

Technical Report Documentation Page

1. REPORT No.

FHWA/CA/TE-99/12

2. GOVERNMENT ACCESSION No.**3. RECIPIENT'S CATALOG No.****4. TITLE AND SUBTITLE**State Route 37 Safety Evaluation Report
(Supplemental Report)**5. REPORT DATE**

May 1999

6. PERFORMING ORGANIZATION

51-366-680410

7. AUTHOR(S)

Ahmad Korashadi

8. PERFORMING ORGANIZATION REPORT No.**9. PERFORMING ORGANIZATION NAME AND ADDRESS**California Department of Transportation
Traffic Operations Program
1120 "N" Street
Sacramento, CA 95814**10. WORK UNIT No.****11. CONTRACT OR GRANT No.**

F98TE08

12. SPONSORING AGENCY NAME AND ADDRESSCalifornia Department of Transportation
Traffic Operations Program
1120 N Street**13. TYPE OF REPORT & PERIOD COVERED****14. SPONSORING AGENCY CODE**

51-366

15. SUPPLEMENTARY NOTES**16. ABSTRACT**

The original scope of this project was to determine the accident impact of median striping and double fine zone regulation on 2 and 3 lane conventional roads. However, several other improvement projects were implemented on the test segment (state route 37) that was intended to be used for this study. The combination of many other improvements including road widening, installation of concrete median barrier and rumble strip, and shoulder widening made it impossible to determine the impact of median striping. Therefore, the scope of the study was changed. It was decided to examine the impact of the double fine zones (DFZ) legislation and median striping on road safety be studied in separate reports. The first of this two part report entitled "Safety Enhancement, Double Fine Zone" was published in December 1997. This report provides an accident impact of all other improvements (excluding the DFZ impact) on state route 37.

There is a general decrease in Total, Fatal, Fatal plus Injury, Head-On, Sideswipe, and Run-Off-Road accidents. The decrease is statistically significant for Fatal, Head-On, and Sideswipe accidents at 95 percent level of confidence. The improvements are associated with a general decrease in accident frequencies and significant reduction in more severe accidents. The percent reductions reflect not only the effect of the improvement project, but also the effect of other factors such as widening, super elevation improvement, rumble strip and median barrier installation, and enhanced enforcement project.

17. KEYWORDS

Rumble strip, median barrier, state route 37, double fine zone, construction phase

18. No. OF PAGES:

74

19. DRI WEBSITE LINKhttp://www.dot.ca.gov/hq/research/researchreports/1997-2001/route_37.pdf**20. FILE NAME**

route_37.pdf

| | | | |
|--|-------------------------------|--|--|
| 1. Report NO FHWA/CA/TE-99/12 | 2. Government Association No. | 3. Recipient's Catalog No. | |
| 4. Title and Subtitle State Route 37 Safety Evaluatrion Report (Supplimental Report) | | 5. Report Date May 1999 | |
| | | 6. Performing Organization Code 51-366-680410 | |
| 7. Author Ahmad Khorashadi | | a. Performing Organization Report No. | |
| 9. Performing Organization Name and address California Department of Transportation Traffic Operations Program 1120 "N" Street Sacramento CA 95814 | | 10. Work Unit No. | |
| | | 11. Contract or Grant No. F98TE08 | |
| 12. Sponsoring Agency and Address California Department of Transportation Traffic Operations Program 1120 "N" Street Sacramento CA 95814 | | 13. Type of Report and Period Covered | |
| | | 14. Sponsoring Agency Code 51-366 | |
| 15. Supplementary Notes | | | |
| <p>16. Abstract</p> <p>The original scope of this project was to determine the accident impact of median striping and double fine zone regulation on 2 and 3 lane conventional roads. However, several other improvement projects were implemented on the test segment (state route 37) that was intended to be used for this study. The combination of many other improvements including road widening, installation of concrete median barrier and rumble strip, and shoulder widening made it impossible to determine the impact of median striping. Therefore, the scope of the study was changed. It was decided to examine the impact of the double fine zones (DFZ) legislation and median striping on road safety be studied in separate reports. The first of this two part report entitled "Safety Enhancement, Double Fine Zone" was published in December 1997. This report provides an accident impact of all other improvements (excluding the DFZ impact) on state route 37.</p> <p>There is a general decrease in Total, Fatal, Fatal plus Injury, Head-On, Sideswipe, and Run-Off-Road accidents. The decrease is statistically significant for Fatal, Head-On, and Sideswipe accidents at 95 percent level of confidence. The improvements are associated with a general decrease in accident frequencies and significant reduction in more severe accidents. The percent reductions reflect not only the effect of the improvement project, but also the effect of other factors such as widening, superelevation improvement, rumble strtip and median barrier installation, and enhanced enforcement project.</p> | | | |

| | | | |
|---|--|---------------------------|----------|
| 7. Key Words Rumble strtip, median barrier, state route 37, double fine zone, construction phase | | 1a Distribution Statement | |
| 19 Security Classification (of this report) Unclassified | 20. Security Classification (of this report) Unclassified | 21 No. of Pages 69 | 22 Price |

DISCLAIMER

The contents of this report reflect the views of the investigator and authors who are responsible for the facts and accuracy of the data presented. The contents of this report do not necessarily reflect the official views or policies of the State of California. This report does not constitute a standard specification, design standard, or regulation.

California Department of Transportation
Traffic Operations Program

State Route 37
Safety Evaluation Report
May, 1999

Report prepared by:

A. Khorashadi
Associate Transportation Engineer
Registered

6/4/99
Date



Reviewed By:

Craig Copelan
Senior Transportation Engineer

6/4/99
Date



Approved By:

Kim F. Nystrom
Chief, Office of Transportation Safety

6/4/99
Date



Table of Contents

| | |
|--|----|
| LIST OF FIGURES | II |
| LIST OF TABLES | II |
| EXECUTIVE SUMMARY | 1 |
| INTRODUCTION | 3 |
| CONSTRUCTION PHASES..... | 5 |
| PRE-CONSTRUCTION (BEFORE PHASE I) | 5 |
| INTERIM PROJECT (PHASE I) | 5 |
| CONSTRUCTION PHASE II | 7 |
| CONSTRUCTION PHASE III | 7 |
| ACCIDENT ANALYSIS..... | 8 |
| BACKGROUND..... | 8 |
| BEFORE-AFTER ACCIDENT SUMMARY (PHASE I AND II)..... | 9 |
| STATISTICAL ANALYSIS AND RESULTS..... | 13 |
| FINDINGS AND DISCUSSION OF RESULTS..... | 16 |
| REFERENCES..... | 18 |
| APPENDIX A..... | 19 |
| STATE ROUTE 37 REPORT TO THE SENATE TRANSPORTATION COMMITTEE | 19 |
| APPENDIX B..... | 32 |
| A PROPOSAL FOR A DEMONSTRATION PROJERCT..... | 32 |
| APPENDIX C..... | 49 |
| COMBINED PROJECT STUDY REPORT/PROJECT REPORT (PHASE II) | 49 |
| APPENDIX D..... | 64 |
| PROJECT SCOPE SUMMARY REPORT (PHASE III) | 64 |

List Of Figures

| | |
|--|----|
| Figure 1 Route 37 Before Construction Phase I | 29 |
| Figure 2 Route 37 Phase I: Concrete Barrier Demonstration Proposal (Include Temporary Buffer Zone Alternative Proposal) | 30 |
| Figure 3 Route 37 Concrete Barrier Demonstration Proposal | 31 |
| Figure 4 Route 37 Concrete Barrier Demonstration Proposal Exhibit A..... | 45 |
| Figure 5 Route 37 Concrete Barrier Demonstration Proposal Exhibit B..... | 46 |
| Figure 6 Route 37 Concrete Barrier Demonstration Proposal Exhibit C..... | 47 |
| Figure 7 Route 37 Concrete Barrier Demonstration Proposal Exhibit D..... | 48 |
| Figure 8 Phase II Construction Typical Cross Section..... | 62 |
| Figure 9 Phase II Construction of Concrete Barrier and Widening Roadway..... | 63 |
| Figure 10 Fatal , Fatal + injury, and Total accident trends | 11 |
| Figure 11 Rear End Accident trend..... | 12 |
| Figure 12 Head On Accident trend..... | 12 |
| Figure 13 Run Off Road Accident trend | 12 |
| Figure 14 Sideswipe Accident trend | 13 |

List Of Tables

| | |
|---|----|
| Table 1. Construction Improvement Time Frame..... | 5 |
| Table 2. Accident Frequency and Rates (Prior to Phases I and II)..... | 8 |
| Table 3. Accident Frequency by Type (Phase I + Phase II)..... | 9 |
| Table 4. Detailed Accident Frequency, Phase I + Phase II (Solano)..... | 10 |
| Table 5. Detailed Accident Frequency, Phase I + Phase II (Sonoma)..... | 10 |
| Table 6. Detailed Accident Frequency, Phase I + Phase II (Solano+ Sonoma) . | 10 |
| Table 7. Traffic Volume On SR 37 within Project Limits | 11 |
| Table 8. Percent Change and Variability in Accident Types..... | 15 |

Executive Summary

This report provides a safety evaluation of the installation of concrete barrier, median striping, rumble strip, roadway widening, and implementing enhanced enforcement program on State Route 37 (SR-37) between the intersection of Route 121 in Sonoma County and the Napa River (Mare Island) Bridge in Solano County. The project eliminated existing passing lanes, and replaced them with concrete barrier, two 4 to 5-foot inside shoulders, a 12-foot lane in each direction, and 8-foot outside shoulders. The construction improvements on SR-37 resulted in a two-lane conventional highway separated by Type 50 concrete barrier.

The improvements were not intended to increase the capacity of the highway, but to reduce or eliminate head on collisions. The improvement project was developed to be implemented in three phases. Phase I and II have been completed. Construction of phase III is underway. Phase III of construction consists of widening the Sonoma Creek Bridge to include two 12-foot lanes, two 4-foot inside shoulders, and two 8-foot outside shoulders for continuity with the rest of the road. The bridge widening is being done in conjunction with seismic retrofit project. This evaluation pertains only to phase I and II of the construction improvement.

The accident analysis done by the Department prior to initiation of the current project had shown SR-37 had a comparatively lower accident rates compared to similar roadway classification in the state. However, the analysis had shown a higher than the statewide average accident rate for fatal accident type compared to similar roadway classification. The improvement project initiated was intended to reduce the more severe head-on accidents, by installing concrete median barrier.

The current study provides a post evaluation of accidents due to highway improvements in phase I and phase II. The safety evaluation showed that the safety improvement project has resulted in a reduction in both frequency and severity of accidents on Route 37. Cross center accidents have not occurred since the improvements were implemented. The accident trends in general suggest

reductions in fatal, total, fatal plus injury, sideswipe, and head-on accidents, and an increase in rear-end accidents. The reductions in fatal, sideswipe, and head-on accidents were statistically significant. The increase in rear-end accidents however, was not statistically significant. Accidents have a random occurrence, and as such, there exists large variability in accident counts from one year to the next especially when the road segment is short and the accident data is limited. Therefore, the percent changes in accidents are reported (in Table 8) with large variability for each accident type.

The reductions in accident are interpreted with considerations given to impact of other improvements outside the scope of phase I and phase II that could have influenced the results (i.e. the 1990 shoulder widening, the 1994 shoulder widening and superelevation improvement, new striping and pavement, and enhanced enforcement project; Safety Enhancement Double Fine Zone mandated by Senate Bill 414).

Introduction

This report provides a before and after comparison of accidents frequency and rate on State Route 37. The safety improvement treatments implemented on SR 37 included the installation of concrete barrier, median striping, and widening of Route 37 between the intersection of Route 121 in Sonoma County and the Napa River (Mare Island) Bridge in Solano County, a distance of about nine miles. The project eliminated passing lanes and replaced them with a 2-foot wide concrete barrier and two 4 to 5-foot inside shoulders, a 12-foot lane in each direction, and 8-foot outside shoulders.

The proposed project was not intended to increase the capacity of the highway. The proposal eliminated the passing opportunities within the section of the highway. This created a recovery area for vehicles leaving their lane by constructing either a median, with a concrete barrier, or a buffer zone between the opposing lanes. Eight foot shoulders were constructed along the entire length of this segment, except in the vicinity of Skaggs Island Road where the shoulder width was 4 feet due to the need to continue to provide a left-turn lane at that location.

An opening in the Type 50 concrete barrier was provided and opposing left-turn lanes were constructed at PM 5.35 (Sonoma), from either direction of Route 37 to provide access to sanitation trucks and farm vehicles needing to access both northern and southern private cross roads at this point. In addition, as Skaggs Island Road is a public road, an opening in the Type 50 concrete barrier was also provided at this intersection, PM 1.69 (Solano), in order to retain the existing eastbound left-turn lane, and eastbound storage/acceleration lane for motorists negotiating a left turn out of Skaggs Island Road. The concrete barrier openings facilitating left-turns, were also intended to improve the overall operation of the highway and aid emergency response units.

The widened segment of Route 37 was an environmentally sensitive wet land area that required permits from both federal and state agencies. Therefore, an interim project was developed from a combination of two of the five alternatives proposed by Caltrans. Detailed description of the alternatives are provided in Appendix B [4]. Presentation of the detailed background

information on phase I and phase II of the project is organized as in the following:

- A detailed historical background on the original construction standards, previous improvement projects on SR 37, and alternative designs proposed is provided in a 1995 report to the Senate Transportation Committee [3]. This report is provided in Appendix A. Figure 1 through Figure 3 at the end of Appendix A provide a schematic summary of the design and operational characteristics of State Route 37 before and after construction improvements in phase I and phase II.
- Additional background information, along with a detailed description of alternatives proposed before the interim project (phase I) is provided in a 1995 report entitled: "A Proposal for a Demonstration Project" [4]. This proposal was included as "Attachment K" in a project study/project report developed in 1996 [2] and is included in this report in Appendix B.
- A portion of the project study/project report [2] describing the background information on phase I and II of construction project is provided in Appendix C.
- A portion of project report on Phase III of construction (Sonoma Creek Bridge) entitled "Project Scope Summary Report Seismic Retrofit and Barrier Placement Project" published in April 1998 is provided in Appendix D. The current safety evaluation analysis does not include phase III of the project.
- A summary of the above reports pertaining to pre-construction; interim project (phase I) and phase II of project is provided in the following.

A separate research report [1] prepared in 1997 dealt with the evaluation of the enhanced enforcement elements of the safety improvements on SR 37.

Construction Phases

The improvement project was implemented in three phases as summarized in Table 1.

Table 1. Construction Improvement Time Frame

| Project Phase | Construction Started | Construction Ended | Post Mile Limit (Sonoma/Solano County) |
|----------------------|-----------------------------|---------------------------|---|
| Phase I | 9/7/95 | 12/23/95 | Son 3.9-R6.07, Sol R0.0-6.9 |
| Phase II | 4/21/96 | 10/15/97 | Son 4.1-R5.9, Sol R0.2-3.5 |
| Phase III | 7/1998 | December 2001 | Son R5.9-R6.07, Sol R0.0- 6.9 |

Figure 1 through 3 in Appendix A provide a schematic summary of the design and operational characteristics of the State Route 37 before and after construction improvements in phase I and phase II.

Pre-Construction (Before phase I)

SR 37, from the SR I21/37 intersection in Sonoma County to the Sonoma Creek Bridge was a two-lane conventional highway. SR 37 from the Sonoma Creek Bridge to the beginning of the four-lane section near Mare Island Naval Shipyard, was a two-lane conventional highway with alternating passing lanes that started at approximately 0.80 miles east of the Sonoma/Solano County Line. The shoulders on this portion of SR 37 "varied in width from 2 to 8 feet. A major part of this facility was surrounded on both sides by wetlands and other environmentally sensitive areas, and was controlled by numerous State and Federal laws and regulations.

Interim Project (phase I)

The proposed interim project (phase I) was to construct a concrete barrier for a 5.3 mile segment of SR 37 in Solano County from Skaggs Island Road to the west end of the freeway near the Walnut Street Overcrossing where pavement width was available to provide adequate lane and shoulder widths. It was also proposed that, as an interim measure, a buffer zone on SR 37 be constructed

from intersection of SR 121 with SR 37 in Sonoma County, to Skaggs Island Road in Solano County, a distance of about 3.9 miles. This interim buffer zone was to be utilized only until Caltrans received the clearances and permits necessary to widen this portion of SR 37 to provide sufficient pavement width for lane and increased shoulder widths. A schematic description of the concrete barriers, rumble strips, and Buffer Zone in phase I is provided in Figure 4 through 7 in Appendix B. The proposed interim project consisted of the following segments:

The Sonoma County segment from the 121/37 intersection to the west side of the Sonoma Creek bridge, a distance of approximately 2.1 miles, was proposed to be re-striped to two 11 foot lanes, eight foot shoulders, a 2 foot buffer zone treated with recessed rumble strips and raised profile thermoplastic pavement marking, and channelizers down the center of the buffer zone on a 50 to 100 foot spacing (Figure 4, Appendix B).

