Memorandum

To: Laura Prickett, Horizon Water and Environment

From: Thanh T. Luc, INCE, Noise and Vibration Lead, Parsons Transportation Group

cc: Parag Mehta, Kimley Horn

Date: October 24, 2017

Re: Santa Cruz Route 1 Tier I and Tier II HOV Lane/TSM Widening Project – Review of Effects of Changes to Project Description and Traffic Modeling Methodology on the Noise Analysis in the DEIR

1.0 Purpose of the Noise Analysis Review

The purpose of this memorandum is to:

(1) Review the CDM Smith technical memorandum titled, *Highway 1 Widening/HOV Lane Project – Estimation of Induced Traffic Demand and Congestion-Related Costs*, dated August 16, 2017 (included in Attachment 1);

(2) Review the updated Tier I Corridor Alternatives descriptions (included in Attachment 2), which includes avoidance of all project impacts to the upland habitat of the Santa Cruz long-toed salamander (SCLTS); and

(3) Assess the need for updates to the project noise analysis per the aforementioned review items.

This noise technical memorandum includes a general project description (Section 1.0) followed by a review of potential effects to the noise analysis in relation to the findings of the traffic memorandum (Section 2.0) and the anticipated changes to Tier I Corridor Alternatives description (Section 3.0).

2.0 Project Description

The California Department of Transportation (Caltrans), in cooperation with the Federal Highway Administration (FHWA) and the Santa Cruz County Regional Transportation Commission (RTC), proposes improvements to State Route 1 (Route 1) in Santa Cruz County. This project is divided into two components: the Tier I component from approximately 0.4 mile south of the San Andreas-Larkin Valley Road interchange to 0.3 mile north of the Morrissey Boulevard interchange, a distance of approximately 8.9 miles; and the Tier II component from 41st Avenue to Soquel Avenue/Drive.

Tier I Project

The Noise Study Report (NSR) prepared for the project in 2013 evaluates two build alternatives for the Tier I Project: a Tier I Corridor HOV Lane Alternative and a Tier I Corridor Transportation Systems Management

(TSM) Alternative. Since the completion of the NSR, the description of each of these alternatives has been modified to assure avoidance of the upland habitat of the Santa Cruz long-toed habitat, in the southern portion of the alignment. The complete, updated project description is provided in Attachment 1. The modifications of the project description include the proposed elimination of the widening of some ramps at Rio Del Mar Boulevard, Freedom Boulevard, and San Andreas Road; other project features, such as shoulder paving, retaining walls associated with ramp widening along the project corridor south of Rio Del Mar Boulevard, might be eliminated if, during future environmental review of other Tier II projects, the project features cannot be designed to avoid impact to upland habitat for the Santa Cruz long-toed salamander.

The Tier I Corridor HOV Lane Alternative

The Tier I Corridor HOV Lane Alternative would expand the existing four-lane highway to a six-lane facility by adding one HOV lane in each direction next to the median and an auxiliary lane on the outside in each direction. Expanding the highway from four lanes to six lanes would be achieved by building the new lane in each direction in the existing freeway median and widening the freeway footprint in those locations where the median is not wide enough to fit the new lane. The Tier I Corridor HOV Lane Alternative would modify or reconstruct all nine interchanges within the project limits to improve merging operations and ramp geometry. The Bay Avenue/Porter Street and 41st Avenue interchanges would be modified to operate as one interchange, with a frontage road to connect the two halves of the interchange. Where feasible, design deficiencies on existing ramps would be corrected. Ramp metering and HOV bypass lanes and mixed-flow lanes would be added to Route 1 on-ramps within the project limits. The Tier I Corridor HOV Lane Alternative would include an auxiliary lane in each direction between Freedom Boulevard and Bay Avenue/Porter Street and between 41st Avenue and Soquel Avenue/Drive. Transportation Operations System infrastructure, such as changeable message signs, highway advisory radio, microwave detection systems, and vehicle detection systems, would also be provided under the Tier I Corridor TSM Alternative. The Tier I Corridor HOV Alternative would not construct a northbound auxiliary lane between State Park Drive and Park Avenue.

Tier I Corridor TSM Alternative

The Tier I Corridor TSM Alternative proposes to add an auxiliary lane along the highway between major interchange pairs from Morrissey Boulevard to Freedom Boulevard, provide ramp metering, construct an HOV bypass lane and mixed-flow lane on on-ramps, and improve nonstandard geometric elements at various ramps, in both directions. The Tier I Corridor TSM Alternative also would include Transportation Operations System electronic equipment as described for the Tier I Corridor HOV Lane Alternative. In addition, the Tier I Corridor TSM Alternative would reconstruct the north and south Aptos railroad bridges and lower Route 1 in Aptos to achieve standard vertical clearance; reconstruct the State Park Drive, Capitola Avenue, and 41st Avenue overcrossings; widen the Aptos Creek Bridge; and construct three new pedestrian/ bicycle overcrossings over Route 1 at Mar Vista Drive, Chanticleer Avenue, and Trevethan Avenue. All of the aforementioned reconstructed bridges would include improvements to pedestrian and bicycle facilities. The Tier I Corridor TSM Alternative shares many features with the Tier I Corridor HOV Lane Alternative; the major exceptions are the absence of an HOV lane and a reconfiguration of only the Soquel Drive/Soquel Avenue interchange. The Tier I Corridor TSM Alternative would include a northbound auxiliary lane between State Park Drive and Park Avenue.

Tier II Project

One build alternative is evaluated for the Tier II Project: the Tier II Auxiliary Lane Alternative. This alternative would add an auxiliary lane to both the northbound and southbound directions of Route 1 between the 41st Avenue and Soquel Avenue/Drive interchanges. In addition, an Americans with Disabilities Act-compliant pedestrian and bicycle overcrossing would be constructed at Chanticleer Avenue. The total roadway widening would be approximately 1.4 miles along Route 1. The new auxiliary lanes would be 12 feet wide. In the southbound direction, the width needed for the new lane would be added in the median, and the median barrier would be shifted approximately 5 feet toward the northbound side of the freeway to make room for the new lane and a standard 10-foot wide shoulder. Where the new southbound lane meets the existing ramps, outside shoulder widening would occur to achieve standard 10-foot wide shoulders. In the northbound direction, the project proposes to pave a 10-foot-wide median shoulder and widen to the outside to add the 12-foot wide auxiliary lane and a new 10-foot wide shoulder.

The pedestrian/bicycle overcrossing constructed at Chanticleer Avenue would connect to a new 360-foot long by 6-foot wide sidewalk on Chanticleer Avenue on the south side of Route 1. The sidewalk, located along the south side of Soquel Drive, would be separated from the street by a 4-foot wide park strip. Retaining walls would be constructed as part of the roadway widening along Route 1, with a total of four separate walls: three on the north side of the roadway and one on the south side. One of the retaining walls would start after the 41st Avenue on-ramp and extend approximately 150 feet; two other retaining walls on the northbound side would be 375 feet and 408 feet. On the southbound side, a 350-foot-long wall would be constructed along the highway mainline and Soquel Avenue, over the Rodeo Creek Gulch culvert.

No Build Alternative

The No Build Alternative offers a basis for comparing the Tier I Corridor Alternatives and the Tier II Auxiliary Lane Alternative in the future analysis year of 2035. Although the Tier I Corridor Alternatives and the Tier II Auxiliary Lane Alternative are separate projects, the assumptions regarding the No Build Alternative conditions are the same. Both assume no major construction on Route 1 through the Tier I corridor project limits or Tier II project limits other than currently planned and programmed improvements and continued routine maintenance. Planned and programmed improvements that are assumed in the No Build Alternative are the following, as contained in the 2014 Regional Transportation Plan:

- Installation of median barrier on Route 1 from Freedom Boulevard to Rio Del Mar Boulevard.
- Installation of a Class 1 bicycle and pedestrian facility on Morrissey Boulevard over Highway 1.
- Implementation of single interchange improvements at 41st Avenue and Bay Avenue/Porter Avenue as detailed and expensed in the Highway 1 HOV Project (RTC 24) as a standalone project, if the RTC project does not proceed.

