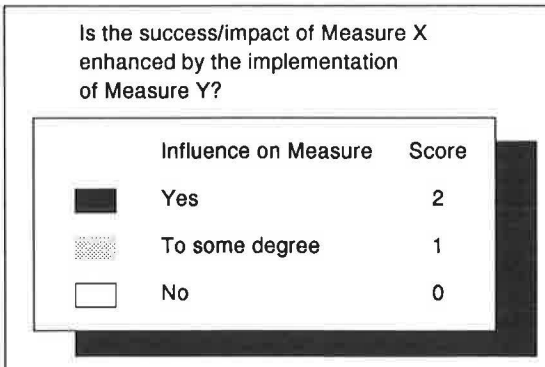
Although the tables previously discussed provide much information about each of the TMP measures studied, none offers much insight into the advantages and disadvantages of each measure. Although the tables give a quantitative ranking of each TMP measure, a listing of the advantages and disadvantages provides a qualitative description of the characteristics of each measure. A listing of advantages and disadvantages was developed but not included in this paper as the information was site specific.

Cost-Effectiveness

One of the objectives of this study was to evaluate the cost-effectiveness of various TMP measures. The evaluation team found this to be a particularly difficult task to perform because the cost-effectiveness of some measures was difficult to quantify.

It was not the purpose of this analysis to define which measures should be pursued and which should be discarded. This was performed in earlier steps of the TMP evaluation. Rather, this analysis provides a means of determining the

TABLE 3 STRATEGY VERSUS STRATEGY MATRIX



Measure Y / Measure X	NEWS BUREAU	FACT SHEETS/BROCHURES	HIGHWAY ADVISORY RADIO (HAR)	PROJECT INFORMATION LINE	PROJECT BRIEFINGS TO PUB OFF	TOW SERVICES	RAMP METERING	MOBILE CMS/INCIDENT RESPONSE	TOC, DETECTORS AND CCTV	CONTROLS ON CONTRACTOR OPS	RIDESHARE PROMO/EMP OUTREACH	VANPOOL INCENTIVE PROGRAM	LEASED PARK-AND-RIDE LOTS	ALT RTES/LOCAL STREET IMPROVE	PROJECT INFORMATION CENTER	TELECOMMUTING PILOT PROJECT	Total Influence on Other Measures	Percent Influence on Other Measures
Group I -- Public Awareness Measures																		
1 NEWS BUREAU		2	1	2	2		2	2	1	0	2	2	2	2	1	2	23	77%
2 FACT SHEETS/BROCHURES	1		2	1	2		1	2	0	0	1	1	1	2	0	1	15	50%
3 HIGHWAY ADVISORY RADIO (HAR)	1	0		0	0		2	0	0	0	2	0	0	1	0	0	6	20%
4 PROJECT INFORMATION LINE	2	1	2		0		1	0	0	0	1	2	2	2	1	2	17	57%
5 PROJECT BRIEFINGS TO PUBLIC OFFICIALS	1	1	0	0			2	2	0	0	2	2	2	2	0	2	16	53%
Group II -- On-Site Measures																		
1 TOW SERVICES	0	0	2	0	0		0	0	0	0	0	0	0	0	2	0	4	13%
2 RAMP METERING	0	0	0	0	0			0	0	0	1	2	0	0	0	0	3	10%
3 MOBILE CMS/INCIDENT RESPONSE	0	0	2	0	0	1	0		0	2	0	0	0	0	2	0	7	23%
4 TOC, DETECTORS AND CLOSED CIRCUIT TV	2	0	2	0	0	2	2	2		0	0	0	0	1	1	0	12	40%
5 CONTROLS ON CONTRACTOR OPERATIONS	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0%
Group III -- Off-Site Measures																		
1 RIDESHARE PROMO/EMPLOYER OUTREACH	0	0	0	0	0	0	0	0	0	0		2	2	0	0	2	6	20%
2 VANPOOL INCENTIVE PROGRAM	0	0	0	0	0	0	0	0	0	0	0		2	0	0	0	2	7%
3 LEASED PARK-AND-RIDE LOTS	0	0	0	0	0	0	0	0	0	0	1	2		0	0	0	3	10%
4 ALTERNATE RTES/LOCAL STREET IMPROVE	0	0	0	0	0	0	1	0	0	0	0	0	0		0	0	1	3%
5 PROJECT INFORMATION CENTER	2	2	1	1	1	0	0	2	1	2	0	0	0	2		0	14	47%
6 TELECOMMUTING PILOT PROJECT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0%

relative priority of various recommended measures that have already met much scrutiny for their appropriateness to this study.