The Sonoma Creek Bridge was proposed to be maintained as two-12 foot lanes and 4 foot shoulders with the opposing lanes separated by a double yellow pavement marking composed of raised profile thermoplastic pavement marking. (Figure 5, Appendix B).

From the east side of the Sonoma Creek bridge to Skaggs Island Road, a distance of approximately 1.5 miles, SR 37 was re-striped to two 11 to 12 foot lanes, 8 foot shoulders, and a 2 to 4 foot buffer zone treated with recessed rumble strips and raised profile thermoplastic pavement marking, and channelizers down the center of the buffer zone on a 50 to 100 foot spacing (Figure 6, Appendix B).

From Skaggs Island Road to the west end of the freeway section near the Walnut Street Overcrossing, a distance of 5.3 miles, passing lanes were eliminated to provide a 12 foot lane in each direction, 8 foot outside shoulders with recessed rumble strips and inverted profile thermoplastic striping, concrete median barrier, and 2 to 5-foot wide inside shoulder (Figure 7, Appendix B).

Construction Phase II

The Buffer Zone constructed in phase I was eliminated in phase II after the necessary permits were obtained and the widening of the roadway was completed. The type 50 concrete barrier installed in phase I was extended from its termination point to the junction of Route 121, a distance of about four miles. The highway was widened to provide eight-foot outside shoulders. Rumble strips were also placed between the opposing lanes and on the outside shoulders. A conceptual plan is included as Attachment C in Appendix C. Figure 8 and Figure 9 in Appendix C provide typical cross sections, and post mile limits for the installation of concrete barrier and widening of the roadway respectively.

Construction Phase III

The existing roadway on the bridge, consisting of two twelve-foot lanes and two four-foot outside shoulders that remained unchanged during first two phases but will be upgraded in phase III of construction. Phase III of construction includes widening the Sonoma Creek Bridge to two 12-foot lanes, two 4-foot inside shoulders, and two 8-foot outside shoulders to provide continuity in design with the rest of the road. The widening is being done in conjunction with seismic retrofit project. A detailed description of the seismic retrofit project is provided in Appendix D. This phase is scheduled to be completed in December 2001.

Accident Analysis

Background

Previous accident data on SR 37 analyzed by the Department [2] had shown that SR 37 had a comparatively low accident rate history compared to other roadways with similar roadway classification. The same accident data is reproduced in Table 2. The five year accident data (July 1, 1990 and June 30, 1995) analyzed then indicated a total accident rate for SR 37 between 1/3 to 2/3 of the statewide average rate.

Table 2. Accident Frequency and Rates (Prior to Phases I and II)
(Sonoma Post Mile 4.1 to Solano Post Mile 3.5, 7/1/90 to 6/30/95)

| Total No. of Accidents | Actual Accident Rates (Accident/MVM) | | | Average Accident Rates (Accident/MVM) | | |
|---------------------------|--------------------------------------|----------------------|--------------------|---------------------------------------|----------------------|--------------------|
| | Fatal Acc. Rate | Fatal+Injury Rate | Total Acc. Rate | Fatal Acc. Rate | Fatal+Injury Rate | Total Acc. Rate |
| 162 | 0.044 | 0.37 | 0.64 | 0.035 | 0.48 | 0.93 |

Source: Reference No. 2

The severity of accidents on the route were somewhat higher than the average rate (Fatal rate: 0.044 vs. 0.035). Total and fatal plus injury accidents for this portion of Route 37 remained lower than the statewide average rates for similar types of roadways. Note that fatal accident rates do not in general provide a reliable measure of safety of a site especially when other accident types (total, and injury accidents) are lower than expected value. This is because fatal accidents are random events and thus their low frequency do not provide a reliable level of confidence to establish a statistical significance.

From the operational stand point, concerns were raised that the installation of the concrete barriers complicate incident response by introducing barriers that will not allow passage for emergency vehicles. Traffic control around a maintenance zone on SR 37 with a concrete barrier could require full directional road closures resulting in a 9-mile one-way traffic control or a 25-mile detour to avoid the road. Another concern regarding the installation of median barriers was that the installation of barriers according to a study [5] may

result in a larger increase in less severe accident types in exchange for the reduction barriers bring about in more severe accident type (i.e. fatal accidents) for this type of road.

Before-After Accident Summary (Phase I and II)

A before and after comparison of accidents was done to assess the impact of improvement projects in phase I and phase II. Since the time period between phase I and II was too short to provide a sufficient number of accidents, separate analyses of phase I and phase II would not be conclusive. Thus, the impact of improvements due to both phases of construction was investigated.

Available accident data for 11 months in the 'after' period was compared with the accident counts in corresponding time periods in the five years before the implementation of the improvements. The after period covered 11/1/97 to 9/30/98. The post mile limits for this project were from Sonoma County post mile 3.9 to Solano County post mile 6.9. A summary of the accidents (Fatal, Total Fatal + Injury) are provided in Table 3.

Table 3 Accident Frequency by Type (Phase I + Phase II)

| Year | Sonoma | | | Solano | | | Solano+ Sonoma | | |
|------------------------|----------|-------------|-------------|------------|-------------|-----------|-------------------|-----------|-----------|
| | Fatal | Total | F+I | Fatal | Total | F+I | Fatal | Total | F+I |
| 1990-91 | 0 | 25 | 17 | 0 | 18 | 11 | 0 | 43 | 28 |
| 1991-92 | 1 | 18 | 8 | 1 | 39 | 23 | 2 | 57 | 31 |
| 1992-93 | 1 | 18 | 12 | 3 | 30 | 13 | 4 | 48 | 25 |
| 1993-94 | 3 | 23 | 13 | 2 | 21 | 12 | 5 | 44 | 25 |
| 1994-95 | 1 | 23 | 9 | 3 | 31 | 16 | 4 | 54 | 25 |
| Average Before | 6 | 21.4 | 11.8 | 1.8 | 27.8 | 15 | 3 | 49 | 27 |
| 1997-98 (After) | 0 | 32 | 15 | 0 | 12 | 4 | 0 | 44 | 19 |

Fatal, Total, and Fatal plus Injury accidents for 1991 through 1997 for SR 37 are tabulated in Table 3. Other detailed accident types for Solano and Sonoma County section of the road are provided in Tables 4 and Table 5 respectively. Table 6 Combines the data in table 4 and 5. Detailed statistical calculations are

provided after the presentation of data. Accident occurrences are rare events. Therefore, the percent changes in accidents are reported with large variability for accident types in Table 8.

Table 4 Detailed Accident Frequency, Phase I + Phase II (Solano)

| Year | Head On | Sideswipe | Rear End | Run Off Road |
|-----------------|---------|-----------|----------|--------------|
| 1990-91 | 0 | 3 | 3 | 10 |
| 1991-92 | 5 | 3 | 7 | 15 |
| 1992-93 | 4 | 2 | 3 | 14 |
| 1993-94 | 3 | 6 | 2 | 8 |
| 1994-95 | 2 | 3 | 9 | 10 |
| 1997-98 (After) | 0 | 0 | 6 | 2 |

Table 5 Detailed Accident Frequency, Phase I + Phase II (Sonoma)

| Year | Head On | Sideswaibe | Rear End | Run Off Road |
|-----------------|---------|------------|----------|--------------|
| 1990-91 | 1 | 6 | 11 | 6 |
| 1991-92 | 2 | 2 | 5 | 6 |
| 1992-93 | 2 | 1 | 8 | 2 |
| 1993-94 | 5 | 1 | 12 | 2 |
| 1994-95 | 2 | 2 | 8 | 2 |
| 1997-98 (After) | 1 | 1 | 17 | 1 |

Table 6 Detailed Accident Frequency (Phase I + Phase II) (Solano +Sonoma)

| Year | Head On | Sideswaibe | Rear End | Run Off Road |
|-----------------|---------|------------|----------|--------------|
| 1990-91 | 1 | 9 | 14 | 16 |
| 1991-92 | 7 | 5 | 12 | 21 |
| 1992-93 | 6 | 3 | 11 | 16 |
| 1993-94 | 8 | 7 | 14 | 10 |
| 1994-95 | 4 | 5 | 17 | 12 |
| Avg. (Before) | 5.2 | 5.8 | 13.6 | 15 |
| 1997-98 (After) | 1 | 1 | 23 | 3 |

The Annual Average Daily Traffic(AADT) for Route 37, within the project limits, is almost constant with a slight decrease in the after period (1997-98) compared to the before time period (before 1997) as shown in Table 7. Therefore, the accident analysis based on accident counts were not adjusted to account for change in the amount of travel taken place on SR 37.

Table 7 Traffic Volume On SR 37 within Project Limits

| year | AADT |
|------|--------|
| 1997 | 24,900 |
| 1996 | 24,900 |
| 1994 | 25,000 |
| 1992 | 25,000 |
| 1990 | 25,500 |

Figure 10 through 14 provide a schematic presentation of trends for different accident types.

Figure 10. Fatal, Fatal+Injury , and Total Accident Trends

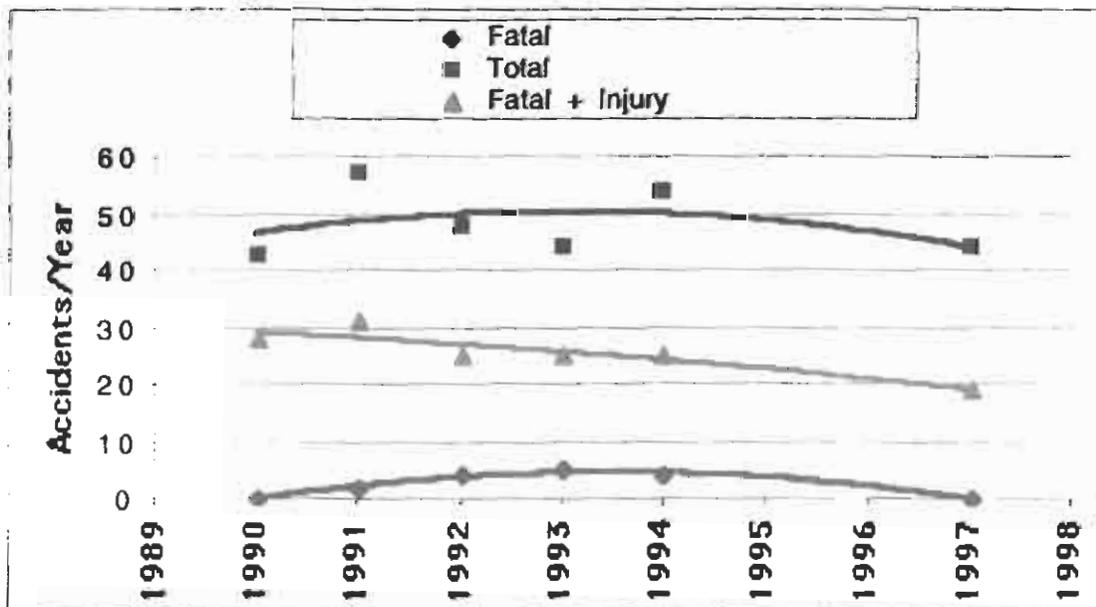


Figure 11. Rear End Accidents Trend

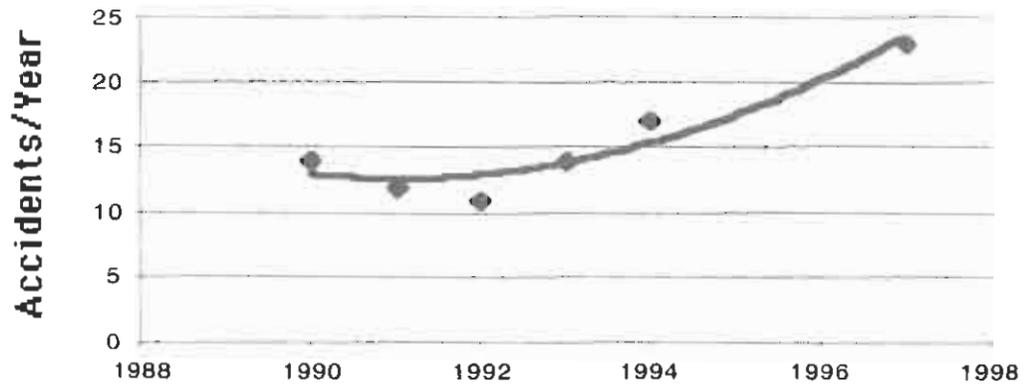


Figure 12. Head On Accidents Trend

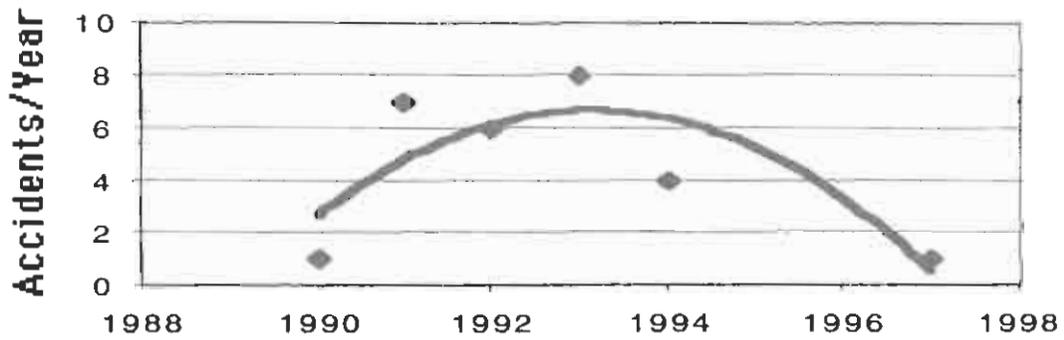
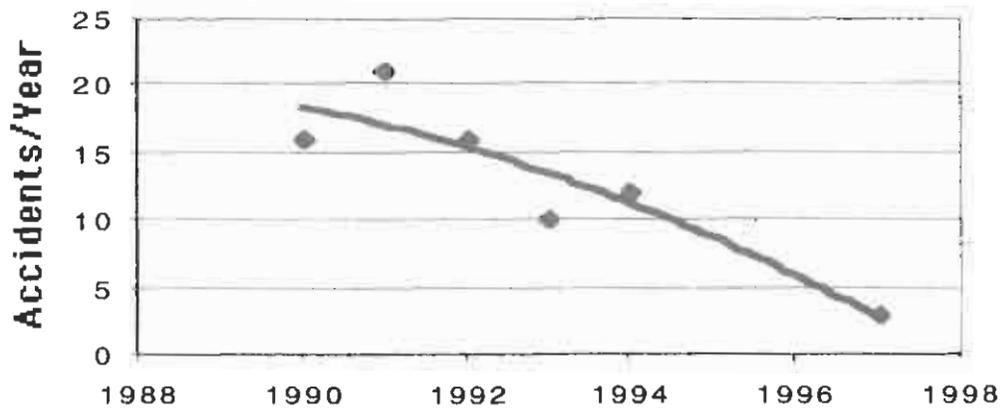
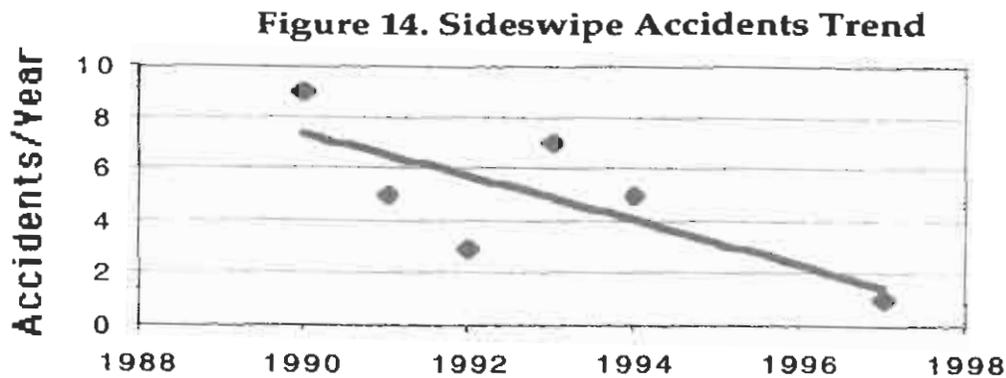


Figure 13. Run Off Road Accidents Trend





The accident trends in general suggest a reduction in fatal, total, fatal plus injury, sideswipe, head-on, run-off-road accidents, and an increase in rear-end accidents. The statistical significance of the above accident changes are analyzed in the following.

Statistical Analysis and Results

Accidents are random occurrences. Therefore a more accurate measure of safety at a site is not the observed accidents at the site, but the expected accident at the site which is to be estimated. To estimate the impact of the safety improvements on accidents, we need to *predict* what the *expected* number of accidents would have been in the 'after' period had the improvements not been implemented and then compare the predicted values with what the expected accidents in the 'after' period is with the safety improvements in place.

The model of accidents occurrence is treated as a random variables with an assumed Poisson distribution. The safety of a site is described by the mean from this distribution along with its variability.

