State Route 1 Auxiliary Lane Bus-on-Shoulder Concept of Operations

Santa Cruz County Regional Transportation Commission

May 23, 2019



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Section 1

Introduction

The Santa Cruz County Regional Transportation Commission (RTC) in partnership with the Santa Cruz Metropolitan Transit District (Santa Cruz Metro), the California Department of Transportation (Caltrans) and the California Highway Patrol (CHP) is interested in implementing Bus-on-Shoulder (BOS) operations on State Route 1 (SR 1) in Santa Cruz County in an effort to provide a viable transit alternative to single occupant auto travel in this important travel corridor. The decision to consider BOS operations on SR 1 was a result of the findings of the recent *Monterey Bay Area Feasibility Study of Bus on Shoulder Operations on State Route 1 and the Monterey Branch Line.* That study concluded, after evaluating four alternatives, that a hybrid auxiliary lane/BOS project on SR 1 between the Morrissey and Freedom Boulevard interchanges could be a very cost-effective way to provide meaningful benefits to transit riders in the corridor. The hybrid auxiliary lane/BOS project would have the buses using the existing and planned new auxiliary lanes between interchanges and the shoulder areas within interchanges. This document defines how such a project would be designed and operated.

1.1 Purpose of this Document

This Concept of Operations (ConOps) document describes system characteristics of the to-be-delivered system from the user's viewpoint. The ConOps plan will serve as the framework for the design, implementation and operation of the future SR 1 BOS facility. The plan lays out how BOS will function and operate on SR 1 in terms of the required physical design features, signage and pavement markings, hours of operation, transit service operations plan, transit operator training, incident management, marketing, and institutional responsibilities and commitments for each of the partner agencies that would be involved with BOS implementation, operations and maintenance.

1.2 Project Overview

SR 1 in Santa Cruz County experiences significant levels of traffic congestion and delay. The congestion is prevalent on both weekdays and weekend days. The most severe congestion occurs between the City of Santa Cruz and the community of Aptos. Santa Cruz Metro services which operate on SR 1 in this segment are subject to the same delays as general traffic which results in low travel speeds, poor transit service reliability and increased transit operating costs.

California Assembly Bill No. 946 which was passed in 2013 authorizes the Monterey-Salinas Transit District (MST) and the Santa Cruz Metropolitan Transit District to conduct a transit-only program using the shoulders of certain state highways as transit-only traffic corridors, subject to approval by the department (Caltrans) and the California Highway Patrol.

To this end MST, in partnership with the Transportation Agency for Monterey County (TAMC), Association of Monterey Bay Area Governments (AMBAG), Caltrans, Santa Cruz Metro, the CHP, and the RTC conducted the *Monterey Bay Area Feasibility Study of Bus on Shoulder Operations on State Route 1 and the Monterey Branch Line*, which was completed June 2018, to explore the



potential for implementing bus-on-shoulder operations on SR 1 in the areas that are found to be best suited to bus-on-shoulder treatments. That study concluded that in general, with the exception of some areas, the existing highway shoulders along SR 1 in Santa Cruz County were not of sufficient width or structural depth to support BOS operations. However, it also concluded that a BOS concept that combined the use of the new auxiliary lanes by buses with BOS operation

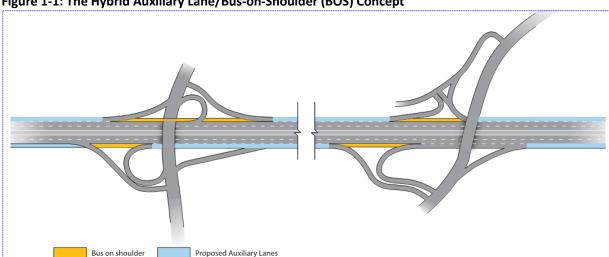


Figure 1-1: The Hybrid Auxiliary Lane/Bus-on-Shoulder (BOS) Concept

on the short segments of shoulders within interchanges could be a very cost-effective and beneficial way of improving bus operations on SR 1 without impacting traffic operations or safety as shown in **Figure 1-1**. The term "auxiliary lane" is not defined in either the California Motor Vehicle Code or Streets and Highways Code. For the purposes of this document, auxiliary lanes are freeway travel lanes that only extend between freeway on- and off-ramps.

The RTC in cooperation with Caltrans and the Federal Highway Administration (FHWA) is implementing improvements on Highway 1 as part of the Highway 1 Corridor Investment Program. It consists of a Tiered program with Tier I being the long-term program level vision for the corridor between Santa Cruz and Aptos, which would be constructed over time through a series of smaller incremental projects (referred to as Tier II projects). The first Tier II project includes constructing auxiliary lanes on Highway 1 in both directions between the Soquel Avenue/Drive interchange and the 41st Avenue interchange. That project is in the final design phase and is expected to begin construction in 2020.

The RTC will be the implementing agency for the development of the BOS facility by integrating the improvements into future auxiliary lane projects. The RTC administers the half-cent sales tax measure for transportation passed in 2016 known as Measure D, which has an expenditure plan that includes constructing auxiliary lanes on Highway 1 from Soquel Avenue/Drive to State Park Boulevard.

Figure 1-2 shows the project location on Highway 1 in Santa Cruz County, which extends from Morrissey Boulevard in the City of Santa Cruz south to Freedom Boulevard in Aptos (County of Santa Cruz), a distance of 7.5 miles. There are existing auxiliary lanes between the Morrissey Boulevard and Soquel Avenue/Drive interchanges and between the 41st Avenue and Bay Avenue/Porter Street interchanges. The first phase of the project will close the gap between the



Soquel Avenue/Drive and 41st Avenue interchanges. A future project will extend the auxiliary lanes south to the State Park Drive interchange. Ultimately the auxiliary lanes will extend throughout the corridor to Freedom Boulevard, but this last segment from State Park Drive to Freedom Boulevard is not funded.

This ConOps report defines how the concept of a BOS operation in which buses use the auxiliary lanes, as they are implemented, in combination with BOS use of improved shoulder areas between the off-ramps and on-ramps at each interchange along the corridor will function.

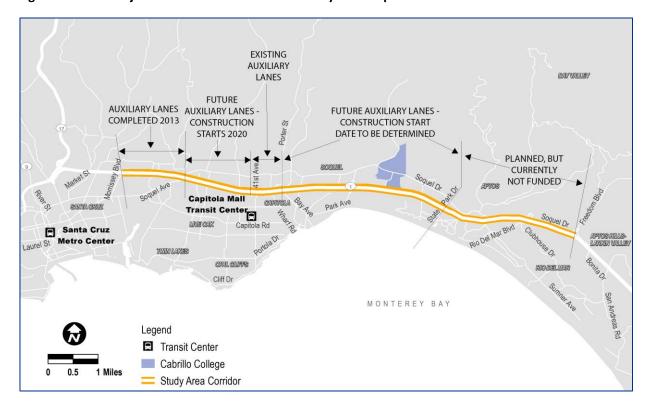


Figure 1-2: BOS Project Location and Planned Auxiliary Lane Improvements

1.3 Project Goals and Objectives

Implementation of BOS operations on SR 1 is expected to provide, at a minimum, three important benefits to the public in the region as outlined below:

- **Increase efficiency of existing roadway**: The objective is to implement the BOS project in a manner that will increase the person carrying capacity of SR 1, without impacts to traffic operations, traffic safety and the safety of Caltrans and CHP personnel working on SR 1.
- **Fast, reliable transit travel**: Through the use of the SR 1 auxiliary lanes and the shoulder areas between off-ramps and on-ramps by Santa Cruz Metro buses, the objective is to improve transit travel times and the reliability of transit services, while also reducing transit operating costs



• **Positive Return on Investment**: The objective is to achieve positive benefits related to enhanced transit operations and increased transit ridership, while minimizing capital and operations/maintenance expenditures.

1.4 Referenced Documentation

The following documents were used as reference materials during the creation of this ConOps:

- Monterey Bay Area Feasibility Study of Bus on Shoulder Operations on State Route 1 and the Monterey Branch Line, June 2018
- Transit Cooperative Research Program Report 151 A Guide for Implementing Bus on Shoulder (BOS) Systems, 2012
- State Route 1 HOV Lane Widening Project (From Morrissey Boulevard to San Andreas Road) Traffic Operations Report, April 2012
- Transportation Concept Report, SR 1, Caltrans District 5, June 2017
- Decision Document Interstate 805 and State Route 94 Transit Only Lane, SANDAG, August 2018
- Project Initiation Charter Transit Only Lane Demonstration Project I-805 and SR-94, SANDAG, August 2018



Section 2

Current System Description

The BOS facility will be on SR 1 in Santa Cruz County between the Morrissey Boulevard and Freedom Boulevard interchanges.