The No Build Alternative also includes planned improvements to roadways and roadsides on Rio Del Mar Boulevard from Esplanade to Route 1, which includes the addition of bike lanes, transit turnouts, left-turn pockets, merge lanes, and intersection improvements. Road work includes major rehabilitation and maintenance of road and roadsides.

3.0 Effects of Traffic Technical Memorandum on Noise Analysis

A review of the *Highway 1 Widening/HOV Lane Project – Estimation of Induced Traffic Demand and Congestion-Related Costs* Technical Memorandum, as provided in Attachment 1, was conducted to investigate the potential need for re-evaluation of the noise analysis.

The memorandum states that:

> *Even with the additional capacity provided under the HOV Build Alternative, the mixed-flow lanes would continue to experience congestion. Under 2035 HOV Build conditions, the HOV lane would operate at LOS C or better in the peak commute directions, while the mixed-flow lane would operate at LOS E. Since any substantial improvements to traffic operations during the peak hours would be limited to carpools and buses only in the long run, the proposed corridor improvements are not anticipated to provide any substantial inducement for new or longer trips.*

Furthermore, it states that:

> *The VMT increase due to induced demand is expected to be minimal (less than 1 percent) for the project alternatives. This conclusion is consistent with the South Coast (SC) 101 HOV Traffic Study*[1]*, which was conducted to evaluate the widening of Highway 101 by providing a HOV lane in each direction in Santa Barbara County.*

In other words, the memorandum concludes that the traffic volumes and results that were reported in the previously approved traffic study report are still valid and earlier traffic numbers have not been replaced. As such, there would be no changes to the earlier traffic analysis, assumptions, and results. The noise analysis was conducted to assess the worst-case traffic noise scenario, which occurs when traffic is free-flowing at highway capacity, or Level-of-Service (LOS) C traffic conditions. All freeway mainlines were modeled using LOS C volumes and ramp traffic volumes were also capped at LOS C volumes if such volumes were exceeded. Therefore, it can be concluded that the findings of the traffic memo would have no effect on the noise analysis as the modeled noise levels are still valid and no re-evaluation is necessary because of induced traffic demand.

4.0 Effects of the Updated Tier I Corridor Alternatives Description on Noise Analysis

Since the completion of the latest noise analysis, as included in the latest Draft Environmental Impact Report (DEIR), the description of the Tier I Corridor Alternatives was modified to assure avoidance of SCLTS habitat, in the southern portion of the alignment, as provided in Attachment 2. The modifications eliminated the proposed widening of some ramps at the Rio Del Mar Boulevard, Freedom Boulevard, and San Andreas Road interchanges. In the vicinity of these three interchanges, all improvements associated with the proposed project, such as shoulder paving, retaining walls, and soundwalls, will still be included

[1] SC101 HOV Traffic Study, Dowling Associates, Inc., October 2009 (webpage: http://www.dot.ca.gov/dist05/projects/sb_101hov/draft_revised/Draft%20Revised%20EIR%20Related%20Traffic%20Studies/forecast_report.pdf)

only if the proposed design fully avoids upland habitat for SCLTS, as determined during environmental review of future Tier II projects.

As stated in the project's Draft Environmental Impact Report/Environmental Assessment (November 2015), the selection of a Tier I Corridor Alternative would not result in actual construction and commitments to providing soundwalls in the Tier I project area. As future projects in the Tier I corridor are prioritized and programmed for funding, they will be subject to separate Tier II, project-level, environmental review and additional noise analysis if warranted. As part of preparing Tier II environmental documents for future projects, such as projects that include improvements in the vicinity of the Rio Del Mar Boulevard, Freedom Boulevard, and San Andreas Road interchanges, the noise analysis presented in the 2013 NSR will need to be re-evaluated, and it may be necessary for the Traffic Noise Model (TNM) to be remodeled to incorporate any design modifications, with updated design drawings and profiles. Predicted noise levels and impacts may be altered considerably depending on the extent of design modifications that may occur as part of Tier II project level environmental analysis.

ATTACHMENT 1

Highway 1 Widening/HOV Lane Project – Estimation of Induced Traffic Demand and Congestion-Related Costs (August 16, 2017)

CDM Smith

Memorandum

To: *Kim Shultz, Santa Cruz County Regional Transportation Commission*

From: *Bhanu Kala*

Date: *August 16, 2017*

Subject: *Highway 1 Widening/HOV Lane Project – Estimation of Induced Traffic Demand and Congestion-Related Costs*

CDM Smith prepared this technical memorandum as part of the Highway 1 Widening/HOV Lane project in Santa Cruz County, California. The purpose of this memorandum is to estimate the induced traffic demand and congestion-related costs that would be associated with the proposed project. This technical memorandum will serve as an addendum to the 2012 Traffic Operations Report (TOR) that was approved by Caltrans.

1. Induced Traffic Demand

1.1 Background

This section of the technical memorandum was prepared to address some of the public comments received on the Draft Environmental Impact Report/Environmental Assessment (DEIR) that was circulated in November 2016, specifically the following:

- Comment by Campaign for Sensible Transportation – The DEIR does not acknowledge the role of induced travel in affecting the outcome of adding lanes or capacity on existing congested freeways. Page 2.1.5-23 about this does not provide full citation information for the referenced studies, and the DEIR does not make those studies accessible to the public. The associated claim that recent research indicates induced travel is a minor effect, is just not true and is out of date. The research work "Handy 2003" cited to support that, should be updated to Susan Handy and Marlon Boarnet's more current published research finding that "Given the induced travel effect, capacity expansion has limited potential as a strategy for reducing congestion." The outdated traffic model used for the DEIR does not account for induced travel, according to the AMBAG staff who managed it, and there is no indication that any model post-processing steps were taken to otherwise account for induced travel. The DEIR's failure to take induced travel into account distorts the data results and leads to overly favorable conclusions regarding congestion reduction and travel time reduction from adding highway lanes, throughout the DEIR. This is no small mistake.

- Comment by Nancy Faulstich – 2.1.5 – 23 Please refer to Handy's 2014 policy brief, updated from 2003 that is cited in the EIR. (my emphasis) Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions Policy Brief Susan Handy, University of California, Davis Marlon G. Boarnet, University of Southern California September 30, 2014. One concern with this strategy is that the additional capacity may lead to additional vehicle travel. The basic economic principles of supply and demand explain this phenomenon: adding capacity decreases travel time, in effect lowering the "price" of driving; when prices go down, the quantity of driving goes up (Noland and Lem, 2002). An increase in vehicle miles traveled (VMT) attributable to increases in capacity is called "induced travel." Any induced travel that occurs reduces the effectiveness of capacity expansion as a strategy for alleviating traffic congestion and offsets any reductions in greenhouse gas (GHG) emissions that would result from reduced congestion. If the percentage increase in VMT matches the percentage increase in capacity, congestion (a function of the ratio of VMT to capacity) is not alleviated at all.

- Comment by Rick Longinotti – Induced travel needs to be included in the traffic projections The EIR needs to clarify to what extent (if any) calculations of "induced demand" have been included in the traffic modeling. The DEIR acknowledges an increase in highway traffic following expansion. "If improvements increase a highway's travel speed, then the peak-period traffic using the highway will likely increase. However, the Draft appears to apply the AMBAG model of future traffic without factoring in induced demand. If that is the case, this should be corrected. Numerous studies have examined the effectiveness of this approach and consistently show that adding capacity to roadways fails to alleviate congestion for long because it actually increases vehicle miles traveled".

- Comment by Bill Malone – The EIR fails to adequately analyze the Project's induced traffic demand impacts. A growing body of research shows that building more roads and more lanes will temporarily reduce traffic congestion, but over time, just encourage more cars and more traffic congestion. This phenomenon is known as induced demand. The California DOT (aka Caltrans) recently acknowledged induced demand by linking to a policy brief titled "Increasing Highway Capacity Unlikely to Relieve Traffic Congestion." The EIR must indicate VMT changes (including induced traffic demand impacts) on a per-capita and county wide basis for the years 2020, 2035 and 2050.