To predict what the expected accidents would have been without the treatment being implemented, several alternative procedures could be utilized (i.e. accident trend lines, averaging three years of 'before' accidents, developing a least square fit to the observed before accidents, etc.). Different approaches to

the prediction of the count of accidents in the 'after' period results in different estimates of the safety.

For this analysis, a four step procedure outlined in reference [6] is used. Assuming that the accident counts at the site are Poisson Distributed¹, the change in accidents are measured by the Index of Effectiveness \hat{i} :

$$\hat{i} = (Y/X) / \{1 + (\text{Variance of } X) / X^2\} \quad \text{where}$$

X = is what the *expected* number of accidents in the 'after' period would have been had the road segment received *no* safety improvement.
 Y = *Expected* number of accidents in the 'after' period to be estimated when safety improvement is implemented.

In this study, 'X' is *estimated* to be the 5 year average of the observed accidents from the 'before' time period. Similarly, 'Y' is *estimated* by the observed accidents in the after period. The following calculation is carried out for total accident type. Similar calculation is done for other accident types, but only the final results are presented in Table 8.

Sample Calculation for Total Accident Type

For Poisson distribution, the expected accidents are equal to their Variance (Var). In all calculation the value of random variable is unknown and thus should be estimated. The estimated value for any variable is shown with hat (^) symbol. The average *total* accidents in the before and after time period from table 3 is:

$$\begin{aligned} \hat{X} &= (43 + 57 + 48 + 44 + 54) / 5 &= 49 \text{ accidents} \\ \hat{Y} &= (44) / 1 &= 44 \text{ accidents} \end{aligned}$$

For Poisson distributed data, the mean is equal to the variance and thus

¹ The Probability of obtaining an accident count L is given by $\lambda^L e^{-\lambda} / L!$ where λ is the mean (expected) accident count.

$$\begin{aligned} \text{Var}(\hat{X}) &= 49 \text{ (Accident/year)}^2 && \text{Reference [6]} \\ \text{Var}(\hat{Y}) &= 44 \text{ (Accident/year)}^2 && \text{Reference [6]} \end{aligned}$$

The index of effectiveness is: $i = Y/X$. Since X and Y are random variables, 'i' would be a random variable and therefore its value is unknown and has to be estimated. The best estimate of 'i' and its variance are provided in reference [6]:

$$\hat{i} = (\hat{Y} / \hat{X}) / [1 + \text{Var}\{\hat{X}\} / \hat{X}^2] = (44/49) / [1 + 49 / 49^2] = 0.88$$

The percentage change in total accidents is : $(1 - \hat{i})(100) = 12\%$

The variance of 'i' is:

$$\text{Var}\{\hat{i}\} \cong i^2 [(\text{Var}\{\hat{Y}\} / \hat{Y}^2) + (\text{Var}\{\hat{X}\} / \hat{X}^2)] / [1 + \text{Var}\{\hat{X}\} / \hat{X}^2]^2 = 0.03$$

Standard Deviation of \hat{i} = Square route of Variance (\hat{i})
 = Square route of (0.03) = .18 = 18%

Similar calculation for other accident types are done and the final results are presented in Table 8.

Table 8: Percent Change and Variability in Accident Types

| Accident Type | % Change | Standard Deviation |
|----------------|-------------------|--------------------|
| Total | -12 % (Decrease) | ± 18 |
| Fatal + Injury | - 32 % (Decrease) | ± 20 |
| Fatal | -100 % (Decrease) | ± 0 |
| Head On | -84 % (Decrease) | ± 15 |
| Sideswipe | -85 % (Decrease) | ± 14 |
| Rear End | 58 % (Increase) | ± 50 |
| Run Off Road | -81 % (Decrease) | ± 11 |

Findings and Discussion of Results

From Table 8, there is a general decrease in Total, Fatal, Fatal plus Injury, Head-On, Sideswipe, and Run-Off-Road accidents. The decrease is statistically significant for Fatal, Head-On, and Sideswipe accidents at 95 percent level of confidence. The reductions are reported with large variabilities. Note that while Fatal plus Injury accident shows a reduction of 32 ± 20 , the reduction for Fatal accidents is 100%. In other word, while the improvements is associated with a general decrease in accident frequencies, they are associated with significant reduction in more severe accidents (i.e. 100% decrease in Fatal accidents).

Caution should be exercised in attributing the safety improvement to the project phase I and II alone and in making conclusive interpretation of the results for the following reasons. The percent reductions reflect not only the effect of the improvement project in phase I and II, but also the effect of other factors. For example, in 1990, the shoulders were widened to 8 feet from approximately 2 miles east of Skaggs Island Road to the Western end of the freeway section near Walnut Street overcrossing in Vallejo. Also, in 1994 a project was undertaken to widen shoulders, improve superelevation, and provide new striping and pavement markers on a two mile portion of Route 37 starting near Skaggs Island Road and going east. Furthermore, an enhanced enforcement project (Safety Enhancement Double Fine Zone) was implemented in 1995 [1]. Therefore, the analysis of data to exclusively assess the safety benefit of the current improvement project faced with the following three constraints.

- Impact of other improvement projects in the before period.
- Changes from the 'before' to the 'after' period in factors other than treatment factor (improvement effect) that influence accident frequency and severity. These factors include but not limited to enhanced enforcement, vehicle mix, changes in weather, driver behavior, economy, etc.
- Spontaneous regression-to-the-mean phenomenon. This phenomenon occurs because of the non-random selection of sites for improvement projects. Because of this selection bias, there exists a high probability that a

reduction in accidents might be observed from one time period to the next even if these sites were left untreated.

Because of the short time period after safety improvement project was implemented, there is not sufficient accident data and therefore the evaluation results are provided with large variability in both the total and fatal plus injury accidents. A longer time period and more accident data, or additional sites with similar treatment are needed so that the analysis yields higher levels of certainty.

References

1. Khorashadi, A., "Safety Enhancement, Double Fine Zone", California Department of Transportation, Traffic Operation Program, December 1998.
2. Gutierrez, R., "Combined Project Study Report/Project Report", California Department of Transportation, January 10, 1996.
3. California Department of Transportation, "State Route 37 Report to the Senate Transportation Committee", June 15, 1995.
4. California Department of Transportation "A proposal for A Demonstration Project", June, 1995.
5. Seamons, L. and Smith, R.N., "Past and Current Median Barrier Practice In California", California Department of Transportation, June 1991.
6. Hauer, E., "Observational Before-After Studies in Road Safety", 1997.

Appendix A

State Route 37 Report to the Senate Transportation Committee

State Route 37

Report to the Senate Transportation Committee



June 15, 1995

Caltrans
CALIFORNIA DEPARTMENT OF TRANSPORTATION

TABLE OF CONTENTS

| | |
|---|---|
| Introduction..... | 1 |
| Background..... | 1 |
| Concrete Barrier Demonstration Proposal..... | 3 |
| Buffer Zone Demonstration Alternative Proposal..... | 4 |
| Informational Meetings & Public Input..... | 5 |
| Decision..... | 6 |
| Schedule..... | 6 |
| Other Considerations..... | 7 |

Introduction

On May 16, 1995 the Department of Transportation (Caltrans) presented a proposal to the Senate Transportation Committee for an operational improvement project on Route 37 between the intersection of Route 121 in Sonoma County and the Napa River (Mare Island) Bridge in Solano County. During the hearing, Caltrans committed to present this proposal to the public for comment and report back to the Senate Transportation Committee by June 16th the results of the public input process, the decision on what proposal is to be implemented, and the schedule for completion.

On May 25th the California Senate and Assembly passed "Senate Concurrent Resolution No. 35 - Relative to State Highway Route 37." In the Resolution "the Legislature strongly recommends that median barriers be installed on State Highway Route 37 between the intersection of State Highway Route 121 and the Mare Island Bridge." A similar resolution was passed by the Sonoma County Board of Supervisors. At the Public Informational Meetings held May 31st in Vallejo and June 1st in Novato, Caltrans presented a Concrete Barrier Demonstration Proposal as well as the Buffer Zone Demonstration Alternative Proposal that was originally presented to the Senate Transportation Committee.

Background

Route 37, between the intersection of Route 121 in Sonoma County and the Napa River Bridge in Solano County, was originally constructed as a toll road for which the State assumed maintenance in 1938. Between the 1940's and the 1960's numerous projects were constructed to widen the traveled way and existing shoulders.

In the mid-1970's, a safety project was constructed to add 3500 feet of passing lanes in each direction. This was done to mitigate the number of fatal and injury accidents caused by frustrated drivers making unsafe decisions to pass. A combination of widening the roadway by 4 feet and using part of the 8-foot shoulders provided a 12-foot alternating passing lane. This project reduced the number of accidents by 31%. From 1977 to 1983 a total of four construction

Department of Transportation
State Route 37
June 15, 1995

projects were completed. These projects primarily focused on improving shoulders, placing asphalt concrete overlays to improve the riding surface and skid resistance, installing new pavement markers, and improving the roadway delineation.

In 1990 the shoulders were widened to 8 feet from approximately 2 miles east of Skaggs Island Road to the western end of the freeway section near the Walnut Street overcrossing in Vallejo. This project provided full shoulder widths aimed at reducing accidents. Full shoulders provide both a refuge for a disabled vehicle and also a recovery zone for errant vehicles. The widening was the maximum that could be constructed without encroaching into the extremely sensitive environmental wetlands adjacent to this segment of Route 37.

In 1994 a project was undertaken to widen shoulders, improve superelevations, and provide new striping and pavement markers on a two-mile portion of Route 37 starting near Skaggs Island Road and going east. A project currently under construction will provide the same safety improvements as the 1994 project from the Sonoma Creek Bridge to about Skaggs Island Road. Upon completion of the current project under construction, the State will have invested nearly \$4.5 million in improvements on Route 37 since 1990.

State Route 37 from the Walnut Street overcrossing to Skaggs Island Road currently operates as a two-lane conventional highway with alternating passing lanes. The average speed is 65 mph. The average daily traffic is approximately 25,000 vehicles per day.

The Department has been monitoring the accident data on Route 37 on a quarterly basis. This roadway has had a comparatively low accident rate history compared to other similar roadways. In the last 10 years, the actual total accident rates have varied between 1/3 and 2/3 of the average total accident rate for similar highways. Because of this very favorable accident history, it has been difficult to identify patterns or concentrations of accidents which can be used to develop safety improvement projects.

Although the total accident rates on Route 37 have been less than average, the severity of the accidents is somewhat greater than anticipated for the low overall accident rate. The Department has

Department of Transportation
State Route 37
June 15, 1995

searched for innovative solutions that address the primary cause of the majority of the severe accidents - namely excessive speed and driver inattentiveness. Two options are summarized in the following.

Concrete Barrier Demonstration Proposal

The Concrete Barrier Demonstration Proposal would be a demonstration project as it does not meet the current criteria that Caltrans uses for conducting a study to address the need for concrete median barriers. There are no current installations of concrete median barrier on 2-lane non-freeway locations on the State's highway system except on some bridges. This project proposal would install concrete barrier between the Napa River Bridge in Solano County to the intersection of Route 121 in Sonoma County, a distance of about nine miles. The existing passing lanes would be removed and replaced with a 2-foot wide concrete barrier and two 4 to 5-foot inside shoulders, a 12-foot lane in each direction, and full 8-foot outside shoulders.

The benefits of the Concrete Barrier Demonstration Proposal are that it would eliminate the risk of head-on accidents in the area where the concrete barrier is installed. It would slow traffic by eliminating the passing lane. With an average speed of 65 mph, slowing the traffic should positively help the accident situation. Maintenance workers would be protected by the barrier while performing routine maintenance to the roadway.

There are also concerns about this proposal. A concrete barrier is a fixed object. A 1991 Caltrans median barrier study showed that after the installation of median barrier at five multi-lane non-freeway locations, the accidents increased an average of 79%, and the injury accidents increased an average of 55%. This study also indicated that as the distance decreases from the edgeline to the barrier, accident rates increase. While not on a comparable facility, a recent study of 5-years of accident data on State Route 120 in Manteca, which is a two-lane freeway installation with concrete median barrier, showed a decrease in the number of all types of accidents.

From an operational stand point a concrete barrier will add complications to incident response after accidents. Just as errant vehicles cannot cross into opposing traffic with a concrete barrier,

Department of Transportation
State Route 37
June 15, 1995

neither can emergency vehicles such as a fire truck or an ambulance. Also delays caused by maintenance will be exacerbated. Traffic control around a maintenance zone with a concrete barrier may require full directional road closures resulting in a 9-mile one-way traffic control or a 25-mile detour.

Some logistic processes of this Proposal will impact the total project schedule. The existing roadway will need to be widened. Widening is required from east of Skaggs Island Road to the intersection of Route 121 to accommodate both the concrete barrier and shoulders wide enough for emergency stops. This roadway widening will require fill to be placed adjacent to the existing roadway. To comply with existing laws and regulations, placing this fill will require permits or clearances from the Bay Conservation and Development Commission (BCDC), the Corps of Engineers, the US Fish and Wildlife Service, the California Department of Fish and Game, and the California Regional Water Quality Control Board. Also access at a public road connection, Skaggs Island Road, and several private driveways will need to be modified as the concrete barrier will eliminate the possibility of left turn access.

Buffer Zone Demonstration Alternative Proposal

As Caltrans was searching for innovative solutions to address the cause of the accidents on this roadway a case was discovered in Pennsylvania that has analogous applications here. This case led to this Buffer Zone Demonstration Alternative Proposal. This proposal was presented to the Senate Transportation Committee on May 16, 1995.

This situation in Pennsylvania was similar to the Route 37 situation. This was a roadway also difficult to widen due to a mountain on one side and a historic canal on the other. The passing lane was replaced with a 6-foot buffer zone, vividly marked by a 3-foot concrete rumble strip. In the two years before construction in Pennsylvania there were 52 accidents with 60 people injured and 9 people killed. In the two years after construction there have been 19 accidents with 13 people injured and no fatalities.

There are some differences between the Buffer Zone Demonstration Alternative Proposal and the Pennsylvania installation. This proposal has a 4 to 8-foot buffer zone where possible as compared to 6 feet in

Department of Transportation
State Route 37
June 15, 1995

Pennsylvania. The narrow Sonoma Creek Bridge does not have the width to accommodate a buffer zone, and the western stretch from Route 121 to the Sonoma Creek Bridge is only wide enough to allow a two-foot buffer zone. Also included in the Buffer Zone Demonstration Alternative Proposal is the installation of highly reflectorized channelizers every 50 feet on centerline to provide more of a visual sensation of a divided highway.

A buffer zone will not eliminate the possibility of head-on accidents. The buffer zone proposal is intended to address the cause of the accidents. With the passing zone eliminated, speeds will decrease and the audio and visual signals with the buffer zone will alert an inattentive motorist. As a barrier is a fixed object that provides no opportunity for penetration when it is needed for traffic control or incident response, the buffer zone allows penetration for these purposes.

Informational Meetings & Public Input

Public Informational Meetings were held on Wednesday May 31, 1995 from 1 to 4:30 pm and 6 to 9 pm in Vallejo, and on June 1, 1995 from 4 to 7 pm in Novato. Also a formal public hearing format meeting was held in Novato between 7 and 10 pm on June 1st. At these meetings both proposals were presented and public input was solicited.

There were 114 people that signed the attendance roster in Vallejo and 121 in Novato. Caltrans representatives presented both proposals to small groups, answered questions, and requested comments. Written comments were either received at the meeting or mailed in after. Forty-four respondents believed the concrete barrier was the best solution, 13 believed the buffer zone was the best solution, 19 believed 4-lane widening was the only solution, and 13 had other comments.

During the formal public meeting 36 people spoke for the record. The support for the Concrete Barrier Demonstration Proposal was nearly unanimous. The audience at the formal meeting had a strong contingent of victims and families of victims of accidents on Route 37. One speaker presented a petition at Novato supporting the barrier with 8 signatures. The same petition was received by mail with over 1300 signatures.

Department of Transportation
State Route 37
June 15, 1995

Decision

In reviewing both these demonstration-type proposals, Caltrans' analysis has weighed the historical accident history studies, the operational concerns, public comments, and Legislative Resolutions. Although operational flexibility would be enhanced with the Buffer Zone Demonstration Alternative Proposal, this project would not eliminate the possibility of head-on accidents. Since the consequence to the innocent driver of "driver error" is usually very severe when a driver crosses over the centerline causing a head-on accident, Caltrans is recommending the Concrete Barrier Demonstration Proposal as the most viable option for this portion of SR 37.

Schedule

Due to the necessary permits and clearances discussed under the Concrete Barrier Demonstration Proposal, Caltrans is recommending this project be implemented in two phases. Phase I will include the installation of the concrete barrier where possible without roadway widening, i.e. from the Napa River Bridge to just east of Skaggs Island Road, a distance of approximately five miles. If the necessary permits have not been secured by the time Phase I is completed, the Buffer Zone Demonstration Alternative Proposal will be installed from Skaggs Island Road to the intersection of Route 121 as an interim measure.