2.1 Existing Facility Description

This segment of SR 1 in a four-lane limited access, freeway facility with two general purpose lanes in each direction. There are 7 interchanges, at Morrissey Boulevard, Soquel Drive, 41st Avenue, Porter Street/Bay Avenue, Park Avenue, State Park Drive, and Rio Del Mar Boulevard. There are three freeway overcrossings, Capitola Avenue and the two railroad bridges just south of the State Park Drive interchange, that are short in terms of span length and have very narrow shoulder areas. There are existing auxiliary lanes between the Morrissey Boulevard and Soquel Avenue/Drive interchanges and between the 41st Avenue and Bay Avenue/Porter Street interchanges.

2.2 Planned Improvements

As part of the RTC Highway 1 Corridor Investment Program, southbound and northbound auxiliary lanes will be constructed in phases at the following locations:

- Auxiliary Lane 1: Between Soquel Avenue/Drive and 41st Avenue interchanges
- Auxiliary Lane 2: Between Bay Avenue/Porter Street and Park Avenue interchanges
- Auxiliary Lane 3: Between Park Avenue and State Park Drive interchanges
- Auxiliary Lane 4: Between State Park Drive and Rio Del Mar Boulevard interchanges
- Auxiliary Lane 5: Between Rio Del Mar Boulevard and Freedom Boulevard interchanges

It is important to note that the Auxiliary Lane 4 and 5 phases are considered more as long-range improvements. They are not currently funded by Measure D and they require significant mainline reconstruction and railroad bridge replacements.

Additionally, as part of the auxiliary lane projects, right shoulders in either direction will be improved and widened and should be 10 feet wide in most areas. The design will ensure that there is adequate horizontal clearance on the right side of the shoulder to protect the protruding bus mirrors. Construction of these auxiliary lanes will be completed in stages. Auxiliary Lane 1 will be starting construction by year 2021, Auxiliary Lanes 2 and 3 will begin construction by year 2023-24, but this is contingent upon the availability of funds. The construction timeframe for Auxiliary Lanes 4 and 5 is currently unavailable.



2.3 Existing Traffic Conditions

The segment of SR 1 between Morrissey Boulevard and Freedom Boulevard is heavily traveled as shown in **Table 2-1**. Average annual daily traffic volumes ranging from 88,000 to 97,000 vehicles were reported by Caltrans.

Table 2-1: SR 1 Daily Traffic Volumes

Limits of SR	1 Segment	Average Annual Daily								
Southern Limit	Southern Limit Northern Limit									
Freedom Boulevard	Bay Avenue	89,000								
Bay Avenue	41st Avenue	104,000								
41st Avenue	Soquel Avenue/Drive	86,000								
Soquel Avenue/Drive	Morrissey Boulevard	97,000								

Source: 2017 Traffic Volumes on the California State Highway System - Caltrans

An SR 1 speed analysis was based on data obtained from the INRIX database for all midweek days (Tuesday through Thursday) in year 2016. The INRIX data represent anonymous tracking of trajectories based on signals from a sample of mobile devices (mobile phones and global positioning system/GPS units). Speed data was obtained from the INRIX database for all 12 months (from January 1 to December 31) in year 2016. The raw speed data included every day of the year, every segment between freeway interchanges or major cross streets, and is split into designated time periods.

Speed contour maps were prepared for each segment and 15-minute time period representing the 50th (median) and 95th percentile travel time day for each corridor and time period. The congestion and queues shown for the 95th percentile represent the typical maximum travel times over what is experienced on weekdays during the course of a year (all but the worst five percent of weekdays, which most likely include major incident conditions).

Speed profiles along SR 1 in Santa Cruz County are provided in **Table 2-2** through **Table 2-9**. A discussion on traffic operations along the corridor is provided below. BOS operations typically only allow buses to use the shoulders when traffic speeds drop below 35 mph. All the areas shaded in red on the tables indicate speeds of 35 mph or less. While there is significant congestion near and north of the junction of SR 1 and SR 17 between SR 17 and River Street this project will not benefit that area. The focus of this project is on the congested areas which are generally south of the Morrissey Boulevard interchange and during the times identified below:

Northbound

- AM Peak Period Significant traffic congestion was observed along northbound SR 1 between Buena Vista Drive and Commercial Way during the period from 6:45 AM to beyond 10:00 AM.
- **PM Peak Period** Some congestion was observed on SR 1 between Larkin Valley Road and 41st Avenue from 5:00 PM to 6:00 PM.



Southbound

- AM Peak Period During a typical weekday, some congestion was observed along southbound SR 1 between Morrissey Boulevard and Bay Avenue from 7:45 AM to 9:30 AM.
- PM Peak Period During the PM peak period, significant congestion was observed between SR 17 and Rio Del Mar Boulevard that began before 3:00 PM and ended after 7:00 PM.

Overall, for the portion of the study corridor located within Santa Cruz County, traffic operations are worse along northbound SR 1 during the AM peak period and along southbound SR 1 during the PM peak period.



Table 2-2: Weekday 50th Percentile (Median) Speeds – Northbound AM (Santa Cruz County)

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Time	Riverside Drive to Harkins Slough Road	Harkins Slough Road to SR-152	SR-152 to Airport Boulevard	Airport Boulevard to Buena Vista Drive	Buena Vista Drive to La Selva Drive	La Selva Drive to Larkin Valley Road	Larkin Valley Road to Freedom Boulevard	Freedom Boulevard to Rio Del Mar Boulevard	Rio Del Mar Boulevard to State Park Drive	State Park Drive to Park Avenue	Park Avenue to Bay Avenue	Bay Avenue to 41st Avenue	41st Avenue to Commercial Way	Commercial Way to Morrissey Boulevard	Morrissey Boulevard to Emeline Avenue	Emeline Avenue to SR- 17	SR-17 to River Street
5:00	58	57	56	53	53	55	55	56	55	56	56	53	55	59	59	46	45
5:15	62	64	63	62	63	65	64	64	62	60	59	57	59	61	60	46	42
5:30	61	63	60	59	60	63	63	63	64	67	71	72	68	72	67	46	39
5:45	62	64	62	63	67	65	65	66	64	61	62	60	59	65	66	44	44
6:00	59	60	56	55	58	60	63	64	64	69	69	68	67	66	60	48	34
6:15	62	62	60	62	63	63	65	62	63	63	60	60	58	61	56	47	37
6:30	70	70	67	68	65	63	62	61	61	60	58	58	57	61	53	45	32
6:45	61	63	61	63	57	59	57	38	53	58	58	55	52	62	58	46	29
7:00	64	64	60	68	56	22	31	31	52	59	57	45	42	57	59	44	36
7:15	69	68	60	68	37	16	18	34	57	60	58	59	59	64	61	45	31
7:30	70	66	64	68	48	10	14	26	53	55	45	36	40	58	56	41	26
7:45	66	65	62	70	69	14	13	21	40	30	18	20	37	56	56	39	23
8:00	66	67	64	66	66	33	9	11	18	22	20	24	37	58	58	38	13
8:15	68	69	69	70	68	34	9	13	21	21	24	24	36	59	57	39	13
8:30	67	67	63	64	64	44	15	17	19	19	23	24	37	58	56	34	16
8:45	64	65	61	60	62	49	12	17	19	22	30	27	37	61	57	42	25
9:00	67	67	66	71	66	63	11	17	24	31	28	29	33	56	55	41	28
9:15	64	66	64	71	70	65	37	22	33	39	40	48	49	57	56	36	32
9:30	67	69	66	71	68	68	68	48	44	51	44	51	46	59	57	39	35
9:45	73	73	68	71	67	67	67	67	51	40	38	38	39	56	55	31	31
10:00	67	69	63	68	69	66	68	63	61	62	45	50	46	57	58	30	22

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph



Table 2-3: Weekday 95th Percentile Speeds – Northbound AM (Santa Cruz County)

