# FINAL REPORT

## Route 101 Corridor Interchange Study in Mendocino County (Ukiah Area)

## For Mendocino Council of Governments

August 30, 2005

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# EXECUTIVE SUMMARY

The need for the Route 101 Corridor Interchange Study in Mendocino County resulted from concerns regarding growth and development in the Ukiah Area. The participating agencies within the Mendocino Council of Governments determined that a comprehensive review of all Ukiah area interchanges on Route 101 was in order. The study was created out of those initial concerns.

This final report summarizes the technical analysis performed throughout the study including preliminary designs and cost estimates for the concepts for interchange improvements. Specific designs and estimates are included in this report's Technical Appendix.

## Background and Context of Transportation Planning in Mendocino County

Transportation planning in Mendocino County is the responsibility of the Mendocino Council of Governments (MCOG), which is the designated as the Regional Transportation Planning Agency (RTPA). MCOG is a Joint Powers Agency comprised of Mendocino County and the Cities of Fort Bragg, Point Arena, Ukiah and Willits. The MCOG Board of Directors is comprised of two members of the County Board of Supervisors, one representative from each of the four cities, and one Countywide elected official. With the addition of the California Department of Transportation (Caltrans) District 1 Director, the MCOG Board becomes the Policy Advisory Committee. A Technical Advisory Committee (TAC) serves to advise the MCOG on various transportation matters. The TAC is comprised of representatives from the Planning and Public Works/Transportation staff of the joint powers entities, transit, air quality, rail, and Caltrans representatives. MCOG contracts annually with an Executive Director to handle staffing needs.

U.S. Route 101 is the primary north-south transportation corridor that serves the region's ground transportation needs. It is the most important route in Caltrans District 1, providing access to three of the five county seats, five of the six urban areas, and eight of the fourteen incorporated cities, including the three largest cities in the District (Eureka, Arcata and Ukiah).

## Purpose of the Study

Although Route 101 was built as a rural roadway to carry low volumes, recent growth in the region has increased traffic volumes. Apart from the general growth, there are planned developments in the Brush Street area, Lovers Lane area, and the Masonite area. A number of other major developments east of the Route 101 corridor are expected to occur in the future. Because of the significance of such developments on the operations of Route 101 and on the safety of the traveling public, MCOG decided to undertake a comprehensive study of the Route 101 corridor in the greater Ukiah area that would identify needed improvements, their costs, and priorities.

## Scope of the Study

The scope of this study has been to complete an evaluation of six freeway interchanges along Route 101 in the Ukiah area. The evaluation included an analysis of present needs, existing and future levels of service (LOS), constraints on improvement options, right of way needs, and planning level improvement costs. Conceptual designs and preliminary cost estimates have been prepared. The study interchanges listed from north to south are:

- Lake Mendocino Drive
- North State Street
- East Perkins Street / Vichy Springs Road
- East Gobbi Street

- Talmage Road (State Route 222)
- South State Street (State Route 253)

Apart from these interchanges, there are northbound slip ramps at City Well Road located about 3500 feet north of the East Perkins Street interchange. Due to the low volumes on these ramps, they are not expected to adversely influence the adjoining interchanges at present. However, they should be monitored for future planning purposes.

**Initial Data Collection and Review**

TJKM compiled existing conditions data from several sources for this study. These data include traffic volumes, number of collisions by location, and aerial photography. In this report, TJKM details initial trends that were evident from the data, which were used for evaluating existing interchange conditions.

**Initial Screening Criteria and Existing Condition Analysis Results**

Existing conditions for the six study interchanges were evaluated using three main criteria:

- Collision experience
- Congestion experience
- Geometric adequacy

Based on this existing condition analysis, TJKM determined the following:

- Collisions
  - Three interchange ramps are experiencing higher than normal collision rates: East Perkins Street northbound on-ramp, North State Street northbound off-ramp, and North State southbound off-ramp
  - On the freeway mainline, the section containing the North State Street interchange is experiencing higher than normal collision rates
  - The top three intersections with high total collisions over four years are North State / 101 Northbound Off-Ramp (10 collisions), East Perkins / 101 Northbound Off-Ramp (8 collisions), and East Perkins / 101 Southbound Off-Ramp (4 collisions).

- Operations
  - All interchange ramps are operating at uncongested levels.
  - All freeway mainline sections are operating at uncongested levels.
  - Five intersections are operating at congested levels:
    - North State Street / 101 NB Off-Ramp
    - East Perkins Street / Orchard Avenue
    - East Perkins Street / 101 SB Ramps / Pomeroy Street
    - East Perkins Street / 101 NB Ramps
    - East Gobbi Street at 101 SB Ramps
  - Queuing is affecting existing operations at the East Perkins Street / Orchard Avenue and East Perkins Street / 101 Southbound Ramp intersections. The segment between these two intersections experiences significant congestion during peak hours. Analysis revealed that:
    - During the a.m. and p.m. peak periods the westbound through movement at East Perkins Street / Orchard Avenue experiences a queue that is long

enough to block the upstream 101 Southbound Ramp intersection. Also, the left turn queue at Orchard Avenue may spill over into the through lane.
    - At the East Perkins Street / 101 Southbound Ramp intersection, the southbound left turn off the freeway experiences significant queues

  - Field observations revealed that North State Street off-ramp queues spill over to the freeway during AM peak hours.
  - All freeway merging and weaving areas operate acceptably under existing conditions.

- Geometric Adequacy - TJKM compared existing on-ramp taper lengths with current Caltrans on-ramp design standards. The majority of on-ramps have taper lengths that are below current on-ramp design standards. The East Perkins to 101 Southbound and South State to 101 southbound on-ramps are the only ramps that currently meet or exceed the standard. The North State to 101 Southbound, East Perkins to 101 Northbound, and Talmage to 101 southbound on-ramps fall short but are very close to the standard.

- Interchange Spacing Adequacy - all interchanges are spaced less than two miles apart, and therefore do not meet the desired spacing criteria. In addition, there currently are no auxiliary lanes for weaving and merging traffic. In particular, the East Perkins, East Gobbi, and Talmage interchanges are spaced less than one mile apart from one another. A likely challenge to adding an auxiliary lane between the East Perkins Street and East Gobbi Street interchanges is the pedestrian overcrossing between these locations, whose bridge piers are located very close to the pavement edges on both sides of the freeway.

- Initial Interchange Evaluation - The North State Street and East Perkins Street interchanges are by far the top two interchanges with the highest cost of excess delay and/or collisions. For the North State Street interchange, the excess cost is primarily due to collisions. For the East Perkins Street interchange, the excess cost is primarily due to congestion. Congestion costs are the only costs associated with three other interchanges, while the South State Street (SR 253) interchange has no associated costs.

**Future 2025 Condition Analysis Results**

For the year 2005 condition, six study interchanges were evaluated based on three main criteria: 1) collision experience, 2) congestion experience, and 3) geometric adequacy. For year 2025, only congestion is evaluated, since collision and geometric criteria cannot be meaningfully evaluated in the future. Facilities with traffic volume demand equal to or greater than their capacities are given a more detailed examination later in this report, where specific interchange improvements are discussed.

TJKM forecasted future 2025 traffic volumes for this study. All future developments, including those near the North State Street interchange area, were considered while forecasting future volumes. TJKM determined the following results for future 2025 conditions:

- Five interchange ramps are projected to operate unacceptably:

  - Southbound off-ramp at North State Street (a.m. peak)
  - Southbound off-ramp at East Perkins Street (a.m. peak)
  - All four North State Street interchange ramps (p.m. peak)

- All freeway mainline segments will operate without congestion under future conditions.

- The following study intersections are anticipated to operate unacceptably under future conditions:

    - Lake Mendocino Drive at 101 Southbound Ramps (a.m. and p.m. peak)
    - Lake Mendocino Drive at North State Street (p.m. peak only)
    - North State Street at 101 Northbound Ramps (a.m. and p.m. peak)
    - North State Street at 101 Southbound Off-Ramp (a.m. and p.m. peak)
    - North State Street at 101 Southbound Off-Ramp (p.m. peak only)
    - North State Street at Kuki Lane (a.m. and p.m. peak)
    - East Perkins Street at Orchard Avenue (a.m. and p.m. peak)
    - East Perkins Street at 101 Southbound Ramps (a.m. and p.m. peak)
    - East Perkins Street at 101 Northbound Ramps (a.m. and p.m. peak)
    - East Gobbi Street at Orchard Avenue (a.m. and p.m. peak)
    - East Gobbi Street at 101 Southbound Ramps (a.m. and p.m. peak)
    - Talmage Road at Airport Park Boulevard (a.m. and p.m. peak)
    - Talmage Road at 101 Southbound Ramps (p.m. peak only)
    - Talmage Road at 101 Northbound Ramps (p.m. peak only)

- All merging and weaving sections in the study area will operate acceptably.

**Preliminary Improvements**

The operational concerns identified during the analysis were examined in more detail to determine preliminary improvements. Concerns highlighted include high collision rates for on- and off-ramps, ramp junctions with cross streets, and mainline locations; and traffic volume demand at or greater than mainline, ramp or intersection capacity. Other criteria include the geometric adequacy of on- and off-ramps, warrants for signals at ramp and ramp-related intersections, interchange spacing, and observations from field checks of the interchanges.

Specific problems and operational concerns were identified for each interchange under both 2005 and 2025 traffic conditions. Based on the identified concerns, graphics are provided in this report to illustrate the details of the recommended improvements at each interchange. All improvements described herein are preliminary and were evaluated further in terms of conceptual engineering and cost estimation where appropriate.

*Interchange 1: Route 101 at Lake Mendocino Drive*

<u>Concerns</u>

- Inadequate merge capacity for northbound and southbound on-ramps (2025)
- Inadequate overall intersection capacity at 101 Southbound Ramp / Lake Mendocino Drive and North State Street / Lake Mendocino Drive (West Leg) intersections (2025)

<u>Improvements</u>

- 2025: Install signal at 101 Southbound Ramp / Lake Mendocino Drive intersection
- 2025: Increase acceleration lengths for both northbound and southbound on-ramps

*Interchange 2: Route 101 at North State Street*

<u>Concerns</u>

- Excess collision rate on both northbound and southbound off-ramps (2005)
- Excess collision rate on northbound on-ramp (2005)
- Excess collision rate at northbound ramp intersection (2005)

- Excess collision rate on freeway mainline in vicinity of ramp merging areas - northbound in particular (2005)
- Congestion at northbound and southbound ramp intersections (2005 and 2025)
- Congestion on all on- and off-ramps (2025), including queuing on both off-ramps leading to near capacity or over capacity (queue spillover to mainline) in 2025 p.m. peak hour
- Congestion and queue spillover for southbound North State left turn onto 101 Southbound on-ramp without signal (2025)
- Congestion at nearby Kuki Lane intersection south of interchange (2025)
- Inadequate merge length and tight/substandard radius for northbound on-ramp (2005)
- Inadequate merge capacity for northbound and southbound on-ramps (2025)

<u>Improvements</u>

- 2005: Install signals at northbound and southbound ramp intersections, and coordinate with existing nearby North State Street / Kuki Lane signal
- 2005: Provide three lanes on northbound Route 101 mainline structure to accommodate extended acceleration lane by re-striping the bridge area and adding pavement to the north and south of the bridge

  TJKM also examined a potential alternative to increase the radius of the 101 Northbound loop on-ramp, which would lengthen the on-ramp and thereby increase the merge taper length. This alternative would have the following constraints:

  1. Potential land takings – there is a large building located only 145 feet away from the pavement edge of the 101 Northbound off-ramp to North State. Therefore, the possibility exists that the building may need to be taken, since increasing the loop on-ramp radius would also move the adjacent off-ramp closer to this building. This could significantly increase the overall cost of improvements at the North State interchange.
  2. The on-ramp taper length, currently 420 feet, would still not likely meet Caltrans standards even with loop ramp lengthening. Current Caltrans standards are 180 meters (590 feet) of on-ramp taper length. Because of the nearby building constraint, increasing taper length to a minimum of 590 feet is difficult.

- 2025: Realign southbound on- and off-ramps to meet at a single signalized intersection
- 2025: Increase acceleration length for southbound on-ramp merge onto southbound mainline
- There has been a recent proposal to create a driveway access for a private property at a midpoint of the 101 Northbound ramps. The access would be located only approximately 400 feet from the ramp terminals at North State Street. This access is not recommended for two reasons: Caltrans standards require at least 600 feet between ramp terminals and any mid-ramp access, and Caltrans only permits mid-ramp access for public streets, not private roadways.

*Interchange 3: Route 101 at East Perkins Street*

<u>Concerns</u>

- Excess collision rates at northbound and southbound ramp intersections (2005)
- Excess collision rates on northbound on-ramp (2005)
- Congestion at northbound and southbound ramp intersections and nearby East Perkins Street / Orchard Avenue intersection (2005 and 2025)
- Queuing from westbound vehicles at East Perkins Street / Orchard Avenue intersection causing blockages of nearby southbound ramp intersection (2005 and 2025). Queue extends past intersection to East Perkins Overcrossing in 2025 p.m. peak

- Queuing of southbound off-ramp vehicles (2005 and 2005), with queue spillover to mainline in 2025, without signal
- Queuing of northbound off-ramp vehicles with queue spillover to mainline in 2025 a.m. peak, without signal
- Inadequate merge length for northbound on-ramp
- Merging congestion for northbound on-ramp (2025)
- Poor sight distance at both northbound and southbound ramp intersections due to sharp vertical curvature of the East Perkins Street Overcrossing (2005)
- Tight / substandard radii for both northbound and southbound loop on-ramps. Right turns onto these on-ramps have poor channelization (2005)

Improvements

- 2005: Add signal to southbound ramp intersection and coordinate with optimized East Perkins / Orchard signal. Add signal to northbound ramp intersection and coordinate with nearby signals. There is also potential to add a roundabout to the northbound ramp intersection, as was outlined in the May 2003 *Brush Street Triangle Study*.

- 2025 (preliminary alternative): A preliminary alternative would be to close the southbound ramps at East Perkins and relocate them to Orchard Avenue at Brush Street, north of the current ramp location. A signal at the Brush Street / Orchard Avenue intersection would be recommended along with the ramp relocation. There is also potential to add a roundabout to the Brush Street / Orchard Avenue intersection, as was outlined in the May 2003 *Brush Street Triangle Study*. It should be noted that while congestion at the East Perkins interchange would decrease, it is likely that congestion would increase at the East Perkins Street / Orchard Avenue intersection due to the redistribution of ramp trips to / from the Brush Street / Orchard Avenue intersection.

  However, some modifications to the East Perkins Street / Orchard Avenue intersection by adding lanes could alleviate congestion at this intersection. Preliminary analysis indicates that adding a westbound through-left lane and a southbound right turn lane would improve the level of service to acceptable levels. Following are some of the pros and cons of this improvement:

  - Pros: Removal of southbound Perkins ramps would improve traffic operations for East Perkins Street and its nearby intersection with Orchard Avenue. It would also eliminate the current queuing concern on the southbound Perkins ramps, the need for a signal at those ramps, and potentially the need to widen the East Perkins Overcrossing. Furthermore, the improvement could potentially reduce collisions.

  - Cons: Potential new ramps at the Orchard Avenue / Brush Street intersection provide new operation and collision concerns, including those related to a new non-standard interchange configuration. Caltrans does not support splitting interchanges in this way. Also, the new configuration would add turning movement traffic to the East Perkins Street / Orchard Avenue intersection, which already has operational concerns.

    It also should be noted that the proposed preliminary configuration for new Brush Street ramps at 101 Southbound would be a partial diamond, or half of a standard diamond interchange. To address driver orientation for a newly split interchange, TJKM recommends that “trailblazing” signage supplement the new configuration, so that clear routes are indicated to the relocated ramps and the existing northbound Perkins ramps.

- 2025: Increase acceleration length for northbound on-ramp
- 2025: Add auxiliary lane connecting northbound off-ramp with upstream northbound on-ramp from East Gobbi Street interchange to improve merging and weaving operations
- 2025: Widen East Perkins Street Overcrossing as needed to accommodate queued vehicles at newly signalized ramp intersections

*Interchange 4: Route 101 at East Gobbi Street*

<u>Concerns</u>

- Congestion at East Gobbi Street / Orchard Avenue and East Gobbi Street / 101 Southbound Ramp intersections (2005 and 2025)
- Southbound off-ramp near capacity in 2025
- Poor sight distance at both northbound and southbound ramp intersections due to sharp vertical curvature of the East Gobbi Street Overcrossing (2005)

<u>Improvements</u>

- 2005: Add signals at East Gobbi Street / Orchard Avenue and East Gobbi Street / 101 Southbound Ramp intersections and coordinate their operations. The City of Ukiah has programmed signal installation at the East Gobbi Street / Orchard Avenue intersection for its 2005-06 Fiscal Year. There is also potential to add a roundabout to the East Gobbi Street / Orchard Avenue intersection, as was outlined in the May 2003 *Brush Street Triangle Study*.
- 2025: Add auxiliary lane connecting northbound on-ramp with downstream northbound off-ramp at East Perkins Street interchange to improve merging and weaving operations
- 2025: Widen East Gobbi Street Overcrossing as needed to accommodate queued vehicles at newly signalized southbound ramp intersection

*Interchange 5: Route 101 at Talmage Road (S.R. 222)*

<u>Concerns</u>

- Congestion at nearby Talmage Road / Airport Park Boulevard intersection (2005 and 2025)
    - 2005 p.m. westbound left turn queue spillover – could block southbound ramp intersection
    - 2025 westbound queues could block southbound ramp intersection

- Congestion at northbound and southbound ramp intersections (2025)
- Southbound off-ramp to westbound Talmage Road – queue spillover to mainline in 2025 p.m. peak
- Excess collision rate at nearby Talmage Road / Airport Park Boulevard intersection
- Poor sight distance at both northbound and southbound ramp intersections due to sharp vertical curvature of the Talmage Road Overcrossing

<u>Improvements</u>

- 2025: Add signals to northbound and southbound ramp intersections. This would very likely require modification of the entire interchange to a tight diamond (Type L-1) configuration. Coordinate new signals with optimized existing signal at Talmage Road / Airport Park Boulevard intersection. A second option would be to modify the existing interchange to a partial cloverleaf design utilizing existing right-of-way.

- 2025: Widen Talmage Road Overcrossing as needed to accommodate queued vehicles at newly signalized ramp intersections

*Interchange 6: Route 101 at South State Street / Boonville-Ukiah Road (S.R. 253)*

Concerns*:* No significant concerns in 2005, and no significant concerns anticipated in 2025

Improvements*:* No improvements considered at this time.

Before implementation of the above-recommended improvements, the following points should be considered:

- Proposed new signals that are in close proximity to existing signals must be coordinated to address both State Highway and local street operational concerns.
- All proposed signal design and construction must be reviewed by and coordinated with Caltrans Traffic Operations staff for coordination with State Highway operations in the Ukiah Valley.
- Increasing capacity on local routes parallel to the freeway should be considered as an alternative to freeway improvements. Expanding local street capacity may preclude the need for expensive freeway mainline improvements, such as increasing merging lengths.

Relative to this final point, Mendocino County currently is evaluating an extension of Orchard Avenue northerly from its current Brush Street terminus to Lake Mendocino Drive. Orchard Avenue is a local roadway that is west of and runs parallel to the U.S. Route 101 freeway. This improvement would add to local street capacity and reduce local trips on the freeway.

**Prioritization of Near-Term Improvements / Final Recommendations**

TJKM prioritized those near-term improvements that can be implemented easily in the near term. These near-term improvements were prioritized based on a cost-benefit analysis using a 10-year horizon. Annualized benefits from the improvements and their annualized costs were used to calculate the benefit to cost (B/C) ratio. Based on this B/C ratio, projects were prioritized. Table ES-1 shows the results of the prioritization of proposed near-term improvements.

**TABLE ES-1: PRIORITIZATION OF NEAR-TERM IMPROVEMENTS**

| *Rank* | *Improvements* | *Capital Cost* | *Cumulative Capital Cost* | *Annualized Capital Cost* | *Cumulative Annualized Capital Cost* | *Annualized Benefits* | *Cumulative Benefits* | *B/C Ratio* |
|---|---|---|---|---|---|---|---|---|
| 1 | E. Perkins St./SB Ramps Signal | $230,000 | $230,000 | $32,200 | $31,000 | $1,093,421 | $1,093,421 | 33.96 |
| 2 | E. Perkins St./NB Ramps Signal | $230,000 | $460,000 | $32,200 | $63,200 | $87,905 | $1,181,326 | 2.73 |
| 3 | Restripe / add lane on Route 101 NB at N. State St. merge | $160,000 | $620,000 | $22,400 | $85,600 | $48,469 | $1,229,795 | 2.16 |
| 4 | N. State St./NB Ramps Signal | $230,000 | $850,000 | $32,200 | $117,800 | $51,574 | $1,281,369 | 1.60 |
| 5 | N. State St./SB Ramps Signal | $240,000 | $1,090,000 | $33,600 | $151,400 | $32,922 | $1,314,291 | 0.98 |
| 6 | Gobbi St./Orchard Ave. Signal | $230,000 | $1,320,000 | $32,200 | $183,600 | $16,834 | $1,331,125 | 0.52 |
| 7 | Gobbi/SB Ramps Signal | $165,000 | $1,485,000 | $23,100 | $206,700 | $1,518 | $1,332,643 | 0.07 |

*Notes:* *1. B/C Ratio calculation assumptions include a 10-year annualized capital cost, cost of $41,000 per collision, and $15/hour cost for lost wages.*
*2. Gobbi St./Orchard Ave. Signal has been programmed by the City of Ukiah for FY 05-06*

The above table illustrates that the proposed signal at the East Perkins Street / 101 Southbound Ramp intersection will realize the most benefits at the least cost in the near term. The East Perkins Street / 101 Northbound Ramp intersection signal and 101 Northbound / North State merge restriping are the next highest in terms of benefit to cost ratios.

# INTRODUCTION AND STUDY BACKGROUND

## Introduction

The need for the Route 101 Corridor Interchange Study in Mendocino County resulted from concerns regarding growth and development in the Ukiah Area. The participating agencies within the Mendocino Council of Governments determined that a comprehensive review of all Ukiah area interchanges on Route 101 was in order. The study was created out of those initial concerns.

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Mendocino County lies within the northern extension of California's Coastal Ranges. The mountainous nature of the county tends to minimize the ground transportation options particularly in the east-west direction. The U.S. Census Bureau, Census 2000 places Mendocino County's population at 86,265. The bulk of the population in the Mendocino County is concentrated in a few areas of the county. Ukiah, Talmage, and Redwood Valley make up the largest single population concentration in Mendocino County.

U.S. Route 101 is the primary north-south transportation corridor that serves the region's ground transportation needs. It is the most important route in Caltrans District 1, providing access to three of the five county seats, five of the six urban areas, and eight of the fourteen incorporated cities, including the three largest cities in the District (Eureka, Arcata and Ukiah). It connects with three other principal arterials within District 1 - Route 20 near Ukiah, Route 299 north of Arcata, and Route 199 north of Crescent City. Route 101 is functionally classified as a Rural Principal Arterial and is a Federal Aid Primary Route. Route 101 also has significant inter-regional and inter-state importance. It is heavily used for the transportation of inter-city/interstate commerce, and thus is the lifeline of the North Coast. Goods needed by residents of the area are shipped to merchants along the route while logs and lumber products are transported from local harvest areas and mills to markets in the Bay Area and beyond.

## Purpose of the Study

Although Route 101 was built as a rural roadway to carry low volumes, recent growth in the region has increased traffic volumes. Apart from the general growth, there are planned developments in the Brush Street area, Lovers Lane area, and the Masonite area. A number of other major developments east of the Route 101 corridor are expected to occur in the future. Because of the significance of such developments on the operations of Route 101 and on the safety of the traveling public, MCOG decided to undertake a comprehensive study of Route 101 corridor in the greater Ukiah area that would identify needed improvements, their costs, and priorities.

**Scope of the Study**

The scope of this study has been to complete an evaluation of six freeway interchanges along Route 101 in the Ukiah area. The evaluation included an analysis of present needs, existing and future levels of service (LOS), constraints on improvement options, right of way needs, and planning level improvement costs. Conceptual designs and preliminary cost estimates have been prepared. The study interchanges listed from north to south are:

- Lake Mendocino Drive
- North State Street
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- East Gobbi Street
- Talmage Road (State Route 222)
- South State Street (State Route 253)

Apart from these interchanges, there are northbound slip ramps at City Well Road located about 3500 feet north of the East Perkins Street interchange. Due to the low volumes on these ramps, they are not expected to adversely influence the adjoining interchanges at present. However, they should be monitored for future planning purposes.

## INITIAL DATA COLLECTION AND REVIEW

TJKM compiled existing conditions data from several sources for this study, which are outlined below. These data include traffic volumes, number of collisions by location, and aerial photography. In addition, this section details initial trends that were evident from the data, which were used for evaluating existing interchange conditions.

### New and Existing Traffic Count Data

The California Department of Transportation (Caltrans) provided TJKM with published 1994 through 2003 average daily traffic (ADT) information for the Route 101 freeway mainline and interchange ramps. The mainline volumes are two-way without directional splits, while the ramps are one-way volumes. These volumes were used as a basis for calculating collision rates for all freeway mainline, ramp, and local intersection locations in the study area.

TJKM collected existing a.m. and p.m. peak hour turning count data at eight study area intersections in October and November 2004. Field Data Services supplemented these data by collecting a.m. and p.m. peak hour turning count data in March 2005 at additional study area locations, which included eleven intersections and one freeway mainline count. The intersection counts were used as the basis for a.m. and p.m. peak hour level of service (LOS) calculations at all study intersections, and the freeway mainline count was used to evaluate the mainline facility's congestion.

### Recent Area Studies

TJKM consulted recent traffic studies conducted within the study area to assess their scope, breadth, sufficiency and relevancy to this study. This enabled the development of a needs assessment for further data collection, and it also provided an initial understanding of possible operational constraints at the study interchanges.

The May 2003 *Brush Street Triangle Study* identified specific congestion and safety problems at the segment of East Perkins Street between the signalized intersection at Orchard Avenue and the Route 101 Southbound ramp terminals. The study also found that the Orchard Avenue / East Perkins Street intersection had a collision rate of 0.90 crashes per million vehicle miles (c/mvm), versus the statewide collision rate of 0.58 c/mvm for this type of facility, based on 1999-2001 SWITRS data.

The April 1997 *Airport / Redwood Business Park Traffic Analysis* included evaluation of traffic conditions at the Talmage / 101 Southbound Ramps and Airport Park Boulevard / Talmage Road intersections. In particular, a sight distance problem related to the Talmage Overcrossing and the 101 southbound ramps was identified.

### Collision Information

TJKM collected collision history information over the four-year period from 2000 through 2003 within the study area. This information came from two sources – Caltrans and the California Highway Patrol (CHP). Caltrans provided collision information on the Route 101 freeway mainline and interchange ramps from its Traffic Accident Surveillance and Analysis System (TASAS) database. CHP collision data came from its Statewide Integrated Traffic Records System (SWITRS) database. The SWITRS data covers a 1,000-foot radius around all study area intersections and also includes the freeway mainline and ramps. This data was used to calculate collision rates at all study mainline, ramp, and intersection locations.

**Other Information Sources**

TJKM received aerial photography from two main sources. Mendocino County provided 2004 color aerial photography, which covers the entire study area. The County supplemented this information with 1993 USGS aerial photography. The City of Ukiah also provided aerial photography from 2001 for the study interchanges.

The 2004 aerial photography contains all recent modifications to the study interchanges, including a realignment of the Route 101 southbound off-ramp at North State Street and widening of the North State Street northbound on-ramp at the merge location. All aerial information was used to supplement existing geometric information already collected at many of the study locations.

## Initial Screening Criteria

Existing conditions for the six study interchanges were evaluated using three main criteria:

- Collision experience
- Congestion experience
- Geometric adequacy

These criteria provided an initial screening to identify existing concerns at locations in the study area. In terms of collisions, TJKM calculated average collision rates using TASAS and SWITRS collision data and Caltrans average daily traffic (ADT) data. These rates were determined for each type of study facility – on/off ramps, mainline locations, ramp/street intersections, and nearby local street intersections. Calculated collision rates for all study facilities were then compared with published 2001 Caltrans, TASAS and SWITRS average rates for each facility.

Locations with calculated collision rates higher than the 95% upper control limit (UCL) of the published averages were considered significant and subsequently were evaluated in terms of correctable collision types. The 95% UCL criterion is based upon the rate-quality control analysis method detailed in the Institute of Transportation Engineers (ITE) *Traffic Engineering Handbook.* Generally, collision rates above a control limit (in this study, the 95th percentile) indicate that it is unlikely that the collision rates occurred due to chance, or normal variation. The inference is that features of traffic control, street, or intersection geometry or ambient causes are contributing to the elevated collision rate, and thus, countermeasures can be designed to reduce the excess collisions at the location or along the road segment.

In terms of traffic congestion, locations with traffic volume demand at or greater than the capacity of the facility were also flagged as areas of concern for existing conditions.

Geometric criteria included adequacy of interchange spacing, on- and off-ramp layout, lane layout and storage lengths at ramp / street intersections, and the presence and length of freeway acceleration and deceleration lanes. Locations with geometric concerns were identified for further evaluation.

The collision and congestion criteria were assigned costs and then evaluated together to determine a first-order rank of interchanges, in order of priority from most operationally constrained to least under existing conditions. This ranking is provided later in this report. Specific results are reported below.

## Collision Analysis Results

TJKM reviewed the four-year collision history in the study area to aid evaluation of interchanges. The locations reviewed included all study freeway ramps, mainline locations, ramp terminal intersections, and local street intersections in close proximity to the interchanges. The analysis method for each facility type was detailed in the Task 3 report. (Working Paper No. 1)

### *Ramp Collision Analysis*

TJKM calculated collision rates for those collisions occurring at the beginning, middle, or end of the study interchange ramps. Table 1 illustrates the results of the ramp collision analysis. The UCL represents the collision rate at the upper limit of the 95th percentile confidence interval. Ramps with calculated rates above this UCL are highlighted and were evaluated further.

**TABLE 1: RAMP COLLISION RATES**

| *Ramp Description* | *Four Year Collision Total* | *ADT (1,000 vehicles)* | *MVM* | *Actual Collision Rate* | *Statewide Average Rate* | *Rate Above Statewide* | *95% UCL* |
|---|---|---|---|---|---|---|---|
| SB ON FR RTE 253 | 0 | 1.0 | 1.46 | 0.00 | 0.50 | - | 1.80 |
| NB OFF TO RTE 253 | 1 | 1.0 | 1.39 | 0.72 | 0.60 | 0.12 | 2.04 |
| 2WAY SEG 253/101 OFF-ON | 1 | 2.4 | 3.50 | 0.29 | 1.20 | - | 2.30 |
| NB ON FR RTE 253 | 1 | 1.5 | 2.12 | 0.47 | 0.65 | - | 1.79 |
| SB OFF TO RTE 253 | 2 | 1.9 | 2.77 | 0.72 | 1.90 | - | 3.44 |
| 101/222 SEP NB OFF | 1 | 1.3 | 1.83 | 0.55 | 0.90 | - | 2.32 |
| 101/222 SEP SB ON | 0 | 1.3 | 1.90 | 0.00 | 0.45 | - | 1.51 |
| NB ON FR EB RTE 222 | 0 | 3.7 | 5.33 | 0.00 | 0.75 | - | 1.46 |
| NB ON FR WB RTE 222 | 0 | 1.8 | 2.63 | 0.00 | 0.40 | - | 1.23 |
| SEG SB OFF TO UKIAH | 3 | 2.6 | 3.80 | 0.79 | 0.45 | 0.34 | 1.15 |
| 101SB OFF TO 222E SEG 1 | 3 | 1.6 | 2.34 | 1.28 | 0.90 | 0.38 | 2.13 |
| 101/222 SEP SB OFF | 1 | 4.2 | 6.13 | 0.16 | 0.25 | - | 0.66 |
| SB ON FR GOBBI ST | 0 | 1.8 | 2.56 | 0.00 | 0.80 | - | 1.91 |
| NB OFF TO GOBBI ST | 0 | 1.4 | 1.97 | 0.00 | 1.35 | - | 2.96 |
| SB OFF TO GOBBI ST | 3 | 2.0 | 2.92 | 1.03 | 1.35 | - | 2.64 |
| NB ON FR GOBBI ST | 0 | 1.9 | 2.70 | 0.00 | 0.80 | - | 1.88 |
| E PERKINS ST NB OFF RMP | 8 | 2.7 | 3.87 | 2.07 | 1.50 | 0.57 | 2.65 |
| E PERKINS ST NB ON LOOP | 10 | 4.2 | 6.13 | 1.63 | 0.85 | 0.78 | 1.54 |
| E PERKINS ST SB ON LOOP | 1 | 2.7 | 3.94 | 0.25 | 0.85 | - | 1.74 |
| E PERKINS ST SB OFF RAMP | 10 | 4.3 | 6.28 | 1.59 | 1.50 | 0.09 | 2.38 |
| N STATE ST UC NB OFF | 18 | 4.5 | 6.50 | 2.77 | 1.50 | 1.27 | 2.36 |
| N STATE ST SB ON RAMP | 7 | 5.0 | 7.23 | 0.97 | 0.80 | 0.17 | 1.41 |
| N STATE ST NB ON RAMP | 6 | 3.9 | 5.69 | 1.05 | 0.85 | 0.20 | 1.57 |
| N STATE ST SB OFF RAMP | 14 | 4.2 | 6.13 | 2.28 | 1.15 | 1.13 | 1.94 |
| LAKE MEN DR NB OFF RAMP | 6 | 2.4 | 3.43 | 1.75 | 1.15 | 0.60 | 2.25 |
| LAKE MEN DR SB ON RAMP | 0 | 2.7 | 3.87 | 0.00 | 0.55 | - | 1.30 |
| LAKE MEN DR NB ON RAMP | 0 | 1.8 | 2.67 | 0.00 | 0.55 | - | 1.48 |
| LAKE MEN DR SB OFF RAMP | 2 | 1.8 | 2.67 | 0.75 | 1.15 | - | 2.41 |

*Notes: ADT = average daily traffic*
*MVM = million vehicle miles*
*95% UCL = upper 95% control limit for average collision rate for segment or intersection*
*NB = Northbound, SB = Southbound*
*Off =Off-ramp, On = On-Ramp*

As highlighted above, there are three locations with actual collision rates higher than the 95% UCL. They are the East Perkins Street northbound on-ramp, North State Street northbound off-ramp, and the North State southbound off-ramp. All other locations fall below the 95% UCL for the corresponding ramp types.

*Mainline Collision Analysis*

Table 2 shows the results of the mainline collision analysis. Caltrans groups TASAS collision data by mainline segment. This can provide a means of detecting any influence of on/off ramps at interchanges on mainline collisions.

**TABLE 2: MAINLINE COLLISION RATES**

| *Mainline Section* | *Beginning Post Mile* | *Ending Post Mile* | *Four Year Collision Total* | *ADT (1000's)* | *MVM* | *Actual Collision Rate* | *Statewide Average Rate* | *95% UCL* |
|---|---|---|---|---|---|---|---|---|
| South State Interchange | 21.048 | 21.589 | 3 | 21.54 | 17.04 | 0.26 | 0.49 | 0.80 |
| Between South State and Talmage | 21.59 | 21.768 | 0 | 23.60 | 6.16 | 0.00 | 0.46 | 0.99 |
| Between South State and Talmage | 21.769 | 21.839 | 0 | 23.60 | 2.45 | 0.00 | 0.56 | 1.55 |
| Between South State and Talmage | 23.046 | 23.205 | 0 | 23.60 | 5.51 | 0.00 | 0.56 | 1.17 |
| Talmage-East Gobbi-East Perkins | 23.206 | 24.903 | 28 | 25.11 | 62.36 | 0.53 | 0.61 | 0.78 |
| North State Interchange | 25.77 | 26.313 | 24 | 30.54 | 24.29 | 1.16 | 0.59 | 0.87 |
| Between North State and Lake Mendocino | 26.314 | 26.563 | 10 | 31.01 | 19.47 | 0.60 | 0.49 | 0.78 |
| Lake Mendocino Interchange | 27.029 | 27.795 | 13 | 30.68 | 34.35 | 0.45 | 0.49 | 0.70 |

*Notes:* *ADT = average daily traffic in thousands of vehicles*
*MVM = million vehicle miles*
*95% UCL = upper 95% confidence interval for average collision rate for segment or intersection*

As highlighted in Table 2, there is one mainline freeway segment with higher than the 95% UCL. It is the segment that includes the North State Street interchange. All other locations fall within the 95% UCL for the corresponding mainline facilities. However, attention will also be paid to locations where the actual collision rates are higher than the statewide average rates.

### *Intersection Collision Analysis*

Table 3 illustrates the results of the intersection collision analysis. Intersections were grouped together by interchange in order to evaluate the effect of the interchange ramps on the ramp intersections and nearby local street intersections. In order to calculate the collision rates at each interchange grouping, average daily traffic (ADT) had to be estimated. ADT was calculated by adding total (a.m. plus p.m. peak) volumes through the grouped intersections, then multiplying by a factor of six to approximate ADT. The final calculated rate represents collisions per million entering vehicles per year.

**TABLE 3: INTERSECTION COLLISION RATES BY INTERCHANGE**

| *Local Street* | *Total Collisions* | *Collisions Per Year* | *Estimated ADT* | *Annual Entering Vehicles (million)* | *Calculated Collision Rate* | *Statewide Average Collision Rate* | *95% UCL* |
|---|---|---|---|---|---|---|---|
| East Gobbi | 2 | 0.50 | 59,352 | 21.66 | 0.02 | 0.43 | 0.68 |
| North State | 14 | 3.50 | 69,804 | 25.48 | 0.14 | 0.43 | 0.66 |
| East Perkins | 12 | 3.00 | 32,910 | 12.01 | 0.25 | 0.43 | 0.78 |
| South State | 3 | 0.75 | 15,252 | 5.57 | 0.13 | 0.43 | 0.98 |
| Talmage | 4 | 1.00 | 55,908 | 20.41 | 0.05 | 0.43 | 0.69 |

*Notes:* *Units for calculated and statewide average rates are collisions per million entering vehicles per year.*
*ADT = average daily traffic*
*95% UCL = upper 95% confidence interval for average collision rate for segment or intersection*

In total, there were 35 total reported collisions at the ramp and local intersections during the four-year evaluation period. As the table above shows, collision rates at the interchange groupings fall below 95% UCL for intersections.

Table 4 below shows intersection collisions at specific local intersections in the study area according to SWITRS data records. They illustrate where collisions are concentrated in relation to the interchanges. According to the table, the top three collision locations are North State Street at 101 Northbound Ramps, East Perkins Street at 101 Northbound Ramps, and East Perkins Street at 101 Southbound Ramps.

**TABLE 4: COLLISIONS BY INTERSECTION**

| *Intersection* | *Total Collisions* |
| --- | --- |
| East Gobbi at 101 NB Off-Ramp | 1 |
| East Gobbi at 101 SB Off-Ramp | 1 |
| North State at 101 NB Off-Ramp | 10 |
| North State at 101 SB On-Ramp | 2 |
| North State at 101 SB Off-Ramp | 2 |
| East Perkins at 101 NB Ramps | 8 |
| East Perkins at 101 SB Ramps | 4 |
| South State at 101 NB Ramps | 2 |
| South State at 101 SB Off-Ramp | 1 |
| Talmage at Babcock Lane / Hastings Road (East of US 101) | 3 |
| Talmage at Airport Park Boulevard (West of US 101) | 1 |

## Ramp and Mainline Operations Analysis – Existing Conditions

Table 5 illustrates existing volume-to-capacity (v/c) ratios at all study interchange ramp locations. Table 6 shows v/c ratios at key mainline freeway locations.

**TABLE 5: FREEWAY RAMP VOLUME – CAPACITY RATIOS (EXISTING CONDITIONS)**

| *Interchange* | *Ramp* | *Capacity* | *A.M. Peak Hour* | | *P.M. Peak Hour* | |
|---|---|---|---|---|---|---|
| | | | *Volume* | *V/C* | *Volume* | *V/C* |
| Lake Mendocino | NB OFF | 900 | 147 | 0.16 | 260 | 0.29 |
| | NB ON | 900 | 80 | 0.09 | 147 | 0.16 |
| | SB OFF | 900 | 234 | 0.26 | 113 | 0.13 |
| | SB ON | 900 | 230 | 0.26 | 276 | 0.31 |
| North State | NB OFF | 900 | 412 | 0.46 | 360 | 0.40 |
| | NB ON | 750 | 188 | 0.25 | 383 | 0.51 |
| | SB OFF | 900 | 391 | 0.43 | 318 | 0.35 |
| | SB ON | 900 | 247 | 0.27 | 409 | 0.45 |
| Perkins / Vichy Springs | NB OFF | 900 | 370 | 0.41 | 212 | 0.24 |
| | NB ON | 750 | 275 | 0.37 | 436 | 0.58 |
| | SB OFF | 900 | 621 | 0.69 | 350 | 0.39 |
| | SB ON | 750 | 180 | 0.24 | 168 | 0.22 |
| Gobbi | NB OFF | 750 | 137 | 0.18 | 107 | 0.14 |
| | NB ON | 900 | 219 | 0.24 | 181 | 0.20 |
| | SB OFF | 750 | 246 | 0.33 | 276 | 0.37 |
| | SB ON | 900 | 165 | 0.18 | 163 | 0.18 |
| Talmage | NB OFF | 900 | 104 | 0.12 | 149 | 0.17 |
| | NB ON (from WB) | 900 | 122 | 0.14 | 187 | 0.21 |
| | NB ON (from EB) | 750 | 278 | 0.37 | 356 | 0.47 |
| | SB OFF (to WB) | 900 | 388 | 0.43 | 509 | 0.57 |
| | SB OFF (to EB) | 750 | 86 | 0.11 | 206 | 0.27 |
| | SB ON | 900 | 109 | 0.12 | 116 | 0.13 |
| South State (SR 253) | NB OFF | 900 | 97 | 0.11 | 66 | 0.07 |
| | NB ON | 750 | 131 | 0.17 | 162 | 0.22 |
| | SB OFF | 900 | 139 | 0.15 | 123 | 0.14 |
| | SB ON | 900 | 62 | 0.07 | 60 | 0.07 |

*Notes: v/c = volume-to-capacity ratio*
*NB = Northbound, SB = Southbound, WB = Westbound, EB = Eastbound*
*ON = On-Ramp, OFF = Off-Ramp*

Based on assumed capacities of 750 vehicles per hour for loop ramps and 900 vehicles per hour for all other ramp types, all study ramps currently operate with v/c ratios of 0.69 or less. Perkins Street southbound off-ramp has the highest v/c ratio and therefore needs attention.

Off-ramp operational analysis is also included as part of the study intersection operational analysis in the next section.

**TABLE 6: FREEWAY MAINLINE VOLUME – CAPACITY RATIOS (EXISTING CONDITIONS)**

| *Mainline Location* | *A.M. Peak Hour* | | | | | | *P.M. Peak Hour* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Northbound* | | *Southbound* | | *Two-Way* | | *Northbound* | | *Southbound* | | *Two-Way* | |
| | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* |
| N of Lake Mendocino | 563 | 0.14 | 1,724 | 0.43 | 2,287 | 0.29 | 1,445 | 0.36 | 1,098 | 0.27 | 2,543 | 0.32 |
| N of North State | 630 | 0.16 | 1,720 | 0.43 | 2,350 | 0.29 | 1,558 | 0.39 | 1,261 | 0.32 | 2,819 | 0.35 |
| N of East Perkins / Vichy Springs | 854 | 0.21 | 1,576 | 0.39 | 2,430 | 0.30 | 1,535 | 0.38 | 1,352 | 0.34 | 2,887 | 0.36 |
| N of East Gobbi | 949 | 0.24 | 1,135 | 0.28 | 2,084 | 0.26 | 1,311 | 0.33 | 1,170 | 0.29 | 2,481 | 0.31 |
| East Gobbi Over-crossing | 730 | 0.18 | 889 | 0.22 | 1,619 | 0.20 | 1,130 | 0.28 | 894 | 0.22 | 2,024 | 0.25 |
| N of Talmage | 867 | 0.22 | 1,054 | 0.26 | 1,921 | 0.24 | 1,237 | 0.31 | 1,057 | 0.26 | 2,294 | 0.29 |
| Talmage Over-crossing | 745 | 0.19 | 666 | 0.17 | 1,411 | 0.18 | 1,050 | 0.26 | 548 | 0.14 | 1,598 | 0.20 |
| N of South State (SR 253) | 571 | 0.14 | 689 | 0.17 | 1,260 | 0.16 | 843 | 0.21 | 458 | 0.11 | 1,301 | 0.16 |
| S of South State (SR 253) | 537 | 0.13 | 612 | 0.15 | 1,149 | 0.14 | 747 | 0.19 | 395 | 0.10 | 1,142 | 0.14 |

*Notes: Assumes capacity of 4,000 vehicles per hour per direction*
*Vol = volume*
*v/c = volume-to-capacity ratio*

A typical capacity for a mainline freeway lane is 2,000 vehicles per hour per lane. Based on this standard, all mainline locations have demand below this threshold, as they currently operate with v/c ratios no greater than 0.43. Such a ratio generally is considered acceptable.

### Intersection Operations Analysis – Existing Conditions

TJKM evaluated level of service (LOS) at the 20 study local street intersections. Table 7 shows the results of the Synchro analysis performed using Highway Capacity Manual (HCM) 2000 methodology. Working Paper 1 contains a description of this methodology and also the LOS calculation sheets for intersection existing conditions.

**TABLE 7: INTERSECTION LEVEL OF SERVICE – EXISTING CONDITIONS**

| *Interchange* | *ID* | *Intersection* | *Control* | *A.M. Peak* | | *P.M. Peak* | |
|---|---|---|---|---|---|---|---|
| | | | | *Delay* | *LOS* | *Delay* | *LOS* |
| Lake Mendocino | 1 | 101 SB Ramps | One-Way STOP | 14.0 (21.4) | B (C) | 9.3 (17.2) | A (C) |
| | 2 | 101 NB Ramps | One-Way STOP | 2.3 (12.7) | A (B) | 3.6 (12.0) | A (B) |
| | 3 | North State Street | Signal | 10.5 | B | 14.9 | B |
| North State | 4 | 101 NB Ramps | One-Way STOP | 4.4 (21.4) | A (C) | 4.6 (37.8) | A (E) |
| | 5 | 101 SB Off-Ramp | One-Way STOP | 4.0 (23.0) | A (C) | 2.5 (28.6) | A (D) |
| | 6 | 101 SB On-Ramp | None | 0.6 (1.0) [1] | A (A) | 1.5 (14.0) | A (B) |
| | 7 | Kuki Lane | Signal | 15 | B | 19.9 | B |
| East Perkins | 8 | Orchard Avenue | Signal | 35.7 | D | 70.5 | E |
| | 9 | 101 SB Ramps | Two-Way STOP | (39.5) [2] | (E) | 7.4 (> 50) | A (F) |
| | 10 | 101 NB Ramps | One-Way STOP | 15.1 (44.8) | B (E) | 3.8 (17.6) | A (C) |
| East Gobbi | 11 | Orchard Avenue | All-Way STOP | 26.7 | D | 16.2 | C |
| | 12 | 101 SB Ramps | One-Way STOP | 10.4 (41.6) | B (E) | 8.6 (25.5) | A (D) |
| | 13 | 101 NB Ramps | One-Way STOP | 5.2 (15.4) | A (C) | 3.9 (14.5) | A (B) |
| | 14 | Club House Drive | One-Way STOP | 0.8 (9.2) | A (A) | 1.8 (10.0) | A (A) |
| Talmage | 15 | Airport Park Boulevard | Signal | 32.8 | C | 47.1 | D |
| | 16 | 101 SB Ramps | One-Way STOP | 5.0 (14.5) | A (B) | 8.3 (21.3) | A (C) |
| | 17 | 101 NB Ramps | One-Way STOP | 1.4 (14.3) | A (B) | 2.1 (19.4) | A (C) |
| South State (SR 253) | 18 | 101 NB Ramps | One-Way STOP | 3.0 (12.1) | A (B) | 2.2 (11.3) | A (B) |
| | 19 | 101 SB Off-Ramp / Stipp Lane | Two-Way STOP | 4.0 (12.3) | A (B) | 3.8 (11.2) | A (B) |
| | 20 | 101 SB On-Ramp / Boonville-Ukiah Road | None | 8.7 (12.3) [3] | A (B) | 8.7 (12.3) [3] | A (B) |

*Notes:* *[1] Minor delay is for southbound North State Street left turn.*
*[2] Minor delay for southbound off-ramp left turn. Delay on northbound Pomeroy Street (opposite SB ramp terminals) is very high (LOS F), thus overall delay cannot be calculated in the a.m. peak hour.*
*[3] Minor delay for southbound South State Street through movement onto 101 SB On-Ramp*
*Delay = Average control delay in seconds per vehicle, LOS = Level of Service. Figures in parentheses indicate delay and LOS for the minor left turn. Figures outside parentheses indicate values for the overall intersection.*
*NB = Northbound, SB = Southbound*

A typical service level threshold for intersections is LOS D. Based on this common standard, many study intersections and minor movements are operating acceptably under existing conditions. The exceptions are:

- North State Street / 101 NB Off-Ramp - minor westbound left turn off freeway, p.m. peak only (LOS E)
- East Perkins Street / Orchard Avenue - overall LOS E (p.m. peak only)
- East Perkins Street / 101 SB Ramps / Pomeroy Street - minor southbound left turn off freeway, with LOS E / F (a.m./p.m. peak)
- East Perkins Street / 101 NB Ramps - minor northbound left turn off freeway, a.m. peak only (LOS E)
- East Gobbi Street at 101 SB Ramps - minor northbound left turn off freeway, a.m. peak only (LOS E)

Based on the above LOS analysis, it was also observed that queuing is affecting existing operations at the East Perkins Street / Orchard Avenue and East Perkins Street / 101 Southbound Ramp intersections. As noted earlier, the segment of Perkins Street between Orchard Avenue and the 101 southbound ramps experiences significant congestion during peak hours. The LOS analysis revealed that:

- During the a.m. peak, the westbound through movement at East Perkins Street / Orchard Avenue experiences a maximum queue of about 17 vehicles, with the westbound left turn having a maximum queue of 10 vehicles. The through queue is enough to block the 101 Southbound Ramp intersection. Also, the left turn queue may spill over into the through lane.
- During the p.m. peak, the westbound through movement at Perkins Street / Orchard Avenue experiences a maximum queue of about 27 vehicles, with the westbound left turn having a maximum queue of 5 vehicles. The through queue is enough to block the 101 Southbound Ramp intersection.
- At East Perkins Street / 101 Southbound ramps, the southbound left turn off the freeway experiences a maximum queue of 18 vehicles during the a.m. peak and about two vehicles during the p.m. peak. The v/c being 0.69 for this off-ramp, it deserves attention.
- Field observations have indicated the North State Street off-ramp queue spills over to the freeway during AM peak hours.

**Merging and Weaving Analysis – Existing Conditions**

TJKM evaluated the merging operations for all six study interchanges using the merging and weaving methodologies contained in HCS software. HCS software utilizes the HCM 2000 Operations methodology. Working Paper 1 contains the LOS calculation sheets for existing merging conditions.

Table 8 illustrates the results of the interchange merging analysis. All merging locations currently operate at LOS C or better during both the a.m. and p.m. peak periods.

**TABLE 8: INTERCHANGE MERGING OPERATIONS – EXISTING CONDITIONS**

| *Ramp Junction* | *Level of Service* | |
|---|---|---|
| | *A.M.* | *P.M.* |
| Northbound Diagonal on-ramp at Lake Mendocino Drive | B | B |
| Southbound Diagonal on-ramp at Lake Mendocino Drive | C | B |
| Northbound Loop on-ramp at North State Street | B | B |
| Southbound Loop on-ramp at North State Street | B | B |
| Northbound Loop on-ramp at East Perkins Street | B | B |
| Southbound Loop on-ramp at East Perkins Street | B | B |
| Northbound Diagonal on-ramp at East Gobbi Street | B | B |
| Southbound Diagonal on-ramp at East Gobbi Street | B | B |
| Northbound Loop on-ramp at Talmage Road | B | B |
| Southbound Loop on-ramp at Talmage Road | B | B |
| Northbound Diagonal on-ramp at Talmage Road | B | B |
| Southbound Diagonal on-ramp at Talmage Road | B | A |
| Northbound Loop on-ramp at South State Street | B | B |
| Southbound Loop on-ramp at South State Street | A | A |

Weaving operational analysis was also performed only for the northbound freeway section between East Gobbi Street and East Perkins Street. For both a.m. and p.m. periods, LOS was found to be A under existing conditions. However, the weaving length available is only about 1,000 feet and demands attention. No weaving problems are expected for other study area segments as the weaving lengths were found to be sufficient.

### Study Interchange Classification

The Caltrans Highway Design Manual designates interchange types according to different ramp configurations. The configurations and their descriptions are contained in Working Paper 1. The designations that most closely match the six study interchanges are as follows:

- Lake Mendocino – Type L-1 (diamond interchange)
- North State – Types L-1 and L-8 (diamond SB side, partial cloverleaf NB side)
- East Perkins – Type L-8 (partial cloverleaf)
- East Gobbi – Type L-8 (partial cloverleaf)
- Talmage – Type L-9 (partial cloverleaf)
- South State – Type L-11 (trumpet interchange)

### Geometric Adequacy

TJKM compared existing on-ramp taper lengths with current Caltrans on-ramp design standards. The Caltrans standard is 180 meters (590 feet). The approximate merging distances for each study on-ramp are listed below:

- Lake Mendocino to 101 Northbound – 430 feet
- Lake Mendocino to 101 Southbound – 500 feet
- North State to 101 Northbound – 420 feet
- North State to 101 Southbound – 580 feet
- East Perkins to 101 Northbound – 560 feet

- East Perkins to 101 Southbound – 800 feet
- East Gobbi to 101 Northbound – 445 feet
- East Gobbi to 101 Southbound – 460 feet
- Westbound Talmage to 101 Northbound – 400 feet
- Eastbound Talmage to 101 Northbound – 400 feet
- Talmage to 101 Southbound – 535 feet
- South State to 101 Northbound – 250 feet
- South State to 101 Southbound – 600 feet

As shown in the list above, the majority of on-ramps have taper lengths that are below current design standards. This fact is not surprising since there have been no significant design modifications to the study interchanges since their original construction. The East Perkins to 101 Southbound and South State to 101 southbound on-ramps are the only ramps that currently exceed the standard. The North State to 101 Southbound, East Perkins to 101 Northbound, and Talmage to 101 southbound on-ramps fall short but are very close to the standard.

**Interchange Spacing Adequacy**

Interchange spacings greater than two miles (10,560 feet) are typical for rural freeways. The study interchange spacings were reviewed to determine their adequacy. TJKM measured approximate spacings by measuring the centerlines of each interchange using aerial photography. The approximate spacings for the interchanges are listed below:

- Lake Mendocino to North State: 7,485 feet (1.4 mile)
- North State to East Perkins: 8,750 feet (1.65 mile)
- East Perkins to East Gobbi: 2,460 feet (0.47 mile)
- East Gobbi to Talmage: 3,265 feet (0.62 mile)
- Talmage to South State: 9,800 feet (1.86 mile)

All interchanges are spaced less than two miles apart, and therefore do not have adequate spacing under the above criteria. In addition, there currently are no auxiliary lanes for weaving and merging traffic. In particular, the East Perkins, East Gobbi, and Talmage interchanges are spaced less than one mile apart from one another. Based on these spacings, these interchanges may have weaving and merging problems, and this is evaluated in subsequent sections of this report.

A likely challenge to adding an auxiliary lane between the East Perkins Street and East Gobbi Street interchanges will be the pedestrian overcrossing between these locations. Currently, there are bridge piers located very close to the pavement edges on either side of the freeway.

**Initial Interchange Evaluation**

TJKM evaluated each interchange according to costs associated with congestion (based on volume to capacity ratios) and collision rates. Table 9 illustrates the interchanges and annualized delay and collision costs in 2005.

Congestion costs were determined by first identifying turning movements of concern at study intersections that have control delays exceeding those associated with LOS C (25 seconds per vehicle for unsignalized intersections and 35 seconds per vehicle for signalized intersections). Costs were calculated for each turning movement of concern and then aggregated by study interchange. It should be noted that since there are currently no ramps or mainline segments with v/c ratios over 1, these facility types were not included in the congestion cost calculation.

Collision costs were calculated by using excess collision rates, which are the actual rates minus the statewide average rates. Also, these costs assume Caltrans' average cost of $40,400 per collision.

**TABLE 9: INITIAL INTERCHANGE EVALUATION AND TOTAL COSTS**

| *Rank* | *Interchange* | *Congestion Cost* | *Collision Cost* | *Total Cost* |
|---|---|---|---|---|
| 1 | North State | $ 20,113 | $ 293,170 | $ 313,283 |
| 2 | East Perkins | $ 120,268 | $ 48,292 | $ 168,560 |
| 3 | Talmage (SR 222) | $ 39,099 | - | $ 39,099 |
| 4 | East Gobbi | $ 2,643 | - | $ 2,643 |
| 5 | Lake Mendocino | $ 783 | - | $ 783 |
| 6 | South State (SR 253) | - | - | - |

*Notes: Annualized congestion costs assume 250 commute days per year and $15 per hour of excess delay. Annualized collision costs assume Caltrans' value of $40,400 per collision.*

As Table 9 shows, the North State Street and East Perkins Street interchanges are by far the top two interchanges with the highest cost of excess delay and/or collisions. For the North State Street interchange, the added cost is primarily due to collisions. For the East Perkins Street interchange, the additional cost is primarily due to congestion. Congestion costs are the only costs associated with three other interchanges, while the South State Street (SR 253) interchange has no associated costs.

For the year 2005 condition, six study interchanges were evaluated based on three main criteria: 1) collision experience, 2) congestion experience, and 3) geometric adequacy. For year 2025, only congestion is evaluated, since collision and geometric criteria cannot be meaningfully evaluated in the future. Facilities with traffic volume demand equal to or greater than their capacities are given a more detailed examination later in this report, when specific interchange improvements are discussed.

## Year 2025 Traffic Forecast

Future 2025 a.m. and p.m. peak hour traffic volumes were developed using the existing peak hour volumes presented in the study's Working Paper No. 1 and a calculated growth factor. The growth factor was developed using the City of Ukiah travel demand model's ADT volumes as well as the historic volumes. This factor was estimated to be 1.5, which represents approximately 50% traffic growth over the next twenty years. Therefore, the existing volumes were multiplied by 1.5 to estimate future 2025 baseline volumes.

There is additional development not currently represented in the model's 2025 forecast ADT volumes. This additional commercial and residential development is located in the vicinity of the North State Street interchange. TJKM compared the list of developments anticipated by the City of Ukiah and Mendocino County with a similar list detailing future developments accounted for in the model. TJKM then singled out those future developments (i.e. near North State Street interchange) not included in the model's 2025 baseline traffic scenario. Trip generation, distribution, and assignment were subsequently performed for these additional future developments. Table 10 shows the anticipated size of the additional development and its trip generation.

**TABLE 10: TRIP GENERATION FOR ADDITIONAL FUTURE DEVELOPMENT**

| *Land Use* | *ITE Code* | *Size* | *Daily Trips* | *A.M. Peak Hour* | | | *P.M. Peak Hour* | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *In Trips* | *Out Trips* | *Total* | *In Trips* | *Out Trips* | *Total* |
| Commercial (Shopping Center) | 820 | 680 ksf | 29,199 | 427 | 273 | 700 | 1,224 | 1,326 | 2,550 |
| Single Family Detached Homes | 210 | 1,110 d.u. | 10,623 | 208 | 624 | 832 | 706 | 415 | 1,121 |
| Residential Condos / Townhomes | 230 | 93 d.u. | 545 | 7 | 34 | 41 | 32 | 16 | 48 |
| Total | | | 40,367 | 642 | 931 | 1,573 | 1,962 | 1,757 | 3,719 |

*Notes:* *ksf = 1,000 square feet gross floor area*
*d.u. = occupied dwelling units*
*Source: ITE Trip Generation Manual, 7th Edition (2003)*

For the additional developments shown in Table 10, trip distribution was estimated based on discussions with City of Ukiah and MCOG staff and TJKM's knowledge of the study area. Specifically, the distribution is based on existing directional distributions of traffic on North State Street and the Route 101 corridor. As a result, project trip distributions were determined to be the following:

- 50% to Route 101 Freeway – North
- 30% to Route 101 Freeway – South
- 10% to North State Street – North
- 10% to North State Street – South

The resulting trips were assigned to the North Street study intersections and ramps, as well as the Route 101 mainline. This additional future traffic is added to the 2025 baseline traffic (existing traffic X 1.5 growth factor).

**Ramp and Mainline Operations Analysis – Future Conditions**

Just as was done in the existing conditions report, TJKM evaluated level of service (LOS) for the study freeway ramps and mainline locations under future 2025 conditions. Table 11 illustrates future volume-to-capacity (v/c) ratios at all ramp locations. Table 12 shows future v/c ratios at key mainline freeway locations.

**TABLE 11: FREEWAY RAMP VOLUME – CAPACITY RATIOS (FUTURE CONDITIONS)**

| *Interchange* | *Ramp* | *Capacity* | *A.M. Peak Hour* | | *P.M. Peak Hour* | |
|---|---|---|---|---|---|---|
| | | | *Volume* | *V/C* | *Volume* | *V/C* |
| Lake Mendocino | NB OFF | 900 | 221 | 0.25 | 390 | 0.43 |
| | NB ON | 900 | 120 | 0.13 | 221 | 0.25 |
| | SB OFF | 900 | 351 | 0.39 | 170 | 0.19 |
| | SB ON | 900 | 345 | 0.38 | 414 | 0.46 |
| North State | NB OFF | 900 | 808 | 0.90 | 1,130 | 1.26 |
| | NB ON | 750 | 747 | 1.00 | 1,454 | 1.94 |
| | SB OFF | 900 | 907 | 1.01 | 1,453 | 1.61 |
| | SB ON | 900 | 651 | 0.72 | 1,144 | 1.27 |
| Perkins / Vichy Springs | NB OFF | 900 | 555 | 0.62 | 318 | 0.35 |
| | NB ON | 750 | 413 | 0.55 | 654 | 0.87 |
| | SB OFF | 900 | 932 | 1.04 | 525 | 0.58 |
| | SB ON | 750 | 270 | 0.36 | 252 | 0.34 |
| Gobbi | NB OFF | 750 | 206 | 0.27 | 161 | 0.21 |
| | NB ON | 900 | 329 | 0.37 | 272 | 0.30 |
| | SB OFF | 750 | 369 | 0.49 | 414 | 0.55 |
| | SB ON | 900 | 248 | 0.28 | 245 | 0.27 |
| Talmage | NB OFF | 900 | 156 | 0.17 | 224 | 0.25 |
| | NB ON (from WB) | 900 | 183 | 0.20 | 281 | 0.31 |
| | NB ON (from EB) | 750 | 417 | 0.56 | 534 | 0.71 |
| | SB OFF (to WB) | 900 | 582 | 0.65 | 764 | 0.85 |
| | SB OFF (to EB) | 750 | 129 | 0.17 | 309 | 0.41 |
| | SB ON | 900 | 164 | 0.18 | 174 | 0.19 |
| South State (SR 253) | NB OFF | 900 | 146 | 0.16 | 99 | 0.11 |
| | NB ON | 750 | 197 | 0.26 | 243 | 0.32 |
| | SB OFF | 900 | 209 | 0.23 | 185 | 0.21 |
| | SB ON | 900 | 93 | 0.10 | 90 | 0.10 |

*Notes:* *v/c = volume-to-capacity ratio*
*NB = Northbound, SB = Southbound, WB = Westbound, EB = Eastbound*
*ON = On-Ramp, OFF = Off-Ramp*

Based on assumed capacities of 750 vehicles per hour for loop ramps and 900 vehicles per hour for all other ramp types, there are five study ramps that are projected to operate at v/c ratios greater than one. During the a.m. peak, the southbound off-ramp at North State Street and southbound off-ramp at East Perkins Street have v/c ratios of 1.01 and 1.04, respectively. During the p.m. peak, all four North State Street interchange ramps have v/c ratios ranging from 1.26-1.94. All other study ramps are projected to operate at v/c ratios less than one.