As soon as the necessary permits are secured, Phase II of the Concrete Barrier Demonstration Proposal will be built. This phase will widen the roadway and continue the concrete barrier from the Phase I termination point to the junction of Route 121.

The design of Phase I of this project is being completed as this report is being finalized. Caltrans anticipates that the \$1.2 million needed for the construction of Phase I will be voted by the California Transportation Commission on July 13, 1995. The project then will be advertised and awarded. Construction is scheduled to begin immediately following Labor Day. It is anticipated that construction will be completed by the end of October.

Department of Transportation
State Route 37
June 15, 1995

The Design of Phase II is being initiated as this report is being finalized. The schedule of this element is dependent upon obtaining permits from the involved permitting agencies. Caltrans will expedite all activities within their control to implement Phase II as soon as possible. When all permits and clearances are obtained Caltrans will request the CTC to vote the necessary funds for Phase II.

Other Considerations

It is important to note that both these proposals eliminate passing over this stretch of Route 37. This will lower speeds and therefore should have a positive influence on the accidents. However, many commuters or other frequent Route 37 travelers who were not at, and did not comment during, the public input period, may find the lowered speeds and delays on this route undesirable.

Also, a strong consensus throughout the public input period was that the only long term solution is a widened divided facility. This solution is complicated due to environmental concerns and may require legislation. Fundability is a major concern in this type of long term solution. It is currently estimated that a four lane divided highway for Route 37 from the Napa River Bridge in Solano County to the Intersection of Route 121 in Sonoma County would cost between \$100 to \$200 million. This type of capacity-increasing project would need to be prioritized along with all the other transportation needs in the Transportation Improvement Plan developed by the Metropolitan Transportation Commission (MTC). Caltrans is committed to work with MTC to explore the feasibility of development of a 4-lane divided highway.

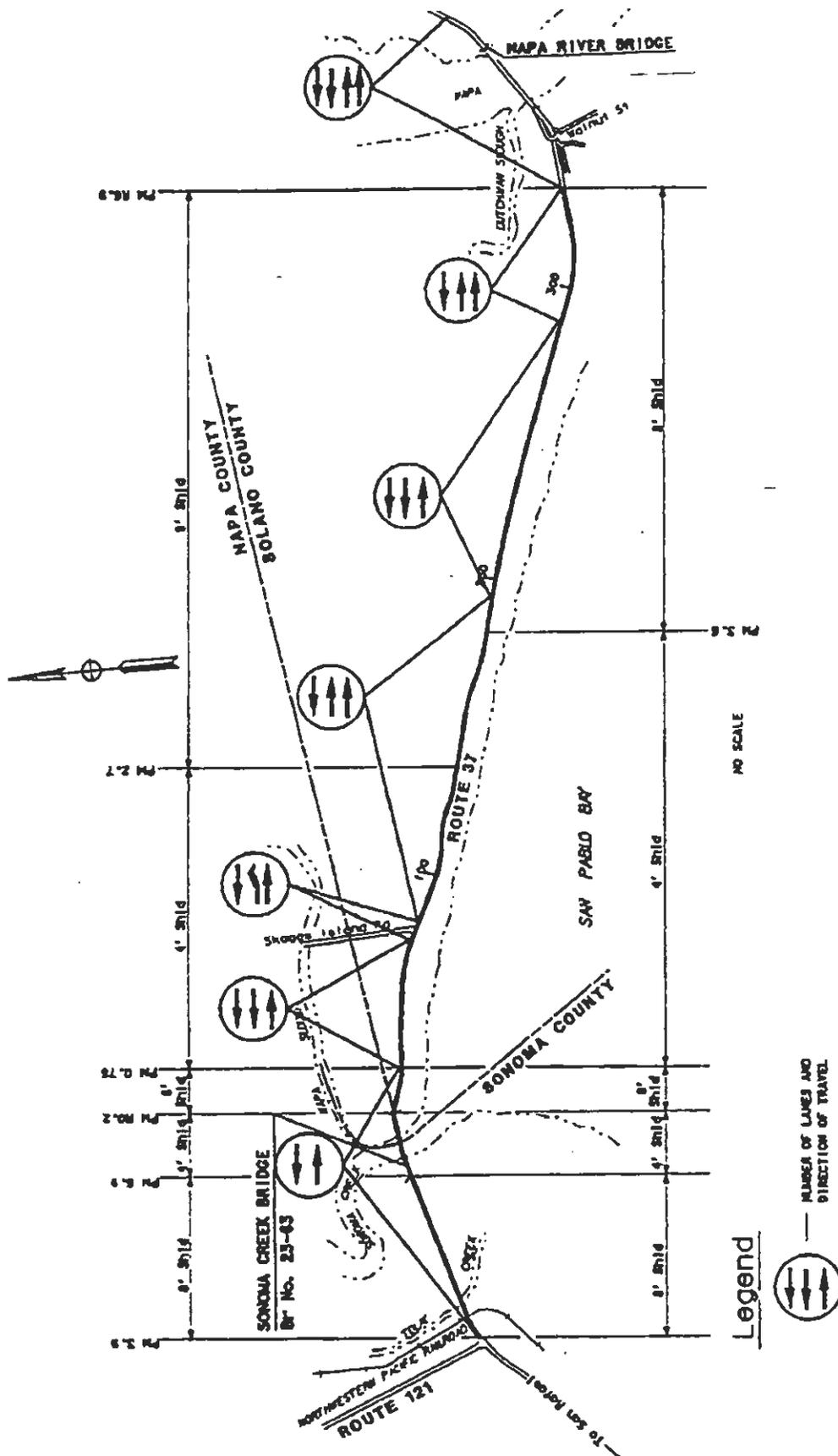


Figure 1. Route 37 Before Construction Phase I
 Source: Reference No. 3

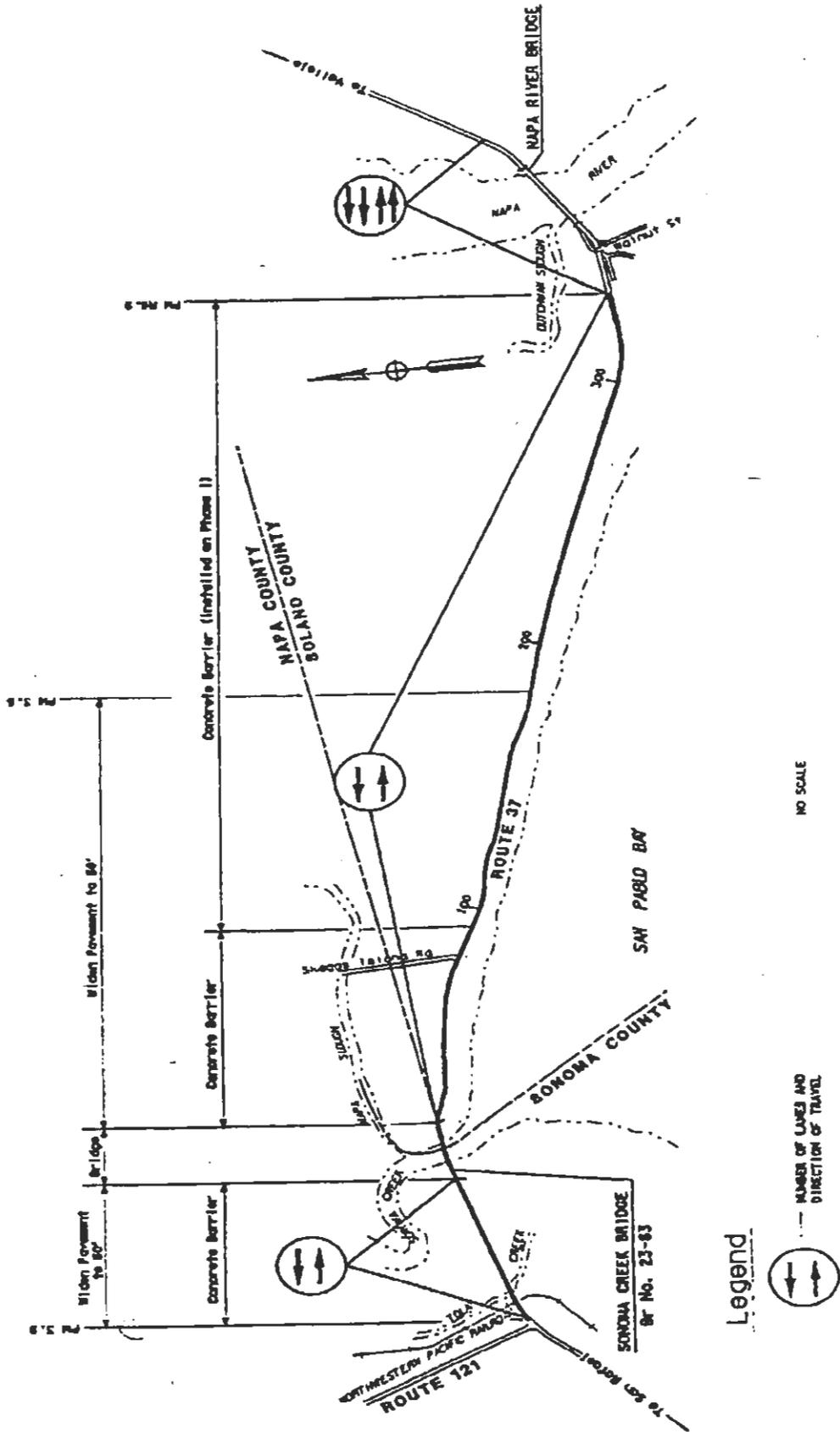


Figure 3. Route 37 Concrete Barrier Demonstration Proposal.
Source: Reference No. 3

Appendix B

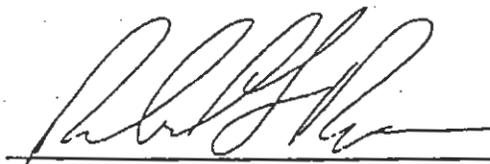
A Proposal for A Demonstration Project

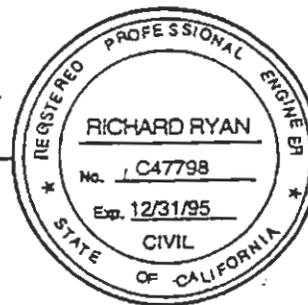
REGISTERED CIVIL ENGINEERS STAMP

This Demonstration Proposal Report has been prepared under the direction of the following Registered Engineers. The Registered Civil Engineer attests to the technical information contained therein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.


REGISTERED CIVIL ENGINEER DATE 6/7/95




REGISTERED CIVIL ENGINEER DATE 6/7/95



- From just east of Skaggs Island Road to the west end of the freeway section near the Walnut Street Overcrossing, a distance of 5.3 miles, includes the elimination of all passing lanes and providing a 12-foot lane in each direction, 8 foot outside shoulders with recessed rumble strips and inverted profile thermoplastic striping, concrete barrier, and a 2 to 5-foot wide inside shoulder. (See attached sketch "Exhibit D").

To place a concrete barrier along that portion of SR 37 where the interim "Buffer Zone" will be constructed will require a "sliver" fill up to 10 feet in width. This widening is needed to provide adequate lane and shoulder widths. The area where the widening will occur is in environmentally sensitive areas requiring permits from state and federal agencies. Caltrans may or may not be able to obtain these permits at all. Even if we do the permits may or may not be in time to construct the concrete barrier this construction season. However, Caltrans will initiate efforts to obtain these permits in an attempt to include this as a part of the interim project.

II. BACKGROUND

In recent years, budget shortfalls and environmental regulations have seriously hampered the Department's ability to upgrade 2-lane highways to expressways or freeways. This inability has generated a growing need to address problems for which the more normal solution of upgrading is not a viable option. This proposal is to be constructed as a demonstration project to address these problems, which did not exist until very recently. This proposal, if constructed, will be studied and, if successful, could be used to develop new warrants and standards.

This demonstration project was initiated in response to analysis of statistical accident information regarding the recent fatal accidents on this segment of conventional highway. From January 1, 1988, through December 31, 1992, actual accident rates for this segment of SR 37 were significantly less than the average accident rates for similar highways. Despite the low total accident rates, there has been a recent increase in the fatal accident rate on this segment of the highway due to driver error. Because of the high speed of vehicles and high volumes, driver errors are resulting in an increase in fatal accident rates.

SR 37 represents a new and unusual situation for two lane conventional highways in California as well other states. This situation is characterized by total accident rates about 1/2 of the statewide average and fatal accident rates near the statewide average. The routes are similar in that they are two-lane conventional highways, have traffic volumes about 25,000 ADT, and there is an inability to upgrade the highway to meet operational needs because of environmental and/or financial constraints.

Problems associated with high volumes of traffic are usually mitigated by construction of the roadways by adding lanes to increase capacity. Adding

lanes on this roadway is estimated to cost between \$100 and 200 million, and would require extensive involvement and permits from many state and federal agencies. This type of project does not compete well for the limited funds available. This situation is further exacerbated by the Department's current \$5 billion budget shortfall.

A nationwide search for similar situations and any mitigating actions was undertaken and only one situation was discovered. This highway, located in Pennsylvania, was set between a mountain and a historical canal, thus it also was not easily capable of being widened. The general operating characteristics were similar to those of SR 37, a two lane conventional highway with alternating passing lanes. Due to the high numbers of head-on fatal accidents, Pennsylvania DOT constructed a 6-foot buffer zone with a 3 foot portland cement concrete inverted profile rumble strip level with the pavement surface, double yellow pavement marking, and inverted profile shoulder rumble strips. They called the buffer zone a "singing strip." The intent was to warn motorists when they enter the buffer zone. In the two years prior to the construction of the buffer zone, there were 52 accidents on this stretch of highway. Of these, 6 of the accidents were fatal accidents resulting in 9 persons being killed. In the two years since the construction of the buffer zone, there were 19 accidents, none of which were fatal.

III. EXISTING FACILITY

This segment of SR 37, from the SR 121/37 intersection in Sonoma County to the Sonoma Creek Bridge is a two-lane conventional highway. SR 37 from the Sonoma Creek Bridge to the beginning of the four-lane section near Mare Island Naval Shipyard, is a two-lane conventional highway with alternating passing lanes that start at approximately 0.80 miles east of the Sonoma/Solano County Line. The shoulders on this portion of SR 37 vary in width from 2 to 8 feet. A major part of this facility is surrounded on both sides by wetlands and other environmentally sensitive areas, and is controlled by numerous State and Federal laws and regulations.

IV. NEEDS AND PURPOSE

This demonstration project proposes improvements which are aimed at preventing or reducing cross-centerline accidents and correcting driver behavior which is the main contributing factor for the fatal accidents. The improvements will not increase the capacity of the highway. In fact, the proposal will eliminate the passing opportunities within this section of the highway. This should platoon traffic, which should lower the overall operating speed of traffic on this section of the highway. The elimination of the passing lanes will either create a recovery area by constructing either a median, with a concrete barrier, or a buffer zone between the opposing lanes. It will also provide 8-foot shoulders along the entire length of this segment, except in the

vicinity of Skaggs Island Road where the shoulder width will be 4 feet due to the need to perpetuate the left-turn pocket there.

V. TRAFFIC DATA

SR 37, between SR 121 and the west end of the freeway near the Walnut Street Overcrossing, currently has an ADT of approximately 25,000 vehicles with a peak hour volume of 2600 vehicles. During the 5-year period from January 1, 1988 to December 31, 1992 there were a total of 210 accidents reported within the project limits. Of these 210 accidents, 3 were fatal accidents and 115 were injury accidents.

The actual fatal accident rate for the above-noted time period was .008 fatal accidents per million vehicle miles traveled along this section of the highway, which is less than 1 fatal accident per year over the entire length. The average fatal accident rate for other similar sections of highways throughout the state was .034 fatal accidents per million vehicle miles traveled, which equates to about 3 fatal accidents per year. The actual fatal accident rate along this section of the highway for the time period of January 1, 1988 to December 31, 1992 is 75% less than the average.

During 1993 and 1994, however, the actual fatal accident rate were .074 and .049 fatal accidents per million vehicle miles traveled along this section of the highway, respectively. Thus, in 1993 there were six fatal accidents and in 1994 there were 4 fatal accidents. The actual total accident rate for 1993-1994 was 0.48 accidents per million vehicle miles traveled along this section of the highway, which is about 39 accidents per year. The average total accident rate for other similar sections of highway throughout the state was 0.94 total accidents per million vehicle miles traveled, which is about 76 accidents per year. The actual total accident rate along this section of the highway is approximately 49% less than the average.

VI. SIMILAR ROADWAYS

As a part of the research for potential solutions and similar problems, a review for those roadways which have concrete barrier and were similar to SR 37 was made. There are no routes which meet both criteria. The most similar situation is on SR 120 in the Manteca area where a concrete barrier was constructed on a two lane access controlled freeway. SR 120 is dissimilar in that it has controlled access (no direct access) and is very flat with significant recovery areas for vehicles that either lose control or impact the concrete barrier and run off the roadway. SR 37 has a standard 3 foot backing to the shoulder with 2:1 slopes beginning a foot or two beyond the shoulder backing. These slopes are up to 6 feet in height. SR 37 must also accommodate local access.