Time	Riverside Drive to Harkins Slough Road	Harkins Slough Road to SR-152	SR-152 to Airport Boulevard	Airport Boulevard to Buena Vista Drive	Buena Vista Drive to La Selva Drive	La Selva Drive to Larkin Valley Road	Larkin Valley Road to Freedom Boulevard	Freedom Boulevard to Rio Del Mar Boulevard	Rio Del Mar Boulevard to State Park Drive	State Park Drive to Park Avenue	Park Avenue to Bay Avenue	Bay Avenue to 41st Avenue	41st Avenue to Commercial Way	Commercial Way to Morrissey Boulevard	Morrissey Boulevard to Emeline Avenue	Emeline Avenue to SR- 17	SR-17 to River Street
5:00	61	63	60	61	61	60	60	60	58	58	59	56	55	56	57	40	39
5:15	58	61	58	60	61	65	65	64	65	64	65	62	63	63	60	40	38
5:30	61	62	59	60	59	60	60	60	61	60	64	62	61	68	66	40	38
5:45	60	62	60	61	60	62	62	62	63	63	63	61	64	65	68	42	31
6:00	62	62	60	61	62	60	65	64	62	64	63	58	59	66	44	42	32
6:15	62	63	60	59	59	61	62	63	62	62	64	62	63	65	20	41	43
6:30	63	65	62	60	60	60	60	57	58	58	58	57	60	62	26	42	38
6:45	60	63	59	60	54	42	53	51	46	55	55	55	56	58	55	42	36
7:00	60	63	62	66	29	26	30	25	29	56	59	58	58	62	62	46	37
7:15	62	65	68	67	18	12	15	22	29	51	60	59	57	60	60	46	41
7:30	67	66	63	64	19	8	11	18	27	35	55	54	55	57	61	44	29
7:45	68	69	66	69	27	6	8	14	22	39	50	42	47	63	61	39	21
8:00	65	68	66	68	61	7	8	15	23	24	23	22	36	62	57	42	19
8:15	61	71	65	66	66	10	10	12	17	18	21	23	34	61	59	45	14
8:30	67	68	62	70	68	8	7	12	16	17	21	20	32	56	57	44	13
8:45	68	65	63	66	65	8	9	12	19	20	22	23	32	56	57	40	15
9:00	68	69	65	71	54	10	10	16	25	26	24	25	35	59	62	42	18
9:15	61	63	59	63	60	13	12	22	34	27	31	34	38	59	64	41	24
9:30	65	68	65	65	64	19	15	20	29	27	28	27	36	62	64	39	34
9:45	67	67	67	64	65	38	14	15	17	28	33	23	36	63	61	41	37
10:00	65	67	63	66	65	53	13	17	22	37	32	23	36	58	57	43	30

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph



Table 2-4: Weekday 50th Percentile (Median) Speeds – Northbound PM (Santa Cruz County)

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Time	Riverside Drive to Harkins Slough Road	Harkins Slough Road to SR-152	SR-152 to Airport Boulevard	Airport Boulevard to Buena Vista Drive	Buena Vista Drive to La Selva Drive	La Selva Drive to Larkin Valley Road	Larkin Valley Road to Freedom Boulevard	Freedom Boulevard to Rio Del Mar Boulevard	Rio Del Mar Boulevard to State Park Drive	State Park Drive to Park Avenue	Park Avenue to Bay Avenue	Bay Avenue to 41st Avenue	41st Avenue to Commercial Way	Commercial Way to Morrissey Boulevard	Morrissey Boulevard to Emeline Avenue	Emeline Avenue to SR- 17	SR-17 to River Street
15:00	64	65	62	65	67	65	64	63	61	63	68	60	58	62	56	40	23
15:15	66	67	63	67	67	66	64	67	64	68	62	57	56	59	59	45	22
15:30	65	66	59	65	67	67	64	63	62	63	60	60	58	62	60	44	24
15:45	62	62	58	60	60	62	62	61	60	60	61	58	59	61	61	45	37
16:00	62	68	65	64	64	63	63	62	62	60	60	55	55	61	58	44	21
16:15	61	64	59	61	65	64	67	64	63	64	66	60	59	63	62	42	35
16:30	64	64	60	63	64	64	66	65	63	63	58	57	58	61	60	43	27
16:45	66	67	65	67	66	67	69	66	63	64	58	57	55	63	58	45	39
17:00	64	65	61	65	65	65	64	61	60	59	55	54	55	59	56	43	32
17:15	65	68	59	64	63	68	64	62	61	61	47	47	49	56	55	39	11
17:30	66	67	62	64	64	59	60	58	57	48	32	46	47	53	55	26	11
17:45	65	67	62	69	66	67	66	64	63	56	53	55	55	57	54	41	20
18:00	62	64	61	65	64	64	61	61	61	56	43	55	55	57	55	41	25
18:15	65	67	63	65	65	62	62	61	61	60	56	56	56	57	55	41	35
18:30	72	75	70	69	67	69	69	64	59	60	56	54	60	66	58	41	36
18:45	69	71	68	67	67	72	71	65	61	60	62	61	60	64	61	41	34
19:00	65	66	64	61	64	63	70	68	65	63	65	62	59	63	58	45	40

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph



Table 2-5: Weekday 95th Percentile Speeds – Northbound PM (Santa Cruz County)

											• • • • • • • • • • • • • • • • • • • •						
Time	Riverside Drive to Harkins Slough Road	Harkins Slough Road to SR-152	SR-152 to Airport Boulevard	Airport Boulevard to Buena Vista Drive	Buena Vista Drive to La Selva Drive	La Selva Drive to Larkin Valley Road	Larkin Valley Road to Freedom Boulevard	Freedom Boulevard to Rio Del Mar Boulevard	Rio Del Mar Boulevard to State Park Drive	State Park Drive to Park Avenue	Park Avenue to Bay Avenue	Bay Avenue to 41st Avenue	41st Avenue to Commercial Way	Commercial Way to Morrissey Boulevard	Morrissey Boulevard to Emeline Avenue	Emeline Avenue to SR- 17	SR-17 to River Street
15:00	67	67	64	66	68	65	64	65	59	59	56	55	53	58	57	41	20
15:15	68	67	61	63	63	61	60	61	60	59	48	52	54	55	54	39	13
15:30	63	61	62	63	63	62	61	59	60	57	38	48	52	58	54	41	11
15:45	64	64	61	64	64	60	63	57	58	58	52	47	50	57	55	27	12
16:00	61	64	61	62	61	56	61	60	58	58	58	56	56	59	57	32	18
16:15	62	64	60	63	62	55	60	60	59	59	57	55	56	60	56	42	19
16:30	65	66	63	61	64	65	66	62	59	60	60	59	56	58	57	36	24
16:45	62	65	63	64	65	67	65	40	52	58	54	55	53	55	53	38	21
17:00	64	63	60	63	63	59	44	37	45	54	50	56	46	55	50	36	20
17:15	63	63	60	61	61	57	47	30	38	48	39	54	52	52	48	36	20
17:30	63	62	57	62	60	40	27	34	48	46	32	51	51	53	49	36	14
17:45	61	63	58	65	57	55	34	35	45	49	32	51	50	54	54	39	18
18:00	62	64	61	62	61	59	51	47	46	56	38	44	47	56	56	39	25
18:15	62	65	65	63	64	59	63	61	60	61	59	56	57	57	56	40	34
18:30	62	63	59	60	61	64	61	57	55	59	58	51	52	54	56	39	35
18:45	62	63	62	63	61	58	58	55	55	55	55	51	56	55	56	40	33
19:00	63	64	63	64	66	61	61	59	58	55	56	44	48	53	56	44	35

Green	Greater than 55 mph
Yellow	45 to 55 mph
Orange	35 to 45 mph
Red	Less than 35 mph



Table 2-6: Weekday 50th Percentile (Median) Speeds – Southbound AM (Santa Cruz County)