**TABLE 12: FREEWAY MAINLINE VOLUME – CAPACITY RATIOS (FUTURE CONDITIONS)**

| *Mainline Location* | *A.M. Peak Hour* | | | | | | *P.M. Peak Hour* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Northbound* | | *Southbound* | | *Two-Way* | | *Northbound* | | *Southbound* | | *Two-Way* | |
| | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* | *Vol* | *V/C* |
| N of Lake Mendocino | 1,310 | 0.33 | 2,906 | 0.73 | 4,216 | 0.53 | 3,048 | 0.76 | 2,624 | 0.66 | 5,672 | 0.71 |
| N of North State | 1,411 | 0.35 | 2,900 | 0.73 | 4,311 | 0.54 | 3,217 | 0.80 | 2,868 | 0.72 | 6,085 | 0.76 |
| N of Perkins / Vichy Springs | 1,472 | 0.37 | 2,644 | 0.66 | 4,116 | 0.51 | 2,893 | 0.72 | 2,559 | 0.64 | 5,452 | 0.68 |
| N of Gobbi | 1,614 | 0.40 | 1,982 | 0.50 | 3,596 | 0.45 | 2,557 | 0.64 | 2,286 | 0.57 | 4,843 | 0.61 |
| Gobbi Over-crossing | 1,285 | 0.32 | 1,613 | 0.40 | 2,898 | 0.36 | 2,285 | 0.57 | 1,872 | 0.47 | 4,157 | 0.52 |
| N of Talmage | 1,491 | 0.37 | 1,861 | 0.47 | 3,352 | 0.42 | 2,446 | 0.61 | 2,117 | 0.53 | 4,563 | 0.57 |
| Talmage Over-crossing | 1,308 | 0.33 | 1,279 | 0.32 | 2,587 | 0.32 | 2,165 | 0.54 | 1,353 | 0.34 | 3,518 | 0.44 |
| N of South State (SR 253) | 1,047 | 0.26 | 1,314 | 0.33 | 2,361 | 0.30 | 1,855 | 0.46 | 1,218 | 0.30 | 3,073 | 0.38 |
| S of South State (SR 253) | 996 | 0.25 | 1,198 | 0.30 | 2,194 | 0.27 | 1,711 | 0.43 | 1,123 | 0.28 | 2,834 | 0.35 |

*Notes: Assumes capacity of 4,000 vehicles per hour per mainline direction*
*Vol = volume*
*v/c = volume-to-capacity ratio*

## Intersection Operations Analysis – Future Conditions

TJKM also evaluated future 2025 LOS at the 20 study local street intersections. Table 13 shows the results of the intersection analysis performed using the Highway Capacity Manual (HCM) 2000 methodology contained in Synchro software. Working Paper 2 contains a description of this methodology and also the LOS calculation sheets for future intersection conditions.

**TABLE 13: INTERSECTION LEVEL OF SERVICE – FUTURE CONDITIONS**

| *Interchange* | *ID* | *Intersection* | *Control* | *A.M. Peak* | | *P.M. Peak* | |
|---|---|---|---|---|---|---|---|
| | | | | *Delay* | *LOS* | *Delay* | *LOS* |
| Lake Mendocino | 1 | 101 SB Ramps | One-Way STOP | 78.6 (>80) | F (F) | 17.1 (45.2) | C (E) |
| | 2 | 101 NB Ramps | One-Way STOP | 2.8 (16.8) | A (C) | 4.3 (15.2) | A (C) |
| | 3 | North State Street | Signal | 13.5 | B | 55.5 | E |
| North State | 4 | 101 NB Ramps | One-Way STOP | > 50 (>50) | F (F) | > 50 (>50) | F (F) |
| | 5 | 101 SB Off-Ramp | One-Way STOP | > 50 (>50) | F (F) | > 50 (>50) | F (F) |
| | 6 | 101 SB On-Ramp [1] | None | 1.9 (29.2) | A (D) | > 50 (>50) | F (F) |
| | 7 | Kuki Lane | Signal | > 80 | F | > 80 | F |
| East Perkins | 8 | Orchard Avenue | Signal | > 80 | F | > 80 | F |
| | 9 | 101 SB Ramps | Two-Way STOP | > 80 (> 80) | F | > 80 (> 80) | F |
| | 10 | 101 NB Ramps | One-Way STOP | > 50 (>50) | F (F) | 15.4 (>50) | C (F) |
| East Gobbi | 11 | Orchard Avenue | All-Way STOP | > 50 | F | > 50 | F |
| | 12 | 101 SB Ramps | One-Way STOP | > 50 (>50) | F (F) | > 50 (>50) | F (F) |
| | 13 | 101 NB Ramps | One-Way STOP | 6.0 (24.8) | A (C) | 4.6 (21.8) | A (C) |
| | 14 | Club House Drive | One-Way STOP | 0.8 (9.8) | A (A) | 2.0 (11.2) | A (B) |
| Talmage | 15 | Airport Park Boulevard | Signal | 72.6 | E | > 80 | F |
| | 16 | 101 SB Ramps | One-Way STOP | 13.3 (42.6) | B (E) | > 50 (>50) | F (F) |
| | 17 | 101 NB Ramps | One-Way STOP | 2.5 (25.3) | A (D) | 9.3 (> 50) | A (F) |
| South State (SR 253) | 18 | 101 NB Ramps | One-Way STOP | 3.3 (15.4) | A (C) | 2.5 (13.6) | A (B) |
| | 19 | 101 SB Off-Ramp / Stipp Lane | Two-Way STOP | 5.1 (16.8) | A (C) | 4.4 (13.8) | A (B) |
| | 20 | 101 SB On-Ramp / Boonville-Ukiah Road [2] | None | 9.4 (15.6) | A (C) | 9.5 (15.7) | A (C) |

*Notes:* [1] *Minor delay is for southbound North State Street left turn.*
[2] *Minor delay for southbound South State Street through movement onto 101 SB On-Ramp*
*Delay = Average control delay in seconds per vehicle, LOS = Level of Service. Figures in parentheses indicate delay and LOS for the minor left turn. Figures outside parentheses indicate values for the overall intersection.*
*NB = Northbound, SB = Southbound*

A typical intersection service level threshold is LOS D. Based on this common standard, the following study intersections are anticipated to operate unacceptably under future 2025 conditions:

- Lake Mendocino Drive at 101 Southbound Ramps (a.m. and p.m. peak)
- Lake Mendocino Drive at North State Street (p.m. peak only)
- North State Street at 101 Northbound Ramps (a.m. and p.m. peak)
- North State Street at 101 Southbound Off-Ramp (a.m. and p.m. peak)
- North State Street at 101 Southbound Off-Ramp (p.m. peak only)
- North State Street at Kuki Lane (a.m. and p.m. peak)
- East Perkins Street at Orchard Avenue (a.m. and p.m. peak)
- East Perkins Street at 101 Southbound Ramps (a.m. and p.m. peak)
- East Perkins Street at 101 Northbound Ramps (a.m. and p.m. peak)
- East Gobbi Street at Orchard Avenue (a.m. and p.m. peak)
- East Gobbi Street at 101 Southbound Ramps (a.m. and p.m. peak)
- Talmage Road at Airport Park Boulevard (a.m. and p.m. peak)
- Talmage Road at 101 Southbound Ramps (p.m. peak only)
- Talmage Road at 101 Northbound Ramps (p.m. peak only)

### Merging and Weaving Analysis – Future Conditions

TJKM evaluated future 2025 merging operations for all six study interchanges using the merging and weaving methodologies contained in HCS software. HCS software utilizes the HCM 2000 Operations methodology.

**TABLE 14: INTERCHANGE MERGING OPERATIONS – FUTURE CONDITIONS**

| *Ramp Junction* | *Level of Service* | |
|---|---|---|
| | *A.M.* | *P.M.* |
| Northbound Diagonal on-ramp at Lake Mendocino Drive | B | D |
| Southbound Diagonal on-ramp at Lake Mendocino Drive | D | D |
| Northbound Loop on-ramp at North State Street | B | D |
| Southbound Diagonal on-ramp at North State Street | D | C |
| Northbound Loop on-ramp at East Perkins Street | B | D |
| Southbound Loop on-ramp at East Perkins Street | C | C |
| Northbound Diagonal on-ramp at East Gobbi Street | B | C |
| Southbound Diagonal on-ramp at East Gobbi Street | C | C |
| Northbound Loop on-ramp at Talmage Road | B | C |
| Northbound Diagonal on-ramp at Talmage Road | B | C |
| Southbound Diagonal on-ramp at Talmage Road | B | B |
| Northbound Loop on-ramp at South State Street | B | C |
| Southbound Diagonal on-ramp at South State Street | B | B |

Table 14 above illustrates the results of the future 2025 interchange merging analysis. Using a typical service level threshold of LOS D, no on-ramps are anticipated to exceed acceptable LOS during either or both peak periods. All merging locations are anticipated to remain operating at LOS D or better during both the a.m. and p.m. peak periods.

Weaving operational analysis for future conditions was also performed only for the northbound freeway section between East Gobbi Street and East Perkins Street. This weaving section is expected to operate at LOS B during the a.m. peak and LOS C during the p.m. peak. No weaving problems are expected under future conditions for all other study area segments as current weaving lengths are sufficient. Working Paper 2 contains the LOS calculation sheets for future merging conditions.

# PRELIMINARY IMPROVEMENTS

## Analysis Methodology

The operational concerns identified during the analysis were examined in more detail. These concerns include high collision rates for on- and off-ramps, ramp junctions with cross streets, and mainline locations; and traffic volume demand at or greater than mainline, ramp or intersection capacity. Other criteria include the geometric adequacy of on- and off-ramps, warrants for signals at ramp and ramp-related intersections, interchange spacing, and observations from field checks of the interchanges.

In the following section, TJKM has expanded the analysis of the interchanges of concern. Locations identified with high collision rates were evaluated in more detail by creating collision diagrams and tabulating collisions by specific features at each interchange. The purpose was to determine how collision patterns may suggest design or operational problems at a given mainline, ramp, or intersection location.

In terms of congestion, ramps or intersections with the potential for excessive queuing and queue spillover onto mainline or past upstream intersections were identified. Ramps and ramp-related intersections were also evaluated for adequacy of capacity. Signal warrants were conducted under existing and future conditions to determine possible short-term and long-term needs for signals. Freeway merging and weaving areas were also identified for possible improvements based on previous level of service (LOS) analysis.

## Specific Concerns and Preliminary Improvements

In this section, specific problems and operational concerns are identified for each interchange under both 2005 and 2025 traffic conditions. These problems and concerns are based on all study analyses performed, including collision, congestion, and geometric analysis and field checks. Based on the identified concerns, graphics are provided to illustrate the details of the recommended improvements at each interchange.

All improvements described herein are preliminary and were evaluated further in terms of conceptual engineering and cost estimation where appropriate.

Figures showing operational concerns and preliminary improvements for all six interchanges follow this report section. Figures 1a and 1b depict existing operational concerns. Figures 2a and 2b show preliminary improvements for existing conditions. Figures 3a and 3b depict future operational concerns. Figures 4a and 4b show preliminary improvements for future conditions.

*Interchange 1: Route 101 at Lake Mendocino Drive*

<u>Concerns</u>

- Inadequate merge capacity for northbound and southbound on-ramps (2025)
- Inadequate overall intersection capacity at 101 Southbound Ramp / Lake Mendocino Drive and North State Street / Lake Mendocino Drive (West Leg) intersections (2025)

<u>Improvements</u>

- 2025: Install signal at 101 Southbound Ramp / Lake Mendocino Drive intersection
- 2025: Increase acceleration lengths for both northbound and southbound on-ramps

*Interchange 2: Route 101 at North State Street*

<u>Concerns</u>

- Excess collision rate on both northbound and southbound off-ramps (2005)
- Excess collision rate on northbound on-ramp (2005)
- Excess collision rate at northbound ramp intersection (2005)
- Excess collision rate on freeway mainline in vicinity of ramp merging areas - northbound in particular (2005)
- Congestion at northbound and southbound ramp intersections (2005 and 2025)
- Congestion on all on- and off-ramps (2025), including queuing on both off-ramps leading to near capacity or over capacity (queue spillover to mainline) in 2025 p.m. peak hour
- Congestion and queue spillover for southbound North State left turn onto 101 Southbound on-ramp without signal (2025)
- Congestion at nearby Kuki Lane intersection south of interchange (2025)
- Inadequate merge length and tight/substandard radius for northbound on-ramp (2005)
- Inadequate merge capacity for northbound and southbound on-ramps (2025)

<u>Improvements</u>

- 2005: Install signals at northbound and southbound ramp intersections, and coordinate with existing nearby North State Street / Kuki Lane signal
- 2005: Provide three lanes on northbound Route 101 mainline structure to accommodate extended acceleration lane by re-striping the bridge area and adding pavement to the north and south of the bridge.

  TJKM also examined a potential alternative to increase the radius of the 101 Northbound loop on-ramp, which would lengthen the on-ramp and thereby increase the merge taper length. This alternative would have the following constraints:

  - Potential land takings – there is a large building located only 145 feet away from the pavement edge of the 101 Northbound off-ramp to North State. Therefore, the possibility exists that the building may need to be taken, since increasing the loop on-ramp radius would also move the adjacent off-ramp closer to this building. This could significantly increase the overall cost of improvements at the North State interchange.
  - The on-ramp taper length, currently 420 feet, would still not likely meet Caltrans standards even with loop ramp lengthening. Current Caltrans standards are 180 meters (590 feet) of on-ramp taper length. Because of the nearby building constraint, increasing taper length to a minimum of 590 feet is difficult.

- 2025: Realign southbound on- and off-ramps to meet at a single signalized intersection
- 2025: Increase acceleration length for southbound on-ramp merge onto southbound mainline

- There has been a recent proposal to create a driveway access for a private property at a midpoint of the 101 Northbound ramps. The access would be located only approximately 400 feet from the ramp terminals at North State Street. This access is not recommended for two reasons: Caltrans standards require at least 600 feet between ramp terminals and any mid-ramp access, and Caltrans only permits mid-ramp access for public streets, not private roadways.

*Interchange 3: Route 101 at East Perkins Street*

Concerns

- Excess collision rates at northbound and southbound ramp intersections (2005)
- Excess collision rates on northbound on-ramp (2005)
- Congestion at northbound and southbound ramp intersections and nearby East Perkins Street / Orchard Avenue intersection (2005 and 2025)
- Queuing from westbound vehicles at East Perkins Street / Orchard Avenue intersection causing blockages of nearby southbound ramp intersection (2005 and 2025). Queue extends past intersection to East Perkins Overcrossing in 2025 p.m. peak
- Queuing of southbound off-ramp vehicles (2005 and 2005), with queue spillover to mainline in 2025, without signal
- Queuing of northbound off-ramp vehicles with queue spillover to mainline in 2025 a.m. peak, without signal
- Inadequate merge length for northbound on-ramp
- Merging congestion for northbound on-ramp (2025)
- Poor sight distance at both northbound and southbound ramp intersections due to sharp vertical curvature of the East Perkins Street Overcrossing (2005)
- Tight / substandard radii for both northbound and southbound loop on-ramps. Right turns onto these on-ramps have poor channelization (2005)

Improvements

- 2005: Add signal to southbound ramp intersection and coordinate with optimized East Perkins / Orchard signal. Add signal to northbound ramp intersection and coordinate with nearby signals. There is also potential to add a roundabout to the northbound ramp intersection, as was outlined in the May 2003 *Brush Street Triangle Study*.
- 2025 (preliminary alternative): A preliminary alternative would be to close the southbound ramps at East Perkins and relocate them to Orchard Avenue at Brush Street, north of the current ramp location. A signal at the Brush Street / Orchard Avenue intersection would be recommended along with the ramp relocation. There is also potential to add a roundabout to the Brush Street / Orchard Avenue intersection, as was outlined in the May 2003 *Brush Street Triangle Study*. It should be noted that while congestion at the East Perkins interchange would decrease, it is likely that congestion would increase at the East Perkins Street / Orchard Avenue intersection due to the redistribution of ramp trips to / from the Brush Street / Orchard Avenue intersection.

  However, some modifications to the East Perkins Street / Orchard Avenue intersection by adding lanes could alleviate congestion at this intersection. Preliminary analysis indicates that adding a westbound through-left lane and a southbound right turn lane would improve the level of service to acceptable levels. Following are some of the pros and cons of this improvement:
    - Pros: Removal of southbound Perkins ramps would improve traffic operations for East Perkins Street and its nearby intersection with Orchard Avenue. It would also eliminate the current queuing concern on the southbound Perkins ramps, the need for a signal at those ramps, and potentially the need to widen the East Perkins Overcrossing. Furthermore, the improvement could potentially reduce collisions.
    - Cons: Potential new ramps at the Orchard Avenue / Brush Street intersection provide new operation and collision concerns, including those related to a new non-standard interchange configuration. Caltrans does not support splitting interchanges in this way. Also, the new configuration would add turning movement traffic to the East

Perkins Street / Orchard Avenue intersection, which already has operational concerns.

It also should be noted that the proposed preliminary configuration for new Brush Street ramps at 101 Southbound would be a partial diamond, or half of a standard diamond interchange. To address driver orientation for a newly split interchange, TJKM recommends that "trailblazing" signage supplement the new configuration, so that clear routes are indicated to the relocated ramps and the existing northbound Perkins ramps.

- 2025: Increase acceleration length for northbound on-ramp
- 2025: Add auxiliary lane connecting northbound off-ramp with upstream northbound on-ramp from East Gobbi Street interchange to improve merging and weaving operations
- 2025: Widen East Perkins Street Overcrossing as needed to accommodate queued vehicles at newly signalized ramp intersections

*Interchange 4: Route 101 at East Gobbi Street*

Concerns
- Congestion at East Gobbi Street / Orchard Avenue and East Gobbi Street / 101 Southbound Ramp intersections (2005 and 2025)
- Southbound off-ramp near capacity in 2025
- Poor sight distance at both northbound and southbound ramp intersections due to sharp vertical curvature of the East Gobbi Street Overcrossing (2005)

Improvements
- 2005: Add signals at East Gobbi Street / Orchard Avenue and East Gobbi Street / 101 Southbound Ramp intersections and coordinate their operations. The City of Ukiah has programmed signal installation at the East Gobbi Street / Orchard Avenue intersection for its 2005-06 Fiscal Year. There is also potential to add a roundabout to the East Gobbi Street / Orchard Avenue intersection, as was outlined in the May 2003 *Brush Street Triangle Study*.
- 2025: Add auxiliary lane connecting northbound on-ramp with downstream northbound off-ramp at East Perkins Street interchange to improve merging and weaving operations
- 2025: Widen East Gobbi Street Overcrossing as needed to accommodate queued vehicles at newly signalized southbound ramp intersection

*Interchange 5: Route 101 at Talmage Road (S.R. 222)*

Concerns
- Congestion at nearby Talmage Road / Airport Park Boulevard intersection (2005 and 2025)
  - 2005 p.m. westbound left turn queue spillover – could block southbound ramp intersection
  - 2025 westbound queues could block southbound ramp intersection
- Congestion at northbound and southbound ramp intersections (2025)
- Southbound off-ramp to westbound Talmage Road – queue spillover to mainline in 2025 p.m. peak
- Excess collision rate at nearby Talmage Road / Airport Park Boulevard intersection
- Poor sight distance at both northbound and southbound ramp intersections due to sharp vertical curvature of the Talmage Road Overcrossing

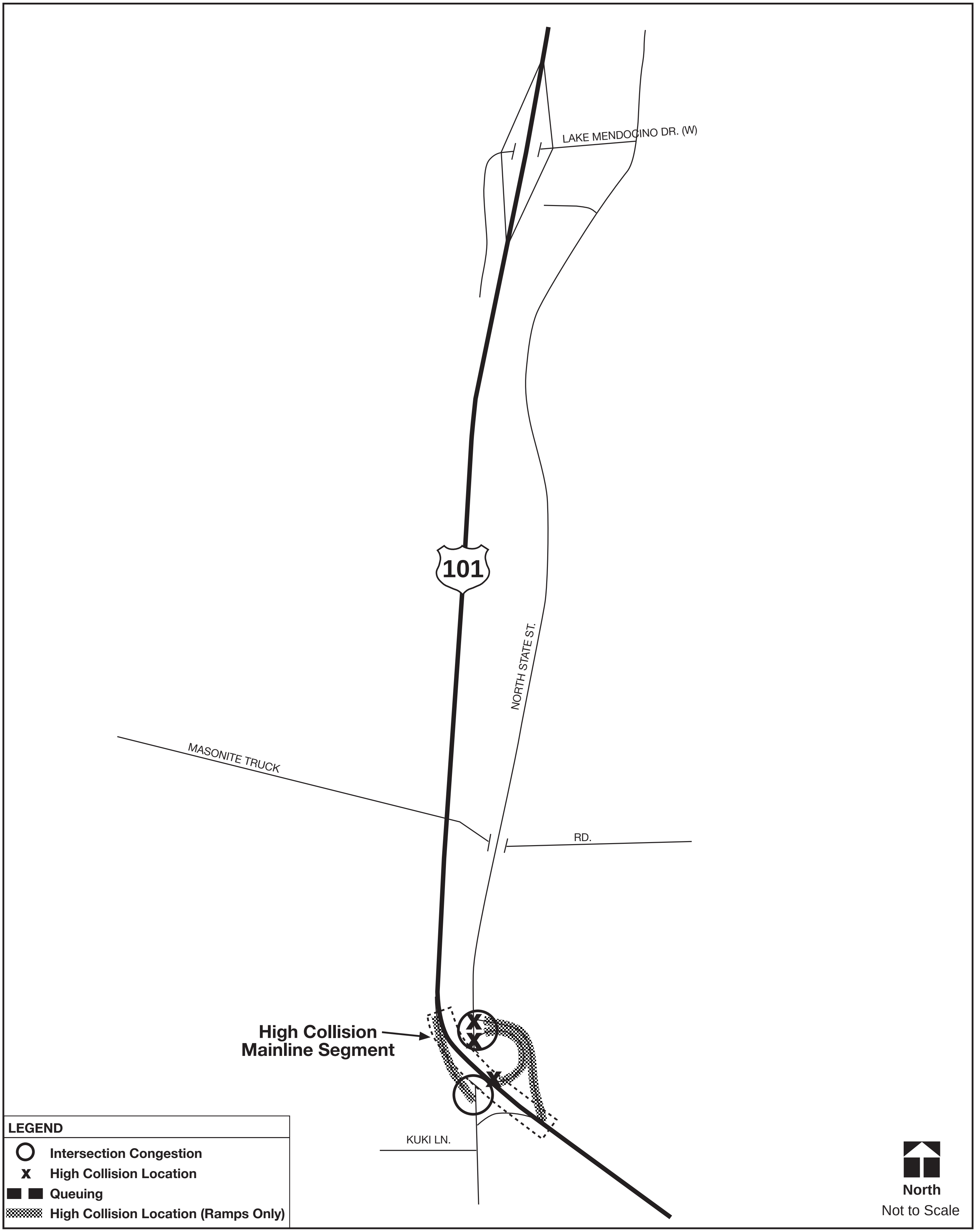
Improvements

- 2025: Add signals to northbound and southbound ramp intersections.  This would very likely require modification of the entire interchange to a tight diamond (Type L-1) configuration. Coordinate new signals with optimized existing signal at Talmage Road / Airport Park Boulevard intersection.  A second option would be to modify the existing interchange to a partial cloverleaf design utilizing existing right-of-way.
- 2025: Widen Talmage Road Overcrossing as needed to accommodate queued vehicles at newly signalized ramp intersections

*Interchange 6: Route 101 at South State Street / Boonville-Ukiah Road (S.R. 253)*

Concerns*:* No significant concerns in 2005, and no significant concerns anticipated in 2025

Improvements*:* No improvements considered at this time.



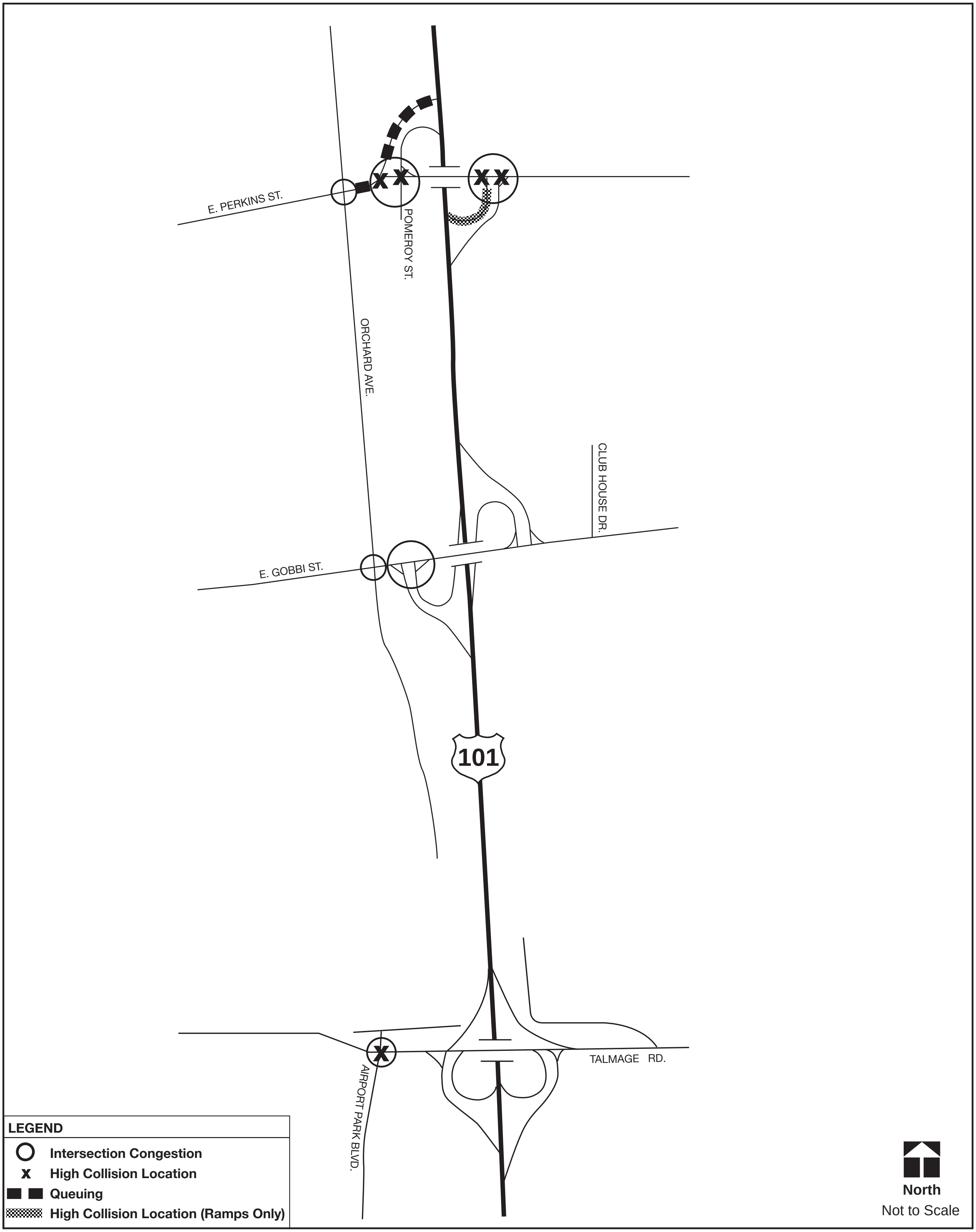

Mendocino County
Route 101 Corridor Interchange Study (Ukiah Area)

**Existing Operational Concerns (2005)**

Figure **1a**

TJKM

80-020 - 5/12/05 - AK




Mendocino County

Route 101 Corridor Interchange Study (Ukiah Area)

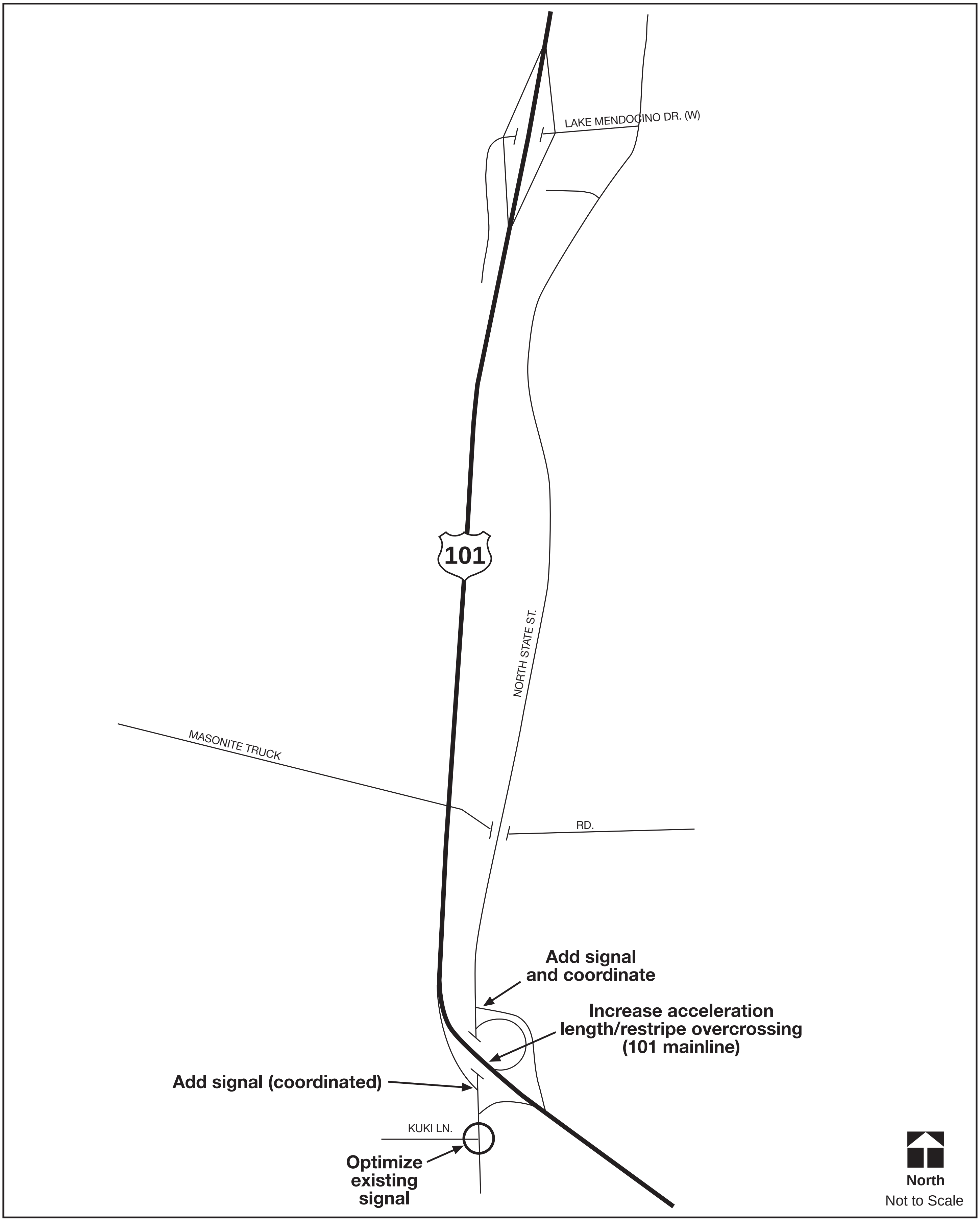
# Existing Operational Concerns (2005)

Figure

1b

TJKM

80-020 - 5/12/05 - AK



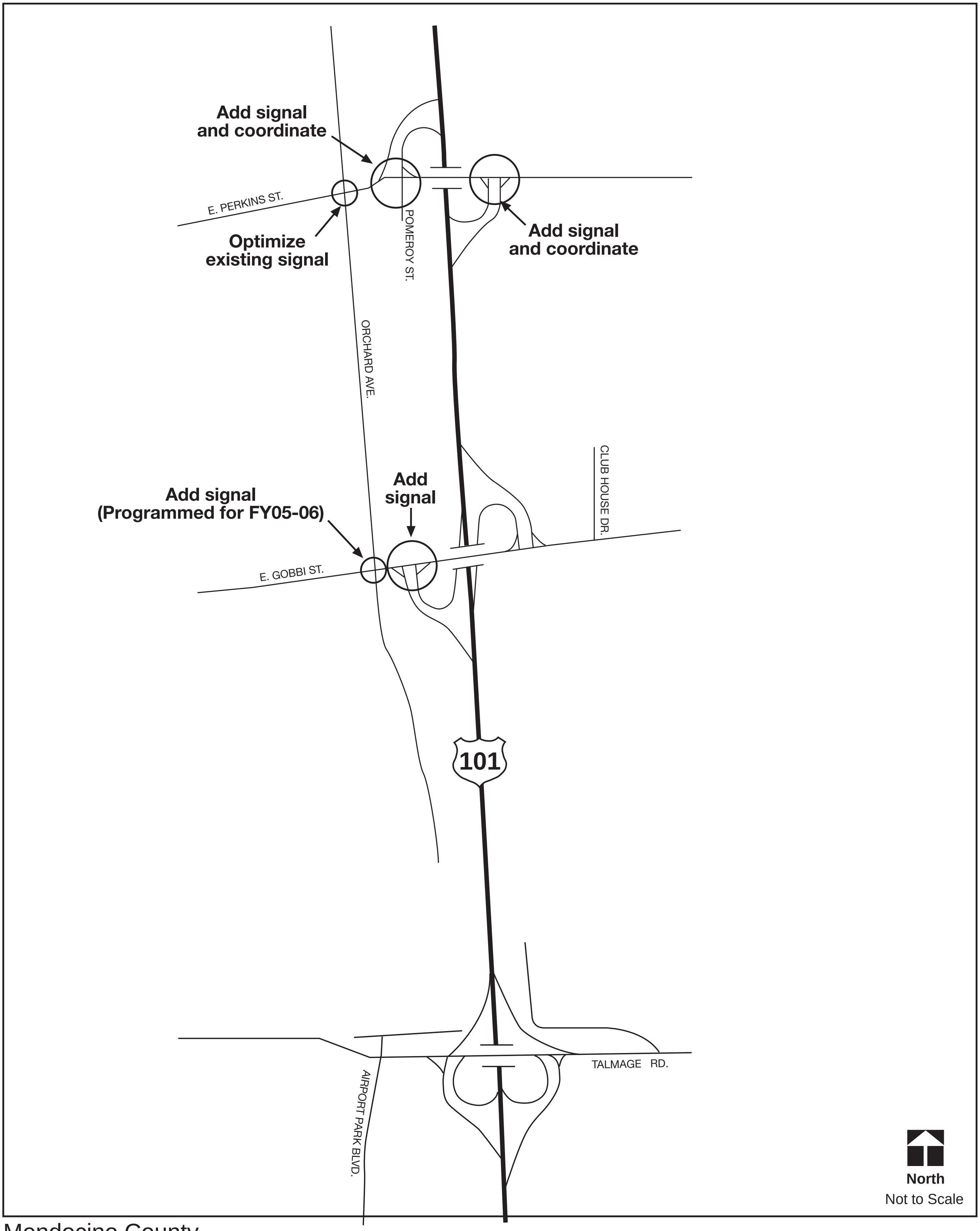

Mendocino County
Route 101 Corridor Interchange Study (Ukiah Area)

**Proposed Near-Term Improvements–**
**Existing Conditions (2005)**

**Figure**
**2a**

TJKM

80-020 - 5/17/05 - AK



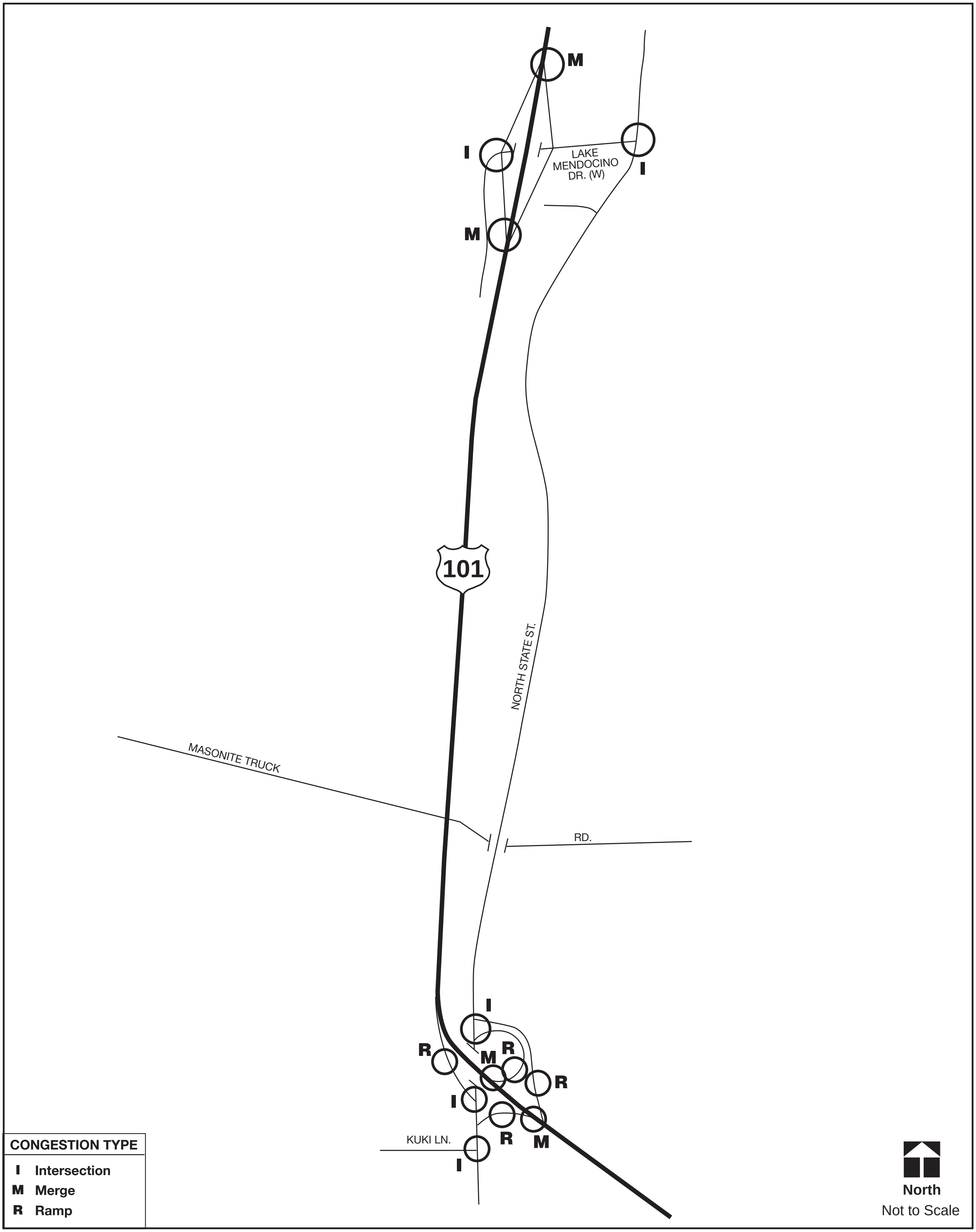

Mendocino County
Route 101 Corridor Interchange Study (Ukiah Area)

**Proposed Near-Term Improvements–
Existing Conditions (2005)**

**Figure 2b**

TJKM

80-020 - 5/12/05 - AK



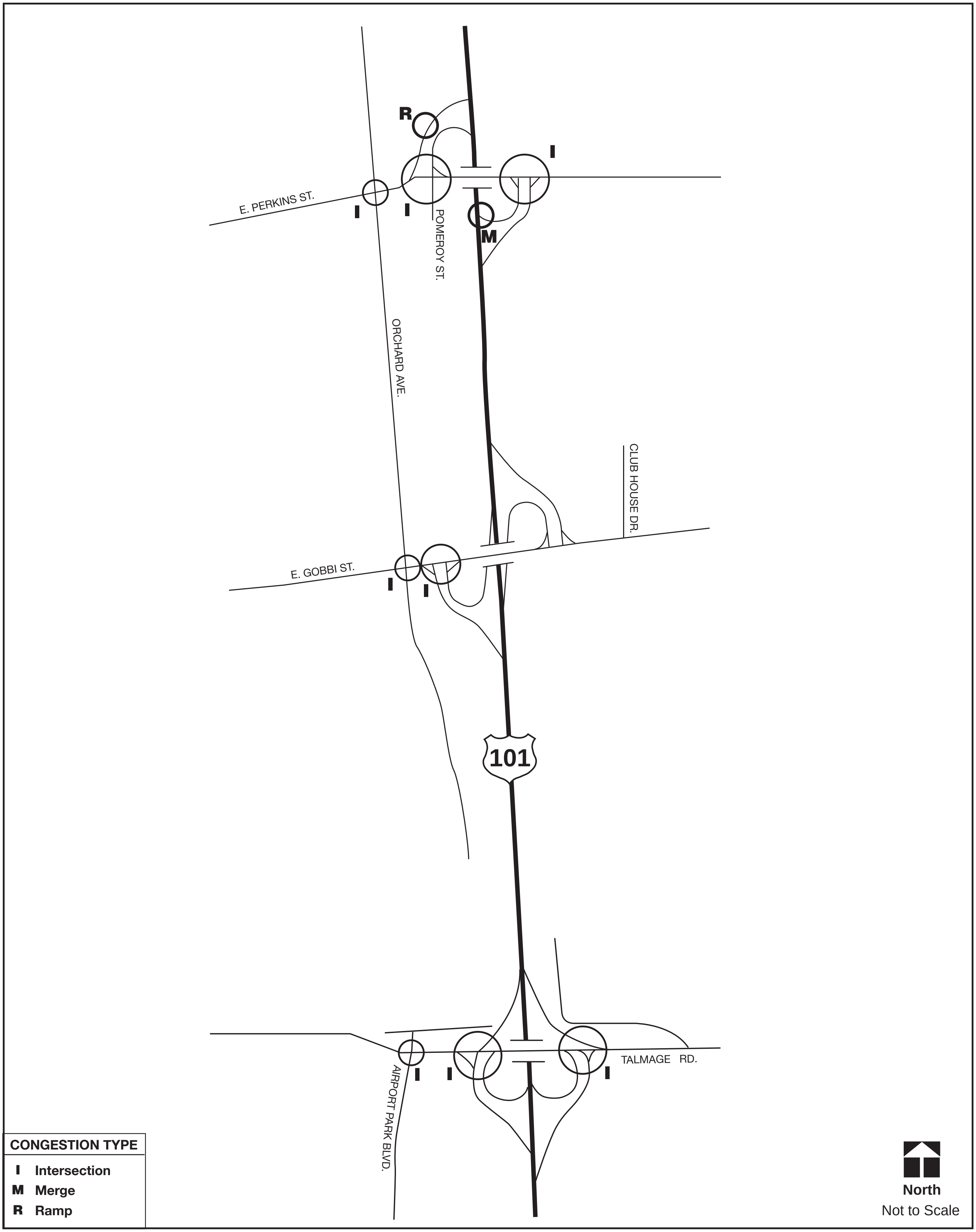

Mendocino County
Route 101 Corridor Interchange Study (Ukiah Area)

# Future Operational Concerns (2025)

Figure
3a

TJKM

80-020 - 5/17/05 - AK



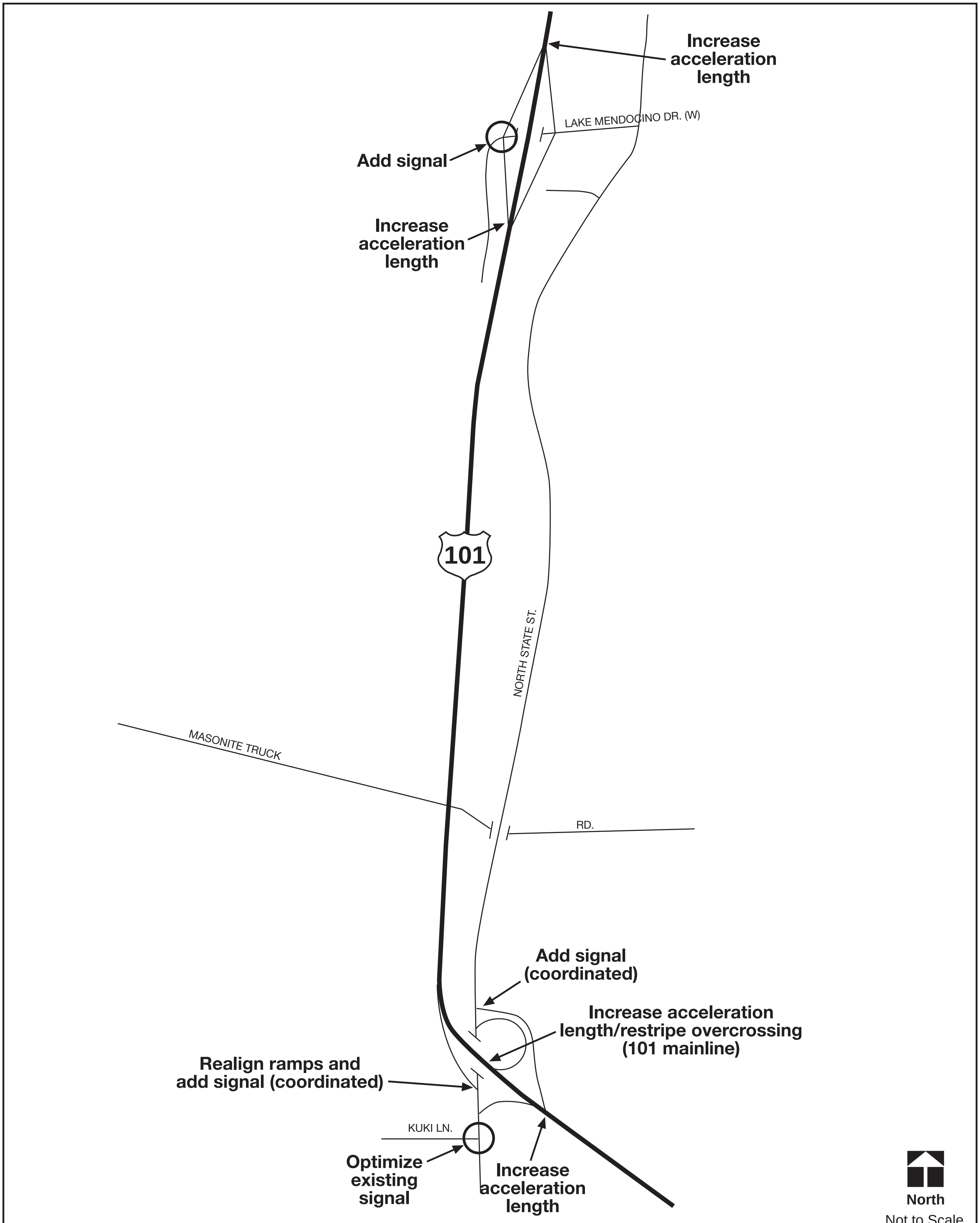

Mendocino County
Route 101 Corridor Interchange Study (Ukiah Area)

# Future Operational Concerns (2025)

Figure
3b

TJKM

80-020 - 5/12/05 - AK



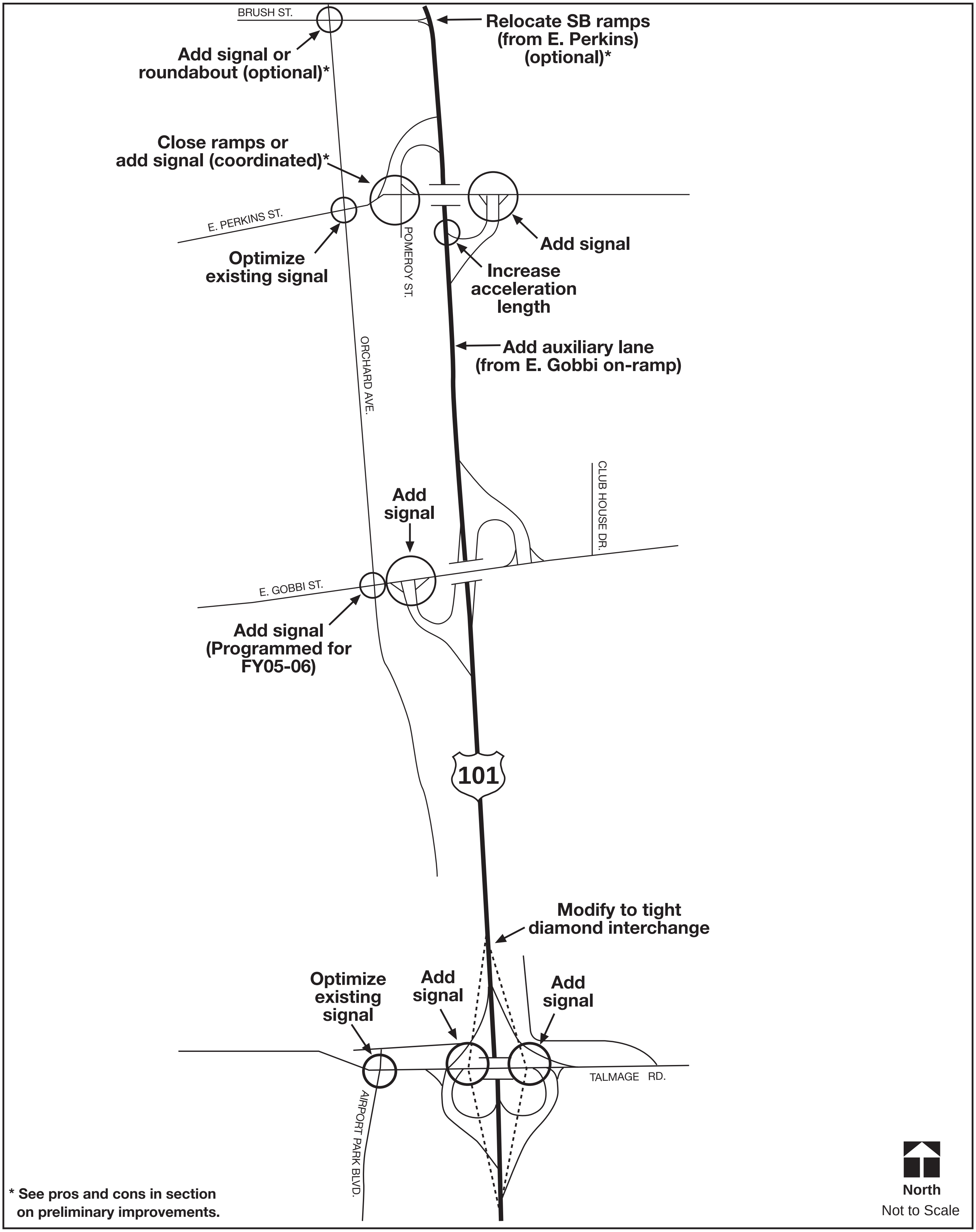

Mendocino County
Route 101 Corridor Interchange Study (Ukiah Area)

# Proposed Future Improvements through 2025

Figure
4a

TJKM

80-020 - 5/17/05 - AK




Mendocino County

Route 101 Corridor Interchange Study (Ukiah Area)

**Proposed Future Improvements through 2025**

**Figure 4b**

TJKM

80-020 - 5/17/05 - AK

Before implementation of the above-recommended improvements, the following points should be considered:

- Proposed new signals that are in close proximity to existing signals must be coordinated to address both State Highway and local street operational concerns. In particular, since some ramp and local street intersections in the study area are spaced less than 500 feet apart, signal coordination will be essential. Proper coordination will help to avoid ramp queuing onto the freeway mainline and also local street queuing.

- All proposed signal design and construction must be reviewed by and coordinated with Caltrans Traffic Operations staff for coordination with State Highway operations in the Ukiah Valley.

- Increasing capacity on local routes parallel to the freeway should be considered as an alternative to freeway improvements. Expanding local street capacity may preclude the need for expensive freeway mainline improvements, such as increasing merging lengths. Furthermore, increasing local street capacity has the potential to divert local trips from the freeway, which is meant to function as a regional facility. This has the potential to improve freeway service levels.

  Relative to this final point, Mendocino County currently is evaluating an extension of Orchard Avenue northerly from its current Brush Street terminus to Lake Mendocino Drive. Orchard Avenue is a local roadway that is west of and runs parallel to the U.S. Route 101 freeway. This improvement would add to local street capacity and reduce local trips on the freeway.

## Near-Term Improvement Prioritization

This section represents the final step in the Route 101 Corridor Interchange Study in Mendocino County. TJKM prioritized those near-term improvements that can be implemented easily in the near term. These near-term improvements were prioritized based on a cost-benefit analysis using a 10-year horizon. Annualized benefits from the improvements and their annualized costs were used to calculate the benefit to cost (B/C) ratio. Based on this B/C ratio, projects were prioritized. Table 15 shows the results of the prioritization of proposed near-term improvements.

**TABLE 15: PRIORITIZATION OF NEAR –TERM IMPROVEMENTS**

| *Rank* | *Improvements* | *Capital Cost* | *Cumulative Capital Cost* | *Annualized Capital Cost* | *Cumulative Annualized Capital Cost* | *Annualized Benefits* | *Cumulative Benefits* | *B/C Ratio* |
|---|---|---|---|---|---|---|---|---|
| 1 | E. Perkins St./SB Ramps Signal | $230,000 | $230,000 | $32,200 | $31,000 | $1,093,421 | $1,093,421 | 33.96 |
| 2 | E. Perkins St./NB Ramps Signal | $230,000 | $460,000 | $32,200 | $63,200 | $87,905 | $1,181,326 | 2.73 |
| 3 | Restripe / add lane on Route 101 NB at N. State St. merge | $160,000 | $620,000 | $22,400 | $85,600 | $48,469 | $1,229,795 | 2.16 |
| 4 | N. State St./NB Ramps Signal | $230,000 | $850,000 | $32,200 | $117,800 | $51,574 | $1,281,369 | 1.60 |
| 5 | N. State St./SB Ramps Signal | $240,000 | $1,090,000 | $33,600 | $151,400 | $32,922 | $1,314,291 | 0.98 |
| 6 | Gobbi St./Orchard Ave. Signal | $230,000 | $1,320,000 | $32,200 | $183,600 | $16,834 | $1,331,125 | 0.52 |
| 7 | Gobbi/SB Ramps Signal | $165,000 | $1,485,000 | $23,100 | $206,700 | $1,518 | $1,332,643 | 0.07 |

*Notes: 1. B/C Ratio calculation assumptions include a 10-year annualized capital cost, cost of $41,000 per collision, and $15/hour cost for lost wages.*
*2. Gobbi St./Orchard Ave. Signal has been programmed by the City of Ukiah for FY 05-06*

The above table illustrates that the proposed signal at the East Perkins Street / 101 Southbound Ramp intersection will realize the most benefits at the least cost in the near term. The East Perkins Street / 101 Northbound Ramp intersection signal and 101 Northbound / North State merge restriping are the next highest in terms of benefit to cost ratios.

The final section outlines preliminary estimates of cost for all proposed improvements, both in the near term and in 2025.

## Preliminary Designs and Cost Estimates of Preliminary Improvements

HDR conducted design and cost estimation for all conceptual improvements, both in the near-term and the future. Table 16 provides a cost breakdown for each improvement based on estimated signal, roadway, and bridge structure costs. The technical appendix contains preliminary design layouts for all proposed improvements.

**TABLE 16: PRELIMINARY COST ESTIMATES – NEAR-TERM IMPROVEMENTS**

| *Interchange* | *Year* | *Construction Cost (2005 Dollars)* | | | *Right-Of-Way Take (ft²)* | | | | *Total ROW (Acres)* | *Comments* |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Roadway* [1] | *Structure* | *Total* | *NE Quad* | *NW Quad* | *SE Quad* | *SW Quad* | | |
| 1 - Lake Mendocino Drive | 2025 | $ 1,796,000 | $ - | $ 1,796,000 | 0 | 0 | 0 | 0 | 0.00 | None |
| 2 - North State Street | 2005 | $ 630,000 | $ - | $ 630,000 | 0 | 0 | 0 | 0 | 0.00 | See note 2. |
| | 2025 | $ 3,949,000 | $ - | $ 3,949,000 | 0 | 107,900 | 0 | 0 | 2.48 | See note 3. |
| 3 - East Perkins Street | 2005 | $ 460,000 | $ - | $ 460,000 | 0 | 0 | 0 | 0 | 0.00 | None |
| | 2025 | $ 2,010,000 | $ 2,093,000 | $ 4,103,000 | 0 | 250 | 0 | 3,630 | 0.09 | See note 4. |
| 4 - East Gobbi Street | 2005 | $ 395,000 | $ - | $ 395,000 | 0 | 0 | 0 | 0 | 0.00 | None |
| | 2025 | $ 2,117,000 | $ 628,000 | $ 2,745,000 | 0 | 0 | 0 | 6,550 | 0.15 | See note 5. |
| 5 - Talmage (Option 1) | 2025 | $ 8,259,000 | $ 2,317,000 | $ 10,576,000 | 130,000 | 53,200 | 26,500 | 25,200 | 5.39 | See note 6. |
| (Option 2) | 2025 | $ 4,024,000 | $ 1,112,000 | $ 5,136,000 | 0 | 0 | 0 | 0 | 0.00 | See note 7. |

*Notes:* *Quad = quadrant*

*[1] Roadway cost includes all roadway construction and signal installation costs.*
*[2] Two signals (NB and SB Ramps) and restriping of NB On-Ramp acceleration lane.*
*[3] Existing and proposed SB ramp intersection and local road intersection separation does not meet minimum design standards. Considerable ROW taking from junk yard with possible impact to business.*
*[4] East Gobbi to East Perkins NB auxiliary lane construction and removal / reconstruction of pedestrian over-crossing included.*
*[5] Existing and proposed NB ramp intersection and local road intersection separation do not meet minimum design standards.*
*[6] ROW acquisition required in SE and NW quadrant with conflict to commercial and residential structures. Complex staging and ramp closure required.*
*[7] Existing and proposed ramp intersections and local road intersection separations do not meet minimum design standard.*

# STUDY PARTICIPANTS

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Geri Foley
Evi Pagh

**HDR**

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**Data Collection**

Field Data Services, Inc.

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**California Department of Transportation (Caltrans)**

Dave Carstensen

**Mendocino County**

Bob Parker, P.E.

**City of Ukiah**

Richard J. Seanor, P.E.

**Mendocino County Air Quality Management District (AQMD)**

Chris Brown, AICP

# TECHNICAL APPENDIX: HDR PRELIMINARY DESIGN DRAWINGS


PRELIMINARY SPECIFIC IMPROVEMENTS
TASK 5
RT 101 CORRIDOR INTERCHANGE STUDY
IN MENDOCINO COUNTY (UKIAH AREA)
MAY 2005

INTERCHANGE 01 FOR 2025:
RT 101 AND LAKE MENDOCINO DRIVE

HDR
2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630

\12036\20996\PLANS\WIP\UKIA_01_2025_V8.DGN Date plotted: 03/25/2003 2:52 pm

PRELIMINARY SPECIFIC IMPROVEMENTS
TASK 5
RT 101 CORRIDOR INTERCHANGE STUDY

IN MENDOCINO COUNTY (UKIAH AREA)

MAY 2005

INTERCHANGE 02 FOR 2005:
RT 101 AND N STATE STREET

HDR 2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630


\I2036\20996\PLANS\WIP\UKIA_02_2005.DGN Date plotted: 03/25/2003 2:52 pm

**PRELIMINARY SPECIFIC IMPROVEMENTS**
**TASK 5**
**RT 101 CORRIDOR INTERCHANGE STUDY**
**IN MENDOCINO COUNTY (UKIAH AREA)**
MAY 2005

**INTERCHANGE 02 FOR 2025:**
**RT 101 AND N STATE STREET**

HDR
2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630


\I2036\20996\PLANS\WIP\UKIA_02_2025.DGN Date plotted: 03/25/2003 2:52 pm

**PRELIMINARY SPECIFIC IMPROVEMENTS**
**TASK 5**
**RT 101 CORRIDOR INTERCHANGE STUDY**

**IN MENDOCINO COUNTY (UKIAH AREA)**
MAY 2005

**INTERCHANGE 03 FOR 2005:**
**RT 101 AND E PERKINS STREET**

HDR
2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630

SCALE: 1"=300'


\2036\20996\PLANS\WIP\UKIA_03_2005.dgn Date plotted: 03/25/2003 2:52 pm

**PRELIMINARY SPECIFIC IMPROVEMENTS**
**TASK 5**
**RT 101 CORRIDOR INTERCHANGE STUDY**

**IN MENDOCINO COUNTY (UKIAH AREA)**
MAY 2005

**INTERCHANGE 03 FOR 2015:**
**RT 101 AND E PERKINS STREET**

HDR 2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630

SCALE: 1"=300'


\I2036\20996\PLANS\WIP\UKIA_03_2015.dgn Date plotted: 03/25/2003 2:52 pm

**PRELIMINARY SPECIFIC IMPROVEMENTS**
**TASK 5**
**RT 101 CORRIDOR INTERCHANGE STUDY**

**IN MENDOCINO COUNTY (UKIAH AREA)**
MAY 2005

**INTERCHANGE 03 FOR 2025:**
**RT 101 AND E PERKINS STREET**

HDR
2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630


\I2036\20996\PLANS\WIP\UKIA_03_2025.dgn Date plotted: 03/25/2003 2:52 pm

PRELIMINARY SPECIFIC IMPROVEMENTS
TASK 5
RT 101 CORRIDOR INTERCHANGE STUDY
IN MENDOCINO COUNTY (UKIAH AREA)
MAY 2005

INTERCHANGE 04 FOR 2005
RT 101 AND E GOBBI STREET

HDR 2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630


\I2036\20996\PLANS\WIP\UKIA_04_2005.DGN Date plotted: 03/25/2003 2:52 pm

**PRELIMINARY SPECIFIC IMPROVEMENTS**
**TASK 5**
**RT 101 CORRIDOR INTERCHANGE STUDY**

**IN MENDOCINO COUNTY (UKIAH AREA)**
MAY 2005

**INTERCHANGE 04 FOR 2025**
**RT 101 AND E GOBBI STREET**

HDR
2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630


\I2036\20996\PLANS\WIP\UKIA_04_2025.DGN Date plotted: 03/25/2003 2:52 pm

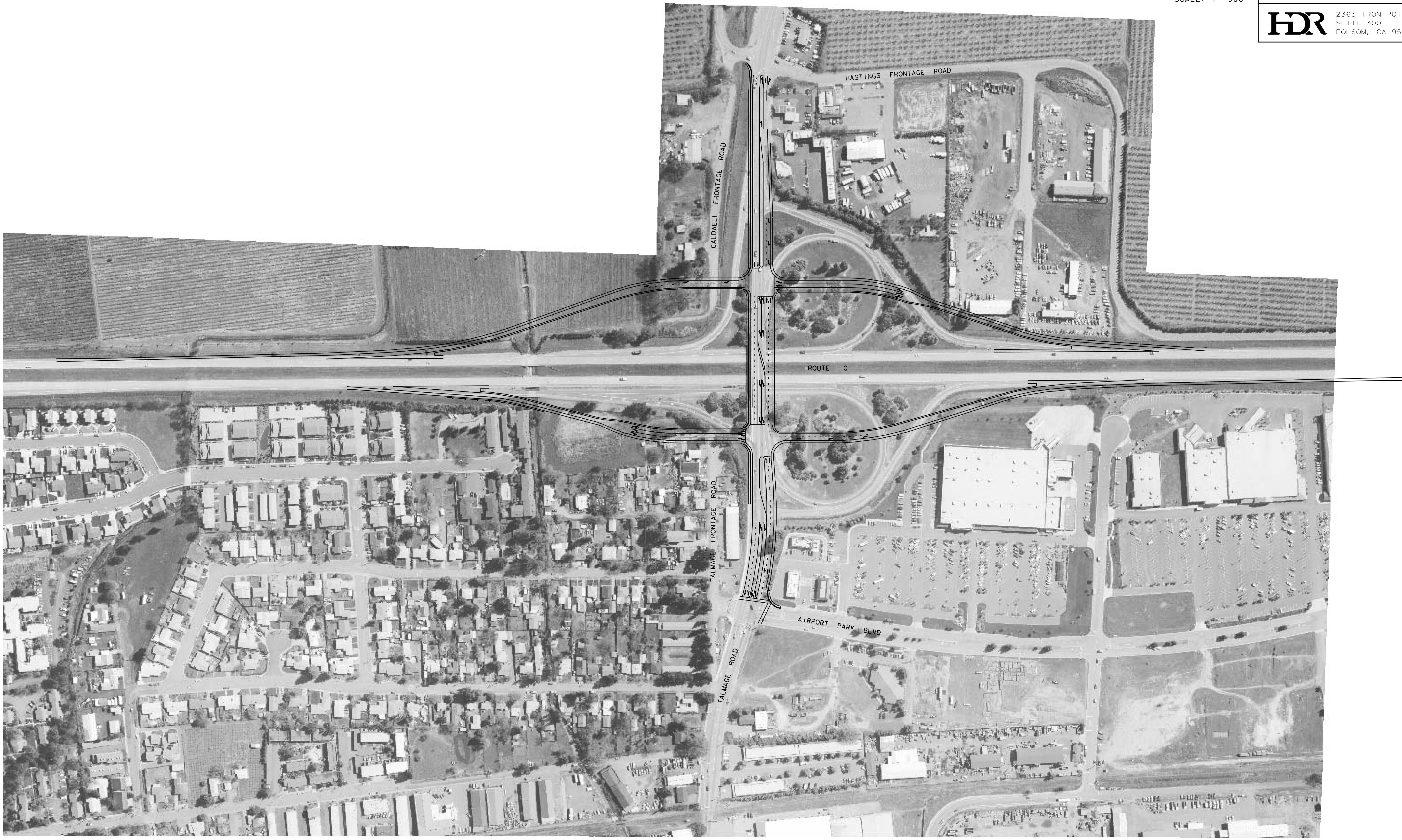
**PRELIMINARY SPECIFIC IMPROVEMENTS**
**TASK 5**
**RT 101 CORRIDOR INTERCHANGE STUDY**

**IN MENDOCINO COUNTY (UKIAH AREA)**
MAY 2005

**INTERCHANGE 05 FOR 2025-OPT1:**
**RT 101 AND TALMAGE ROAD**

HDR
2365 IRON POINT ROAD
SUITE 300
FOLSOM, CA 95630

SCALE: 1"=300'




\I2036\20996\PLANS\WIP\UKIA_05_2025_OPT1.DGN Date plotted: 03/25/2003 2:52 pm

PRELIMINARY SPECIFIC IMPROVEMENTS
TASK 5
RT 101 CORRIDOR INTERCHANGE STUDY
IN MENDOCINO COUNTY (UKIAH AREA)
MAY 2005

INTERCHANGE 05 FOR 2025-OPT2:
RT 101 AND TALMAGE ROAD

HDR
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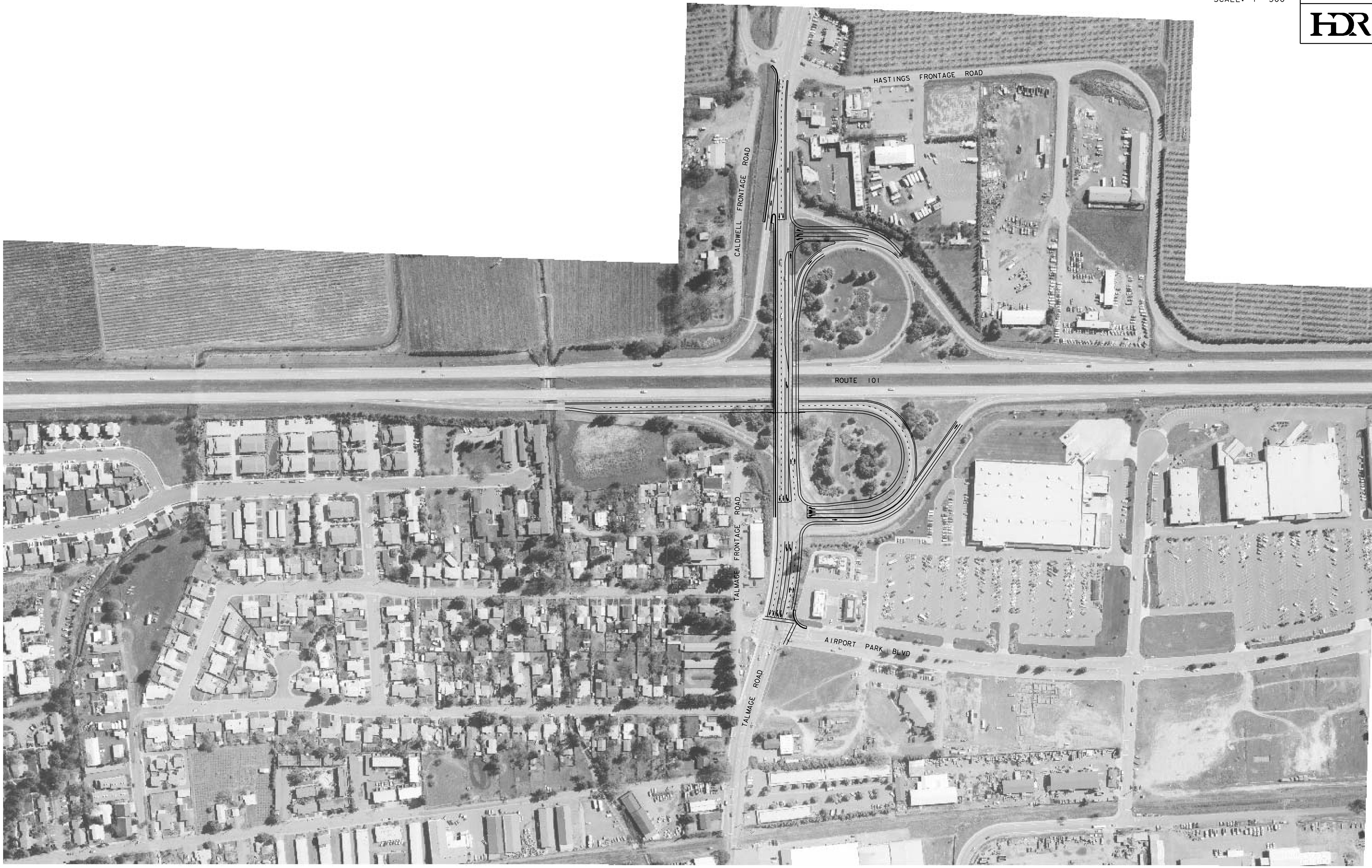
SUITE 300
FOLSOM, CA 95630

SCALE: 1"=300'




\I2036\20996\PLANS\WIP\UKIA_05_2025_OPT2.DGN Date plotted: 03/25/2003 2:52 pm

# Ukiah Ramps Improvement Project On State Route 101 In Mendocino County

01-MEN-101 PM 24.59/26.24
01-48190K
September 2008

**This document can be used to program capital support for the Project Approval and Environmental Document phase. The remaining support and capital components of the project are preliminary estimates and are not suitable for programming purposes. Either a Supplemental PSR or a Project Report will serve as the programming document for the remaining support and capital components of the project. A project report will provide for approval of the "selected" alternative.**

This Project Study Report (Project Development Support) has been prepared under the direction of the following Registered Engineer. The registered civil engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

| | |
|---|---|
| **JEFFREY L. PIMENTEL, P.E.**<br>REGISTERED CIVIL ENGINEER | **Date** |

# 1. INTRODUCTION

Project Description:

The project proposes ramp improvements along Route 101 at the East Perkins Street and North State Street Interchanges in Ukiah, CA.