The accident information from SR 120, however, indicates that the construction of concrete barrier on a two lane freeway may yield a reduction in accident rates. In the two years prior to the construction of the concrete

barrier on SR 120; the actual fatal accident rate was 0.029 accidents/mvm as compared to an average of 0.010 accidents /mvm. The total actual accident rate for the same period was 0.54 accidents/mvm as compared to an average of 0.58 accidents/mvm for similar highways. Note the relationship to previously identified characteristics of high volume 2 lane roadways. The fatal accident rate for SR 120 prior to the installation of concrete barrier was three times the state wide average rate for similar roads.

In the four year period from January 1991 through December 1993, after the installation of the concrete barrier, the actual fatal accident rate was 0.0 accidents/mvm as compared to an average of .010 accidents /mvm. The total actual accident rate for the same period was 0.54 accidents/mvm as compared to an average of 0.58 accidents/mvm for similar highways. It needs to be noted that while the information on SR 120 would seem to indicate that concrete barrier may address the cross-centerline accidents on SR 37, the true impact of constructing such a barrier is not known. SR 120 has significant recovery room available for errant vehicles and is access controlled, both of which do not exist on SR 37. Thus the data must be used with skepticism until the direct impacts on SR 37 can be assessed.

VII. POTENTIAL CONCERNS

As with any project, there are aspects which have the potential to cause concern to users of such a facility. The following are the potential concerns presently identified:

- The most obvious concern is the loss of passing opportunities throughout that segment of SR 37 which currently has alternate passing lanes (approximately 7 miles). This will force vehicles to drive at the speed of the slowest vehicle and may generate public complaints. These passing lanes were constructed in the 1970's to address accident problems due to the lack of passing opportunities. The construction of the passing lanes was successful in reducing the number of accidents:
- There is a concern that with the removal of the passing opportunities, drivers may attempt to utilize the shoulders for passing slow vehicles. To help prevent this, recessed rumble strips in the shoulders have been included in this proposal.
- Past studies indicate that adding passing lanes on two-lane highways reduce accidents. The impact of reducing the passing lanes under the conditions that exist is unknown.
- Emergency access, lane closures, etc. will certainly increase traffic congestion when they occur.

VIII. PROPOSAL DESCRIPTION

There were four alternatives considered:

Alternative 1

The "do nothing" alternative would not change the current striping plan on SR 37. It would include continuing our normal operational procedures of monitoring SR 37 and making whatever changes in signing and delineation are deemed appropriate. This alternative was considered because of the current total accident statistics, which are well below average for highways with similar physical characteristics. However, this alternative did not address the fatal accidents on this segment of the highway.

With the recent development of the inverted profile thermoplastic pavement marking and raised profile thermoplastic pavement marking (new products), and the recent information from the Pennsylvania DOT, this alternative was rejected in favor of evaluating whether or not the new products on the market could be utilized as part of a project to reduce the number of fatal accidents without negatively impacting overall accident rates.

Alternative 2

This alternative includes a complete upgrade by widening the roadway to a 4-lane divided highway with two lanes in each direction, 8-foot shoulders, and a median. Widening the highway requires encroachment into wetlands and other environmentally sensitive areas of concern. The McAteer-Petris Act of 1969, which established the Bay Conservation and Development Commission (BCDC), prohibits the construction of highways on fills in wetland areas. Since this segment of the highway is in a highly sensitive environmentally area, the resulting mitigation could be very expensive and, more importantly, very difficult if not impossible to achieve without changes in current legislation. To further complicate the environmental issue, there are a number of rare and endangered species of flora and fauna present along SR 37 which would require extensive mitigation.

Upgrading the facility at this location is beyond the jurisdiction of Caltrans. The Metropolitan Transportation Commission (MTC) has not identified such an upgrade as a priority in their Regional Transportation Plan. Identifying this as a priority project will be difficult. The potential \$100 to 200 million cost of a project will be extremely difficult to fund, in light of the state of the economy and the current \$5 billion shortfall in the Departments currently approved budget.

Alternative 3

This alternative involves the installation of a concrete barrier to separate the traffic lanes and would eliminate the passing lanes along SR 37 from the intersection of SR 37 and SR 121 in Sonoma County to the west end of the freeway near the Walnut Overcrossing in Solano County. It would require widening of about 8 to 10 feet for the fill section. This alternative is a good deterrent to cross-centerline accidents, but there are critical drawbacks to it for a situation like SR 37.

In addition to all passing opportunities being eliminated along this entire section of highway, other drawbacks include:

- a) It restricts emergency response capabilities, because the access for the emergency vehicles, i.e., fire trucks, ambulance, Medi-evac helicopters, etc., would be impaired.
- b) Data collected on barriers installed at non-freeway locations indicate that overall accident rates may increase 79% and the severity may increase 55%.
- c) Errant vehicles deflecting from the barriers have very little recovery area beyond the paved shoulders and, if they leave the roadway, may traverse the slopes.
- d) Concrete barrier may cause some sight distance problems at access points, such as Skaggs Island Road.
- e) Concrete barrier would require fixed-end treatment at all openings and ends. Even though the fixed-end treatment usually reduces the severity of impacts, it still remains a fixed object and can result in traffic crashes.
- f) Maintenance activities would often require full directional closure or one-way traffic causing major traffic delays. The nearest available detour would require 26 miles of travel over a route that is already experiencing some congestion, as opposed to the approximately 10 mile trip on SR 37.
- g) Turning movements would be concentrated at the openings. This would reduce the operational efficiency of vehicles entering and exiting the highway and may require additional traffic control devices.
- h) Platooning will often require drivers to slow down to the speed of the slowest driver. This may lead to driver frustration causing improper passing attempts. During this passing maneuver one of the vehicles could impact the concrete barrier and be redirected into the other vehicle (see item c).
- i) Accidents would likely close the highway in one direction requiring one-way traffic control causing major traffic delays. This is especially significant if the number of accidents increase due to impacts with the concrete barrier. The nearest available detour would require 26 miles of travel over a route that is already

experiencing some congestion, as opposed to the approximately 10 mile trip on SR 37.

- j) It should be noted that the Sonoma Creek Bridge is within the limits of this highway segment. The Sonoma Creek Bridge has a usable width of 32 feet (two 12-foot lanes and 4-foot shoulders). The bridge would be need to be widened to place a barrier on the bridge.
- k) Construction of the concrete barrier from the SR 121/37 intersection in Sonoma County to the west end of the freeway in Solano County will require widening into extremely sensitive environmental lands to maintain lane and shoulder widths. The ramifications of this are discussed in alternative 2.
- l) The cost of this alternative is in excess of \$6 million. This alternative does not include widening or replacing the Sonoma Creek bridge. It would cost an additional \$4 million to widen the bridge to accommodate the concrete barrier.

Alternative 4

This alternative proposes the Sonoma County segment from the 121/37 intersection to the west side of the Sonoma Creek bridge, a distance of approximately 2.1 miles, be restriped to 11 foot lanes in each direction, eight foot shoulders, a 2 foot buffer zone treated with inverted rumble strips and raised profile thermoplastic pavement marking, and channelizers down the center of the buffer zone on a 50 to 100 foot spacing.

The Sonoma Creek Bridge, a distance of approximately 0.3 miles, is proposed to be maintained as two 12 foot lanes and 4 foot shoulders with the opposing lanes separated by a double yellow pavement marking composed of raised profile thermoplastic pavement marking. It is proposed that, given the 32 foot width available on the Sonoma Creek bridge.

SR 37 on Solano County from the end of the Sonoma Creek Bridge to the beginning of the passing lanes west of Skaggs Island road, a distance of approximately 0.6 miles, be restriped to 11 foot lanes in each direction, eight foot shoulders, a 2 foot buffer zone treated with inverted rumble strips and raised profile thermoplastic pavement marking, and channelizers down the center of the buffer zone on a 50 to 100 foot spacing.

This alternative also proposes the elimination of the passing lanes in both directions from just west of Skaggs Island Road to the west end of the freeway near the Walnut Street Overcrossing and re-striping this section of the highway to provide 12 to 14-foot lanes in each direction, providing an 8-foot shoulder with rumble strips, and a buffer zone of 4 to 8 feet treated with inverted profile thermoplastic striping and raised profile thermoplastic striping (new products), and recessed rumble strips. Channelizers would be placed down the centerline of the buffer

zone at 100 to 200-foot centers. A left-turn pocket will be provided at Skaggs Island Road using the buffer zone area in connection with a reduction in the shoulder width.

In addition to all passing opportunities being eliminated along this entire section of highway, other drawbacks include:

- a) Emergency response capabilities could be impaired to a minor degree.
- b) Maintenance activities could be impacted to some degree.
- c) Platooning will often require drivers to slow down to the speed of the slowest driver. This may lead to driver frustration causing improper passing attempts.
- d) Accidents could close the highway in one direction requiring one-way traffic control causing major traffic delays.
- e) This alternative may increase the exposure to traffic by maintenance crews when replacing damaged channelizers, pavement markers, and delineation.
- f) The number of head-on accidents should be reduced but may not be eliminated as this is a passive, not a positive, barrier that can be breached and passed over by vehicles.
- g) There is insufficient width to construct a 4 to 8 foot buffer zone along this entire length of SR 37 without widening the roadway into environmentally sensitive areas. The ramifications of this are discussed in alternative 2.
- h) The cost of this proposal is approximately \$800,000

Alternative 5

This alternative is a combination of alternatives 3 and 4. It involves the construction of a concrete barrier from just east of Skaggs Island Road to the west end of the freeway near the Walnut Street Overcrossing in Solano County. It also proposes the construction of a "buffer zone" from the SR 121/SR 37 intersection in Sonoma County to just east of Skaggs Island Road in Solano County. This alternative contains all the same drawbacks discussed under Alternatives 3 and 4. The estimated cost of this project is \$1,200,000.

This alternative was developed in recognition of a need to address the fatal accident history occurring on SR 37 without the probable delay that will be inherent in any project requiring environmental permits from the various state and federal agencies involved. This proposal can be altered to provide a concrete barrier along the entire length of SR 37 from the intersection of SR 37 and SR 121 in Sonoma County to the west end of the freeway near the Walnut Overcrossing in Solano County if, and when, all permits and clearances are obtained.

The limits of the proposed concrete barrier is the limit that could be placed while still maintaining adequate lanes and shoulders without widening the fill in the sensitive environmental areas. The balance of this segment of SR 37 would have a "buffer zone" constructed consisting

of; 11 to 12 foot lanes, eight foot shoulders, recessed rumble strips in the middle and on the shoulders, inverted profile thermoplastic pavement marking, and channelizers on 50 to 100 foot spacing down the centerline.

IX. PUBLIC HEARING

Public informational meetings were held on May 31, 1995 in Vallejo and on June 1 in Novato. In addition a formal public hearing was held on June 1 in Novato. More than 200 people attended the informational meetings and/or spoke at the public hearing. In addition, comment boxes at the meetings and hearing received a number of replies. Of all those who presented information, the clear majority were in favor of constructing a concrete barrier at this time as a temporary solution to the problems on SR 37. Almost without exception, those present were in favor of constructing a four lane divided roadway (alternative 2) as the "final" solution. Many present were surprised to discover that there were no long range plans to widen SR 37 to four lanes.

X. ANALYSIS AND RECOMMENDATIONS

There are no solutions for the described problems which do not have adverse impacts. It is clear that Alternative 2 is the preferred alternative from both an engineering perspective and the desires of those that use this portion of SR 37, as it provides a facility capable of handling the existing and future traffic volumes and reducing the type of accident this report is addressing. However, it is environmentally and economically unattainable at this time.

From a review of the traffic and accident information, as well as information provided at the public meetings, head-on type accidents are the major focus. Upon review of the five above-mentioned alternatives, and in consideration of all the benefits and adverse impacts, it is recommended that alternative 3, construction of a concrete barrier, be implemented. Because of the anticipated delays and in recognition of the need to pursue a project this construction season, it is proposed that alternative 5 be immediately implemented as an interim project until Alternative 3 can be constructed. Thus, this section of State Route 37 in Sonoma and Solano County between the SR 121/37 intersection in Solano County and the west end of the freeway near the Walnut Street Overcrossing would be altered with a combination of concrete barrier and "buffer zone" until such time as a concrete barrier could be constructed along the entire route.

Although the recommended proposal may not prevent all the cross centerline accidents, it will prevent those in the area of the concrete barrier and, in the area of the buffer zone, may prevent the vast majority of the

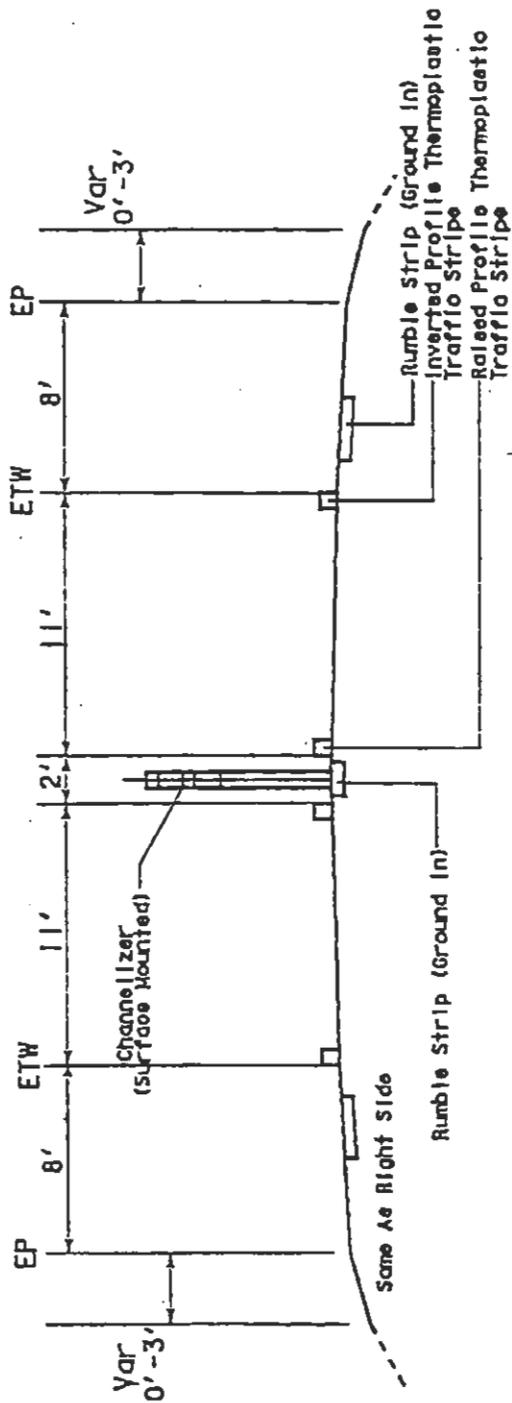
accidents, if the recent project results by Pennsylvania DOT are reflective of what will happen on SR 37.

While this proposal is being implemented, Caltrans will pursue acquisition of the necessary permits to widen the westerly portion of SR 37 to permit construction of concrete barrier (Alternative 3). If the permits can be obtained prior to the interim project being constructed concrete barrier will be installed on the entire stretch of SR 37. If the permits cannot be obtained in time for this seasons construction, a follow-up project to construct the remaining concrete barrier will be initiated immediately upon acquiring the necessary clearances.

Because of the unknown impacts of this proposed demonstration project, the accident rates will be continuously monitored after construction to ensure there is no detrimental effect on the accident rates. Thus, a before-and-after study will be conducted for a minimum 12-month period. Accident rates prior to construction will be compared to accident rates after completion of the project.

The need for placing guardrail along this portion of SR 37 was evaluated. Based on the traffic manual, the severity of striking the guardrail is greater than the severity of leaving the roadway. Therefore, the monitoring phase will include monitoring the accident history with respect to need for guardrail.