Time	River Street to SR-17	SR-17 to Morrissey Boulevard	Morrissey Boulevard to Soquel Drive	Soquel Drive to 41st Avenue	41st Avenue to Bay Avenue	Bay Avenue to Park Avenue	Park Avenue to State Park Drive	State Park Drive to Rio Del Mar Boulevard	Rio Del Mar Boulevard to Freedom Boulevard	Freedom Boulevard to Larkin Valley Road	Larkin Valley Road to La Selva Drive	La Selva Drive to Buena Vista Drive	Buena Vista Drive to Airport Boulevard	Airport Boulevard to SR-152	SR-152 to Harkins Slough Road
5:00	43	65	65	65	66	62	65	60	62	59	63	62	63	60	63
5:15	43	66	65	68	68	66	68	67	68	66	71	69	70	66	70
5:30	48	58	64	61	67	67	67	65	67	66	69	70	73	69	68
5:45	48	60	65	65	60	62	65	63	63	62	67	64	68	67	68
6:00	40	58	62	62	58	60	64	66	64	64	68	57	67	66	68
6:15	41	64	64	63	61	62	63	61	63	61	65	65	66	63	66
6:30	43	62	63	63	65	66	69	69	66	66	69	65	64	61	69
6:45	41	63	63	61	59	60	65	67	63	63	64	64	64	62	67
7:00	37	56	63	65	64	65	66	64	70	67	70	69	72	65	71
7:15	40	57	63	65	65	65	68	67	69	68	70	67	69	72	68
7:30	45	62	62	62	61	63	65	63	64	63	67	67	66	63	66
7:45	35	65	49	51	43	56	60	62	65	65	70	69	67	63	67
8:00	30	59	45	37	29	41	58	58	60	60	65	63	64	62	64
8:15	38	59	64	53	46	53	63	56	61	54	62	64	65	61	64
8:30	41	60	61	57	55	60	62	59	62	60	65	65	68	71	71
8:45	31	58	62	54	55	57	68	60	66	61	71	67	66	62	66
9:00	39	60	62	63	61	62	65	60	63	61	69	69	69	64	66
9:15	28	62	61	58	58	59	61	57	60	60	68	67	69	63	67
9:30	26	62	62	59	56	58	61	59	63	61	65	67	69	66	67
9:45	39	65	64	59	56	60	61	59	62	58	62	66	66	62	65
10:00	39	65	64	63	61	59	62	58	60	59	63	66	68	63	72

Green	Greater than 55 mph				
Yellow	Yellow 45 to 55 mph				
Orange 35 to 45 mph					
Red	Less than 35 mph				



Table 2-7: Weekday 95th Percentile Speeds – Southbound AM (Santa Cruz County)

											• •				
Time	River Street to SR-17	SR-17 to Morrissey Boulevard	Morrissey Boulevard to Soquel Drive	Soquel Drive to 41st Avenue	41st Avenue to Bay Avenue	Bay Avenue to Park Avenue	Park Avenue to State Park Drive	State Park Drive to Rio Del Mar Boulevard	Rio Del Mar Boulevard to Freedom Boulevard	Freedom Boulevard to Larkin Valley Road	Larkin Valley Road to La Selva Drive	La Selva Drive to Buena Vista Drive	Buena Vista Drive to Airport Boulevard	Airport Boulevard to SR 152	SR-152 to Harkins Slough Road
5:00	51	59	62	61	54	57	59	62	66	62	63	62	63	61	65
5:15	51	61	64	67	55	61	68	64	65	60	70	68	69	60	64
5:30	45	60	66	64	58	61	63	62	61	57	66	66	66	61	64
5:45	39	61	56	56	53	56	62	63	63	60	65	60	63	59	67
6:00	40	60	51	56	54	53	55	58	63	59	67	63	65	64	68
6:15	43	59	61	60	57	54	57	55	57	57	58	57	61	61	65
6:30	43	57	61	60	57	57	60	59	59	57	63	62	63	61	62
6:45	41	58	63	61	59	59	61	61	64	61	66	65	64	63	67
7:00	42	60	49	57	55	57	59	59	62	66	66	65	65	63	68
7:15	39	59	53	58	58	62	61	62	67	58	65	63	64	62	67
7:30	47	57	57	59	63	64	63	66	72	57	68	65	67	64	65
7:45	41	53	53	54	37	49	57	57	59	56	65	63	67	67	68
8:00	32	56	35	53	39	49	57	56	56	52	64	61	62	59	65
8:15	31	58	34	50	52	55	59	59	60	58	64	64	64	63	65
8:30	39	55	46	46	53	57	60	61	62	60	68	65	61	63	67
8:45	39	53	46	46	45	57	58	57	58	55	64	59	65	63	64
9:00	40	56	45	52	51	57	60	58	58	57	67	65	70	67	67
9:15	34	59	55	57	54	57	60	60	61	54	64	64	64	61	66
9:30	36	60	55	58	55	57	62	60	59	59	62	62	64	60	61
9:45	31	56	55	55	52	57	61	59	58	64	61	62	64	62	65
10:00	40	59	60	63	55	58	60	58	58	62	63	61	61	58	61

Green	Greater than 55 mph					
Yellow 45 to 55 mph						
Orange 35 to 45 mph						
Red Less than 35 mph						



Table 2-8: Weekday 50th Percentile (Median) Speeds – Southbound PM (Santa Cruz County)

						•						-,,			
Time	River Street to SR-17	SR-17 to Morrissey Boulevard	Morrissey Boulevard to Soquel Drive	Soquel Drive to 41st Avenue	41st Avenue to Bay Avenue	Bay Avenue to Park Avenue	Park Avenue to State Park Drive	State Park Drive to Rio Del Mar Boulevard	Rio Del Mar Boulevard to Freedom Boulevard	Freedom Boulevard to Larkin Valley Road	Larkin Valley Road to La Selva Drive	La Selva Drive to Buena Vista Drive	Buena Vista Drive to Airport Boulevard	Airport Boulevard to SR- 152	SR-152 to Harkins Slough Road
15:00	32	55	18	34	24	41	61	61	62	60	70	67	67	63	65
15:15	42	67	27	16	15	41	60	62	66	64	74	70	71	62	73
15:30	41	59	21	14	18	39	44	39	59	55	69	66	65	62	68
15:45	39	58	13	15	15	26	30	30	60	57	73	68	64	66	72
16:00	25	64	13	14	12	27	25	30	58	55	66	65	64	61	63
16:15	30	59	10	11	10	19	24	30	61	59	69	67	66	63	68
16:30	38	63	16	13	8	13	28	37	61	59	67	65	65	62	67
16:45	34	55	11	10	19	18	33	36	55	56	65	64	67	66	71
17:00	42	54	10	10	15	20	23	32	61	60	67	67	68	66	69
17:15	52	51	8	5	15	16	22	29	66	57	69	66	69	64	68
17:30	37	41	6	5	6	16	21	28	67	52	70	66	69	65	63
17:45	35	40	6	5	8	16	22	34	58	54	67	65	65	56	66
18:00	40	38	7	8	11	24	23	34	56	53	66	66	68	61	65
18:15	40	47	18	12	13	19	22	31	57	54	67	62	64	56	64
18:30	40	55	25	17	24	32	29	27	58	60	66	65	65	62	65
18:45	37	59	47	19	22	34	39	31	60	63	69	64	61	58	62
19:00	38	59	59	40	32	46	55	32	58	54	67	59	56	54	60

Green	Greater than 55 mph				
Yellow	45 to 55 mph				
Orange	35 to 45 mph				
Red	Less than 35 mph				



Table 2-9: Weekday 95th Percentile Speeds – Southbound PM (Santa Cruz County)

								•			• •				
Time	River Street to SR-17	SR-17 to Morrissey Boulevard	Morrissey Boulevard to Soquel Drive	Soquel Drive to 41st Avenue	41st Avenue to Bay Avenue	Bay Avenue to Park Avenue	Park Avenue to State Park Drive	State Park Drive to Rio Del Mar Boulevard	Rio Del Mar Boulevard to Freedom Boulevard	Freedom Boulevard to Larkin Valley Road	Larkin Valley Road to La Selva Drive	La Selva Drive to Buena Vista Drive	Buena Vista Drive to Airport Boulevard	Airport Boulevard to SR- 152	SR-152 to Harkins Slough Road
15:00	41	45	14	19	16	34	40	55	59	59	67	66	68	64	67
15:15	33	52	13	12	10	26	34	47	61	60	69	66	67	66	67
15:30	38	54	8	10	11	20	31	36	60	59	65	63	68	68	71
15:45	33	17	9	11	12	23	30	28	56	57	62	61	62	63	66
16:00	35	10	6	7	11	18	24	28	57	60	70	66	69	64	65
16:15	37	8	5	6	8	15	22	23	58	61	71	67	71	66	72
16:30	40	7	4	5	8	13	21	26	63	59	68	66	67	65	65
16:45	44	8	7	4	10	13	18	24	59	58	65	64	66	61	65
17:00	39	9	7	5	9	12	16	27	61	62	70	67	70	67	69
17:15	38	15	2	5	7	13	22	32	58	60	70	68	67	61	65
17:30	36	8	4	6	11	15	21	29	56	60	69	65	70	64	71
17:45	41	13	9	6	8	13	19	27	56	59	65	64	67	64	71
18:00	40	8	11	8	8	12	16	29	57	61	67	65	68	57	66
18:15	35	14	7	13	10	17	23	27	69	61	67	67	68	59	67
18:30	34	19	6	13	12	22	20	34	62	62	70	67	73	64	70
18:45	41	47	6	10	12	24	33	32	57	60	66	64	69	62	65
19:00	43	61	15	18	20	25	40	44	61	61	66	65	68	65	68