- Comment by Robert Morgan – My opposition to the Tier I Corridor HOV and Tier I TSM Alternative (with notable exceptions above) is founded on an anticipated increase in carbon dioxide emissions, discouragement of sustainable transportation modes and DEIR documentation which does not account for "Generated and Induced Traffic." The project to widen and build out Highway 1 in the Tier I boundaries will encourage more vehicle use and congestion and greater carbon emissions from automobiles. The DEIR does not satisfy Executive Order B-30-15. In fact, the project will produce more congestion through well documented traffic phenomena: Generated Traffic: Additional peak-period vehicle trips on a particular roadway that occur when capacity is increased. This may consist of shifts in travel time, route, mode, destination and frequency. Induced travel: An increase in total vehicle mileage due to roadway improvements that increase vehicle trip frequency and distance, but exclude travel shifted from other times and routes. Latent demand: Additional trips that would be made if travel conditions improved (less congested, higher design speeds, lower vehicle costs or tolls). Triple Convergence: Increased peak-period vehicle traffic volumes that result when roadway capacity increases, due to shifts from other routes, times and modes. The relationship between increases in highway capacity and traffic is very complex, involving various travel behavior responses, residential and business location decisions, and changes in regional population and economic growth.

- Comment by Robert Morgan – Page 2.1.5-23 – Induced Demand – Inclusion of a discussion of induced demand in the DEIR/EA is appreciated. However, simply summarizing the studies in two sentences seems inadequate given the community concern with this issue and the anecdotal information from numbers of people who won't drive during peak hours due to congestion on Highway 1 and local streets. Santa Cruz County may be different from other communities studied due to the minimal number of alternative routes to the highway. The Final EIR/EA should include an expanded discussion of this issue with statistical data and an explanation as to how other communities studied are similar to Santa Cruz County.

- Comment by Barry Scott – The EIR fails to account for the additional traffic that they'll surely attract and this is simply in direct opposition to our own county Regional Transportation Plan goals of reducing VMT and getting people to use cars less and use other forms of transportation. Adding highway lanes is also not likely to be necessary as our population growth is limited by the amount of water available and other constraints. Additional lanes are likely to induce more long-distance commuters, which would defeat the goal of congestion relief. Finally, while parts of our county are already densely developed, others are not. The stretch of highway through quiet and tranquil Aptos has two lanes in each direction and that is quite adequate and only becomes backed up due to other problems closer to the City of Santa Cruz. Tier I project fails to meet our RTP goal of reducing vehicle miles traveled. Induced travel needs to be considered and included in the EIR.

- Comment by Vasant Sharma – Furthermore, this boondoggle will undoubtedly fill up in no time with cars, an irony and testament to its failure as a viable solution. The concept of induced demand should be no strange concept to the State Department of Transportation.

1.2 Overview

The total increase in vehicle traffic on a roadway that would result from improvements to its capacity is referred to as the generated traffic. It consists of two parts – diverted traffic and induced traffic. Diverted traffic refers to the additional traffic on the roadway that shift from parallel routes and another time period. Induced traffic refers to the additional traffic that shift from another mode of transportation, are associated with new developments or land use changes that result from the roadway improvement, shift to another destination due to improved travel conditions, and are created due to increased automobile dependency associated with the roadway improvement. A summary of the types of generated traffic and their classification is provided in **Table 1**.

Table 1 Types of Generated Traffic

Type of Generated Traffic	Category	Time Frame
Shorter Route – Improved road allows drivers to use more direct route	Diverted Traffic	Short term
Longer Route – Improved road attracts traffic from more direct routes	Diverted Traffic	Short term
Time Change – Reduced peak period congestion reduces the need to defer trips to off-peak periods	Diverted Traffic	Short term
Mode Shift, Existing Travel Choices – Improved traffic flow makes driving relatively more attractive than other modes	Induced Traffic	Short term
Mode Shift, Changes in Travel Choice – Less demand leads to reduced rail and bus service, less suitable conditions for walking and cycling, and more automobile ownership	Induced Traffic	Long term
Destination Change, Existing Land Use – Reduced travel costs allow drivers to choose farther destinations. No change in land use patterns.	Induced Traffic	Short term
Destination Change, Land Use Changes – Improved access allows land use changes, especially urban fringe development	Induced Traffic	Long term
New Trip, No Land Use Changes – Improved travel time allows driving to substitute for non-travel activities	Induced Traffic	Short term
Automobile Dependency – Synergetic effects of increased automobile-oriented land use and transportation system	Induced Traffic	Long term

Source: *Generated Traffic and Induced Travel – Implications for Transport Planning*, Victoria Transport Policy Institute, July 2017 (webpage: http://www.vtpi.org/gentraf.pdf)

Simply put, induced traffic is the increase in travel demand associated with roadway improvements that reduce the generalized costs of travel, excluding the travel demand shifted from other times and routes. Research indicates that diverted traffic often fills a significant portion of capacity added to congested urban roadways. Currently, travel demand models capture diverted traffic, but they fall short in capturing all aspects of induced traffic.

1.3 Literature Review

As mentioned in Table 1, induced traffic is caused due to the following four factors:

1. **Travel Mode Shift –** Induced travel due to mode shift is captured by travel demand models. Traffic forecasts obtained from the Association of Monterey Bay Area Governments (AMBAG) Travel Demand Model and reported in the 2012 TOR include the shift of traffic that is expected to occur from single occupancy vehicles (SOVs) to high occupancy vehicles (HOVs) and transit, especially for the HOV Build alternative.

2. **New Development/Additional Land Use –** Induced travel from new development/ additional land use typically applies where a new roadway is constructed in an undeveloped area. By contrast, Highway 1 is a well-established highway through Santa Cruz County and the project area encompasses land already developed for the most part.

3. **Destination Changes –** Induced travel due to this factor is typically not captured in travel demand models.

4. **Automobile Dependency –** Induced travel due to this factor is typically not captured in travel demand models.

Many research studies have evaluated the impact of roadway improvements on VMT. This correlation between added capacity and VMT is defined in terms of demand elasticity, which is the ratio of the percent change in demand of a good to the percent change in its price. The most commonly used equation for the calculation of demand elasticity of travel is:

$$Elasticity = \frac{Percent\ Change\ in\ VMT}{Percent\ Change\ in\ Lane\ Miles}$$

An elasticity of 0.0 means that any increase in lane-miles does not cause an increase in VMT, while an elasticity of 1.0 means that every percentage increase in lane-miles causes an equal percentage increase in VMT.

The complexities of the topic of induced travel have led to a variety of conclusions in the literature. Previous research studies found that the elasticity value for short-term effects varied from 0.10 to 0.60, while that of long-term effects varied from 0.50 to 1.03. A summary of elasticity values obtained from select research studies is provided in **Table 2**. It should be noted that these elasticity values are for generated traffic (both diverted and induced traffic), not just for induced traffic.

Table 2 Impact of Capacity Expansion on VMT

Study	Study Location	Study Years	Demand Elasticity[1]	Time Period
Duranton and Turner (2009)	U.S. (MSAs)	1983-2003	1.03	10 years
Cervero (2003)	California (Freeway Corridors)	1980-1994	0.10 0.39	short-term long-term
Cervero and Hansen (2002)	California (Urban Counties)	1976-1997	0.59 0.79	short-term (1 year) Intermediate (5 years)
Noland (2001)	U.S. (States – all roadway types)	1984-1996	0.30 to 0.60 0.70 to 1.00	short-term long-term
Noland and Cowart (2000)	U.S. (Metro Areas – Freeways and arterials)	1982-1996	0.28 0.90	short-term long-term
Hansen and Huang (1997)	California (Metro Areas – State-owned highways)	1973-1990	0.20 0.60 to 0.70 0.90	short-term long-term counties long-term metro areas

Source: Susan Handy and Marlon G. Boarnet, *Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions*, California Environmental Protection Agency, Air Resources Board, September 2014 (webpage: https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf)

Note:

[1]These demand elasticity values are for generated traffic (both diverted and induced traffic), not just for induced traffic.