The cost-effectiveness methodology builds on a comparison between current estimates of cost and an understanding of the effectiveness that could be considered in the context of this project. Costs are inclusive of cost commitments for the concept, either defined for commitment on this project or already committed.

The effectiveness ranking is composed of two factors: a group ranking and an individual ranking (Table 4). The group ranking was determined on the basis of an understanding of the relative benefits derived from the collective implementation of these measures. Public awareness measures were felt to have the highest potential for improving public understanding and changing commute patterns. This group received the highest ranking of 3.

On-site measures were felt to have greater potential than off-site measures in mitigating demand on the freeway. There are point-specific locations where on-site measures are particularly critical. This group received a ranking of 2.

The balance of the measures in off-site measures received a 1 ranking. These measures were felt to be complementary to the TMP, but their benefits were more long-term and difficult to quantify when placed in perspective with construction activities.

Individual rankings were made within each grouping, on the basis of an understanding of how each would be applied on this project and the incremental benefit that each had to others in the overall TMP. Some values tied in the ranking process.

The overall effectiveness ranking was obtained by multiplying the group rank by the individual rank. The resulting percentage was then divided by the cost percentage to yield a cost-effectiveness ratio. The value of the ratio is of lesser importance than grouping each within a range of relative priorities.

Results indicate that various priorities are found in each grouping. The basis for priority is quite often a direct reflection of total cost, at least for the more expensive measures. Measures that reflect lower priorities should not be discarded, but rather, be given more scrutiny during implementation to ensure that they are meeting intended objectives. Some lower priority measures are also more favorable in a broader regional context in which their incremental benefits are shared by other projects; this analysis does not address these interrelationships and agency commitments to selected measures (e.g., TOC, rideshare promotion, etc.).

TABLE 4 SUMMARY OF COST-EFFECTIVENESS FOR RECOMMENDED TMP MEASURES

	Cost	Effectiveness Ranking				Cost Effectiveness	
Measures	Percent of Total	Group Multiplier	Individual Multiplier	Rank	Percent of Total	Ratio of Effectiveness to Cost	Cost Effectiveness Index
Group I -- Public Awareness Measures							
1 NEWS BUREAU	11.20%	3	5	15	14.02%	1.25	HIGH
2 FACT SHEETS/BROCHURES	7.78%	3	4	12	11.21%	1.44	HIGH
3 HIGHWAY ADVISORY RADIO (HAR)	7.78%	3	3	9	8.41%	1.08	HIGH
4 PROJECT INFORMATION LINE	0.72%	3	4	12	11.21%	15.67	HIGH
5 PROJECT BRIEFINGS TO PUBLIC OFFICIALS	3.73%	3	1	3	2.80%	0.75	MODERATE
Group II -- On-Site Measures							
1 TOW SERVICES	23.34%	2	4	8	7.48%	0.32	LOW
2 RAMP METERING*	0.00%	2	3	6	5.61%	***	HIGH
3 MOBILE CMS/INCIDENT RESPONSE	3.11%	2	5	10	9.35%	3.00	HIGH
4 TOC, DETECTORS AND CCTV*	0.00%	2	1	2	1.87%	**	LOW
5 CONTROLS ON CONTRACTOR OPERATION*	0.00%	2	4	8	7.48%	***	HIGH
Group III -- Off-Site Measures							
1 RIDESHARE PROMO/EMP OUTREACH	19.60%	1	3	3	2.80%	0.14	LOW
2 VANPOOL PROGRAM	2.66%	1	3	3	2.80%	1.05	HIGH
3 LEASED PARK-AND-RIDE LOTS	7.00%	1	6	6	5.61%	0.80	MODERATE
4 ALT ROUTES/LOCAL STREET IMPROVE	3.11%	1	4	4	3.74%	1.20	HIGH
5 PROJECT INFORMATION CENTER	0.62%	1	5	5	4.67%	7.51	HIGH
6 TELECOMMUTING PILOT PROJECT	9.34%	1	1	1	0.93%	0.10	LOW
TOTALS				107	100.00%		

* Measure already proposed by others.

** TOC has relatively low priority because success of the TMP does not rest on immediate implementation.

*** Ramp Metering and Contractor Controls should be implemented immediately, but they carry no cost to the TMP.

Summary of Evaluation Matrices and Recommendations

The quantitative scores for each measure on each of the evaluation matrices were collected and arrayed in this summary matrix to make a recommendation for the TMP (Table 5). The recommendations are not made strictly on the point total each measure received, but involve the application of the advantages and disadvantages that were outlined.