Green	Greater than 55 mph	
Yellow	45 to 55 mph	
Orange 35 to 45 mph		
Red	Less than 35 mph	



Congested off-ramps that experience queuing that extends onto the freeway require buses on the shoulder or in the auxiliary lane to take action to avoid the congestion. In this situation, bus operators are instructed to merge into the rightmost general purpose traffic lane on the freeway before the beginning of the off-ramp queue and then move onto the shoulder once the ramp related queue is bypassed. Congestion along off-ramps that may extend back to the freeway mainline was identified based on Google Maps' "typical" traffic conditions for a typical weekday (Wednesday). The following ramps were noted to have slow traffic speeds on the full extent of the off-ramp during at least a portion of the AM and PM peak periods:

- Northbound off-ramp to Freedom Boulevard (AM peak period)
- Southbound off-ramp to Freedom Boulevard (AM peak period)
- Northbound off-ramp to Rio Del Mar Boulevard (AM peak period)
- Northbound off-ramp to Park Avenue (AM peak period)
- Southbound off-ramp to Park Avenue (PM peak period)
- Southbound off-ramp to Bay Avenue (AM and PM peak periods)
- Southbound off-ramp to 41st Avenue (PM peak period)
- Southbound off-ramp to Soquel Drive (AM and PM peak periods)
- Southbound off-ramp to Morrissey Boulevard (PM peak period)

If the congestion on these off-ramps is limited to the ramp itself, there would be no impact on freeway operations. However, congestion that directly impacts the auxiliary lane does affect BOS operations, as the bus operators must move left into the general purpose lane and operate in mixed-traffic until the congested area is bypassed.



Section 3

Proposed BOS System Concept

The hybrid auxiliary lane/BOS concept where buses would use the auxiliary lanes between interchanges and the shoulder areas through interchanges is proposed for SR 1 between the Morrissey Boulevard and Freedom Boulevard interchanges in Santa Cruz County.

3.1 Project Description

The project will provide transit-only shoulder lanes between auxiliary lanes through interchanges. The transit-only shoulder lane will serve as an extension of the auxiliary lane across an interchange between the off-ramp and the on-ramp. These lanes would be provided on the right shoulder. The buses will operate on:

- Auxiliary lanes between interchanges, and
- Transit-only shoulder lanes through interchanges.

Within the study area there are no existing 2-lane off-ramps, however single lane off-ramps may be widened to 2-lane off-ramps as part of future Tier II projects along the SR 1 corridor. At locations with a two-lane off-ramp, buses will operate on the outermost non-exit-only lane (the first through traffic lane on the right). Once past the off-ramp the bus can move to the right into the transit-only lane on the shoulder.

The schematic layout of the project is provided in **Figure 3-1**. Ideally the design and construction of the BOS facility will be integrated into the auxiliary lanes projects to minimize construction impacts on the general public. The first phase of the auxiliary lane project – Auxiliary Lane 1: Between Soquel Avenue/Drive and 41st Avenue interchanges – is now in the final design phase. **Figure 3-2** provides a more detailed view of how the BOS project would be implemented in that segment of the freeway. This figure also includes the proposed details of signage and pavement markings for the project. It would be very beneficial and efficient to implement the transit-only shoulder lanes at the same time as each phase of the auxiliary lane project is implemented. This would avoid multiple construction projects and reduce the inconvenience for motorists. It should also save capital construction related costs by performing all the work under a single contract.

The California Manual for Uniform Traffic Control Devices (MUTCD) Section 3D.01 may be used for lane word and symbol markings. The MUTCD does not include a current standard for signage concerning transit-only lanes (TOL). Signing and striping not addressed by the existing policies in the MUTCD would need to be presented at the California Traffic Control Devices Committee (CTCDC). Concurrence from Caltrans and the CHP should be secured prior to presenting the project at a CTCDC meeting.

An experimental project requested by San Diego Association of Governments (SANDAG) went before the CTCDC at the August 2018 board meeting. The objective of their experimental project is to determine the usage and effectiveness of proposed signing and striping to improve TOL



operations and safety for bus operators, ramp meter users, and mainline traffic. Attachments 1-5 include the latest information on the SANDAG I-805/SR 94 TOL project, including a listing of CTCDC members. The CTCDC may require additional experimentation because SANDAG's project includes ramp meters whereas the SCCRTC concept does not. SCCRTC's bus on shoulders concept may ultimately be determined to be an experimental project.

Per Streets and Highways Code (SHC) 148.1, transit agencies need the approval of Caltrans and the CHP for the operation of buses on shoulder. It is also stated in the SHC 148.1 that locations where buses are allowed should be jointly determined by the transit agency, Caltrans, and the CHP.

Transit Cooperative Research Program Report 151 - A Guide for Implementing Bus On Shoulder (BOS) Systems sets forth the basic requirements for successful bus-on-shoulder operations, which include:

- Presence of buses usually at least four buses per hour.
- Congested freeways speeds of less than 35 miles per hour for right side shoulder use.
- Minimum 10-foot continuous shoulder of sufficient strength to support buses. Ideally, the shoulder should be at least 12 feet wide to better protect protruding bus mirrors.
- Avoidance of multi-lane entrance and exit ramps and ramps with very high traffic volumes (more than 1,000 vehicles per hour).
- Bus operators receive special training in how to operate on the shoulder and buses are typically limited to a speed no more than 10 miles per hour faster than the general freeway traffic.
- Special signage and driver education programs to inform motorists of the bus-on-shoulder presence.

The Monterey Bay Area Feasibility Study of Bus on Shoulder Operations on State Route 1 and the Monterey Branch Line, June 2018 examined a number of alternative approaches for BOS operations on SR 1 in Santa Cruz county including continuous use of the freeway shoulder rather than the hybrid auxiliary lane/BOS approach that is now the proposed BOS project. The following were the advantages and disadvantages of the proposed BOS project:

Advantages:

- Higher Bus Speeds: For most part, buses will travel on auxiliary lanes, where traffic speeds
 are typically higher compared to those on the remaining travel lanes. Also, auxiliary lanes
 do not have speed restrictions like those for BOS operations.
- Moderately Cost-Effective: The proposed BOS project is cost-effective it involves no construction between interchanges and minimal construction across interchanges.
- Open Shoulders: Shoulders between interchanges will be available for the exclusive use of emergency vehicles.



Disadvantages

- *Queue Spillovers*: Traffic spilling back from a congested off-ramp onto an auxiliary lane would reduce bus speeds. However, as the buses will be in the auxiliary lane already, or in the next lane to the left, if the auxiliary lane is congested with queued vehicles, the buses can avoid the problem by bypassing it in the mixed-flow traffic lanes.
- Two-Lane Off-Ramps: At locations with two-lane off-ramps, a transit-only shoulder lane can be provided on the far side of the off-ramp immediately after the auxiliary lane terminates. At such locations, buses would have to shift over from the auxiliary lane to the outermost non-exit-only lane to travel across the off-ramp junction. It is expected that with the construction of all of the planned auxiliary lanes in Tier II, there will be five two-lane off-ramps in the study corridor. It is not practical to consider reducing these ramps to a single lane, as forecast traffic volumes dictate the lane requirement and removing one lane would likely cause queuing onto the freeway, which is also detrimental for BOS operations.