Improvements at Route 101/East Perkins Street include traffic signals at the Southbound (SB) and Northbound (NB) Ramp intersections, sidewalk, pedestrian ramps and signal coordination with the existing traffic signal at Orchard Avenue. Improvements at Route 101/North State Street include minor widening to allow free right turn movements for SB and NB off-ramp vehicles, re-stripe North State Street to provide left turn movements for SB and NB off-ramp vehicles, and Northbound on-ramp entry improvements.

For specific work items included in this project see the cost estimate, included as Attachment D.

| | |
|---|---|
| **Project Limits Dist., Co., Rte., PM)** | 01-MEN-101 PM 24.59/26.24 |
| **Number of Alternatives:** | 1 Build Alternative |
| **Capital Outlay Support for PAED** | $421,000 |
| **Capital Construction Cost Range (excluding "no build").** | $1,750,000 - $2,250,000 (2008) |
| **Right of Way Cost Range (excluding "no build").** | $14,000 |
| **Funding Source:** | RIP |
| **Type of Facility (conventional, expressway, freeway):** | Freeway, Ramps and City Streets |
| **Number of Structures:** | N/A |
| **Anticipated Environmental Determination or Document:** | CE |
| **Legal Description** | In Mendocino County within the Ukiah city limits on SR 101 at PM 24.59 and 26.24. |
| **Project Category** | 20.10.075.600 |

The remaining support, right of way and construction components of the project are preliminary estimates and are not suitable for programming purposes. Either a Supplemental PSR or Project Report will serve as the programming document for the remaining support and capital components of the project. A project report will serve as approval of the "selected" alternative.

## 2. BACKGROUND

### A. Project History

TJKM Transportation Consultants completed the *Route 101 Corridor Interchange Study* (Corridor Study) in August 2005 for the Mendocino Council of Governments (MCOG). Due to concerns regarding growth and development in the Ukiah area, MCOG decided to undertake a comprehensive study of the Route 101 corridor in the greater Ukiah area that would identify needed improvements, their costs, and priorities. The Corridor Study initiated the preparation of this PSR (PDS). A benefit-to-cost ratio was included in the Corridor Study for the various recommended improvements. The highest benefit-to-cost ratios were associated with improvements at the Route 101/East Perkins Street and Route 101/North State Street Interchanges. At the request of MCOG, Caltrans initiated the study of the subject project.

### B. Existing Facility

Within the project limits Route 101 is classified as a four-lane freeway with 12-foot lanes, 8-foot outside shoulders, and inside shoulders that vary from 2 feet to 5 feet. The off-ramps at East Perkins Street and North State Street have 12-foot lanes and 8-foot shoulders. The posted speed limit on Route 101 is 65 mph within the project limits.

East Perkins Street is a four-lane facility on the west side of the East Perkins Street Overcrossing (OC) at Route 101 and a two-lane facility to the east. The lane widths to the west of the overcrossing vary between 10 and 12 feet with no shoulders. Lane widths to the east of the overcrossing vary between 12 and 16 feet with no striped shoulder. Within the project limits East Perkins Street is within the City of Ukiah.

North State Street is a four-lane facility within the project limits. Lane widths vary between 11 and 12 feet with bike lanes on both sides. Route 101 passes above North State Street at this location outside the Ukiah city limits.

## 3. PURPOSE AND NEED STATEMENT

**Need:**
The Route 101/East Perkins Street location experiences total collision rates two times the statewide average at the NB ramp intersection. In addition to greater than the statewide average collision rates, the NB ramp, SB ramp and Orchard Avenue intersections experience significant congestion. Queuing from westbound vehicles at the East Perkins Street/Orchard Avenue intersection currently obstruct the SB ramp intersection and will extend to the East Perkins Overcrossing in 2025 during the peak hour.

The Route 101/North State Street location experiences collision rates three times the statewide average along both the NB and SB off-ramps as well as the NB on/off-ramp intersection. In addition to greater than the statewide average collision rates, the NB and SB ramp intersections experience congestion. The queues at all off-ramps are expected to extend to the mainline in 2025 during the peak hour.

**Purpose:**
The purpose of this project is to reduce collisions and improve traffic operations at both locations.

## 4. DEFICIENCIES

The North State Street and East Perkins Street collision and level of service data is summarized below.

Collision Data:

| Collision Data Summary (10/1/04 to 9/30/07) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Total | Fatal | Injury | PDO | MV | Wet | Dark |
| E. Perkins NB off-ramp | 7 | 0 | 2 | 5 | 5 | 2 | 0 |
| E. Perkins NB on-ramp | 7 | 0 | 2 | 5 | 7 | 2 | 2 |
| E. Perkins SB on-ramp | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| E. Perkins SB off-ramp | 6 | 0 | 3 | 3 | 3 | 0 | 2 |
| N. State NB off-ramp | 14 | 0 | 3 | 11 | 12 | 2 | 1 |
| N. State NB on-ramp | 6 | 0 | 4 | 2 | 3 | 3 | 2 |
| N. State SB on-ramp | 4 | 0 | 3 | 1 | 3 | 3 | 1 |
| N. State SB off-ramp | 14 | 0 | 6 | 8 | 8 | 3 | 2 |

PDO = Property Damage Only, MV = Multiple Vehicle

At the E. Perkins Street NB ramp intersection the majority of the collisions were broadside type collisions caused primarily by a failure to yield. At the E. Perkins Street SB ramp intersection the majority of the collisions were sideswipe or hit object type collisions caused primarily by driving under the influence and speeding. The majority of collisions at the N. State Street NB off-ramp were rear end and broadside type collisions caused by improper turns. The N. State Street NB on-ramp experienced auto-pedestrian type collisions and were isolated incidents involving pedestrians standing in the roadway. There has not been a reoccurring problem with pedestrians at the N. State Street NB on-ramp. The majority of collisions at the N. State Street SB off-ramp were rear end type collisions caused primarily by speeding. The N. State Street SB on-ramp had a majority of broadside type collisions caused primarily by a failure to yield.

The proposed new signals at the E. Perkins Street NB and SB ramp intersections will likely reduce the broadside type collisions by providing protected movements. The construction of free right movements at the N. State Street NB and SB off-ramps will likely reduce the rear end type collisions by decreasing the traffic queue. Moving the stop bar closer to N. State Street at the NB and SB off-ramps will likely reduce the number of broadside type collisions by reducing the number of lanes crossed by left turning traffic.

| Collision Rates* (10/1/04 to 9/30/07) | | | | | | |
|---|---|---|---|---|---|---|
| | Actual | | | State Average | | |
| Location | Fatal | F+I | Total | Fatal | F+I | Total |
| E. Perkins NB off-ramp | 0.000 | 0.54 | 1.89 | 0.005 | 0.61 | 1.50 |
| E. Perkins NB on-ramp | 0.000 | 0.38 | 1.33 | 0.003 | 0.32 | 0.85 |
| E. Perkins SB on-ramp | 0.000 | 0.00 | 0.37 | 0.003 | 0.32 | 0.85 |
| E. Perkins SB off-ramp | 0.000 | 0.58 | 1.15 | 0.005 | 0.61 | 1.50 |
| N. State NB off-ramp | 0.000 | 0.65 | 3.03 | 0.005 | 0.61 | 1.50 |
| N. State NB on-ramp | 0.000 | 0.87 | 1.31 | 0.003 | 0.32 | 0.85 |
| N. State SB on-ramp | 0.000 | 0.60 | 0.80 | 0.002 | 0.32 | 0.80 |
| N. State SB off-ramp | 0.000 | 1.48 | 3.46 | 0.014 | 0.43 | 1.15 |

*Rates are per million vehicles

(shaded) Collision rates greater than the statewide average

Total collision rates for the E. Perkins Street NB on/off-ramp, N. State Street NB on/off-ramp and N. State Street SB off-ramp exceed the corresponding statewide average. Total collision rates for E. Perkins Street SB on/off-ramp and N. State Street SB on-ramp are less than or equal to the corresponding statewide average.

The highest collision rates from above are at the N. State Street NB off-ramp (two times the statewide average) and the N. State Street SB off-ramp (three times the statewide average).

The TASAS Table B Accident Rate Calculation sheet is included as Attachment K for reference.

Level of Service:

| Level of Service Summary* | |
|---|---|
| Location | Existing Condition |
| E. Perkins St/Orchard Ave | E |
| E. Perkins St/SB Ramp | F |
| E. Perkins St/NB Ramp | C |
| N. State St/SB Ramp | D |
| N. State St/NB Ramp | D |

* Existing Condition LOS data obtained from the *Route 101 Corridor Interchange Study* dated 08/2005 prepared by TJKM Consultants.

The Caltrans typical service level threshold for intersections is the transition between LOS C and D. Based on this threshold only the E. Perkins Street NB Ramp intersection operates acceptably under existing conditions. By 2025 all intersections are forecasted to operate unacceptably at LOS F under the "no build" alternative.

Current and Forecasted Traffic Data:

The current and forecasted traffic data is listed in the table below. The data was provided in a memorandum dated May 7, 2008 from the Caltrans Office of Travel Forecasting and Modeling.

| | Annual ADT | Peak Hour |
|---|---|---|
| Base Year 2007 | 28,200 | 2,900 |
| Year 2010 | 32,100 | 3,310 |
| Year 2020 | 42,000 | 4,330 |
| Year 2030 | 51,900 | 5,350 |

| | |
|---|---|
| 20-Year Directional Percentage (2034) | 60 % |
| 20-Year Truck Percentage (2034) | 8.0 % |
| 10-Year Traffic Index (ramps) (2024) | 9.0 |
| 20-Year Traffic Index (ramps) (2034) | 10.0 |

The Annual Average Daily Traffic (ADT) within the project limits is expected to increase by 60% of the 2010 ADT in 2030, further contributing to the existing congestion problem. Without the construction of the proposed improvements it can be expected the congestion will increase and result in increased delay to vehicles.

## 5. CORRIDOR AND SYSTEM COORDINATION

Route 101 traverses the entire length of District 1 from the Mendocino/Sonoma County line to the Oregon border. Route 101 is the primary north-south transportation corridor, and by far the most important route in District 1. Route 101 is of interregional and interstate significance, and is designated as a High Emphasis Focus Route in the State Interregional Transportation Strategic Plan (ITSP) with relatively high traffic volumes and heavy use by both truck and tourist traffic. The route is used for the transportation of intercity/interstate commerce to Gateways, and is the lifeline of the north coast connecting rural areas to and through urban centers. The level of service (LOS) concept is C for four-lane segments in rural areas, and D for urban areas and two-lane segments in rural areas. The Concept for Route 101 is a four-lane freeway/expressway within the project limits.

Future projects planned for the general area of this proposed project are listed in the following table:

| Project Location | EA | Project Description | Fiscal Years of Construction |
|---|---|---|---|
| MEN-101 PM R21.1/R33.7 | 01-44940 | Remove & Replace Portland Concrete Pavement | 10/11, 11/12 |
| MEN-101 PM 9.2/21.1 | 01-36291 | Roadway Rehabilitation | 14/15, 15/16 |

## 6. ALTERNATIVES

**Concurrence by the Project Development Coordinator for further study of the viable alternatives included in this PSR (PDS) does not constitute approval of any non-standard features identified currently or in the future. Separate documentation and approval(s) will be required as per Chapter 21 of the Project Development Procedures Manual (PDPM).**

This project proposes ramp improvements at the East Perkins Street and North State Street Interchanges on Route 101 in Mendocino County at PM 24.59 and PM 26.24. There is one viable build alternative and a no build alternative for this project.

Typical sections and layouts are included as Attachments B and C, respectively. A detailed cost estimate is included as Attachment D.

**Alternative 1 ($1.75 - $2.25 million) –** 2008 Dollars

<u>Route 101/East Perkins Street ($1,030,000 -$1,310,000):</u>

The proposed improvements at the Route 101/East Perkins Street location include signalization of the NB and SB ramp intersections, adding a left turn pocket for WB vehicles turning left onto the NB on-ramp, pedestrian ramp replacement at Pomeroy Street, coordination of the existing traffic signal at East Perkins Street/Orchard Avenue and constructing curb, gutter and sidewalk at the SE corner of the NB ramp intersection.

Signal interconnect will be required in order to coordinate the proposed signals at the NB and SB ramp intersections with the existing signal at Orchard Avenue. The signal interconnect will need to be anchored to the outside of the East Perkins OC since empty conduits do not exist within the structure. The existing signal controller at the Orchard Avenue/East Perkins Street intersection would most likely need to be upgraded in order to communicate with Caltrans Model 170E/2070 controllers in the event traffic signals are installed at the NB and SB ramp intersections.

Along with the left turn pocket for WB vehicles turning left onto the NB on-ramp, the project proposes a 1 foot wide raised median extending just beyond the west driveway to the retail development on the NE corner of the NB ramp intersection. Currently NB off-ramp vehicles travel diagonally and often stop in the travel lane to enter the west driveway of the development.

The raised median will force vehicles to utilize the proposed two way left turn lane and enter the development at the east driveway eliminating the diagonal movement and obstruction of through traffic.

In addition, the following metal beam railing terminal systems and bridge transitions will be replaced at the Perkins Street OC:

- NE quadrant – upgrade to SRT terminal system with WB bridge transition
- SE quadrant – upgrade to WB bridge transition
- SW quadrant – new ET terminal system with WB transition
- NW quadrant – upgrade to WB bridge transition

The City of Ukiah will construct a dedicated right turn lane project at the intersection of East Perkins Street/Orchard Avenue beginning in Summer 2009. The City's proposed improvements are shown on the attached project layouts, but will be constructed prior to the construction of 48190K. The ultimate configuration of the City's project will not take place until construction of the subject project. The additional work required to reach the ultimate configuration includes revised striping, traffic signal loops and signal heads and has been captured in the cost estimate for the subject project. New traffic signal poles and mast arms will be installed during the first phase of the City's project in Summer 2009 and are not included in the scope of the subject project.

The proposed traffic signals at the NB and SB ramp intersections were recommended by TJKM's Corridor Study (2005) and require further analysis to determine whether the recommendation is appropriate to meet the purpose and need of the project. At the next stage of the project the City of Ukiah will be required to complete a traffic study to evaluate the proposed improvements. The results of the traffic study will be required by Caltrans to justify improvements at this location during the Caltrans encroachment permit process. Caltrans has made the following observations, which should be considered by the City of Ukiah at the next stage of the project:

- Poor pedestrian visibility at the NB on-ramp due to vertical curve, vegetation, utility pole and signage.
- NB off-ramp vehicles obstruct eastbound traffic by stopping diagonally prior to entering the west driveway of the NE development.
- Vehicles exiting the west driveway of the NE development obstruct westbound traffic while waiting to turn left onto the NB on-ramp.
- Poor sight distance for through and left turning vehicles from Pomeroy Street and the SB off-ramp due to vertical curve and vegetation.

Caltrans suggests the following be reviewed in the traffic study:

- Investigate right-in/right-out only movements at Pomeroy Street and force other movements to use the Orchard Avenue signal.
- In the event the NB ramp is signalized a right turn lane should be constructed to avoid low right turn volumes triggering the signal and stopping mainline.

- In the event the SB ramp intersection is signalized and Pomeroy Street is not made a right-in/right-out only movement, a right turn lane should be constructed at Pomeroy Street to avoid stopping mainline for low right turn volumes.
- Investigate signal timing changes at Orchard Avenue without proposed signals at the NB and SB ramp intersections.

Route 101/North State Street ($720,000 - $940,000):

The proposed improvements at the Route 101/North State Street location include minor widening for free right turns and a dedicated receiving lane for NB off-ramp vehicles turning left onto SB North State Street. A portion of North State Street will need to be re-striped in order to construct the improvements. At the NB ramp intersection the SB and NB directions of North State Street will be decreased to one lane of through traffic to shadow the NB off-ramp free right turn movement and provide a dedicated receiving lane for NB off-ramp vehicles turning left onto SB North State Street. The free right turn radius for NB on-ramp traffic will be decreased, which will reduce speeds and result in less speed differential between vehicles and the cyclists continuing North along North State Street. At the SB ramp intersection the SB direction of North State Street will be decreased to one lane of through traffic to shadow the SB off-ramp free right turn movement.

A significant portion of the existing pavement has failed and will require repair. The cost to cold plane and overlay fifty percent of the pavement to a depth of 0.25 feet has been captured in the attached cost estimate.

The vertical clearance at the North State Street Undercrossing (UC) meets the minimum standard of 15’ with a clearance of 15’-1” at the right structure. Asphalt concrete overlays near this location will require grinding the existing asphalt concrete a thickness equal to the amount of asphalt concrete being placed in order to maintain the existing vertical clearance.

The total estimated cost for Alternative 1 ranges from $1,750,000 to $2,250,000. The right of way costs associated with this alternative are $14,000. There are no structure costs associated with this alternative.

Other options considered:

Initially it was thought signalizing both the NB and SB ramp intersections at North State Street was the solution to the traffic congestion and collision problem. The assumption to install traffic signals was based on recommendations made by TJKM Transportation Consultants who completed the Corridor Study in August 2005 for MCOG. Caltrans Traffic Operations developed a traffic model for North State Street and determined that signalization at the Route 101/North State Street location did not meet the purpose and need of the project. High right turn volumes at the NB and SB off-ramps triggered the need to review free right turn movements at both ramps.

No Build Alternative:

The "no build" alternative was also considered, but did not meet the purpose and need of the project.

Scenarios that do not meet the purpose and need of the project will not be considered further.

Design Exceptions:

The following includes a brief discussion of the design exceptions that may be required in this project. Approval of any non-standard features identified currently or in the future is not within the scope of this PSR (PDS) and separate documentation and approval will be required in the PA&ED phase of this project.

Sight Distance:
HDM Topic 201.1 and Table 201.1 set the minimum standards for sight distance. The Perkins Street OC crest vertical curve does not meet the minimum standard for sight distance. The project does not propose improvements to the OC; however, it is within the project limits and may require a design exception.

Corner sight distance may be an issue for SB and NB off-ramp vehicles turning left onto North State Street due to the North State Street Undercrossing (UC) support columns. The project proposes to move the stop bars at both ramps closer to North State Street, which will improve corner sight distance. This should be reviewed in further detail at the next stage of the project to determine if a design exception is needed.

Shoulder Width:
Shoulder widths on East Perkins Street do not meet the minimum standard for a local street and may require a design exception.

Clear Recovery Zone:
HDM Topic 309.1 sets the minimum horizontal clearances for state facilities, local streets and county roads. There are locations along North State Street and East Perkins Street that do not meet the minimum horizontal clearances and may require a design exception.

Transportation Management Plan

A Transportation Management Plan (TMP) was prepared for this project and is included for reference as Attachment J. Significant traffic impacts are not anticipated provided the recommendations in the TMP are incorporated into the project.

Except during complete ramp closures, the full width of the traveled way shall be open for use by public traffic on Saturdays, Sundays, designated legal holidays and the day preceding designated legal holidays, after 3:00 p.m. on Fridays, and when construction operations are not actively in progress. Work that requires a lane closure shall be in conformance with Caltrans Standard Plan

T-10, "TRAFFIC CONTROL SYSTEM FOR LANE CLOSURE ON FREEWAYS AND EXPRESSWAYS." Work that occurs within 15 feet of the traveled way shall require a shoulder closure in conformance with Caltrans Standard Plan T-10. Work that requires a ramp closure shall be in conformance with Caltrans Standard Plan T-14, "TRAFFIC CONTROL SYSTEM FOR RAMP CLOSURE." Ramp closures will only be allowed from 7 p.m. to 7 a.m. at East Perkins Street, and 9 p.m. to 7 a.m. at North State Street. A minimum of one Portable Changeable Message Sign (PCMS) in advance of both ends of the construction site shall be required in order to notify the public of the closures associated with this project.

## 7. OTHER LOCATIONS REVIEWED

The *Route 101 Corridor Interchange Study* (Corridor Study) prepared by TJKM Consultants identified the need for additional acceleration lane length at the North State Street NB on-ramp for vehicles merging with Route 101 mainline vehicles. MCOG had requested that Caltrans Advance Planning review this location in addition to the scope of work included in this report. The location received a high benefit to cost ratio by TJKM Consultants in comparison to other study locations within the Corridor Study.

TJKM Consultants had proposed to provide three lanes on the Route 101 mainline structure to accommodate an extended acceleration lane by re-striping the existing bridge. Caltrans has determined the existing structure width cannot accommodate an extension of the acceleration lane while maintaining sufficient shoulder width. Advance Planning reviewed the option of widening the existing structure to extend the acceleration lane. Widening the structure at a cross slope matching the existing superelevation of 8% would decrease the vertical clearance such that it would not meet the HDM standard. The controlling vertical clearance of the existing structure is 15'-1" with the standard being 15'. In order to meet vertical clearance standards the structure would either need to be replaced at a higher elevation or the vertical profile of North State Street would need to be adjusted.

Advance Planning also reviewed the option of realigning the NB ramps to increase the radius of the NB on-ramp, which would lengthen the on-ramp and increase the acceleration lane length. A significant realignment of the NB on/off-ramps in the northeast direction would be required to increase the acceleration lane length. In addition to realignment, a significant amount of right of way acquisition would be required. It is likely an existing industrial metal building would be impacted by the realignment. A large drainage ditch runs parallel to the NB off-ramp, which would require relocation as well as an extension of a 54" RCP culvert that passes under the NB ramps.

Both options identified by Advance Planning for increasing the acceleration lane length at the NB on-ramp are paired with high cost and significant impacts. On February 25$^{th}$, 2008 Caltrans met with MCOG and presented the issues associated with improving this location. Consensus was reached that the scope of work for this report would not include improvements to the NB on-ramp acceleration lane at this time due to the high cost associated with this option.

## 8. COMMUNITY INVOLVEMENT

There are many businesses along East Perkins Street and North State Street within the project limits. The City of Ukiah and County of Mendocino will need to coordinate with both the business and property owners for their respective projects.

## 9. ENVIRONMENTAL DETERMINATION/DOCUMENT

A Preliminary Environmental Analysis Report (PEAR) was prepared for the subject project and lists potential impacts to cultural resources, California Species of Concern, endangered plants, and wetlands as the primary environmental concerns. Mitigation measures may be required for impacts to trees, shrubs and any special status species. Additional mitigation measures may be necessary if any unanticipated sensitive biological or cultural resources are discovered.

It is anticipated that the Initial Study (IS) required by CEQA for this project would result in preparation of a Categorical Exemption (CE). It is possible that initial botanical field surveys could find there is a potential for significant impacts that would require a Negative Declaration (ND) under CEQA, but this is considered unlikely for this project.

The NEPA document likely would be a Categorical Exclusion (CE) unless environmental studies determined that the project would have significant impacts to endangered species or on properties protected by Section 4(f) of the Department of Transportation Act or Section 106 of the National Historic Preservation Act. In that case, an Environmental Assessment (EA) would be required, and it's likely that the EA would result in a Finding of No Significant Impact (FONSI)

The general time schedule after receipt of a completed Environmental Study Request (ESR) is 18 months for a CE/CE; 24 months to complete an ND/CE and 30 months if an EA is necessary.

<u>Hazardous Waste:</u>

An Initial Site Assessment (ISA) was prepared for this project on May 8, 2008 and is included for reference as Attachment F. The ISA stated the project limits fall within an area identified by the Mendocino Air Quality Management District as possibly containing naturally occurring asbestos. It was also stated that a Preliminary Site Investigation (PSI) will be required and once requested would take 2 to 4 months to complete and prepare a final report. The PSI will need to be initiated at the PA&ED phase of the project.

## 10. RIGHT OF WAY

Right of Way acquisition will not be required for the construction of this project. A portion of the proposed improvements are within the State Right of Way, which will require the local agencies to obtain an encroachment permit in order to construct the improvements.

Right of Way costs for the project total $14,000, which includes $9,000 for Project Development Permit Fees and $5,000 for the state's share of utility potholing. Two utility pole relocations are anticipated along North State Street. Right of Way lead time will require a minimum of three months after submitting appraisal maps, utility conflict maps, and the necessary environmental clearance has been approved and obtained. In addition a minimum of three months will be required after submitting the last appraisal map for certification.

A Right of Way Data Sheet was prepared for the project and is included in this report as Attachment G.

## 11. FUNDING

### 11A. CAPITAL COST

**Capital Cost Estimate for the Alternative Identified for Programming in the 2010 STIP**

**Capital Outlay Estimate**

| | Range for Total Cost | STIP Funds | Fund Source "A" |
|---|---|---|---|
| **Alternative 1** | $1,750,000 - $2,250,000 | | |

**The level of detail available to develop these capital cost estimates is only accurate to within the above ranges and are useful for long-range planning purposes only. The capital costs should not be used to program or commit capital funds. The Project Report will serve as the appropriate document from which the remaining support and capital components of the project will be programmed.**

Caltrans project staff met with MCOG, the City of Ukiah and Mendocino Department of Transportation to discuss project funding/delivery on August 8, 2008. Caltrans anticipates sharing funding of the project based upon a ratio of the number of legs of an intersection on the state highway system to the total number of legs of the intersection.

The City of Ukiah and Mendocino Department of Transportation have agreed to act as the lead agency for the projects located at Route 101/East Perkins Street and Route 101/North State Street, respectively. Both agencies will be required to complete the projects through the Caltrans encroachment permit process.

### 11B. CAPITAL SUPPORT ESTIMATE FOR THE PROGRAMMABLE ALTERNATIVE IN THE 2010 STIP

| | PA&ED Only | | |
|---|---|---|---|
| Fiscal Year | 10/11 | 11/12 | Total |
| Est. PY's | 2.01 | 1.44 | 3.45 |
| Est. PY $'s ($1000) | 234 | 187 | 421 |

The total estimated support costs for the PA&ED component of this project is $421,000. The Programming Sheet summarizing project support costs is included as Attachment L.

## 12. SCHEDULE

The tentative project schedule is shown in the table below. Only the "PA&ED" milestone is to be used for programming commitments. All other milestones are used to indicate relative time frames for planning purposes.

| HQ Milestones | Delivery Date (Month, Day, Year) |
|---|---|
| Begin Environmental Document (ED) | 9/1/10 |
| Circulate Draft ED | 9/1/11 |
| PA & ED | 12/1/11 |
| Right of Way Maps | 9/1/11 |
| PS&E | 2/1/13 |
| Right of Way Certification | 7/1/13 |
| Ready to List | 7/15/13 |
| HQ Advertise | 8/15/13 |
| Approve Contract | 10/15/13 |
| Contract Acceptance | 11/1/14 |
| End Project | 3/1/16 |

## 13. FHWA COORDINATION

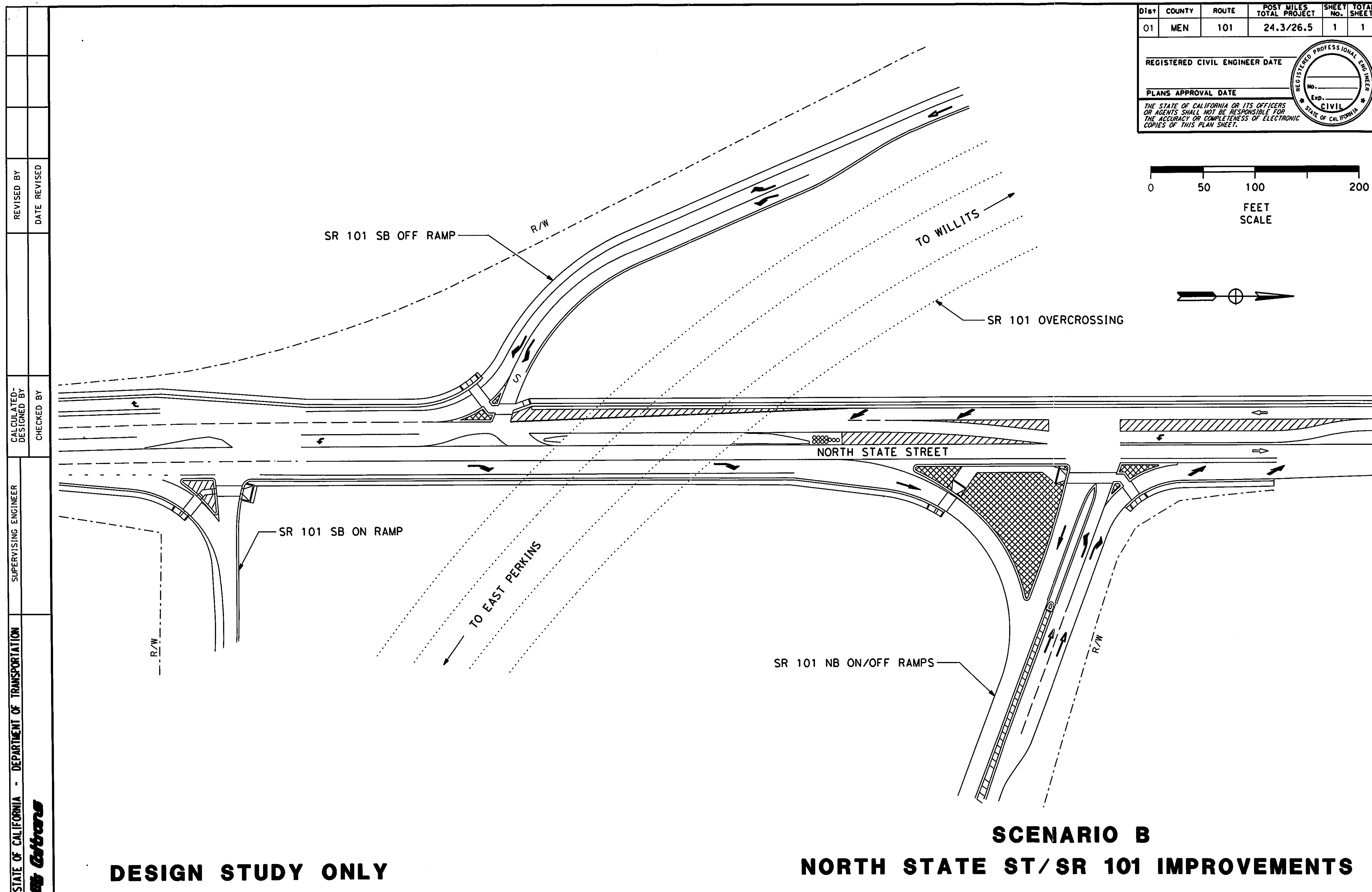
No federal-aid funding anticipated or no FHWA action required for this project.

## 14. DISTRICT CONTACTS

| Name | Title | Phone Number |
|---|---|---|
| Jeffrey Pimentel | Project Engineer | (707) 445-6358 |
| Ilene Poindexter | Chief, Advance Planning | (707) 441-3969 |
| Steven Blair | Project Manager | (707) 441-5899 |
| Ralph Martinelli | Chief, Traffic Safety | (707) 445-6376 |
| Troy Arseneau | Chief, Traffic Operations | (707) 445-6377 |
| Gary Berrigan | Environmental Coordinator | (707) 441-5730 |
| Mark Ricards | Senior Right of Way Agent | (707) 445-6582 |
| Karol Petsch | Ukiah Maintenance Supervisor | (707) 463-4751 |
| Ron den Heyer | Area Construction Engineer | (707) 485-8307 |

## 15. ATTACHMENTS

A. Project Location Map
B. Typical Sections
C. Project Layouts
D. PSR (PDS) Cost Estimate
E. Preliminary Environmental Assessment Report
F. Initial Site Assessment
G. Right of Way Data Sheet & Utility Information Sheet
H. Landscape Architecture Assessment Sheet
I. Preliminary Materials Recommendation
J. Transportation Management Plan
K. Collision Analysis & TASAS Table B
L. Programming Sheet

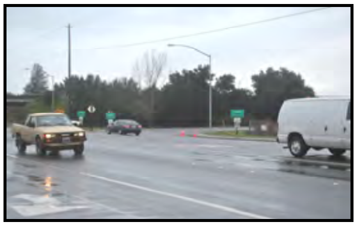



# SCENARIO B

# NORTH STATE ST/SR 101 IMPROVEMENTS

**DESIGN STUDY ONLY**







# Ukiah Crossing Intersection Rehabilitation Along North State Street

## Final Report

Prepared for:

Mendocino County

Prepared by:

omni·means
ENGINEERS · PLANNERS

*July 5, 2010*

# UKIAH CROSSING INTERSECTION REHABILITATION
# ALONG NORTH STATE STREET

**PREPARED FOR:**
**MENDOCINO COUNTY**
**DEPARTMENT OF TRANSPORTATION**
**340 LAKE MENDOCINO DRIVE**
**UKIAH, CA 95482-9432**

**PREPARED BY:**
**OMNI-MEANS, LTD.**
**ENGINEERS & PLANNERS**
**943 RESERVE DRIVE, SUITE 100**
**ROSEVILLE, CA 95678**
**(916) 782-8688**

**JULY 2011**

**25-4558-01**

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## *APPENDICES*

# 1. INTRODUCTION

This corridor study was initiated by the Mendocino County Department of Transportation (MCDoT) to complete a design study addressing traffic conditions experienced at the Ukiah Crossroads Shopping Center along North State Street between Ford Street and US Highway 101 (US 101). North State Street is a north-south roadway which is classified as a minor arterial in the City of Ukiah and within Mendocino County immediately north of the Ukiah city limits. In addition to providing local access, North State Street carries significant volumes of through traffic.

With growth and development continuing to occur within the City of Ukiah, as well as the adjacent unincorporated area, traffic is forecast to increase along North State Street. The increase in traffic will degrade traffic operations, increase congestion and exacerbate existing traffic safety issues.

The project study corridor does not encompass the entire State Street facility; rather it extends along North State Street from the intersection of Ford Road/Empire Drive to the south to the US Highway 101 northbound on/off ramps to the north. The study area is contained within Mendocino County; however, a portion of the roadway crosses the Caltrans right of way from the southbound US 101 ramp intersection, beneath US 101, to the northbound US 101 ramp intersection.

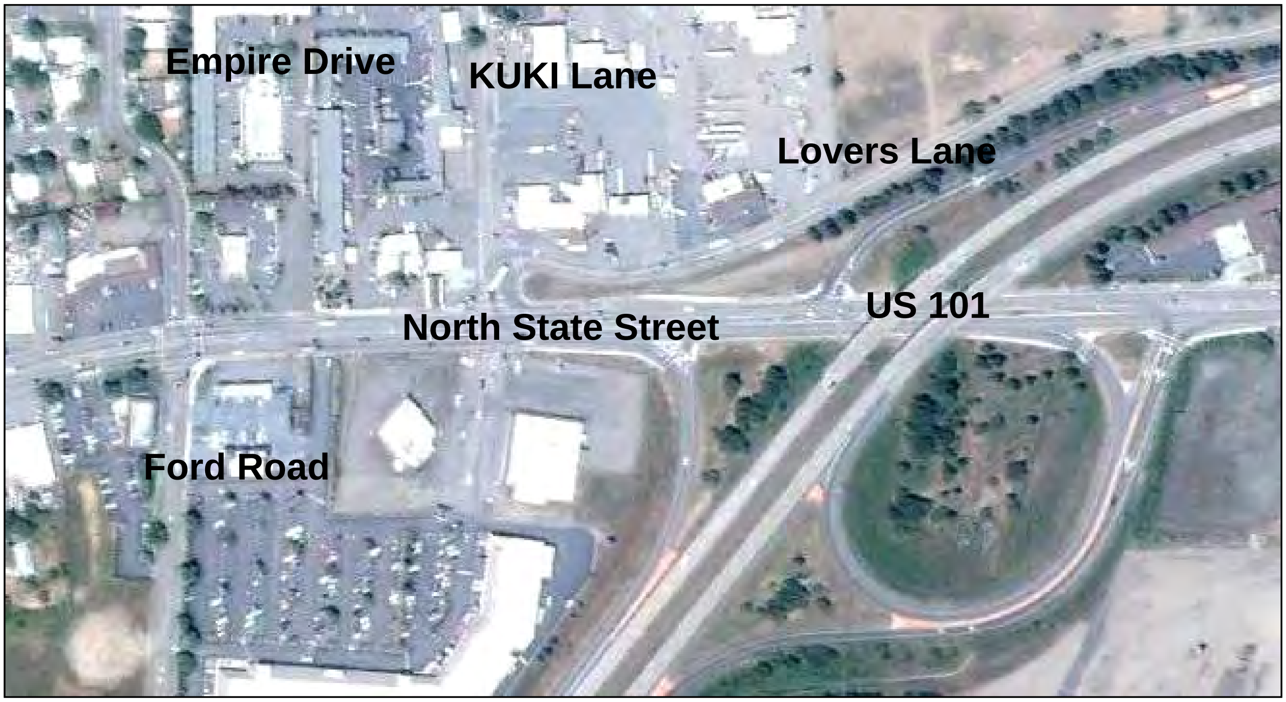
This study focuses on identifying cost effective solutions for the future ultimate design of the corridor as well as potential interim, phased improvements. This effort was intended as the first step toward future modification of the corridor. The outcome of this study is a conceptual corridor plan that will best conform to the following project objectives:

- **Provide traffic capacity to accommodate projected 2030 traffic volumes,**
- **Increase public safety for all corridor users,**
- **Improve the aesthetics of North State Street by revamping the urban streetscape,**
- **Improve pedestrian and bicycle access along the corridor, and**
- **Recognize the need for sufficient parking opportunities**

This project was designed to analyze a series of potential traffic operational improvements, consistent with the project objectives outlined above, including:

- **Traffic signal modifications (KUKI Road and Ford Road/Empire Drive),**
- **Traffic signal installations (US 101 ramp terminals),**
- **Traffic signal timing and coordination,**
- **Raised medians,**
- **Roundabouts, and**
- **Combinations of these measures.**

This report presents the results of an evaluation of the current circulation system (Base Condition) and design year (Year 2030) traffic conditions within the study area spanning on North State Street from Ford Road to the US 101 Northbound ramp intersection.




This study considers the impact on traffic operations that result from various improvement scenarios within the study area (signalized intersections, roundabouts or combination of each).

## Background

North State Street is a four-lane facility. There are multiple access points within the study area with a variety of configurations ranging from fully signalized intersections to limited access non-signalized intersections, driveways with channelized left-turn pockets as well as driveways with no access channelization. Many of these access points are offset from one another or are in close proximity to other intersections so as to create vehicle turning and queuing conflicts.

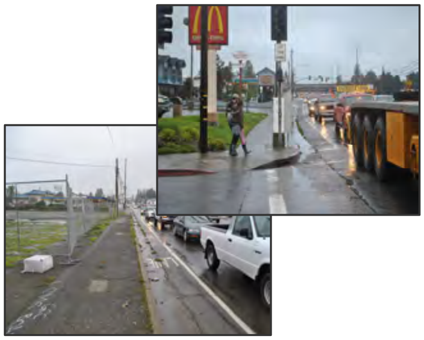
The result of this variety of access points is a reliance on the status quo to maintain access to the various parcels along the corridor. A change in one access opportunity (i.e., turning movement) has the potential to adversely affect the traffic circulation patterns on another parcel, or perhaps the entire roadway segment, or it may unduly limit access; given that few alternative access points are available for many parcels along the corridor.

There is a wide variety in the land uses along the study corridor as well. At the south end of the study area near Ford Road, North State Street is fronted by fast food restaurants and strip mall retail. The study area near KUKI Lane is characterized by a truck stop, service stations, a bowling alley, the Ukiah Crossing Shopping Center and motels mixed with a few vacant parcels.

## Study Area Roadways

Roadways that provide the primary vehicle circulation within the study area include US Highway 101, North State Street, Lovers Lane, KUKI Lane, Empire Drive, and Ford Road. The following is a brief description of these primary roadways within the study area, taking into consideration their ability to safely handle, motor vehicle traffic, bicycle traffic and pedestrian activity:

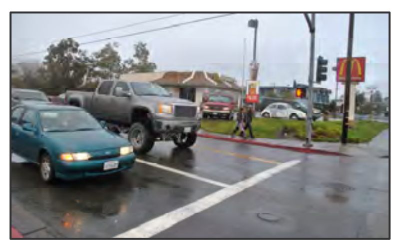
***US Highway 101*** - US Highway 101 is a north-south highway which extends from the Oregon border to the north to its terminus in Los Angeles County in southern California. Through the study area US 101 is a controlled access four-lane freeway with both northbound and southbound on and off ramps to North State Street at the northern end of the study corridor.



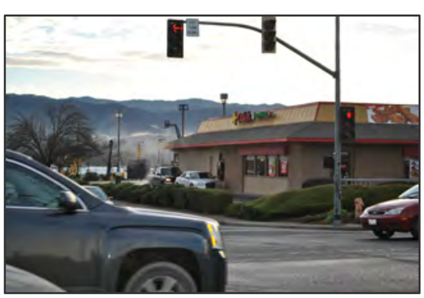
***North State Street*** - A north-south arterial which is the study corridor from just south of the Ford Road/Empire Street intersection to the northern on-off ramps to US 101. The land uses in the study area are primarily commercial in nature. The roadway is four lanes in an approximate 80 foot right of way; a left turn lane is provided at key locations. The corridor is marked by numerous driveway connections, discontinuous pedestrian walkways and non-standard bicycle facilities.

***Lovers Lane*** - Lovers Lane is parallel to North State Street extending from KUKI Lane north-westerly to the foothills west of Ukiah. Lovers Lane is a two-lane roadway, without frontage improvements, which serves a truck stop/service station adjacent to KUKI Lane and residential traffic to and from the west. The intersection of Lovers Road with KUKI Lane is immediately adjacent to the KUKI Lane /State Street intersection which creates turning and queuing issues.

***KUKI Lane*** - KUKI Lane is a short two-lane roadway segment, extending west from North State Street. Frontage improvements are mostly non-existent; land uses are commercial/industrial in nature. The intersection of Lovers Lane with KUKI Lane is immediately adjacent to the KUKI Lane/State Street intersection which creates turning and queuing issues.



***Empire Drive*** - Empire Drive is a two-lane roadway with frontage improvements. Immediately adjacent to North State Street land uses are commercial in nature and to the west of North State Street are residential in nature with access to an elementary school. Opposite Empire Drive at State Street is Ford Road.

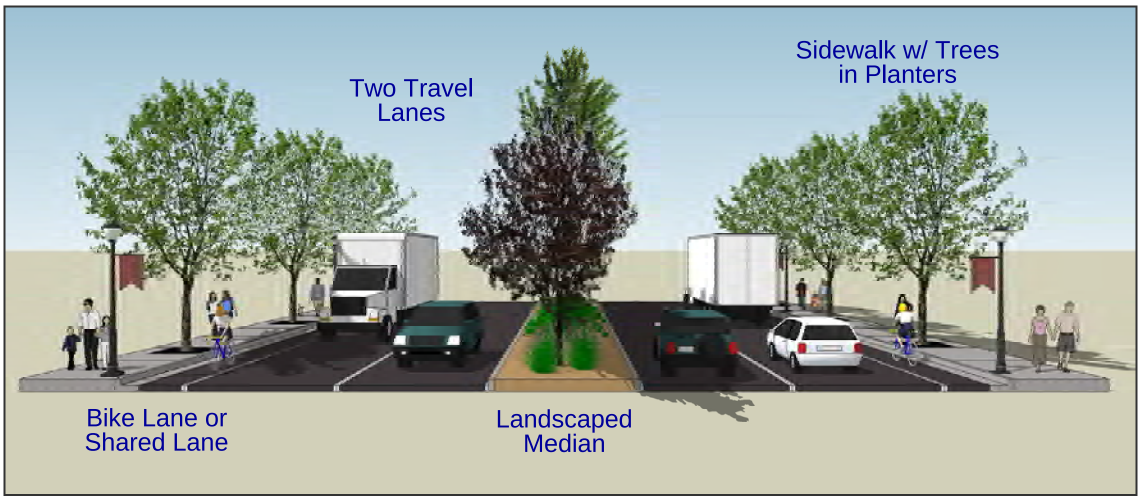


***Ford Road*** - Ford Road is a two-lane roadway with frontage improvements. Land uses are commercial adjacent to North State Street, with access to the Ukiah Crossing Shopping Center. The roadway extends to the east where it terminates beneath the US 101 freeway viaduct. Future plans call for Ford Road to connect to Orchard Avenue which is planned as a parallel route to North State Street. Opposite Ford Road is Empire Drive at State Street.

# 2. CONCEPTUAL ALTERNATIVES

The purpose of this study is to develop remedial plans (concepts) to improve the traffic operational conditions along North State Street for all roadway users, motor vehicles, bicyclists and pedestrians alike. Early in the project process it became acutely obvious; from public comment (see Appendix E) consultant team members and county and city staff, that the nature of the roadway is aesthetically unpleasing and in need of enhancement.

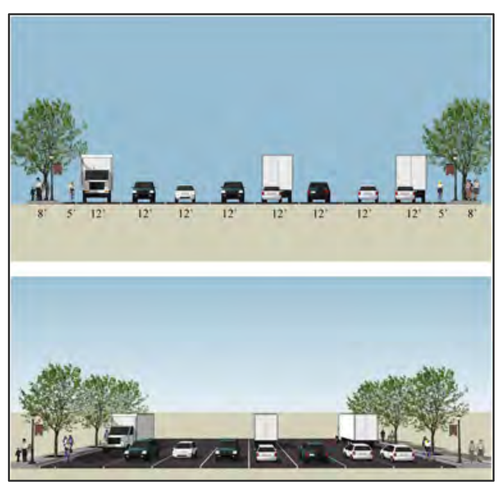
The current term used for upgrading roadways of this nature is *"Complete Streets"*, complete streets improve the roadway for all users, and enhance the business opportunity's along the roadway with improvements to the public way both operationally and aesthetically. This became the mission of the project. Recent proposed legislation at both the state and federal level will increase the awareness for a "Complete Street" approved roadway design.




During the course of identifying possible roadway operational improvements both traffic signal improvements and roundabout improvements were deemed to be acceptable concepts for roadway improvement. A total of ten (10) conceptual alternatives were developed, these are all presented below. A comprehensive evaluation process was developed to compare each concept one to the other considering such issues as operations, cost, aesthetics, environmental, and sustainability amongst others. This evaluation is presented in the following sections of this document.

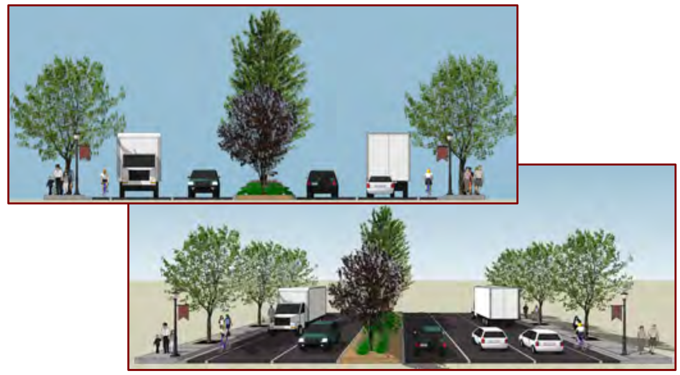
## The Concepts

Of the ten (10) concepts, five of them include traffic signal improvements, some include retiming and coordination, some include limited channelization medians. The basic roadway cross section for traffic signal concepts (including limited median landscaped area) is illustrated to the right.



The remaining five concepts involve roundabouts one, concept 2D, includes a combination roundabouts with a single traffic signal. The typical cross sections for the roundabout concepts are illustrated below.

The Lovers Lane intersection with KUKI Lane presents an operational problem both for truck access and turning movements as well as queuing. Several concepts recommend the relocation of the Lovers Lane to a new intersection with North State Street at or near the southbound US 101 on-ramp. This change has significant positive operational effect through the corridor.

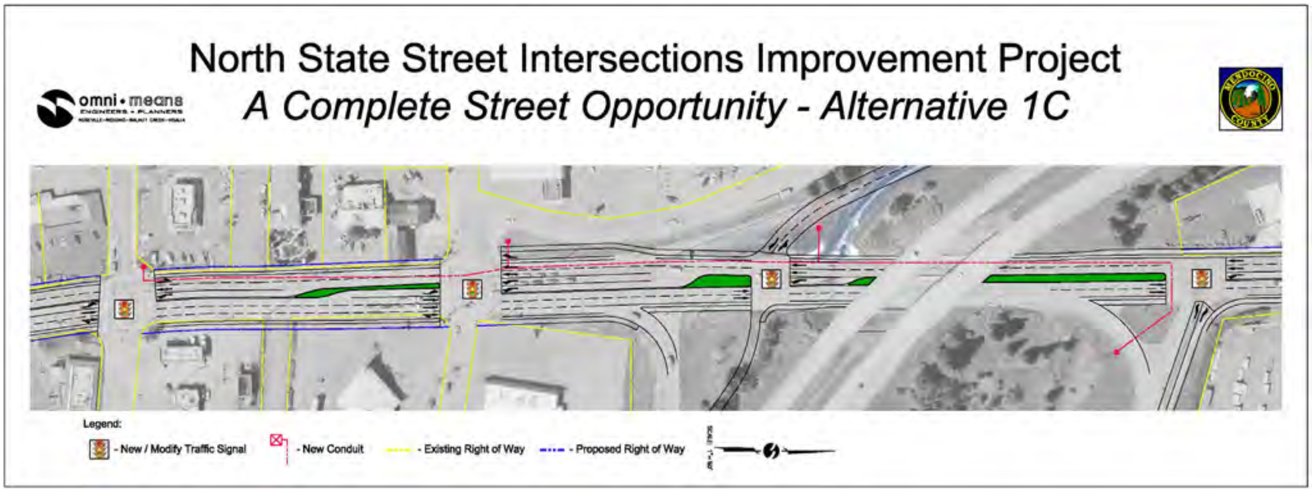


## Conceptual Alternatives 1A -1E (Traffic Signal Concepts)

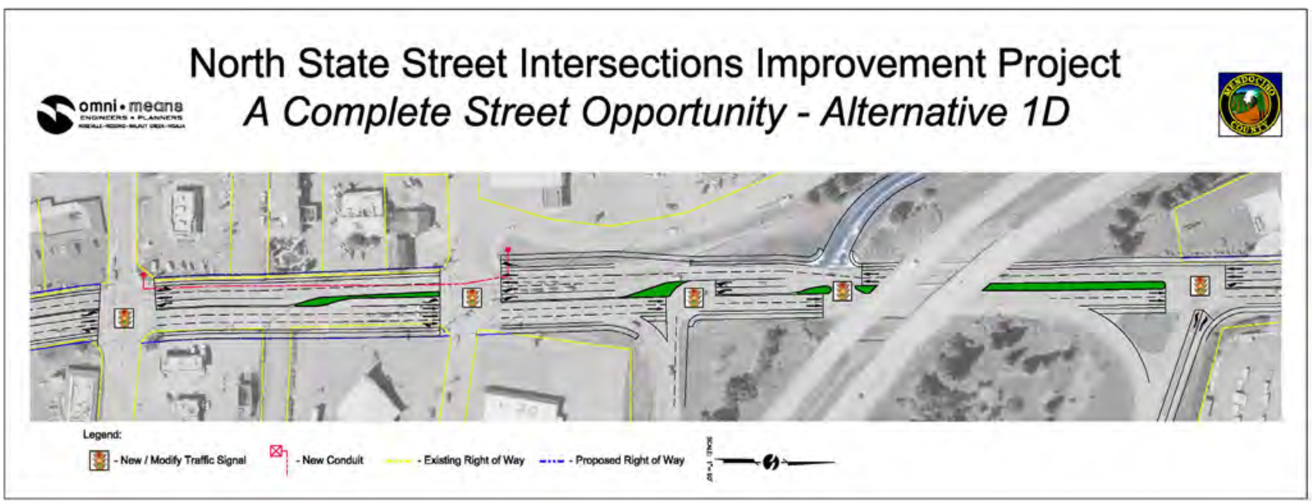
**Concept 1A** – Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections, with traffic signal interconnect between.


**Concept 1B** - Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections, with traffic signal interconnect between. Includes median improvements through the corridor, medians are primarily for channelization.

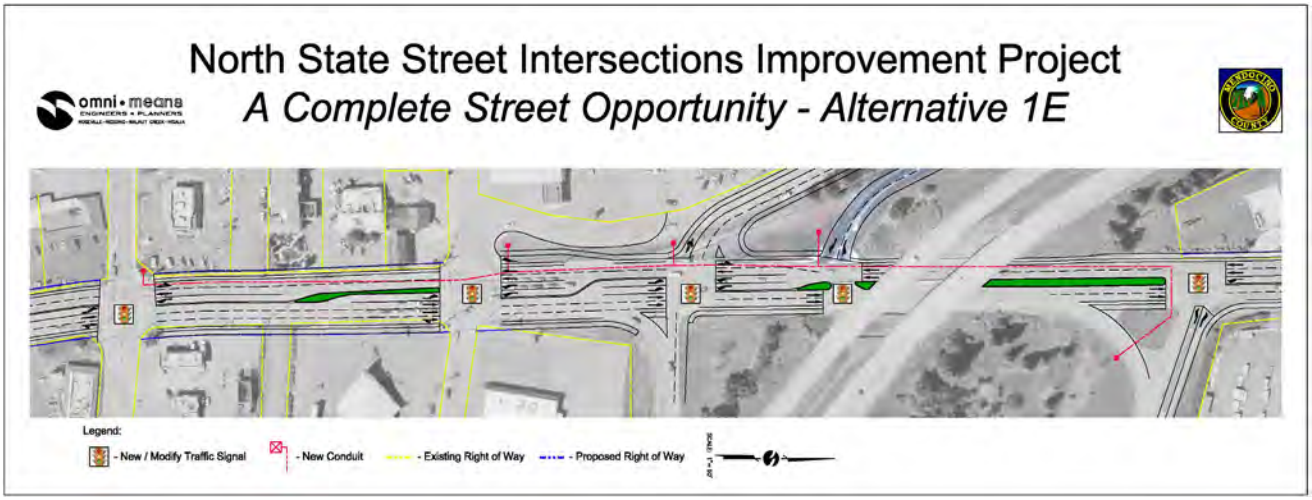
**Concept 1C** – Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at both US 101 ramp terminal intersections, with traffic signal interconnect throughout. This concept also includes the median construction and requires re-alignment to both the southbound on and off ramps to US 101.




**Concept 1D** - Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at all three (3) US 101 ramp terminal intersections, with traffic signal interconnect throughout.



**Concept 1E** – Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at all three (3) US 101 ramp terminal intersections, with traffic signal interconnect throughout. This concept includes the re-alignment of Lovers Lane to the new signalized intersection opposite the southbound US 101 on-ramp.




## Conceptual Alternatives 2A - 2C, 2E (Roundabout Concepts)

**Concept 2A**– Four (4) roundabouts installed along North State Street at Ford Road/Empire Drive, KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.

**Concept 2B** - Four (4) roundabouts installed along North State Street at Ford Road/Empire Drive, KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. In addition, this concept provides for the re-alignment of Lovers Lane to the new roundabout located at the Southbound US 101 on-ramp. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.


**Concept 2C** – Three (3) roundabouts installed along North State Street at KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. The intersection of KUKI Lane and North State Street would be limited to right turns in and out and left turn in-bound traffic only. The Ukiah Crossing Shopping Center access at this intersection would be limited to right turns in and out. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.

**Concept 2E** - Three (3) roundabouts installed along North State Street at KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. The intersection of KUKI Lane and North State Street would be limited to right turns in and out and left turn in-bound traffic only. In addition, this concept provides for the re-alignment of Lovers Lane to the new roundabout located at the Southbound US 101 on-ramp The Ukiah Crossing Shopping Center access at this intersection would be limited to right turns in and out. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features


## Conceptual Alternatives 2D (Roundabouts with a Traffic Signal)

**Concept 2D** – Three (3) roundabouts installed along North State Street at Ford Road/Empire Drive, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. The intersection of Ford Road/Empire Drive and North State Street would remain as a traffic signalized intersection with upgraded traffic signal equipment. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.

# 3. CONCEPTUAL ALTERNATIVES EVALUATION PROCESS

Conceptual alternative improvements are evaluated one against another over many interrelated criteria. Each conceptual alternative was evaluated against the project review criteria established at the outset of the project. Within this evaluation the resulting comparative advantages and disadvantages of each conceptual alternative were identified. The criteria for comparison often includes traffic operating conditions, safety, improvement costs, land use, economic criterion, environmental sensitivity and right-of-way criteria, to name a few.

Each conceptual alternative will likely meet or exceed the threshold for some criterion, and fall short on others. In the end, the determination of the relative importance of each criterion will determine the relative merits, specific to the North State Street corridor, of each conceptual alternative. As a result, evaluating conceptual alternative improvements one against the other is complicated, and includes both qualifications and subjective evaluations.

*Conceptual Alternative Selection Decision Matrix (ASDM)* is a process that simplifies the conceptual alternative selection process. The procedure provides a means to identify and either quantitatively or qualitatively evaluate the advantages and disadvantages of each conceptual alternative. The ASDM provides a means to "weigh" the importance of each criterion, so that the advantages and disadvantages of each conceptual alternative can be compared and ranked in relation to each other. These rankings allow the identification of preferred conceptual alternative(s), taking into consideration the technical and social concerns of the community. Matrix analysis involves a five-step process that includes:

- **A) Articulate the purpose and need of the project**
- **B) Develop a list of "evaluation criteria".**
- **C) Determine "relative weighing" for each evaluation criteria.**
- **D) Score each evaluation criteria for each conceptual alternative.**
- **E) Calculate the weighted scores for each conceptual alternative.**

## A. Project Purpose and Need

The Project Purpose criteria were determined through the initial project process by the Project Development Team (PDT). The intent was to develop minimum criteria that any feasibly acceptable conceptual alternative should meet in whole or in part. The Project Purpose evaluation, for each conceptual alternative, was weighed subjectively by each PDT member with the results representing the consensus of the group. The Project Purpose weighing used the scale presented below:

| NEED AND PURPOSE | |
|---|---|
| | Points |
| Strongly Meets | 5 |
| Adequately Meets | 3 |
| Somewhat Meets | 2 |
| Does NOT Meet | 0 |

The ability of each conceptual alternative to meet the project objectives as outlined in the Project Purpose criteria was then summarized and the resulting adjustment factor to be utilized in the conceptual alternative rating process, was determined and is presented below.

| NEED AND PURPOSE CHECKLIST | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Address Public Safety | 2.0 | 2.5 | 2.5 | 2.5 | 2.5 | 5.0 | 5.0 | 4.8 | 3.8 | 5.0 |
| Consistent with County General Plan | 2.5 | 2.5 | 3.0 | 3.0 | 3.0 | 4.5 | 4.8 | 4.5 | 4.3 | 4.5 |
| Facilitate Goods Movement | 2.5 | 2.5 | 2.5 | 2.0 | 2.0 | 4.0 | 4.8 | 4.0 | 3.5 | 4.0 |
| Improve Public Transportation Opportunities | 2.5 | 2.5 | 2.3 | 1.8 | 2.0 | 4.3 | 4.8 | 4.5 | 4.0 | 4.3 |
| Enhance the Aesthetic Environment | 0.8 | 1.8 | 1.8 | 1.8 | 1.5 | 5.0 | 5.0 | 4.5 | 4.3 | 5.0 |
| Enhance Pedestrian and Bicycle Access and Facilities | 1.0 | 1.0 | 1.8 | 1.8 | 1.8 | 4.8 | 4.8 | 4.0 | 4.0 | 4.0 |
| **Meet Purpose and Need Cummulative** | **11.3** | **12.8** | **13.8** | **12.8** | **12.8** | **27.5** | **29.0** | **26.3** | **23.8** | **26.8** |
| **Meet Purpose and Need Factor** | **1.0** | **1.1** | **1.2** | **1.1** | **1.1** | **2.4** | **2.6** | **2.3** | **2.1** | **2.4** |

## B. Evaluation Criteria

The next step in the matrix procedure was to develop a list of criterion for consideration. Following is a brief description of the eight (8) evaluation categories recommended for use in this study. The criteria presented below were developed in coordination with the consulting team and the PDT:

| Evaluation Criteria |
|---|
| **Public Safety** |
| **Right of Way Impacts** |
| **Community Impacts** |
| **Design Standard Conformance** |
| **Cost** |
| **Transportation Operations** |
| **Environmental** (fatal flaw) |
| **Sustainability** |
| **Funding Capability** |

The following discussion provides a brief overview of the function each of these criteria had in determining the most appropriate conceptual alternative for this project. A more detailed discussion is provided within the individual criteria analysis section of this document.

### 1. Public Safety Improvements

One of the primary reasons this project was being advanced was the concern over road user safety. For this project the public safety evaluation centers on three users of North State Street. The three identified user groups are; the motor vehicle community, the pedestrian user, and the bicyclist (both commuter and recreationalist). The safety criterion provides a measure of potential safety enhancements as a result of the proposed improvement for each conceptual alternative.

### 2. Right of Way Impacts

Right-of way criteria are essentially a quantification of impacts by type and include potential impacts to developed/occupied commercial property, vacant structures, vacant private land, public land and Relocation Assistance Program (RAP) considerations.

## 3. Community Impacts

Community Impacts refers to the feasibility and cost impacts, such as short and/or long tem effects of each particular conceptual alternative. In general, this was related to ease of maintaining local access, construction access and staging, project phasing (short term and long term objectives) and the efficient movement of traffic during construction.