Each measure was ranked essential, desirable, or beneficial, on the the basis of the evaluation and analysis performed. With the exception of the TOC, are all appropriate for inclusion in the Route 91 TMP. Some of the measures that received low effectiveness totals were considered essential because of the impact they have on implementation of other measures. Conversely, measures that may have ranked higher were considered highly desirable or beneficial because of cost or scheduling shortcomings.

It is clear from the analysis that no one or two TMP measures will effectively achieve the TMP objectives. Rather, a combination of many elements should constitute the Route 91 TMP. It is recommended that implementation of the TMP proceed in three phases:

Essential Components

These are first priority and need to be implemented immediately.

- Project information center—serves as the point of contact and clearinghouse for operational information related to the project.
- Roving tow service—recommended for the entire corridor to maintain throughput and remove stranded motorists from the mainline. Extremely positive public image.
- Mobile changeable message signs, incident response—purchase of incident response vehicles to support the TMP is recommended to provide motorists with information about mainline conditions.
- Controls on contractor operations—close coordination between project segments for construction scheduling, lane and ramp closures, and maintenance of mainline operations. Requires no direct funding commitments, but could reflect a modest increase in contract bids.
- Ramp metering in support of construction project—recommend aggressive use of ramp meters to maintain mainline throughput during construction.
- News bureau—translate project information for the media and the public. Serves as the focal point for public awareness activities.
- Fact sheets, brochures—targeted collateral materials designed to meet the needs of various audiences.
- Highway advisory radio—a corridor-wide public awareness and education tool that would broadcast Route 91 con-

TABLE 5 SUMMARY OF EVALUATION MATRICES AND TMP MEASURE RECOMMENDATIONS

Measures	Effectiveness of TMP Measure	Strategy vs. Strategy	Strategy vs. Impact	Cost Effectiveness Index	TMP Recommendation		
					Beneficial	Desireable	Essential
Group I -- Public Awareness Measures							
1 NEWS BUREAU	47%	77%	100%	HIGH			X
2 FACT SHEETS/BROCHURES	36%	50%	100%	HIGH			X
3 HIGHWAY ADVISORY RADIO (HAR)	57%	20%	50%	HIGH			X
4 PROJECT INFORMATION LINE	30%	57%	50%	HIGH		X	
5 PROJECT BRIEFINGS TO PUB OFF	25%	53%	100%	MODERATE			X
Group II -- On-Site Measures							
1 TOW SERVICES	57%	13%	50%	LOW			X
2 RAMP METERING	75%	10%	0%	HIGH			X
3 MOBILE CMS/INCIDENT RESPONSE	49%	23%	75%	HIGH			X
4 TOC, DETECTORS AND CCTV	45%	40%	100%	LOW	X		
5 CONTROLS ON CONTRACTOR OPS	43%	0%	100%	HIGH			X
Group III -- Off-Site Measures							
1 RIDESHARE PROMO/EMP OUTREACH	57%	20%	0%	LOW			X
2 VANPOOL INCENTIVE PROGRAM	34%	7%	0%	HIGH		X	
3 LEASED PARK-AND-RIDE LOTS	40%	10%	0%	MODERATE		X	
4 ALT RTES/LOCAL STREET IMPROVE	55%	3%	25%	HIGH		X	
5 PROJECT INFORMATION CENTER	31%	47%	75%	HIGH			X
6 TELECOMMUTING PILOT PROJECT	27%	0%	0%	LOW	X		

struction and maintenance information to motorists on the freeway.

- Project briefings to public officials and organizations—a systematic method of keeping public officials and opinion leaders informed about the project.
- Rideshare promotion and employer outreach—augment existing budgets to include additional staff to market ridesharing and vanpools to Orange County firms with a large number of Riverside County residents. Also provides additional funding for rideshare-specific targeted collateral material for employers.

Desirable Components

These are second priority—important and would greatly enhance the effectiveness of TMP objectives.

- Project information telephone line—direct existing project information line to include construction and maintenance information related to the Route 91 project.
- Park-and-ride lots—recommend allocating 75 percent of annual measure "A" Route 91 and Route 60 funds specifically to Route 91 for development of additional spaces through an innovative leasing program. Funded from measure "A" annual park-and-ride allocation.
- Alternate routes, local street improvements—recommend allocating funds to local jurisdictions as an incentive to move alternate route project up for early completion.
- Vanpool incentive program—recommend providing an incentive program to spur formation of new vanpools along Route 91.