The elasticity results from various studies demonstrate that the increase in roadway capacity causes VMT increases that often dampen the ability of capacity expansion projects to relieve congestion and thereby generate higher levels of emissions. This conclusion is supported by Susan Handy and Marlon Boarnet in their policy brief "Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions"[1]. However, Ronald Milam, et al., note the following in the publication "Closing the Induced Vehicle Travel Gap Between Research and Practice"[2]:

> *Based on the elasticities for the long-term condition, congestion relief effects of adding lane miles diminish over time and can result in higher long-term VMT and greater reliance on auto travel. This limited conclusion may not fully consider the two-way relationship between demand and supply. As Robert Cervero*[3] *notes, "Many induced-demand studies have suffered from methodological problems that, I believe, have distorted their findings." He goes on to mention that one of the problems is dealing with causality, asking, "Are rising traffic volumes caused by more road capacity? Or, might added road capacity be even more strongly caused by historical growth in traffic?" This question, known as 'simultaneity bias' was addressed by Robert Cervero in his analysis and he concludes, "To the degree that the path model better captures causal relationships than previous studies, many past elasticity estimates could very well be inflated."*

Two of the three research studies conducted using California specific data reached similar conclusions about the long-term demand elasticity, however, Robert Cervero calculated a lower value of about 0.80 in his research study[4]. Of the increased VMT, Cervero's research indicated that approximately 50 percent of the new VMT was related to background growth in employment and population that would have occurred without the project. The other 50 percent of the new VMT was associated with behavior shifts and new land use growth. As such, the demand elasticity of VMT increase associated with induced traffic is about 0.39. In other words, for every 100 percent increase in roadway capacity or lane-miles, induced travel would increase VMT traveled within the transportation corridor (which is an area within a two-mile buffer of the roadway project) by 39 percent.

Limited information is available on the effects of roadway capacity increase on induced demand for projects involving managed (including HOV, toll, and express lanes) and auxiliary lanes.

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[1] Susan Handy and Marlon G. Boarnet, *Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions*, California Environmental Protection Agency, Air Resources Board, September 2014 (webpage: https://www.arb.ca.gov/cc/sb375/policies/hwycapacity/highway_capacity_brief.pdf)

[2] Ronald T. Milam, Marc Birnbaum, Chris Ganson, Susan Handy, Jerry Walters, *Closing the Induced Vehicle Travel Gap between Research and Practice*, Transportation Research Record: Journal of the Transportation Research Board, No. 2653, 2017, Page 6 (webpage: http://trrjournalonline.trb.org/doi/pdf/10.3141/2653-02)

[3] Robert Cervero, *Road Expansion, Urban Growth, and Induced Travel: A Path Analysis*, American Planning Association Journal, Spring 2003, Volume 69, No.2 (webpage: http://escholarship.org/uc/item/05x370hr#page-1)

Nonetheless, research findings of induced traffic would generally be applicable to these projects as well.

Robert Cervero noted the following in his publication[4]:

> *Considerable knowledge gaps remain regarding induced travel demand. We know relatively little about how induced demand varies between urban and suburban settings, by type of facility (e.g., radial highway versus beltway), size of metropolitan area, or level of traffic congestion. All that can be said with certainty is that induced-demand effects exist (i.e., elasticities exceed zero) and they generally accumulate with time. Being able to draw generalizations much beyond this will require far more research, conducted in different settings and at different resolutions of analysis. Because of data limitations, this will be no easy feat.*
>
> *The contention that capacity additions are quickly absorbed by increases in traffic and that "you can't build yourself out of traffic congestion" might not hold in all settings. Houston is a case in point. Over the past 15 years, during which the city invested about a billion dollars annually in freeway improvements, Houston has made greater headway in relieving traffic congestion than most of its U.S. counterparts.*

1.4 Analysis Methodology

As noted in Section 1.3, it is complicated to estimate VMT changes associated with induced demand. However, for this project, simple elasticity-based estimates of induced demand related VMT derived from the project's lane mile changes was calculated based on the demand elasticity value estimated by Robert Cervero in his research. Since Robert Cervero's research were based on data obtained for 24 California freeway projects across 15 years, its results are more applicable to this project.

Induced demand is not expected to be localized to the study corridor, but would be perceived in the surrounding areas as well, since additional capacity will be available in neighboring roadways due to shift of traffic to Highway 1 with the proposed project. As noted by Robert Cervero in his publication[4], impact zones of roads generally extend out about two to three miles. Using this methodology, induced demand estimates were developed within the transportation corridor, which is the area within a two-mile buffer of the roadway project.

1.5 Induced Demand Estimates

The following information was used to develop induced demand estimates for the proposed project:

- Approximate lane miles within the transportation corridor under 2035 No Build conditions: 1,000 (from 2035 AMBAG Model)
- Approximate daily VMT within the transportation corridor under 2035 No Build conditions: 2,991,000 (from 2035 AMBAG model)

- Approximate increase in lane miles (HOV Build alternative): 16.5 miles of HOV lane, 13.5 miles of auxiliary lanes
- Approximate increase in lane miles (TSM Build alternative): 15 miles of auxiliary lanes
- Freeway Lane Capacity: 2,200 vehicles per hour (2010 Highway Capacity Manual)
- HOV lane capacity: 1,600 vehicles per hour (2010 Highway Capacity Manual)
- Capacity adjustment factor for HOV lane: 0.727
- Capacity adjustment factor for Auxiliary lane: 0.5 (since the capacity of an auxiliary lane is lower than that of a regular lane and the primary purpose of an auxiliary lane is to improve traffic operations, but not to increase capacity)
- Demand elasticity associated with induced travel: 0.39 (from Robert Cervero's publication)

Percent VMT increase for a HOV and an auxiliary lane was calculated as follows:

$$\%\,VMT\ Increase\ = \%\,Lane\ Miles\ Increase \times Demand\ Elasticity \times Capacity\ Adjustment\ Factor$$

The capacity adjustment factor was introduced to account for the lower capacity values associated with HOV and auxiliary lanes, i.e., a capacity (or lane mile) increase of a general-purpose (GP) lane is not the same as the capacity increase of a HOV or auxiliary lane. A summary of induced demand estimates developed for the project alternatives is provided in **Table 3**.

Based on simple elasticity calculations, induced demand associated with the proposed project is expected to be about 0.8 percent and 0.3 percent for the HOV Build and TSM Build alternatives under 2035 conditions, respectively. It should be noted that the 0.8 percent VMT increase calculated for the HOV Build alternative includes the portion of the induced traffic associated with mode shift. However, as mentioned in Section 1.3, trips associated with mode shift are already included in the traffic forecasts obtained from the AMBAG Model for the HOV Build alternative. Therefore, discounting the mode shift trips from these calculations, the effective increase in VMT associated with induced demand is expected to be less than 0.8 percent for the HOV Build alternative.

Table 3 Induced Demand Estimates

Parameter	HOV Lane	Auxiliary Lane	Total
HOV Build Alternative			
% Increase in Lane Miles in Transportation Corridor[1]	1.65	1.35	3.00
Demand Elasticity	0.39	0.39	0.39
Capacity Adjustment Factor	0.73	0.50	-
% Increase in VMT in Transportation Corridor due to Induced Demand	0.47	0.26	0.73
Approximate increase in VMT in Transportation Corridor due to Induced Demand (2035 Conditions)	***14,100***	***7,800***	***21,900***
TSM Build Alternative			
% Increase in Lane Miles in Transportation Corridor	-	1.5	1.5
Demand Elasticity	-	0.39	-
Capacity Adjustment Factor	-	0.50	-
% Increase in VMT in Transportation Corridor due to Induced Demand	-	0.29	0.29
Approximate increase in VMT in Transportation Corridor due to Induced Demand (2035 Conditions)	***-***	***8,700***	***8,700***

Note:

[1] Transportation corridor is the area within a two-mile buffer of the roadway project.