## 4. Design Standard Conformance

Roadway design standards are set by the local agency (Mendocino County), Caltrans and the FHWA establish the standards for interchange planning and design. For purposes of the ASDM, consistency with the requirements of the agency, or accepted standards for, roadway and interchange design was evaluated.

## 5. Cost

The costs presented in the ASDM are for comparative purposes only and may not represent the actual final construction costs. Actual project construction costs for each listed component or as totaled may vary from the early estimates and therefore should not be used outside of the context of this comparative study. Within this criterion the opportunities to reduce the cost to the county was evaluated as well.

## 6. Transportation Operations

This criterion refers to the quantification of transportation service provided to the area accessed via North State Street. Transportation impacts associated with each of the conceptual alternatives was considered, so that the "relative" operating merits of the conceptual alternatives can be assessed from a transportation standpoint. The transportation function is not just a matter of passenger vehicle level of service (LOS), but rather a measure of the transportation service function for all road users, including time delays and traffic signal synchronization, public transit, goods carriers, bicycle and pedestrian users as well.

## 7. Environmental

This criterion provides a subjective indication of any possible environmental "fatal flaws" resulting from any of the conceptual alternatives under consideration. Environmental consequences can result from each conceptual alternative including the "no-build" conceptual alternative.

## 8. Sustainability

This criterion provides a subjective indication of each improvement as it relates to the national goal of sustainable roadway improvements. Sustainability has been defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Within this context our designs should attempt to reduce impacts on energy, create a healthier community, and reduce the consumption of materials.

## 9. Aesthetic Opportunities

This criterion was a comparative measure of the capability of each conceptual alternative to provide meaningful improvement to the aesthetic nature of the roadway corridor. The "complete street" approach was considered within this criterion.

## C. Weighing the Evaluation Criteria

The third step in the ASDM evaluation procedure was to determine the "relative importance" of each evaluation criteria by weighing them on a scale. Certain criterion will more than likely be considered more important than others. Therefore, each evaluated criterion was assigned a rating which was the representation of its relative importance to the overall project.

Each of the evaluation criteria was rated on a scale of one (1) to ten (10). Ten (10) is the upper end of the scale and indicates that the evaluated criterion is of extreme importance; whereas, one (1) is the low end of the scale and indicates that the evaluation criterion is far less important.

Each criterion was rated independent of the others. For example, multiple criteria may be considered extremely important and each assigned a ten. Conversely, other criteria may be considered far less important and assigned lower numbers. The following table presents the rating level scale that each Project Development Team member was asked to use in valuing each project Criteria.

| Relative Weighing Scale | |
|---|---|
| **Criteria Value in this Study** | **Rating** |
| **Unimportant** | 1 |
| **Less Important** | 3 |
| **Important** | 6 |
| **Very Important** | 8 |
| **Critical** | 10 |

## D. Project Development Team (PDT) Evaluation Criteria Rating

The formal **Categorical** "weighing" process as undertaken in this ASDM procedure was dependent upon the evaluation and ranking of each conceptual alternative within each evaluation category, the result of which was the "relative weighing" to be used with respect to each study conceptual alternative. The "weighing" process was the cumulative judgment of the relative importance of each project criteria, as provided by all Project Development Team participants. The individual ratings in each evaluation category was accumulated and the "relative weighing" factor for each criteria identified.

| RELATIVE WEIGHING RESULTS | | | | | | |
|---|---|---|---|---|---|---|
| **Criteria** | **PDT Member** | | | | | |
| | **#1** | **#2** | **#3** | **#4** | **Total** | **Adj'tment** |
| Public Safety | 10 | 10 | 10 | 10 | **40** | 1.47 |
| Right of Way Impacts | 7 | 10 | 6 | 6 | **29** | 1.07 |
| Community Impacts | 8 | 8 | 8 | 6 | **30** | 1.10 |
| Design Standard Conformance | 8 | 8 | 3 | 3 | **22** | 0.81 |
| Cost | 8 | 9 | 6 | 6 | **29** | 1.07 |
| Transportation Operations | 9 | 10 | 10 | 8 | **37** | 1.36 |
| Environmental (fatal flaw) | 10 | 9 | 3 | 6 | **28** | 1.03 |
| Sustainability | 8 | 10 | 2 | 8 | **28** | 1.03 |
| Aesthetic Opportunities | 5 | 10 | 6 | 8 | **29** | 1.07 |
| | | | | **Total** | **272** | |

The "relative weighing" factor was applied to the individual score for each criteria for each conceptual alternative evaluated within the study. In this manner the "relative weighing" (importance) of the category was equally applied to all conceptual alternatives evaluated. This "adjusted" value for each category of evaluation was then totaled to arrive at an overall conceptual alternative "categorical" score. The last adjustment occurs at the conclusion of the "relative weighing" and that was the final adjustment, a measure of the adherence each conceptual alternative had to the "*Project Purpose*" as defined at the project initiation.

Internal to the ASDM categories there may be several sub-categories that compose the entire categorical evaluation. In these cases the PDT was requested to provide a relative importance to the sub-categories. This measure was then applied internally to the sub-categories in forming the overall categorical scoring. In this way, even down to the sub-categorical evaluations, critical issues are given relatively greater importance within the matrix, with the level of importance determined by the Project Development Team..

For these sub-categories a qualitative scale of 1 to 5 was utilized, where: a score of 5 represents a critically important element to the study, and 1 represents an element of insignificant or no importance to the project. Many of the criteria may have weighted sub-categories. If the issue was inadvertently excluded in the categorical weighing process in the evaluation it was given the score of 1 to prevent undue influence in the process results.

The following discussion provides a more detailed description of each criteria included in the process.

## 1. Public Safety

Rating the safety criteria was based on review of accident data and other safety considerations. The ranking would consider whether a conceptual alternative was expected to improve traffic safety at all locations (10 points), marginally improves traffic safety at some but not all locations (7 points), or provides only minimal improvements to traffic safety (4 points), or possible reduces traffic safety (0 points). The following scales were used to rank each conceptual alternative:

| Safety | |
|---|---|
| **Level of Improvement** | **Point Value** |
| Greatly Improves | 10 |
| Improves | 7 |
| Minimal or Minor Change | 4 |
| Status Quo | 0 |

The weighing scale to the right reflects the PDT members determination as to the critical nature of each component making up the public safety criteria.

| PUBLIC SAFETY | | |
|---|---|---|
| **Criteria** | | |
| Motor Vehicle Traffic | 4.5 | 33% |
| Pedestrian traffic | 4.5 | 33% |
| Bicycle Traffic | 4.75 | 35% |

The three (3) year accident history on State Street was obtained from the California Highway Patrol. The motor vehicle safety for each of the conceptual alternatives were calculated using the Safety Index Calculation Procedure for HSIP Program published by Caltrans.

The corridor has experienced 68 accidents during the three year study period. The resulting accident rate is three (3) times the statewide average for facilities of this nature.

The pedestrian and bicycle safety were determined by the presence of usable/standard sidewalk/bike lanes for each of the conceptual alternatives. The corridor presently consists of limited sidewalks, intermittent with unpaved areas, and sub-standard bicycle facilities.

| North State Street Accident History (2007-2009) | | | |
|---|---|---|---|
| | Total | Intersection | Mid-Block |
| **North State Street** | | | |
| Ford/Empire | 21 | 5 | 16 |
| KUKI Lane | 22 | 7 | 15 |
| US 101 | 7 | 3 | 4 |
| **Ford Rd/Empire Dr** | | | |
| North State Street | 11 | 3 | 8 |
| **KUKI Road** | | | |
| North State Street | 1 | 0 | 1 |
| **US 101** | | | |
| North State Street | 43 | 8 | 35 |

| PUBLIC SAFETY IMPROVEMENTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | Cat Wgt | Concept No. | | | | | | | | | |
| | | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Motor Vehicle Safety | 33% | 2.3 | 3 | 5.3 | 5.3 | 5.3 | 10 | 10 | 7.8 | 9.1 | 7.8 |
| Pedestrian Safety | 33% | 0 | 0 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Bicycle Safety | 35% | 0 | 0 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| **Total Score** | 1.00 | 0.8 | 1.0 | 6.8 | 6.8 | 6.8 | 8.3 | 8.3 | 7.6 | 8.0 | 7.6 |
| **Adjusted Score** | **1.2** | **0.9** | **1.2** | **8.2** | **8.2** | **8.2** | **10.0** | **10.0** | **9.1** | **9.6** | **9.1** |

Additional accident information is provided within Appendix B.

## 2. Right of Way Impacts

Right-of way criteria was essentially a quantification of impacts by type and included the following:

- Commercial Structures:
  Five (5) points per occupied Commercial Structure - full take
  Three (3) points per unoccupied Commercial Structure - full take
  Three (3) points per occupied Commercial Structure - partial take *(parking loss was scored as a partial take)*
  One (1) point per unoccupied Commercial Structure – partial take

- Commercial Zoned Land:
  Four (4) points per acre involved (pro-rated)

- Public Property:
  One (1) point per acre involved (pro-rated)

- Additional Vacant Land:
  One (1) point per acre involved (pro-rated)

- Relocation Assistance Program (RAP):
  Per the Uniform Relocation Assistance And Real Property Acquisition Act (Federal Uniform Act) expenses related to relocation, including searching for replacement

property, tangible losses, moving expenses etc. are reimbursable by the relocating agency to the property owner. One (1) additional point for each potential RAP.

The right of way impacts vary depending upon the concept. Generally the traffic signal concepts tend to require additional right of way linearly along both sides of North State Street to accommodate an additional northbound through lane and/or turning lanes at the signalized intersections, as well as for the installation of standard bicycle and pedestrian facilities. This condition is most acute from Ford Road/Empire Drive to KUKI Lane. No structures would be impacted although there would likely be the need to re align some parking and access.

The roundabout concepts generally reduce the need for additional right-of way linearly along North State Street, due to the fact that additional north-south travel lanes are not required. However, at the roundabout intersections additional right of way will be required most acutely at Ford Road/Empire Drive and KUKI Lane. No structures are impacted although some parking facilities may require replacement or the parking fields redesigned, and access immediately adjacent to the intersections will require alteration.

Generally the overall impact to right-of way is greater with the roundabout concepts, which is reflected in the right of way scoring.

| ***Mendocino County North State Street Right of Way Estimates*** | | | | | |
|---|---|---|---|---|---|
| **Alternative** | **Total R/W (SF)** | **South of Empire** | | **Empire to Kuki** | |
| | | **NB** | **SB** | **NB** | **SB** |
| ***Traffic Signal Concepts*** | | | | | |
| 1A | 0 | 0 | 0 | 0 | 0 |
| 1B | 1,250 | 0 | 0 | 650 | 600 |
| 1C | 9,500 | 0 | 0 | 7,300 | 2,200 |
| 1D | 9,500 | 0 | 0 | 7,300 | 2,200 |
| 1E | 9,500 | 0 | 0 | 7,300 | 2,200 |
| ***Roundabout Concepts*** | | | | | |
| 2A | 21,040 | 440 | 2,200 | 13,600 | 4,800 |
| 2B | 21,040 | 440 | 2,200 | 13,600 | 4,800 |
| 2C | 16,590 | 440 | 2,200 | 10,250 | 3,700 |
| 2D | 10,150 | 0 | 0 | 9,050 | 1,100 |
| 2E | 16,590 | 440 | 2,200 | 10,250 | 3,700 |
| 2B-Phase 1 | 10,150 | 0 | 0 | 9,050 | 1,100 |

| **RIGHT-OF-WAY** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Concept No.** | | | | | | | | | |
| **Criteria** | **1A** | **1B** | **1C** | **1D** | **1E** | **2A** | **2B** | **2C** | **2D** | **2E** |
| Commercial Structures (occupied) - full take | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Commercial Structures (unoccupied) - full take | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Commercial Structures (occupied) - partial take | 0.0 | 2.0 | 2.0 | 2.0 | 2.0 | 8.0 | 8.0 | 8.0 | 4.0 | 8.0 |
| Commercial Structures (unoccupied) - partial take | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Commercial Land (ac) | 0.0 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.4 | 0.2 | 0.3 |
| Public Lands (ac) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Vacant Land (ac) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Relocation Assistance | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total | 0.0 | 2.2 | 2.2 | 2.2 | 2.2 | 9.5 | 9.5 | 9.4 | 5.2 | 9.3 |
| Total Adjusted Score | **10.0** | **7.7** | **7.7** | **7.7** | **7.7** | **0.0** | **0.0** | **0.1** | **4.5** | **0.1** |

County of Mendocino and Caltrans Right of Way assumed to be available for improvement without compensation.

The low score (least impacted alternative) has received ten (10) and others were scored on an inversely proportional basis.

## 3. Community Impacts

Community Impacts refers to the feasibility and cost implications of constructing a particular conceptual alternative. This includes local access impacts, traffic handling during construction, equipment access capability, adequate staging areas, seasonal issues to school activity, fair grounds, and holiday events. Points are applied based on a qualitative ranking scale using the following criteria:

| Community Impacts [1.] | |
|---|---|
| **Phasing, Access, Utilities** | **Point Value** |
| **No Impact** | 10 |
| **Limited Impact** (short term) | 7 |
| **Significant Impact** (long term) | 4 |
| **Major Impact** (short & long | 0 |

*1. Short term impacts - Construction Only; Long term impacts - Construction and Permanent*

| Categorical Weighing | | |
|---|---|---|
| **Category** | **Rating** | **Weighing** |
| Project Phasing/Staging | 3.5 | 23% |
| Permanent Local Access | 4.5 | 30% |
| Construction Access | 3.5 | 23% |
| Utility Impacts | 3.5 | 23% |
| **Total** | **15** | **100%** |

- Local Access:
  The potential effect on business activity within the study area was considered relative to the magnitude and duration of disruption; and, whether access interruption was short term or long term in nature. Based on the proposed conceptual improvements, the traffic signal conceptual alternatives have the most long term impact, they do not accommodate "U" turning traffic and median installations will impact local access. Roundabouts provide "U" turn opportunities thus maintaining all local access as well as improving safety.

- Construction Access:
  This has been quantified subjectively. Roundabouts are more complex during construction and therefore more disruptive to corridor traffic flow during construction. Median construction is disruptive for all conceptual alternatives which include them.

- Utility Impacts:
  Can utilities be left unchanged; can they be readily relocated or does the project present a significant disruption to utility services. This has been quantified subjectively. In general the traffic signal conceptual alternatives include roadway widening, additional right-of way linearly, to accommodate future traffic channelization, this will impact utility' along the corridor.

- Project Phasing/Staging
  Can the project be phased or staged to minimize community impacts. Each of the project conceptual alternatives have the potential for phasing over an extended period of time.

The weighing scale above reflects the PDT members determination as to the critical nature of each component making up the community impacts criteria.

| COMMUNITY IMPACTS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | Cat Wgt | Concept No. | | | | | | | | | |
| | | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Project Phasing/Staging | 23% | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |
| Permanent Local Access | 30% | 10 | 0 | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 7 |
| Construction Access | 23% | 7 | 7 | 7 | 7 | 7 | 4 | 4 | 4 | 4 | 4 |
| Utility Impacts | 23% | 10 | 10 | 4 | 4 | 4 | 7 | 7 | 7 | 7 | 7 |
| **Total** | | 9 | 6 | 4 | 4 | 4 | 6 | 6 | 6 | 6 | 6 |
| **Total Adjusted Score** | | **10.0** | **6.5** | **4.9** | **4.9** | **4.9** | **7.3** | **7.3** | **7.3** | **7.3** | **7.3** |

## 4. Design Standards Conformance

Roadway and interchange design standards are set by the local agency, Caltrans and the FHWA. For purposes of the ASDM, and consistent with the Caltrans' Highway Design Manual, three levels of standards are identified: Mandatory, Advisory and preferential. On the State highway system, it is required that a Design Exception Fact Sheet be prepared and approved for each deviation from a mandatory or advisory standard. The Caltrans requirements were considered with regards to US 101.

Since major portions of this project do not reside on the Caltrans System, a simpler, more streamlined process was adhered to for issues relating to the county maintained roadways. Deviations from normal design requirements as outlined in the governing documents of Mendocino County, or some yet to me identified funding source will govern. Relevant standards that can be quantified and measured in the ASDM was rated as indicated on the following table:

| Design Standards | |
|---|---|
| **Level of Conformity** | **Point Value** |
| **Fully Conforms** | 10 |
| **Minor Deviation** | 7 |
| **Acceptable Deviation** | 4 |
| **Un-acceptable Deviation** | 0 |

| DESIGN STANDARDS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | Concept No. | | | | | | | | | |
| | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| **Mendocino County Design Standards (North State Street, Kiku Lane, Empire-Ford Streets)** | | | | | | | | | | |
| Travel Lane Width | 7 | 7 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Shoulder Width | 4 | 4 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Height Clearance | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Bicycle Facility | 0 | 0 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| **Caltrans Standards (US 101 -North State Street Interchange)** | | | | | | | | | | |
| Intersection Spacing | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Geometric Standards | 0 | 0 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| **Total** | 25 | 25 | 54 | 54 | 54 | 54 | 54 | 54 | 54 | 54 |
| **Total Adjusted Score** | 4.6 | 4.6 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |

## 5. Costs

The costs presented in the ASDM was for comparative purposes only and was adequate for this comparative analysis. These costs will likely vary from final cost estimates derived at the conclusion of this project. Actual project construction costs for each listed component or as totaled may vary from the final actual construction cost and therefore should not be used outside of the context of this comparative study. The individual ranking for each conceptual alternative was based on the estimated cost. For this evaluation only capital cost was taken into consideration. For example, if this study results in five (5) conceptual alternatives being evaluated, the least expensive conceptual alternative would be ranked as ten while the remaining conceptual alternatives will scored inversely proportional to the least expensive.

There are sources to support funding for projects of this nature, two obvious potential sources are CMAQ (congestion management and air quality) and HSIP (safety funding). The corridor should score well in either of these potential sources; other sources can be explored as well.

| COST | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Estimated Capital Cost | **448.0** | **784.0** | **2,814.0** | **3,111.0** | **3,229.0** | **4,285.0** | **4,410.0** | **3,689.0** | **3,418.0** | **3,778.0** |
| **Total Score** | 448.0 | 784.0 | 2814.0 | 3111.0 | 3229.0 | 4285.0 | 4410.0 | 3689.0 | 3418.0 | 3778.0 |
| **Total Adjusted Score** | 10.0 | 5.7 | 1.6 | 1.4 | 1.4 | 1.0 | 1.0 | 1.2 | 1.3 | 1.2 |

*CAUTION: The costs presented above are for comparative purposes only and do not represent actual costs. Actual project construction costs for each component listed above or as totaled may vary substantially and therefore should not be used outside of the*

More detailed Cost information is available in Appendix F.

## 6. Transportation Operations

Transportation Operations refers to the quantification of traffic operations at key intersection locations and/or roadway segments served by North State Street in the project area. For this project we have identified several locations along the corridor that should be evaluated for appropriate operations. In order to help score and rank the conceptual alternatives based on Levels of Service, a point system was applied to quantify LOS operations for the facilities analyzed. Points are assigned for LOS "A" through "F". In addition to motor vehicle Level of Service (LOS), we was evaluating the corridor for both pedestrian transportation facilities as well as bicycle facilities as this roadway is marked for bicycle lanes in this area. The rating criteria for each transportation mode is presented on the two tables below:

| LOS Operations Point System | |
|---|---|
| **Level of Service** | **Point Value** |
| **A** | 10 |
| **B** | 10 |
| **C** | 8 |
| **D** | 4 |
| **E** | 1 |
| **F** | 0 |
| **Bicycle /Pedestrian Point System** | |
| **Quality of Service** | **Point Value** |
| **Full Access** | 10 |
| **Limited Access** | 5 |
| **No Access** | 0 |

| Categorical Weighing | | |
|---|---|---|
| **Category** | **Rating** | **Weighing** |
| LOS | 4.5 | 34% |
| Bicycle Facilities | 4.25 | 32% |
| Pedestrian Fac | 4.5 | 34% |
| **Total** | **13.25** | **100%** |

*Rate each on a scale of 1-5, 5 being very important, this is NOT a ranking, multiple categories may have the same rating*

A complete transportation evaluation including long range forecasts is available in Appendix A.

| Design Year 2030 - Transportation Operations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Prime Study Intersections Peak Hour Level of Service (LOS)** | **Cat Wgt** | **1A** | **1B** | **1C** | **1D** | **1E** | **2A** | **2B** | **2C** | **2D** | **2E** |
| No. State Street & US 101 NB-Ramps | 34% | F | F | E | B | B | B | B | D | B | B |
| No. State Street & US 101 SB-Ramps | | F | F | C | B | B | C | C | C | C | C |
| No. State Street & Kuki Road | | D | D | E | D | E | D | B | F | B | F |
| No. State Street & Ford/Empire Streets | | C | C | D | D | D | A | A | C | C | C |
| **LOS Score** | | 3.0 | 3.0 | 3.5 | 7.0 | 6.3 | 8.0 | 9.5 | 5.0 | 9.0 | 6.5 |
| **Bicycle Facilities** | | | | | | | | | | | |
| Bicycle Facilities | 32% | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| **Bicycle Facility Score** | | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| **Pedestrian Facilities** | | | | | | | | | | | |
| Pedestrian Facilities | 34% | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| **Pedestrian Facility Score** | | 5.0 | 5.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| **Total** | | 4.3 | 4.3 | 7.8 | 9.0 | 8.7 | 9.3 | 9.8 | 8.3 | 9.7 | 8.8 |
| **Total Adjusted Score** | | 4.4 | 4.4 | 7.9 | 9.1 | 8.9 | 9.5 | 10.0 | 8.4 | 9.8 | 9.0 |

## 7. Environmental

Environmental sensitivity subjectively (field observation only) is a "fatal flaw" evaluation of the conceptual alternatives that may consider the potential impacts on various environmental criteria such as biological, wetlands, historical, neighborhood and others. The adjacent scales were used to rank each conceptual alternative:

| Environmental | |
|---|---|
| | **Point Value** |
| No Impact | 10 |
| Minimal (or minor) | 7 |
| Moderate Impact | 4 |
| Substantial Impact | 0 |

| Categorical Weighing | | |
|---|---|---|
| **Category** | **Rating** | **Weighing** |
| Land Use | 3.75 | 15% |
| Biological Resources | 3 | 12% |
| Cultural Resources | 2.5 | 10% |
| Socio-Economic | 3.25 | 13% |
| Noise | 3.75 | 15% |
| Services & Utilities | 3.75 | 15% |
| Aesthetics | 4.75 | 19% |
| **Total** | **24.75** | 100% |

***Rate each on a scale of 1-5, 5 being very important, this is NOT a ranking, multiple categories may have the same rating***

<u>Conceptual alternatives 1A through 1E</u>

No environmental "fatal flaws" have been identified based on a visit to the project site with Conceptual alternatives 1A-E. However, there could be less-than-significant land use impacts with the construction of medians within North State Street, since existing vehicular movements to and from certain (but not all) adjacent commercial businesses could be restricted. As associated but likely minor land use impact would be the need to acquire additional right-of-way to accommodate a bicycle land and 7-foot wide sidewalk adjacent to North Main Street.

There also would be impacts, but less-than-significant, with respect to cultural resources with more trenching and excavation for new ramp construction. Disturbance of the soil could uncover unrecorded archeological or historic artifacts. Appropriate mitigation needs to be identified through a future CEQA process.

Similar to land use impacts, minor loss of land from adjacent properties to provide for a widened sidewalk and bicycle lanes would result with Conceptual alternatives 1A-E.

Regarding aesthetics, the addition of more traffic signals associated with Conceptual alternatives 1C-1E would somewhat degrade the localized aesthetic character of the area by adding more "clutter" to the streetscape.

Conceptual alternatives 2A through 2E

Installation of roundabouts under all of the Conceptual alternatives would require "take" of property from adjacent parcels of land, although the amount of take does seem to be less-than-significant. Additional research is needed on this topic. Excavation of the soil for installation of roundabouts could also disturb buried cultural resources, although this can be mitigated through the CEQA process.

Finally, installation of roundabouts could result in less-than-significant impacts to public services by requiring maintenance of landscaping within the roundabouts where no such maintenance is currently needed.

A study conducted by Kansas State University (*Environmental Impacts of Kansas Roundabouts, September 2003*) at three different locations that were converted from four-way stop control intersections to modern roundabouts. The report found a 38-45 percent decrease in Carbon Monoxide emissions, a 55-61 percent decrease in Carbon Dioxide emissions, a 44-51 percent decrease in Nitrogen Oxides, and a 62-68 percent decrease in Hydrocarbons. Other compiled studies found that when conventional intersections (signalized and unsignalized) are converted to modern roundabouts, there is an average reduction of 30 percent in carbon monoxide and nitrogen oxides, and a 30 percent reduction in fuel consumption. These preliminary conclusions indicate that modern roundabouts significantly reduce the amount of pollutants released into the atmosphere and reduce overall fuel consumption.

Appendix C includes additional information related to vehicular emissions and fuel consumption.

| **ENVIRONMENTAL** (subjective "fatal flaw" ) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Cat** | **Concept No.** | | | | | | | | | |
| **Environmental Criteria** | **Wgt** | **1A** | **1B** | **1C** | **1D** | **1E** | **2A** | **2B** | **2C** | **2D** | **2E** |
| Land Use | 15% | 10 | 7 | 7 | 7 | 7 | 4 | 4 | 3 | 7 | 3 |
| Biological Resources | 12% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Cultural Resources | 10% | 10 | 9 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Socio-Economic | 13% | 10 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 |
| Noise | 15% | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Services & Utilities | 15% | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 |
| Aesthetics | 19% | 7 | 8 | 8 | 8 | 7 | 10 | 10 | 10 | 10 | 10 |
| **Total** | | 9.4 | 8.9 | 8.8 | 8.8 | 8.6 | 8.6 | 8.6 | 8.4 | 9.0 | 8.4 |
| ***Adjusted Score*** | 0.0 | 10.0 | 9.5 | 9.4 | 9.4 | 9.2 | 9.1 | 9.1 | 8.9 | 9.6 | 8.9 |

***Note:*** *The rating provides for an overall sensitivity, however, it should not be utilized to identify the superior environmental alternative since there are other environmental issues that could elevate an alternative from less than significant to significant. The highest rated alternative will receive the score of ten (10), others will be scored proportionaly*

## 8. Sustainability

This criteria is new to our ASDM process and reflects the changing environment within the public works field. Sustainability has been defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Within this context sustainability results from conceptual alternatives that take into account the need to reduce impacts on energy, create a healthier community, and reduce the consumption of materials and reduce maintenance requirements. Issues such as improved pedestrian and bicycle access, reduced storm water facilities (i.e. absorption) and rain gardens and bio swales enhanced with streetscapes and shade trees are examples of sustainable designs. Toward this end a subjective determination on sustainability for the following criteria and their associated scoring methodology has been developed.

| Sustainability | |
|---|---|
| | **Point Value** |
| Significantly Meets | 10 |
| Moderately Meets | 7 |
| Minimally Meets | 4 |
| Insignificant | 0 |

Assumptions were made on whether or not the conceptual alternative would have an impact on the criteria and if compared to the other conceptual alternatives where it would rank in comparison. For example the "0, or do nothing" conceptual alternative would do nothing to reduce energy consumption. However, doing nothing would also not have an impact on material resources (no construction – no resource use). This logic also applies for reducing impacts to environmental resources. As applied to the other conceptual alternatives, the signal modifications may improve circulation flow / queuing issues thereby reducing energy use to some degree. When applied to the roundabout conceptual alternatives, the sustainability benefits are maximized as a result of better / continuous circulation flow (air quality improvements), reduced energy (gasoline) consumption, reduction or elimination of energy using signals, and increased landscape opportunities.

| SUSTAINABILITY | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Concept # | | | | | | | | | |
| **Sustainability Criteria** | **1A** | **1B** | **1C** | **1D** | **1E** | **2A** | **2B** | **2C** | **2D** | **2E** |
| Reduce Energy Consumption | 5 | 5 | 5 | 5 | 5 | 10 | 10 | 8 | 8 | 8 |
| Reduce Consumption on Material Resources | 10 | 8 | 8 | 8 | 8 | 10 | 10 | 8 | 8 | 8 |
| Reduce Impacts to Environmental Resources | 7 | 7 | 7 | 7 | 7 | 10 | 10 | 8 | 8 | 8 |
| Support Healthy Urban Communities | 0 | 4 | 4 | 4 | 4 | 10 | 10 | 8 | 8 | 8 |
| Reduce Maintenance Costs | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 7 |
| **Total** | **22** | **24** | **24** | **24** | **24** | **47** | **47** | **39** | **39** | **39** |
| ***Total Adjusted Score*** | 4.7 | 5.1 | 5.1 | 5.1 | 5.1 | 10.0 | 10.0 | 8.3 | 8.3 | 8.3 |

The methodologies relative to the sustainability analysis is presented in Appendix D

## 9. Aesthetic Opportunities

This criterion was a comparative measure of the ability of each corridor conceptual alternative to provide meaningful opportunities to beautify and enhance the aesthetics of the corridor. Items to be considered are corridor landscaping, use of decorative street fixtures, opportunities for entry features, etc.

| Aesthetic Opportunities | Rating Scale |
|---|---|
| Maximum Opportunity | 10 |
| Significant Opportunity | 8 |
| Limited Opportunity | 4 |
| No Opportunity | 0 |

Ranking of aesthetic opportunities was fairly straight forward. For example, the "do nothing" and signal improvements only approaches do not provide aesthetic opportunities. As the conceptual alternatives add medians and improve sidewalks aesthetic opportunities improve and are ranked accordingly based on quantity of potential landscape space.

As noted in the ranking, the combination of roundabouts and increased medians score the highest in aesthetic opportunities. It should be noted that the opportunities to introduce street furniture is limited in all improvements due to the restricted opportunities for sidewalk or pedestrian node improvements, and needs for ADA clearances.

| Aesthetic Opportunities | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Aesthetic Opportunities | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Median Landscaping | 0 | 8 | 8 | 8 | 8 | 10 | 10 | 8 | 8 | 8 |
| Linear Landscaping | 0 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Entry Features | 0 | 4 | 4 | 4 | 4 | 10 | 10 | 10 | 10 | 10 |
| Street Furniture | 0 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Shade Trees | 0 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| **Total** | 0 | 28 | 28 | 28 | 28 | 36 | 36 | 34 | 34 | 34 |
| **Adjusted Score** | 0 | 7.8 | 7.8 | 7.8 | 7.8 | 10.0 | 10.0 | 9.4 | 9.4 | 9.4 |

The methodology relative to aesthetic opportunity is presented in Appendix D.

# E. Preferred Conceptual Alternative

In this fifth and final step, raw scores earned within each evaluation criteria were adjusted using their corresponding relative weighted factor to achieve a corresponding weighted score. The sum of the weighted scores for each conceptual alternative gives an overall indication of its standing with respect to the other conceptual alternatives. The conceptual alternative, or conceptual alternatives, that received the highest point total can then be identified as candidate projects for further consideration.

| SUMMARY CATEGORICAL RANKING | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Concept No. | | | | | | | | | |
| Criteria | Relative Weighing | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Public Safety | 1.47 | 0.9 | 1.2 | 8.2 | 8.2 | 8.2 | 10.0 | 10.0 | 9.1 | 9.6 | 9.1 |
| Right of Way Impacts | 1.07 | 10.0 | 7.7 | 7.7 | 7.7 | 7.7 | 0.0 | 0.0 | 0.1 | 4.5 | 0.1 |
| Community Impacts | 1.10 | 10.0 | 6.5 | 4.9 | 4.9 | 4.9 | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 |
| Design Standard Conformance | 0.81 | 4.6 | 4.6 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Cost | 1.07 | 10.0 | 5.7 | 1.6 | 1.4 | 1.4 | 1.0 | 1.0 | 1.2 | 1.3 | 1.2 |
| Transportation Operations | 1.36 | 4.4 | 4.4 | 7.9 | 9.1 | 8.9 | 9.5 | 10.0 | 8.4 | 9.8 | 9.0 |
| Environmental (fatal flaw) | 1.03 | 10.0 | 9.5 | 9.4 | 9.4 | 9.2 | 9.1 | 9.1 | 8.9 | 9.6 | 8.9 |
| Sustainability | 1.03 | 4.7 | 5.1 | 5.1 | 5.1 | 5.1 | 10.0 | 10.0 | 8.3 | 8.3 | 8.3 |
| Aesthetic Opportunities | 1.07 | 0.0 | 7.8 | 7.8 | 7.8 | 7.8 | 10.0 | 10.0 | 9.4 | 9.4 | 9.4 |
| Total Unweighted Score | | 54.61 | 52.45 | 62.47 | 63.53 | 63.01 | 66.96 | 67.45 | 62.92 | 69.93 | 63.45 |
| Total Weighted Score | | 58.52 | 56.20 | 69.31 | 70.79 | 70.17 | 75.22 | 75.89 | 70.32 | 78.38 | 71.04 |
| *Purpose and Need Statement Factor [2]* | | *1.0* | *1.1* | *1.2* | *1.1* | *1.1* | *2.4* | *2.6* | *2.3* | *2.1* | *2.4* |
| ***Final Scoring*** | | ***58.5*** | ***63.7*** | ***84.7*** | ***80.2*** | ***79.5*** | ***183.9*** | ***195.6*** | ***164.1*** | ***165.5*** | ***168.9*** |
| **FINAL ALTERNATIVE RANKING** | | **10** | **9** | **6** | **7** | **8** | **2** | **1** | **5** | **4** | **3** |

***Relative Weighting uses a scale of 1 to 10, with 10 being very important and 1 being unimportant. Initially selected***

***1. From Weighing Criteria Worksheet***

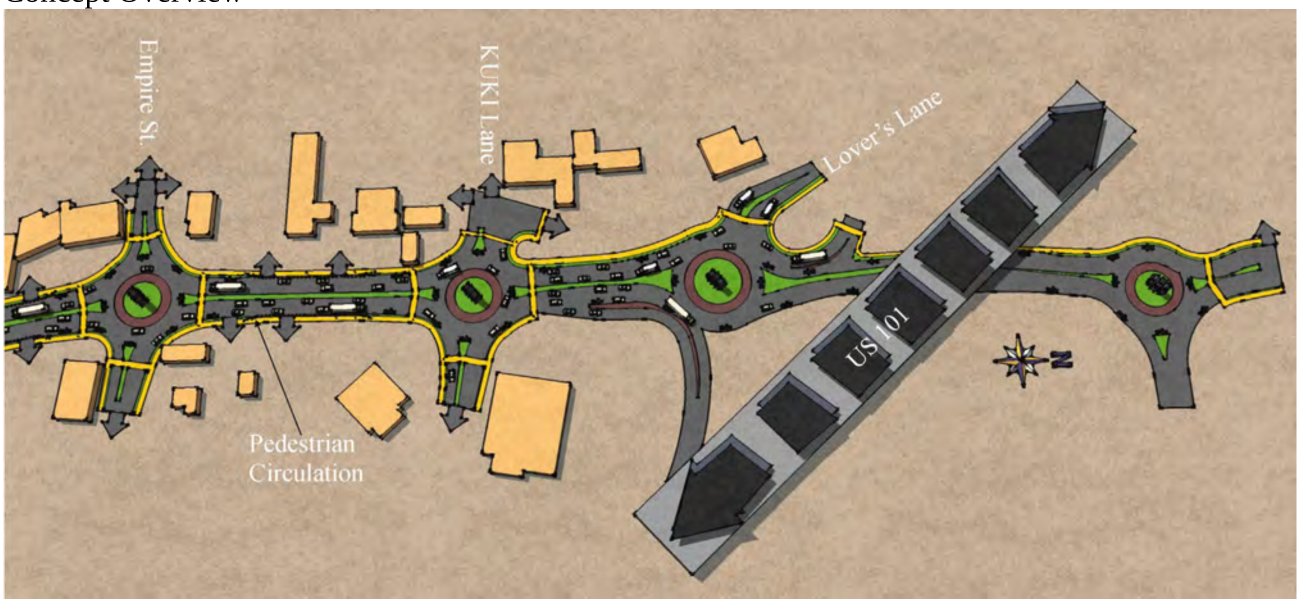
***2. From Purpose and Need Worksheet***

The results of this evaluation indicate that the "Preferred Conceptual Alternative" is Concept 2B, which includes roundabouts at four locations as well as landscaped medians, and a "Complete Streets" approach to improving North Main Street. The Lovers Lane intersection will be relocated to connect with the new roundabout opposite the northbound US 101 on-ramp.

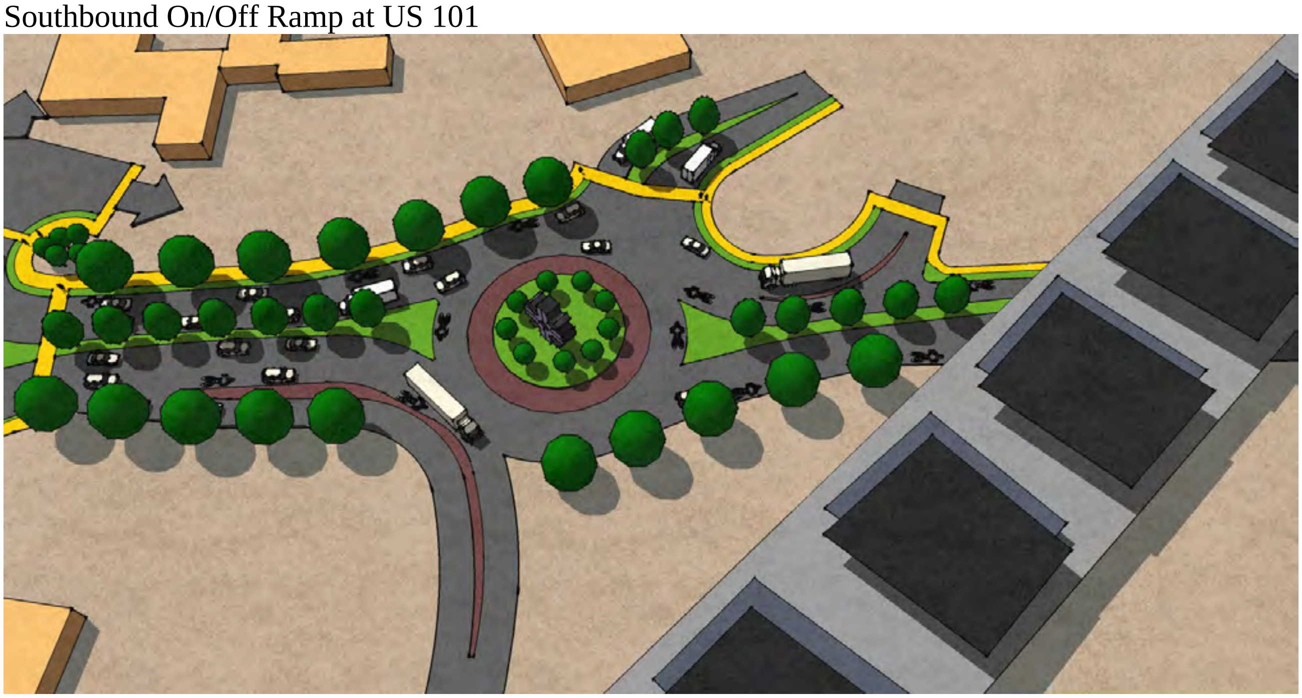
Appendix G has been included within this report to provide additional background information relative to the benefits that roundabouts offer, which were significant in this selection process. This Appendix provides the reader statistical and anecdotal data regarding roundabout operations.

**Concept 2B** includes four (4) roundabouts installed along North State Street at Ford Road/Empire Drive, KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. In addition, this concept provides for the re-alignment of Lovers Lane to the new roundabout located at the Southbound US 101 on-ramp. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features. The conceptual cost estimate for this concept is $4,425,000; concept 2B is could be constructed in phases as illustrated on the phasing plan presented below.

Concept Overview




Southbound On/Off Ramp at US 101



Empire Drive / Ford Road Intersection

**Concept 2B – Phase 1** consists of a new traffic signal upgrade to the North State Street and Ford Road/Empire Drive intersection, along with a roundabout at the KUKI Lane intersection. Medians would also be added along North State Street through the Northbound on and off ramps to US 101. The Conceptual estimate cost for the phase 1 project is $1,850,000.

# APPENDICES

Appendix A: Long Range Traffic Analysis
Appendix B: Traffic Accident Analysis
Appendix C: Environmental Fatal Flaw Evaluation
Appendix D: Sustainability and Aesthetics
Appendix E: Public Outreach
Appendix F: Concept Level Cost Analysis
Appendix G: Roundabout Informational Report

# APPENDIX A:  LONG RANGE TRAFFIC ANALYSIS

## Traffic Demand Forecasts - Model Adjustments

The Project Development Team (PDT) determined that the Mendocino County Travel Demand Forecast Model updated October, 2010 (hereafter referred to as “model”) should be utilized to derived future volume forecasts at the study intersections.  The model provides Year 2030 projections on a daily, AM peak hour, and PM peak hour basis.  Use of the model forecasts is intended for a comprehensive transportation analysis of the four North State Street intersections within the County.  The traffic model forecasts are based on assumptions in land use development and circulation improvements over the next 20 years, and therefore, it is necessary to verify the accuracy of these assumptions.

## Land Use

Review of the Year 2030 model land uses indicated that the land use development associated with the Ukiah Valley Area Plan (UVAP) was not included.  County planning staff cited that UVAP is not formally adopted and therefore the UVAP land uses were not included.  In order to address full potential impacts, it is necessary to analyze the immediate localized areas under the assumption that these areas would be built-out.  Therefore, the PDT concluded that UVAP land uses (for the preferred project alternative) in the immediate vicinity of the study area be included within the Year 2030 model land uses.  A separate travel demand model (TDM) was prepared to assess impacts associated with UVAP.  The uses within the TDM were reviewed and the Year 2030 model land uses were updated to include UVAP land uses.  Land use changes were specifically made to the following UVAP areas:

- Brush Street Triangle
- Lovers Lane
- Masonite

## Roadway Network

Orchard Avenue currently terminates at Ford Street. The County envisions that with the development of Brush Street triangle area and Masonite Area Orchard Avenue will be extended from its current terminus to Lake Mendocino Drive.  This extension is included within the model.  However, appropriate connections from the associated developments were not provided.  The model roadway network was refined to provide appropriate connections to Orchard Avenue extension.

## Year 2030 Traffic Operations

Year 2030 intersection Level of Service is quantified using the 2030 forecasts and are shown in Table 2.

**TABLE 2**
**YEAR 2030 CONDITIONS INTERSECTION LEVEL OF SERVICE**

| # | Intersection | Control Type | Target LOS | AM Peak Hour Delay | AM Peak Hour LOS | AM Peak Hour Warrant Met? | PM Peak Hour Delay | PM Peak Hour LOS | PM Peak Hour Warrant Met? |
|---|---|---|---|---|---|---|---|---|---|
| **1** | State Street/Empire Drive/Ford | **Signal** | **D** | **81.6** | **F** | **-** | 49.0 | D | **-** |
| **2** | State Street/KUKI Lane | **Signal** | **D** | **82.7** | **F** | **-** | **172.4** | **F** | **-** |
| **3** | State Street/NB Ramps | **TWSC** | **D** | **519.1** | **F** | **Yes** | **OVR** | **F** | **Yes** |
| **4** | State Street/SB Ramps | **TWSC** | **D** | 24.7 | C | - | **OVR** | **F** | Yes |

*Notes:* **Bolded entries indiacate intersections operating at unacceptable LOS.**

*TWSC = Two Way Stop Control* *OVR = Overflow, Delay exceeding 1000 seconds*

*LOS = Worst case movement's LOS for TWSC intersections; Warrant = Caltrans Peak hour volume based signal warrant*

As shown in Table 2, all of the study intersections are projected to operate at unacceptable LOS for Year 2030 conditions.

Table 3 identifies the various improvement scenarios developed with signals and roundabouts as major intersections.

**TABLE 3**
**NORTH STATE STREET IMPROVEMENT SCENARIOS**

| Scenario (Year) | | State St./ Empire Dr. | State St./ Kuki Ln. | State St./ SB Ramps. | State St./ NB Ramps. | Median - Empire to Kuki | Median - Kuki to SB Ramps | Median - SB Ramps to NB Ramps |
|---|---|---|---|---|---|---|---|---|
| ALT 1A | Traffic Control | Signal | Signal | No change | No change | No change | No change | No change |
| ALT 1B | | Signal | Signal | No change | No change | Yes | Yes | Yes |
| ALT 1C | | Signal | Signal | Signal | Signal | Yes | Yes | Yes |
| ALT 1D | | Signal | Signal | Signal | Signal | Yes | Yes | Yes |
| ALT 1E | | Signal | Signal | Signal | Signal | Yes | Yes | Yes |
| ALT 2A | | 4 Leg Roundabout | 4 Leg Roundabout | 3 Leg Roundabout | 3 Leg Roundabout | Yes | Yes | Yes |
| ALT 2B | | 4 Leg Roundabout | 4 Leg Roundabout | 4 Leg Roundabout | 3 Leg Roundabout | Yes | Yes | Yes |
| ALT 2C | | 4 Leg Roundabout | Unsignalized | 3 Leg Roundabout | 3 Leg Roundabout | Yes | Yes | Yes |
| ALT 2D | | Signal | 4 Leg Roundabout | 3 Leg Roundabout | 3 Leg Roundabout | Yes | Yes | Yes |
| ALT 2E | | 4 Leg Roundabout | Unsignalized | 4 Leg Roundabout | 3 Leg Roundabout | Yes | Yes | Yes |

## Traffic Analysis of Improvement Scenarios

The analyses take into account five (5) signal improvement scenarios and five roundabout improvement scenarios under Year 2030 conditions. As noted previously, the circulation alternative studied under *Cumulative* Conditions includes the Orchard Avenue extension to Lake Mendocino Drive.

The objective of the following analyses was to test the operations of the various improvement scenarios and the effect each would have if any, on the adjacent intersections. The criteria under which the alternatives were evaluated was Level-of-Service, which is based on intersection delay; and queue length, which is constrained by the distance between intersections. Tables 4 and 5 present the Year 2030 PM Peak hour LOS (worse case) for the signalized and roundabout alternatives, respectively.

**TABLE 4**
**YEAR 2030 CONDITIONS INTERSECTION LEVEL OF SERVICE – SIGNALIZED ALTERNATIVES**

| Design Year 2030 - Transportation Operations | | | | | |
|---|---|---|---|---|---|
| Study Intersections PM Peak Hour Level of Service | Improvement Scenario | | | | |
| | 1A | 1B | 1C | 1D | 1E |
| No. State Street & US 101 NB-Ramps | **F** | **F** | **E** | B | B |
| No. State Street & US 101 SB-Ramps | **F** | **F** | C | B | B |
| No. State Street & KUKI Lane | D | D | **E** | D | **E** |
| No. State Street & Ford/Empire Streets | C | C | D | D | D |

As shown in Table 4, Alternative 1D provides acceptable operations at all four study locations. Alternative 1E provides acceptable operations at all but one location, while Alternatives 1A, B and C provide unacceptable operations at two of the four locations.

**TABLE 5**
**YEAR 2030 CONDITIONS INTERSECTION LEVEL OF SERVICE – ROUNDABOUT ALTERNATIVES**

| Design Year 2030 - Transportation Operations | | | | | |
|---|---|---|---|---|---|
| Study Intersections PM Peak Hour Level of Service | Improvement Scenario | | | | |
| | 2A | 2B | 2C | 2D | 2E |
| No. State Street & US 101 NB-Ramps | B | B | D | B | B |
| No. State Street & US 101 SB-Ramps | C | C | C | C | C |
| No. State Street & KUKI Lane | D | B | **F** | B | **F** |
| No. State Street & Ford/Empire Streets | A | A | C | C | C |

As shown in Table 5, Alternatives 2A, B and D provides acceptable operations at all four study locations. Alternatives 2C and 2E provides acceptable operations at all but one location

# APPENDIX B:  TRAFFIC ACCIDENT ANALYSIS

Traffic Accidents throughout this corridor represent a serious issue needing resolution.  The following table represents the traffic accident experience for the three (3) year period January 2007 through December 2009 (the most current information available at the time of this analysis.)

| North State Street Accident History (2007-2009) | | | |
|---|---|---|---|
| | **Total** | **Intersection** | **Mid-Block** |
| **North State Street** | | | |
| Ford/Empire | 21 | 5 | 16 |
| KUKI Lane | 22 | 7 | 15 |
| US 101 | 7 | 3 | 4 |
| **Ford Rd/Empire Dr** | | | |
| North State Street | 11 | 3 | 8 |
| **KUKI Road** | | | |
| North State Street | 1 | 0 | 1 |
| **US 101** | | | |
| North State Street | 43 | 8 | 35 |

The number of accidents that have occurred along the corridor under study during this period is 68. The corridor length is just over a half mile.  The accident rate experienced along North State Street exceeds the statewide average for similar roadway by three (3) times.

This unacceptable accident experience can be attributed to several factors;

- Traffic signals at Ford Road/Empire Drive and North State Street are obsolete
- Traffic signals at KUKI Lane and North State Street are obsolete
- Numerous driveway access points through the corridor resulting in numerous opportunities for angle collisions
- Lack of traffic control at the on-off ramps to US 101

Clearly these issues require addressing in the evaluation of the conceptual alternatives.

# APPENDIX C:  ENVIRONMENTAL FATAL FLAW EVALUATION

**The environmental Fatal Flaw evaluation was carried out buy Jerry Haag, Environmental Planning located in Berkeley and Healdsburg, California**.

**North State Street**
**Crossroads shopping Center**

**Selection Process document**

**March 21, 2011**

## Environmental Issues

Alternatives 1A through 1E

No environmental “fatal flaws” have been identified based on a visit to the project site with Alternatives 1A-E.

However, there could be less-than-significant land use impacts with the construction of medians within North State Street, since existing vehicular movements to and from certain (but not all) adjacent commercial businesses could be restricted. As associated but likely minor land use impact would be the need to acquire additional right-of-way to accommodate a bicycle land and 7-foot wide sidewalk adjacent to North Main Street.

There would also would be impacts, but less-than-significant, with respect to cultural resources with more trenching and excavation for new ramp construction. Disturbance of the soil could uncover unrecorded archeological or historic artifacts. Appropriate mitigation needs to be identified through a future CEQA process.

Similar to land use impacts, minor loss of land from adjacent properties to provide for a widened sidewalk and bicycle lanes would result with Alternatives 1A-E.

Regarding aesthetics, the addition of more traffic signals associated with Alternatives 1C-1E would somewhat degrade the localized aesthetic character of the area by adding more “clutter” to the streetscape.

Alternatives 2A through 2E

Installation of roundabouts under all of the Alternatives would require “take” of property from adjacent parcels of land, although the amount of take does seem to be less-than-significant. Additional research is needed on this topic.

Excavation of the soil for installation of roundabouts could also disturb buried cultural resources, although this can be mitigated through the CEQA process.

Finally, installation of roundabouts could result in less-than-significant impacts to public services by requiring maintenance of landscaping within the roundabouts where no such maintenance is currently needed.

Similar to the analysis of Alternatives 1A through 1E, no environmental fatal flaws have been identified.

**The issue relating to "green house gas" emissions and fuel consumption have become significant factors over the past few years. Several studies have been conducted which analyze the comparative effects of traffic signal operations and roundabout operations. The following treatise is a summary of recent findings on the subject.**

According to a study done by the Environmental Defense Fund, the US accounts for 45% of carbon dioxide emissions worldwide (Freeman). The EPA reported in March of 2006 that 27% of US greenhouse gas emissions from 1990-2003 were from the transportation sector (Greenhouse 1).

As stated by Barry Crown, a roundabout expert from the UK: "When vehicles are idle in a queue they emit about 7 times as much carbon monoxide (CO) as vehicles traveling at 10 mph. The emissions from a stopped vehicle are about 4.5 times greater than a vehicle moving at 5 MPH" (5).

The Bärenkreuzung/Zollikofen project undertaken in Bern, Switzerland, replaced two important signalized intersections by roundabouts and the result was a reduction of emissions and fuel savings by about 17 percent. The roundabouts also steadied the driving patterns (7).

On a microscale there have been studies conducted on the effect that different traffic flows have on emissions at an intersection. Of the studies that reported quantitative results, roundabouts reduced vehicle emissions for hydrocarbons (HC) in 5 studies by an average of 33 percent, carbon monoxide (CO) in 6 studies by an average of 36 percent, and nitric oxides (NOx) in 6 studies by an average of 21 percent. The regional scale air quality benefits of roundabouts would depend on their percent contribution to regional mobile source emissions (8, 9).

In a study conducted by Mustafa et.al (1993), the authors concluded that there exists a direct relationship between vehicle emissions and traffic volumes at urban intersections regardless of traffic control. Their simulation results showed that traffic signals generate more emissions (almost 50 percent higher) than a roundabout. In case of higher traffic volumes the HC generated by traffic signals is twice as high as that generated at roundabouts (10).

In another study conducted by Varhelyi in Sweden, he found that replacing a signalized intersection with a roundabout resulted in an average decrease in CO emissions by 29 percent and NOx emissions by 21 percent and fuel consumption by 28 percent per car within the influence of the junction (11).

Results of a study conducted by Jarkko Niittymaki show fuel consumption reductions of 30 percent in an intersection designed as a roundabout instead of using traffic signals and environmentally optimized traffic control systems have proved an energy saving potential of 10 percent to 20 percent in different cases (12).

A study was conducted by Kansas State University (*Environmental Impacts of Kansas Roundabouts, September 2003*) at three different locations that were converted from four-way stop control intersections to modern roundabouts. The report found a 38-45 percent decrease in Carbon Monoxide emissions, a 55-61 percent decrease in Carbon Dioxide emissions, a 44-51 percent decrease in Nitrogen Oxides, and a 62-68 percent decrease in Hydrocarbons. Other compiled studies found that when conventional intersections (signalized and unsignalized) are converted to modern roundabouts, there is an average reduction of 30 percent in carbon monoxide and nitrogen oxides, and a 30 percent reduction in fuel consumption. These preliminary conclusions indicate that modern roundabouts significantly reduce the amount of pollutants released into the atmosphere and reduce overall fuel consumption.

A Status Report published by the *Insurance Institute for Highway Safety* in the fall of 2005 (Volume 40, No. 9) studied 10 intersections where roundabouts were considered as alternatives for an intersection improvement project, but ultimately the road authority determined to use traffic signals as the entry control. During this study, researchers estimated vehicle delays and fuel consumption at the existing conventional signalized intersections, and compared them with estimates of what could have been expected if a modern roundabout were chosen as the preferred alternative at the ten intersections.

A key finding from the study indicated that combined vehicle delays at the 10 intersections would have been reduced by 62-74 percent, saving 325,000 hours (or 37.10 years) of motorist's time annually. It was estimated that fuel consumption would have also decreased by about 235,000 gallons per year. Assuming an average cost of $2.50 for a gallon regular gasoline, that is an annual savings of $587,500 for the ten intersections. Since less fuel would have been consumed at modern roundabout intersections, fewer emissions would have been released into the atmosphere.

# APPENDIX D: SUSTAINABILITY AND AESTHETICS

## Sustainability Ranking Approach

Assumptions were made on whether or not the alternative would have an impact on the criteria and if compared to the other alternatives where would it rank in comparison. For example the "0, or do nothing" alternative would do nothing to reduce energy consumption. However, doing nothing would also not have an impact on material resources (no construction – no resource use). This logic also applies for reducing impacts to environmental resources. As applied to the other alternatives, the signal modifications may improve circulation flow / queuing issues thereby reducing energy use to some degree. When applied to the roundabout alternatives, the sustainability benefits are maximized as a result of better / continuous circulation flow (air quality improvements), reduced energy (gasoline) consumption, reduction or elimination of energy using signals, and increased landscape opportunities.

## Aesthetic Opportunities Ranking Approach

Ranking of aesthetic opportunities is fairly straight forward. For example, the "do nothing" and signal improvements only approaches do not provide aesthetic opportunities. As the alternatives add medians and improve sidewalks aesthetic opportunities improve and are ranked accordingly based on quantity of potential landscape space. As noted in the ranking, the combination of roundabouts and increased medians score the highest in aesthetic opportunities. It should be noted that the opportunities to introduce street furniture is limited in all improvements due to the restricted opportunities for sidewalk or pedestrian node improvements, and needs for ADA clearances.

# APPENDIX E:  PUBLIC OUTREACH

## Public Outreach

A series of public meetings and/or presentations were conducted to, first introduce the study approach and goals and then to present the findings and the rational behind them.  For each meeting formal meeting notices, news releases and a mailing to 15 corridor property owners/operators were made.

The first meeting was held on February 9, 2011 beginning at 5:00 PM in the foyer in front of the Mendocino County Board of Supervisors meeting room.  The meeting was attended by seven (7) parties who signed in plus City of Ukiah staff, Mendocino County staff and Consultant team members.  It was our observation that there were attendees who failed to sign in.  Formal comment cards were available, as well as graphics on which participants would note their issue or concern.  The comments were tallied and are presented below:

**Comments:**

- Do something with Fjords location
- Trash blows around at Jensens Truck Stop
- Parking on Lover's Lane, creates a dangerous  sight problem for outbound Private Drive traffic
- Leave all driveways along Raley's entrance
- Left turn from McDonalds to State St is dangerous
- Old Sambo's near Ford/Empire –" vacant"
- Ford traffic signal is  broken
- Safety & aesthetics both are a problem
- Trucks block intersection going from SB Lover's Lane to NB So State St
- State Street looks like a poor step child
- Pedestrian countdowns on crosswalk
- Improve access and visibility to Ukiah Crossroads Shopping Center, i.e. streetscape, sidewalk, remove fence at Fjords building
- Additional street lights
- Speed limit
- Middle median landscaping
- Old hotel leave up
- Status of old wrecking yard ownership
- Weeds along Lover's Lane unsightly
- Bike issues at intersections
- Pavement bad for bikes
- Pavement crosswalks with lights when pedestrians are in crosswalk
- Wayfinding
- LED signage
- Signage
- Wayfinding
- Access to vineyard property only via Lover's Lane, freeway cutoff access, future problems?

The comments were summarized by type with the most predominant comments listed below, these comments directly relate to the approach selected for this corridor evaluation:

| | |
|---|---|
| Aesthetic Opportunities | 28% |
| Public Safety | 26% |
| Transportation Operations | 24% |
| Community Impacts | 14% |
| Right of Way Impacts | 4% |
| Sustainability | 3% |
| Environmental (fatal flaw) | 1% |
| Design Standard Conformance | 0% |
| Cost | 0% |

The second public meeting was held the evening of March 31, 2011 within the Board of Supervisors regular meeting room.  This meeting was attended by City of Ukiah staff, Mendocino County staff and Consultant team members.   The public was not represented despite the advance notice and efforts of the consultant team and county staff.

# APPENDIX F: CONCEPT LEVEL COST ANALYSIS

As a part of this evaluation concept level cost estimates were prepared, to allow for a meaningful comparison of the cost impacts of each conceptual alternative under evaluation. These opinions of conceptual level cost are presented below.

**PLANNING LEVEL CONSTRUCTION COST ESTIMATE**
**Mendocino County North State Street Improvement Project**
**Alternative 1A**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 0 | $50.00 | $0 |
| 2 | | Asphalt Concrete (Type A) | Ton | 0 | $90.00 | $0 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 0 | $100.00 | $0 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 0 | $20.00 | $0 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 0 | $28.00 | $0 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 0 | $4.75 | $0 |
| 8 | | Roadway & Intersection Striping | LS | 0 | $15,000.00 | $0 |
| 9 | | Traffic Signal Conduit | LF | 635 | $20.00 | $12,700 |
| 10 | | Landscaping & Irrigation | SF | 0 | $10.00 | $0 |
| 11 | | Right of Way Acquisition (Developed) | SF | 0 | $20.00 | $0 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$232,700** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $93,080 |
| | | **Construction Administration** | | | 10% | $32,578 |
| | | **Design Development/PSE** | | | 25% | $89,590 |
| | | | | | | |
| | | **Alternative 1A Preliminary Total** | | | | **$447,948** |

**PLANNING LEVEL CONSTRUCTION COST ESTIMATE**
**Mendocino County North State Street Improvement Project**
**Alternative 1B**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 177 | $50.00 | $8,863 |
| 2 | | Asphalt Concrete (Type A) | Ton | 0 | $90.00 | $0 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 0 | $100.00 | $0 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2722 | $20.00 | $54,440 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 1,354 | $28.00 | $37,912 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 10,155 | $4.75 | $48,236 |
| 8 | | Roadway & Intersection Striping | LS | 0 | $15,000.00 | $0 |
| 9 | | Traffic Signal Conduit | LF | 635 | $20.00 | $12,700 |
| 10 | | Landscaping & Irrigation | SF | 0 | $10.00 | $0 |
| 11 | | Right of Way Acquisition (Developed) | SF | 1,234 | $20.00 | $24,680 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$406,831** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $162,733 |
| | | **Construction Administration** | | | 10% | $56,956 |
| | | **Design Development/PSE** | | | 25% | $156,630 |
| | | | | | | |
| | | **Alternative 1B Preliminary Total** | | | | **$783,150** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 1C**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,515 | $50.00 | $75,750 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,416 | $90.00 | $127,429 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 1152 | $20.00 | $23,040 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,296 | $28.00 | $64,288 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 17,220 | $4.75 | $81,795 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 1,886 | $20.00 | $37,720 |
| 10 | | Landscaping & Irrigation | SF | 10,680 | $10.00 | $106,800 |
| 11 | | Right of Way Acquisition (Developed) | SF | 9,491 | $20.00 | $189,820 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 2 | $200,000.00 | $400,000 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,461,642** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $584,657 |
| | | **Construction Administration** | | | 10% | $204,630 |
| | | **Design Development/PSE** | | | 25% | $562,732 |
| | | | | | | |
| | | **Alternative 1C Preliminary Total** | | | | **$2,813,661** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 1D**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,054 | $50.00 | $52,693 |
| 2 | | Asphalt Concrete (Type A) | Ton | 888 | $90.00 | $79,954 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2656 | $20.00 | $53,120 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,210 | $28.00 | $61,880 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 16,575 | $4.75 | $78,731 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 1,886 | $20.00 | $37,720 |
| 10 | | Landscaping & Irrigation | SF | 10,680 | $10.00 | $106,800 |
| 11 | | Right of Way Acquisition (Developed) | SF | 9,491 | $20.00 | $189,820 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 3 | $200,000.00 | $600,000 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,615,719** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $646,288 |
| | | **Construction Administration** | | | 10% | $226,201 |
| | | **Design Development/PSE** | | | 25% | $622,052 |
| | | | | | | |
| | | **Alternative 1D Preliminary Total** | | | | **$3,110,259** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 1E**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,314 | $50.00 | $65,714 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,131 | $90.00 | $101,772 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2674 | $20.00 | $53,480 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,623 | $28.00 | $73,444 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 19,673 | $4.75 | $93,444 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 1,886 | $20.00 | $37,720 |
| 10 | | Landscaping & Irrigation | SF | 10,680 | $10.00 | $106,800 |
| 11 | | Right of Way Acquisition (Developed) | SF | 9,491 | $20.00 | $189,820 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 3 | $200,000.00 | $600,000 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,677,194** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $670,877 |
| | | **Construction Administration** | | | 10% | $234,807 |
| | | **Design Development/PSE** | | | 25% | $645,720 |
| | | | | | | |
| | | **Alternative 1E Preliminary Total** | | | | **$3,228,598** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2A**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 6,349 | $50.00 | $317,472 |
| 2 | | Asphalt Concrete (Type A) | Ton | 6,481 | $90.00 | $583,251 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 374 | $300.00 | $112,156 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2979 | $20.00 | $59,580 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,204 | $28.00 | $89,712 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 24,030 | $4.75 | $114,143 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 33,375 | $10.00 | $333,750 |
| 11 | | Right of Way Acquisition (Developed) | SF | 21,044 | $20.00 | $420,880 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$2,225,942** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $890,377 |
| | | **Construction Administration** | | | 10% | $311,632 |
| | | **Design Development/PSE** | | | 25% | $856,988 |
| | | | | | | |
| | | **Alternative 2A Preliminary Total** | | | | **$4,284,939** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2B**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 6,576 | $50.00 | $328,792 |
| 2 | | Asphalt Concrete (Type A) | Ton | 6,711 | $90.00 | $603,976 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 374 | $300.00 | $112,156 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 3333 | $20.00 | $66,660 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,395 | $28.00 | $95,060 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 25,463 | $4.75 | $120,947 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 34,699 | $10.00 | $346,990 |
| 11 | | Right of Way Acquisition (Developed) | SF | 21,044 | $20.00 | $420,880 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$2,290,460** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $916,184 |
| | | **Construction Administration** | | | 10% | $320,664 |
| | | **Design Development/PSE** | | | 25% | $881,827 |
| | | | | | | |
| | | **Alternative 2B Preliminary Total** | | | | **$4,409,135** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2C**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 5,315 | $50.00 | $265,753 |
| 2 | | Asphalt Concrete (Type A) | Ton | 5,344 | $90.00 | $480,946 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 287 | $300.00 | $85,978 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 3213 | $20.00 | $64,260 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,418 | $28.00 | $95,704 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 25,635 | $4.75 | $121,766 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 27,476 | $10.00 | $274,760 |
| 11 | | Right of Way Acquisition (Developed) | SF | 16,603 | $20.00 | $332,060 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,916,227** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $766,491 |
| | | **Construction Administration** | | | 10% | $268,272 |
| | | **Design Development/PSE** | | | 25% | $737,747 |
| | | | | | | |
| | | **Alternative 2C Preliminary Total** | | | | **$3,688,737** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2D**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 5,070 | $50.00 | $253,510 |
| 2 | | Asphalt Concrete (Type A) | Ton | 5,190 | $90.00 | $467,122 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 287 | $300.00 | $85,978 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2265 | $20.00 | $45,300 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,527 | $28.00 | $70,756 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 18,953 | $4.75 | $90,024 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 26,489 | $10.00 | $264,890 |
| 11 | | Right of Way Acquisition (Developed) | SF | 10,148 | $20.00 | $202,960 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 1 | $100,000.00 | $100,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,775,540** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $710,216 |
| | | **Construction Administration** | | | 10% | $248,576 |
| | | **Design Development/PSE** | | | 25% | $683,583 |
| | | | | | | |
| | | **Alternative 2D Preliminary Total** | | | | **$3,417,914** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2E**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 5,633 | $50.00 | $281,627 |
| 2 | | Asphalt Concrete (Type A) | Ton | 5,678 | $90.00 | $511,031 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 287 | $300.00 | $85,978 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 3567 | $20.00 | $71,340 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,609 | $28.00 | $101,052 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 27,068 | $4.75 | $128,571 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 28,800 | $10.00 | $288,000 |
| 11 | | Right of Way Acquisition (Developed) | SF | 14,991 | $20.00 | $299,820 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,962,418** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $784,967 |
| | | **Construction Administration** | | | 10% | $274,738 |
| | | **Design Development/PSE** | | | 25% | $755,531 |
| | | | | | | |
| | | **Alternative 2E Preliminary Total** | | | | **$3,777,654** |

# PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Phase 1**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,644 | $50.00 | $82,223 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,646 | $90.00 | $148,143 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 87 | $300.00 | $26,178 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2688 | $20.00 | $53,760 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 1,017 | $28.00 | $28,476 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 7,628 | $4.75 | $36,231 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 14,352 | $10.00 | $143,520 |
| 11 | | Right of Way Acquisition (Developed) | SF | 10,148 | $20.00 | $202,960 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 1 | $100,000.00 | $100,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$956,491** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $382,596 |
| | | **Construction Administration** | | | 10% | $133,909 |
| | | **Design Development/PSE** | | | 25% | $368,249 |
| | | | | | | |
| | | **Phase 1 Preliminary Total** | | | | **$1,841,245** |

}

# PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**

**Phase 1**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item |
|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,644 | |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,646 | |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 87 | |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2688 | |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 1,017 | |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 7,628 | |
| 8 | | Roadway & Intersection Striping | LS | 1 | $1 |
| 9 | | Traffic Signal Conduit | LF | 0 | |
| 10 | | Landscaping & Irrigation | SF | 14,352 | |
| 11 | | Right of Way Acquisition (Developed) | SF | 10,148 | |
| 12 | | Coordinate Existing Signal | EA | 0 | $1 |
| 13 | | Modify Existing Signal | EA | 1 | $10 |
| 14 | | New Traffic Signal | EA | 0 | $20 |
| | | | | | |
| | | **Subtotal** | | | |
| | | | | | |
| | | **Construction Contingency** | | | |
| | | **Construction Administration** | | | |
| | | **Design Development/PSE** | | | |
| | | | | | |
| | | **Phase 1 Preliminary Total** | | | |

# PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**

**Concept 2B -Phase 1**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,644 | $50.00 | $82,223 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,646 | $90.00 | $148,143 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 87 | $300.00 | $26,178 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2688 | $20.00 | $53,760 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 1,017 | $28.00 | $28,476 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 7,628 | $4.75 | $36,231 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 14,352 | $10.00 | $143,520 |
| 11 | | Right of Way Acquisition (Developed) | SF | 10,148 | $20.00 | $202,960 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 1 | $100,000.00 | $100,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$956,491** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $382,596 |
| | | **Construction Administration** | | | 10% | $133,909 |
| | | **Design Development/PSE** | | | 25% | $368,249 |
| | | | | | | |
| | | **Phase 1 Preliminary Total** | | | | **$1,841,245** |

# APPENDIX G:  ROUNDABOUT INFORMATIONAL REPORT


# ROUNDABOUTS

## *An Informational Summary Booklet*

omni · means
ENGINEERS · PLANNERS

# Introduction

Many communities are beginning to recognize the positive effect of properly designed and located roundabout intersections. Although their use has been promoted primarily to improve safety, the modern roundabout can provide numerous advantages over conventional intersection traffic control treatments.