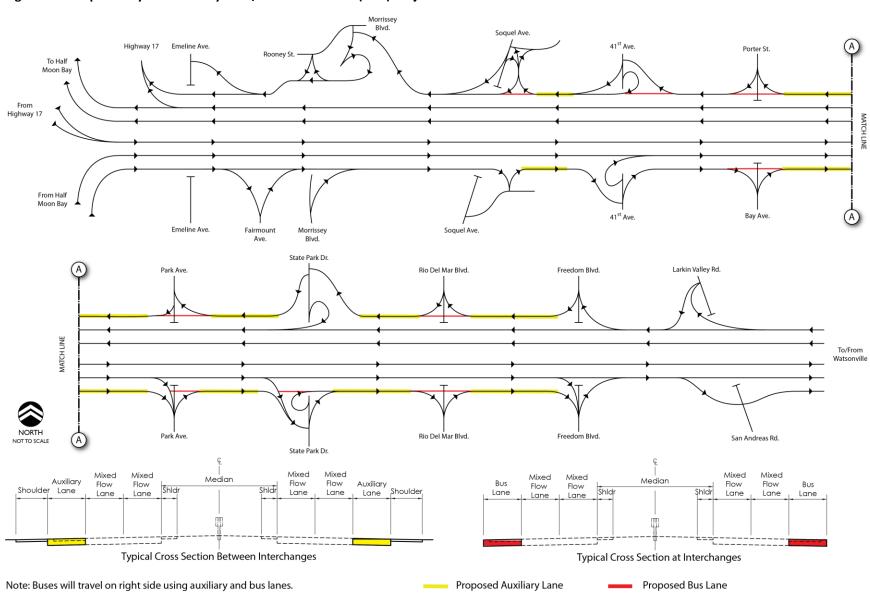
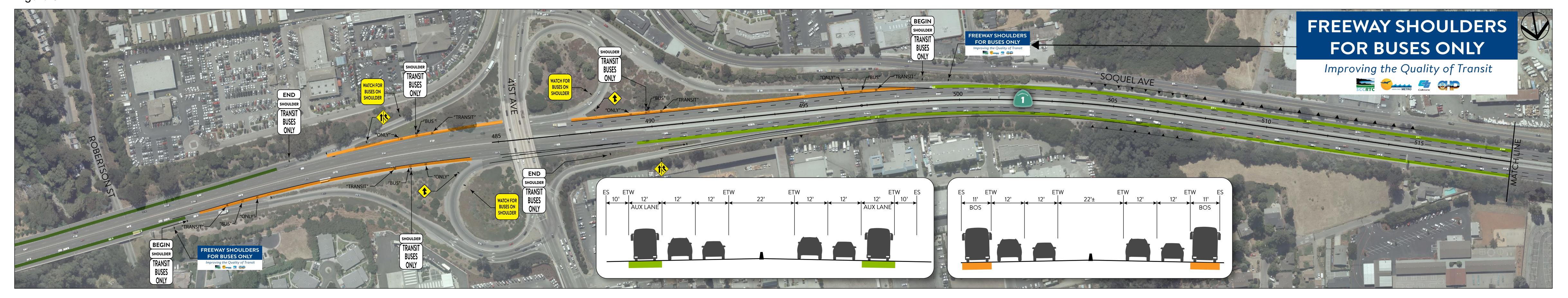


Figure 3-1: Proposed Hybrid Auxiliary Lane/Bus-on-Shoulder (BOS) Project



Figure 3-2



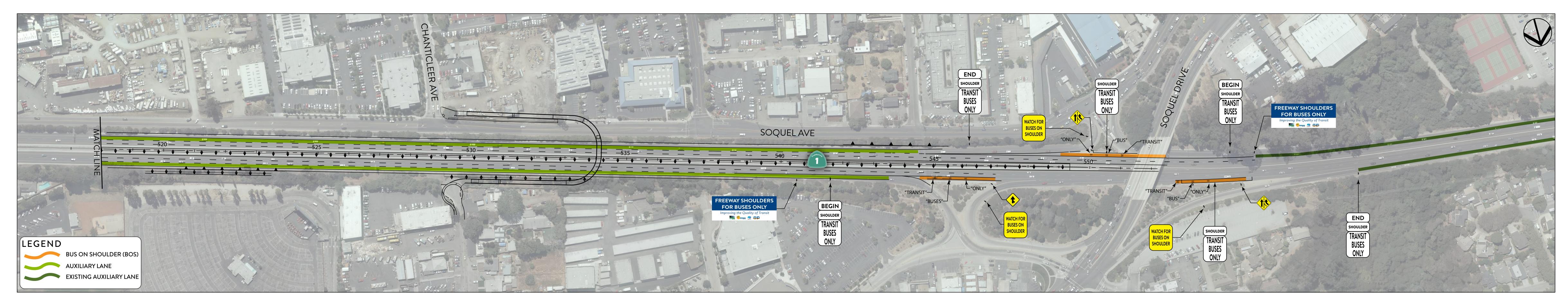




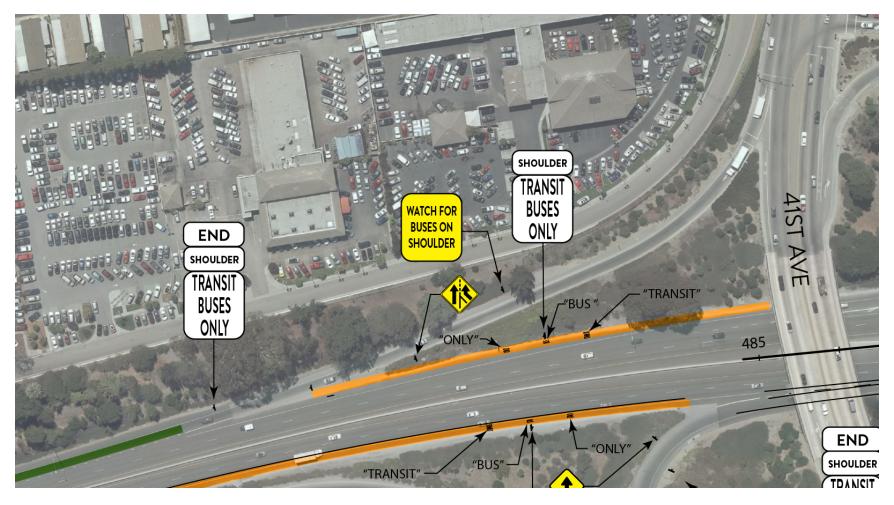








Figure 3-3: Signage Detail





The following sections provide more detail on the definition of the proposed BOS system concept on SR 1 in Santa Cruz County.

3.1.1 Hours of Operation

SR 1 is very congested on weekdays in both the AM peak period northbound and the PM peak period southbound. Congestion also occurs on the weekend days but is much more variable in terms of when and where it occurs and the duration of the congestion. The duration of the of the weekday congestion is typically 3-4 hours in the morning and 4-5 hours in the afternoon. Because of the long duration of the congestion and the variability of congested conditions from one day to the next, it is proposed to operate the BOS project from 5:00 AM to 8:00 PM, seven days a week. Actual BOS operations would only occur during periods when freeway travel speeds in the mixed-flow or general purpose lanes are 35 mph or less, and other operational rules as described in the flowing sections are satisfied. Buses shall not use the shoulder during periods of rain and when the potential for flooding is evident.

3.1.2 Transit Services

Santa Cruz Metro Line 91X would be the primary transit service using the proposed BOS facilities. Currently Santa Cruz Metro Line 91X: Commuter Express Santa Cruz/Watsonville operates in the Cabrillo/South Santa Cruz region providing express commuter service between the Watsonville Transit Center and the Santa Cruz METRO Center. South of Aptos, it operates primarily along SR 1, while north of Aptos, it operates along SR 1 and arterials. Along northbound SR 1, METRO Line 91X operates from Main Street to State Park Drive interchanges, from Park Avenue to 41st Avenue interchanges, and from Soquel Drive to Morrissey Boulevard interchanges for a total distance of 9.5 miles. Along southbound SR 1, it operates from Morrissey Boulevard to Park Avenue interchanges and from State Park Drive to Main Street interchanges for a total distance of 11.1 miles. In addition, Santa Cruz Metro identified the services listed in **Table 3-1**, that they would plan to implement with as part of the BOS project.

Table 3-1: Existing and Planned Santa Cruz Metro Services - SR 1

Route	Span (in hours per day)	Frequency	Trips per Day	Frequency w/ Existing and Proposed Service
91x (existing service)	11.5	30 min	42	30 min
91x Santa Cruz- Watsonville	6	30 min	24	15 min
91x Santa Cruz- Watsonville	15	30 min	60	30 min
Hwy 17 Mid County	6	30 min	12	30 min

Currently there are two Line 91X buses per hour using SR 1. If the hybrid auxiliary lanes/BOS project were implemented, Santa Cruz Metro would increase the number of buses, which would result in as many as ten buses per hour using the BOS facilities during a weekday peak period. Santa Cruz Metro plans to operate these new routes as freeway express services, using the entire proposed BOS facility between Morrissey and Freedom Boulevards.