1.6 Conclusions

Research clearly indicates that adding traffic capacity or otherwise substantially improving travel speeds in a highly congested corridor like Highway 1 (which has confined local roads as well), would cause some amount of induced travel demand. However, since the additional freeway capacity would be in the form of HOV lanes that encourage motorists to carpool or take bus transit services which utilize the HOV lanes, it could off-set induced trips to some extent.

Even with the additional capacity provided under the HOV Build Alternative, the mixed-flow lanes would continue to experience congestion. Under 2035 HOV Build conditions, the HOV lane would operate at LOS C or better in the peak commute directions, while the mixed-flow lane would operate at LOS E. Since any substantial improvements to traffic operations during the peak hours would be limited to carpools and buses only in the long run, the proposed corridor improvements are not anticipated to provide any substantial inducement for new or longer trips. Simple elasticity calculations support that VMT increase due to induced demand is expected to be minimal (less than 1 percent) for the project alternatives.

2. Economic Costs of Congestion

2.1 Background

This section of the technical memorandum was prepared to address the following public comment received on the Draft Environmental Impact Report/Environmental Assessment (DEIR) that was circulated in November 2016:

- Comment by Bill Comfort – FREQ (or related analysis) needs to show the economic cost we all suffer because of HWY 1 congestion—a cost needs to be assigned to delay—it's been done by others. At one time, AMBAG had an analyst that did that (Dean Munn, no longer at AMBAG).

2.2 Methodology

The economic costs of congestion were estimated based on the "Life-Cycle Benefit-Cost Analysis Economic Parameters 2016" provided by the Caltrans' Economic Analysis Branch[4]. For the proposed project, travel time costs associated with congestion were developed. Vehicle operation, collision, and emissions' costs were excluded from this analysis, since they are dependent on the overall difference in the VMT values of project alternatives, which requires county-level VMT estimates, not just corridor-level estimates to get a full understanding of the VMT changes associated with each project alternative.

2.3 Travel Time Costs of Congestion

Estimates of travel time costs of congestion were developed based on the following assumptions:

- Traffic congestion on the study corridor is limited to the 12-hour (six hours in the morning and six hours in the evening) peak commute periods only; outside of the peak commute periods, traffic congestion is assumed to be negligible.
- Traffic congestion on a weekend day is about 20 percent of that on a weekday. This was based on the typical congestion patterns provided in Google Maps on a weekday and weekend day.
- Average number of weekdays in a year is 262.
- Based on the standard economic valuations provided by the Caltrans' Economic Analysis Branch[6], the average auto/truck composite value of time is $18.95 per hour (2016 $).

A summary of the travel time costs of congestion associated with the proposed project is provided in **Table 4**.

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[4] Webpage: http://www.dot.ca.gov/hq/tpp/offices/eab/benefit_cost/LCBCA-economic_parameters.html

Table 4 Travel Time Costs of Congestion

Performance Measure	Northbound Highway 1		Southbound Highway 1		Total
	AM Peak Period	PM Peak Period	AM Peak Period	PM Peak Period	
Baseline Conditions					
Average Travel Delay (minutes/person)	5	2	0	7	-
Hourly Person Throughput (persons/hour)	3,447	3,489	2,705	3,297	-
Peak Period Person Hours of Delay	1,724	698	0	2,308	-
Daily Person Hours of Delay[1]	-	-	-	-	4,729
Annual Person Hours of Delay[2]	-	-	-	-	1,336,472
Annual Cost of Congestion on SR-1 (2016 $)[3]	-	-	-	-	***$ 25,326,143***
2035 No Build Conditions					
Average Travel Delay (minutes/person)	28	12	8	35	-
Hourly Person Throughput (persons/hour)	3,542	3,927	3,443	3,168	-
Peak Period Person Hours of Delay	9,918	4,712	2,754	11,088	-
Daily Person Hours of Delay[1]	-	-	-	-	28,472
Annual Person Hours of Delay[2]	-	-	-	-	8,046,300
Annual Cost of Congestion on SR-1 (2016 $)[3]	-	-	-	-	***$ 152,477,390***
2035 HOV Build Conditions					
Average Travel Delay (minutes/person)	3	2	1	5	-
Hourly Person Throughput (persons/hour)	5,271	5,271	4,090	5,443	-
Peak Period Person Hours of Delay	1,581	1,054	409	2,722	-
Daily Person Hours of Delay[1]	-	-	-	-	5,766
Annual Person Hours of Delay[2]	-	-	-	-	1,629,472
Annual Cost of Congestion on SR-1 (2016 $)[3]	-	-	-	-	***$ 30,878,487***
2035 TSM Build Conditions					
Average Travel Delay (minutes/person)	15	9	1	21	-
Hourly Person Throughput (persons/hour)	4,441	4,474	3,638	4,216	-
Peak Period Person Hours of Delay	6,662	4,027	364	8,854	-
Daily Person Hours of Delay[1]	-	-	-	-	19,906
Annual Person Hours of Delay[2]	-	-	-	-	5,625,294
Annual Cost of Congestion on SR-1 (2016 $)[3]	-	-	-	-	***$ 106,599,327***

Notes:

[1]Assuming that traffic congestion is limited to the 12-hour peak commute periods only.

[2]Assuming that traffic congestion on a weekend day is about 20 percent of that on a weekday.

[3]Based on the average auto/truck composite value of time of $18.95 per hour.

The annual costs of congestion on the study corridor is about $25 million under Baseline conditions. It is however expected to increase to about $153 million under 2035 No Build conditions. With the implementation of the proposed project alternatives, the annual cost of congestion is expected to be about $31 million and $107 million under 2035 HOV Build and 2035 TSM Build conditions, respectively. All of these costs are reported in 2016 dollars. As mentioned earlier, these costs include travel time costs associated with congestion, but do not include vehicle operation costs, collision costs, and emission costs associated with high levels of congestion. With those additional costs, the total costs of congestion would be higher than those reported above.

ATTACHMENT 2

Updated Tier I Corridor Alternatives Description

Updated Description of the Tier I Corridor Alternatives

The following text supersedes the description of the Tier I Corridor HOV Lane Alternative and the Tier I Corridor TSM Alternative, included in the Draft EIR/EA.

Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives

The Tier I HOV Lane and TSM Alternatives share many features, such as: the addition of auxiliary lanes, new pedestrian/bicycle overcrossings over Route 1, and Transportation Operations System elements. These common design features are described below.

Auxiliary Lanes

Auxiliary lanes are designed to reduce conflicts between traffic entering and exiting the highway by connecting the on-ramp of one interchange to the off-ramp of the next; they are not designed to serve through traffic. Auxiliary lanes would be constructed to improve merging operations at the locations listed below:

- Freedom Boulevard and Rio Del Mar Boulevard – northbound and southbound
- Rio Del Mar Boulevard and State Park Drive – northbound and southbound
- State Park Drive and Park Avenue – both directions in the TSM Alternative; southbound only in the HOV Lane Alternative
- Park Avenue and Bay Avenue/Porter Street – northbound and southbound
- 41st Avenue and Soquel Avenue/Drive – northbound and southbound

New Pedestrian/Bicycle Overcrossings

Both Tier I alternatives would construct new pedestrian/bicycle overcrossings of Route 1 at the following locations:

- Mar Vista Drive – A crossing of Route 1 is proposed at Mar Vista Drive in the unincorporated community of Aptos. A potential design approach is included in the Draft Environmental Document, in Appendices G, Tier I Corridor HOV Lane Alternative Plan Drawings and H, Tier I Corridor TSM Alternative Plan Drawings, which would include ramps with switchbacks on both sides of Route 1. Multiple configurations are possible, and the final design would be determined as part of the Tier II design/environmental analysis of this facility.
- Chanticleer Avenue – The crossing would start at the Chanticleer Avenue cul-de-sac on the north side of Route 1 and run parallel the highway for approximately 400 feet to the west and then cross Route 1 and Soquel Avenue (frontage road) on a curved alignment, terminating just west of Chanticleer Avenue on the south side of the highway and Soquel Avenue (frontage road).