Roundabouts can reduce the number and severity of collisions for all highway users. Additionally, roundabouts help to address other benefits such as:

- Vehicle Operating Speeds
- Improve access and traffic circulation
- Reduce queuing and delay
- Reduce number of through and channelization lanes
- Provide space for bicycle and pedestrian facilities
- Improve pedestrian mobility
- Reduce fuel and/or energy consumption
- Lower vehicle emissions
- Provide unique opportunities for landscaping and other aesthetic treatments
- Have the unique ability to serve as a physical and operational interface or gateway between rural and urban areas where speed limits change

The "modern" roundabout, coupled with proper design, appropriate geometric and non-geometric design measures such as proper lighting and landscaping, are the traffic control devices of choice for intersections in many countries throughout the world. The United States has began to recognize the benefits presented by "modern" roundabouts by converting old traffic circles, stop controlled, and signalized intersections to "modern" roundabouts with appropriate geometric design measures.

Modern American roundabouts have produced remarkable safety records, similar to the roundabout experience reported in other parts of the world. The safety of roundabouts compared to signalized intersections, and old traffic circles, has been adequately documented. As a result, the number of roundabouts in the United States is expected to increase geometrically in the next decade.

**Redding, California (OMNI-MEANS)**

There are only about 300 roundabouts in the United States and most are on the East Coast. However, acceptance on the West Coast was accelerated when Caltrans approved preliminary guidelines in 1998 for building roundabouts adjoining state roads and freeways. The May-June 2002 issue of the Caltrans *Journal* introduces the concept to Caltrans employees.

As noted by Mayor Jim Test, of the City of Arcata in Northern California, he speaks highly of two roundabouts installed on a former highway bordering Humboldt Bay.

*"The traffic there was terrible," he said, resulting in multiple serious accidents. However, the new road design [roundabouts] has slowed traffic and brought out numerous bicyclists who now safely share the roadway with the cars - and pedestrians."*

# Roundabout Categories

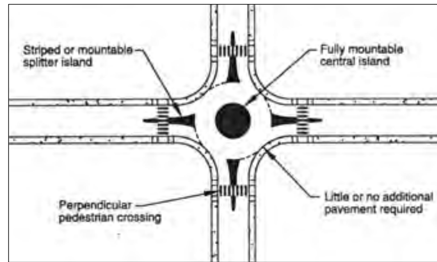
Roundabouts are categorized into six (6) basic categories according to size and environment to facilitate discussion of specific performance or design issues.

- Mini-Roundabouts
- Urban Compact Roundabouts
- Urban Single-Lane Roundabouts
- Urban Double-Lane Roundabouts
- Rural Single-Lane Roundabouts
- Rural Double-Lane Roundabouts

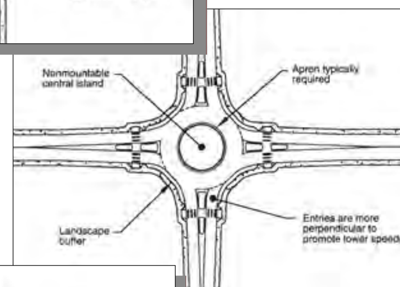
It should be noted that separate categories have not been explicitly identified for suburban environments. Suburban settings may combine higher approach speeds common in rural areas with multimodal activity that is more commonly found in urban settings.

*Pedestrians:* Designers should anticipate the needs of pedestrians, bicyclists, and large vehicles. Whenever a raised splitter island is provided, there should also be an at-grade pedestrian refuge. In this case, the pedestrian crossing facilitates two separate moves: curb-to-island and island-to-curb. The exit crossing will typically require more vigilance from the pedestrian and motorist, than the entry crossing. It is also recommended that all urban crosswalks be marked. Under all urban design categories, special attention should be given to assist pedestrian users who are visually impaired or blind, through design elements. For example, these users typically attempt to maintain their approach alignment to continue across a street in the crosswalk, since the crosswalk is often a direct extension of the sidewalk.

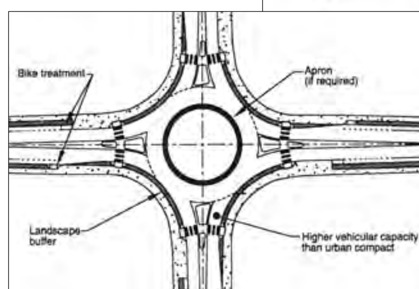
A roundabout requires deviation from that alignment, and attention is needed to provide appropriate informational cues to pedestrians regarding the location of the sidewalk and the crosswalk, even at mini-roundabouts. For example, appropriate landscaping is one method of providing some information. Another is to align the crosswalk ramps perpendicular to the pedestrian's line of travel through the pedestrian refuge.



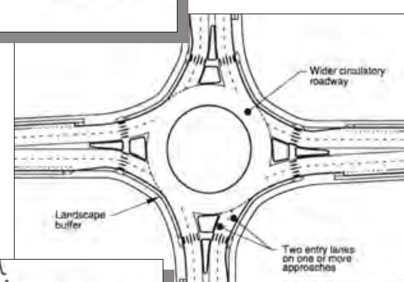

Mini



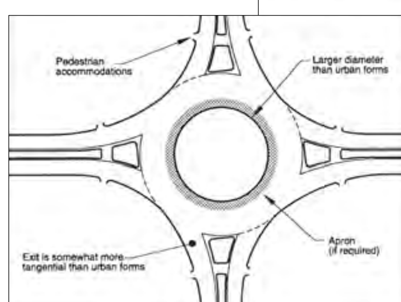

Urban Compact



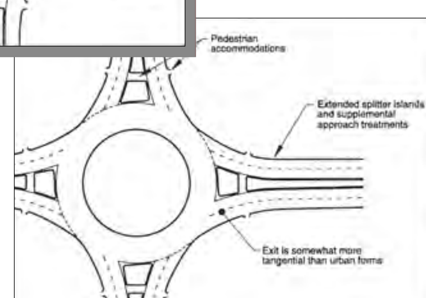

Urban Single-Lane




Urban Double-Lane




Rural Single-Lane




Rural Double-Lane

*Source: Roundabouts: An Informational Guide, US DOT*

# Why Use a Roundabout?

There are many reasons why the "modern" roundabout is gaining favor in the United States (US), and more specifically within California. These reasons are clearly articulated in the next few pages.

## Vehicle Safety

Roundabouts have been shown to reduce fatal and injury accidents as much as 76% in the US, 75% in Australia, and 86% in Great Britain. The reduction in accidents is due to slower speeds and reduced the number of conflict points.

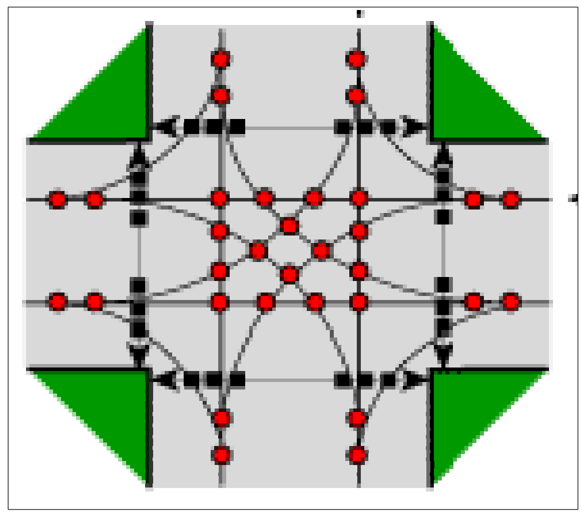
**U.S. Safety Research** of 24-intersections comparing crash histories before roundabouts and after roundabouts:

- 40% reductions for all crash severities
- 70% reduction for all injury crashes
- 90% reduction in fatal and incapacitating injury crashes
- Results found to be consistent with international studies

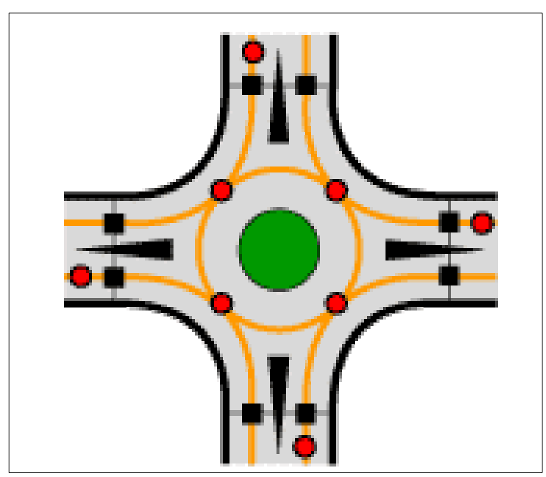
For the design of a new roundabout, safety can be optimized not only by relying on recorded past performance of roundabouts in general, but also primarily by applying all design knowledge proven to impact safety. For optimum roundabout safety and operational performance the following should be noted:

- Minimizing the number of potential conflicts at any geometric feature should **reduce** the multiple **vehicle crash rate** and severity.
- Minimizing the potential relative speed between two vehicles at the point of conflict will minimize the multiple vehicle crash rate and severity (it may also optimize capacity). To reduce the potential relative speed between vehicles, either the absolute speeds of both vehicles need to be reduced or the angle between the vehicle paths needs to be reduced.
- **Commuter bicyclist** speeds can range from 12 to 15 mph and designs that constrain the speeds of motor vehicles to similar values will **minimize the relative speeds** and improve safety. Lower absolute speeds will also assist pedestrian safety.
- Limiting the maximum change in speed between successive horizontal geometric elements will minimize the single vehicle crash rate and severity.

Conflict Points on a Regular 4-way Intersection Compared to a Modern Roundabout Intersection



● 32 Vehicle to Vehicle Conflicts
■ 24 Vehicle to Pedestrian Conflicts

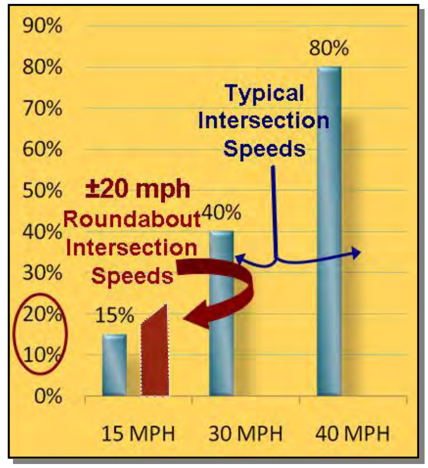


● 8 Vehicle to Vehicle
■ 8 Vehicle to Pedestrian

# Why Use a Roundabout? (cont.)

## Pedestrian Safety

All research suggests that modern roundabouts are safer than signalized intersections for pedestrians. This safety advantage has been attributed to the slower traffic speeds entering and traveling through a roundabout, and the division of the pedestrian crossing into two stages, from the near-side wheelchair ramp out to the splitter island, and then from the splitter island to the far-side wheelchair ramp. In each stage, the pedestrian has to be concerned with on-coming traffic in only one direction to cross a "one-way" traffic stream. Pedestrian refuges are provided in the areas within the splitter islands.




**British crash rates for pedestrians at Roundabouts and signalized intersections**

| Intersection Type | Pedestrian Crashes per Million Trips |
|---|---|
| Mini-roundabout | 0.31 |
| Conventional roundabout | 0.45 |
| Flared roundabout | 0.33 |
| Signals | 0.67 |

*Source: Roundabouts: An Informational Guide, US DOT*

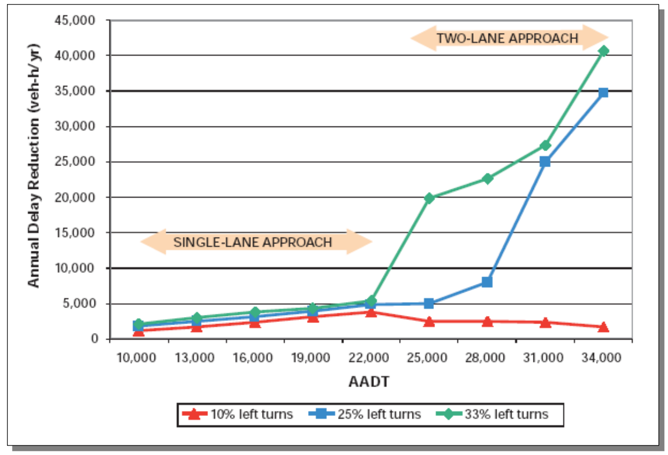
## Low Maintenance

Roundabouts eliminate maintenance costs associated with traffic signals that can amount to approximately $3,500 per year per intersection. In addition, electricity costs are reduced with a savings of approximately $1,500 per year per intersection.

***There is 50% delay savings when using a roundabout vs. a traditional intersection on major streets.***

## Reduced Delay

By yielding at the entry rather than stopping and waiting for a green light, queuing and delay are significantly reduced.




*Source: Roundabouts: An Informational Guide, US DOT*

## Capacity

Intersections with a high volume of left turns are better handled by a roundabout than a multi-phased traffic signal.

**OMNI-MEANS Landscape Design**
**Ripon, CA**

## Aesthetics

A reduction in delay corresponds to a decrease in fuel consumption and air pollution. In addition, the central island provides an opportunity to provide landscaping.

## Environmental

Since modern roundabouts have the advantage of requiring vehicles to slow down and reduce delay / stop time, there are environmental benefits when compared to a traditional intersection. The benefits are achieved in two ways:

- Reduction in Vehicle Emissions (less idleing time)
- Reduction in Fuel Usage

A U.S. Environmental Protection Agency document reporting the results of seven studies indicated a significant reduction in vehicle emissions (hydrocarbons 33%; carbon monoxide 36%; nitric oxides 21%). Other studies, and simulations, have identified fuel usage reductions in the 8% – 20% range.

01-MEN-CR 104-PM 0.17/0.58
PPNO 4590
February 2014

# Project Study Report
# to
# Request Programming in the 2014 STIP for Capital Support
# for
# Project Approval and Environmental Document
# Plans, Specifications and Estimate
# for
# North State Street Intersection and Interchange Improvements

| | |
|---|---|
| On Route | North State Street, County Road 104 |
| Between | Post Mile 0.17 |
| and | Post Mile 0.58 |

APPROVAL RECOMMENDED:

February 25, 2014

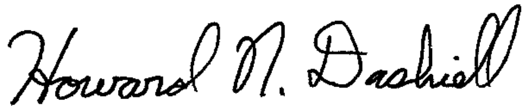
**Howard N. Dashiell** Date
Director of Transportation, Mendocino County

APPROVED:

**Phil Dow** Date
Executive Director, Mendocino Council of Governments

# Project Vicinity Map

This project study report has been prepared under the direction of the following registered civil engineer. The registered civil engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.



February 25, 2014

Howard N. Dashiell — Date

Director of Transportation

# Table of Contents

# 1. INTRODUCTION

Project Description:

This project proposes intersection and interchange improvements along the North State Street corridor from the intersection of Ford Road/Empire Drive to the US 101 northbound on/off ramps. Proposed improvements entail Phase I of the preferred alternative, which include installing a roundabout (probably single-lane) at the KUKI Lane intersection and installing medians along North State Street through the northbound on and off-ramps to US 101 with center island areas for hardscaping and median separation.

Funding is being sought by other sources for the first portion of this phase of work, which will include a new traffic signal upgrade to the North State Street and Ford Road/Empire Drive intersection and the North State Street/KUKI Lane intersection and a tie-in between the two intersections. The first portion of the Phase I work will be accommodated by non-STIP funding.

Phase II (future) will include installing three roundabouts (probably single-lane) along North State Street at the Ford Road/Empire Drive, US 101 southbound on-ramp and US 101 northbound on/off-ramp intersections, as well as installing medians with center island areas for median separation and hardscaping. Phase II will also re-align Lovers Lane to the new roundabout located at the southbound US101 on-ramp.

| | |
|---|---|
| **Project Limits** | 01-MEN-CR 104-PM 0.17/0.58 |
| **Number of Alternatives** | 10 Build Alternatives |
| **Alternative Recommended for Programming** | Concept 2B (Phase 1) |
| **Current Capital Outlay Support Estimate** | $720,297 – $1,128,739 (2020)<br>(2B Phase 1: $468,000) |
| **Current Capital Outlay Construction Estimate** | $2,638,220 - $3,976,228 (2020)<br>(2B Phase 1: $1,425,000) |
| **Current Capital Outlay Right-of-Way Estimate** | $242,970 - $538,726 (2020)<br>(2B Phase 1: $232,000) |
| **Funding Source** | Regional Improvement Funding |
| **Funding Year** | 2017/2018 |
| **Type of Facility** | County Road |
| **Number of Structures** | N/A |
| **Anticipated Environmental Determination or Document** | Categorical Exemption/Categorical Exclusion |
| **Legal Description** | In Mendocino County, north of the Ukiah city limits, on North State Street (CR 104), between PM 0.17 and 0.58. |
| **Project Development Category** | Category 5 or 7 |

# 2. BACKGROUND

North State Street is a four-lane facility. There are multiple access points within the project area with a variety of configurations ranging from fully signalized intersections to driveways with channelized left-turn pockets as well as driveways with no access channelization. Many of these access points are offset from one another or are in close proximity to other intersections so as to create vehicle turning and queuing conflicts.

The result of this variety of access points is a reliance on the status quo to maintain access to the various parcels along the corridor. A change in one access opportunity (i.e., turning movement) has the potential to adversely affect the traffic circulation patterns on another parcel, or perhaps the entire roadway segment, or it may unduly limit access given that few alternative access points are available for many parcels along the corridor.

There is a wide variety in the land uses along the project corridor as well. North State Street is fronted by fast food restaurants and strip mall retail at the south end of the project area near Ford Road. The project area near KUKI Lane is characterized by a truck stop, service stations, a bowling alley, the Ukiah Crossroads Shopping Center and motels mixed with a few vacant parcels.

## 3. PURPOSE AND NEED

**Purpose:**

The purpose of this project is to provide traffic capacity to accommodate projected 2030 traffic volumes along the North State Street corridor, increase public safety for all corridor users, improve the aesthetics of North State Street by revamping the urban streetscape, improve pedestrian and bicycle access along the corridor and recognize the need for sufficient parking opportunities.

**Need:**

This project is needed to address traffic conditions experienced at the Ukiah Crossroads Shopping Center along North State Street between Ford Road and US 101. North State Street carries significant volumes of through traffic, in addition to providing local access. With growth and development continuing to occur within the City of Ukiah, as well as the adjacent unincorporated area, traffic is forecast to increase along North State Street. The increase in traffic will degrade traffic operations, increase congestion and exacerbate existing traffic safety issues.

## 4. DEFICIENCIES

The North State Street collision and level of service data are summarized below.

<u>Collision Data</u>

Table 1

| North State Street Accident History (2007-2009) | | | |
|---|---|---|---|
| | **Total** | **Intersection** | **Mid-Block** |
| **North State Street** | | | |
| Ford/Empire | 21 | 5 | 16 |
| KUKI Road | 22 | 7 | 15 |
| US 101 | 7 | 3 | 4 |
| **Ford Rd/Empire Dr** | | | |
| North State Street | 11 | 3 | 8 |
| **KUKI Road** | | | |
| North State Street | 1 | 0 | 1 |
| **US 101** | | | |
| North State Street | 43 | 8 | 35 |

Traffic accidents throughout this corridor represent a serious issue needing resolution. Table 1 above represents the traffic accident experience for the three (3) year period, January 2007 through December 2009 (the most current information available at the time of the study.)

The number of accidents that have occurred along the corridor of this project during this period is 50. The corridor length is just over a half mile. The accident rate experienced along North State Street exceeds the statewide average for similar roadway by almost three (3) times.

This unacceptable accident experience can be attributed to several factors:

- Obsolete traffic signals at North State Street and Ford Road/Empire Drive,
- Obsolete traffic signals at North State Street and KUKI Lane,
- Numerous driveway access points through the corridor resulting in numerous opportunities for angle collisions,
- Lack of traffic control at the on-off ramps to US 101.

Clearly these issues require addressing in the evaluation of the conceptual alternatives.

Level of Service

Year 2030 intersection Level of Service (LOS) is quantified using the 2030 forecasts and are shown in Table 2 below.

Table 2
Year 2030 Conditions Intersection Level of Service

| | | | | **AM Peak Hour** | | | **PM Peak Hour** | | |
|---|---|---|---|---|---|---|---|---|---|
| **#** | **Intersection** | **Control Type** | **Target LOS** | **Delay** | **LOS** | **Warrant Met?** | **Delay** | **LOS** | **Warrant Met?** |
| **1** | State St./Empire Dr./Ford Rd. | **Signal** | **D** | **81.6** | **F** | - | 49.0 | D | - |
| **2** | State Street KUKI Lane | **Signal** | **D** | **82.7** | **F** | - | **172.4** | **F** | - |
| **3** | State Street/NB Ramps | **TWSC** | **D** | **519.1** | **F** | **Yes** | **OVR** | **F** | **Yes** |
| **4** | State Street/SB Ramps | **TWSC** | **D** | 24.7 | C | - | **OVR** | **F** | Yes |

*Notes* **Bolded entries indicate intersections operating at unacceptable LOS.**
*TWSC = Two Way Stop Control* *OVR = Overflow, Delay exceeding 1000 seconds*
*LOS -= Worst case movement's LOS for TWCS intersections;* *Warrant = Caltrans Peak hour volume based signal warrant*

As shown in Table 2, all of the project intersections are projected to operate at unacceptable LOS for Year 2030 conditions.

## 5. CORRIDOR AND SYSTEM COORDINATION

Roadways that provide the primary vehicle circulation within the project area include US 101, North State Street, Lovers Lane, KUKI Lane, Empire Drive, and Ford Road. The following is a brief description of these primary roadways within the project area, taking into consideration their ability to safely handle motor vehicle traffic, bicycle traffic and pedestrian activity:

**US 101** is a north-south highway which extends from the Washington border to the north to its terminus in Los Angeles County in southern California. Through the study area US 101 is a controlled access four-lane freeway with both northbound and south-bound on and off ramps to North State Street at the northern end of the study corridor.

**North State Street** is a north-south arterial, which is the study corridor, from just south of the Ford Road/Empire Street intersection to the US 101 northbound on/off ramps. The land uses in the study area are primarily commercial in nature. The roadway is four lanes in an approximate 80 foot right of way; a left turn pocket is provided at key locations. The corridor is marked by numerous driveway connections, discontinuous pedestrian walkways and non-standard bicycle facilities.

**Lovers Lane** is parallel to North State Street extending from KUKI Lane north-westerly to the foothills west of Ukiah. Lovers Lane is a two-lane roadway, without frontage improvements, which serves a truck stop/service station adjacent to KUKI Lane and residential traffic to and from the west. The intersection of Lovers Lane with KUKI Lane is immediately adjacent to the KUKI Lane /State Street intersection which creates turning and queuing issues.

**KUKI Lane** is a short two-lane roadway segment, extending west from North State Street. Frontage improvements are mostly non-existent; land uses are commercial/industrial in nature. The intersection of Lovers Lane with KUKI Lane is immediately adjacent to the KUKI Lane/State Street intersection which creates turning and queuing issues.

**Empire Drive** is a two-lane roadway with frontage improvements. Immediately adjacent to North State Street land uses are commercial in nature and to the west of North State Street are residential in nature with access to an elementary school. Opposite Empire Drive at State Street is Ford Road.

**Ford Road** is a two-lane roadway with frontage improvements. Land uses are commercial adjacent to North State Street, with access to the Ukiah Crossing Shopping Center. The roadway extends to the east where it terminates beneath the US 101 freeway viaduct. Future plans call for Ford Road to connect to Orchard Avenue which is planned as a parallel route to North State Street. Opposite Ford Road is Empire Drive at State Street.

## 6. ALTERNATIVES

In order to determine acceptable alternatives for this project, Mendocino County hired Omni Means Engineers & Planners to study the project site and determine feasible alternative designs for this project. During the course of identifying possible roadway operational improvements, both traffic signal improvements and roundabout improvements were deemed to be acceptable concepts for roadway improvement. A total of ten (10) conceptual alternatives were developed. A comprehensive evaluation process was developed to compare each concept one to the other considering such issues as operations, cost, aesthetics, environmental, and sustainability amongst others.

The study conducted by Omni Means comprised a preliminary review of the alternatives, focusing on identifying cost effective solutions for the future ultimate design of the corridor as well as potential interim, phased improvements. An operational analysis will be conducted at the beginning of the Preliminary Engineering (PE) Phase to determine the final design.

The results of the evaluation are shown in Table 3 below.

Table 3

| SUMMARY CATEGORICAL RANKING | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Criteria | Relative Weighting | Concept No. | | | | | | | | | |
| | | Signal Improvements | | | | | Roundabout Improvements | | | | |
| | | 1A | 1B | 1C | 1D | 1E | 2A | 2B | 2C | 2D | 2E |
| Public Safety | 1.47 | 0.9 | 1.2 | 8.2 | 8.2 | 8.2 | 10.0 | 10.0 | 9.1 | 9.6 | 9.1 |
| Right of Way Impacts | 1.07 | 10.0 | 7.7 | 7.7 | 7.7 | 7.7 | 0.0 | 0.0 | 0.1 | 4.5 | 0.1 |
| Community Impacts | 1.10 | 10.0 | 6.5 | 4.9 | 4.9 | 4.9 | 7.3 | 7.3 | 7.3 | 7.3 | 7.3 |
| Design Standard Conformance | 0.81 | 4.6 | 4.6 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Cost | 1.07 | 10.0 | 5.7 | 1.6 | 1.4 | 1.4 | 1.0 | 1.0 | 1.2 | 1.3 | 1.2 |
| Transportation Operations | 1.36 | 4.4 | 4.4 | 7.9 | 9.1 | 8.9 | 9.5 | 10.0 | 8.4 | 9.8 | 9.0 |
| Environmental (fatal flaw) | 1.03 | 10.0 | 9.5 | 9.4 | 9.4 | 9.2 | 9.1 | 9.1 | 8.9 | 9.6 | 8.9 |
| Sustainability | 1.03 | 4.7 | 5.1 | 5.1 | 5.1 | 5.1 | 10.0 | 10.0 | 8.3 | 8.3 | 8.3 |
| Aesthetic Opportunities | 1.07 | 0.0 | 7.8 | 7.8 | 7.8 | 7.8 | 10.0 | 10.0 | 9.4 | 9.4 | 9.4 |
| Total Unweighted Score | | 54.61 | 52.45 | 62.47 | 63.53 | 63.01 | 66.96 | 67.45 | 62.92 | 69.93 | 63.45 |
| Total Weighted Score | | 58.52 | 56.20 | 69.31 | 70.79 | 70.17 | 75.22 | 75.89 | 70.32 | 78.38 | 71.04 |
| Purpose and Need Statement Factor 2 | | 1.0 | 1.1 | 1.2 | 1.1 | 1.1 | 2.4 | 2.6 | 2.3 | 2.1 | 2.4 |
| Final Scoring | | 58.5 | 63.7 | 84.7 | 80.2 | 79.5 | 183.9 | 195.6 | 164.1 | 165.5 | 168.9 |
| **Final Alternative Ranking** | | **10** | **9** | **6*** | **7** | **8** | **2** | **1*** | **5** | **4** | **3** |
| *Relative Weighting uses a scale of 1 to 10, with 10 being very important and 1 being unimportant.* | | | | | | | | | | | |
| ** Viable Alternatives* | | | | | | | | | | | |

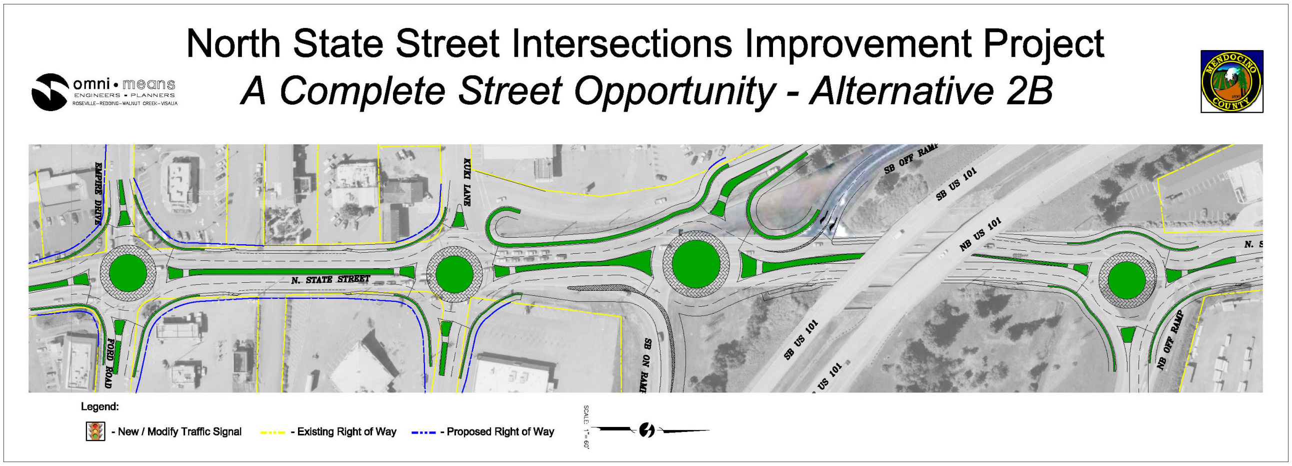
## 6A. Viable Alternatives

Based on the findings of the Omni Means study report, public comment, and acceptance by the Mendocino County Board of Supervisors, the Mendocino County Department of Transportation proposes the following alternatives.

**Concept 2B**

Concept 2B is the preferred alternative of the ten alternatives evaluated by Omni Means, as it received the highest point total in the categorical ranking. The County believes that this alternative is the best alternative because it addresses all of the deficiencies of this project, meets current mandatory and advisory design standards, and satisfies the purpose and need of the project.

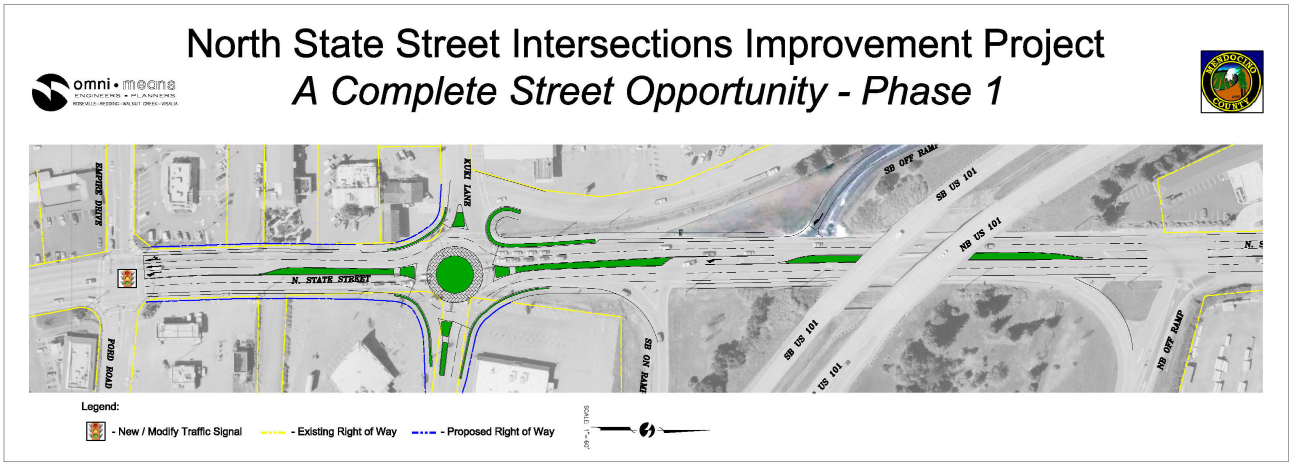
This design includes four (4) roundabouts (probably single lane) installed along North State Street at Ford Road/Empire Drive, KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. In addition, this concept provides for the re-alignment of Lovers Lane to the new roundabout located at the Southbound US 101 on-ramp. This concept includes medians throughout the corridor with center island areas for median separation and hardscaping. The conceptual estimate cost for Concept 2B is $5,645,000.




Concept 2B Phase I

Concept 2B Phase I consists of a new traffic signal upgrade to the North State Street and Ford Road/Empire Drive intersection, along with a roundabout at the KUKI Lane intersection. Medians would also be added along North State Street through the Northbound on and off ramps to US 101. The conceptual estimate cost for the phase 1 project is $2,352,000.

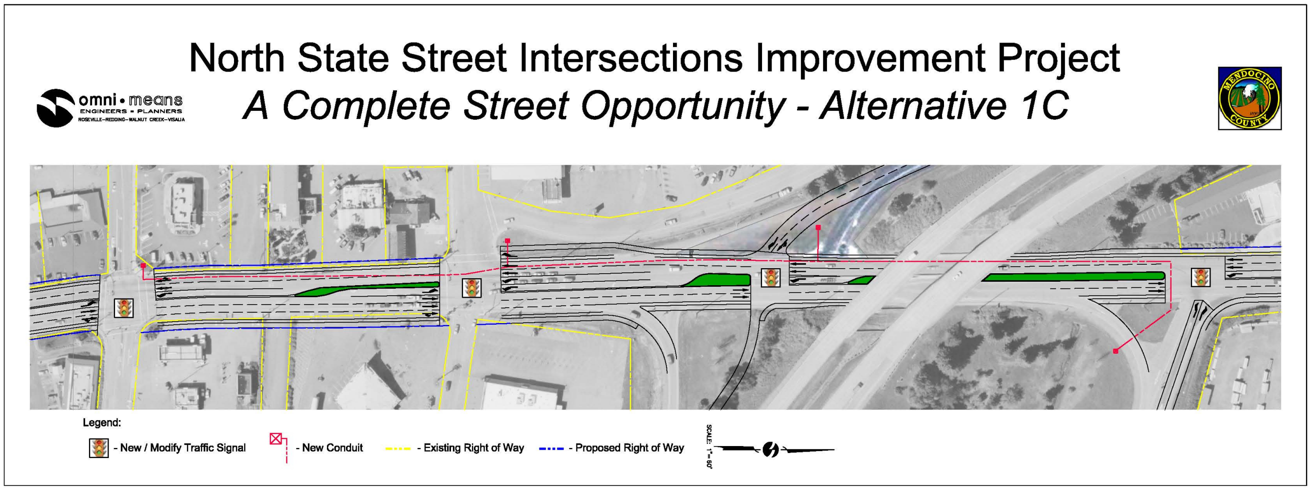
The County is currently seeking funding for the second portion of Phase I of Concept 2B through the 2014 STIP, which will include the roundabout at the KUKI Lane intersection and medians along North State Street through the Northbound on and off ramps to US 101. The first portion of the Phase I work will be accommodated by non-STIP funding. Once the county has secured funding for Phase I, the county will continue to seek funding for Phase II, which would complete the entire Concept 2B alternative.




**Concept 1C**

Concept 1C is the Minimum Build Alternative selected from the ten alternatives by Omni Means. The County believes that this alternative still addresses the deficiencies of this project, as well as satisfying the purpose and need of the project.

This alternative includes traffic signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at both US 101 ramp terminal intersections, with traffic signal interconnect throughout. This concept also includes the median construction and requires re-alignment to both the southbound on and off ramps to US 101.




## <u>No Build Alternative</u>

The "no build" alternative was also considered, but did not meet the purpose and need of the project.

Scenarios that do not meet the purpose and need of the project will not be considered further.

### 6B. Rejected Alternatives

Alternatives 1A, 1B, 1D, and 1E are all similar to alternative 1C. These alternatives were rejected due to the fact that they do not meet the basic purpose and need of this project, or because they did not score as highly on the project rating scale set forth by Omni Means.

Alternatives 2A, 2C, 2D, and 2E are all similar to alternative 2B. These alternatives were not recommended due to the fact that they did not score as highly on the rating scale set forth by Omni Means.

See Attachment A for a description of all ten (10) alternatives considered.

## 7. COMMUNITY INVOLVEMENT

A series of public meetings and/or presentations were conducted by Omni Means to first introduce the study approach and goals, and then to present the findings and the rational behind them. For each meeting formal meeting notices, news releases and a mailing to 15 corridor property owners/operators were made.

The first meeting was held on February 9, 2011 beginning at 5:00 PM in the foyer in front of the Mendocino County Board of Supervisors meeting room. The meeting was attended by seven (7) parties who signed in plus City of Ukiah staff, Mendocino County staff and Consultant team members. It was observed that there were attendees who failed to sign in. Formal comment cards were available, as well as graphics on which participants could note their issue or concern.

The comments were summarized by type, with the most predominant comments listed below. These comments directly relate to the approach selected for this corridor evaluation:

| | |
|---|---|
| Aesthetic Opportunities | 28% |
| Public Safety | 26% |
| Transportation Operations | 24% |
| Community Impacts | 14% |
| Right of Way Impacts | 4% |
| Sustainability | 3% |
| Environmental (fatal flaw) | 1% |
| Design Standard Conformance | 0% |
| Cost | 0% |

The second public meeting was held the evening of March 31, 2011 within the Board of Supervisors regular meeting room. This meeting was attended by City of Ukiah staff, Mendocino County staff and Consultant team members. The public was not represented despite the advance notice and efforts of the consultant team and county staff.

## 8. ENVIRONMENTAL DETERMINATION/DOCUMENT

A Preliminary Environmental Analysis Report (PEAR) has not been prepared for this project. MCDoT is expecting that the likely document type to be issued is a Categorical Exemption and/or Categorical Exclusion. An Environmental Fatal Flaw Evaluation was carried out during the study conducted by Omni Means. The following is an excerpt from that evaluation.

See Attachment B for the full Environmental Fatal Flaw Evaluation.

**Environmental Issues:**

Alternative 2B

No environmental "fatal flaws" have been identified with Alternative 2B based on a visit to the project site.

Installation of roundabouts under this alternative would require "take" of property from adjacent parcels of land, although the amount of take does seem to be less-than-significant. Additional research is needed on this topic.

Excavation of the soil for installation of roundabouts could also disturb buried cultural resources, although this can be mitigated through the CEQA process.

Alternative 1C

No environmental "fatal flaws" have been identified with Alternative 1C based on a visit to the project site.

However, there could be less-than-significant land use impacts with the construction of medians within North State Street, since existing vehicular movements to and from certain (but not all) adjacent commercial businesses could be restricted. Additional right-of-way acquisition would be required to accommodate a bicycle lane and 7-foot wide sidewalk adjacent to North State Street, which would likely result in a minor land use impact.

There would also be impacts, but less-than-significant, with respect to cultural resources with more trenching and excavation for new ramp construction. Disturbance of the soil could uncover unrecorded archeological or historic artifacts. Appropriate mitigation needs to be identified through a future CEQA process.

Similar to land use impacts, minor loss of land from adjacent properties to provide for a widened sidewalk and bicycle lanes would result with Alternative 1C.

Regarding aesthetics, the addition of more traffic signals associated with Alternative 1C would somewhat degrade the localized aesthetic character of the area by adding more "clutter" to the streetscape.

## 9. FUNDING/PROGRAMMING

It has been determined that this project is eligible for federal-aid funding, although specific funding sources through the 2014 STIP have not yet been determined.

Project Cost Estimates

| Fund Source | Fiscal Year Estimate | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2014 STIP Program | Prior | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | Future | Total |
| Component | In thousands of dollars ($1,000) | | | | | | | |
| PA&ED | | $132 | | | | | | $132 |
| PS&E | | | $336 | | | | | $336 |
| Right-of-Way | | | | $232 | | | | $232 |
| Construction | | | | | $1,425 | | | $1,425 |
| County Share | | | | | | | | |
| Right-of-Way | | | | $32 | | | | $32 |
| Construction | | | | | $195 | | | $195 |
| Total | | $132 | $336 | $264 | $1,620 | | | $2,352 |

For specific work items included in this project, see the construction cost estimates included in Attachment C. Cost estimates adjusted to 2020/2021 construction season.

## 10. SCHEDULE

| Project Milestones | | Scheduled Delivery Date (Month/Day/Year) |
|---|---|---|
| PROGRAM PROJECT | M015 | 10/01/2017 |
| BEGIN ENVIRONMENTAL | M020 | 02/01/2018 |
| CIRCULATE DPR & DED EXTERNALLY | M120 | 11/01/2018 |
| PA & ED | M200 | 01/30/2019 |
| PROJECT PS&E | M380 | 04/30/2021 |
| RIGHT OF WAY CERTIFICATION | M410 | 04/30/2021 |
| READY TO LIST | M460 | 04/30/2021 |
| AWARD | M495 | 05/01/2021 |
| APPROVE CONTRACT | M500 | 09/01/2021 |
| CONTRACT ACCEPTANCE | M600 | 11/01/2021 |
| END PROJECT | M800 | 05/01/2022 |

## 11. RISKS

A formal Risk Register has not been completed at this preliminary stage.

## 12. FHWA COORDINATION

No federal-aid funding has been secured at this time; however, funding sources through the STIP are yet to be determined. No FHWA action is currently required, although this project is eligible for federal aid funding.

## 13. PROJECT REVIEWS

This project has been reviewed by Rex Jackman, District 1 Caltrans Transportation Planning Chief, and Caltrans agrees there is a need for improvement along this corridor. An operational analysis will be completed in the early PE Phase to determine the final design. Further project review will be conducted at that time.

## 14. PROJECT PERSONNEL

The Project Development Team (PDT) will be comprised of the following personnel:

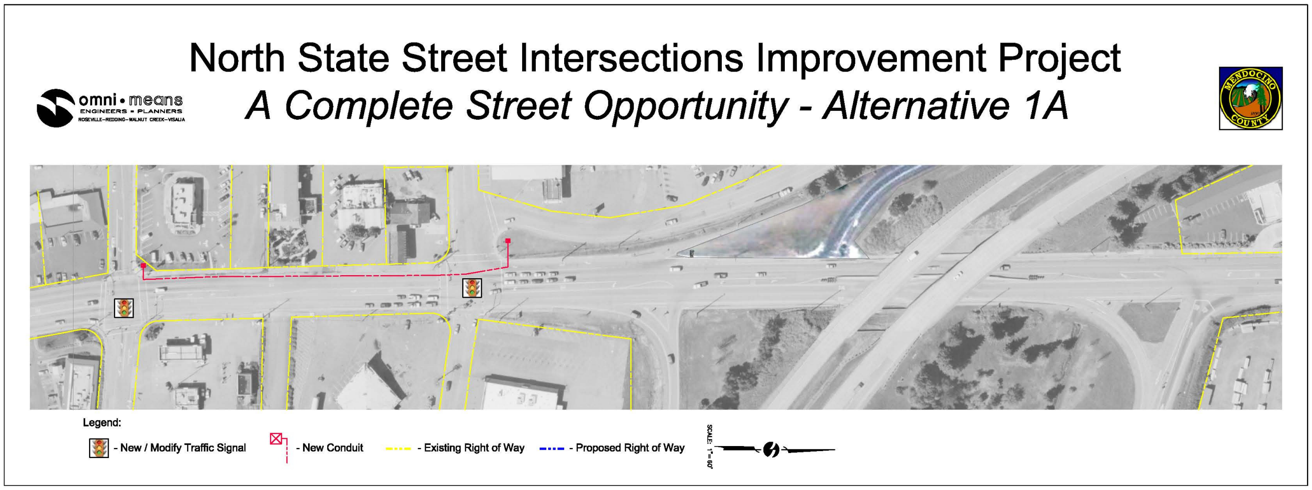
| Name | Title | Phone Number |
|---|---|---|
| Howard Dashiell | Director of Transportation, County of Mendocino | (707) 463-4366 |
| Alicia Meier | Sr. Engineering Technician, County of Mendocino | (707) 463-4352 |
| Rex Jackman | Chief, Transportation Planning, Caltrans District 1 | (707) 445-6412 |
| Phil Dow | Executive Director, Mendocino Council of Governments | (707) 463-1859 |
| Tim Eriksen | Director and City Engineer, City of Ukiah | (707) 463-6280 |

## 15. ATTACHMENTS

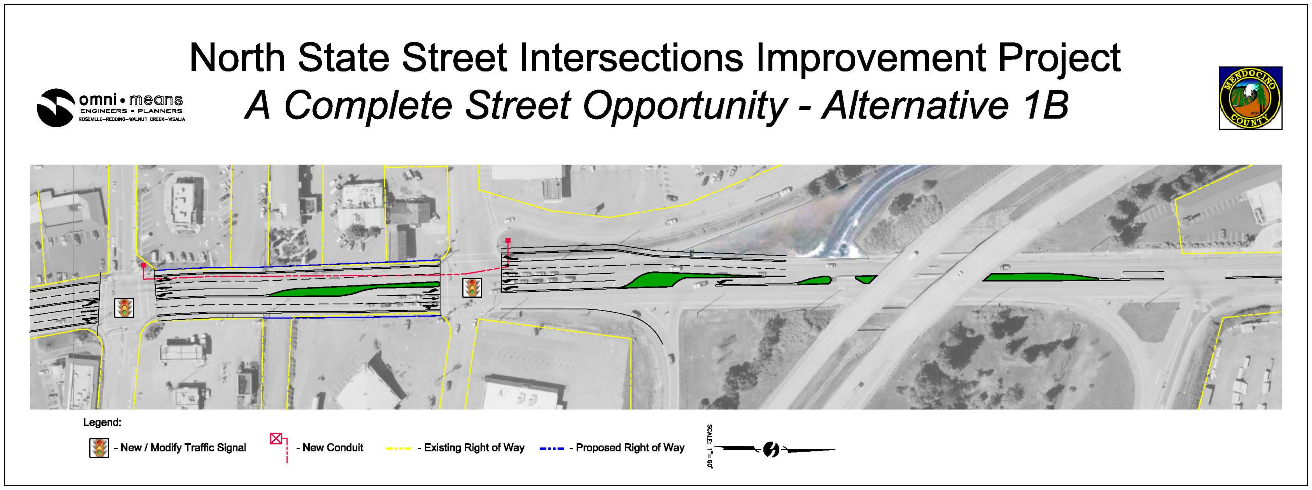
Attachment A: Project Alternatives
Attachment B: Environmental Fatal Flaw Evaluation
Attachment C: Concept Level Cost Analysis
Attachment D: Project Programming Request

## Attachment A:  Project Alternatives

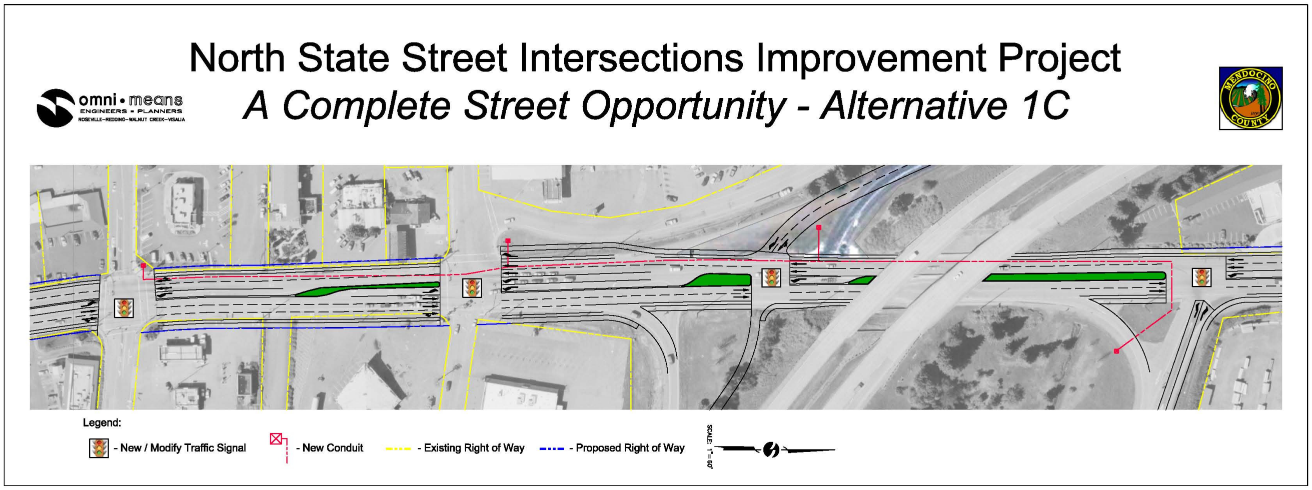
**Concept 1A** – Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections, with traffic signal interconnect between.



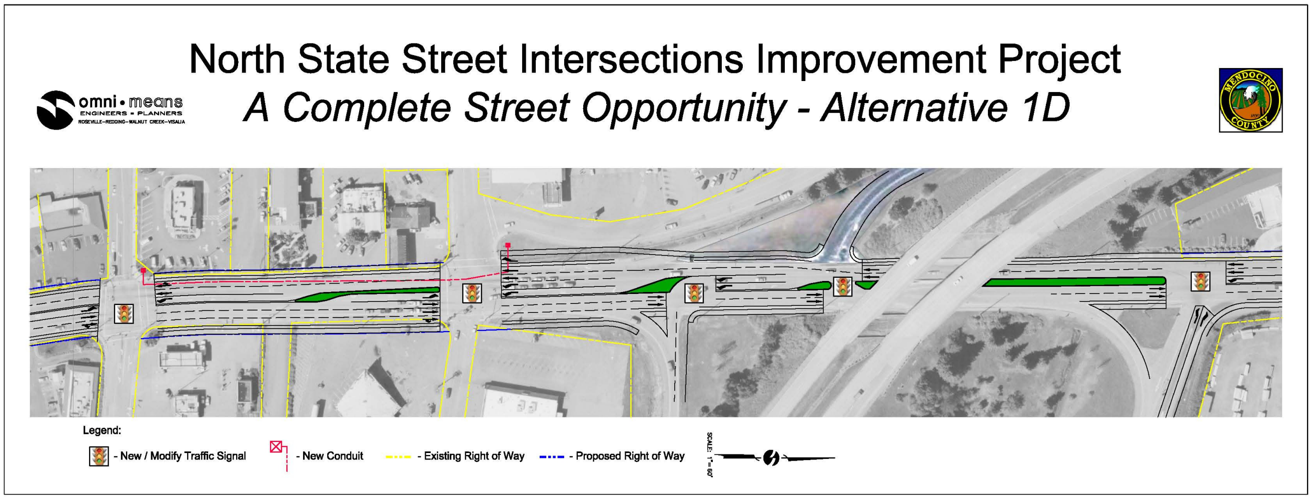

**Concept 1B** - Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections, with traffic signal interconnect between. Includes median improvements through the corridor, medians are primarily for channelization.



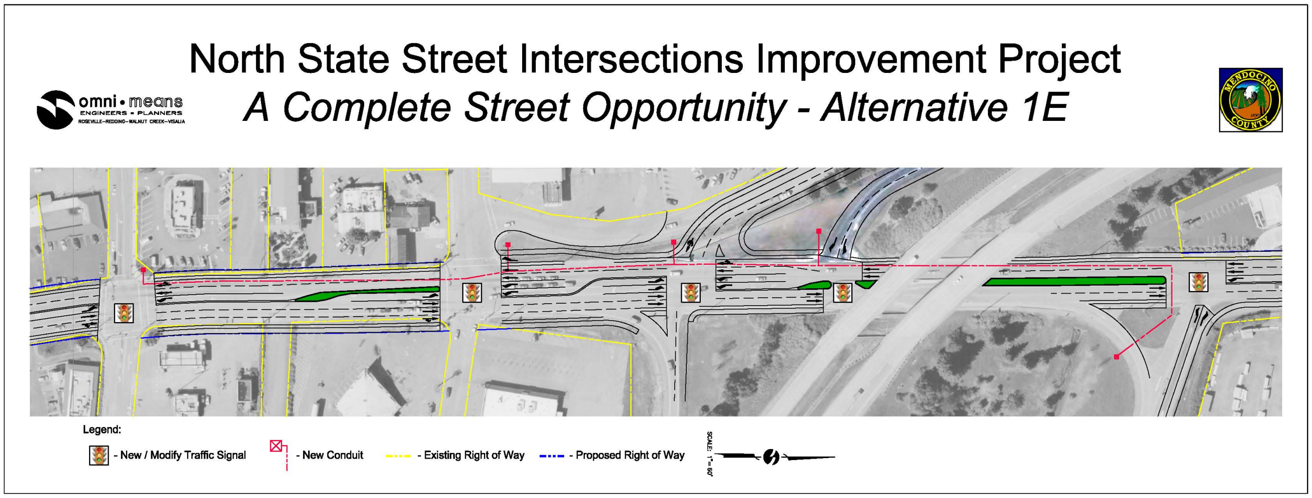
**Concept 1C** – Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at both US 101 ramp terminal intersections, with traffic signal interconnect throughout. This concept also includes the median construction and requires re-alignment to both the southbound on and off ramps to US 101.




**Concept 1D** - Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at all three (3) US 101 ramp terminal intersections, with traffic signal interconnect throughout.

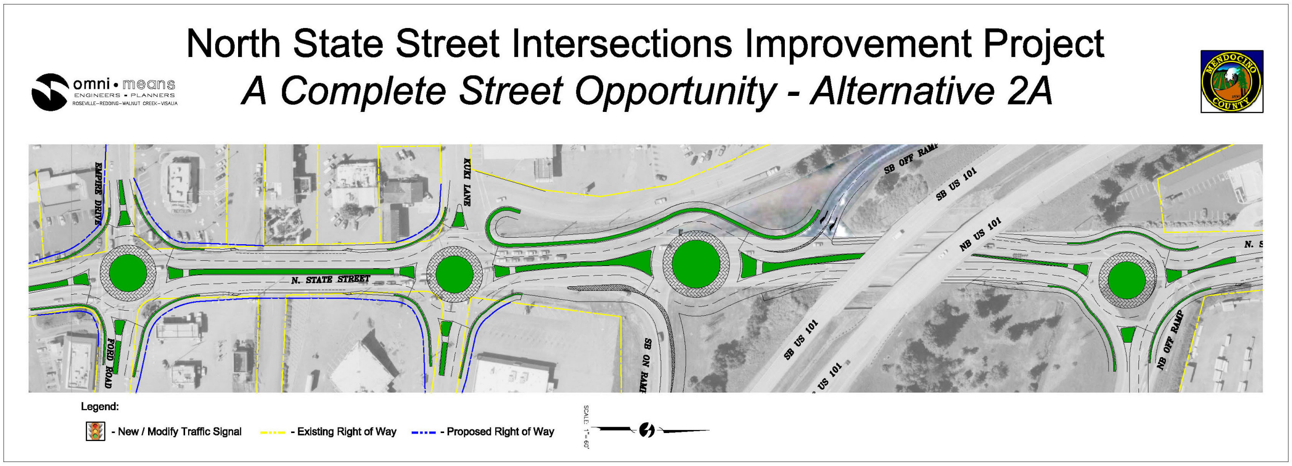


**Concept 1E** – Traffic Signal upgrades to North State Street and KUKI Lane and Ford Road/Empire Drive intersections; new traffic signals at all three (3) US 101 ramp terminal intersections, with traffic signal interconnect throughout. This concept includes the re-alignment of Lovers Lane to the new signalized intersection opposite the southbound US 101 on-ramp.

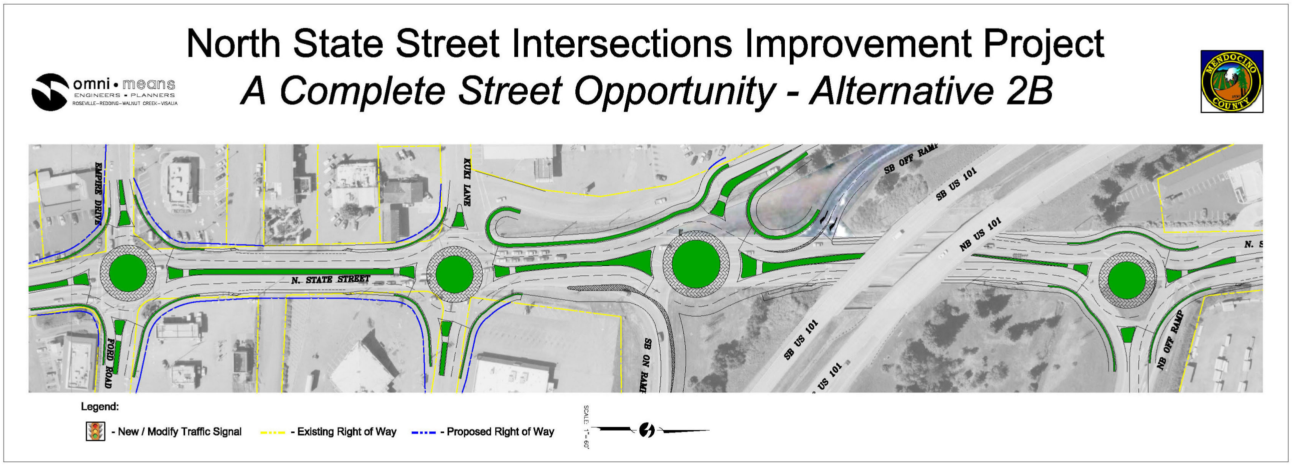



**Conceptual Alternatives 2A - 2C, 2E (Roundabout Concepts)**

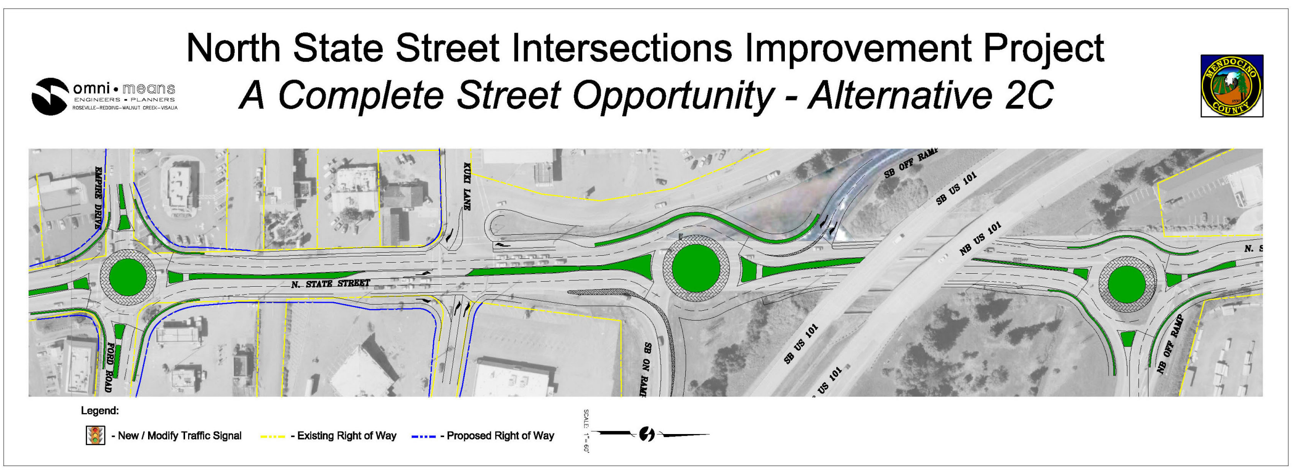
**Concept 2A**– Four (4) roundabouts installed along North State Street at Ford Road/Empire Drive, KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.



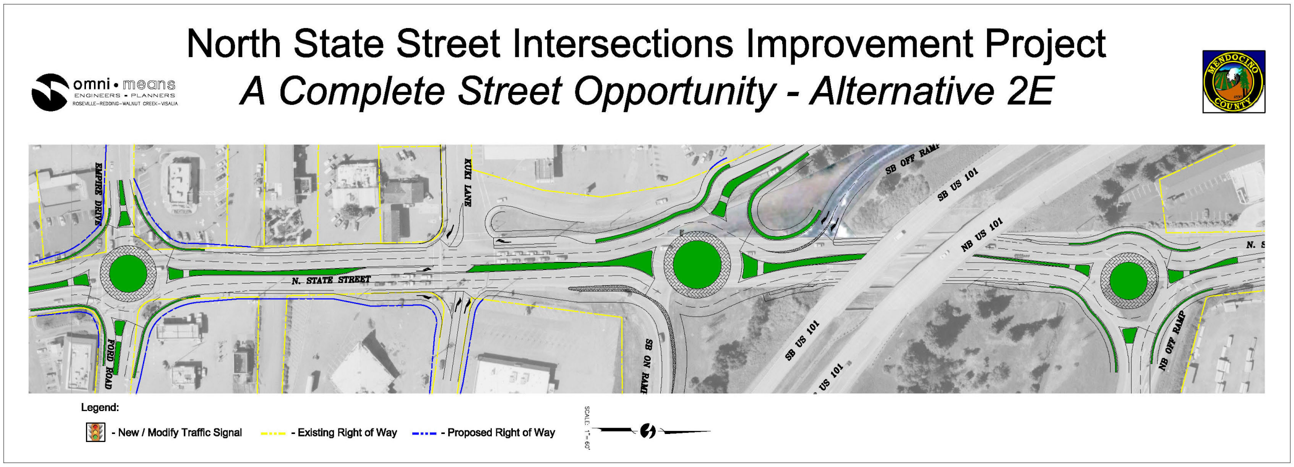
**Concept 2B** - Four (4) roundabouts installed along North State Street at Ford Road/Empire Drive, KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. In addition, this concept provides for the re-alignment of Lovers Lane to the new roundabout located at the Southbound US 101 on-ramp. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.




**Concept 2C** – Three (3) roundabouts installed along North State Street at KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. The intersection of KUKI Lane and North State Street would be limited to right turns in and out and left turn in-bound traffic only. The Ukiah Crossing Shopping Center access at this intersection would be limited to right turns in and out. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.

