SR-12 Comprehensive Corridor Evaluation and Corridor Management Plan

Alternatives Analysis

Final Technical Memorandum

March 2012

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SR-12 Comprehensive Corridor Evaluation and Corridor Management Plan

Alternatives Analysis

Final Technical Memorandum[1]

The purpose of this memorandum is to provide a comparative analysis of three conceptual improvement strategies for the SR-12 Corridor. These strategies are compared to a baseline set of improvements for the Corridor consisting of projects already planned or underway. The baseline set of improvements includes projects implemented along SR-12 to improve safety such as the Bouldin Island project in San Joaquin County, projects underway such as the Jameson Canyon widening project in Solano and Napa Counties and planned improvements such as the first phase of the I-80/I-680/SR-12 Interchange project. All of these projects are built, underway or expected to be completed in the 2012 – 2035 timeframe covered by this analysis.

Additional explanation on the baseline improvements may be found beginning on page 11 of this document and depicted graphically in Exhibit 4. The most thorough treatment of the baseline projects may be found in the SR 12 Future Conditions Technical Report (July 2011). Documents that preceded this technical memorandum and are incorporated here by reference include:

- SR-12 Environmental Scan (April 2011),
- SR-12 Existing Conditions Technical Report (April 2011),
- SR-12 Future Conditions Technical Report (July 2011), and
- SR-12 Corridor Improvement Strategies Technical Memorandum in (October 2011).

The technical evaluation of conceptual alternatives for SR-12 is intended to inform the development of an overall improvement strategy consisting of both short- and long-range plans for SR-12. The overall improvement strategy is anticipated to combine elements of all three of the concepts evaluated and presented in this technical memorandum. It will then be presented to stakeholders and the public in early 2012 before being finalized.

Summary

Three conceptual improvement strategies were developed by the Project Development Team (PDT). These included a 1) Gap-fill Strategy, 2) Barrier Separated Two-Lane Strategy and 3) Four-Lane Strategy. These concepts were presented to stakeholders and to the public in July of 2011. Additional detail on the specifics of each of these strategies in presented in the body of this technical memorandum.

[1] Final Technical Memorandum, March 2012. This memorandum is subject to change with respect to findings and/or conclusions. It should also be noted that these findings and/or conclusions may not ever be programmed due to various reasons, including but not limited to, engineering judgment and/or budget constraints.

In the alternatives analysis, each of the conceptual improvement strategies was refined and detailed. This process included the preparation of conceptual improvement drawings, engineering evaluations, cost estimates and a traffic analysis. From these evaluations, a series of quantitative and qualitative measures were developed to allow the comparative analysis of the baseline and each conceptual alternative. The metrics used for this comparison included measures that address mobility, safety, impacts to the environment and consistency with regional planning objectives.

Later sections of this technical memorandum describe the metrics in more detail and how they were applied to this comparative evaluation. Conceptual improvement drawings and cost estimates may be found in the supplemental report to this technical memorandum entitled Alternatives Analysis for SR-12 – Conceptual Drawings and Cost Estimates. A summary of the results of this analysis is presented in Exhibit 1.

Key Findings

The three strategy options were first evaluated using measures that are grouped in terms of 1) Transportation System Efficiency, 2) Safety, 3) Economic Vitality, 4) Environment and 5) Healthy Communities. These evaluations were conducted without consideration for cost which was considered later in the evaluation of cost effectiveness.

In terms of the measures described, the four-lane strategy performed best in terms of system efficiency, safety and healthy communities. This was due to the relatively large expansion of capacity in the corridor that effectively mitigated all of the projected bottlenecks and the delays at the moveable Rio Vista and Mokelumne bridges.

The four-lane strategy did have the most impact on the environment due to the amount of construction required in existing rights-of-way and new right-of-way required. The gap-fill strategy, because of the relatively small scope of construction that is included in this strategy, results in the smallest environmental impact.

These conclusions are indicated in Exhibit 1 which includes both quantitative measures and a qualitative ranking that is expressed using dots with different levels of shading. These dots are qualitative rankings for each area of system performance – transportation effectiveness, safety, etc. That is to say the solid dots denote the best performance relative to the baseline case and the dots with progressively less shading indicate relatively lower performance for the areas evaluated.

This simple ranking provides a high level overview of each scenario over the 42-mile length of the corridor. In some cases, the actual differences between certain metrics are rather subtle when the best and next best ranked alternatives are compared. However, in every case, there is at least one metric in each of the evaluation areas that shows a difference compelling enough to warrant an overall, qualitative ranking relative to the other scenarios. For instance, under the environmental evaluation criteria, the differences in CO2 emissions are not particularly significant, but the number of new acres of right-of-way with the potential for environmental impact is significant.