CONCRETE BARRIER DEMONSTRATION PROPOSAL
 STRIPING AND CHANNELIZERS
 (NOT ENOUGH WIDTH FOR CONCRETE BARRIER)

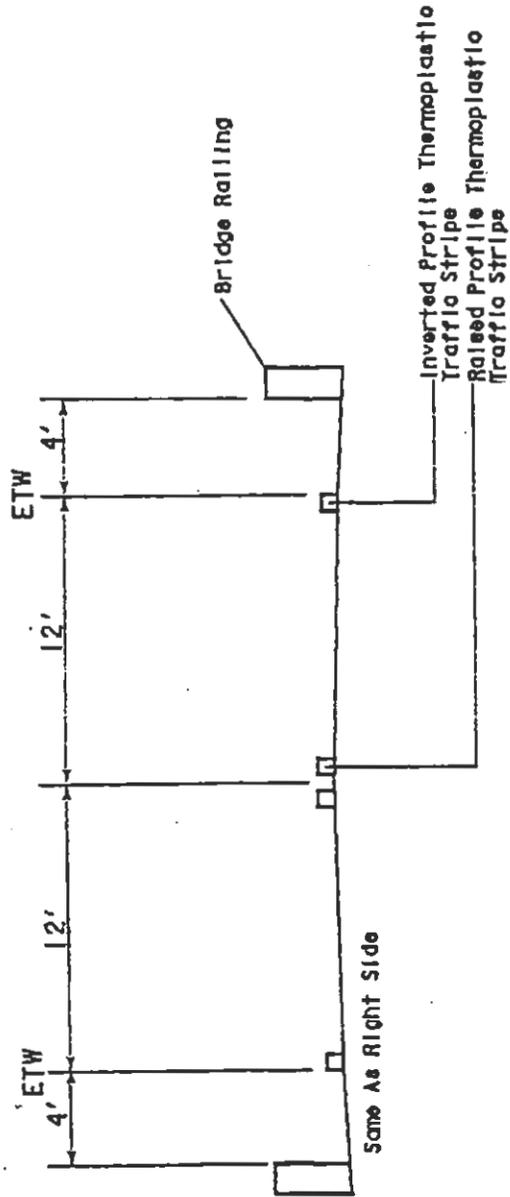


ROUTE 37
 SONOMA COUNTY
 P.M. 3.9 TO P.M. 5.9

EXHIBIT A

Figure 4. Route 37 Concrete Barrier Demonstration Proposal Exhibit A
 Source: Reference No. 2

CONCRETE BARRIER DEMONSTRATION PROPOSAL
 SONOMA CREEK BRIDGE
 (NOT ENOUGH WIDTH FOR CONCRETE BARRIER)

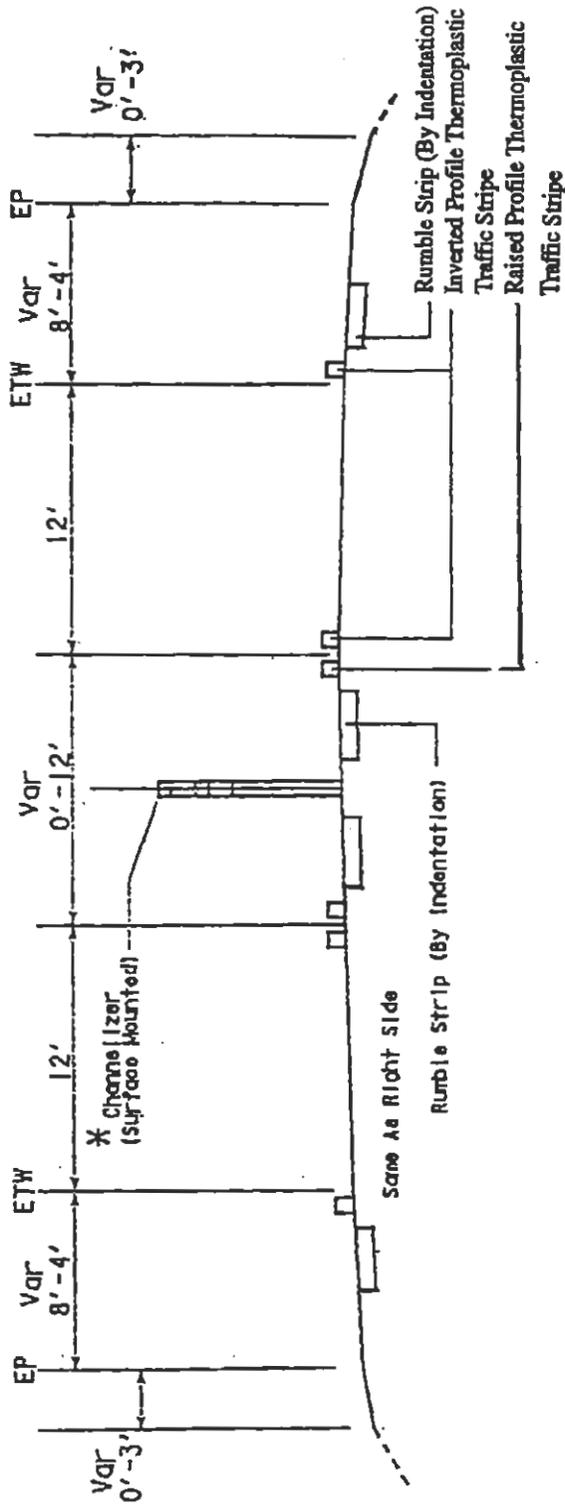


SON P.M. R5.9 TO P.M. R6.1
 SOL P.M. R0.0 TO P.M. R0.2

EXHIBIT B

Figure 5. Route 37 Concrete Barrier Demonstration Proposal Exhibit B
 Source: Reference No. 2

**CONCRETE BARRIER DEMONSTRATION PROPOSAL
STRIPING AND CHANNELIZERS
(NOT ENOUGH WIDTH FOR CONCRETE BARRIER)**



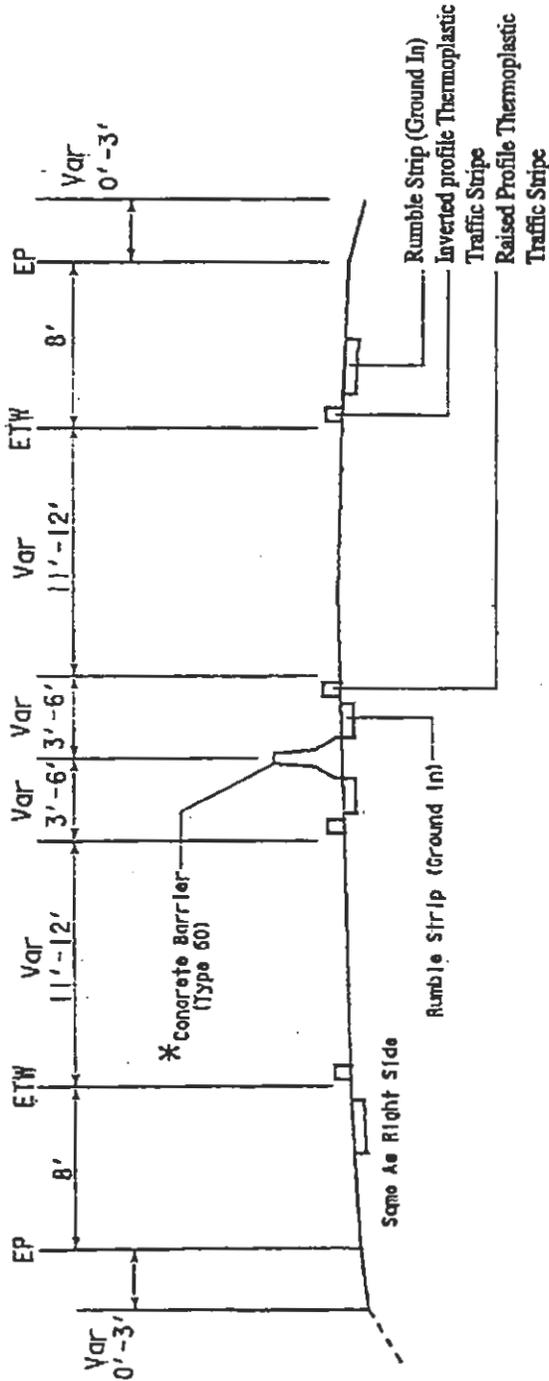
ROUTE 37
SOLANO COUNTY
P.M. RO.2 TO P.M. 1.7

* No Channelizer within the limits of Left turn pocket at Staggs Island Rd.

EXHIBIT C

Figure 6. Route 37 Concrete Barrier Demonstration Proposal Exhibit C
Source: Reference No. 2

CONCRETE BARRIER
DEMONSTRATION PROPOSAL



ROUTE 37
SOLANO COUNTY
P.M. 1.7 TO P.M. 6.9

* No Concrete Barrier within the limits of Acceleration lane at Skaggs Island Rd.

EXHIBIT D

Figure 7 Concrete Barrier Demonstration Proposal Exhibit D
Source: Reference No. 2

Appendix C

Combined Project Study Report/Project Report (Phase II)
(Page 1 through 11)

STATE OF CALIFORNIA * DEPARTMENT OF TRANSPORTATION
 COMBINED PROJECT STUDY REPORT/PROJECT REPORT (PSR/PR)

| | | |
|--|---|--|
| APPLICANT CALTRANS | DATE January 10, 1996 | DISTRICT/COR/TE/PM 4-Son,Sol-37-4.1/R6.1,R0.0/3.5 4-Sol-37-R0.1/R0.3 4-Sol-37-3.5/5.3 |
| PREPARED BY RAMIEL F. GUTIERREZ JR. | BRIEF PROJECT DESCRIPTION Widen the highway, to provide eight-foot outside shoulders, and place Type 50 concrete barrier, on Route 37, from 0.2 mile east of Route 121, in Sonoma County, to 1.8 miles east of Skaggs Island Road, in Solano County; (Mitigation Project No. 1) Construct a pedestrian foot path, under the Sonoma Creek Bridge, and a viewing area, to the south of Route 37, from 0.1 mile to 0.3 mile east of the Sonoma County line, in Solano County; (Mitigation Project No. 2) Construct drainage facilities, to the south of Route 37, from 1.8 miles to 3.6 miles east of Skaggs Island Road, in Solano County. | |
| TITLE ASSOCIATE TRANSPORTATION ENGINEER | | |

| | |
|---|---|
| REGISTERED ENGINEER STAMP  I attest to the technical information contained herein and have judged the qualifications of all technical specialists providing engineering data upon which recommendations, conclusions, and decisions were based. SIGNATURE  REGISTERED CIVIL ENGINEER DATE 1/10/96 | PERMIT No. (if applicable) EA 237000 |
| | CALTRANS RESPONSIBLE UNIT TRAFFIC OFFICE UNIT 389 |
| | PROJECT MANAGER RECOMMENDATION DATE 1/10/96 |
| | TITLE POSITION ASSISTANT CHIEF OF STAFF UNIT 352 |
| | ENVIRONMENTAL CERTIFICATE Based on the information submitted, I have determined: Projects categorically exempt under the State CEQA Guidelines. * Initial EIR (or NEI) prepared for the project complies with CEQA and the State CEQA Guidelines.  Environmental Officer/Chief |
| | RIGHT OF WAY CERTIFICATION I have reviewed the right of way information contained in the Combined Project Study Report/Project Report and the Right of Way Data Sheets attached thereto, and find the data to be complete and accurate.  District Director/Chief for Right of Way |
| PROJECT APPROVAL I have examined the information contained in the PSR/PR and NO prepared by CALTRANS (100) and find that the State Highway Department's approval of the project. SIGNATURE  DISTRICT DIRECTOR/CHIEF DATE 1/10/96 | |

1.) PROPOSAL

The purpose of this Master Combined Project Study Report/Project Report is to serve as the scoping document for the following three separate projects:

A. (EA# 237011)

Throughout the body of this report, reference is made to a phase 1 project (EA# 491204), developed by District 10, which was recently constructed on Route 37. This phase 1 project is described in the report entitled "A Proposal For A Demonstration Project" included as Attachment K. It should be noted that although most of the discussion in the aforementioned report centers around the phase 1 project, portions of it are also applicable to the following phase 2 project.

The limits of work of this phase 2 project are from 0.2 mile east of Route 121, in Sonoma County (PM 4.1), to 1.8 miles east of Skaggs Island Road, in Solano County (PM 3.5), on Route 37: a total length of 5.5 miles. Within these limits, it is proposed that a Type 50 concrete barrier be placed from PM 4.2 (Sonoma) to PM R5.8 (Sonoma) and from PM R0.3 (Solano) to PM 2.8 (Solano). To accommodate the placement of the Type 50 concrete barrier, an existing buffer zone will be eliminated from PM 4.2 (Sonoma) to PM R5.8 (Sonoma) and from PM R0.3 (Solano) to PM R2.0 (Solano), and an existing permanent precast concrete barrier will be removed from PM R2.0 (Solano) to PM 2.8 (Solano). Both improvements were part of a phase 1 project which constructed a buffer zone from PM 3.9 (Sonoma) to PM R6.0 (Sonoma) and from PM R0.2 (Solano) to PM R2.0 (Solano), placed a permanent precast concrete barrier from PM R2.0 (Solano) to PM 2.8 (Solano), and placed a Type 50 concrete barrier from PM 2.8 (Solano) to PM R6.9 (Solano). The buffer zone was constructed and the permanent precast concrete barrier was placed on an interim basis with the understanding that they would be utilized until the appropriate clearances and permits, necessary to widen the highway and place Type 50 concrete barrier, could be obtained. The intent of this phase 2 project is to get the required clearances/permits to supplant the permanent precast concrete barrier with a Type 50 concrete barrier and replace the buffer zone with a Type 50 concrete barrier separated area.

At its easterly terminus, the new Type 50 concrete barrier will conform to an existing Type 50 concrete barrier, constructed during phase 1, at PM 2.8 (Solano). At its westerly terminus, the decision was made to begin the new Type 50 concrete barrier approximately 450 feet east of the Tolay Creek Bridge, PM 4.2 (Sonoma).

In addition, to facilitate the construction of eight-foot out-

side shoulders, the highway will be widened to the north from PM 4.1 (Sonoma) to PM R6.0 (Sonoma) and from PM R0.2 (Solano) to PM 1.69 (Solano), and to the south from PM 1.69 (Solano) to PM 3.5 (Solano). Widening the highway in both directions is necessary to minimize the project's environmental impacts. As a part of the work, "ground in" rumble strips will be placed between the opposing lanes and on the outside shoulders. A conceptual plan is included as Attachment C. It should be noted that during construction, all excess excavated material will be disposed of off the work site at an appropriately permitted disposal area.

Furthermore, as part of the mitigation for placing the Type 50 concrete barrier and widening the highway, this phase 2 project also proposes to construct a parking facility and access road to the north of Route 37, just east of the Sonoma Creek Bridge (Bridge No. 23-63), PM R0.3 (Solano). The development will service a future viewing area, located to the south of the highway, being constructed to satisfy BCDC permit requirements for this phase 2 project. The work will involve placing Class 3 aggregate base over an approximate area of 4500 square feet to accommodate parking. In addition, to provide access between the new parking facility and westbound Route 37, this project also proposes placing Class 3 aggregate base over an existing dirt road. Moreover, to designate the end of the access road, a chain link fence with a gate post will be erected as a part of the work. A conceptual plan is included as Attachment D.

A gap, approximately 0.6 mile long, will exist in the Type 50 concrete barrier from PM R5.8 (Sonoma) to PM R0.3 (Solano) because the Sonoma Creek Bridge is not wide enough to provide eight-foot outside shoulders. The existing roadway on the bridge, consisting of two twelve-foot lanes and two four-foot outside shoulders, will remain unchanged. Alternatives for a phase 3 project to close the gap in the Type 50 concrete barrier are being evaluated.

Because large sanitation trucks and farm vehicles need to access both the northern and southern private cross roads at PM 5.35 (Sonoma), from either direction of Route 37 on a daily basis, an opening in the Type 50 concrete barrier will be provided and opposing left-turn lanes will be constructed at this location. In addition, as Skaggs Island Road is a public road and facilitates traffic to a private duck club, an opening in the Type 50 concrete barrier will also be provided at this intersection, PM 1.69 (Solano), in order to retain the existing eastbound left-turn lane, and eastbound storage/acceleration lane for motorists negotiating a left turn out of Skaggs Island Road. These concrete barrier openings, for the aforementioned left-turn facilities, will improve the overall operation of the highway and aid emergency response units. "ADIEM II (Advanced Dynamic Impact Extension Module)" crash cushions

mitigation work, it is proposed that the 1994 SHOPP Midcycle Revision be amended to include these projects, and an amount of \$9,050,000 be funded from the HB4N Program in the 1995/96 fiscal year.

2.) EXISTING FACILITY

The phase 2 project is located in a rural area between the cities of Novato and Vallejo. Route 37, an east/west facility, is the main connection between Route 101, in Marin County, and Route 80, in Solano County; both major freeways. As stated previously, a recently constructed phase 1 project has changed the characteristics of Route 37 from PM 3.9 (Sonoma) to PM R6.9 (Solano) and, as the limits of work of the phase 2 project coincide with a portion of phase 1, the following description reflects the phase 1 improvements.

Within the limits of the phase 2 project, the existing facility is a two-lane barrier separated conventional highway from the western conform, PM 4.1 (Sonoma), to the beginning of the Sonoma Creek Bridge (Bridge No. 23-63), PM R6.0 (Sonoma). There it transitions into a two-lane conventional highway and remains so until the end of the bridge, PM R0.2 (Solano). From there to the project's eastern conform, PM 3.5 (Solano), Route 37 transitions back into a two-lane barrier separated conventional highway: except at the Skaggs Island Road intersection, PM 1.69 (Solano), where it transitions into a two-lane conventional highway with provisions for left-turn channelization. A majority of the facility is bounded on both sides by wetlands, endangered species habitat, and other environmentally sensitive areas subject to control by numerous State and Federal laws and regulations.