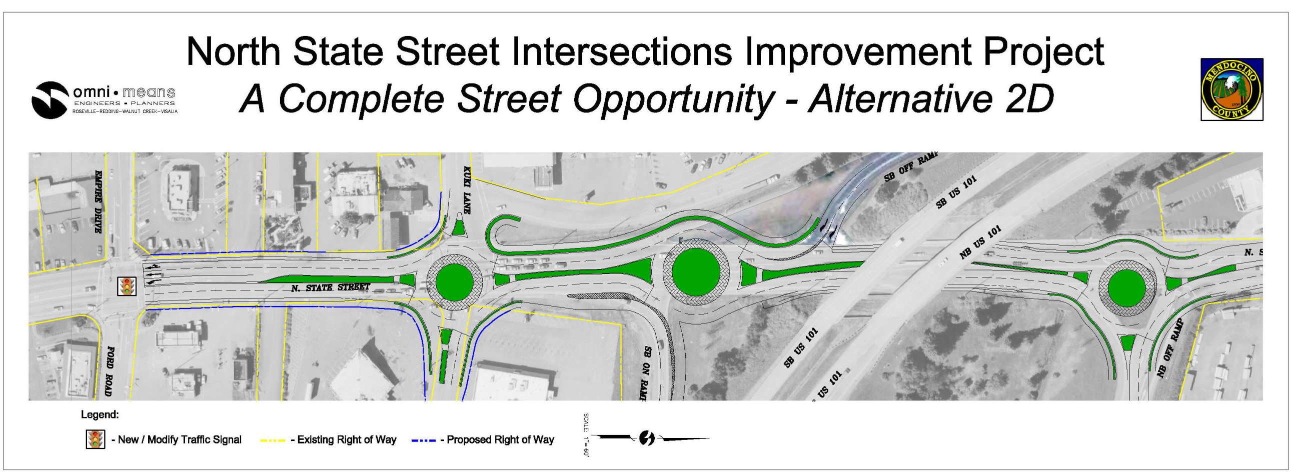


**Concept 2E** - Three (3) roundabouts installed along North State Street at KUKI Lane, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. The intersection of KUKI Lane and North State Street would be limited to right turns in and out and left turn in-bound traffic only. In addition, this concept provides for the re-alignment of Lovers Lane to the new roundabout located at the Southbound US 101 on-ramp The Ukiah Crossing Shopping Center access at this intersection would be limited to right turns in and out. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features




**Conceptual Alternatives 2D (Roundabouts with a Traffic Signal)**

**Concept 2D** – Three (3) roundabouts installed along North State Street at Ford Road/Empire Drive, US 101 Southbound on-ramp intersection and at the US 101 Northbound on/off-ramp intersection. The intersection of Ford Road/Empire Drive and North State Street would remain as a traffic signalized intersection with upgraded traffic signal equipment. This concept includes medians throughout the corridor with center island areas for landscaping and aesthetic features.



## Attachment B: Environmental Fatal Flaw Evaluation

**The environmental Fatal Flaw evaluation was carried out buy Jerry Haag, Environmental Planning located in Berkeley and Healdsburg, California**.

**North State Street**
**Crossroads shopping Center**

**Selection Process document**

**March 21, 2011**

## Environmental Issues

Alternatives 1A through 1E

No environmental "fatal flaws" have been identified based on a visit to the project site with Alternatives 1A-E.

However, there could be less-than-significant land use impacts with the construction of medians within North State Street, since existing vehicular movements to and from certain (but not all) adjacent commercial businesses could be restricted. As associated but likely minor land use impact would be the need to acquire additional right-of-way to accommodate a bicycle land and 7-foot wide sidewalk adjacent to North Main Street.

There would also be impacts, but less-than-significant, with respect to cultural resources with more trenching and excavation for new ramp construction. Disturbance of the soil could uncover unrecorded archeological or historic artifacts. Appropriate mitigation needs to be identified through a future CEQA process.

Similar to land use impacts, minor loss of land from adjacent properties to provide for a widened sidewalk and bicycle lanes would result with Alternatives 1A-E.

Regarding aesthetics, the addition of more traffic signals associated with Alternatives 1C-1E would somewhat degrade the localized aesthetic character of the area by adding more "clutter" to the streetscape.

Alternatives 2A through 2E

Installation of roundabouts under all of the Alternatives would require "take" of property from adjacent parcels of land, although the amount of take does seem to be less-than-significant. Additional research is needed on this topic.

Excavation of the soil for installation of roundabouts could also disturb buried cultural resources, although this can be mitigated through the CEQA process.

Finally, installation of roundabouts could result in less-than-significant impacts to public services by requiring maintenance of landscaping within the roundabouts where no such maintenance is currently needed.

Similar to the analysis of Alternatives 1A through 1E, no environmental fatal flaws have been identified.

**The issue relating to "green house gas" emissions and fuel consumption has become significant factors over the past few years. Several studies have been conducted which analyze the comparative effects of traffic signal operations and roundabout operations. The following treatise is a summary of recent findings on the subject.**

According to a study done by the Environmental Defense Fund, the US accounts for 45% of carbon dioxide emissions worldwide (Freeman). The EPA reported in March of 2006 that 27% of US greenhouse gas emissions from 1990-2003 were from the transportation sector (Greenhouse 1).

As stated by Barry Crown, a roundabout expert from the UK: "When vehicles are idle in a queue they emit about 7 times as much carbon monoxide (CO) as vehicles traveling at 10 mph. The emissions from a stopped vehicle are about 4.5 times greater than a vehicle moving at 5 MPH" (5).

The Bärenkreuzung/Zollikofen project undertaken in Bern, Switzerland, replaced two important signalized intersections by roundabouts and the result was a reduction of emissions and fuel savings by about 17 percent. The roundabouts also steadied the driving patterns (7).

On a micro scale there have been studies conducted on the effect that different traffic flows have on emissions at an intersection. Of the studies that reported quantitative results, roundabouts reduced vehicle emissions for hydrocarbons (HC) in 5 studies by an average of 33 percent, carbon monoxide (CO) in 6 studies by an average of 36 percent, and nitric oxides (NOx) in 6 studies by an average of 21 percent. The regional scale air quality benefits of roundabouts would depend on their percent contribution to regional mobile source emissions (8, 9).

In a study conducted by Mustafa et al. (1993), the authors concluded that there exists a direct relationship between vehicle emissions and traffic volumes at urban intersections regardless of traffic control. Their simulation results showed that traffic signals generate more emissions (almost 50 percent higher) than a roundabout. In case of higher traffic volumes the HC generated by traffic signals is twice as high as that generated at roundabouts (10).

In another study conducted by Varhelyi in Sweden, he found that replacing a signalized intersection with a roundabout resulted in an average decrease in CO emissions by 29 percent and NOx emissions by 21 percent and fuel consumption by 28 percent per car within the influence of the junction (11).

Results of a study conducted by Jarkko Niittymaki show fuel consumption reductions of 30 percent in an intersection designed as a roundabout instead of using traffic signals and environmentally optimized traffic control systems have proved an energy saving potential of 10 percent to 20 percent in different cases (12).

A study was conducted by Kansas State University (*Environmental Impacts of Kansas Roundabouts, September 2003*) at three different locations that were converted from four-way stop control intersections to modern roundabouts. The report found a 38-45 percent decrease in Carbon Monoxide emissions, a 55-61 percent decrease in Carbon Dioxide emissions, a 44-51 percent decrease in Nitrogen Oxides, and a 62-68 percent decrease in Hydrocarbons. Other compiled studies found that when conventional intersections (signalized and unsignalized) are converted to modern roundabouts, there is an average reduction of 30 percent in carbon monoxide and nitrogen oxides, and a 30 percent reduction in fuel consumption. These preliminary conclusions indicate that modern roundabouts significantly reduce the amount of pollutants released into the atmosphere and reduce overall fuel consumption.

A Status Report published by the *Insurance Institute for Highway Safety* in the fall of 2005 (Volume 40, No. 9) studied 10 intersections where roundabouts were considered as alternatives for an intersection improvement project, but ultimately the road authority determined to use traffic signals as the entry control. During this study, researchers estimated vehicle delays and fuel consumption at the existing conventional signalized intersections, and compared them with estimates of what could have been expected if a modern roundabout were chosen as the preferred alternative at the ten intersections.

A key finding from the study indicated that combined vehicle delays at the 10 intersections would have been reduced by 62-74 percent, saving 325,000 hours (or 37.10 years) of motorist's time annually. It was estimated that fuel consumption would have also decreased by about 235,000 gallons per year. Assuming an average cost of $2.50 for a gallon regular gasoline, that is an annual savings of $587,500 for the ten intersections. Since less fuel would have been consumed at modern roundabout intersections, fewer emissions would have been released into the atmosphere.

# Attachment C: Concept Level Cost Analysis

As a part of the Omni Means evaluation, concept level cost estimates were prepared, to allow for a meaningful comparison of the cost impacts of each conceptual alternative under evaluation. These opinions of conceptual level cost are presented below.

**PLANNING LEVEL CONSTRUCTION COST ESTIMATE** — **PROJECT #25-4558-01**
**Mendocino County North State Street Improvement Project** — **CMP #1498**
**Alternative 1A** — **March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 0 | $50.00 | $0 |
| 2 | | Asphalt Concrete (Type A) | Ton | 0 | $90.00 | $0 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 0 | $100.00 | $0 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 0 | $20.00 | $0 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 0 | $28.00 | $0 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 0 | $4.75 | $0 |
| 8 | | Roadway & Intersection Striping | LS | 0 | $15,000.00 | $0 |
| 9 | | Traffic Signal Conduit | LF | 635 | $20.00 | $12,700 |
| 10 | | Landscaping & Irrigation | SF | 0 | $10.00 | $0 |
| 11 | | Right of Way Acquisition (Developed) | SF | 0 | $20.00 | $0 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$232,700** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $93,080 |
| | | **Construction Administration** | | | 10% | $32,578 |
| | | **Design Development/PSE** | | | 25% | $89,590 |
| | | | | | | |
| | | **Alternative 1A Preliminary Total** | | | | **$447,948** |

**PLANNING LEVEL CONSTRUCTION COST ESTIMATE** — **PROJECT #25-4558-01**
**Mendocino County North State Street Improvement Project** — **CMP #1498**
**Alternative 1B** — **March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 177 | $50.00 | $8,863 |
| 2 | | Asphalt Concrete (Type A) | Ton | 0 | $90.00 | $0 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 0 | $100.00 | $0 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2722 | $20.00 | $54,440 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 1,354 | $28.00 | $37,912 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 10,155 | $4.75 | $48,236 |
| 8 | | Roadway & Intersection Striping | LS | 0 | $15,000.00 | $0 |
| 9 | | Traffic Signal Conduit | LF | 635 | $20.00 | $12,700 |
| 10 | | Landscaping & Irrigation | SF | 0 | $10.00 | $0 |
| 11 | | Right of Way Acquisition (Developed) | SF | 1,234 | $20.00 | $24,680 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$406,831** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $162,733 |
| | | **Construction Administration** | | | 10% | $56,956 |
| | | **Design Development/PSE** | | | 25% | $156,630 |
| | | | | | | |
| | | **Alternative 1B Preliminary Total** | | | | **$783,150** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 1C**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,515 | $50.00 | $75,750 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,416 | $90.00 | $127,429 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 1152 | $20.00 | $23,040 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,296 | $28.00 | $64,288 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 17,220 | $4.75 | $81,795 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 1,886 | $20.00 | $37,720 |
| 10 | | Landscaping & Irrigation | SF | 10,680 | $10.00 | $106,800 |
| 11 | | Right of Way Acquisition (Developed) | SF | 9,491 | $20.00 | $189,820 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 2 | $200,000.00 | $400,000 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,461,642** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $584,657 |
| | | **Construction Administration** | | | 10% | $204,630 |
| | | **Design Development/PSE** | | | 25% | $562,732 |
| | | | | | | |
| | | **Alternative 1C Preliminary Total** | | | | **$2,813,661** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 1D**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,054 | $50.00 | $52,693 |
| 2 | | Asphalt Concrete (Type A) | Ton | 888 | $90.00 | $79,954 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2656 | $20.00 | $53,120 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,210 | $28.00 | $61,880 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 16,575 | $4.75 | $78,731 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 1,886 | $20.00 | $37,720 |
| 10 | | Landscaping & Irrigation | SF | 10,680 | $10.00 | $106,800 |
| 11 | | Right of Way Acquisition (Developed) | SF | 9,491 | $20.00 | $189,820 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 3 | $200,000.00 | $600,000 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,615,719** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $646,288 |
| | | **Construction Administration** | | | 10% | $226,201 |
| | | **Design Development/PSE** | | | 25% | $622,052 |
| | | | | | | |
| | | **Alternative 1D Preliminary Total** | | | | **$3,110,259** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 1E**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,314 | $50.00 | $65,714 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,131 | $90.00 | $101,772 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 0 | $300.00 | $0 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2674 | $20.00 | $53,480 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,623 | $28.00 | $73,444 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 19,673 | $4.75 | $93,444 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 1,886 | $20.00 | $37,720 |
| 10 | | Landscaping & Irrigation | SF | 10,680 | $10.00 | $106,800 |
| 11 | | Right of Way Acquisition (Developed) | SF | 9,491 | $20.00 | $189,820 |
| 12 | | Coordinate Existing Signal | EA | 2 | $10,000.00 | $20,000 |
| 13 | | Modify Existing Signal | EA | 2 | $100,000.00 | $200,000 |
| 14 | | New Traffic Signal | EA | 3 | $200,000.00 | $600,000 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,677,194** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $670,877 |
| | | **Construction Administration** | | | 10% | $234,807 |
| | | **Design Development/PSE** | | | 25% | $645,720 |
| | | | | | | |
| | | **Alternative 1E Preliminary Total** | | | | **$3,228,598** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2A**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 6,349 | $50.00 | $317,472 |
| 2 | | Asphalt Concrete (Type A) | Ton | 6,481 | $90.00 | $583,251 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 374 | $300.00 | $112,156 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2979 | $20.00 | $59,580 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,204 | $28.00 | $89,712 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 24,030 | $4.75 | $114,143 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 33,375 | $10.00 | $333,750 |
| 11 | | Right of Way Acquisition (Developed) | SF | 21,044 | $20.00 | $420,880 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$2,225,942** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $890,377 |
| | | **Construction Administration** | | | 10% | $311,632 |
| | | **Design Development/PSE** | | | 25% | $856,988 |
| | | | | | | |
| | | **Alternative 2A Preliminary Total** | | | | **$4,284,939** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2B**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 6,576 | $50.00 | $328,792 |
| 2 | | Asphalt Concrete (Type A) | Ton | 6,711 | $90.00 | $603,976 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 374 | $300.00 | $112,156 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 3333 | $20.00 | $66,660 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,395 | $28.00 | $95,060 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 25,463 | $4.75 | $120,947 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 34,699 | $10.00 | $346,990 |
| 11 | | Right of Way Acquisition (Developed) | SF | 21,044 | $20.00 | $420,880 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$2,290,460** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $916,184 |
| | | **Construction Administration** | | | 10% | $320,664 |
| | | **Design Development/PSE** | | | 25% | $881,827 |
| | | | | | | |
| | | **Alternative 2B Preliminary Total** | | | | **$4,409,135** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Concept 2B -Phase 1**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 1,644 | $50.00 | $82,223 |
| 2 | | Asphalt Concrete (Type A) | Ton | 1,646 | $90.00 | $148,143 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1200 | $100.00 | $120,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 87 | $300.00 | $26,178 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2688 | $20.00 | $53,760 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 1,017 | $28.00 | $28,476 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 7,628 | $4.75 | $36,231 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 14,352 | $10.00 | $143,520 |
| 11 | | Right of Way Acquisition (Developed) | SF | 10,148 | $20.00 | $202,960 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 1 | $100,000.00 | $100,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$956,491** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $382,596 |
| | | **Construction Administration** | | | 10% | $133,909 |
| | | **Design Development/PSE** | | | 25% | $368,249 |
| | | | | | | |
| | | **Phase 1 Preliminary Total** | | | | **$1,841,245** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**PROJECT #25-4558-01**
**Mendocino County North State Street Improvement Project** — **CMP #1498**
**Alternative 2C** — **March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 5,315 | $50.00 | $265,753 |
| 2 | | Asphalt Concrete (Type A) | Ton | 5,344 | $90.00 | $480,946 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 287 | $300.00 | $85,978 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 3213 | $20.00 | $64,260 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,418 | $28.00 | $95,704 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 25,635 | $4.75 | $121,766 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 27,476 | $10.00 | $274,760 |
| 11 | | Right of Way Acquisition (Developed) | SF | 16,603 | $20.00 | $332,060 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,916,227** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $766,491 |
| | | **Construction Administration** | | | 10% | $268,272 |
| | | **Design Development/PSE** | | | 25% | $737,747 |
| | | | | | | |
| | | **Alternative 2C Preliminary Total** | | | | **$3,688,737** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**PROJECT #25-4558-01**
**Mendocino County North State Street Improvement Project** — **CMP #1498**
**Alternative 2D** — **March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 5,070 | $50.00 | $253,510 |
| 2 | | Asphalt Concrete (Type A) | Ton | 5,190 | $90.00 | $467,122 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 287 | $300.00 | $85,978 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 2265 | $20.00 | $45,300 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 2,527 | $28.00 | $70,756 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 18,953 | $4.75 | $90,024 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 26,489 | $10.00 | $264,890 |
| 11 | | Right of Way Acquisition (Developed) | SF | 10,148 | $20.00 | $202,960 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 1 | $100,000.00 | $100,000 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,775,540** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $710,216 |
| | | **Construction Administration** | | | 10% | $248,576 |
| | | **Design Development/PSE** | | | 25% | $683,583 |
| | | | | | | |
| | | **Alternative 2D Preliminary Total** | | | | **$3,417,914** |

## PLANNING LEVEL CONSTRUCTION COST ESTIMATE

**Mendocino County North State Street Improvement Project**
**Alternative 2E**

**PROJECT #25-4558-01**
**CMP #1498**
**March 2011**

| ITEM NO | | ITEM DESCRIPTION | Unit of Measure | Estimated Quantity | Item Price | TOTAL |
|---|---|---|---|---|---|---|
| 1 | | Class 2 Aggregate Base | CY | 5,633 | $50.00 | $281,627 |
| 2 | | Asphalt Concrete (Type A) | Ton | 5,678 | $90.00 | $511,031 |
| 3 | | Reinforced Concrete Pipe Class III (Drainage) | LF | 1800 | $100.00 | $180,000 |
| 4 | | Portland Cement Concrete (Truck Apron Stamped Concrete) | CY | 287 | $300.00 | $85,978 |
| 5 | | Portland Cement Concrete (Central Median & Island Curb) | LF | 3567 | $20.00 | $71,340 |
| 6 | | Portland Cement Concrete (Curb & Gutter, Type 2) | LF | 3,609 | $28.00 | $101,052 |
| 7 | | Portland Cement Concrete (Sidewalk) | SF | 27,068 | $4.75 | $128,571 |
| 8 | | Roadway & Intersection Striping | LS | 1 | $15,000.00 | $15,000 |
| 9 | | Traffic Signal Conduit | LF | 0 | $20.00 | $0 |
| 10 | | Landscaping & Irrigation | SF | 28,800 | $10.00 | $288,000 |
| 11 | | Right of Way Acquisition (Developed) | SF | 14,991 | $20.00 | $299,820 |
| 12 | | Coordinate Existing Signal | EA | 0 | $10,000.00 | $0 |
| 13 | | Modify Existing Signal | EA | 0 | $100,000.00 | $0 |
| 14 | | New Traffic Signal | EA | 0 | $200,000.00 | $0 |
| | | | | | | |
| | | **Subtotal** | | | | **$1,962,418** |
| | | | | | | |
| | | **Construction Contingency** | | | 40% | $784,967 |
| | | **Construction Administration** | | | 10% | $274,738 |
| | | **Design Development/PSE** | | | 25% | $755,531 |
| | | | | | | |
| | | **Alternative 2E Preliminary Total** | | | | **$3,777,654** |

## Attachment D:  Project Programming Request

STATE OF CALIFORNIA ● DEPARTMENT OF TRANSPORTATION

## PROJECT PROGRAMMING REQUEST

DTP-0001 (Revised July 2013) *General Instructions*

| ☑ New Project | | | | | Date: | 2/25/14 |
|---|---|---|---|---|---|---|
| District | EA | Project ID | | PPNO | MPO ID | TCRP No. |
| 01 | | | | | | |
| County | Route/Corridor | PM Bk | PM Ahd | Project Sponsor/Lead Agency | | |
| MEN | | | | Mendocino County | | |
| | | | | MPO | Element | |
| | | | | | | |
| Project Manager/Contact | | Phone | | E-mail Address | | |
| Juan Alvarez | | (707) 463-4351 | | alvarezju@co.mendocino.ca.us | | |

**Project Title**

North State Street Intersection and Interchange Improvements: Phase I

**Location, Project Limits, Description, Scope of Work** ☐ See page 2

The project is located North of the Ukiah city limits long North State Street (CR 104), from its intersection with Ford Road/Empire Drive to the northbound on/off-ramps for U.S. Route 101 at the North State Street interchange. Project will include installing a roundabout (probably single-lane) at the KUKI Lane intersection and installing medians along North State Street through the northbound on and off-ramps to U.S. 101, with center island areas for landscape and aesthetic features.

☐ Includes ADA Improvements ☑ Includes Bike/Ped Improvements

| Component | Implementing Agency |
|---|---|
| PA&ED | Mendocino County |
| PS&E | Mendocino County |
| Right of Way | Mendocino County |
| Construction | Mendocino County |

**Purpose and Need** ☐ See page 2

With growth and development continuing to occur within the City of Ukiah, as well as the adjacent unincorporated area, traffic is forecasted to increase along North State Street. The increase in traffic will degrade traffic operations, increase congestion, and exacerbate existing traffic safety issues. The purpose of this project is to increase public safety for all corridor users, improve the aesthetics of North State Street by revamping the urban streetscape, and improve pedestrian and bicycle access along the corridor.

**Project Benefits** ☐ See page 2

The benefits of this project include an increase in public safety for all corridor users, improvement of the aesthetics of North State Street by revamping the urban streetscape, improvement of pedestrian and bicycle access along the corridor, enhancement of business opportunities along the roadway, improvement of air quality, and reduction in greenhouse gas emissions.

☑ Supports Sustainable Communities Strategy (SCS) Goals ☑ Reduces Greenhouse Gas Emissions

| Project Milestone | | | Proposed |
|---|---|---|---|
| Project Study Report Approved | | | |
| Begin Environmental (PA&ED) Phase | | | 02/01/18 |
| Circulate Draft Environmental Document | Document Type | ND | 11/01/18 |
| Draft Project Report | | | 11/01/18 |
| End Environmental Phase (PA&ED Milestone) | | | 01/30/19 |
| Begin Design (PS&E) Phase | | | 02/01/19 |
| End Design Phase (Ready to List for Advertisement Milestone) | | | 04/30/21 |
| Begin Right of Way Phase | | | 08/01/19 |
| End Right of Way Phase (Right of Way Certification Milestone) | | | 04/30/21 |
| Begin Construction Phase (Contract Award Milestone) | | | 05/01/21 |
| End Construction Phase (Construction Contract Acceptance Milestone) | | | 11/01/21 |
| Begin Closeout Phase | | | 11/01/21 |
| End Closeout Phase (Closeout Report) | | | 05/01/22 |

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STATE OF CALIFORNIA ● DEPARTMENT OF TRANSPORTATION

**PROJECT PROGRAMMING REQUEST**

DTP-0001 (Revised July 2013)

**Date:** 2/25/14

| District | County | Route | EA | Project ID | PPNO | TCRP No. |
|---|---|---|---|---|---|---|
| 01 | MEN | | | | | |
| **Project Title:** | North State Street Intersection and Interchange Improvements: Phase I | | | | | |

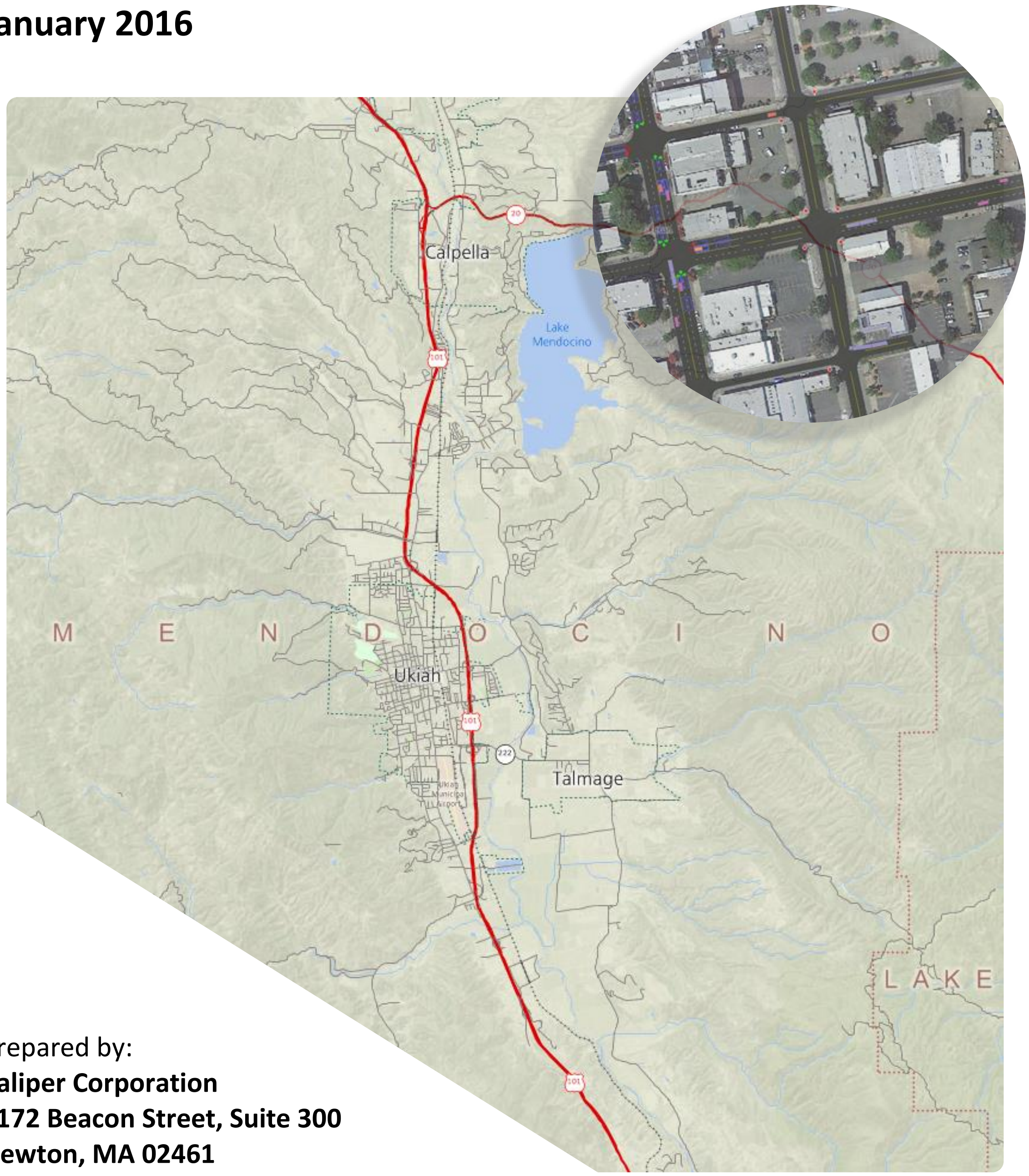
| Proposed Total Project Cost ($1,000s) | | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|
| Component | Prior | 14/15 | 15/16 | 16/17 | 17/18 | 18/19 | 19/20+ | Total |
| E&P (PA&ED) | | | | | 132 | | | 132 |
| PS&E | | | | | | 336 | | 336 |
| R/W SUP (CT) | | | | | | | | |
| CON SUP (CT) | | | | | | | | |
| R/W | | | | | | | | |
| CON | | | | | | | | |
| TOTAL | | | | | 132 | 336 | | 468 |

| Fund No. 1: | | | | | | | | | Program Code |
|---|---|---|---|---|---|---|---|---|---|
| Proposed Funding ($1,000s) | | | | | | | | | |
| Component | Prior | 14/15 | 15/16 | 16/17 | 17/18 | 18/19 | 19/20+ | Total | Funding Agency |
| E&P (PA&ED) | | | | | 132 | | | 132 | |
| PS&E | | | | | | 336 | | 336 | |
| R/W SUP (CT) | | | | | | | | | |
| CON SUP (CT) | | | | | | | | | |
| R/W | | | | | | | | | |
| CON | | | | | | | | | |
| TOTAL | | | | | 132 | 336 | | 468 | |

# *Greater Ukiah Area Micro-simulation Model Final Report*

***Prepared for the Mendocino Council of Governments***

**January 2016**

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## Funding Acknowledgement

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## Executive Summary

In January 2015, the Mendocino Council of Governments (MCOG) retained Caliper Corporation to develop and calibrate a traffic micro-simulation model covering the greater Ukiah area. The area would cover the US 101 corridor between postmiles (PM) 20 and 31.5, or from approximately 5 miles south of the center of Ukiah to approximately eight miles north, and City of Ukiah and Mendocino County streets in between. The model, which begins a bit beyond those limits (from PM 16.7 to PM 32.3) spans the entirety of Ukiah and extends significantly beyond, including coverage of Routes 20, 222, and 253. The model is designed to serve as a complement to the MCOG's and the California Department of Transportation's (Caltrans) current travel demand model for Mendocino County, supporting traffic planning and engineering activities in and around the city.

The **Greater Ukiah Area Micro-simulation Model** (GUAMM) is a microscopic traffic simulation model that is in many respects unlike those that are standard in current micro-simulation modeling practice. Firstly, the GUAMM is different in its combination of geographic scale and highly accurate lane-level roadway geometric detail. Secondly, the GUAMM is capable of simulating route choices in response to shifting congestion patterns that may result from changes in land use or demographic growth. Traditional traffic simulation tools handle route choice poorly or not at all, relying on analyst judgement to specify turning volumes at intersections or entire paths. The scale of the GUAMM and its approach to route choice are critical to analyzing the domino effects that changes in demographics and land use may have across and beyond Ukiah and on US 101 and that are otherwise difficult to foresee.

The GUAMM is designed to work closely with the MCOG travel demand model (TDM). The GUAMM and MCOG TDM are built on a shared geographic information system (GIS) platform. TransModeler, in which the GUAMM has been developed, and TransCAD, in which the MCOG TDM is built, share the same database platform and the same data structures and file formats. This makes it possible to share data, namely origin-destination trip matrices, between the two models. The GUAMM includes every street that is in the MCOG TDM, which itself includes a significant amount of local street detail, and additional streets within the study area limits. Nearly every local street within the study area is included in the GUAMM.

The GUAMM will make it simpler and more cost-effective to perform traffic analyses for projects in and around Ukiah on a consistent basis because all of the data necessary to simulate traffic are assembled in one software environment and because essential model calibration and validation have already been performed. If routinely updated and evolved over time, the GUAMM, like the MCOG TDM, will continue to be of significant value to MCOG, Caltrans, Mendocino County, and the City of Ukiah. By maintaining and improving the model locally, future developments in demographics and land use, traffic management strategies, and roadway improvement projects with city-wide implications can all be studied readily and inexpensively.

This report documents the GUAMM development effort, including the methods used to (1) assemble input and calibration data, (2) develop the simulation model, (3) estimate and calibrate the vehicular traffic demand and driver route choice components of the model using traffic count data, and (4) validate the model using travel time data.

Calibration and validation criteria published by the Federal Highway Administration (FHWA) and Caltrans were targeted in the calibration and validation phases of the project. An extensive traffic count data collection effort was conducted in April of 2015. The traffic count data were used to estimate time-varying origin-to-destination trip matrices for three-hour periods surrounding each of the morning (AM) and evening (PM) peak hours. Simulation-based dynamic traffic assignment (DTA) methods were used to determine the route choices of the estimated trips. Floating car runs with global positioning system (GPS) devices were conducted in the study area to measure travel times with which to validate the simulation model. Calibration measures in terms of percentage error are reported. All calibration and validation targets were met or exceeded.

With a calibrated base-year model in place to establish confidence in the model, future-year scenarios were developed and tested. The future-year scenarios are based on packages of roadway improvement projects in the GUAMM study area. The projects were decided by the technical advisory group (TAG) consisting of members from MCOG, Caltrans, Mendocino County, and the City of Ukiah to represent three scenarios: an *existing+committed* scenario, including projects presently being built or with committed funding sources, an *interim* scenario, including the existing+committed projects and the projects with a reasonable chance of being funded in the near future, and an *optimistic* scenario, including the interim projects and additional projects that might be feasible to build assuming an optimistic funding outlook.

The future-year scenarios were designed to test strategies for managing the city, county, and state transportation infrastructure through horizon years 2020 and 2030 and to demonstrate the GUAMM's ties to the MCOG TDM for planning and forecasting analyses. The MCOG TDM was used to estimate travel demand for the GUAMM study area in the morning and evening peak periods in the future years. Packages of future-year projects were assembled from prior MCOG and Caltrans studies and internal reports to develop scenarios representing increasing levels of investment in transportation projects in and around Ukiah. Various output performance measures, including corridor travel times and corridor and intersection levels of service, were used to demonstrate the benefits of those investments relative to no-build and lower-investment build scenarios. Model results confirm that the projects generally lead to improvements in level of service.

The GUAMM adds considerable scope and value to the range and sophistication of traffic analyses that can be performed by the MCOG, Caltrans, the City of Ukiah, and Mendocino County. But, by virtue of the technology on which the model was developed, there are other substantial benefits that are worth mentioning. The model is built on a GIS and relational database platform, making the model a powerful, lane-level traffic data and signal timing inventory for the greater Ukiah area. The platform also provides an integrated GIS-3D modeling environment that can be leveraged to visualize scenarios and to attract public and stakeholder involvement in the project evaluation process. These and other advantages of the model are described in this report, which includes recommendations for the continued improvement and maintenance of the model.

# 1. Introduction

This report documents Caliper Corporation's methods, experiences, and findings in the development of the **Greater Ukiah Area Micro-simulation Model** (GUAMM), a traffic micro-simulation model of Ukiah, CA. The model was developed for the Mendocino Council of Governments (MCOG) with cooperation and project oversight from District 1 of the California Department of Transportation (Caltrans).

The purpose of the traffic micro-simulation model is to (1) extend and complement the analytical capabilities of the MCOG travel demand model (TDM) and (2) provide a consistent and calibrated base model for conducting detailed traffic impact analyses in the county. The MCOG TDM covers the city of Ukiah, but it also covers the rest of Mendocino County and emphasizes travel at a regional level. The TDM's focus is not exclusively on travel within and to/from the city of Ukiah. Furthermore, the TDM's purview is to forecast traffic volumes and to project travel demand throughout the county based on changes in land use and demographics, not to simulate the effects of those changes on traffic at the operational level. The TDM is, like other travel demand models, not suitable for evaluating operational impacts of projects during the planning process. The GUAMM makes it possible to study and analyze in far greater detail the traffic impacts of population growth, changes in land use, roadway improvements, traffic management and control strategies, and other scenarios whose consequences will affect mobility in and surrounding Ukiah.

However, the GUAMM has many of its roots in the MCOG TDM. For the GUAMM to be a valuable tool for future planning studies, it relies on the travel demand model to produce estimates and forecasts of peak period traffic demand. The GUAMM, however, goes a step further, using traffic count and other data together with state-of-the-art traffic modeling methods to improve upon the TDM's estimates and forecasts. To demonstrate and test the GUAMM's value as a planning tool, future-year scenarios and projects were also developed.

The GUAMM and the methods that were used to develop it present interesting and important technical challenges that are not routinely encountered in the state of micro-simulation modeling practice. However, these challenges were met with a unique and innovative approach. The GUAMM is unique for the following reasons:

First, the GUAMM covers the Greater Ukiah study area in its entirety and spares very little road network detail. It includes all streets in the MCOG TDM, which includes nearly every local street of note in Ukiah, from residential to arterial. This geographic scope, in terms of its comprehensiveness of coverage and level of detail, is not unprecedented, but neither is it commonplace. The model was developed in TransModeler, a GIS for traffic simulation, and its suite of advanced traffic simulation and dynamic traffic assignment (DTA) methods were used to achieve a combined wide area scale and lane-level detail that are highly uncommon in the state of the practice.

Second, the methods used to develop and calibrate the GUAMM are rare in the current state of simulation practice, but are integral to its success. The methods build upon and evolve those applied in previous wide-area traffic simulation projects in Northern California. Those projects include the Greater Eureka Area (GEA) micro-simulation model, developed by Caliper Corporation for the Humboldt County Association of Governments and Caltrans in 2010, and the Lake County Area-wide Micro-simulation Model (LAMM), developed by Caliper Corporation for the Lake County/City Area Planning Council and Caltrans in 2013. Models such as these have only begun to appear in the practice in recent years. There are still very few examples one can look to for direction when estimating, calibrating, or applying wide area micro-simulation models in which route choice is a major component.

While DTA continues to develop into an integral planning tool for evaluating projects, it is still quite rare in the form in which it is used in the GUAMM: in a high fidelity, operationally-sensitive, micro-simulation context. Microscopic traffic simulation-based DTA is a central component of the development and calibration methodology used. In addition to micro-simulation-based DTA, a micro-simulation-based origin-destination matrix estimation (ODME) technique, a tool that exists only in the research and not in any commercial software solution, was employed in the calibration and validation of the GUAMM. The technique was crucial to the calibration of the GUAMM to traffic counts.

Third, MCOG's overall designs for the GUAMM are part of a new and innovative approach to traffic simulation. One of the main objectives of the project is to produce a model that will serve the MCOG, Caltrans, and local governments as a long-term platform for analyzing transportation projects and land use developments, to be maintained and improved on a regular basis in much the same way the MCOG travel demand model is maintained. As part of this report, we make recommendations for maintaining the two models in tandem so that they may continue to add value to one another and to serve the MCOG as powerful decision-making tools. The typical micro-simulation model is discarded when a project is completed and a decision is made, thus representing an expensive analysis step to be retread with each new project rather than a forward-thinking investment. One of the chief advantages of maintaining a current, relevant GUAMM at Caltrans is the ability to, on short turn-around and at low cost, perform state-of-the-art analysis to inform any traffic impact question that comes before MCOG or its partner and member agencies.

In summary, this project, for a variety of reasons, represents an innovative and modernizing development in traffic simulation modeling and as such, is an important example for traffic simulation practitioners considering a similar approach. Like the GEA and LAMM models before it, the GUAMM serves as another case study of a successful integration and application of wide-area microscopic traffic simulation, simulation-based DTA, and GIS.

# 2. Data Assembly and Field Data Collection (Tasks 3-4)

A combination of existing data and new data collected from the field was assembled for the development and calibration of the GUAMM. Existing data, such as aerial imagery and traffic signal timing plans, were needed to build the base model of the road network and traffic control. Data on public transportation systems in the area were also gathered to add to the comprehensiveness of the GUAMM.

To calibrate and validate the model, new data had to be collected. The new data included traffic count data, which would be used to calibrate the traffic demand estimates and route choice parameters, and probe, or floating car, GPS data, which would be used to compute travel times with which to validate the model's calibration.

A more detailed description and file listing of the existing data assembled and field data collected is given below.

## Collection and Assembly of Existing Data (Task 3)

Existing data were used to create the base year simulation model complete with street network geography and lane-level geometry and traffic signal timing plans. The different kinds of existing data that were collected, assembled, and delivered under Task 3 of the project are described in greater detail below.

### *Roadway Geometry and Characteristics Data*

Information about roadway geometry and characteristics was needed to develop an accurate lane-level model of streets in and around Ukiah. The centerline geographic file (ROADS_LOADED_2009.DBD) used in the MCOG TDM in TransCAD was used to establish the minimum set of streets to be included in the model and to determine the functional classes of the streets.

Functional class is especially important because speed limits and free flow speeds are attributes of the road classes assigned to streets in the model. Speed limits directly influence the speeds at which drivers choose to travel when they are not impeded by traffic signals or other vehicles, and free flow speeds are used to compute delays and levels of service. For various reasons, the road classes used in the GUAMM were extended beyond those that were imported were derived from the MCOG TDM centerline geographic file. A more detailed discussion of the road classes in the GUAMM is provided in the *Model Development* section later in this report.

While the MCOG TDM centerline geography was used to for the purposes described, the GUAMM streets were developed by hand using the road editing tools in TransModeler and aerial imagery as a reference for determining shape and geometry. Aerial imagery for the study area was obtained in TransModeler, which uses a high-speed internet connection to download imagery from Google Satellite and other web servers for the visible area in the map window.

### *Historical Count Data*

Historical traffic count data were added to the simulation database, which is the database representing streets and geometry in TransModeler, as attributes of the road segments where that they can be queried, sorted, and charted in the software. By populating the simulation database with the count data, the model can double as an inventory of traffic counts for the Ukiah area. A handful of directional traffic count spreadsheets and turning movement count spreadsheets for various streets and intersections respectively, were received from Caltrans for this purpose. These were not used in the calibration of the model.

### *Signal Timing Data*

Signal timings for the base year 2015 model were assembled for intersections in the study area from plans maintained by Mendocino County and the City of Ukiah. The data was received in PDF format for all intersections. According to the timing plan data, all of the signalized intersections in the GUAMM appeared to run “free” (i.e., are not coordinated with other intersections) and thus did not vary by time of day. Many timing sheets were scanned paper copies of signal timing parameters. However, none of the data included detector configuration plans or specifications, which would have been useful in developing the model of the signals’ operations in the GUAMM. In the absence of detector configuration data from any other source, detector placements similar to those in the GEA and Lake County micro-simulation models were assumed. The road editing tools in TransModeler were used to create sensor devices that would be used to accurately simulate detector actuations. The signal timing plans were entered by hand into the model using the intersection control editing tools in TransModeler. If properly maintained, the simulation model may serve as a warehouse for accurate signal timings in the greater Ukiah area going forwad.

## Field Data Collection (Task 4)

One virtue of the ODME and route choice calibration methodology described later in this report is that it requires the collection of only traffic count data from the field. Traffic counts can be relatively inexpensively collected.

Traffic counts are commonly used to estimate origin-destination matrices, or trip tables. There are various well understood shortcomings of ODME methods, including the one used in this project. These limitations are summarized below:

(1) Counts reveal neither the origins and destinations of vehicles nor their routes.
(2) Poor coverage of the study area may leave links on key routes between origin-destination pairs without counts, and this will degrade the quality of the ODME solution.
(3) Analysts are tempted to combine counts from different days, or even years, to increase coverage, or to average counts together to reflect an "average" day, yielding counts that, taken together, do not represent any observed reality.

These limitations are sources of error, uncertainty, and inconsistency in the ODME solution. It is thus important to understand these limitations designing a traffic count data collection plan for ODME.

A traffic count data collection plan was developed with the objective of capturing, to the extent possible, the pattern of traffic flow and distribution throughout the Greater Ukiah study area. The types of count data collected are listed below:
(1) Volume data was collected at 7 locations on US 101, including south and north of Ukiah and at strategic positions in between, with emphasis on observations nearer the center of Ukiah.
(2) Directional counts were collected at an additional 36 locations including US 101 on- and off-ramps and some surface streets.
(3) Turning movement counts were collected at every signalized intersection and a selection of US 101 interchange ramp terminals.

The ODME methodology uses all these counts, but turning movement counts are generally more valuable. These reveal turning movement volumes in addition to total directional volumes, but are more expensive to collect because they generally require a human to count turning vehicles in the field or while watching a video recording of the intersection. Thus, a balance of different types of counts was maintained in an effort to maximize the benefit of every dollar spent collecting count data.

The traffic count data collection was subcontracted to National Data and Surveying Services (NDS). A full listing of the sites where NDS collected counts is provided in Appendix A.

### *Volume (and speed) data on US 101*

Volume data on US 101 were collected using Wavetronix SmartSensor radar traffic detectors because they do not require encroachment into the right of way, which is not permitted on limited access facilities for safety reasons. The volume data were used in the calibration process. Speed data were also recorded by the SmartSensor units, but after inspection were not used in the calibration or validation process. Rather, travel time data, described later in this report, were used for validation. It can be observed from the SmartSensor speed data, which are also in the simulation database, do not reveal any particularly meaningful pattern over time. Speeds measured on US 101 and averaged across 15-minute intervals very seldom fell below 60 mph for any 15-minute period.

Because of the limited number of Wavetronix units at NDS' disposal, data were collected at the five locations nearest to the center of Ukiah on April 28 and 29, simultaneously with all turning movement and directional count data. Data were collected at the two remaining sites – near the boundaries of the study area north and of Ukiah – the following Tuesday and Wednesday May 5-6, 2015.

Volume and speed data were recorded and reported in 15-minute intervals continuously across 48 hours, and the 15-minute data during three AM peak hours (6:00 – 9:00) and three PM peak hours (3:00 – 6:00) can be found in the GUAMM simulation database.

### *Directional counts*

Machine counts that use pneumatic tubes laid across the road were deployed to collect directional counts at 26 locations on US 101 entrance and exit ramps and at 10 locations on arterials. Like the Wavetronix data on US 101, the directional counts were reported in 15-minute intervals over a 48-hour period. Classified counts were collected at all 26 ramp sites. The classified count reports summarize numbers of vehicles in each 15-minute interval belonging to one of the following 11 classifications:

1. Bike
2. Passenger car
3. Long passenger car
4. Bus
5. Two-axle, Six-tire
6. Three-axle, Single-unit
7. Four-axle, Single-unit
8. Five-axle, Double-unit
9. < Six-axle, Multi-unit
10. Six-axle, Multi-unit
11. > Six-axle, Multi-unit

### *Turning Movement Counts*

Video cameras were used to record intersection turning movement volumes at 18 intersections in the study area. NDS staff used manual counters to count the turning movement volumes while watching the video footage back in the office. Turning movement volumes were thus successfully recorded for all intersections for both days of data collection. The counts were reported in 15-minute intervals and were successfully imported into turning movement tables in the GUAMM for use calibrating the model.

### *Traffic Count Data Errors*

The data were collected on Tuesday and Wednesday April 28-29, 2015 in order to capture a typical weekday in spring. As with any data collection effort, the possibility of data loss or omission due to external factors has to be considered. This was the reason that in each type of count data, two days were planned as a minimum to protect against weather, incidents, or equipment malfunction.

All Wavetronix count data on 101 and video footage of intersection movements were successfully collected, with no apparent equipment failures or inconsistencies in the resulting count data. Tube counts were successfully collected, with only one isolated equipment failure in which the hose was found removed from the machine on the southbound Route 101 off ramp at Burke Hill Road. The problem was corrected and valid data were recorded the following Tuesday and Wednesday, May 5-6.

### *Travel Time Data*

The principal role of the traffic count data was to calibrate the micro-simulation model to ensure that simulated volumes matched well with field measurements. To validate the model, that is, to ensure that the model is robust enough to match more than one set of data, travel time data were collected by performing probe vehicle, or floating car, runs. Subconsultants TJKM drove cars northbound and southbound along sections of US 101 and State Street in both the AM and PM peak periods. The data received from TJKM included travel time and delay reports generated by Tru-Traffic software and the raw GPS tracks, in comma-separated value (CSV) text file format, on which those reports are based.

More about the travel time data collection is discussed with the validation findings later in this report.

### *Saturation Flow Data*

Video footage of seven of the intersections where turning movement counts were recorded were requested and received from NDS. Those intersections included:

1. North State Street & Empire Drive
2. North State Street & Low Gap Road
3. Orchard Avenue & Perkins Street
4. State Street & Perkins Street
5. State Street & Gobbi Street
6. Orchard Avenue & Gobbi Street
7. Airport Park Boulevard & Talmage Road

The video data were used to measure queue discharge headways as part of the calibration task. This in turn was used to adjust driver behavior parameters in TransModeler so that simulated saturation flow rates matched those that were observed.

From the headways computed, however, there did not appear to be any compelling reason to believe that driving behavior was markedly different than that observed in Eureka, CA or Lake County, CA in the development of similar models by Caliper Corporation. Thus, the same driver behavior parameters from those projects were assumed.

A more thorough accounting of all the parameters modified in the GUAMM is provided in Appendix C.

## 3. Model Development (Task 5)

The GUAMM was developed using the input data assembled. First, the road network was developed by hand with road editing tools in TransModeler, with aerial imagery as a reference to determine roadway and intersection geometry and the MCOG TDM street centerline geography as a reference to determine the minimum set of streets to be included and road classification.

Second, the MCOG TDM streets were also used to determine the location and placement of centroids of traffic analysis zones. Centroids were connected to streets based on visual identification of land uses in the aerial imagery and where those land uses provided access to streets in the model (e.g., via on-street parking or off-street parking).

As additional existing data were gathered, including signal timing plans, the model was further developed to incorporate the new information. The steps that were taken to develop the various elements of the GUAMM are described in further detail below.

## Street Network Development

The geographic line layer representing the street network in the MCOG TDM in TransCAD was used as a reference to determine the minimum set of streets to be included in the simulation database in the GUAMM study area. In a map, the TDM street centerlines were overlaid with aerial imagery from Google Satellite. The imagery was used as a reference to create the streets in the simulation database and define the roadway and intersection geometry with road editing tools in TransModeler.

With the road editing tools, model road segments were drawn by hand to align to the roads in the imagery, and intersections were enhanced with turning lanes and appropriate lane connections.  The downstream ends of road segments were also aligned with stop bars where they were visible in the aerial imagery so that the locations of stop bars in the model would reflect ground truth. In some instances, where approaches to intersections with highways are flared to accommodate a right-turning vehicle adjacent to a through- or left-turning vehicle, an additional lane was added in the simulation model to approximate the added capacity afforded by the geometry. For an example of flared right turn geometry at the intersection of North State Street and Orr Springs Rd, see Figure 3-1.

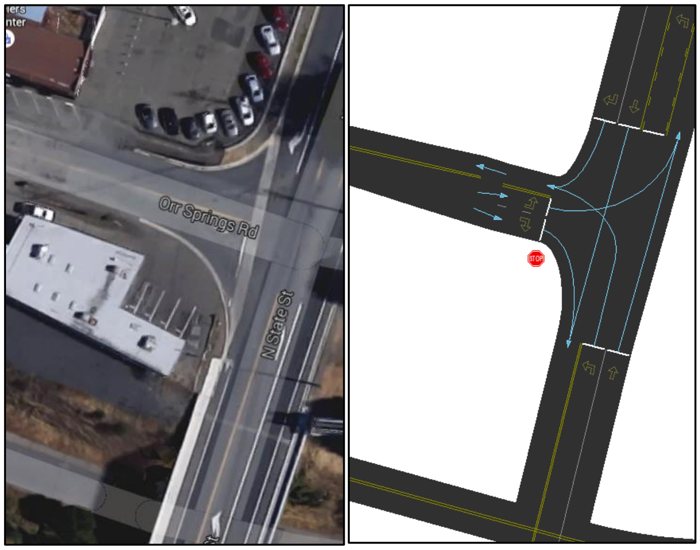


Figure 3-1. Flared right turn at North State & Orr Springs Rd

Solid stripes were added for turning lanes using the lane prohibition option. Segments were split wherever a change in the number of lanes was present. Center two-way left turn lanes (TWLTLs) were also created.

To thoroughly check the database after the streets were created, a network error checking utility in TransModeler was used. This ensured that there were no missing lane connections, unnecessarily short segments, or geometry errors.

### *Roadway Functional Classification*

Determining and applying the appropriate roadway functional class applied to links in TransModeler has an important influence on driver behavior in the model. Perhaps more important to the GUAMM than any other functional class attribute is speed limit. In the micro-simulation model, a driver's desired speed, the speed at which the driver will travel in the absence of the influence of traffic signals or other vehicles, is a function of the speed limit, with more conservative drivers adhering closely to the speed limit and more aggressive drivers traveling faster.

The road classification in the GUAMM network deviates from the MCOG TDM primarily where arterials are concerned. The arterial classification in the GUAMM is more varied than that of the TDM. Initially, arterials in the GUAMM were identified as only major and minor classes. However, a virtual survey of major and minor arterials in Google's Street View revealed relatively frequent changes in speed limit, often over short distances. As part of the validation effort, which was aimed at matching travel times in the model with those measured in the field, it was critical that the model have an accurate and localized representation of speed limits. To better account for speed limit, we introduced three new arterial classes, Semi-urban Arterial, Urban Arterial and Downtown Arterial, to support arterial road classes with three different speed limits.

In addition, a Rural Highway class was introduced in the GUAMM to account for speed limit differences between different classes of highway. Another road class named "Access Road" was used to represent the numerous prominent side streets and driveways throughout the study area that did not appear in the MCOG TDM model but were added in order to accurately represent geometry near intersections or places for centroid connectors to connect to represent local land uses.

Table 3-1 lists the set of road classes in use in the GUAMM, the speed limits for each and the numbers of links using each class.

Table 3-1. Functional road classes used in the GUAMM

| Class Name | Speed Limit | Number of Links | Miles |
|---|---|---|---|
| **Access Road** | 25 | 106 | 2.82 |
| **Collector** | 40 | 52 | 24.47 |
| **Downtown arterial** | 25 | 11 | 0.42 |
| **Freeway** | 65 | 45 | 30.01 |
| **Local Street** | 25 | 952 | 95.44 |
| **Major Arterial** | 45 | 25 | 6.61 |
| **Minor Arterial** | 40 | 71 | 26.73 |
| **Ramp** | 40 | 69 | 8.27 |
| **Rural Highway** | 55 | 1 | 0.14 |
| **Semi-urban arterial** | 35 | 33 | 3.55 |
| **Urban arterial** | 25 | 202 | 15.34 |
| Total | **--** | **4,339** | **726.34** |

### *Continuous Two-Way Left Turn Lanes*

Continuous two-way left turn lanes (TWLTLs) are also explicitly represented in the GUAMM road network. Because of their prevalence, particularly on State Street and Gobbi Street, as well as other non-arterial streets in the study area, TWLTLs were deemed an important feature of the road system in study area, better to be represented and simulated directly rather than approximated by other means such as alternating one-way left turn bays. Figure 3-2 illustrates a TWLTL on Gobbi Street between Leslie Street and Orchard Avenue.


Figure 3-2. A continuous two-way left turn lane on Gobbi Street

## *Road Network Attributes*

In the process of developing the road network, fields were added to the attribute table for street segments in the simulation database in order to facilitate calibration. In the segment table, there are field pairs representing measured traffic counts and speeds, where the pairs store data for each direction on a street segment. Records in the road network database representing one-way streets (e.g., US 101 and ramp links) contain data in only one field per pair.

Count and speed field pairs are prefixed with “AB” to indicate the direction from a database-designated A node to a database-designated B node and “BA” for the reverse direction. Two additional fields indicate the source of the count and speed data: “ADTSourceFile,” which stores the file name of the spreadsheet containing the source traffic counts collected from tube/machine counters, and “WavetronixSourceFile,” which stores the file name of the spreadsheet containing the source traffic counts and speeds collected using microwave Wavetronix data collection units used on US 101.

Following the direction prefix AB or BA, the field pairs have the name “count” or “speed,” which is in turn followed by the clock time (e.g., 1715 = 5:15 PM) indicating the start time of the 15-minute interval in which the count or speed was observed. Counts are numbers of vehicles observed in each 15-minute interval, and speeds are in miles per hour averaged across those vehicles. Fields summarizing counts in one-hour intervals spanning the AM and PM peak periods observed can also be found in the table.

## Transit Network Development

A model of the Mendocino Transit Authority’s (MTA) bus services in Ukiah was developed with the following steps:

1. Public transportation route and service (i.e., schedule) data in General Transit
2. Feed Specification (GTFS) format was obtained from the GTFS Data Exchange website: http://www.gtfs-data-exchange.com/agency/mendocino-transit-authority/ (referral by Mendocino Transit Authority web site: http://mendocinotransit.org/developer/).
3. The routes and stops from the GTFS data were imported.
4. The route and stop locations as well as attributes were manually corrected with the assistance of Mendocino Transit Authority (MTA) maps and schedules.

The route system that is developed in the steps above is a system of geographic layers representing routes and stops. Figure 3-3 depicts Route 9 (Ukiah Local) in the GUAMM.

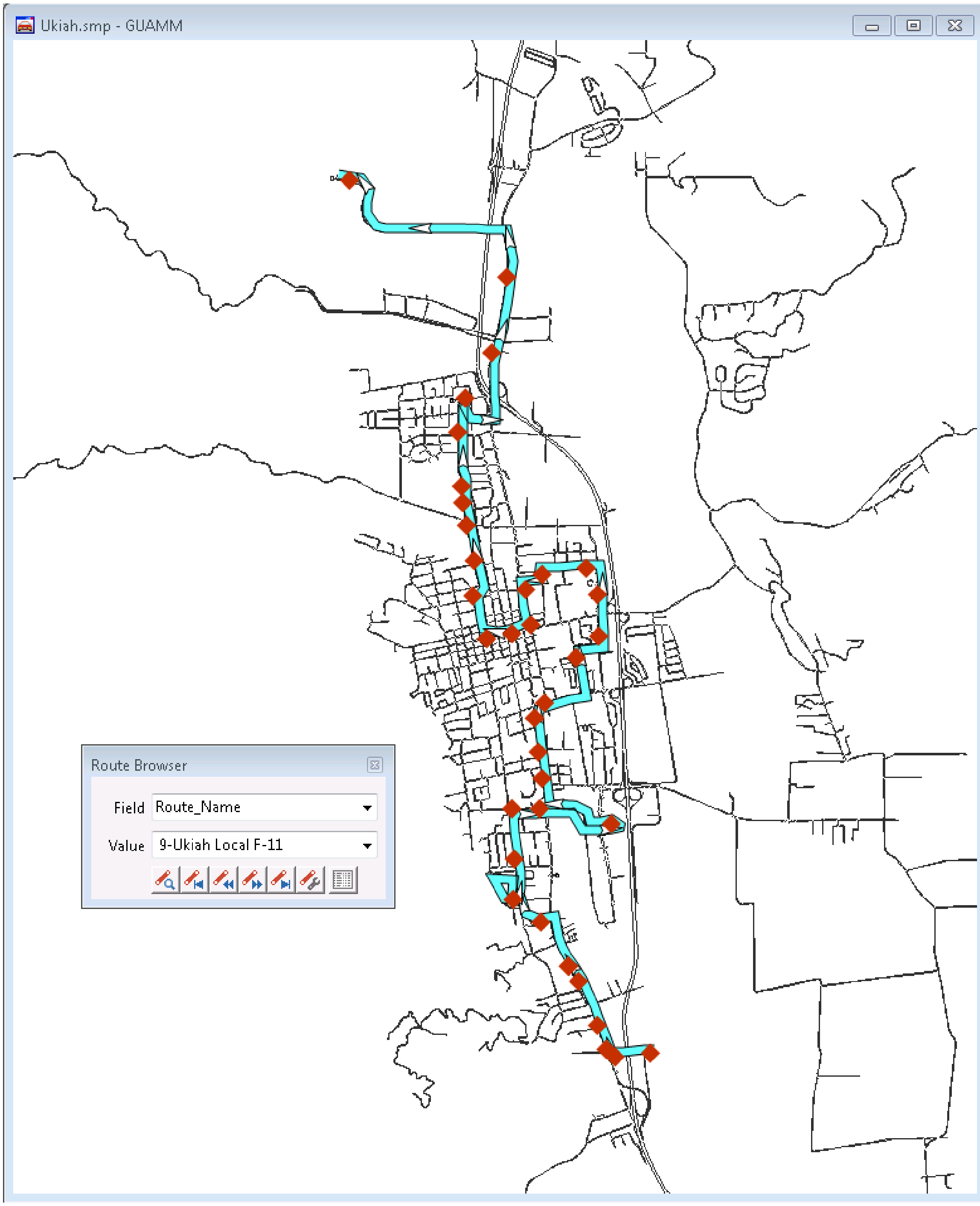

Figure 3-3. One of the routes in the GUAMM route system

## Traffic Signals

Signal timing data for the GUAMM was obtained from Caltrans, the City of Ukiah, and Mendocino County. With the intersection control editing tools in TransModeler, the signal timings were entered into the model.

All signal timings in Ukiah were obtained in PDF format without detector configuration information. Hence, common Caltrans detector geometries, similar to those found in Eureka, CA and in towns in Lake County, were assumed. All signal timings were found to run free (i.e., not in coordination). Figure 3-4 illustrates the signal timing plan and detector layout at State Street and Perkins Street.

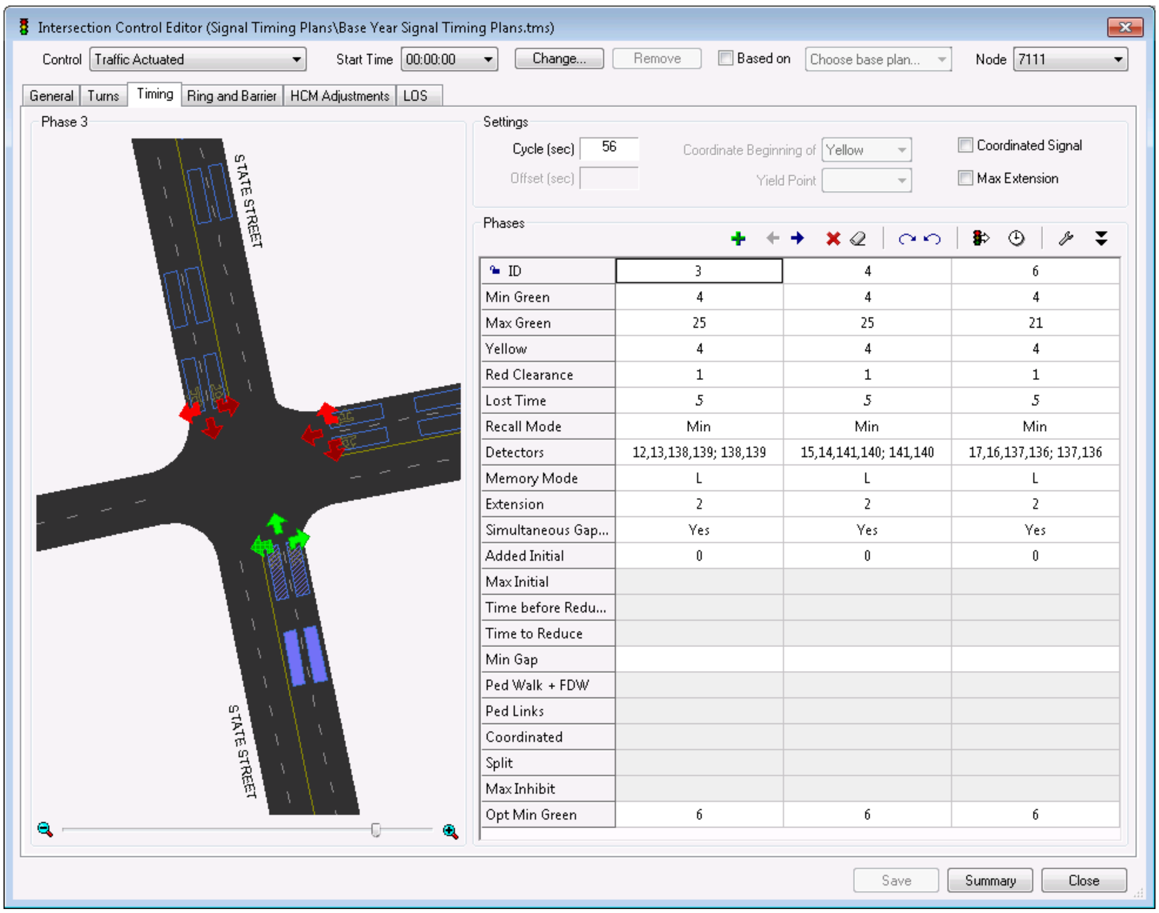


Figure 3-4. Signal data in TransModeler at Perkins and State

## 4. Calibration (Task 6)

The primary focus of the model's calibration was to estimate numbers of trips by origin and destination and the route choices made by those trips such that the simulated volumes match traffic counts collected in the field. The MCOG TDM was used to produce initial estimates of the numbers of trips, and traffic count data were used to improve those estimates using a trip-based and simulation-based dynamic ODME technique, the output of which are origin-destination (OD) matrices of trips in small time intervals. A simulation-based DTA was then used to predict the route choices for all trips.

Once a model is calibrated one set of data, good practice is to validate the model against another set of data. To calibrate and to validate is to establish confidence in the model's predictive power for estimating traffic impacts and operational implications of proposed roadway projects, proposed land use developments, and demographic growth.

The methodology used to develop and calibrate the model is designed to answer two questions, the answers to which are inextricably linked and interdependent:

(1) What are the volumes of vehicles travelling between origins and destinations in the network by time of day?
(2) What are the likely routes drivers take between those origins and destinations?

For compatibility with the MCOG TDM, the origins and destinations are assumed to be the centroids of traffic analysis zones (TAZs) defined in the TDM as well as nodes at the ends of street segments on the boundary of the GUAMM study area (e.g., the northern and southern ends of US 101), which interface with the surrounding, county-wide TDM street network.

The challenges in answering these questions stem mostly from limitations in existing methodologies and in the data that is typically used to answer these questions. To understand the trip pattern and route choices of drivers in a region, it is imperative to directly observe the origins, destinations, and routes. This can be achieved with license plate surveys, for example. Other inventive methods have been used that track or match the identities of vehicles observed at different locations at different times, such as video recorded from airplanes circulating above a site. However, to take enough measurements of origin-destination data for a wide and dense network like that in the GUAMM be prohibitively expensive. In the GUAMM's calibration, traffic counts were relied upon as the principal source of information for estimating the traffic demand and calibrating the route choice parameters.