- Trevethan Avenue – A potential design approach for the crossing at Trevethan Avenue is included in the Draft Environmental Document, in Appendices G, Tier I Corridor HOV Lane Alternative Plan Drawings and H, Tier I Corridor TSM Alternative Plan Drawings, which would cross Route 1 on an angle and continuing along the banks of the western tributary to Arana Gulch to terminate close to Harbor High School. However, multiple configurations are possible, and the final design would be determined as part of the subsequent Tier II design/environmental analysis of this facility.

Other Common Features of the Tier I Corridor Alternatives

The Tier I Corridor Alternatives would include reconstruction of the Santa Cruz Branch Rail Line bridges over Route 1 and the State Park Drive, Capitola Avenue, 41st Avenue, and Soquel Avenue overcrossings. The Santa Cruz Branch Line railroad underpass structures are proposed to be modified or replaced to accommodate highway widening to match the ultimate six-through-lane concept, including shoulder and sidewalk facilities to accommodate pedestrians and bicycles. These modifications will lower the highway profile to provide standard clearances. In addition the Aptos Creek Bridge would be widened.

Both build alternatives would include Transportation Operations System elements such as changeable message signs, closed-circuit television, microwave detection systems, and vehicle detection systems. In addition, ramp metering and HOV on-ramp bypass lanes with highway patrol enforcement areas would be constructed on the Route 1 ramps within the Tier I project limits; however, only the HOV Lane Alternative would include HOV lanes on the mainline.

Table 1-1 summarizes the major features of the Tier I Corridor Alternatives.

Tier I Corridor HOV Lane Alternative

The Tier I Corridor HOV Lane Alternative includes the following main components, which are discussed in detail below:

- Highway mainline to include northbound and southbound HOV lanes throughout the project limits;
- Auxiliary lanes;
- Highway interchange reconfigurations and improvements such as ramp metering, on-ramp HOV bypass lanes and California Highway Patrol enforcement areas, and stormwater drainage/treatment facilities;
- Construction of three pedestrian/bicycle overcrossings;
- Reconstruction of two Santa Cruz Branch Rail Line overcrossings in Aptos;
- Widening of the Aptos Creek Bridge;
- Replacement of the Capitola Avenue overcrossing;
- Retaining walls;

- Soundwalls; and
- Traffic signal coordination and other transportation operation system improvements.

Table 1-1 Major Project Features Tier I Project Alternatives

Project Features	HOV Lane Alternative	TSM	No Build Alternative
Highway Mainline Changes			
HOV lanes	X		
Lower highway profile at Santa Cruz Branch Line bridge crossings[1]	X	X	
Auxiliary Lane Improvements			
Northbound and southbound between Freedom Boulevard and Rio Del Mar Boulevard	X	X	
Northbound and southbound between Rio Del Mar Boulevard and State Park Drive	X	X	
Northbound between State Park Drive and Park Avenue		X	
Southbound between State Park Drive and Park Avenue	X	X	
Northbound and southbound between Park Avenue and Bay Avenue/Porter Street	X	X	
Northbound and southbound from 41st Avenue to Soquel Avenue/Drive	X	X	
Highway Interchange Improvements			
Reconfigure all nine interchanges within project limits	X		
Reconstruct State Park Drive, 41st Avenue, and Soquel overcrossings		X	
Ramp metering	X	X	
On-ramp HOV bypass lanes[2]	X	X	
On-ramp California Highway Patrol enforcement areas	X	X	
Stormwater drainage and treatment facilities	X	X	
New Pedestrian/Bicycle Overcrossings			
Mar Vista Drive Crossing	X	X	
Chanticleer Avenue Crossing	X	X	
Trevethan Avenue Crossing	X	X	
Santa Cruz Branch Line Bridges Replacement	X	X	
Aptos Creek Bridge Widening	X	X	
Capitola Avenue Overcrossing Replacement	X	X	
Retaining Walls	X	X	
Soundwalls	X	X	
Traffic Signal Coordination	X	X	X
Transportation Operations System	X	X	X
Transit-Supportive Improvements	X		

[1] Existing highway profile does not meet vertical clearance standards for railroad bridge crossings.

[2] At three interchanges (Rio Del Mar Boulevard, Freedom Boulevard and San Andreas Road) on-ramps and associated improvements such as local road improvements and retaining walls, will be included only if the proposed design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during environmental review of future Tier II projects.

The Tier I Corridor HOV Lane Alternative would expand the existing four-lane highway to a six through-lane facility by adding HOV lanes in both the northbound and southbound directions. HOV lanes would be constructed entirely within the existing median where possible. In those areas where the median is not wide enough to accommodate additional lanes, widening would occur outside of the existing freeway footprint. In the southernmost 1.5 miles of the project limits, the HOV lane would be constructed inside the existing median. Extension of the median barrier south of its current terminus at Freedom Boulevard would be designed to provide for passage of Santa Cruz long-toed salamander individuals attempting to cross the highway. From approximately Freedom Boulevard to Soquel Drive, the existing median is not wide enough to accommodate an HOV lane, so the space needed for the additional lanes would be achieved through a combination of median conversion within existing right-of-way and acquisition of property adjacent to the freeway.

A mandatory standard median width (22 feet) set by Caltrans in its Highway Design Manual is proposed through most of the project corridor, north of Freedom Boulevard. The mandatory standard median width comprises two 10-foot-wide inside shoulders and a 2-foot-wide barrier. Where meeting the mandatory median width standard would result in acquiring property on the non-highway side of existing frontage roads, inside shoulder widths of 5 feet are proposed to reduce property requirements and impacts. Five feet is a nonstandard inside shoulder width for a Caltrans facility. This exception to shoulder-width design standards has received conceptual review in meetings between Caltrans and the project sponsor. All projects requiring design exceptions must ultimately be approved by Caltrans.

The Tier I Corridor HOV Lane Alternative would modify or reconstruct all nine interchanges within the project corridor to improve merging operations and ramp geometry by increasing the length of lanes for acceleration and deceleration, adding HOV bypass lanes and mixed- flow lanes to on-ramps, and improving sight distances. The Bay Avenue/Porter Street and 41st Avenue interchanges would be modified to operate as one interchange with frontage roads connecting the two interchanges. Where feasible, design deficiencies on existing ramps would be corrected to meet current design standards. Ramp metering and HOV bypass lanes would generally be provided on all Route 1 on-ramps; however, the design of interchanges at Rio Del Mar Boulevard, Freedom Boulevard, and San Andreas Road may exclude HOV bypass lanes on some on-ramps and associated improvements, such as retaining walls and improvements to local roads, if during environmental review of future Tier II documents, the elimination of these features is necessary to avoid impact to Santa Cruz long-toed salamander (SCLTS) upland habitat. During the environmental review of future Tier II projects, more detailed information would be available to determine whether there may be design approaches that could include the HOV bypass lanes while achieving full avoidance of SCLTS upland habitat.

This alternative would include auxiliary lanes between all interchange ramps (with the exception of a northbound auxiliary lane between State Park Drive and Park Avenue) and Transportation Operations System elements, such as changeable message signs, microwave detection systems, and vehicle detection systems. Bridge structures and the Capitola Avenue overcrossing would be modified or replaced to accommodate the HOV lanes. New and widened highway crossing structures would include shoulder and sidewalk facilities to accommodate pedestrians and bicycles. The HOV Lane Alternative would include three new pedestrian/bicycle overcrossings of Route 1. The two existing Santa Cruz Branch Line structures over Route 1 in Aptos would be replaced with longer bridges at the same elevation, and the highway profile would be lowered to achieve standard vertical clearance under the bridges to make room for the HOV and auxiliary lanes. In addition, this design configuration would reduce environmental impacts. The existing Route 1 bridge over Aptos Creek would be widened on the outside to accommodate the HOV lanes in each direction. The existing Capitola Avenue overcrossing would be replaced with a longer structure.