Cost effectiveness was considered next and is expressed as project cost per hour of vehicle delay reduction. The life cycle cost of the three strategies (which includes additional maintenance costs over time), ranges from $102 million for the gap-fill strategy to $2.9 billion for the four-lane strategy. The more modest barrier separated two-lane strategy has a life cycle cost of $397 million.

The four-lane strategy with a life cycle cost of $2.9 billion is over seven times the cost of the barrier separated two-lane strategy. This is due to the extensive realignments required to four-lane the three movable bridges, the cost of the bridges and the amount of new right-of-way required, including environmental mitigation.

The finding that the four-lane strategy performs the best but costs substantially more than the other two alternatives is hardly surprising. To assess benefits based on expenditures, a cost effectiveness calculation was performed that produces a cost for each hour of vehicle delay that is reduced over the life cycle. In the case of this metric, a lower cost for each hour of vehicle delay reduction is the best outcome.

The gap-fill strategy has a cost effectiveness estimate of $4.2 per hour of delay reduction, the barrier separated two-lane strategy $14.5 per hour saved and the four-lane strategy $38.1 per hour saved. To put these in perspective, an hour of delay as perceived cost to the user ranges from $5 per hour for a casual trip for a personal reason to $50 per hour for large truck stuck in traffic due to an accident, or incident. In the Bay Area, the average value of time is about $14 per hour. Using this figure, it can be generally concluded that a strategy which has a cost per hour of delay saved of $14 or less will repay itself overtime.

Obviously, the lower the cost the better and both the gap-fill and barrier separated two-lane strategies exhibit costs that are much lower than the average perceived value of time.

This does not mean that the gap-fill strategy should be chosen over the two or four-lane strategy options. While the gap-fill is effective at what it does, it does not address areas of the corridor that are capacity constrained. In other words, the project areas of heavy congestion in the corridor are not addressed in this option. The gap-fill projects are best thought of as efficient short-term strategies. The most effective plan for the SR-12 corridor will need to combine elements of all three strategy options and this is the next activity that will be conducted for this study.

Exhibit 1 summarizes both the evaluation measures and the cost effectiveness for the baseline and each strategy option, taking into consideration the entire 42-mile corridor for each strategy option. However, impacts on different segments of the corridor located in Solano, Sacramento and San Joaquin counties can be quite different depending on the specific characteristics of each conceptual alternative.

The body of this technical memorandum presents evaluations in much more detail. Information can be found that compares segments, or subsets of the overall 42-mile corridor, and the cost effectiveness of the individual projects that make up each of the alternatives. The reviewer is encouraged to consider the more detailed information in the body of this document before drawing conclusions.

Exhibit 1: Conceptual Improvement Strategies – Summary of Comparative Analysis

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness			○		◉		●	
Average Peak Hour Travel Time (mins)	78	87	75	83	73	78	53	56
Daily VMT	485,000	831,200	485,500	831,200	485,800	848,600	495,000	882,000
Daily VHT	17,300	28,000	15,950	24,650	15,240	24,600	14,240	20,220
Improved pavement (Centerline miles)	N/A		2.5		13.4		25.3	
Number of Bridges with Sufficiency Rating < 80%	2		2		1		0	
Safety			○		◉		●	
Safety enhanced roadway (Centerline miles)	N/A		2.6		31.1		39.0	
Daily non-recurrent delay (vehicle hrs)	584	6,300	470	5,200	460	5,210	50	1,350
Economic Vitality			○		◉		●	
Daily non-recurrent delay (vehicle hrs)	584	6,300	470	4,800	460	5,210	50	1,350
Daily recurrent delay (vehicle hrs)	6,770	10,510	6,360	9,910	6,290	9,660	3,410	6,390
Total daily delay (vehicle hrs)	7,354	16,810	6,830	14,710	6,760	14,460	3,460	7,755
Environment			●		◉		○	
Construction within existing ROW (acres)	N/A		20.0		197.7		214.1	
Construction outside existing ROW (acres)	N/A		5.9		44.2		399.2	
CO2 Emissions (tonnes/year)	51.4		49.2		48.9		46.8	
Healthy Communities			○		○		●	
Fine Particulate Emissions (tonnes/year)	6.7		6.2		6.2		5.6	
Coarse Particulate Emissions (tonnes/year)	10.9		10.3		10.3		9.5	
Bike friendly Roadways (miles)	33.6		35.3		35.6		39.7	
Dedicated Bikeways (miles)	2.9		3.3		3.3		23.1	
Dedicated pedestrian pathways (miles)	2.7		3.3		3.3		3.3	
Cost Effectiveness			●		○		○	
Capital Cost (millions)	N/A		$84		$354		$2,828	
O&M Life Cycle Cost (millions)	N/A		$18		$43		$90	
Life Cycle Cost (millions)	N/A		$102		$397		$2,918	
Cost Effectiveness Index (dollars per person hour of delay saved)	N/A		$4.2		$14.5		$38.1	

Source: Atkins, 2011.