## Methodology

The methodology used to estimate the time-varying OD matrices of trips and to calibrate the route choices for those trips in the GUAMM is summarized in Figure 4-1.

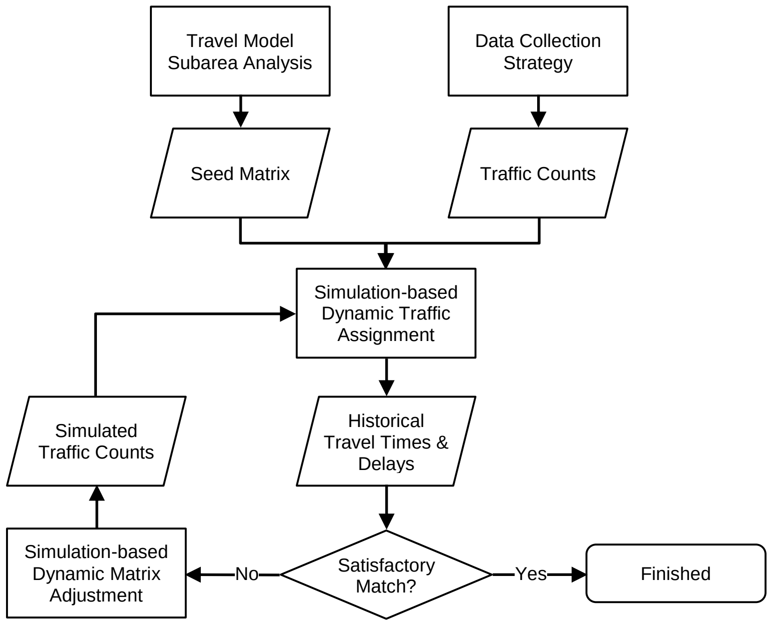


Figure 4-1. Flow diagram illustrating calibration methodology

At the center of the methodology is a feedback loop between a simulation-based DTA, which adjusts the route that trips follow, and a simulation-based ODME procedure, which adjusts the input trip matrix to better fit observed traffic counts. The dynamic ODME uses the route and travel time information generated by the DTA to determine the routes drivers will take, and adds and remove trips in order match the counts on those routes inside of fifteen-minute time bins. These adjustments to the trip matrix may result in changes in congestion patterns, and thus travel times, and therefore must be then fed back to the DTA step.

This procedure continues iteratively until the match between the volumes simulated from the estimated matrix and the counts cannot be improved further. Three limitations with these methods are often overlooked but are important to understand:

(1) The matrix solution is heavily influenced by the matrix used in the initial loading (i.e., the *seed* matrix).
(2) Volumes in a cell in the matrix are adjusted based on the flows and counts on links on the used path(s) between the corresponding OD pair, but volumes by themselves do not reveal routes, origins, or destinations.
(3) No unique solution can be proven to exist, meaning that any number of matrices might match the counts equally well. In other words, a good match with the counts does not in and of itself prove a good estimate of the trip pattern.

The seed matrix that is of such critical importance to the quality of the ODME solution is usually produced by a subarea analysis in a travel demand model. Thus, a poorly calibrated travel demand model can be a source of error in the ODME solution. Put another way, error in the MCOG TDM will propagate to the GUAMM. Effective use of ODME requires a thoughtful consideration of these limitations.

The current state of the practice is to use a static (i.e., one time period) ODME procedure that relies on an analytic loading of volumes onto the network based on a relationship between travel time and volume-to-capacity ratio. When trips cannot be assigned to a different path and improve their travel time, User Equilibrium (UE) is achieved. But, drivers choose their routes differently in the real world. Drivers make independent route choices based on imperfect information and a universe of personal preferences and experiences that would be difficult to enumerate. Route choice-driven simulation models like the GUAMM seek to simulate that behavior. Both the static ODME and the simulation model are premised on the idea that drivers choose routes that minimize their travel times, but the link volumes in the simulation model are the collective result of the independent decisions of discrete, individual drivers, whereas the link volumes in a static ODME are determined by analytical methods that divide fractions of vehicle trips between alternative routes in order to achieve a system-wide objective function (i.e., UE). Thus, the volumes on each link in a dynamic simulation model will not be the same as those resulting from a traditional static traffic assignment. This inconsistency can further complicate the calibration process.

The ideal solution to this inconsistency is an ODME procedure that is simulation-based. Such a method is not found in the state of the practice, and no such procedure is commercially available. However, a simulation-based ODME technique that has been developed and evolved in prior projects at Caliper was applied in the GUAMM's calibration and validation.

## Subarea Analysis

The ODME methodology, which is described in greater detail below, is an iterative process that begins with an initial estimate of the traffic volumes traveling between origin and destination TAZs over the entire analysis period. That estimate is adjusted and refined iteration by iteration to improve the match between counts and model volumes. An initial estimate of the matrix is thus required. The quality of this initial, or "seed," matrix has a significant influence on the outcome of the ODME. Generally, the source for one's best estimate of the OD travel pattern in any study area is the local or regional travel model. Accordingly, the MCOG TDM is the source of the seed matrix for the GUAMM.

A subarea analysis is little more than a traffic assignment of the kind executed in the MCOG TDM to predict traffic volumes on links in the road network. However, additional bookkeeping is performed to determine the OD volumes entering and leaving the chosen subarea, or study area of interest. The "QuickSum" matrices in the MCOG TDM matrix files for the AM and PM peak hours (OD_AM.MTX and OD_PM.MTX, respectively) were assigned in the subarea analysis.

### *Notes about Convergence in the Subarea Analysis*

The subarea analysis was performed once for each of the AM and PM peak hour trip tables generated by the MCOG TDM. Each assignment was run to a relative gap of 0.0001 using a bi-conjugate descent Frank-Wolfe (BFW) solution method for computing UE. The BFW method is generally far more rapidly convergent than the traditional Frank-Wolfe (FW) method, which is the standard of most planning models, including the MCOG TDM. While the objective function is the same, BFW can typically reach a much lower relative gap, the measure of closeness to the UE condition, in substantially less computing time. Where subarea analysis is concerned, the convergence of the assignment is critical, as poorly converged results can contain an enormous amount of noise, leading to a seed matrix with arbitrary errors that will influence the outcome of the ODME.

### *Notes about the Selection of the Subarea*

The GUAMM study area covers Ukiah's city limits and county roads surrounding Ukiah and adjacent to US 101, which stretches from north of SR 20 to further south of SR 253, or about 16 miles. The subarea was selected by hand using select-by-pointing tools in the MCOG TDM master roadway network in TransCAD. The subarea was performed in the most recently calibrated MCOG TDM base year 2009 scenarios.

The subarea consists of 260 origins and destinations, a combination of 247 centroids of MCOG TDM traffic analysis zones (TAZs) inside the study area and 13 nodes that serve as external stations, or gateways, on the boundary of the subarea. A map illustrating the centroids in GUAMM is provided in Figure 4-2, with the TAZ centroids in blue and the external stations in red.

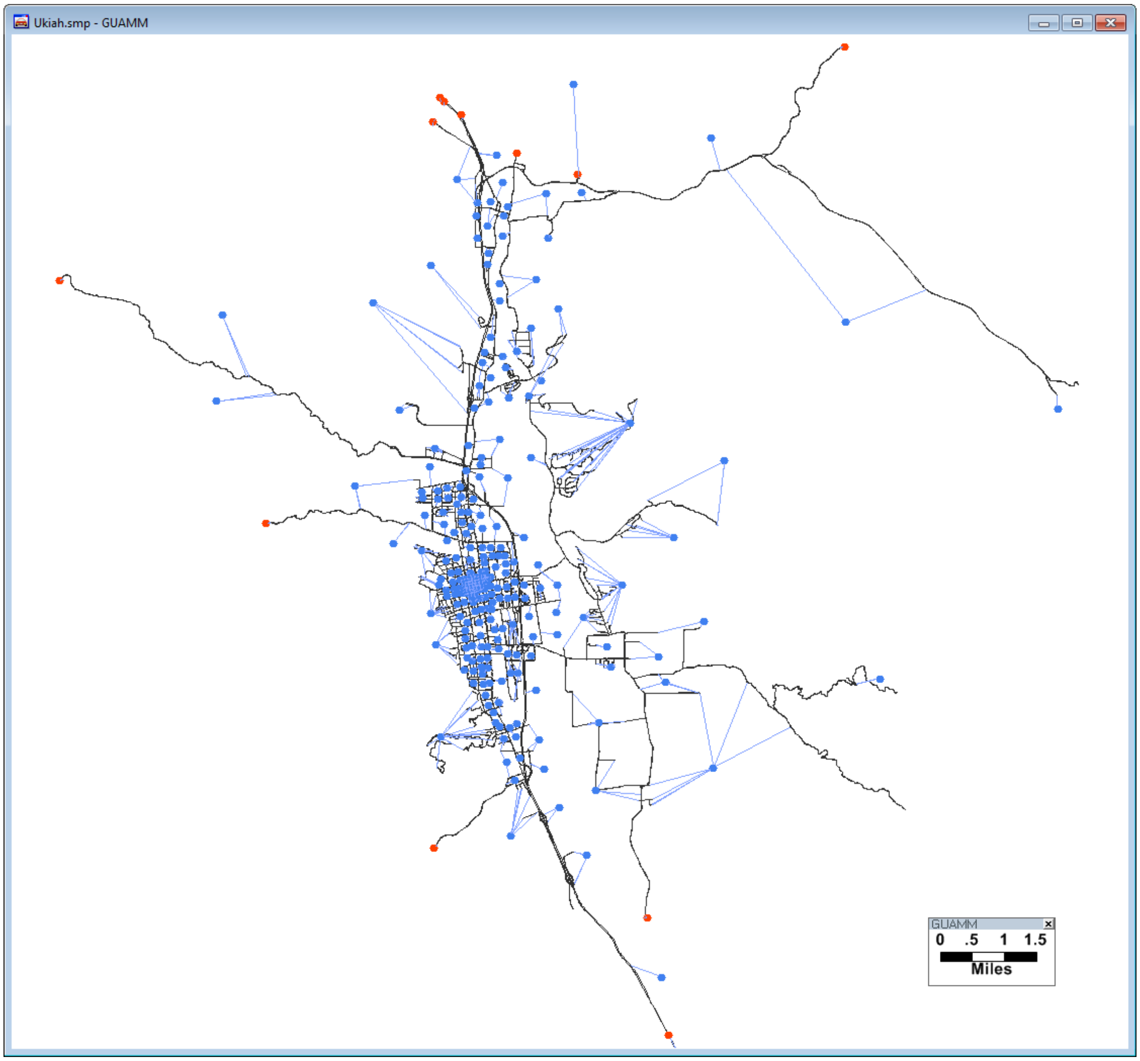

Figure 4-2. Map of TAZ centroids and external stations in the GUAMM

All centroid IDs in the GUAMM match the corresponding TAZ centroid IDs in the MCOG TDM line geographic file ROADS_LOADED_2009.DBD.

To achieve consistency between the nodes at the external stations around the subarea in the MCOG TDM line geographic file and the boundaries of the simulation database in the GUAMM, artificial centroids and centroid connectors were added in the simulation database UKIAH.DBD at the external stations. These external centroids represent the interface with the surrounding travel model network. This was not a required step, as the origins and destinations in the simulation model can be a combination of nodes and centroids (i.e., they need not all be centroids). However, by representing trip origins and destinations in the same geographic type and layer, data management can be made marginally more efficient.

A selection set was created in the MCOG TDM line geographic file in TransCAD to represent the road network in the GUAMM study area. This required some manual study and inspection of the boundaries of the network and of the subarea externals and centroids identified by TransCAD to ensure there were no gaps or missing links, which can cause the subarea analysis to produce a subarea matrix with origins and destinations internal to the study area that are not wanted.

Following steps described above, a subarea matrix produced from a subarea analysis performed in TransCAD can be directly used in the GUAMM in TransModeler without any modification or transformation of the matrix.

## Origin-Destination Matrix (Trip Table) Estimation

OD matrices were estimated to match the counts spanning a three-hour period during the AM and PM peaks. Three-hour periods were not chosen because peak traffic conditions were assumed or observed to last three hours in the study area. But, to capture the full nature and pattern of trip-making in and around an area the size of the GUAMM, and in and around a period resembling a peak hour, requires a broader scope. Three hours was assumed enough to capture the tails on either side of peaks that might develop locally in different parts of the Greater Ukiah area at different times during the peak period.

### *ODME Data Requirements*

The ODME technique used, like other ODME methods, requires a seed matrix, the initial estimate of the OD demand, and traffic count data. For purposes of consistency, it is desirable that the seed matrix and traffic counts used to estimate trip matrices be of the same scale in the time dimension (e.g., a three-hour seed matrix and three-hour counts).

Counts were collected at 15-minute intervals at various locations as detailed in the Model Development task. 15-minute time slices are small enough to permit a meaningful temporal pattern in the demand to emerge together with a geospatial pattern through the calibration, and large enough to be manageable.

Since the matrix from the MCOG model was for a one-hour peak period (7-8 AM, 4-5 PM) while the simulation model being developed was for a three-hour period (6-9 AM, 3-6 PM), there was a need to scale the matrix to cover the entire AM and PM model periods.

Additionally, the scaled matrix, which was static (i.e., representing total volumes of trips in a three-hour period), was converted into a dynamic matrix (i.e., representing volumes of trips by 15-minute interval) in order to serve as a reasonable starting point for a dynamic calibration process.

In order to achieve a basic temporal profile for the seed matrix, the directional counts collected for the AM and PM model periods were used. The sum of counts at all traffic count locations for each 15-minute interval was obtained, with each location weighted by the total count volume at that location during the three-hour simulation period. The purpose of weighting was to preserve the distinction between high volume and low volume locations in the totals. The count totals for each 15-minute interval were then visualized as a percentage of the count total for the 3-hour period to obtain an AM and a PM temporal profile as shown in Figure 4-3 and Figure 4-4 below.

Using the ratio of the sum of all counts in each peak hour to the sum of all counts in each three-hour peak period, the one-hour MCOG subarea demand matrices were extrapolated to cover each full 3-hour simulation period. Further, using the ratio of the sum of all counts in each 15-minute interval to the sum of all counts across each three-hour peak, the MCOG demand matrices were split into 15-minute matrices spanning the three-hour AM and PM simulation periods to obtain the input seed matrices to the ODME.

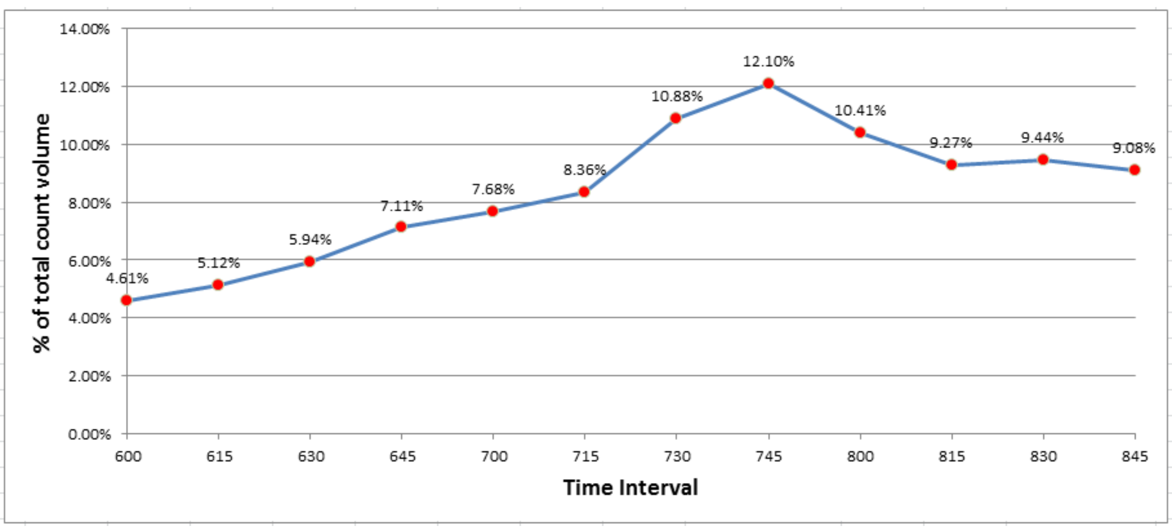


Figure 4-3. Initial loading profile for the AM simulation period

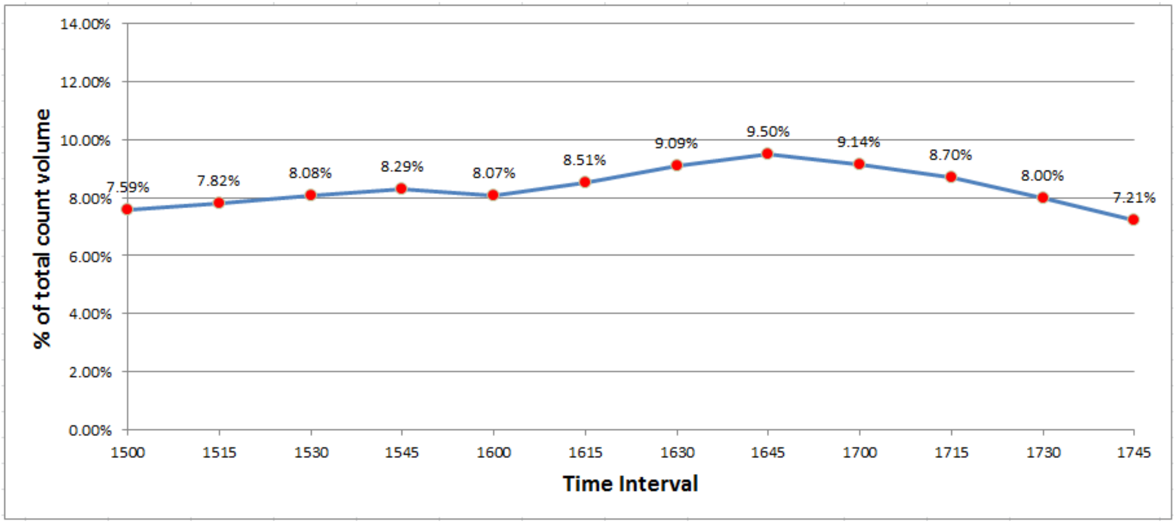

Figure 4-4. Initial loading profile for the PM simulation period

### *The ODME Framework*

The simulation-based ODME methodology is an iterative process whereby the following three steps are repeated until the simulation fits the counts as well as possible:

1. Simulation of the full three-hour period with book-keeping of the 15-minute segment and turning movement volumes.
2. Comparison of counts to volumes on the path used by each trip in order to evaluate the trip's candidacy for addition (i.e., add a trip between the same OD pair departing in the same 15-minute interval) or subtraction (i.e., removal of the trip from the simulation).
3. Addition and subtraction of the "worst" trips – i.e., those traveling on paths along which simulated segment and turning volumes consistently overshoot or undershoot the counts.

This and other, more traditional, ODME methods can have a tendency to favor short trips at the expense of longer ones, thus skewing the trip length distribution and OD pattern in order to better match the counts. Various protections were employed to prevent this, such as limiting the numbers of trips that can be added or removed per OD pair and only allowing trips of a specified minimum length to be added.

A virtue of the simulation-based approach to ODME is that it is capable of producing, in addition to numbers of trips between OD pairs over the simulated period, a temporal distribution of departures. In other words, not only the magnitude, but the complexion of the demand, in terms of departure time that best agrees with the time-varying count data emerges from the process.

### *The Objective Function of the ODME*

The purpose of ODME is to produce estimates of the traffic demand that yield a good fit with traffic count data. Thus, the ODME seeks to drive down the error between simulated and observed volumes. The simulation-based ODME used to calibrate the GUAMM computes the relative root mean square error (RMSE) in the directional and turning movement counts every iteration. Using the seed matrix from the subarea analysis and the aggregated 15-minute traffic counts as inputs, the simulation-based ODME was performed to produce dynamic, 15-minute trip matrices for the 3-hour AM and PM peak periods.

The RMSE is the square root of the mean square error (MSE), which is calculated by averaging the square of the differences between observed and modeled values. The squaring is done so that positive differences do not offset, or cancel out, negative differences. By taking the square root of the MSE, the squaring is "reversed" so that the measure has the same unit as the data (i.e., number of vehicles). The percent RMSE is thus the average percent distance of any data point from a line fitted through the observed data. The relative RMSE is just one measure that is used to determine the quality of the calibration results relative to observed count data. It is an imperfect measure because it can give undue weight to links with low volumes but large errors. However, it gives a reasonable overall picture of the goodness of fit between the model and observed data and of the direction of the improvement during calibration, and is thus a useful indicator of the progress in the iterative ODME process.

## Simulation-based Dynamic Traffic Assignment

In order for reasonable route choices to be simulated, congested, or loaded, travel times on which route choices in the micro-simulation model are based must be estimated. This is the primary function of the simulation-based DTA stage in the methodology. A full simulation is executed iteratively, with the method of successive averages (MSA) applied to output travel times each iteration. The route choices of each run are thus a function of the travel times simulated and averaged over prior runs. In the GUAMM, a 15-minute temporal profile in the demand was estimated based on 15-minute count data, as described earlier. Thus, dynamic, 15-minute travel times were estimated using the simulation-based DTA. Through this dynamic assignment, dynamic, 15-minute travel times (and the dynamic route choices) are expected to stabilize (i.e., drivers cannot switch to paths they perceive to be better).

The averaging of the travel times is intended to "smooth" the travel times over multiple iterations to prevent inefficient and counter-productive "flip-flop" between good and bad routes from one iteration to the next. The assignment runs until it has converged to a target relative gap, the same metric used in traffic assignments like that run in the

MCOG TDM to measure closeness to User Equilibrium, or until a maximum number of iterations is reached.

Unlike the traffic assignment in the MCOG TDM, however, the relative gap is not generally relied on as the stopping criterion in the application of the simulation-based DTA. Because the micro-simulation model is a stochastic Monte Carlo simulation (i.e., each simulation is initiated with a different random seed and will produce variable results) and because vehicle trips are discrete (i.e., they cannot be divided into tiny fractions as they are in the static traffic assignment methods), relative gaps of the order of magnitude expected of static traffic assignments in the MCOG TDM cannot be achieved. Empirical studies have shown that simulation-based assignment methods cannot do better than 2-3%, or a relative gap of 0.02 or 0.03. However, in Caliper's experience, this is entirely model-dependent. In models without serious congestion, as is the case in the GUAMM, far better relative gaps can generally be achieved.

Given that it is only the trend, not the absolute value, in the relative gap that is relevant in this simulation-based context, the only matter of relevance is that the DTA be run until a lower relative gap can no longer be achieved. In the application of the simulation-based DTA in the GUAMM, the DTA was allowed to run for between 30 and 50 iterations, though little change in the relative gap occurs beyond about 20 or 25 iterations.

Very good results are achieved using the simulation-based DTA to estimate the route choices of trips generated from the estimated trip tables. Routes observed visually between OD pairs and passing through critical links all satisfy expectations. Unreasonable routes are effectively filtered out of the set of route choices through the DTA process.

## Model Specification Changes

At reasonably spaced intervals, a visual survey of traffic behavior in the simulation model was conducted. While the ODME framework works to improve the system-wide match between observed and simulation metrics, there might be locations which need individual attention.

For example, an unusual queue was observed with too many vehicles trying to get on US 101 at North State during the peak of the PM simulation around 5 PM. On further investigation, it was noticed that a large number of these vehicles get off US 101 at Perkins. Normally, one would not expect many drivers to get on a highway and get off after a single exit even if there was a nominal travel time saving on offer. To resolve this behavior, ramp penalties were added which add a modest extra time to the trip time perceived by drivers for getting on and off the highway. To some degree, this also addressed a volume-count disparity on State Street, where model volumes were determined to be low on State Street relative to counts at certain points during the calibration process. Further, new driveways and centroid connectors were added at locations with shopping activity where many vehicles were observed to be queued in the model waiting to enter/leave the parking area. During the calibration process, the model was provided to Caltrans for multiple reviews. The feedback subsequently received was incorporated into the final calibrated model.

Changes to the model were followed by reapplication of the ODME and DTA until the system-wide errors were confirmed through visual audit to be resolved.

## Trip Table Refinement

The methodology up through the application of the DTA produces very good results in the GUAMM by any calibration standard. More information about the calibration of the model in terms of statistical measures of goodness of fit is provided below. However, it bears mentioning that further, modest adjustments were made to the trip tables manually in order to ensure that the OD pattern determined by the ODME and DTA processes fit well with the link and turning movement volumes that were collected from the field. Where the numbers of trips passing through a particular link differed to a significant degree in the model from that observed in the field, the numbers of trips in the O-D pairs using that link were manually adjusted. Following this, the DTA step was repeated to account for readjustments of route choice behavior in the study area as a result of the trip table changes.

## Calibration Statistics

After following the calibration methodology described above, the GUAMM meets all standards set by Caltrans for micro-simulation projects for both the AM and PM periods. This exceeds expectations because these standards were proposed over a decade ago when micro-simulation could only be executed on a small corridor, not at the scale seen in the GUAMM.

### *Caltrans Standards*

First, Caltrans' calibration criteria that were applied are listed in Table 4-1. First, there is a percent difference calculation, which is used when flows are between 700 and 2,700 vehicles per hour. Second, there is an absolute difference calculation, which is used when flows are outside of that range to either side. For each segment with a count location, the category it falls into is determined based on the recorded simulation volumes on that segment. It is desirable that over 85% of segments with counts match model volumes within the specified percent or absolute difference.

Table 4-1. Summary table of the Caltrans calibration standards

| Criteria & Measures | | Acceptability Targets |
|---|---|---|
| Individual Flows | % within 15%, for 700 vph < Flow < 2,700 vph | *> 85%* |
| | % within 100 vph, for Flow < 700 vph | |
| | % within 400 vph, for Flow > 2,700 vph | |

## *Performance on Caltrans Standards*

Table 4-2 shows that the GUAMM meets all of the Caltrans standards for both the AM and PM peak periods.

The table displays the relative agreement on the directional counts ("Individual Segment Flows"), and the agreement within each peak hour of the simulation is shown in successive columns. Note that the first hours of the AM and PM simulations, 06:00-07:00 and 15:00-16:00 respectively, were not considered peak hours. The columns grouped under the heading "% of cases satisfying test" report the calculated value for that time period and the statistic is described in the row under "Test". The columns grouped under the heading "Meets Benchmark?" indicate whether the calculated value of the statistic meets the threshold set by Caltrans.

None of the directional counts in Ukiah satisfy the "> 2700 vehicles per hour" qualification in the Caltrans standards. These rows were included in the table nonetheless for completeness.

Table 4-2. Compliance of the GUAMM to Caltrans standards for the AM and PM peak period

| | Test | % of cases satisfying test | | | | Standard | Meets Benchmark? | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 07:00-08:00 | 08:00-09:00 | 16:00-17:00 | 17:00-18:00 | | 07:00-08:00 | 08:00-09:00 | 16:00-17:00 | 17:00-18:00 |
| Individual Segment Flows | % within 15% for 700 vph < Flow < 2,700 vph | 89% | 100% | 100% | 100% | >85% of cases | Yes | Yes | Yes | Yes |
| | % within 100 vph for Flow < 700 vph | 100% | 100% | 98% | 100% | | Yes | Yes | Yes | Yes |
| | % within 400 vph for Flow > 2,700 vph | n/a | n/a | n/a | n/a | | n/a | n/a | n/a | n/a |

In addition to the calibration standards from Caltrans, a general goodness-of-fit analysis for the segment and turning movement flows was performed for the AM and PM peak hours. This is presented in Figure 4-5 and Figure 4-6.

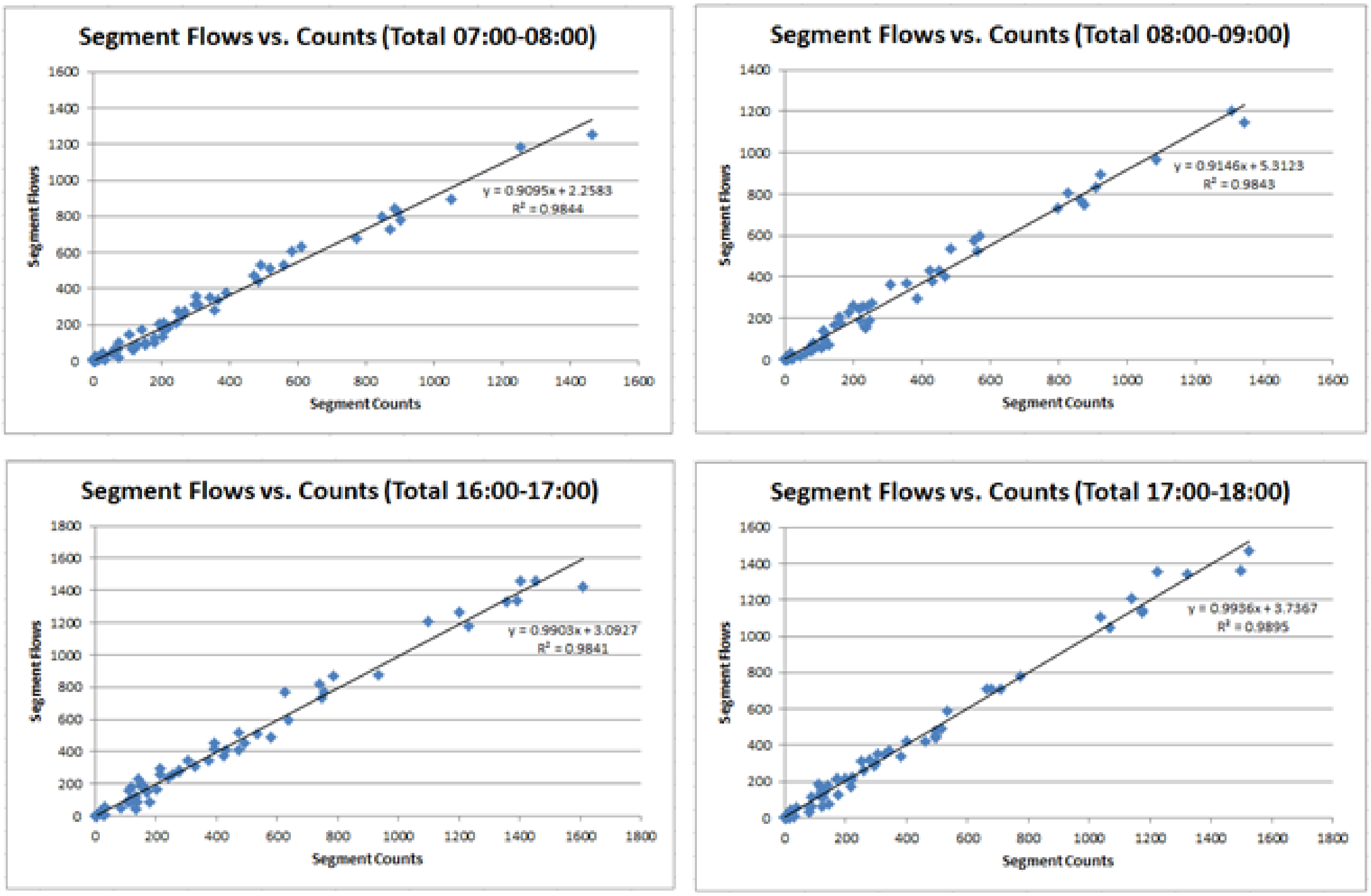


Figure 4-5. Goodness-of-fit: model volumes vs directional counts

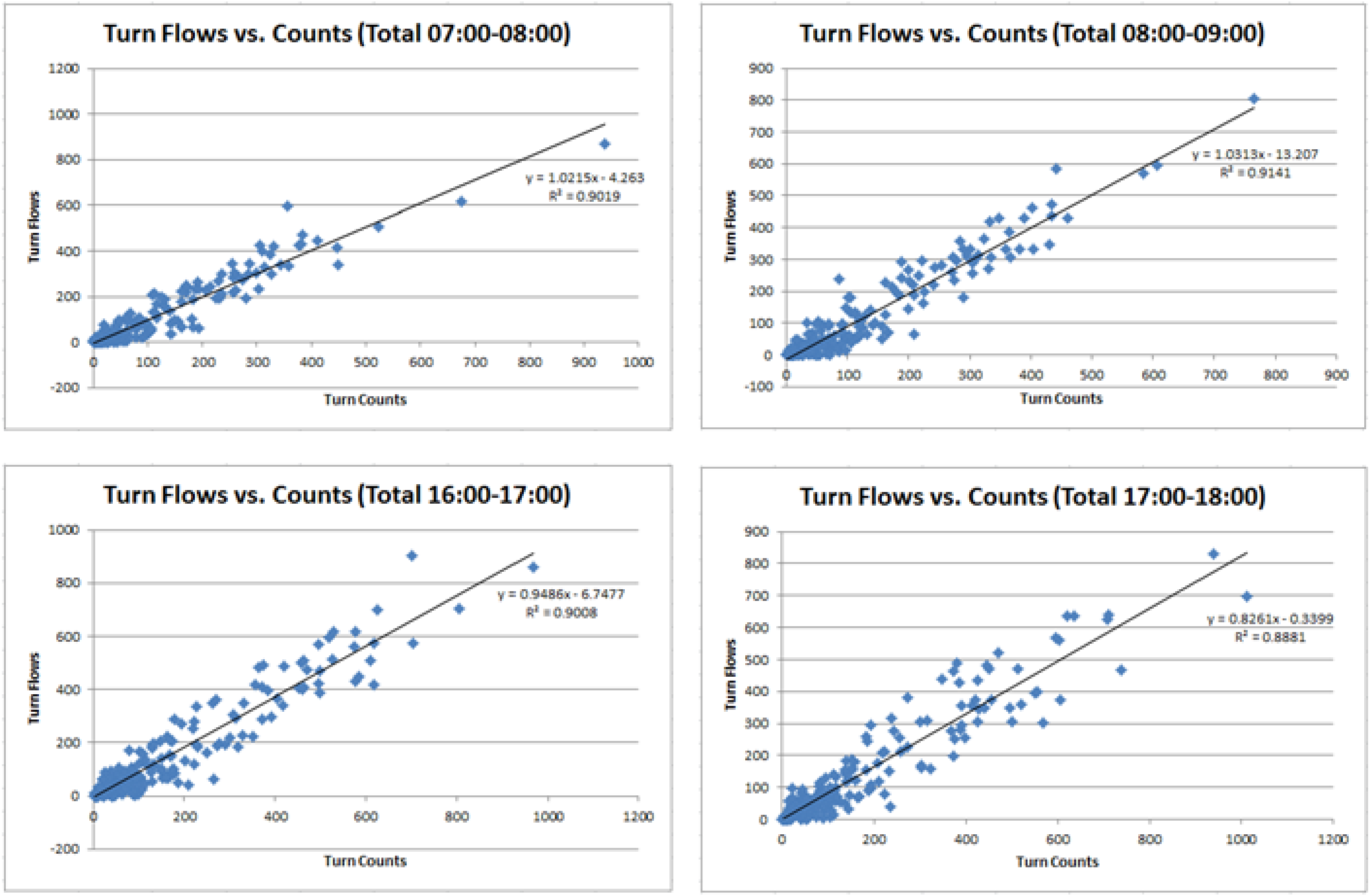


Figure 4-6. Goodness-of-fit, Modeled vs Observed volumes at turn count locations

### *Summary*

In considering the calibration statistics mentioned here, it is important to reiterate the exceptional nature of the GUAMM. The calibration target guidelines suggested by FHWA and Caltrans are made with traditional micro-simulation modeling practice in mind, for projects that lack the scale and spatial complexity of the GUAMM. The Caltrans Guidelines for Applying Traffic Microsimulation Modeling Software (and the FHWA's Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software, which comes from the same authors) are thus not ideal guidelines for a model like the GUAMM. For lack of better, more relevant guidelines, these guidelines were used as the nearest reasonable test of the model's accuracy. To satisfy all of the calibration criteria set forth in these guidelines as the GUAMM does, in spite of the model's numerous technical challenges, is a significant achievement and is accepted as evidence of the model's successful calibration.

It is also worth noting that the degree of accuracy in the calibration of any model should be a function of the model's application requirements. For example, the calibration of a travel demand model does not require the same degree of calibration as a micro-simulation model because the travel demand model's purpose is not to predict what will happen at the intersection level. By the same token, a micro-simulation model of the entire GUAMM does not require the same level of accuracy as a micro-simulation model of a localized local site impact, access management, or corridor study.

The GUAMM's function is to analyze at the operational level the farther reaching effects of changes in demographics (e.g., growth), changes in land use (e.g., significant new development) or major changes to corridors affecting the entire GUAMM. For these purposes, the calibration metrics presented in this report are considered amply sufficient to demonstrate the GUAMM's accuracy.

To further demonstrate the model's accuracy, and to validate its calibration, floating car travel time data were collected and compared to simulated travel times. As these validation efforts will show, the model is not only well-calibrated to counts but is also a very good predictor of journey times throughout the GUAMM study area.

## 5. Model Validation (Task 7)

To validate a simulation model, field data other than those used to calibrate the model are compared with model results. The objective of the validation step is to verify that the model calibration is robust enough to match more than just the field data with which it was calibrated. Travel time data are commonly used to calibrate and/or validate a micro-simulation model.

It is ideal if the validation data are collected at the same time the calibration data are collected. Otherwise, it can be difficult in the validation stage to distinguish the causes of error between calibrated model results and validation field data. The error may derive either from inadequacies in the calibration or from differences in traffic conditions month to month, week to week, and even day to day. For the GUAMM, the travel time data against which the validation was performed were supplied by subconsultant TJKM and came from multiple floating car trips made on US 101 and State Street during the AM and PM peak periods, on the same days that the traffic count data used in the model calibration were collected.

### *Model Validation Using Travel Time Data*

The floating car was driven northbound and southbound along the stretch of US 101 between Gobbi and Moore and the data collected provided one-second GPS tracks for every trip. Similarly, the floating car traversed the stretch of State Street between the two US 101 ramps at North State Street and South State Street. To enable a direct comparison between the floating car data and model output data, sensors were placed at various locations in the GUAMM network in TransModeler. The sensors capture the number of passing vehicles and the travel time to the next sensor in the direction of travel during each 15-minute simulation interval.

It was noted that no vehicles in the simulation model traverse the entire stretch between the South State/101 interchange and the North State/101 interchange as the floating car did. This is understandable given that such a trip would be much faster on US 101 and thus does not represent a likely route choice. To account for this, the State Street sensors were placed in the middle of the middle of the floating car's trip to subdivide State Street into two sections: one between South State and downtown Ukiah and the other between downtown and North State.

Finally, the floating car GPS coordinates (and corresponding travel times) closest to the sensor locations were filtered out for each trip to compare the observed and simulated travel times. The floating car runs were all performed between 7:00 to 8:30 AM and 3:30 to 5:30 PM, hence the simulated times were also extracted for the same periods. The stretches traversed by the floating car along US 101 and along State Street are shown in Figure 5-1.

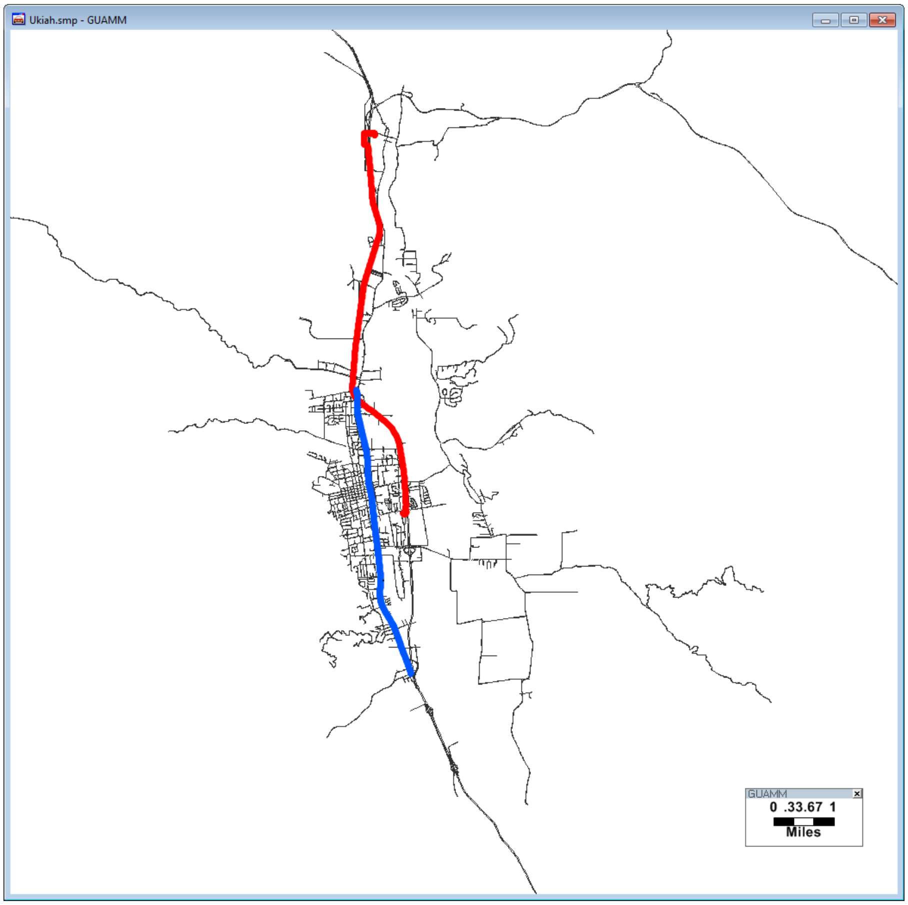

Figure 5-1. Floating car trajectories for collect travel time data collection

## *Performance on Model Validation*

Caltrans standards recommend that 85% of model travel times be within 15% of the travel time measurements from the field for equivalent trips. The GUAMM meets that standard, as is summarized in Table 5-1. A further breakdown of the agreement between travel time measurements and model travel times between specific sensor locations in the GUAMM is presented in Table 5-2 and Table 5-3 for the AM and PM periods, respectively.

Table 5-1. Compliance of GUAMM to Caltrans validation standards for AM and PM peak periods

| | Test | % of cases satisfying test | | Standard | Meets Benchmark? | |
|---|---|---|---|---|---|---|
| | | 07:00-08:30 | 15:30-17:30 | | 07:00-08:30 | 15:30-17:30 |
| Travel Times | Journey times, Model vs. Observed, within 15% or one minute if higher | 100% | 100% | >85% of cases | Yes | Yes |

Table 5-2. Validation of the model from comparing floating car and simulation travel times for AM

| | Path | | | AM average for trips between 7:00 to 8:30 | | | |
|---|---|---|---|---|---|---|---|
| | From | To | On | TransModeler TT | GPS TT | % difference | TransModeler is... |
| Northbound | Gobbi/101 interchange | Moore/101 interchange | 101 | 319.8 s | 295.2 s | 8.33% | Higher |
| Northbound | South St/101 interchange | State/Talmage intersection | State | 205.8 s | 209.8 s | 1.91% | Lower |
| Northbound | State/Luce Av intersection | State/Bricarelli Dr intersection | State | 293.4 s | 304.0 s | 3.49% | Lower |
| Southbound | Moore/101 interchange | Gobbi/101 Interchange | 101 | 331.8 s | 291.4 s | 13.86% | Higher |
| Southbound | State/Talmage intersection | South St/101 interchange | State | 205.2 s | 204.8 s | 0.19% | Higher |
| Southbound | State/Bricarelli Dr intersection | State/Luce Av intersection | State | 312 s | 303.2 s | 2.90% | Higher |

Table 5-3. Validation of the model from comparing floating car and simulation travel times for AM

| | Path | | | PM average for trips between 15:30 to 17:30 | | | |
|---|---|---|---|---|---|---|---|
| | From | To | On | TransModeler TT | GPS TT | % difference | TransModeler is... |
| Northbound | Gobbi/101 interchange | Moore/101 interchange | 101 | 310.8 s | 297.8 s | 4.36 % | Higher |
| Northbound | South St/101 interchange | State/Talmage intersection | State | 211.2 s | 198.0 s | 6.67 % | Higher |
| Northbound | State/Luce Av intersection | State/Bricarelli Dr intersection | State | 304.8 s | 297.2 s | 2.55 % | Higher |
| Southbound | Moore/101 interchange | Gobbi/101 Interchange | 101 | 312.6 s | 287.8 s | 8.62 % | Higher |
| Southbound | State/Talmage intersection | South St/101 interchange | State | 209.4 s | 189.0 s | 10.79 % | Higher |
| Southbound | State/Bricarelli Dr intersection | State/Luce Av intersection | State | 307.2 s | 350.2 s | 12.27 % | Lower |

## *Possible Explanations for Travel Time Error in the Model*

Even though the simulated travel times satisfy accepted validation criteria in all cases, it is worthwhile to consider the possible explanations for any error. These may help to focus future improvements to the model. Excluding the obvious sources of error in the model (i.e., that arising out of the subarea analysis and demand estimation) the following may also explain differences between the micro-simulation model and the field measurements.

### Omitted Influences in the Model

Sources of interruption, interference, and friction, such as pedestrians and a greater prevalence of activity on driveways and minor side streets along some corridors, that are absent from the model probably have a non-negligible effect on speeds in the

GUAMM. A clear direction for improvement of the model in the future is to expand the coverage of pedestrian crossings. Another is to add the more prominent driveways and side streets that are currently only abstractly represented by centroid connectors. However, the latter effort would probably not be complete without a more detailed survey of the volumes of traffic using those driveways and a disaggregation of the TAZs that contain them.

**Driver Behavior**
Some elements of driver behavior were adjusted and other behavioral parameters explicitly calibrated as part of the project. But a comprehensive calibration of the most important components of driver behavior (e.g., gap acceptance and lane changing) was not within the scope of work.

### *Route Choice Parameter Sensitivity Testing: Turn and Ramp Penalties*

The GUAMM includes turn penalties for right and left turns, as well ramp penalties for the usage of ramps entering or leaving a limited access or freeway facility such as US 101.

Turning penalties are used to deter routes with many turning movements where more direct routes exist that are probably favored by drivers even if the direct routes may have longer travel times. In general, drivers are unlikely to prefer making a large number of turning movements on a circuitous route to avoid congestion on direct routes unless the level of service on the direct route is substantially poorer. Turn penalties in the model's routing parameters ensure that a minimum turning delay is perceived for each right or left turn at an intersection even if the time experienced in the model for those turning movements is lesser. Turn penalties in the GUAMM were set to be 10 seconds for right turns and 20 seconds for left turns.

Similarly, ramp penalties impose a minimum perceived delay for entering a freeway on an entrance ramp and for leaving the free on an exit ramp. This penalty accounts for the perceived inconvenience of negotiating high-speed merging and weaving maneuvers when paths of comparable or only slightly longer travel times on surface streets are a viable alternative. Hence, ramp penalties may prevent a driver in the model from using US 101 for a short trip even if the path via US 101 is slightly shorter in travel time than an alternative surface street route. Ramp penalties in the GUAMM were set to be equal to 60 seconds for both on- and off-ramp movements.

We examined the effects of varying the ramp and turn penalties on the Percent Differences (%Diff) between model volumes and traffic counts in the GUAMM. We fit %Diff curves to various combinations of turn and ramp penalties to note their effects on the model's goodness of fit. Note that "R/L" is used to denote the combination of right and left turn penalties. On and off ramp maneuvers were assumed to have equal penalty. The %Diff is the average across all 15-minute directional counts in each of the AM and PM peak period. Figure 5-2 and Figure 5-3 show the results of the sensitivity tests for the AM and PM simulation periods, respectively.

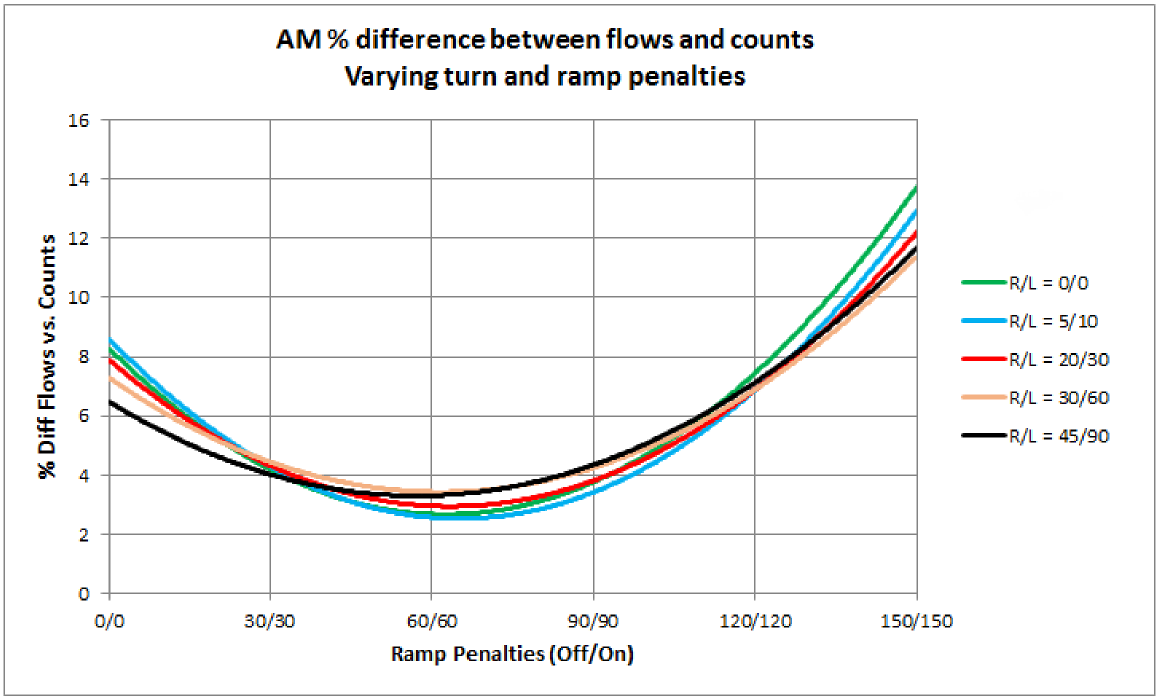


Figure 5-2. Percent differences between AM flows and counts for various turn and ramp penalties

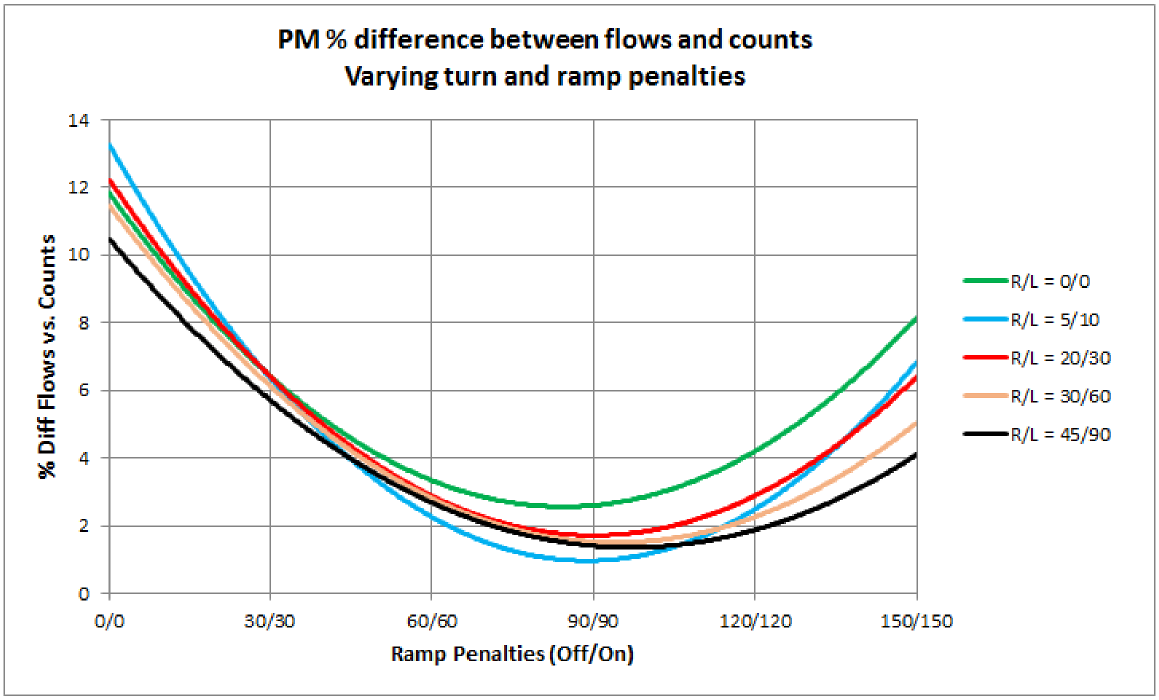


Figure 5-3. Percent differences between AM flows and counts for various turn and ramp penalties

The plots for the different turn penalties are closely aligned in the AM period, demonstrating that the effect of turn penalties is not significant. The effects of ramp penalties are more substantial, with ramp penalties of 60 seconds showing percent differences up to 10 times lower than those with 150-second penalties. Goodness of fit is also poorer with ramp penalties of zero seconds, where the model errors in terms of %Diff are about two times that when penalties are set to be 60 seconds. The plots for the PM period are more dispersed, probably as a result of higher network congestion in the evenings. This leads to more visible effects of varying the routing parameters. It can be seen that setting the ramp penalties to 60 seconds achieves favorable results very near the minima of the curves.

The sensitivity tests of the effects of the turning and ramp penalties on the GUAMM's goodness of fit with counts redouble confidence in the route choice component of the model and in the GUAMM's overall predictive power for evaluating projects that might impact route choice.

# 6. Alternatives Analysis (Task 8)

One of the GUAMM's main functions is as a planning tool to predict the operational impacts of changes in travel demand (e.g., due to changes in land use and/or demographics) as forecasted using the MCOG TDM and to evaluate and plan for improvements to mitigate those impacts. Three scenarios are considered for each of the MCOG TDM's horizon years 2020 and 2030:

1. Existing+Committed (E+C) build
2. Intermediate (I) build
3. Optimistic (O) build

The scenarios were assembled from projects listed in MCOG's Capital Improvement Program (CIP) and other projects identified by the City of Ukiah and Mendocino County.

## Developing the Future Year Demand Estimates

The first step taken to develop each of these scenarios was to perform a subarea analysis using the MCOG TDM for the AM peak hour (7:00-8:00) and the PM peak hour (16:00-17:00) in the 2020 and 2030 MCOG TDM scenarios. This step yielded a total of four trip tables, one for each year and peak period. These will be henceforth referred to as the subarea demand matrices. Then a variety of approaches were explored to derive future-year trip tables that draw both from the base-year calibration and from the future-year forecasts. The family of methodologies for deriving these estimates is referred to as "pivot-point" procedures.

Numerous pivot-point procedures can be found in the literature, but all are generally variations on the same theme, which involves deriving future-year estimates of demand by "pivoting" from the calibrated base-year estimate of demand to a one that conforms to forecasts of demand from a travel demand model. Note that the base-year calibrated matrix reflected 2015 (to match counts collected in 2015), but the base year in the MCOG TDM is 2009. This was accounted for in the pivoting process.

The following section details the pivoting approach that was applied to obtain the future year O-D matrices for the GUAMM future-year scenarios.

Let:

| | | |
|---|---|---|
| $i$ | = | Matrix row |
| $j$ | = | Matrix column |
| $y$ | = | Forecast year |
| $D_{ij,y}$ | = | Value of cell *i-j* in the subarea matrix for year *y* |
| $T_{ij,y}$ | = | Value of cell *i-j* in the calibrated base-year matrix for year *y* |

Then, the total subarea demand in the base year 2009 is given by:

$$D_{2009} = \sum D_{ij,2009} \text{ for all } i,j \quad (1)$$

The change in subarea demand for cell *i-j* between 2009 and a future year *y* is given by:

$$C_{ij,y} = Dij_{,y} - D_{ij,2009} \quad (2)$$

The total change in subarea demand from 2009 to year *y* based on cells seeing a positive growth is given by:

$$P_y = \sum C_{ij,y} \text{ where } C_{ij,y} >= 0 \quad (3)$$

And the total change in subarea demand from 2009 to year *y* based on cells seeing a negative growth is given by:

$$N_y = \sum C_{ij,y} \text{ where } C_{ij,y} < 0 \quad (4)$$

Now, if a cell *i-j* sees positive growth in subarea demand from 2009 to 2020, then the simulated trips for *i-j* in 2020 are given by:

$$T_{ij,2020} = T_{ij,2015} + (T_{ij,2015} * P_{2020} * 5 / (11 * D_{2009})), \text{ for } C_{ij,2020} >= 0 \quad (5)$$

And if a cell *i-j* sees negative growth in subarea demand from 2009 to 2020, then the simulated trips for *i-j* in 2020 are given by:

$$T_{ij,2020} = T_{ij,2015} + (T_{ij,2015} * N_{2020} * 5 / (11 * D_{2009})), \text{ for } C_{ij,2020} < 0 \quad (6)$$

Similarly, for the year 2030, if a cell *i-j* sees positive growth in subarea demand from 2009 to 2030, then the simulated trips for *i-j* in 2030 are given by:

$$T_{ij,2030} = T_{ij,2015} + (T_{ij,2015} * P_{2030} * 15 / (21 * D_{2009})), \text{ for } C_{ij,2030} >= 0 \quad (7)$$

And if a cell *i-j* sees negative growth in subarea demand from 2009 to 2030, then the simulated trips for *i-j* in 2030 are given by:

$$T_{ij,2030} = T_{ij,2015} + (T_{ij,2015} * N_{2030} * 15 / (21 * D_{2009})), \text{ for } C_{ij,2030} < 0 \quad (8)$$

The factors (5/11) and (15/21) are adjustments because the subarea demand changes are for 11 years (2009 to 2020) and 21 years (2009 to 2030), respectively, while the calibrated base-year matrix represents 2015.

Equations (5) through (8) assert the premise that the simulated trips for a given O-D pair in a future year are obtained by adding a term, based on travel demand model patterns, to the simulated trips in the base year. This term can be either positive or negative and incorporates the share of the growth in the subarea demand that can be attributed to that O-D pair.

However, Equations (5) through (8) are unable to predict what the future year trips might be when the calibrated base-year matrix has zero trips for a specific O-D pair (i.e., if $T_{ij,2015}$ is zero).

Broadly, we strive to see the same net growth in the O-D volumes as is observed in the subarea matrices for the same time span. With Equations (5) through (8), we found that the growth in total O-D volumes fell short of the target growth. We attributed this gap to the future-year trips coming from cells with zero trips in the calibrated base-year matrix. To account for these trips, we identified O-D pairs having at least one trip in the future-year subarea matrix. Let us call this subset *B*.

The "missing" demand we expect to see in the O-D matrix for the future year *y* is given by:

$$M_y = (\sum Dij_{,y} - \sum D_{ij,2009})*K - (\sum T_{ij,y} - \sum T_{ij,y2015}),$$
$$\text{where } \{K,y\} = \{5/11,2020\} \text{ or } \{15/21,2030) \qquad (9)$$

The total subarea demand in future year *y* based only on cells in subset *B* is given by:

$$S_y = \sum D_{ij,y} \text{ where } \{i,j\} € B \qquad (10)$$

For a cell *i-j* in subset *B*, we define the simulated trips in future year *y* as:

$$T_{ij,y} = D_{ij,y} * M_y / S_y \qquad (11)$$

And we do this so that for a specified year *y*:

$$\sum T_{ij,y} = \sum (D_{ij,y} * M_y / S_y) = (M_y/S_y) * \sum D_{ij,y} = (M_y/S_y) * S_y = M_y \qquad (12)$$

In this way, we compensate for the "missing trips" in the O-D matrix for year *y* with cells in the subset *B*.

The O-D tables thus derived for the years 2020 and 2030 represent a single hour in the AM and PM periods because the traffic assignments in the travel demand model are performed for these hours. The one-hour O-D matrices were thus converted into three-hour trip tables for the AM and PM peak periods, with volumes segmented by departure in 15 min intervals. The conversion was done using the pattern of temporal distribution seen in the base-year matrix calibrated to 15-minute 2015 traffic counts.

The next step involved the development of simulation networks with the roadway changes planned for the near- and long-term in the study area implemented in various buils scenarios in TransModeler.

## Planned Roadway Project Specifications

A list of all projects to be included in the alternatives analysis was prepared with input and feedback from the GUAMM technical advisory group (TAG). Available documents and drawings detailing the planning process and conceptual designs for some of the projects were consulted. Three new simulation networks were created to accommodate projects classified under the E+C, I and O scenarios. Various assumptions were made in the geometric design of projects for which details were not available. A spreadsheet listing the projects and assumptions was circulated to the TAG for concurrence prior to developing the networks. Certain projects were also discussed during progress meetings, and input from the TAG during those meetings was incorporated into the network development process. The list of projects under each future-year scenario along with basic project specifications and assumptions made during the coding of each project into TransModeler, are given in Appendix B.

## Evaluation of Level of Service

The 2020 and 2030 O-D matrices for the AM and PM periods were simulated in future-year E+C, I and O scenarios. Traffic patterns and queueing behavior were subjected to visual audit to confirm accurate model specification in terms of the various E+C, I, and O roadway improvement and signal timing projects. Subsequently, dynamic traffic assignments were performed in each year and scenario to allow route choice behaviors in the model to adjust to new, expected traffic patterns arising from the growth and the roadway and signal timing improvements. This step mirrors the real-world adjustments that drivers make to changes in experienced travel times and delays over long periods of time as recurring congestion patterns in the city evolve.

Once the dynamic traffic assignments were completed for each year and scenario, 25 simulations were done for each year and scenario to produce performance metrics with the intention of gauging operations in the network. The analysis that follows is categorized by the facility type considered in the level of service (LOS) computations. The performance measures were derived from Highway Capacity Manual (HCM) guidance for each facility type and with concurrence from the TAG.

### *Freeway Segments*

The HCM defines four freeway segment types: Basic, Diverge, Merge and Weave. It uses a lookup table based on density (in passenger-cars-per-mile-per-lane) to define the LOS on these segment types as shown in Table 6-1 and Table 6-2 for Basic segments and Merge/Diverge/Weave segments, respectively.

Table 6-1. HCM Levels of Service for Basic freeway segments

| Level of Service | Average Density (pc/mi/ln) |
|---|---|
| **A** | 0 < x <= 11 |
| **B** | 11 < x <=18 |
| **C** | 18 < x <=26 |
| **D** | 26 < x <=35 |
| **E** | 35 < x <=45 |
| **F** | x > 45 |

Table 6-2. HCM Levels of Service for Merge/Diverge/Weave freeway segments

| Level of Service | Average Density (pc/mi/ln) |
|---|---|
| **A** | 0 < x <= 10 |
| **B** | 10 < x <=20 |
| **C** | 20 < x <=28 |
| **D** | 28 < x <=35 |
| **E** | x > 35 |
| **F** | When lane capacity is exceeded |

The LOS on each segment along US 101 is presented in Table 6-3 and Table 6-4, identified by its type and the interchange nearest to it, and ordered from north to south in the study area.

Similarly, Table 6-5 and Table 6-6 give the LOS on US 101 segments ordered from south to north. Certain segments only exist in one or more future scenarios, such as those created as a result of roadway projects adding acceleration lanes or new ramps.

Table 6-3. Levels of Service for US101 southbound segments ordered north to south in the study area

| Description | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| North of SH20 interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of SH20 interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At SH20 interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of SH20 interchange, Merge | B | B | B | B | B | B | B | A | A | A | A | A | A | A |
| North of Moore St interchange, Diverge | B | B | B | B | B | B | B | A | A | A | A | A | A | A |
| At Moore St interchange, Basic | B | B | B | B | B | B | B | A | A | A | A | A | A | A |
| South of Moore St interchange, Merge | B | B | B | B | B | B | B | A | B | B | B | B | B | B |
| North of Lake Mendocino interchange, Diverge | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| At Lake Mendocino interchange, Basic | B | A | B | B | B | A | B | A | A | A | A | A | A | A |
| South of Lake Mendocino interchange, Merge | B | B | B | B | B | B | B | B | B | B | B | B | A | B |
| North of North State interchange, Basic | N/A | N/A | N/A | N/A | N/A | B | B | N/A | N/A | N/A | N/A | N/A | B | B |
| North of North State interchange, Diverge | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| At North State interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of North State interchange, Merge | B | A | B | A | B | A | B | B | A | A | A | A | A | A |
| At new SB off-ramp to Brush, Diverge | N/A | N/A | N/A | N/A | N/A | B | B | N/A | N/A | N/A | N/A | N/A | B | B |
| North of Perkins interchange, Basic | N/A | B | B | B | B | B | B | N/A | B | B | B | B | B | B |
| North of Perkins interchange, Diverge | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| At Perkins interchange, Basic | A | A | B | A | A | A | B | A | A | B | A | B | A | B |
| South of Perkins interchange, Merge | A | A | B | A | A | A | B | A | A | B | A | B | A | B |
| North of Gobbi interchange, Diverge | A | B | B | B | A | B | B | A | A | B | A | B | A | B |
| At Gobbi interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Gobbi interchange, Merge | A | A | A | A | A | A | A | A | A | B | A | B | A | B |
| North of Talmage interchange, Diverge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| At Talmage interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Talmage interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of South State interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |

Table 6-4. Levels of Service for US101 southbound segments ordered north to south in the study area (Continued)

| Description | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| At South State interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of South State interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of Fracchia Lane interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At Fracchia lane interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Fracchia lane interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of Burke Hill interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At Burke Hill interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Burke Hill interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Burke Hill interchange, Basic | A | B | B | B | B | A | A | A | A | B | A | B | A | A |

Table 6-5. Levels of Service for US101 southbound segments ordered south to north in the study area

| Description | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| South of Burke Hill interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Burke Hill interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At Burke Hill interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of Burke Hill interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Fracchia lane interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At Fracchia lane interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of Fracchia Lane interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of South State interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At South State interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of South State interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| South of Talmage interchange, Diverge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| At Talmage interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of Talmage interchange, Merge | A | A | A | A | A | A | A | B | B | B | B | B | A | A |
| South of Gobbi interchange, Diverge | A | A | A | A | A | A | B | B | B | B | B | B | B | B |
| At Gobbi interchange, Basic | A | A | A | A | A | A | B | B | B | B | B | B | B | B |
| At Gobbi interchange, Merge | A | A | A | A | A | A | A | A | A | B | B | B | B | B |
| North of Gobbi interchange, Weave | N/A | N/A | N/A | A | A | A | A | N/A | N/A | N/A | A | A | A | A |
| North of Gobbi interchange, Merge | A | A | A | N/A | N/A | N/A | N/A | B | B | B | N/A | N/A | N/A | N/A |
| South of Perkins interchange, Diverge | A | A | A | N/A | N/A | N/A | N/A | B | B | B | N/A | N/A | N/A | N/A |
| At Perkins interchange, Basic | A | A | A | A | A | A | A | A | B | B | B | B | A | A |
| North of Perkins interchange, Merge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| South of Ukiah Sports Complex off-ramp, Diverge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| At Ukiah Sports Complex ramps, Basic | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| North of Ukiah Sports Complex on-ramp, Merge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| South of North State interchange, Diverge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| At North State interchange, Basic | A | A | A | A | A | A | A | B | B | B | B | B | B | B |

Table 6-6. Levels of Service for US101 southbound segments ordered south to north in the study area (Continued)

| Description | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| North of North State interchange, Merge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| South of Lake Mendocino interchange, Diverge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| At Lake Mendocino interchange, Basic | A | A | A | A | A | A | A | A | B | B | B | B | B | B |
| North of Lake Mendocino interchange, Merge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| South of Moore St interchange, Diverge | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| At Moore St interchange, Basic | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| North of Moore St interchange, Weave | A | A | A | A | A | A | A | A | A | A | A | B | A | B |
| At SH20 interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of SH20 interchange, Merge | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North of SH20 interchange, Basic | A | A | A | A | A | A | A | A | A | A | A | A | A | A |

A majority of freeway segments in the GUAMM have a LOS A which is desirable. A look at the AM peak hour across both tables reveals almost all of the occurrences of LOS B to be among the southbound segments, while the PM peak hour does not show such a trend. This implies a distinct directionality to travel in the AM peak hour, specifically, one going south on US 101 toward downtown Ukiah.