From the western project conform to the west end of the Sonoma Creek Bridge, PM 4.1 (Sonoma) to PM R6.0 (Sonoma), and from the east end of the Sonoma Creek Bridge to 0.3 mile east of the Skaggs Island Road intersection, PM R0.2 (Solano) to PM R2.0 (Solano), except at the intersection, the existing cross section consists of two through lanes that vary from eleven to twelve feet in width; two eight-foot outside shoulders with rumble strips; and a two to twelve-foot buffer zone with rumble strips and channelizers mounted down its center. At the Skaggs Island Road intersection, PM 1.69 (Solano), the existing cross section consists of two twelve-foot through lanes, a twelve-foot left-turn lane, and two five-foot outside shoulders with rumble strips. On the Sonoma Creek Bridge, PM R6.0 (Sonoma) to PM R0.2 (Solano), the highway's existing cross section consists of two twelve-foot through lanes and two four-foot outside shoulders. From PM R2.0 (Solano) to PM 3.5 (Solano), the highway's existing cross section consists of two through lanes that vary from eleven to twelve feet in width; two eight-foot outside shoulders with rumble strips; and a six to twelve-foot concrete barrier separated area with rumble strips and either a permanent precast (PM

mately twelve months to complete. A complete cost breakdown is given in the preliminary project cost estimate summary sheet included as Attachment F.

B. (EA# 237021)

This is the first of two projects which will serve as environmental mitigation for the phase 2 project (EA# 237011). Specifically, this mitigation project is needed to satisfy requirements set forth in the BCDC permit for phase 2. It is proposed that a pedestrian foot path be constructed, under the Sonoma Creek Bridge (Bridge No. 23-63), and a viewing area be constructed, to the south of Route 37, from 0.1 mile to 0.3 mile east of the Sonoma County line (PM R0.1 to PM R0.3), in Solano County. The foot path will enable pedestrians to access the viewing area from a parking facility, to the north of Route 37, built as a part of phase 2. Caltrans will be responsible for the PS&E preparation, contract award, and construction administration. The project's construction cost will not exceed \$250,000, and the work will commence immediately after the phase 2 project has been completed. A conceptual plan is included as Attachment E.

C. (EA# 237031)

This is the second of two projects which will serve as environmental mitigation for the phase 2 project (EA# 237011). In addition, this project will also mitigate for portions of the phase 1 project. Specifically, this mitigation project is needed to satisfy conditions set forth in the Army Corps of Engineers permit for phase 2. This project will supplement the scuppers, placed in the Type 50 concrete barrier as a part of phases 1 and 2, as mitigation for the salt marsh harvest mouse. It is proposed that drainage facilities be constructed, to the south of Route 37 and outside State right of way, from 1.8 miles to 3.6 miles east of Skaggs Island Road (PM 3.5 to PM 5.3), in Solano County, to improve the channelization of water during times when the San Pablo Bay is both high and at high tide. A contribution agreement with the Marin/Sonoma Mosquito Abatement District will be required. The Marin/Sonoma Mosquito Abatement District will be responsible for the preparation of the plans, contract award, and construction administration. Caltrans will contribute an amount not to exceed \$250,000 towards the construction cost, and the work is scheduled to commence in the Summer of 1996. A location map is included as Attachment A.

Funding

The total estimated cost of the phase 2 project (EA# 237011) is \$8,550,000. An accurate estimate for the combined cost of the mitigation projects (EA# 237021, 237031), however, cannot be calculated because the extent of the work required has not yet been determined. Nevertheless, to account for both phase 2 and the

will be provided, at these openings, to shield the barrier's exposed ends.

The District Hydraulics Section has determined that the "Sonoma County" portion of the project lies within a floodplain. In addition, the Environmental Planning Office has determined that the "Solano County" portion of the project lies in an area inhabited by the salt marsh harvest mouse, an endangered species. The placement of a Type 50 concrete barrier could limit the mouse's ability to cross the highway: a necessary maneuver for survival during certain times of the year. To mitigate for both the floodplain and the salt marsh harvest mouse, scuppers (3"x18") will be placed at the base of the Type 50 concrete barrier spaced eight feet center to center.

To reduce the severity of potential accidents with the ends of the Type 50 concrete barrier, the decision was made to install "ADIEM II (Advanced Dynamic Impact Extension Module)" crash cushions at all locations where the ends of the Type 50 concrete barrier will be exposed to traffic.

Glare screens will not be included in this project. An analysis indicates that for the five year period between July 1, 1990, and June 30, 1995, headlight glare was not a contributing factor in any of the nighttime accidents along this section of Route 37. This justifies the omission of glare screens from this phase 2 project.

The need for placing guardrail beyond the outside shoulders, along the segment of Route 37 within the limits of this phase 2 project, was evaluated. Based on the Traffic Manual, the severity of striking the guardrail is greater than the severity of leaving the roadway. Therefore, the decision was made to forego the installation of guardrail.

This proposed project should eliminate cross-centerline accidents; where most of the fatals occurred during the study period. It should be noted that all of the accidents within the study period occurred prior to the construction of the buffer zone and placement of the permanent precast concrete barrier, both placed on an interim basis as a part of phase 1. These improvements were made to address cross-centerline accidents along this segment of Route 37. What true impacts the buffer zone, the permanent precast barrier, and ultimately the new Type 50 concrete barrier will have are not known.

There are many benefits to this phase 2 project, however, there are also some potential concerns. For more information on this topic, see Section VIII (Alternative 3) of Attachment K.

This phase 2 project is scheduled to begin construction in May 1996, and it is estimated that the work will take approxi-

R2.0 to 2.8) or Type 50 (PM 2.8 to 3.5) concrete barrier constructed down its center.

As the construction of a Type 50 concrete barrier on this two-lane highway will change the characteristics of the roadway, possibly altering driver behavior, various operational analyses will be performed and accidents, from the time prior to phase 1 to after phase 2, will be evaluated along this segment of Route 37 once the phase 2 project has been constructed. In addition, because guardrail will not be installed, for reasons given previously, included in these analyses will be the monitoring of the operational characteristics of the roadway with respect to the need for guardrail.

3.) ANALYSIS

An accident analysis reveals that for the five-year study period between July 1, 1990, and June 30, 1995, the actual total accident rate for Route 37, within the project limits, is less than the average total accident rate for similar highways. However, despite the actual total accident rate being less than the average total accident rate, drivers' errors, compounded by the high speeds of vehicles and high volumes of traffic, are resulting in an increase in the actual fatal accident rate. For this five year study period, the actual fatal accident rate is roughly 26% greater than the average fatal accident rate for similar highways. Further investigation reveals that all of the accidents involving fatalities occurred during the last three years of the study period.

To address the situation, Caltrans first considered the upgrading of Route 37 to either a four-lane expressway or freeway. Unfortunately, budget shortfalls and environmental concerns have seriously hampered the Department's ability to upgrade this two-lane highway to a multi-lane facility. This inability generated a growing need to develop other ways to meet the operational needs of Route 37.

As an interim improvement, District 10's phase 1 project constructed a buffer zone and placed a permanent precast concrete barrier on Route 37, within the limits of the phase 2 project, to reduce the number and severity of cross-centerline accidents. What true impact these improvements will have are not known.

This phase 2 project is a demonstration project that proposes improvements aimed at reducing or preventing cross-centerline accidents; where most of the fatalities occurred along this portion of Route 37 during our study period. As previously mentioned, it is proposed that a Type 50 concrete barrier be placed and the highway be widened to provide eight-foot outside shoulders. This will transform Route 37 into a two-lane Type 50 concrete barrier separated conventional highway, from PM 4.2 (Sonoma) to PM 3.5 (Solano), except at the barrier openings and on the Sonoma Creek

Bridge. As the modifications to Route 37, due to the phase 1 and phase 2 projects, will result in the first two-lane Type 50 concrete barrier separated conventional highway in the State of California, the impact of these improvements will be closely monitored because data from this highway will be collected and studied for future use on other highways.

4.) ENVIRONMENTAL CLEARANCE

The Negative Declaration has been prepared in accordance with Caltrans' Environmental Regulations and the attached Negative Declaration is the appropriate document for the proposal (Attachment G).

5.) OTHER INFORMATION

Alternatives

The following alternatives to the proposed phase 2 project were considered but not pursued due to prohibitive costs, environmental impacts and/or an inability to fully address the operational needs of the existing highway. It should be noted that some of the potential concerns listed under each alternative are also applicable to the phase 2 proposal.

1. Do Nothing - Should phase 2 not be constructed, the modifications to Route 37, constructed as a part of District 10's phase 1 project (EA# 491204) between PM 4.1 (Sonoma) and PM 3.5 (Solano), would remain intact and the existing facility would not change.

Some potential concerns to this proposal include:

- a.) The number of head-on accidents is expected to be reduced, due to the construction of phase 1, but may not be eliminated as the existing buffer zone is a passive, not positive, barrier that can be traversed by vehicles.
 - b.) Maintenance crews will be exposed to traffic when replacing damaged channelizers, pavement markers, and delineation.
 - c.) Platooning would often require drivers to slow down to the speed of the slowest driver. This will lead to driver frustration.
2. Widen highway to increase width of buffer zone - The widening proposed as a part of the phase 2 project could be utilized to increase the width of the existing buffer zone, in lieu of accommodating the placement of Type 50 concrete barrier. Should this be accomplished, the existing passive

barrier would remain in place and the subsequent expectation would be that the number of cross-centerline accidents would be reduced. However, it is a possibility that cross-centerline accidents may not be eliminated, as this "non-positive" barrier can be traversed by vehicles. Furthermore, all of the potential concerns listed previously in Alternative 1 also are applicable to this alternative.

3. Upgrade to a multi-lane facility - Additional widening of the highway would require additional encroachment into wetlands and other environmentally sensitive areas of concern. The McAteer-Petris Act of 1969, which created the San Francisco Bay Conservation and Development Commission (BCDC), established laws that make it difficult to construct highways on fills in those areas under BCDC's jurisdiction. Since this segment of the highway is in a highly sensitive environmental area, the resulting mitigation could be very expensive and very difficult to achieve without changes in current legislation. To further complicate the environmental issue, there are a number of rare and endangered species of flora and fauna present along Route 37 which would require extensive mitigation.

The Metropolitan Transportation Commission (MTC) has not identified upgrading this type of facility into a multi-lane highway as a priority in their Regional Transportation Plan. Without their support, such a project is not likely to receive enough priority to get funded. Also, as the project's cost is anticipated to be extremely high, securing funds will be difficult in light of the current \$5 billion shortfall in the State Transportation Improvement Program (STIP). In recognition of the transportation needs of the area, however, the Metropolitan Transportation Commission has initiated a Major Investment Study (MIS), for the north bay, which includes the current route as well as other state routes within the area. Environmental and transportation agencies are active participants in this effort to identify an ultimate solution that will be acceptable to all the interest groups.

Traffic and Accident Data

The "1994 Traffic Volumes on California State Highways" publication notes that the AADT for Route 37, within the phase 2 project limits, is 25,000 vehicles, and the peak hour volume is 2600 vehicles. The AADT is expected to increase to a projected demand of 36,000 vehicles by the year 2010.

For the five year study period between July 1, 1990, and June 30, 1995, the accident rates per million vehicle miles are as follows:

| LOCATION (PM TO PM) | TOTAL NUMBER OF ACCIDENTS | ACTUAL RATES | | | AVERAGE RATES | | |
|------------------------------------|------------------------------------|------------------------------|------|--------|------------------------------|------|--------|
| | | PER MILLION VEHICLE MILES | | | PER MILLION VEHICLE MILES | | |
| | | *F | #F+I | @TOTAL | *F | #F+I | @TOTAL |
| PM 4.1 (SON) TO PM 3.5 (SOL) | 162 | 0.044 | 0.37 | 0.64 | 0.035 | 0.48 | 0.93 |

* Fatal accidents

Fatal + Injury accidents combined

@ Fatal + Injury + Property Damage Only accidents combined

TOTAL ACCIDENTS - 162

FATAL - 11 (7%)
INJURY - 83 (51%)

HEAD-ON - 16 (10%)
SIDESWIPE - 16 (10%)
REAR-END - 40 (25%)
BROADSIDE - 8 (5%)
HIT-OBJECT - 52 (32%)
OVERTURN - 13 (8%)
OTHER - 17 (10%)

DAYLIGHT - 109 (67%)
DARK - 53 (33%)

DRY - 141 (87%)
WET - 21 (13%)

After the construction of phase 2, there should be an overall reduction in cross-over fatal accidents as the Type 50 concrete barrier will prevent cross-centerline accidents. However, as the true impact of placing a Type 50 concrete barrier is not known, accidents will be evaluated along this segment of Route 37 once the phase 2 project has been constructed.

It is anticipated that the volume of vehicles turning into and out of the newly constructed access road, on the north side of Route 37, just east of the Sonoma Creek Bridge at PM R0.3 (Solano), servicing the new parking facility, will be low and, therefore, not impact the operation of Route 37. The situation will be monitored after the construction of phase 2. Furthermore, it is anticipated that the new drainage facilities, to be constructed to the south of Route 37, from PM 3.5 (Solano) to PM 5.3 (Solano), also will not impact the operation of Route 37. Nevertheless, this situation too will be monitored.

Non-Standard Design Features.

Since several non-standard features will exist once the phase 2 project has been constructed, an exception from mandatory design standards was requested. This request was approved by Frank Baxter, Headquarters Coordinator (OPPD), on January 10, 1996.

Railroads

Neither the phase 2 project nor the mitigation projects will have any railroad involvement.

Utilities

Utility relocation may be required as a part of all three projects. As the PS&E for the phase 2 project is being done concurrently with this report, utilities verification for the phase 2 project has been requested from the District Right of Way Division. Utilities verification for each mitigation project will be requested during their respective PS&E processes.

Structures

There are no structures involved in either the phase 2 project or the mitigation projects.

As previously mentioned, a Type 50 concrete barrier will not be placed, as a part of phase 2, from PM R5.8 (Sonoma) to PM R0.3 (Solano), a distance of 0.6 mile, because the Sonoma Creek Bridge does not possess sufficient width to accommodate eight-foot outside shoulders. This bridge was programmed to be seismically retrofitted in the 1996/97 fiscal year. The feasibility of a project to retrofit and widen the bridge, and place Type 50 concrete barrier to close the gap, is presently being studied.

Permits

For the phase 2 project, permits will be required from the following agencies: The U.S. Army Corps of Engineers, San Francisco Bay Conservation and Development Commission, and California Regional Water Quality Control Board. It should be noted that the U.S. Fish and Wildlife Service will provide recommendations to the Army Corps of Engineers during the Corps' permit process. As previously mentioned, the purpose of the two mitigation projects being developed is to satisfy these agencies and obtain the permits.

Coordination

To expedite the delivery of this phase 2 project, three separate coordination meetings were held, on July 14, 1995, Septem-

the regulatory agencies and elected officials involved. In addition, as a part of the development of the Negative Declaration, a public meeting was held on December 20, 1995.

On July 31, 1995, FHWA Engineer, John Hoole, reviewed this project. Per ISTEA, this project is considered exempt and subject only to environmental review by FHWA.

Right of Way

Most of the work involved in the phase 2 project is within existing State right of way. Portions of the work involved in the mitigation projects are outside existing State right of way. Right of Way Data Sheets are included as Attachments H, I, and J.

Remarks

The phase 1 project was completed in December 1995. It is anticipated that construction of the phase 2 project will commence by May 1996, and be completed by Summer 1997.

Recommendations

It is recommended that this Master Combined Project Study Report/Project Report be approved and authorization be given to proceed with the PS&E for the phase 2 project (EA# 237011), prepare the PS&E for the "BCDC" mitigation project (EA# 237021), and negotiate a contribution agreement with the Marin/Sonoma Mosquito Abatement District for the "Army Corps of Engineers" mitigation project (EA# 237031).