Retaining walls would be constructed to minimize property acquisitions and reduce environmental impacts. At locations where frontage roads are adjacent to Route 1, concrete barriers would be constructed to separate the highway and frontage road.

Changes to Highway Mainline with the Tier I Corridor HOV Lane Alternative

- Route 1 would be expanded to allow for two standard-width (12-foot) mixed-flow lanes, one standard-width (12-foot) HOV lane, and standard-width outside (10-foot) shoulders in each direction.
- The proposed lanes would be constructed within the existing 45-foot median. In locations where the existing median width is less than 45 feet, widening would occur both in the median and at the outside, generally within the existing Route 1 right-of- way.
- Where auxiliary lanes are proposed, widening by approximately 12 feet outside of the existing highway footprint would occur.
- A mandatory standard median width of 22 feet is proposed through most of the corridor.
- The highway centerline would be shifted northward in the vicinity of the Santa Cruz Branch Line crossings in Aptos to reduce impacts to wetlands. The bridge over Aptos Creek would be widened to allow for four new lanes: two HOV, two auxiliary, and pedestrian/bicycle facilities.
- Route 1 would be lowered to obtain vertical clearance at the Santa Cruz Branch Line crossings in Aptos. A mandatory standard median width of 22 feet is proposed to minimize impact to the railroad bridge.
- At three locations, median and inside shoulder widths would be nonstandard to reduce impacts to adjacent streets. The three locations are: McGregor Drive, Cabrillo College Drive, and Kennedy Drive. At these three constrained locations, the inside shoulder in the constrained direction would be a nonstandard 5 feet, and the median would be a nonstandard 17 feet.

Auxiliary Lane Improvements with the Tier I Corridor HOV Lane Alternative

The auxiliary lane improvements are discussed above in Section 1.5 Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives.

Interchange Improvements with the Tier I Corridor HOV Lane Alternative

All nine interchanges within the project corridor would be modified under the Tier I Corridor HOV Lane Alternative, including overcrossing and undercrossing widening or replacement. These modifications would improve merging operations and ramp geometrics, and accessibility and safety for pedestrians and bicyclists. Major interchange improvements would include the following:

- Reconfiguration of intersections, including replacement or widening of highway overcrossings and undercrossings.
- Intersections of freeway ramps with local roads would be modified to shorten the pedestrian and bike crossing distances. Additionally, free right turns would be eliminated where feasible and traffic signals installed to improve traffic flow and slow vehicle traffic speeds through the bike and pedestrian crossing areas.
- Local roadways would be widened at the interchanges to accommodate the anticipated travel demand.
- Drainage and stormwater runoff treatment facilities would be provided.

Interchange improvements and design reconfigurations proposed for each interchange are listed in Table 1-2.

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	**Project Plan Sheet No.**	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
San Andreas / Larkin Valley Roads Interchange[2]	HOV-20	**The existing northbound cloverleaf off-ramp free right-turn onto Larkin Valley Road would be eliminated in favor of a signalized 90-degree intersection**.
		A signalized intersection would be provided at the San Andreas Road ramps and the free right-turns would be eliminated.
		The existing northbound and southbound on-ramps would be widened to accommodate HOV bypass lanes.

[2] HOV bypass lanes at three interchanges (Rio Del Mar Boulevard, Freedom Boulevard and San Andreas Road) and associated improvements, such as retaining walls and improvements to local roads, will be included only if the proposed design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during environmental review of future Tier II projects.

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	**Project Plan Sheet No.**	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
		The southbound Route 1 bridge over San Andreas/Larkin Valley Road would be widened into the median to accommodate the HOV lanes.
		San Andreas/Larkin Valley Roads would be widened within the Tier I project limits to add turn lanes (including bridge widening).
		New sidewalks would be added along San Andreas/Larkin Valley Roads within the Tier I project limits.
Freedom Boulevard Interchange[1]	HOV-18	**The existing ramp termini at Freedom Boulevard would be modified to provide less-skewed intersections with Freedom Boulevard. These intersections would be signalized, and free right-turns would be eliminated.**
		The southbound off-ramp would be widened to two exit lanes.
		The existing northbound on-ramp would be widened to accommodate HOV bypass lanes.
		The existing southbound on-ramp would be widened to accommodate HOV bypass lanes.
		Freedom Boulevard would be widened within the Tier I project limits to add turn lanes.
		The Freedom Boulevard/Bonita Drive intersection would be enlarged to add turn lanes and achieve acceptable level of service.
		The Freedom Boulevard bridge would be replaced with a wider structure that would accommodate a new turn lane on Freedom Boulevard and the new HOV lanes on Route 1.
		New sidewalks would be added along Freedom Boulevard within the Tier I project limits.
Rio Del Mar Boulevard Interchange[1]	HOV-16	The northbound on-ramp would be realigned to form the north leg of a four-way intersection with Rio Del Mar Boulevard and the northbound off-ramp. This intersection would be signalized and free right turns would be eliminated

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	**Project Plan Sheet No.**	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
		The northbound off-ramp would be widened to two exit lanes.
		The southbound on-ramp would be widened to accommodate an HOV bypass lane.
		The southbound off-ramp would be widened, the intersection with Rio Del Mar Boulevard signalized, and free right-turns eliminated.
		The existing northbound on-ramp would be widened to accommodate an HOV bypass lane.
		Soquel Drive would be shifted northward to accommodate the roadway widening along the northbound off-ramp.
		Rio Del Mar Boulevard would be widened within the Tier I project limits to add turn lanes and a through lane in each direction.
		The Rio Del Mar Boulevard bridge over Route 1 would be replaced with a longer, wider bridge to accommodate a new turn lane and a through lane in each direction on Rio Del Mar Boulevard and the new HOV lanes on Route 1.
		Sidewalk would be added along eastbound Rio Del Mar Boulevard within the Tier I project limits; the sidewalk on westbound Rio Del Mar Boulevard would be retained.
State Park Drive Interchange	HOV-13	The existing northbound cloverleaf on-ramp free-right turn would be changed to a signalized right turn.
		The existing northbound off-ramp terminus would be modified to form, together with the realigned northbound on-ramp terminus, the south leg of a signalized intersection with State Park Drive.
		The northbound and southbound off-ramps would be widened to two exit lanes.
		The existing on-ramps would be widened to accommodate HOV bypass lanes.
		State Park Drive would be widened within the Tier I project limits to add turn lanes and a through lane in each direction.

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	**Project Plan Sheet No.**	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
		The State Park Drive bridge over Route 1 would be replaced with a longer, wider bridge to accommodate a new through-lane in each direction on State Park Drive and the new HOV lanes on Route 1.
		Sidewalk would be added along eastbound State Park Drive within the Tier I project limits; the sidewalk along westbound State Park Drive would be retained.
Park Avenue Interchange	HOV-10	The existing diamond interchange ramp design would be retained and ramps would be widened.
		The northbound and southbound off-ramps would be widened to two exit lanes.
		The existing on-ramps would be widened to accommodate HOV bypass lanes.
		Park Avenue would be widened within the Tier I project limits to add turn lanes.
		The two Route 1 bridges over Park Avenue would be replaced with one, wider structure to accommodate the new HOV lanes on Route 1.
		Sidewalk would be added within the Tier I project limits along westbound Park Avenue; the sidewalk along eastbound Park Avenue would be retained.
Bay Avenue/ Porter Street and 41st Avenue Interchanges	HOV-7	Improvements at the Bay Avenue/Porter Street and 41st Avenue interchanges would be designed so that these two interchanges would work as a single interchange connected by a collector/frontage road running between the interchanges.
		The freeway ramps would be reconstructed to form less-skewed intersections with Bay Avenue/Porter Street.
		The existing southbound Route 1 off-ramp to Bay Avenue/Porter Street would be eliminated. Southbound traffic bound for Bay Avenue/Porter Street would exit at the 41st Avenue two-lane off-ramp and continue on a new southbound collector/frontage road to Bay Avenue/Porter Street.