### *Interchanges*

Five major interchanges between arterials in the study area and US 101 were analyzed for their LOS metrics under different future-year scenarios. Each interchange included the NB and SB on and off ramps and the arterial segments immediately adjacent to the ramp intersections. The HCM defines LOS for an interchange based on the average delay (in sec) experienced by any vehicle passing through it. The delay is measured from the time the vehicle enters any part of the interchange geometry as defined previously until the time it leaves it.

Table 6-7 presents the lookup table used to assign the LOS to an interchange.

Table 6-7. HCM Levels of Service for interchanges

| Level of Service | Average Delay (sec) |
|---|---|
| **A** | 0 < x <= 15 |
| **B** | 15 < x <=30 |
| **C** | 30 < x <=55 |
| **D** | 55 < x <=85 |
| **E** | 85 < x <=120 |
| **F** | x > 120 |

The LOS for each interchange for which data was collected in the model is summarized in Table 6-8.

Table 6-8. Levels of Service for Interchanges analyzed as part of the Alternatives Analysis task

| Description | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| Gobbi Interchange | B | B | B | B | B | C | C | A | A | B | A | B | A | A |
| Lake Mendocino Interchange | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| North State Interchange | A | A | B | A | A | A | A | B | A | B | B | B | A | A |
| Perkins Interchange | B | B | B | B | C | B | B | B | B | B | B | B | B | B |
| Talmage Interchange | A | B | B | B | B | B | B | B | B | B | C | C | B | B |

It is worth noting that certain expected trends are observed in the LOS results. Relative to simulation of 2020 demand, the LOS occasionally becomes poorer with the simulation of 2030 demand for the same build scenario (i.e. all roadway projects being the same). This can be explained by the increased demand in 2030.

It can also be seen that signalization of the southbound ramps at the Gobbi interchange in the Optimistic scenario leads to an apparent worsening of the LOS relative to the E+C and Intermediate scenarios. There are two reasons this result should be interpreted with care. First, the Gobbi interchange is not signalized in the E+C and Intermediate scenarios, and LOS cutoffs are generally different in the HCM between unsignalized and signalized facilities (i.e., intersections). The HCM offers no LOS procedure for unsignalized interchanges. Hence, lacking an alternative, to apply the same cutoff values between the unsignalized and signalized scenarios is not an ideal comparison. Secondly, it is likely that the average control delay per vehicle at an unsignalized interchange will be lower because control delay is largely incurred by those vehicles stopping on the off ramps. Other vehicles use the interchange without incurring any control delay. With signalization, all movements through the interchange may be subject to control delay.

The Talmage interchange sees a decline in LOS in the AM peak in all future-year scenarios relative to existing conditions. This is again despite improvements involving realignment of the southbound ramps and installation of a signal at the southbound ramp intersection.

Both the Gobbi and Talmage cases highlight the interplay of various roadway improvements with the delay experienced by vehicles using an interchange. Some roadway improvement projects, while not necessarily immediately adjacent to the interchange in question, may, in spite of improvements at the interchange, adversely affect the performance of the interchange by inducing traffic demand that might have otherwise taken an alternative route.

### *Intersections*

The HCM defines LOS for intersections based on the average delay, in second per vehicle, experienced by a vehicle passing through the intersection. The lookup tables vary based on whether the intersections are signalized or unsignalized as shown in Table 6-9 and Table 6-10, respectively.

Table 6-9. HCM Levels of Service for signalized intersections

| Level of Service | Average Delay (sec) |
|---|---|
| **A** | 0 < x <= 10 |
| **B** | 10 < x <=20 |
| **C** | 20 < x <=35 |
| **D** | 35 < x <=55 |
| **E** | 55 < x <=80 |
| **F** | x > 80 |

Table 6-10. HCM Levels of Service for unsignalized intersections

| Level of Service | Average Delay (sec) |
|---|---|
| **A** | 0 < x <= 10 |
| **B** | 10 < x <=15 |
| **C** | 15 < x <=25 |
| **D** | 25 < x <=35 |
| **E** | 35 < x <=50 |
| **F** | x > 50 |

Many intersections in the GUAMM base model were modified in the future-year scenarios for projects ranging from signal re-phasing/coordination schemes to adding turn bays or additional approach lanes. Some intersections were not explicitly included in the roadway projects approved by the TAG but warranted signalization changes to accommodate projects at adjacent intersections. The LOS for intersections of interest in the study area compared across scenarios is presented in Table 6-11. Additionally, information on whether a particular intersection falls within the city or the county jurisdiction is specified. Some intersections were created as a result of extensions to existing streets and don't feature in all scenarios.

Table 6-11. Levels of Service for Intersections analyzed as part of the Alternatives Analysis task

| Description | Jurisdiction | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| **State Street Intersections** | | | | | | | | | | | | | | | |
| Lake Mendocino/North State (N) | COUNTY | B | B | B | B | B | A | A | A | A | A | A | A | A | A |
| Lake Mendocino/North State (S) | COUNTY | B | C | C | B | C | B | B | B | B | B | B | B | B | B |
| Redemeyer Rd Ext/North State | COUNTY | N/A | N/A | N/A | N/A | N/A | B | B | N/A | N/A | N/A | N/A | N/A | B | B |
| Hensley Creek/North State | COUNTY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Orr Springs/North State | COUNTY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| KUKI/North State | COUNTY | A | B | B | B | B | A | A | B | B | B | B | B | B | B |
| Empire/North State | CITY | A | A | A | A | B | A | B | B | B | B | B | B | B | B |
| Brush/State | CITY | B | B | B | A | A | A | B | B | B | B | B | B | A | A |
| Clara Av/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Ford St/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Norton/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Scott/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Henry/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Standley/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Clay/State | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Hastings/South State | CITY | B | A | B | A | B | A | A | B | B | B | B | B | B | B |
| **Perkins Street Intersections** | | | | | | | | | | | | | | | |
| Dora/Perkins | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| State/Perkins | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Main/Perkins | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Hospital Drive/Perkins | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Leslie/Perkins | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Orchard/Perkins | CITY | B | B | C | B | B | B | B | B | B | C | B | C | B | C |

Table 6-12. Levels of Service for Intersections analyzed as part of the Alternatives Analysis task (Continued)

| Description | Jurisdiction | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| **Gobbi Street Intersections** | | | | | | | | | | | | | | | |
| Dora/Gobbi | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| State/Gobbi | | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| Main/Gobbi | | A | A | A | A | A | A | A | B | B | B | A | B | A | B |
| Waugh/Gobbi | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Leslie/Gobbi | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Orchard/Gobbi | | A | A | A | B | C | A | A | A | A | A | C | C | B | B |
| **Talmage Road Intersections** | | | | | | | | | | | | | | | |
| Waugh/Talmage | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Airport Park/Talmage | | B | B | B | B | B | B | B | C | B | C | B | C | B | C |
| Hastings Av/Talmage | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| **Dora Street Intersections** | | | | | | | | | | | | | | | |
| Clay/Dora | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Mill/Dora | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Washington Av/Dora | | A | A | A | A | A | A | A | A | A | A | A | A | A | A |

Table 6-13. Levels of Service for Intersections analyzed as part of the Alternatives Analysis task (Continued)

| Description | Jurisdiction | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| **Orchard Avenue Intersections** | | | | | | | | | | | | | | | |
| Lake Mendocino/Orchard Ext | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| Redemeyer Rd Ext/Orchard Ext | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| Hensley Creek Ext/Orchard Ext | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| Orr Springs Ext/Orchard Ext | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| Ford Rd/Orchard Ext | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | B | B |
| Brush/Orchard | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Ford St/Orchard | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Clara/Orchard | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Talmage Frontage/Orchard Ext | CITY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| **Other Intersections** | | | | | | | | | | | | | | | |
| Orr Springs Cntr/Despina | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| Despina/Low Gap | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Clay/Main | CITY | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Clay St Ext/Leslie | CITY | N/A | A | A | A | A | A | A | N/A | A | A | A | A | A | A |
| Clay St Ext/Hospital Dr Ext | CITY | N/A | A | A | A | A | A | A | N/A | A | A | A | A | A | A |
| Airport Park/Commerce Dr | CITY | A | A | A | A | A | A | A | A | A | B | A | A | A | A |
| Airport Park Ext/Norgard | CITY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |
| Oak Knoll Cntr/Stipp | COUNTY | N/A | N/A | N/A | N/A | N/A | A | A | N/A | N/A | N/A | N/A | N/A | A | A |

As was noted in the Interchange LOS chart, there are multiple instances where the LOS deteriorates between the 2020 demand assignment and the 2030 one, within the same scenario. For the most part, the intersections in the GUAMM have excellent or good levels of service across scenarios.

### *Roundabouts*

A roundabout was added to the intersection of Bush Street and Low Gap road in all future year-scenarios converting it from a stop-controlled intersection. The HCM uses average delay (in sec) experienced by any vehicle using the roundabout to determine its LOS as shown in Table 6-14.

Table 6-14. HCM Levels of Service for Roundabouts

| Level of Service | Average Delay (sec) |
|---|---|
| **A** | 0 < x <= 10 |
| **B** | 10 < x <=15 |
| **C** | 15 < x <=25 |
| **D** | 25 < x <=35 |
| **E** | 35 < x <=50 |
| **F** | x > 50 |

The LOS for the Low Gap/Bush roundabout is compared across the future-year scenarios in Table 6-15 and also compared with the base scenario when the roundabout did not exist. Note that the LOS for when this intersection was stop-controlled is determined from Table 6-10 defined earlier.

Table 6-15. Level of Service at the intersection of Bush Street and Low Gap Road

| Bush/Low Gap Intersection | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| Stop-Controlled | A | N/A | N/A | N/A | N/A | N/A | N/A | A | N/A | N/A | N/A | N/A | N/A | N/A |
| Roundabout | N/A | A | A | A | A | A | A | N/A | A | A | A | A | A | A |

### *Urban Streets*

An urban street is defined in TransModeler as any contiguous span non-freeway links for which HCM urban street analysis is desired. Various urban streets were identified from the roadway projects implemented in the future-year scenarios. These included major arterials as well as some corridors along collectors where signal coordination or roadway diet or widening projects are proposed. The HCM specifies LOS for urban streets based on the ratio of the average travel speed on the corridor to the free-flow speed on it, as shown in Table 6-16.

Table 6-16. HCM Levels of Service for Urban Streets

| Level of Service | Travel Speed/Free Flow Speed (%) |
|---|---|
| **A** | x > 85 |
| **B** | 67 < x <=85 |
| **C** | 50 < x <=67 |
| **D** | 40 < x <=50 |
| **E** | 30 < x <=40 |
| **F** | x < 30 |

The LOS for urban streets analyzed in the GUAMM across scenarios is presented in Table 6-17.

Table 6-17. Levels of Service for Urban Streets analyzed as part of the Alternatives Analysis task

| Description | Direction | Jurisdiction | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| **State Street Corridors** | | | | | | | | | | | | | | | | |
| From Lake Mendocino Dr to HWY-101 | SB | County | B | C | C | B | B | B | B | B | B | B | B | B | B | B |
| From HWY-101 to Henry St | SB | County/City | B | B | C | B | C | B | B | C | C | C | C | C | C | C |
| From Henry St to Gobbi St | SB | City | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| From Gobbi St to Washington Av | SB | City | B | B | B | C | C | C | C | C | C | C | C | C | C | C |
| From Washington Av to Gobbi St | NB | City | B | B | B | B | B | B | B | C | C | C | C | C | C | C |
| From Gobbi St to Henry St | NB | City | C | B | B | B | B | B | B | C | B | B | B | B | B | B |
| From Henry St to HWY-101 | NB | County/City | B | B | B | B | B | B | B | C | C | C | C | C | C | C |
| From HWY-101 to Lake Mendocino Dr | NB | County | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| **Perkins Street Corridors** | | | | | | | | | | | | | | | | |
| From State St to HWY-101 | EB | City | C | D | D | C | D | C | C | C | D | D | D | D | C | C |
| From HWY-101 to Oak Manor Dr | EB | City | B | B | B | C | C | B | B | B | B | B | C | C | B | B |
| From Oak Manor Dr to HWY-101 | WB | City | A | A | A | A | A | A | A | A | A | A | B | B | B | B |
| From HWY-101 to State St | WB | City | C | C | C | C | C | C | C | D | D | D | C | D | C | D |
| **Gobbi Street Corridors** | | | | | | | | | | | | | | | | |
| From Dora St to State St | EB | City | B | B | B | B | B | C | C | B | B | B | B | B | C | C |
| From State St to HWY-101 | EB | City | C | C | C | C | C | B | B | C | C | C | C | C | C | C |
| From HWY-101 to Oak Manor Dr | EB | City | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| From Oak Manor Dr to HWY-101 | WB | City | A | A | A | A | A | A | A | B | B | B | B | B | B | B |
| From HWY-101 to State St | WB | City | C | B | B | C | C | B | B | C | C | C | C | C | C | C |
| From State St to Dora St | WB | City | C | C | C | B | C | C | C | C | C | C | C | C | C | C |

Table 6-18. Levels of Service for Urban Streets analyzed as part of the Alternatives Analysis task (Continued)

| Description | Direction | Jurisdiction | AM (07:00-08:00) | | | | | | | PM (16:00-17:00) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Base | E+C | | Intermediate | | Optimistic | | Base | E+C | | Intermediate | | Optimistic | |
| | | | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 | | 2020 | 2030 | 2020 | 2030 | 2020 | 2030 |
| **Orchard Avenue Corridors** | | | | | | | | | | | | | | | | |
| From Lake Mendocino Dr to Brush St | SB | County | N/A | N/A | N/A | N/A | N/A | B | B | N/A | N/A | N/A | N/A | N/A | B | B |
| From Brush St to Perkins St | SB | City | B | B | B | C | B | C | C | B | C | C | B | C | C | C |
| From Perkins St to Gobbi St | SB | City | B | B | B | C | C | C | C | B | B | B | C | C | C | C |
| From Gobbi St to Talmage Rd | SB | City | N/A | N/A | N/A | N/A | N/A | B | B | N/A | N/A | N/A | N/A | N/A | B | B |
| From Talmage Rd to Gobbi St | NB | City | N/A | N/A | N/A | N/A | N/A | C | C | N/A | N/A | N/A | N/A | N/A | B | B |
| From Gobbi St to Perkins St | NB | City | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| From Perkins St to Brush St | NB | City | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| From Brush St to Lake Mendocino Dr | NB | County | N/A | N/A | N/A | N/A | N/A | B | B | N/A | N/A | N/A | N/A | N/A | B | B |
| **Other Corridors** | | | | | | | | | | | | | | | | |
| Brush St from State St to Orchard Av | EB | County/City | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| Brush St from Orchard Av to State St | WB | County/City | A | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Dora St from Perkins St to Washington Av | SB | City | B | B | B | B | B | B | B | B | B | C | C | C | B | B |
| Dora St from Washington Av to Perkins St | NB | City | B | B | B | B | B | B | B | B | B | B | B | B | B | B |
| Low Gap Rd from Despina Dr to State St | EB | City | B | A | A | A | A | A | A | A | A | A | A | A | A | A |
| Low Gap Rd from State St to Despina Dr | WB | City | C | C | C | C | C | C | C | C | C | C | C | C | C | C |
| Talmage Rd from State St to city limits | EB | City | B | B | B | B | B | B | B | C | B | B | B | B | C | C |
| Talmge Rd from city limits to State St | WB | City | B | B | C | B | B | B | B | C | C | C | C | C | C | C |

Similar to the interchange and intersection LOS analysis, there are numerous instances where the LOS becomes poorer in the more distant future years (i.e., as demand increases) for a given build scenario. For the most part, urban streets in the GUAMM have satisfactory levels of service A, B or C across the scenarios. On Perkins Street however, the stretch between State Street and US 101 does reach LOS D in some years and build scenarios. This is one of the busiest corridors in the GUAMM, and is the focal point of multiple proposed projects involving signalization at the ramps, a signal at the Main Street intersection, and changes to the Perkins/Orchard lane geometry. It is conceivable that these roadway projects and others on State Street, such as the downtown road diet, might have impacts leading to a deterioration in LOS.

### *Summary*

By and large, the LOS results summarized above comport with a priori expectations. LOS generally becomes poorer in 2030 than in 2020 due to the increasing traffic demand in more distant years. Further, the projects grouped into the Intermediate and Optimistic scenarios appear generally to mitigate worsening LOS in future years reasonably well, with LOS never worsening by more than one letter grade, if the LOS worsens at all, between the E+C and other scenarios. In any event, the LOS results demonstrate the ways in which the GUAMM can be used by MCOG and partner agencies to analyze performance of transportation facilities in the greater Ukiah area now and in future studies.

# 7. Recommendations for Future Enhancement and Maintenance

There are a number of areas, which may be categorized as methodological, data-related, or model development-related, where the GUAMM can be improved in the future. Some of the ways in which the model can be improved have been discussed briefly throughout this report. Below is a brief review and summary of the more important aspects that might be targeted for future enhancement.

## Methodology

The methodology we used represents a far more evolved approach to wide-area traffic simulation than either the state of the practice or techniques readily available in any commercial software have to offer. We have been advancing calibration and dynamic trip table estimation methods at Caliper for application to models like the GUAMM, but those methods continue to be evolved and refined, and require a period of evolution and refinement still before they will be commercially available to the end user. Dynamic OD estimation on a wide area scale continues to be the most challenging problem facing traffic modelers and continues to evade “push-button” approaches. Caliper will continue to offer these calibration methods as a cost-effective service until such a time as they have matured sufficiently for delivery to the end user. That said, we encourage

Caltrans and the MCOG to reevaluate the state of the practice each time the GUAMM is updated.

Perhaps more importantly than anything else in the methodology, is a simulation-based dynamic ODME method, which was lacking in the afore-mentioned model of the GEA, but has since been achieved and applied successfully to the LAMM, GUAMM and other projects at Caliper. Such an approach is vastly preferable to the state of the practice because, unlike the static assignment-based methods that are conventionally and prevalently used, the mechanism by which the link volumes are determined in the ODME (i.e., the route choice model) are consistent with that used to perform the simulations with the resulting refined trip tables.

The calibration and validation of the base year 2015 model is an important first step in the life of the GUAMM. But in order for the model to continue to be useful to Caltrans, the MCOG and other area governments in the future, periodic data collection and calibration efforts should be undertaken. Those calibration efforts might follow a template similar to that described in this report and ought to be improved upon as evolving methods become available.

## Data

Apart from the methodology, the micro-simulation model could be improved by more and different kinds of data. These include, but are not limited to, the following:

1. A more comprehensive set of dynamic (i.e., 5-, 10-, or 15-minute) counts, particularly in and around the communities surrounding Ukiah, would improve the calibration results irrespective of methodology.
2. More detailed vehicle classification data would improve the realism of the model. While truck data were available from key field count locations in this project, they were not sufficient to estimate the truck OD volumes independently of auto traffic. Rather, they were simply used to approximate their global share of the traffic demand.
3. OD data, such as from an extensive license plate survey, would reveal far more about the origin-to-destination pattern of traffic in the greater Ukiah area than counts. Such data could be hugely beneficial for improving the seed matrix that the MCOG TDM provides and on which the micro-simulation model so heavily relies. More OD data would also benefit calibration efforts for the MCOG TDM.

As future calibration efforts are carried out, it is recommended that the GUAMM in TransModeler be used to preserve the history of traffic count and signal timing data in the Greater Ukiah area. Such an inventory of traffic data will prove invaluable for historical analyses of the kind that were discussed in this report.

## Model Development

The GUAMM could also be improved by adding detail for which the scope and time frame of this project did not allow. For example, a more comprehensive review of the centroid connectors in the model might be considered. We refined the centroid connectors of a great many centroids in the model to reflect the locations of driveway, side streets, and on-street parking access in the corresponding traffic analysis zone.

Further, the GUAMM street network does not contain on-street parking and bicycle lanes. Both may be added to the model to increase the accuracy of the model and to make it sensitive to projects where cycling and parking have significant impacts.

This last recommendation extends to the entire micro-simulation model. We recommend that all of the model's inputs, including the physical representation of the road network, the route system, the signal timings, the traffic volumes, and the route choices be reviewed both to check for accuracy and to gain a better understanding of the model's basic elements.

# APPENDIX A: Data Collection Site Listing

Table A-1. Wavetronix speed and volume data collection sites

| Site | | Approximate Postmile |
|---|---|---|
| **US 101** | NORTH OF SH 20 | 31.3 |
| **US 101** | BETWEEN LAKE MENDOCINO DR & STATE STREET | 26.7 |
| **US 101** | NORTH OF STATE STREET | 24.9 |
| **US 101** | BETWEEN TALMAGE RD & GOBBI ST | 24.3 |
| **US 101** | BETWEEN GOBBI STREET & PERKINS ST/VICHY SPRINGS RD | 23.8 |
| **US 101** | BETWEEN PERKINS ST/VICHY SPRINGS RD & CITY WELL RD/UKIAH SPORTS | 21.8 |
| **US 101** | SOUTH OF BURKE HILL RD | 16.9 |

Table A-2. Directional tube count data collection sites

| Ramps |
|---|
| **RAMP US 101 NB OFF @ BURKE HILL RD** |
| **RAMP US 101 NB OFF @ TALMAGE RD** |
| **RAMP US 101 NB ON @ BURKE HILL RD** |
| **RAMP US 101 NB ON @ TALMAGE RD EB** |
| **RAMP US 101 NB ON @ TALMAGE RD WB** |
| **RAMP US 101 SB OFF @ BURKE HILL RD** |
| **RAMP US 101 SB OFF @ TALMAGE RD EB** |
| **RAMP US 101 SB OFF @ TALMAGE RD WB** |
| **RAMP US 101 SB ON @ BURKE HILL RD** |
| **RAMP US 101 SB ON @ TALMAGE RD** |
| **RAMP US 101 NB OFF @ COX SHRADER/BURKE HILL** |
| **RAMP US 101 NB OFF @ LAKE MENDOCINO DR** |
| **RAMP US 101 NB OFF @ SH 20** |
| **RAMP US 101 NB ON @ COX SHRADER/BURKE HILL** |
| **RAMP US 101 NB ON @ LAKE MENDOCINO DR** |
| **RAMP US 101 NB ON @ SH 20** |
| **RAMP US 101 NB ON/OFF S STATE ST** |
| **RAMP US 101 SB OFF @ COX SHRADER/BURKE HILL** |
| **RAMP US 101 SB OFF @ LAKE MENDOCINO DR** |
| **RAMP US 101 SB OFF @ S STATE ST** |
| **RAMP US 101 SB OFF @ SH 20** |

| |
|---|
| **RAMP US 101 SB ON @ COX SHRADER/BURKE HILL** |
| **RAMP US 101 SB ON @ LAKE MENDOCINO DR** |
| **RAMP US 101 SB ON @ SH 20** |
| **RAMP US 1010 NB OFF @ UKIAH SPORTS** |
| **RAMP US 1010 NB ON @ UKIAH SPORTS** |
| Other Sites |
| **LAKE MENDOCINO DRIVE E/O NORTH STATE ST** |
| **NORTH STATE STREET N/O LAKE MENDOCINO DR** |
| **NORTH STATE STREET S/O LAKE MENDOCINO DR** |
| **REDEMEYER ROAD B/T VICHY SPRINGS RD & EL DORADO RD** |
| **REDEMEYER ROAD N/O DEERWOOD DR** |
| **SH 20 W/O E SIDE POTTER VALLEY RD** |
| **SH 222/TALMAGE RD B/T RUDDICK CUNNINGHAM RD & HASTINGS RD/BABCOCK LN** |
| **SH 253 W/O STIPP LN NEAR US 101** |
| **VICHY SPRINGS ROAD B/T REDERMEYER RD & WATSON RD** |
| **VICHY SPRINGS ROAD B/T WATSON RD & OAK MANOR DR** |

Table A-3. Turning movement count data collection sites

| US 101 Ramps (from North to South) |
|---|
| **MOORE STREET & NB US 101 RAMPS** |
| **CENTRAL AVENUE & SB US 101 RAMPS** |
| **NORTH STATE STREET & NB US 101 RAMPS** |
| **NORTH STATE STREET & SB US 101 OFF RAMP** |
| **NORTH STATE STREET & SB US 101 ON RAMP** |
| **PERKINS STREET & NB US 101 RAMPS** |
| **PERKINS STREET & SB US 101 RAMPS** |
| **GOBBI STREET & SB US 101 RAMPS** |
| **GOBBI STREET & NB US 101 RAMPS** |
| State Street (from North to South) |
| **NORTH STATE STREET & KUKI LANE** |
| **NORTH STATE STREET & FORD ROAD/EMPIRE DRIVE** |
| **STATE STREET & LOW GAP ROAD/BRUSH STREET** |
| **STATE STREET & NORTON STREET** |
| **STATE STREET & SCOTT STREET** |
| **PERKINS STREET & ORCHARD AVENUE** |
| **STATE STREET & STANDLEY STREET** |
| **STATE STREET & PERKINS STREET** |

| |
|---|
| **STATE STREET & MILL STREET** |
| **STATE STREET & GOBBI STREET** |
| **SOUTH STATE STREET & TALMAGE ROAD** |
| **SOUTH STATE STREET & WASHINGTON AVENUE/HASTINGS AVENUE** |
| Other Sites |
| **PERKINS STREET & HOSPITAL DRIVE** |
| **GOBBI STREET & ORCHARD AVENUE** |
| **TALMAGE ROAD & AIRPORT PARK BOULEVARD** |

# APPENDIX B: Project Listing for Alternatives Analysis (Task 8)

| Tier | Project No. | Scenario | Project Name | Project Description | Source | Assumptions* | Comments Received from Caltrans and Ukiah |
|---|---|---|---|---|---|---|---|
| 1 | 6 | E+C | Ukiah Downtown Streetscape Improvement Plan | Pedestrian friendly upgrade of State St. & Main S. from Norton St. to Gobbi St., including:<br>Sidewalk widening [not to be modeled];<br>Raised median between Gobbi and Mill on State;<br>Pedestrian refuge [not to be modeled];<br>Road diet on State St. (change from 4 to 3 lanes);<br>Diagonal parking adjacent to Plaza [not to be modeled];<br>Enhanced paving at crosswalks [not to be modeled];<br>Curb bulb-outs and mid-block extensions [not to be modeled];<br>Intersection treatments and gateways [not to be modeled];<br>Street trees, street furniture, and crosswalk treatments [not to be modeled];<br>Class II bike lanes on Main St. between Clay and Norton [not to be modeled]; | Ukiah Downtown Streetscape Improvement Plan (2009) | | |
| 1 | 22 | E+C | Talmage Road/US 101 Interchange Improvements | 1. Add signal to southbound ramp intersection. Coordinate new signal with optimized existing signal at Talmage Road/Airport Park Boulevard intersection.<br>2. Widen Talmage Road Overcrossing as needed to accommodate queued vehicles at Airport Road/Talmage Road intersection [MCOG Note - Refer to City's current plans for improvements] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study and Route 101 Corridor Interchange Study in Mendocino County (2005) | Assumed actuated signal with standard controller configuration | |
| 1 | 24 | E+C | Talmage Road/Airport Park Boulevard Modifications | Talmage Road/Airport Park Boulevard Intersection - Construct additional WB left turn lane | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed standard controller configuration | Assume 250' WB new lane (source: Costco Final EIR) |
| 1 | 30 | E+C | Gobbi Street/Waugh Lane Intersection | - Install traffic signal | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study<br>2006 Mendocino County Regional Bikeway Plan - Table 4 | Assumed actuated signal with standard controller configuration | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 36 | E+C | S. State Street/Hastings Avenue Intersection | Modify existing traffic signals - Add separate EB and WB left turn lanes | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study (Project 51) | Assumed standard controller configuration | |
| 1 | 44 | E+C | Clay Street and Hospital Drive Extensions | - Hospital Drive extension from Perkins Street to Clay Street<br>- Clay Street extension to Peach Street/Leslie Street intersection (97) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 1 | 202 | E+C | Low Gap Rd/Bush St | A roundabout is planned at Low Gap Road/Bush Street | Railroad Depot Site Traffic Impact Study | | |
| 3 | 215 | E+C | Near Term North State Street/US 101 Improvements | US 101 Interchanges - North State Street/US 101 Improvements - Realign southbound on- and off-ramps to meet at a single signalized intersection; Increase acceleration length for southbound on-ramp merge onto southbound mainline | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study and Route 101 Corridor Interchange Study in Mendocino County (2005) | Assumed actuated signal with standard controller configuration. Assumed 500 ft acceleration lane. Double of existing at 250 ft | |
| 1 | 6 | I | Ukiah Downtown Streetscape Improvement Plan | Traffic signals at Gobbi and Main, and at Perkins and Main; | Ukiah Downtown Streetscape Improvement Plan (2009) | Assumed actuated signal with standard controller configuration | |
| 1 | 23 | I | Airport Park Boulevard / Commerce Drive Signalization | Airport Park Boulevard - Airport Park Boulevard/Commerce Drive Intersection: Install traffic signal and re-stripe to provide EB and WB left turn lanes (68) (Project #68 in AB1600) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | Assume 80 feet EB and 65 feet WB, respectively |
| 1 | 58 | I | Perkins Street/Orchard Avenue Intersection | - E. Perkins Street/Orchard Avenue Intersection: Construct additional eastbound lane on Perkins, widening of south side of Perkins from Orchard Ave to US 101 and north side of Perkins west of Orchard | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study (Project 21) | Assumed standard controller configuration | See Figure 9 "East Perkins Street Widening" contained in the Railroad Depot Site Traffic Impact Study Report |
| 3 | 201 | I | N. State Street/Brush Street Improvements | Brush Street - Intersection of N. State Street/Brush Street - Add WB left turn lane, coordinate signal; OR N. State Street/Brush Street-Low Gap Road widen east leg, new phasing; OR Low Gap Road/Brush Street install signal; OR N. State Street/Low Gap Road-Brush Street WB add right turn lane (20) Preferred Option: Widen east leg to allow for a WB left turn lane. | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed standard controller configuration for conversion from pre-timed to actuated. | The plan is to add a WB left turn lane, 50' in length and extended to Mazzoni as a two-way left turn lane |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 202 | I | Low Gap Road Improvements | - Low Gap Road, from N. State Street to City Limit - Widen to collector street conforming to City Standards but keep street at 2 lanes. [not to be modeled]<br>- Low Gap Road/Despina Drive intersection install signal or roundabout (110) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study (Projects 74, 110) | Actuated signal was installed with standard controller configuration. No widening modeled since only curb-gutter affected. | |
| 3 | 215 | I | Near Term North State Street/US 101 Improvements | US 101 Interchanges - North State Street/US 101 Improvements - (Near-Term) Provide three lanes on northbound Route 101 mainline structure to accommodate extended acceleration lane by re-striping the bridge area and adding pavement to the north and south of the bridge | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study and Route 101 Corridor Interchange Study in Mendocino County (2005) | | |
| 3 | 216 | I | Near Term Perkins Street/US 101 Improvements | US 101 Interchanges - Perkins Street/US 101 Improvements - 1. (Near-Term) Add signal to southbound ramp intersection and coordinate with optimized East Perkins / Orchard signal. Add signal to northbound ramp intersection and coordinate with nearby signals. There is also potential to add a roundabout to the northbound ramp intersection, as was outlined in the May 2003 Brush Street Triangle Study. 2. Add a westbound through-left lane and a southbound right turn lane to the East Perkins Street/Orchard Avenue intersection. 3. Increase acceleration length for northbound on-ramp; 4. Add auxiliary lane connecting northbound off-ramp with upstream northbound onramp from East Gobbi Street interchange to improve merging and weaving operations; 5. Widen East Perkins Street Overcrossing as needed to accommodate queued vehicles at newly signalized ramp intersections. Funded under HSIP | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study and Route 101 Corridor Interchange Study in Mendocino County (2005) | Assumed actuated signal with standard controller configuration. The second point on the WB and SB lane additions was decided to be not modeled after discussion with the TAG. | Signal at NB ramp intersection.<br>1000' ft for increased acceleration lane (AASHTO Green Book) |
| 3 | 232 | I | Talmage Road Expansion | Talmage Road - S. State Street to City Limit - Widen to four lane arterial, add signal interconnect cable | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 30 | O | Gobbi Street Improvements (Phase I) | 1. Dora Street to S. State Street - Widen to Major Arterial standards [not to be modeled] and install signal interconnect cable. Keep street at two lanes.<br>2. Gobbi Street/Oak Street intersection install signal and coordinate. 3. S. State Street to City Limit - Install signal interconnect cable. | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | No widening modeled since only curb-gutter affected. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2 | 32 | O | N. State Street Signal Interconnect and Coordination Project - Phase 1 | - Brush Street to Perkins Street Intersection - Install signal interconnect cable (70)<br>- N. State Street/Norton Street Intersection - coordinate existing traffic signal (6)<br>- N. State Street/Scott Street Intersection - coordinate existing traffic signal (14)<br>- N. State Street/Perkins Street Intersection - coordinate existing traffic signal (36)<br>- N. State Street/Standley Street Intersection - coordinate existing traffic signal<br>- N. State Street/Clara Avenue - install signal, re-stripe add SB left-turn lane, realign EB driveway, coordinate traffic signals<br>- N. State Street/Ford Street Intersection - install traffic signal and coordinate; OR add SB left-turn lane (41); add WB right-turn lane (112) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | |
| 1 | 33 | O | Dora Street Signal Interconnect | Dora Street - N. Terminus to S. City Limit - Install signal interconnect cable (79) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 2 | 58 | O | Perkins Street Interconnect Project | - E. Perkins Street from N. State Street to City Limit - Widen to Major Arterial standards and install signal interconnect cable. This will not change the number of lanes.<br>- E. Perkins Street/Main Street Intersection Install traffic signal, coordinate, re-stripe to provide separate SB, EB and WB left-turn lanes; OR install signal (30) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study (Projects 21, 30, 76) | No widening modeled since only curb-gutter affected. | |
| 3 | 59 | O | Orchard Avenue Signal Interconnect | Orchard Avenue - N. City Limit to E. Perkins Street - Install Signal interconnect cable (81) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 95 | O | Dora Street / W. Perkins Street Signalization | Dora Street - Dora Street/W. Perkins Street intersection install signal and coordinate (107) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | |
| 2 | 96 | O | Talmage Road / Waugh Lane Signalization | Talmage Road/Waugh Lane Intersection Install a traffic signal | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 104 | O | Orchard Avenue/Clara Avenue Modifications | Orchard Avenue/Clara Avenue: provide two-way left-turn lane striping; OR install traffic signal (25) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | |
| 3 | 105 | O | Orchard Avenue/Ford Street Modifications | Orchard Avenue/Ford Street - provide two-way left-turn lane striping; OR install traffic signal (24) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | |
| 3 | 203 | O | Dora Street Improvements | - Dora Street/Clay Street Intersection - Install a traffic signal and re-stripe to provide separate NB and SB left turn lanes<br>- Dora Street/Mill Street Intersection - Install signal and re-stripe to provide separate SB left turn lane (62)<br>- Dora Street/Washington Avenue Intersection - Install a traffic signal and re-stripe to provide separate NB,SB,EB, and WB left turn lanes (63)<br>- Gobbi Street Street/Dora Street Intersection - Signalize and re-stripe to provide separate NB right turn Lane | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study (Projects 56, 61-63) | Assumed actuated signal with standard controller configuration | |
| 3 | 204 | O | Talmage Road/Hastings Avenue Signalization | Talmage Road/Hastings Avenue Intersection Install a traffic signal and re-stripe to provide separate EB and WB left turn lanes | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Assumed actuated signal with standard controller configuration | |
| 3 | 209 | O | Dora Street Extension | South Dora Street Extension - between Oak Knoll Drive and Stipp Lane (98)[Note - County project. Estimated cost is $2.7 million/2008 dollars.] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 210 | O | Southern Orchard Avenue Extension | Orchard Avenue Extension- southern extension to Talmage Road. This would be a 20 year project and would work only if Talmage interchage is changed to a tight diamond as planned. | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | The Orchard Av extension connects to Talmage Frontage Rd as decided after discussion with the TAG. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 214 | O | Gobbi Street Improvements (Phase II) | US 101 Interchanges - Gobbi Street/US 101 Improvements - 1. (Near-Term) Add signal at East Gobbi Street/101 Southbound Ramp intersection and coordinate with Gobbi Street/Orchard Avenue. There is also potential to add a roundabout to the East Gobbi Street/Orchard Avenue intersection, as was outlined in the May 2003 Brush Street Triangle Study; 2. Add auxiliary lane connecting northbound on-ramp with downstream northbound offramp at East Perkins Street interchange to improve merging and weaving operations; 3. Widen East Gobbi Street Overcrossing as needed to accommodate queued vehicles at newly signalized southbound ramp intersection | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study and Route 101 Corridor Interchange Study in Mendocino County (2005) | Assumed actuated signal with standard controller configuration | A traffic signal is currently installed at Gobbi and Orchard. No roundabout is planned. |
| 3 | 222 | O | N. State Street Widening | - Widen to four lanes between US 101 and Lake Mendocino Drive (40)<br>- There is a Class II bikeway on North State Street from the Ford Road/Empire Drive intersection to the point north of the US 101 overpass where the roadway narrows from four lanes to two lanes. The Class II bikeway is proposed to be extended northward an additional 1.49 miles to Lake Mendocino Drive at The Forks [not to be modeled]. | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study<br><br>2006 Mendocino County Regional Bikeway Plan - Table 4 Proposed Bikeway Improvement Projects | N.State is already 3 lanes with the shared center. It was decided not to model the conversion to 4 lanes after discussion with the city. | |
| 3 | 226 | O | Airport Park Blvd Extension | - Extend Airport Park Boulevard to Plant Road or US 101 SB ramps. 20 year plan may extend this to Norgard, but probably not to Plant Road due to technical issues. | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 233 | O | Hensley Creek Road Extension | Hensley Creek Rd - Extend Hensley Creek Rd to new Orchard Ave extension[Note - County project. Estimated cost is $4.2 million/2008 dollars.] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 234 | O | Northern Orchard Avenue Extension | Orchard Avenue - Extend Orchard Avenue to Hensley Creek Road and to Lake Mendocino Drive (for more info on exact alignment see Brush Street Triangle Transportation Study)[Note - County project. Estimated cost is $18.0 million/2008 dollars.] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 235 | O | Orr Springs Rd Extension | Orr Springs Road - Extend Orr Springs Rd from North State Street to new Orchard Ave extension[Note - County project. Estimated cost is $2.8 million/2008 dollars.] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3 | 236 | O | Orr Springs Road Connection | Orr Springs Road Connection to Lovers Lane (possibly via Despina Drive) [Note - County project. Estimated cost is $1.9 million/2008 dollars.] (111) | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 249 | O | US 101 Lake Mendocino Drive interchange improvements | US 101 Interchanges - US 101 Lake Mendocino Drive interchange improvements - 1. Install signal at 101 Southbound Ramp / Lake Mendocino Drive intersection<br>- 2. Increase acceleration lengths for both northbound and southbound on-ramps Long Term Project | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study and Route 101 Corridor Interchange Study in Mendocino County (2005) | | 770' for the increased acceleration lane (source: AASHTO Green Book) |
| 3 | 264 | O | Orchard Avenue/Brush St Improvements | Orchard Avenue/Brush St intersection improvements (27) Widen Brush at Orchard | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Duplicated by project 269 below | |
| 3 | 267 | O | Brush Street US 101 Ramps | Brush Street - US 101 SB ramp installation at Brush Street, if viable and coordinated with improvements and/or limitations at Perkins Street/US 101 interchange (11) [Note - County project. Estimated cost is $2.6 million/2008 dollars.] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | | |
| 3 | 269 | O | Brush Street Widening | Brush Street - Widen Brush Street from 2 to 4 lanes from North State to Orchard Avenue Extension.[Note - County project from Northwestern Pacific railroad grade crossing to Orchard Avenue Extension. Estimated cost is $690,000/2008 dollars] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study | Shared center lane between N.State and Mazzoni was removed in lieu of widening | |
| 3 | 281 | O | Redemeyer Road Extension | Redemeyer Road extension over Russian River to North State Street at the Lake Mendocino Drive interchange. See Redemeyer Road Study for more info on specific alignment.<br>[Note - County project. Estimated cost is $16.9 million/2008 dollars.]<br>[Note 2 - Five alignments were considered for the extension of Redemeyer Road. Alignments D1 and AC, which extend Redemeyer Road west over the Russian River to intersect with North State Street, were recommended for further study by the consultant.]<br>[Note 3 - Howard Dashiell's understanding is that the "water treatment ponds road" was the preferred alternative.] | AB1600 Traffic Mitigation Fee Study (Table 3) - Ukiah Nexus Study & Feasibility Study for the Redemeyer Road Extension Project (2009) | Updated cycle length and phasing at the intersection of the Redemeyer Rd Extension with N.State and Lake Mendocino Drive to account for the new leg. | |

*Assumed broadly for all scenarios: There will be no representation in the GUAMM for proposed bicycle lanes, on-street parking, or interconnect cables.

# APPENDIX C: Simulation Parameters Modified in the GUAMM

For a variety of reasons discussed in this report, model parameters were adjusted to reflect observed or directly measured conditions in Greater Ukiah. In some instances, parameters were modified based on qualitative observations of driver behavior. Below, each of the GUAMM parameters that were adjusted are described, and a rationale for those adjustments is provided.

## Desired Speed Distribution

In the GUAMM, each driver has a “desired speed,” which is the maximum speed at which he or she would travel in the absence of traffic signals, signs, or other vehicles. In other words, the desired speed is the speed at which a driver will travel in free flow conditions. In TransModeler, a driver’s desired speed changes as a function of the speed limit. It is assumed that drivers base their choice of speed on the speed limit and the perceived risk of the consequences for violating the speed limit. In the model parameters, the desired speed is thus specified as a deviation from the posted speed limit.

It is also assumed that desired speeds vary across the driving population. Some drivers tend to drive more conservatively and observe the speed limit, while others are more aggressive and more willing to exceed the speed limit. To capture this variability, a desired speed distribution table determines the percentage of the population that will deviate from the speed limit to varying degrees.

During the collection of speed data on US 101, it was generally observed that drivers in Ukiah were largely compliant with the posted speed limit. When drivers were observed exceeding the speed limit, it was rarely by more than about 5-10 mph. Though no rigorous data collection effort was undertaken to precisely determine the distribution of driver deviation from the speed limit on various roads, the desired speed parameters in TransModeler were subjectively adjusted to be more conservative relative to default parameters in TransModeler and thus to be more consistent with general observations in Ukiah. Figure C-1 shows the modified “Standard” desired speed distribution in the GUAMM.

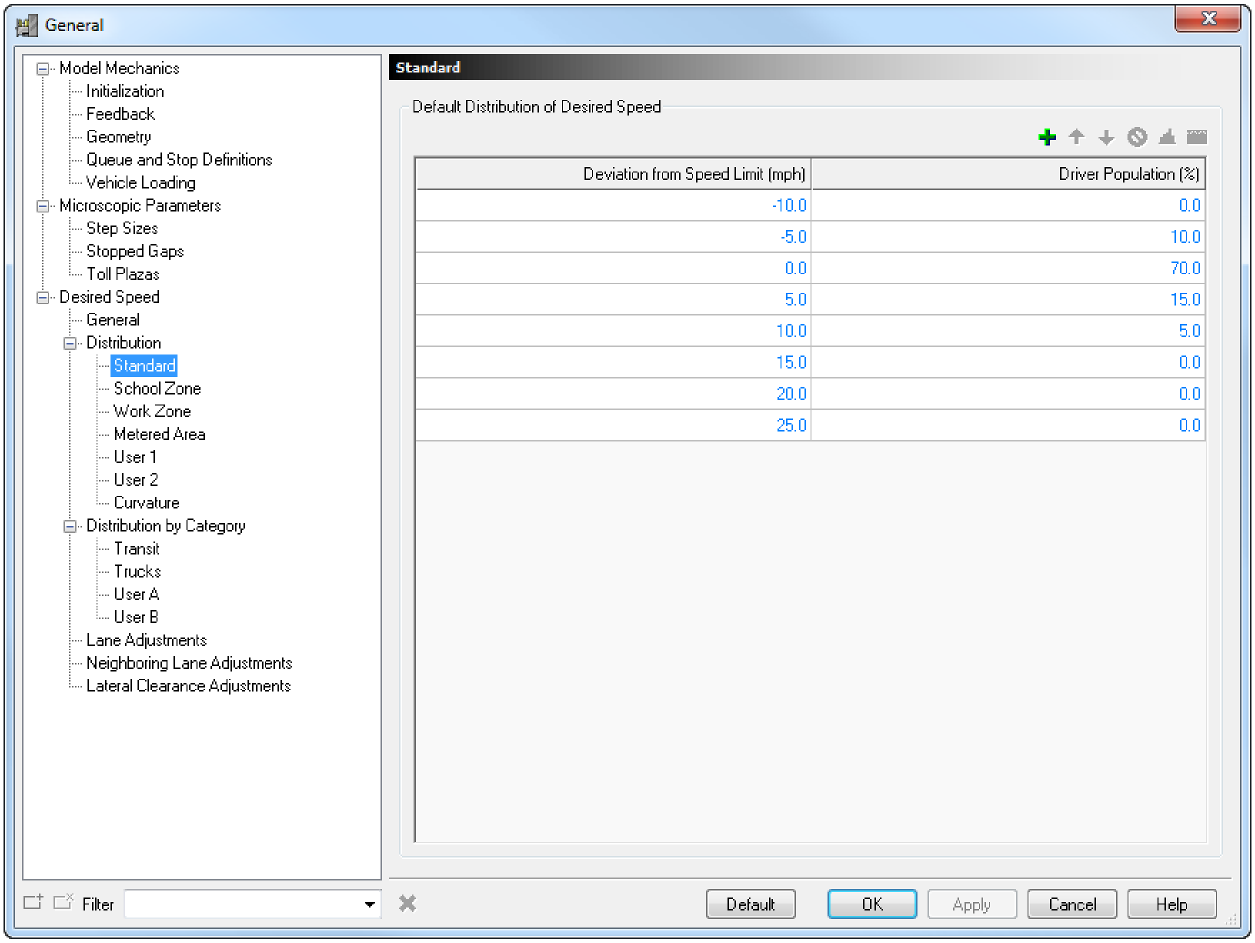


Figure C-1. Adjusted desired speed distribution for GUAMM

## Vehicle Fleet Mix

Vehicle fleet mix parameters were derived from directional tube data collected at 26 sites, including all located on US 101 ramps, where hardware capable of recording FHWA classified counts were deployed. A distribution based on FHWA's classifications was developed for the AM and PM periods. Figures C-2 and C-3 show the general vehicle class distribution tables for the AM and PM models, respectively.

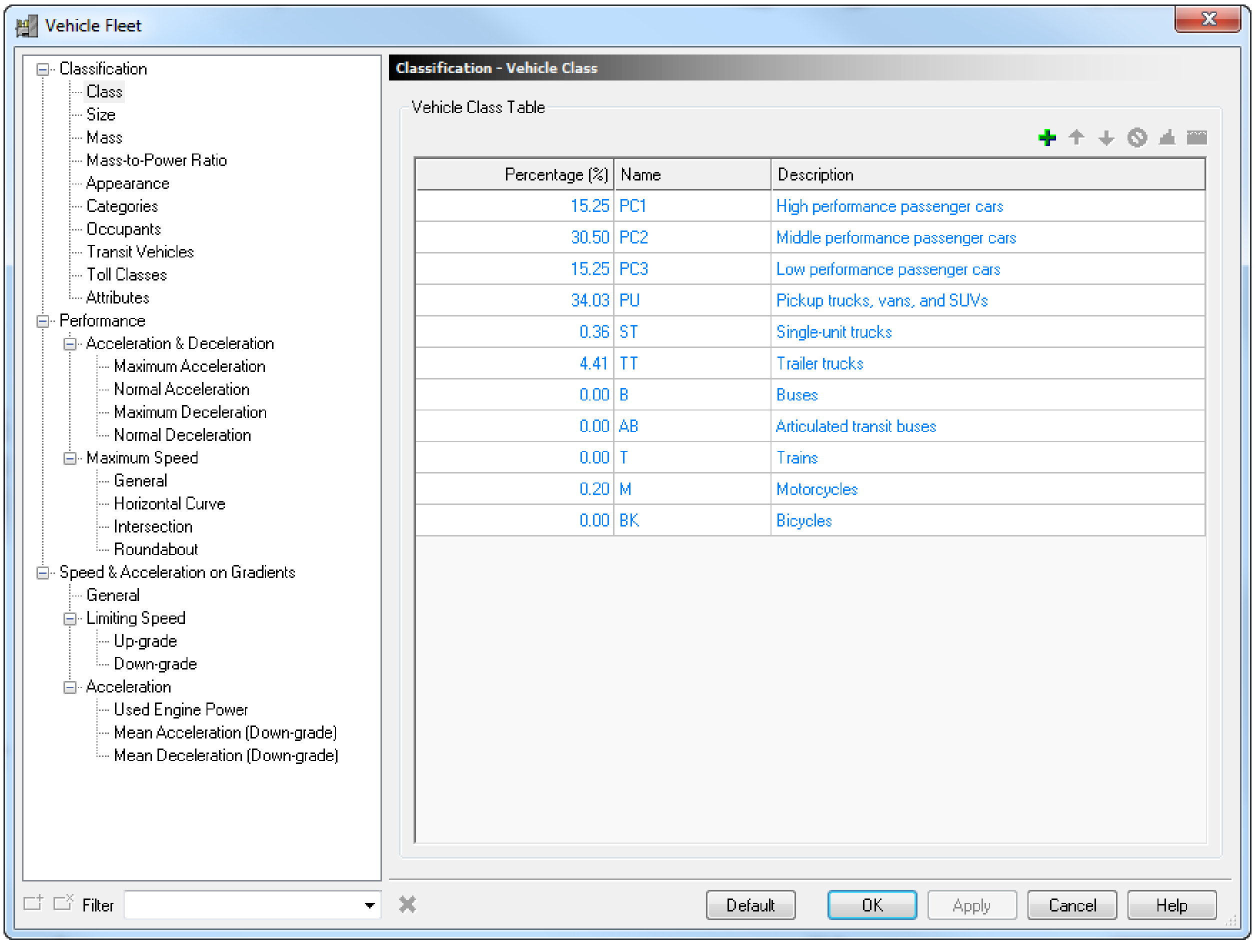


Figure C-2. Adjusted vehicle fleet mix parameters for AM scenarios

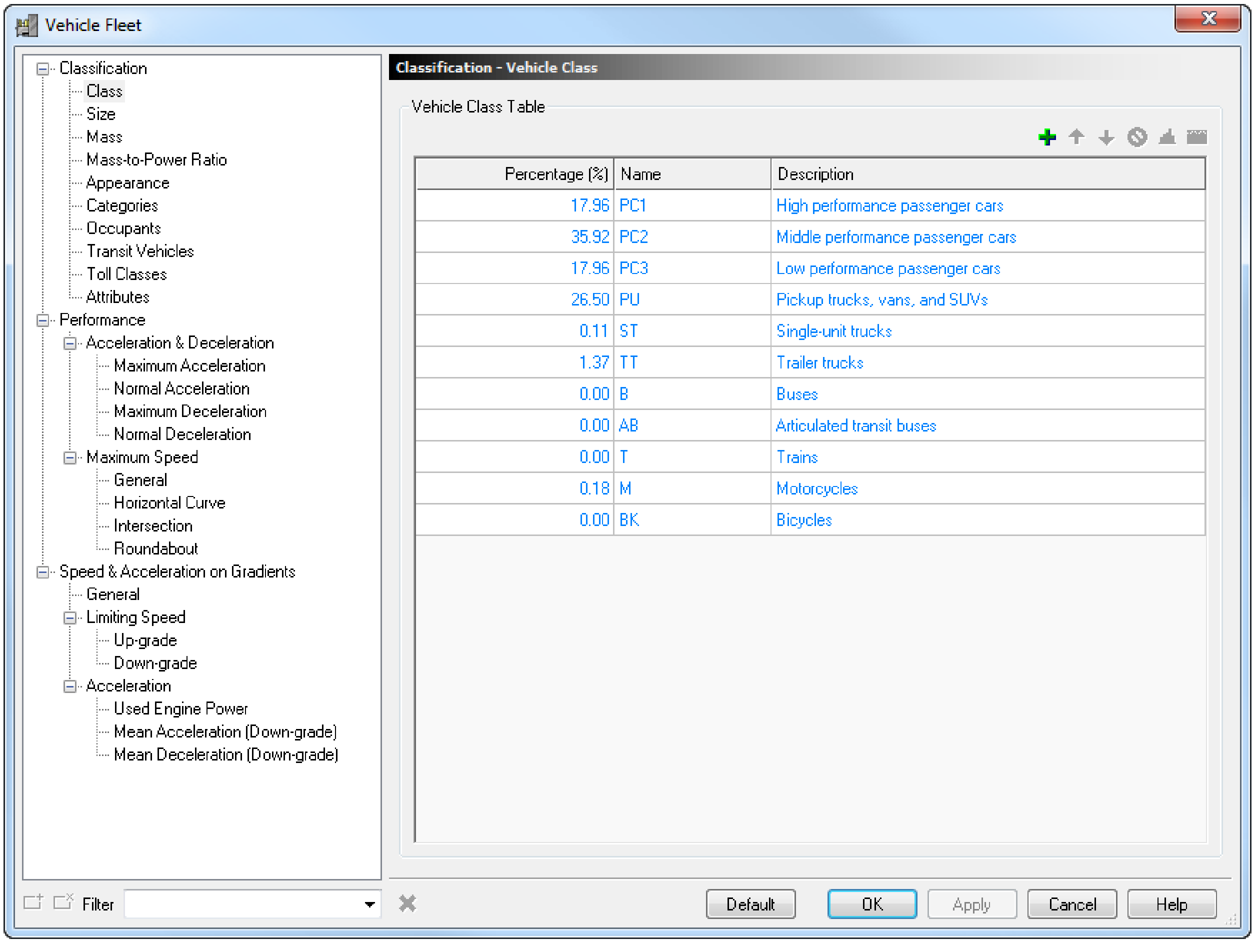


Figure C-3. Adjusted vehicle fleet mix parameters for PM scenarios

## Saturation Flow Data

As described earlier in this report in the section on Field Data Collection (Task #4), queue discharge headways were observed using video footage recorded at key intersections in the GUAMM. From the headways computed, however, there did not appear to be any compelling reason to believe that driving behavior was markedly different than that observed in Eureka, CA or Lake County, CA in the development of similar models by Caliper Corporation. Thus, the same driver behavior parameters from those projects were assumed. The headway buffers used in the GUAMM are shown in Figure C-4.

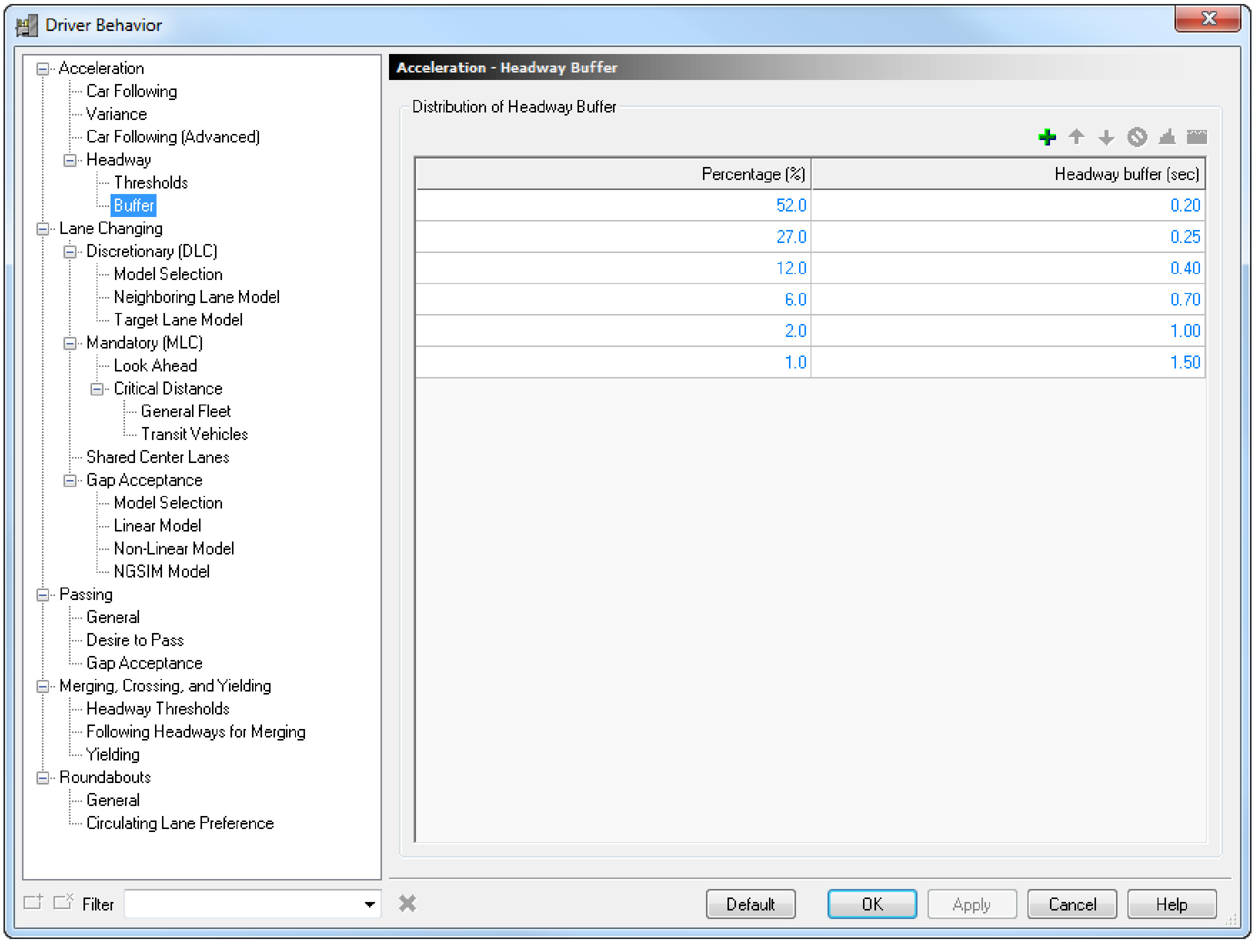


Figure C-4. Adjusted acceleration headway buffer parameters

## Driver Compliance with Rules of Traffic Behavior

TransModeler simulates variable driver compliance with various rules of traffic behavior. For instance, drivers may or may not pull to a stop inside an intersection when queues spill into an upstream intersection. Or, drivers may or may not obey rules that prohibit changing lanes in certain locations. Several driver compliance parameters are modified in the GUAMM.

First, zero compliance was assumed with lane changing prohibitions, symbolized by solid white stripes between lanes both in the field and in the model. In general, this indicates that lane changing is not permitted. However, few drivers comply with this rule. Instances where one might want greater compliance with the rule include high occupancy vehicle (HOV) lanes, where a fine might be assessed for violation. In any event, in the GUAMM, all lane changing “prohibitions” are of the soft variety (e.g., between a left turn bay and a through lane), so zero compliance is used.

On the other hand, compliance with the rule that drivers should not stop inside intersections is set at 100% for controlled intersections and 90% for uncontrolled ones. These parameters ensure maximum compliance with the rule that drivers should not block intersections in order to avoid spillback effects that can hinder the flow of traffic in dense grid areas such as parts of downtown Ukiah. The adjusted compliance parameters are shown in Figure C-5.

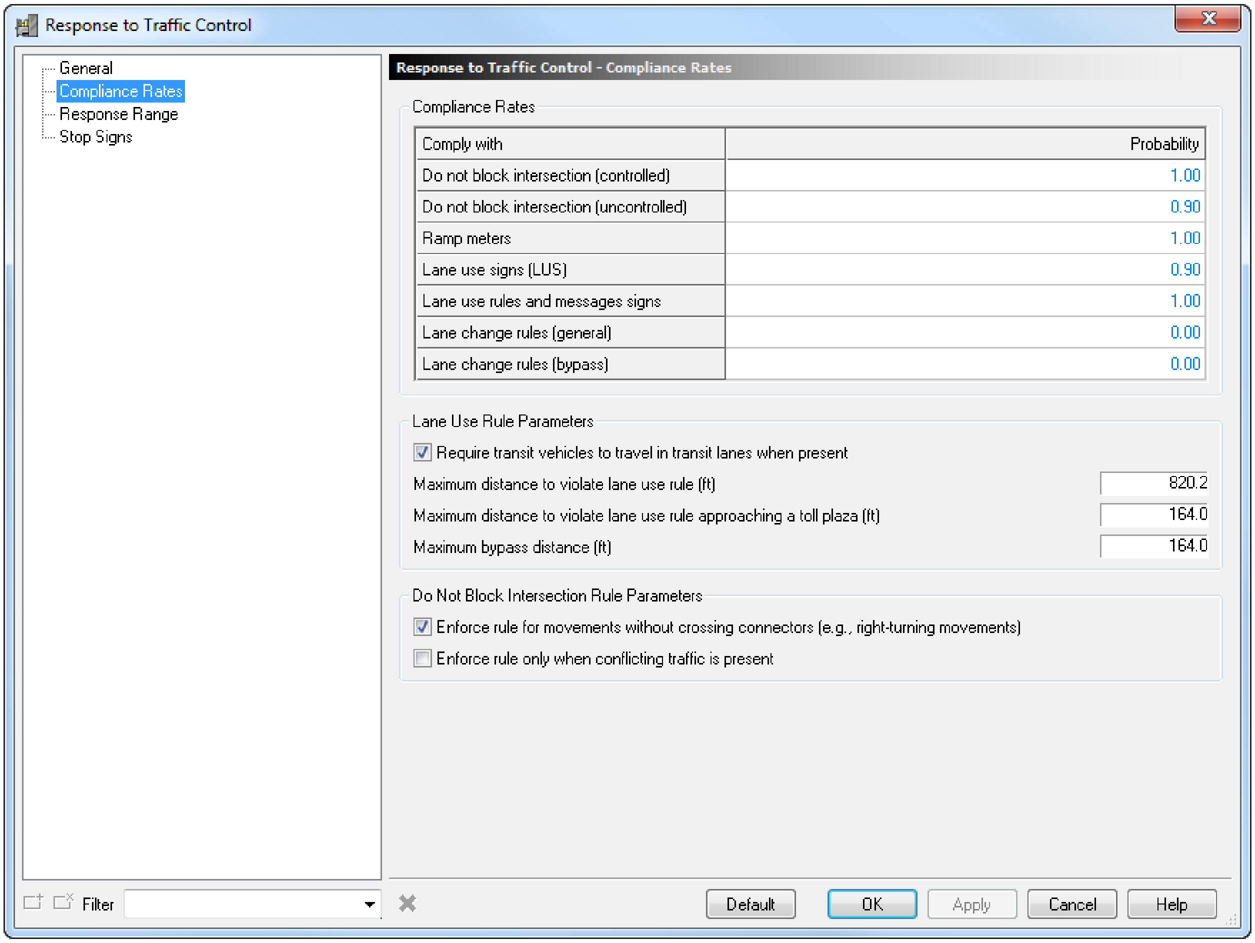


Figure C-5. Adjusted traffic control compliance rate parameters