Beneficial Components

These are third priority—important but not critical to meeting TMP objectives.

- Telecommuting pilot project—recommend promoting a public-private partnership in support of new technologies, such as telecommuting.
- Project traffic operation center, mainline loop detectors and closed circuit television—do not recommend pursuing this option at this time. We recommend that Caltrans Districts 8 and 12 pursue formation of a TOC independent of the Route 91 TMP.

CONCLUSIONS

During this analysis, TMP measures were classified by category—public awareness, on-site, or off-site measures. In reviewing final recommendations, a TMP system emerged that, in many cases, defied continued grouping by category. This system concept should be used in implementing the recommended measures (Figure 3).

What Lessons Have Been Learned from This Study?

Clearly, one of the primary issues resulting from this study is that no one measure will adequately address the impacts of the construction projects along this corridor. A multifaceted approach to mitigating the effects of construction on the operation of the corridor can offer a better solution to the traffic

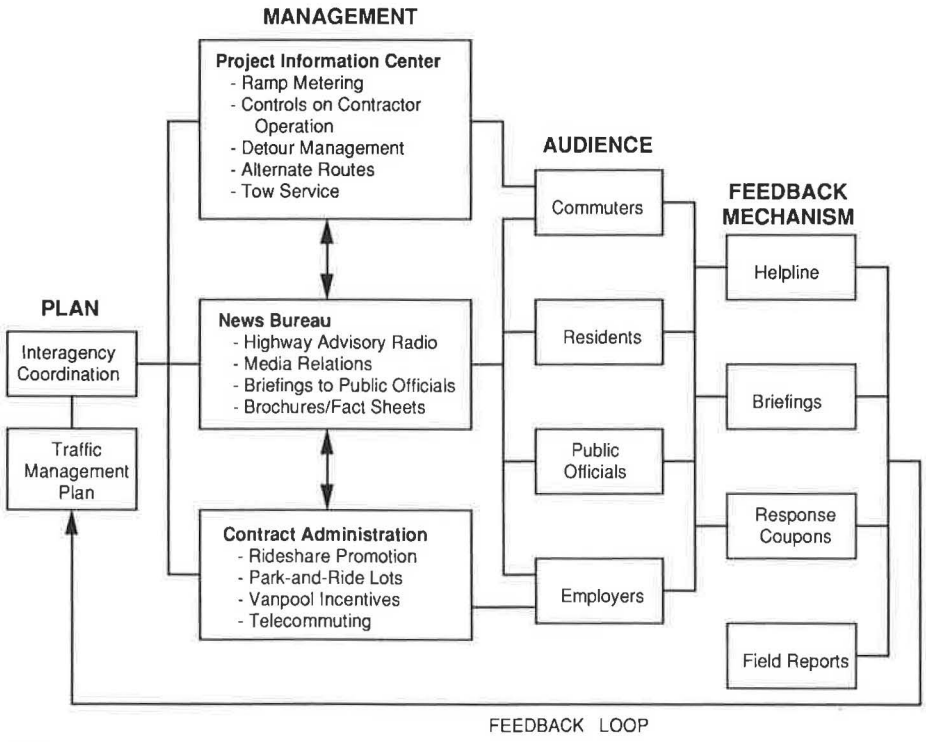


FIGURE 3 Route 91-HOV construction project TMP system.

problems than can any single measure. The study also shows that the TMP will provide benefits in more areas to more of the people if measures from all three groups (public awareness, on-site, and off-site) are employed than if efforts are concentrated on only one of the three.

How Can This Evaluation Benefit Future TMPs?

Experiences from previous TMP activities here and elsewhere are not well documented and evaluated. The evaluation of TMP measures for a specific project are often performed using limited data and local experience. But increasingly TMPs are a requirement for implementing urban transportation improvements in Southern California. At a minimum, some modest effort should be included to determine how drivers, the public, and elected officials react to the TMP measures that are provided and which TMP measures are perceived and measured to be the most effective. The evaluation process employed here is applicable to other corridors and may provide readers with a method of assessing TMP elements for other projects.

A better understanding will help define what level of TMP may be required for specific projects, and this will ultimately be useful in the development of guidelines. Route 91 offers an opportunity to document how closely the recommended TMP measures meet the desired objectives if periodic public surveys and traffic data are collected during construction activities. This type of evaluation will benefit other upcoming projects in the region and give all agencies an improved understanding of what works and how well it works.

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