6.) ATTACHMENTS

- A. Location Map (All Projects)
- B. Typical Cross-Section (EA# 237011)
- C. Layout Plan Sheet (EA# 237011 - Concrete Barrier, Widening)
- D. Conceptual Plan Sheet (EA# 237011 - Parking, Access Road)
- E. Conceptual Plan Sheet (EA# 237021)
- F. Preliminary Project Cost Estimate Summary
- G. Negative Declaration
- H. Right of Way Data Sheet (EA# 237011)
- I. Right of Way Data Sheet (EA# 237021)
- J. Right of Way Data Sheet (EA# 237031)
- K. Report entitled, "A Proposal For A Demonstration Project"

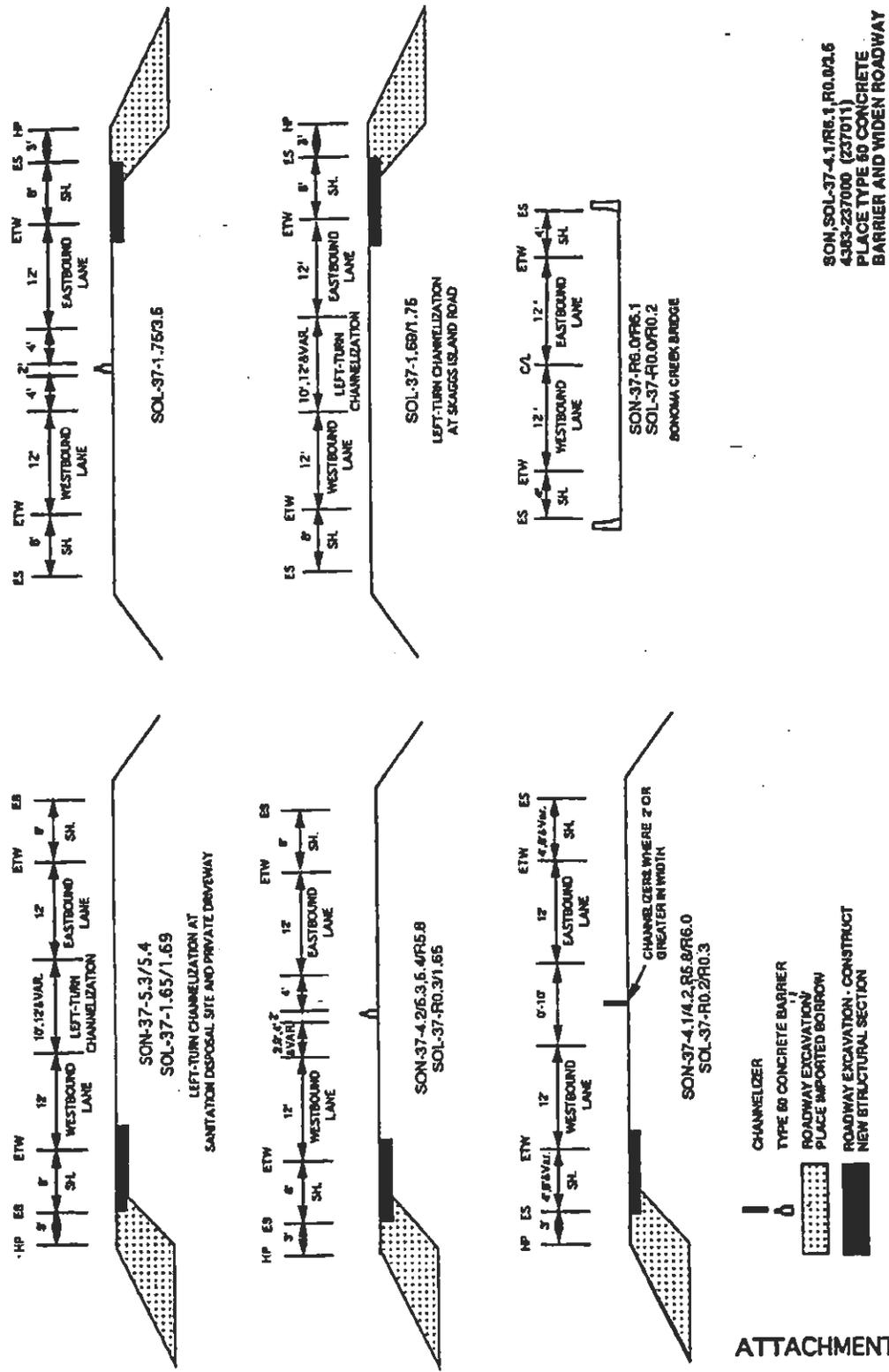


Figure 8 Phase II Construction, Typical Cross Section
Source: Reference No. 2

ATTACHMENT - B

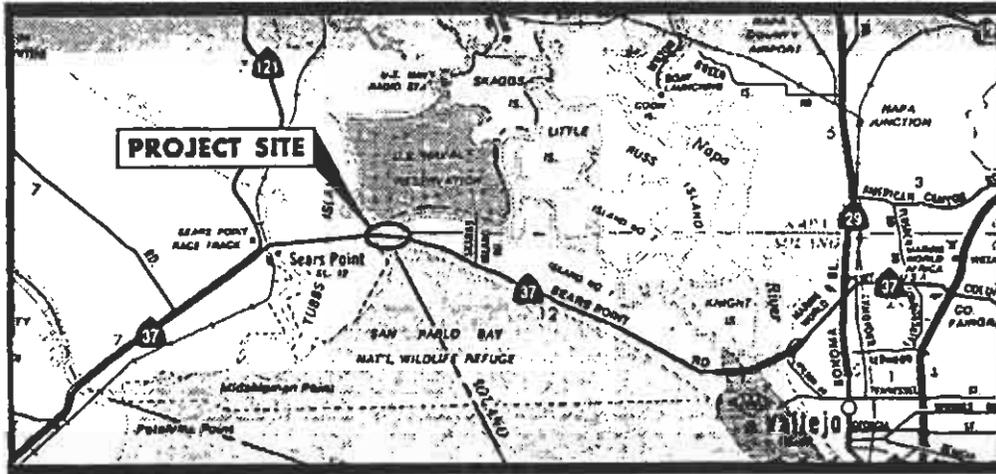
Appendix D

Project Scope Summary Report (Phase III) (Page 1 through 6 only)

04-SOL-37 0.0/1.6 (KP)
0.0/1.0 (PM)
04-SON-37 8.3/9.9 (KP)
5.2/6.1 (PM)

EA 0T04UK
SR 778
HA4S2 Seismic Retrofit
HB4N Construction of Barrier

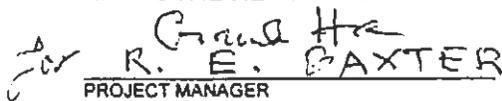
PROJECT SCOPE SUMMARY REPORT SEISMIC RETROFIT AND BARRIER PLACEMENT PROJECT



ON ROUTE 37
From KP 8.3 in Sonoma County (East of Rte 121)
to KP 1.6 in Solano County (West of Skaggs Island Road)

I have reviewed the right-of-way information contained in this Project Scope Summary Report and the RW Data Sheet attached hereto, and find the data to be complete, current, and accurate.


DISTRICT DIVISION CHIEF - RIGHT OF WAY

APPROVAL RECOMMENDED:

PROJECT MANAGER

APPROVAL RECOMMENDED:

SEISMIC RETROFIT PROGRAM MANAGER

APPROVED:

DISTRICT DIVISION CHIEF

DATE 4/17/98

PSSR approval subject to approval of Final Environmental Document

PSSR - SEISMIC RETROFIT
SONOMA CREEK BRIDGE

April 1, 1998

1. INTRODUCTION

It is proposed to seismically retrofit, to widen, and to install a concrete center barrier on the Sonoma Creek Bridge on Route 37 in Sonoma and Solano Counties between Route 121 in the west and the Napa River Bridge to the east. Widening the structure is proposed to accommodate placement of the center barrier. Cost estimated in October 1996 was \$17,529,000, which includes \$12,529,000 for retrofit, \$2,450,000 for bridge widening and barrier placement, \$1,715,000 for environmental mitigation, roadway improvements, and right-of-way acquisition, and \$835,000 for contingencies. The project is proposed to be funded from the HA4S2 and HB4N Programs.

2. RECOMMENDATION

It is recommended that this Project Scope Summary Report (PSSR) for the seismic retrofit and barrier placement at the Sonoma Creek Bridge on Route 37 in Sonoma and Solano Counties be approved and authorization be granted to proceed with the project development process.

3. BACKGROUND

Following the October 1989 Loma Prieta earthquake in Northern California, the State Legislature and Caltrans modified and further developed its Seismic Retrofit Program. As mandated by State Senate Bill 2104, the "Bridge Retrofit Program" report was prepared by Caltrans to identify key structures requiring seismic retrofit. The report was adopted by the State Legislature. The "Bridge Seismic Retrofit Program" is divided into four phases. Phase 1 and Phase 2 were for the seismic retrofit of State Highway structures. The Sonoma Creek Bridge was included in Phase 2 of the Seismic Retrofit Program (see Appendix A)

On May 25, 1995, the State Legislature passed Senate Concurrent Resolution Number 35 (SCR 35) recommending that Caltrans install a center concrete barrier on Route 37 in Sonoma and Solano Counties between Route 121 in the west and the Napa River Bridge to the east. This project was developed in three phases and implemented by Caltrans. The Phase 1 concrete barrier project on Route 37 was completed on December 23, 1995. The Phase 2 barrier project was contract accepted on October 8, 1997. The construction for this Phase 2 barrier project was completed but the construction work is in the process of being accepted by the State. However, a gap in the center concrete barrier still exists at the Sonoma Creek Bridge and its approaches. The gap closure is Phase 3, the final phase, of the center concrete barrier placement projects on Route 37.

To minimize cost and environmental impacts and to fulfill State Legislative mandates, it was concluded that the Sonoma Creek Bridge retrofit and the Phase 3 barrier placement projects should be combined. The proposed combined project is funded from the HA4S2 and the HB4N Programs.

4. LOCATION AND PROBLEM

Bridge Number: 23-0063

Name: Sonoma Creek Bridge

District-Co-Rte-KP: 04-SOL-37-KP 0.0/1.71 and 04-SON-37-KP 9.78/9.87

The Sonoma Creek Bridge was designed in 1967 and construction was completed in December 1969. The bridge is located on Route 37 at the border of Sonoma and Solano Counties, KP 0.3 in Solano County to KP 9.5 in Sonoma County. Route 37 is an east/west facility, serving as the main connection between Route 101 in Marin County and Route 80 in Solano County (see Figure 1 in Appendix B). A significant portion of Route 37 is a two-lane, barrier separated conventional highway on raised fill and surrounded by environmentally sensitive areas including tidal marsh wetlands.

Currently, the bridge is 10.5 m wide (34.5 ft) and consists of two 3.66 m (12 ft) lanes and two 1.22 m (4 ft) outside shoulders (see Figure 2 in Appendix B). The 549.9 m (1,804 ft) length of the bridge is comprised of six frames and 22 spans. Each span is 25 m (82 ft) long (see Figure 3 in Appendix B). The end frames have three spans while the four interior frames have four spans each. Expansion joints are located at the centerlines of bents 4, 8, 12, 16, and 20. All supports are perpendicular to the direction of travel.

The superstructure consists of 5 prestressed/precast I-girders with Reinforced Concrete (R/C) slabs. The I-girders sit on R/C bent caps supported by composite pile extensions. The composite pile extensions are steel H piles for the first 30.5 m (100 ft) from the tip continuing with 508 mm (20 in) square hollow prestressed concrete piles with a 279 mm (11 in) diameter void. The confinement reinforcement is #5 gage wire at 152 mm (6 in) pitch spiral outside of the prestressing strands; however, there is no confinement reinforcement inside the strands around the void. The bent piles are battered transversely at all supports except for the abutments and at bents 2, 4, 8, 16, 20, and 22 which have piles battered longitudinally. The piles were jetted and driven into soft bay mud. The abutments are end diaphragm-type on composite piles battered both transversely and longitudinally and have cantilevered wingwalls.

The installation of a Type 50 center concrete barrier on Route 37 at the Sonoma Creek Bridge will eliminate cross centerline traffic accidents. Accident data was obtained for Route 37 at the project site from Solano PM 0.90 (KP 1.45) to Sonoma PM 5.30 (KP 8.55). During a five-year period between July 1, 1992 and June 30, 1997, a total of 125 accidents with 4 fatalities occurred in this stretch of roadway.

Phase 1 (EA 491204) and Phase 2 (EA 237014) of the barrier installation project provided a center concrete barrier along Route 37 between KP 6.6 (Sonoma) and KP R11.6 (Solano), but left a 915 m (3,000 ft) gap in the barrier at the Sonoma Creek Bridge between Sonoma PM R5.9 and Solano PM R0.2. The center concrete barrier was not constructed in this gap because of insufficient bridge width to accommodate both the concrete barrier and standard shoulders. To allow the barrier to be placed on the bridge, the deck of the Sonoma Creek Bridge needs to be widened 5.8 m (19 ft).

The current standard for concrete barrier is the Type 60 barrier, but this project will be installing Type 50/50A barriers to match the height and safety shape of existing Type 50/50A barriers on each bridge approach. Furthermore, BCDC prefers the Type 50 barrier for this project because it has a lower height than the Type 60 barrier. The Type 50 barrier has been approved by the Project Development Coordinator, Mike Thomas, and the Headquarters' Traffic reviewer Phil Jang (see Appendix C).

The Sonoma Creek Bridge crosses Sonoma Creek (a navigation channel) which is a tidal creek and is approximately 100 m (330 ft) wide at the bridge. A fender system (between bents 11 and 12), consisting of treated Douglas Fir piles, protects the columns from passing vessels. The horizontal distance between the fenders is 18.3 m (60 ft).

Non-standard design features for a conventional two-lane rural highway exist within the project limits. These features are as follows:

- stopping sight distance/design speed for the horizontal curves on each end of the bridge
- stopping sight distance/design speed for the vertical crest curve

The non-standard shoulder widths on the roadway and the bridge will be corrected by this project, but standardizing the other geometric features is not within the scope of the project. Because this project is a combined retrofit/barrier placement project, a "Fact Sheet: Exceptions to Mandatory Design Standards" will be submitted for the nonstandard features.

Vulnerabilities

The epicenter of the 1989 Loma Prieta earthquake was located in Santa Cruz approximately 190 km (118 mi) south of the subject site. Ground accelerations near the bridge measured approximately 0.1g. The Sonoma Creek Bridge experienced displacements both transversely and longitudinally during this earthquake. Most of the observed damage occurred at the connections between the bent cap and pile extensions. Concrete spalling was also observed.

5. PROPOSALS / RECOMMENDED ALTERNATIVE

The seismic performance goal for the Sonoma Creek Bridge is to prevent collapse during a maximum credible event. Based on the Seismic Performance Criteria, the Sonoma Creek Bridge has been classified as a non-vital link within the North Bay Transit District.

The seismic retrofit strategy will remedy the following structural deficiencies of the Sonoma Creek Bridge:

- Poor steel reinforcement detailing at bent diaphragms and weak connections between diaphragm and I-girders and between spans
- Insufficient seat width at expansion joints to account for lateral movement
- No confinement of prestressing strands between strands and a 0.07-meter-square (95-inch-square) void within pile extensions
- Insufficient bending capacity in the pile extension to counteract P-delta effect

The proposed seismic retrofit strategy will provide superstructure continuity using bolsters and prestressing at abutments and every fixed bent. The retrofit will provide a pipe seat extender across the expansion joints and build a new substructure to serve as a catcher and provide additional lateral stiffness.

Six project alternatives were developed and studied: No Build, Retrofit Only, Retrofit/North Side Widening, Retrofit/South Side Widening, New Bridge, and Retrofit/Symmetrical Widening.

No-Build Alternative

The No-Build Alternative would undertake no action to repair or replace the existing bridge (see Figure 4 in Appendix B). This alternative was rejected because State Senate Bill 2104 requires seismic retrofit and traffic safety improvements to ensure public safety.

Seismic Retrofit-Only Alternative

This alternative would allow for seismic strengthening of the bridge but would not widen the bridge to accommodate installation of the center concrete barrier (see Figure 4 in Appendix B). The retrofit strategy would consist of strengthening and extending the existing pier caps by encasing them in concrete and adding two additional piles on both sides of each pier cap.

The Seismic Retrofit-Only Alternative was eliminated from consideration because it would not implement the State Legislature's mandate to construct the continuous center barrier on Route 37. Furthermore, independent construction of seismic retrofit improvements followed by a separate project to widen the bridge deck to accommodate the center barrier would require two independent construction periods which would increase intrusion into endangered species tidal marsh habitat as compared to a single, combined construction period.

Seismic Retrofit with North (Left) Side Widening

The North Side Widening Alternative would consist of seismic retrofit of the bridge, widening the bridge deck to the north by 5.6 m (18.4 ft), and widening the Route 37 east and west approaches to the bridge (see Figure 4 in Appendix B). Total project length, including bridge and approach roadway improvements, would be 925 m (3,035 ft). The seismic retrofit strategy, similar to the Retrofit-Only Alternative, would strengthen and extend the pier caps and add piles at either end of the pier cap. Two new piles would be added at both ends of each pier.

Based on the increased construction period, the increased permanent impacts to tidal marsh and creek channel areas, and the estimated \$18,779,000 construction cost compared to more economical alternatives, the North Side Widening Alternative was withdrawn from further consideration.

Seismic Retrofit with South (Right) Side Widening

The South Side Widening Alternative would consist of seismic retrofit of the bridge, widening the bridge deck to the south by 5.6 m (18.4 ft), and widening the Route 37 east and west bridge approaches (see Figure 4 in Appendix B). The project length, including the bridge and approach roadway improvements, would be 970 m (3,180 ft). The seismic retrofit strategy, similar to the North Side Widening Alternative, would strengthen and extend the pier caps and add piles at both ends of the pier cap. Two new piles would be added at both ends of each pier.