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	Project Plan Sheet No.	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
		The existing two-lane on-ramp from Porter Street to northbound Route 1 would be modified to become a northbound collector/frontage road serving traffic bound for 41st Avenue or northbound Route 1.
		Northbound traffic exiting Route 1 would either bear right to intersect with Porter Street and continue north, or stay left and continue on a new structure over Porter Street, join the northbound collector/frontage road, and end at a new signalized intersection at 41st Avenue.
		At 41st Avenue, southbound on- and off-ramps would be eliminated and replaced with a diagonal off-ramp and a collector/frontage road serving traffic bound for
		Bay Avenue/Porter Street or southbound Route 1. The new ramp and collector/frontage road would form a signalized intersection with 41st Avenue.
		At 41st Avenue, the northbound on-ramps would be realigned.
		New on-ramps would include HOV bypass lanes.
		41st Avenue would be widened within the Tier I project limits to add turn lanes and eastbound though lanes over Route 1.
		Bay Avenue/Porter Street would be widened to add right-turn lanes at the on-ramps.
		A new bridge over Soquel Creek and Soquel Wharf Road would be constructed for the new southbound collector/frontage road from 41st Avenue to Bay Avenue/Porter Street.
Soquel Avenue/ Drive Interchange	HOV-3	The northbound off-ramp would be realigned to a signalized 90-degree intersection with Soquel Drive. The existing access to Commercial Way would be eliminated.
		The westbound Soquel Drive on-ramp to northbound Route 1 would be modified to eliminate the free right-turn access.

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	Project Plan Sheet No.	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
		The existing northbound loop on-ramp from eastbound Soquel Avenue would be realigned and its free-right terminus would become a signalized 90-degree intersection.
		A new, wider southbound diagonal off-ramp that adds turn lanes at its terminus and a new loop on-ramp would form the north leg of a signalized intersection at Soquel Avenue.
		The existing southbound hook on-ramp would be widened to add an HOV bypass lane and realigned to be made standard.
		The northbound and southbound off-ramps would be widened to two exit lanes.
		All new on-ramps would include HOV bypass lanes.
		Soquel Avenue within the Tier I project limits would be widened to add an eastbound through lane and turn lanes.
		Salisbury Lane would be shifted eastward to form an intersection with the realigned northbound off-ramp and loop on-ramp.
		The Soquel Drive bridge over Route 1 would be replaced with a longer, wider bridge to add an eastbound through lane and a turn lane to Soquel Drive and accommodate the new HOV lanes on Route 1.
		The culvert at Arana Gulch would be extended underneath the widened Route 1 and new southbound off-ramp.
		Sidewalk would be added along eastbound Soquel Drive within the Tier I (and Tier) project limits; the sidewalk along westbound Soquel Drive would be retained.
Morrissey Boulevard Interchange	HOV-1	The southbound exit would be realigned to terminate at a new signalized intersection with Morrissey Boulevard.
		The existing southbound on-ramp would be eliminated and replaced with a new, wider diagonal ramp with a signalized terminus.

Table 1-2: Interchange Improvements and Reconfigurations
Tier I Corridor HOV Lane Alternative

Route 1 Interchange Location	**Project Plan Sheet No.**	**Tier I Corridor HOV Lane Alternative Features** (Features shown in **bold** would be included only if the design fully avoids upland habitat for Santa Cruz long-toed salamander, as determined during future Tier II environmental review)
		The existing southbound off- and on-ramp at Elk Street would be eliminated.
		The existing northbound loop on-ramp would be eliminated, as would access to Rooney Street from this northbound loop.
		The northbound off-ramp would be widened to two exit lanes.
		New on-ramps would include HOV bypass lanes.
		Morrissey Boulevard is being replaced with a wider bridge to add an eastbound through lane and turn lanes, and realigned to form a straight line between its intersections with Fairmont Avenue and Rooney Street.
		The Morrissey Boulevard bridge is being replaced with a longer, wider bridge to accommodate a new eastbound through lane and turn lanes on Morrissey Boulevard and new HOV lanes on Route 1.
		Sidewalk would be added along eastbound Morrissey Boulevard within the Tier I project limits; the sidewalk along westbound Morrissey Boulevard would be retained.
Transit- Related Facilities	N.A.	Both on-ramps and both off-ramps at the reconfigured Park Avenue interchange include options for bus pads and bus shelters.
		Ramps and collectors at the Bay Avenue/Porter Street and 41 Avenue interchanges include options for bus pads and shelters.

Transit Supportive Planning and Design

The Tier I Corridor HOV Lane Alternative would not preclude the development of the following features from being added in the future to facilitate freeway-oriented transit services and operations:

- The reconfigured Park Avenue and Bay Avenue/Porter Street/41st Avenue interchanges would allow for future bus pads and bus stop shelters to be constructed as part of a separate project.

- Future park-and-ride lots are under consideration by RTC at the Larkin Valley Road/San Andreas Road and 41st Avenue interchanges, to be coordinated with the bus facilities as part of a future project.

The aforementioned features are not part of the proposed project and would be subject to future environmental clearance. The proposed Tier I project is simply taking into consideration potential future transit projects as a collaborative planning effort.

New Pedestrian/Bicycle Overcrossings

The proposed pedestrian/bicycle overcrossings are discussed above in Section 1.5 Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives.

Tier I Corridor TSM Alternative

The Tier I Corridor TSM Alternative was formulated to provide Route 1 improvements that would partially address the purpose and need, and could be achieved at lower cost and with fewer impacts than the Tier I Corridor HOV Lane Alternative. TSM strategies typically consist of improvements that can benefit the operations of existing facilities without increasing the number of through lanes.

As discussed in Section 1.5 Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives, the Tier I Corridor TSM Alternative proposes to add auxiliary lanes, ramp metering and HOV on-ramp bypass lanes; improve existing nonstandard geometric elements at various ramps; and incorporate other TSM elements, such as changeable message signs, closed circuit television, microwave detection systems, and vehicle detection systems.). In short, the TSM Alternative shares many of the Tier I Corridor HOV Lane Alternative features, except HOV lanes would not be constructed along the mainline and the Soquel Drive interchange would be the only interchange reconfigured.

Auxiliary Lanes

The majority of auxiliary lane improvements are discussed above under the heading, Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives. In addition, the TSM Alternative would have both a southbound and northbound auxiliary lane between State Park Drive and Park Avenue — improvements that are not included in the HOV Lane Alternative.

Interchange Improvements

Improvements to interchanges proposed under the Tier I Corridor TSM Alternative include the following:

- The Soquel Avenue northbound off-ramp from Route 1 would be realigned and widened from one to two exit lanes for a distance of approximately 1,300 feet, widening to four lanes at its intersection with Soquel Drive. The northbound off- ramp/Commercial Way connection would be eliminated, and Commercial Way would become a cul-de-sac north of the realigned ramp. The intersection of the northbound off-ramp with Soquel Drive would be enlarged to achieve an acceptable level of service for the anticipated traffic volume.

- Improve existing nonstandard geometric elements at various ramps.

- Provide HOV bypass lanes on ramps other than the northbound Morrissey Boulevard on-ramps; bypass lanes on ramps at the San Andreas/Larkin Boulevard, Freedom Boulevard, and Rio del Mar Boulevard interchanges would not be constructed if Santa Cruz long-toed salamander upland habitat cannot be avoided.

- Add California Highway Patrol enforcement areas at on-ramps with HOV bypass lanes.

New Pedestrian/Bicycle Overcrossings

The proposed pedestrian/bicycle overcrossings are discussed above in Section 1.5 Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives.

Other Improvements

The details of the other improvements are included above, under the heading, Common Design Features of the Tier I Corridor HOV Lane and TSM Alternatives.