3.1.3 Eligibility Requirements

Initially, it is planned that only Santa Cruz Metro buses will use the BOS facilities. In addition, only authorized, specially trained operators of Santa Cruz Metro buses will be allowed to use the shoulder segments. During the final design phase of the project the types and dimensions of buses that will be allowed will be determined. Vehicle width including mirrors, and vehicle height are key factors to be considered. Qualifying Santa Cruz Metro buses with authorized operators, would be allowed to use the transit-only shoulder lanes within interchanges when all the following conditions are met:

- Shoulder is signed for "Transit-Only" Bus Lane
- Operating only during hours of 5:00 AM to 8:00 PM
- Freeway mixed flow lane speeds are below 35 mph
- When operating in the transit-only shoulder lane, buses are restricted to 15 mph faster than the adjacent general-purpose lane and in no case shall buses operate in the lane at over 40 mph

Buses would not be allowed to use the transit-only shoulder lanes when one or more of the following conditions exist:

- At times which are outside of the approved operating hours
- When one or more of the operating partners, Caltrans, the CHP or the Santa Cruz Metro advises that conditions require that BOS operation be suspended

Santa Cruz Metro buses using the BOS facilities including the auxiliary lanes shall adhere to all traffic law and regulations, and shall yield, by moving back into the general purpose lanes, to:

- Emergency response vehicles
- Freeway Service Patrol (FSP) vehicles
- Enforcement and maintenance vehicles
- Disabled vehicles
- Large debris or other physical obstacles in the shoulder area

For the auxiliary lane segments buses would follow normal traffic rules. Operating procedures for crossing the on-ramp and off-ramps shall be jointly developed by the operating partners and will be part of the operator training program. The enabling legislation specifies that the program is solely for the use of Santa Cruz Metro and Monterey-Salinas Transit. However, the California Motor Vehicle Code states that any bus may use the transit-only shoulder lane. The operating partners should develop protocols for communicating with owners of other buses observed using the lane to inform them of the desirability of training their drivers.



3.1.4 Owner, Operator, Maintenance Relationships

The institutional relationships between Caltrans, the CHP, the RTC and Santa Cruz Metro that would be put in place to implement and manage the BOS project would be defined in the form of a Project Charter document, similar to that developed for the BOS project on SR-94/I-805 in San Diego. The purpose of this project charter is to establish a mutual understanding among the project agency stakeholder partners regarding the BOS project on SR 1. The BOS Project is led by the RTC in partnership with Santa Cruz Metro, Caltrans and the CHP. The charter document will describe the BOS Project, the scope of work, and the roles and responsibilities of stakeholder partners in the project. Responsibilities would include project funding, transit operations, facility maintenance, enforcement, incident management, and marketing/public information. The partners in the charter will agree to the project scope, the roles of each party, the schedule, and commit to work together for a successful project.

3.1.5 Enforcement

The CHP would be responsible for enforcement. The primary enforcement issue would be the prevention of use of the transit-only shoulder lanes within interchanges by vehicles other than buses, emergency response vehicles and FSP vehicles. Section 21655.1 of the California Motor Vehicle Code addresses transit only lanes:

- (a) A person shall not operate a motor vehicle on a portion of a highway that has been designated for the exclusive use of public transit buses, except in compliance with the directions of a peace officer or official traffic control device.
- (b) This section does not apply to a driver who is required to enter a lane designated for the exclusive use of public transit buses in order to make a right turn or a left turn in a location where there is no left-turn lane for motorists, or who is entering into or exiting from a highway, unless there are signs prohibiting turns across the lane or the lane is delineated by a physical separation, including, but not limited to, a curb, fence, landscaping, or other barrier.
- (c) A public transit agency, with the agreement of the agency with jurisdiction over the highway, shall place and maintain, or cause to be placed and maintained, signs and other official traffic control devices, as necessary, indicating that a portion of a highway is designated for the exclusive use of public transit buses and to advise motorists of the hours of operation of the lane as an exclusive public transit bus lane.

It does not have provisions for regulating which specific buses can use the shoulder, so in practice the CHP could not prohibit non-Santa Cruz Metro buses from using the lanes unless the vehicle code was amended which would require an action of the State Legislature.

The charter agreement created between the stakeholders will define the level of enforcement from local CHP area offices. It will also define funding responsibilities.

The design of the transit-only shoulder lanes should consider opportunities to provide refuge areas to the right of the shoulder for use by CHP officers to conduct enforcement. The RTC should work with the local CHP area offices to determine the best locations, taking into account



anticipated traffic patterns, crash history, calls for service, locations for the potential for violations specific to this program, and safety for everyone involved.

3.1.6 Operational Procedures

The ConOps defines standard operation procedures for the common scenarios that would occur when the BOS project is in place:

Normal Operations

In the normal operations scenario, responsibility for operations falls mainly on Santa Cruz Metro to assure the only the proper bus equipment and authorized bus operators use the BOS facilities. Caltrans would be responsible for facility maintenance, the CHP for enforcement and the FSP for emergency vehicle assistance and clearance of debris as appropriate.

Incidents

The operational procedures will include a definition of incidents, which will include crashes, near misses, damage from debris, damage from mirror strikes, etc. It will also include the specific methods and procedures for reporting and retaining information on all types of incidents. It will define how an incident is documented, which agency will be responsible for that documentation, how these incidents will be tracked and analyzed, and how the public will be able to report these incidents.

Bus operators will be trained to recognize that obstacles in the transit-only shoulder lane pose a challenge to the effectiveness BOS operations. The operator is trained to safely leave the transit-only shoulder lane in the event of an obstacle; the decision to re-enter the transit-only shoulder lane is left to the judgment of the operator. Santa Cruz Metro dispatchers will monitor freeway conditions and incident reports from the CHP and communicate information to the bus operator. The CHP and the FSP will be trained on the requirements for the transit-only shoulder lane, so that they can better assess the safety of their own operations as well as the safety of all freeway users. In the event of an incident or enforcement action, the CHP will perform their duties in accordance with CHP policies, procedures, and safe practices. The CHP will try to expedite the clearance of the transit-only shoulder lane whenever possible. The FSP will notify Santa Cruz Metro dispatch when they will be operating in the transit-only shoulder lane and potentially in conflict with the shoulder operations. Caltrans maintenance personnel will, as available, respond to reports of debris on the transit-only shoulder lane and clear the transit-only shoulder lane as soon as possible.

Santa Cruz Metro shall develop communication protocols for sending messages between emergency services to transit dispatch to bus drivers in the event of the need to temporarily suspend bus on shoulder operations (e.g., emergency closures or response). A determination should be made if existing communications equipment is adequate for this purpose, and if not, a new equipment should be specified.

Bus Breakdowns

In the event of a bus breakdown or stoppage of service, operators are responsible for identifying any potential anomalies or bus malfunctions to the operations supervisor and any mechanical or operational issues to the Santa Cruz Metro dispatcher. The Santa Cruz Metro dispatcher will



record any maintenance issues identified and dispatch maintenance to repair the bus, as well as provide an additional bus to take the passengers from the failed bus to their destination if necessary.

Planned Construction

Caltrans will provide Santa Cruz Metro with planned construction notices; Santa Cruz Metro operations staff will provide a Route Bulletin to the bus operators informing them of the planned construction project and the associated impacts to route operations. The drivers will have advanced notice and will operate the route according to the bulletin provided. Santa Cruz Metro dispatch staff will also be briefed on the construction and route modifications to be able to answer any questions from operators in the field. The CHP, the FSP, and Caltrans maintenance will know, from the BOS training, that BOS operations will not occur within the construction zone, but will remain aware of the potential for buses operating on the transit-only shoulder lane on the remaining stretch of the freeway.

Training

Bus operators will be trained in both the classroom and in driving the route to ensure a full understanding of shoulder operating procedures. Operators will be trained on how to react to obstacles on the shoulder, particularly disabled vehicles and law enforcement activities. Santa Cruz Metro dispatchers will attend a classroom training session on operational policies and safety practices and procedures. Dispatchers will observe the training and driving operations to better understand the challenges that operators will face while operating in the shoulder. Santa Cruz Metro operations supervisors will attend both operator and dispatcher trainings, as well as behind the wheel training, to experience the operations first hand. The CHP, the FSP, and Caltrans maintenance staff will attend classroom training sessions informing them of standard operations policies and practices. The CHP will provide an officer to assist development of the operator training program.

Santa Cruz Metro will be responsible for developing the curriculum for the training program. The program will include training for transit operators, dispatchers, the CHP, the FSP, and Caltrans maintenance staff. It may be desirable to design training programs that are consistent with those being developed by SANDAG for I-805/SR 94 TOL project. Santa Cruz Metro should coordinate the curriculum development with each of the stakeholders to confirm their level of participation.

Maintenance

Caltrans will be responsible for the maintenance of the BOS physical facilities not related to the buses. RTC and Caltrans will enter into a maintenance agreement for the implementation of the BOS project.

Program Monitoring

Santa Cruz Metro will be responsible for BOS program performance monitoring. Prior to the implementation of the BOS project, Santa Cruz Metro in association with RTC, the CHP and Caltrans will collect baseline data related to traffic volumes and speeds, transit service levels, transit speeds, ridership, transit volumes and speeds, and incidents. The project partners will develop performance metrics to be used to monitor the project. Potential metrics include:



- Transit Operations
 - o Transit Service Levels
 - Transit travel times and speeds
 - Transit service reliability
 - Transit ridership
- Traffic Operations
 - Traffic Volumes
 - o Traffic Speeds (by lane if possible)
- Safety and Efficiency
 - Number of Traffic Incidents by Type
 - Number of Incidents in the Transit-Only Shoulder Lanes by Type
 - o Number of Times Transit-Only Shoulder Lanes Closures Requested
- User Feedback Comments, Suggestions and Complaints by All Users:
 - Dispatchers
 - CHP Officers
 - Transit Operators
 - Maintenance Personnel
 - FPS Drivers
 - Transit Riders
 - Motorists

Monitoring reports should be prepared every six months for the first two years of operation and every year there-after.

Marketing and Public Information

RTC and Santa Cruz Metro, in coordination with the CHP, will lead an outreach effort to inform the public of the proposed BOS project. This would involve development of a marketing plan to provide pre-project information as well as providing ongoing information and outreach as the project proceeds. BOS is new to Northern California and both the driving and non-driving public needs to be informed as to how it will operate, and the benefits that it will generate to transit riders, motorists and the general public.

3.1.7 Technology Applications

There are a number of technology applications that could be employed to improve the efficiency and safety of bus operations.

Ramp-Metering with Connected Vehicle Interface

The two main areas of conflict for buses using the transit-only shoulder lanes within interchanges are the points where buses cross either the off-ramps or the on-ramps. The research on BOS operations, Transit Cooperative Research Program (TCRP) Report 151, notes that ramp metering can be employed to create gaps to allow the transit vehicles to cross the on-ramp entrance to the freeway with less potential vehicular conflict. This has been tested and has shown to be effective.



A further enhancement is for the bus to have onboard technology which communicates with the ramp metering equipment and actuates a longer gap between vehicles using the on-ramp to allow the bus to pass without interference.

It is important to note that while these enhancements could improve BOS operational safety as a longer term improvement, the conventional practice of warning drivers on the on-ramp that buses are using the shoulder and then advised them to yield to buses has proven to be very effective and safe. TCRP Report 151 concludes: "Ramp metering of on-ramp traffic has proven helpful in breaking up platoons from upstream traffic signals on the on-ramp and helps buses navigate the weave. BOS operations, however, generally work without ramp metering."

Of the 20 BOS projects reviewed in TCRP 151 only two involved ramp metering, and no project had a connected vehicle interface to ramp metering.

The RTC Highway 1 Corridor Investment Program envisions ramp metering in the corridor as a longer term improvement, but at present there is not funding for this project and it has not been environmentally cleared or designed. There would likely need to be interchange ramp modifications to accommodate ramp metering and the local jurisdictions will need to be given the opportunity to participate in any decision to deploy ramp metering, creating a lengthy but essential process. There is no need to delay the BOS project until ramp metering occurs, as conventional BOS operational techniques are proven to be safe and highly effective.

In-Vehicle Safety Enhancements

There are several relatively new technologies that provide features to assist the transit operator as discussed below. At the present time Santa Cruz Metro buses do not currently have these features nor are they part of any upcoming purchase specifications.

Lane Departure Warning (LDW): This system alerts the operator when the bus is departing from the travel lane and the turn/lane change indicator is not on. In order to be functional these systems require good lane markings on both the right and left of the vehicle. One issue with the using this technology for the SR 1 BOS project is that the transit-only shoulder lanes are relatively short and the LDW system will sound and alert as the buses cross the off-ramp and on-ramp lane markings, so that operators may become insensitive to the alerts generated by the system.

Blind Spot Warning (BSW): This system alerts the operator when a vehicle enters the blind-spot along-side either the left or right of the vehicle. This assists operators when making lane changes which is common in BOS operations.

Forward Collision Warning (FCW): This system alerts to operator if the bus is approaching an object in the lane ahead at too high a speed to stop safely. It will also force an emergency stop if the operator fails to act on the alert.

Research conducted as part of the preparation of this document indicates that the transit vehicle manufacturers had been slow to add these safety enhancements to their new vehicles. More research is required to be certain that this technology is tested and available for transit vehicle use. It is recommended that the status of these technology features be monitored by Santa Cruz



Metro and the feasibility of equipping the buses with this technology be determined prior to the launch of the BOS project.

3.2 Operational Summary

The matrix on the following page summarizes the operational responsibilities of the each of the BOS project partners.

3.2.1 Next Steps

The proposed hybrid auxiliary lane/BOS project would be a cost-effective means of providing transit vehicles with preferential treatment over general traffic, providing improved transit speeds and reliability. This should result in increased transit ridership and related reductions in vehicle miles of travel and greenhouse gas emissions, as well as reduced transit operating costs.

Once this ConOps document is complete, the partner agencies: the RTC, Caltrans, the CHP and Santa Cruz Metro, would prepare and approve a Decision Document. The Decision Document is a summary of the project description and the ConOps and its approval signifies that all parties plan to proceed. It will identify the next steps to be taken. As the environmental clearance for the auxiliary lane project is nearly complete, any clearance required for the hybrid auxiliary lane/BOS project would be separate. As this project would not involve any construction outside of the current right-of-way and has largely beneficial impacts, the environmental documentation required should be very limited. It is important to develop a schedule which will allow the hybrid auxiliary lane/BOS project to be implemented when the first Tier II project, which includes constructing auxiliary lanes on SR 1 in both directions between the Soquel Avenue/Drive interchange and the 41st Avenue interchange, begins construction. That project is in the final design phase and is expected to begin construction in 2020.



Table 3-2: Responsibility Matrix

Agency	Responsibilities
RTC	 Lead agency responsible for programming, planning, awarding contracts for professional services and managing the delivery of the capital project
	 Preparing and recommending approval of Decision Document CA Traffic Control Devices Committee requestor
	 Stakeholder and PDT Owner – coordinate and attend meetings and actively participate
	in the project work efforts
	 Review and provide comments to the project deliverables in a timely manner
	 Oversee consultant effort
	Oversee engineering procurement
	 Coordinate with partner agencies
	 Marketing and outreach
	 Invoices and tracking
	 Participate in project conflict resolution
	 Lead agency for environmental clearance
	Participate in development of communication protocols
Santa Cruz Metro	 Develop and implement the transit-operating plan, bus operator training modules including the CHP participation
	 Provide performance measure reports to the Stakeholder group
	Stakeholder and PDT Member
	 Attend meetings and actively participate in the project work efforts
	 Review and provide comments to the project deliverables in a timely manner
	 Ongoing monitoring and reporting of driver performance while utilizing BOS facilities
	 Participate in public outreach/marketing
	Participate in project conflict resolution
	 Develop communication protocols
Caltrans	Approving Decision Document
	 Work with RTC/Metro on development and maintenance of the roadside infrastructure
	to operate the transit priority service
	 Work with RTC/Metro on the integration of Intelligent Transportation Systems (ITS) measures for integration on the project
	 Provide readily available collision and traffic information for performance measure reports
	Issue encroachment permit
	Stakeholder and PDT Member
	Attend meetings and actively participate in the project work efforts
	Provide IQA for project deliverables in a timely manner
	Participate in public outreach
	Participate in project conflict resolution
	Participate in development of communication protocols
CHP	Review the decision document and project concepts; provide input relating to
	enforcement and incident clearance activities
	Stakeholder and PDT member
	 Provide officer input during driver training classes with Santa Cruz Metro drivers
	 Provide enforcement
	 Provide monthly data on all enforcement events and incidents
	Participate in public outreach
	Participate in project conflict resolution
	 Participate in development of communication protocols
Note: This was adap	ted from the proposed project charter for the SANDAG BOS project on SR-94/I-805



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