Note: Refer to Exhibits 27, 28 and 29 for more detailed information on cost effectiveness.

○ Good ◉ Better ● Best

Conceptual Strategies Considered

The conceptual alternatives under consideration are not specific recommendations for improvements in the corridor, but have been defined to explore three possible outcomes for improvements to the SR-12 corridor.

Using the results of this evaluation, an overall plan for short- and long-term improvements for the Corridor will be developed for presentation to stakeholders and the public in outreach activities that will take place in early 2012.

A final report presenting the recommended Corridor Management Plan will then be prepared. The intent of the Corridor Management Plan is to provide a roadmap for near term and ultimate improvements for SR-12. Implementation of the strategies embodied in the Corridor Management Plan is subject to the results of more detailed engineering, environmental studies and the availability of funding over time. The conceptual strategies are described as follows:

- Gap-fill Strategy: Today Caltrans and local jurisdictions are planning and implementing improvements throughout the SR-12 Corridor. The gap-fill strategy builds upon the work that is presently underway by indentifying segments of SR-12 that are not addressed by the current work programs.

  Essentially the gap-fill strategy is the next step towards incrementally improving the SR-12 corridor and will likely be the basis for short-term improvement recommendations. The key components of the gap-fill strategy include corridor wide Intelligent Transportation Systems (ITS) deployments to improve safety, reliability and capacity, alignment and shoulder improvements west of Rio Vista and improvements to SR-12 in downtown Rio Vista that enhance vehicular circulation, pedestrian circulation, landscaping and the streetscape in general.

- Barrier Separated Two-Lane Strategy: This strategy examines improvements to all two-lane sections of SR-12 to incorporate a consistent cross-section of a concrete median barrier and standard shoulders (both on the inside, adjacent to the median barrier and on the outside edges of the roadway). This strategy also includes acceleration lanes that allow for passing of slower moving vehicles at key intersections along the corridor.

  This concept involves improvement of, or re-construction of, much of the corridor to incorporate these improvements to the cross-section and in doing so, considers the geotechnical requirements imposed by peat soils in the Delta areas located in Sacramento and San Joaquin counties.

  The intent of this strategy is to explore the benefits and costs of implementing a consistent two-lane cross-section that can improve safety on SR-12. However, this concept does not provide significant increases in capacity along SR-12.

- Four-Lane Strategy: As its name implies, this concept looks at upgrading all of the existing, two-lane segments of SR-12 to a four-lane divided highway. It can be considered the ultimate improvement for the corridor.

  This strategy incorporates six-lane improvements in the Fairfield / Suisun City areas that include interchange and intersection improvements consistent with the long-range plans for the I-80/I-680/SR-12 Interchange improvements under development by Solano County. Additionally, this concept examines realignments associated with replacing bridges at Rio Vista, Mokelumne, and Potato Slough so that these crossings can accommodate two lanes of traffic in each direction.

  As part of the evaluation of the four-lane concept, consideration will also be given to the implementation of a four-lane expressway option that allows for higher speeds and restricts access.

  To explore these conceptual strategies, this document includes maps, tables and text that present the analytical results. A supplemental report provides graphical presentations of the strategies. These conceptual drawings have been prepared to support cost estimation and to evaluate impacts to the natural and built environment. These are not designs, or specific improvement proposals. Any recommendations that come out of this study will require a significant amount of additional detail in terms of design and environmental impacts before all, or part of any one of these concepts, can be advanced towards implementation.

Evaluation Methodology

The evaluation methodology consists of two basic activities that provide input into the comparative analysis framework and are used to estimate cost effectiveness of the proposed improvements. The first is the development of evaluation measures based on the metrics that were first presented in the Corridor Improvement Strategies Technical Memorandum referenced previously. These metrics include both quantitative and qualitative measures of performance that are used to assess benefits for each conceptual strategy for both the short-term (2015) and the long-term (2035).

The second activity is the development of capital cost estimates for implementation of the conceptual strategies and estimates of maintenance costs over a uniform life cycle. This information is then used to estimate a cost effectiveness rating for each of the proposed improvements that make up a conceptual strategy. The development and application of the measures of effectiveness, cost estimates and the cost effectiveness rating are discussed in sections that follow.

A. Evaluation Measures

In general, the evaluation measures build upon those under development by regional agencies to address the requirements of Sustainable Communities Strategies (SCS). These measures are now being refined and applied to the Regional Transportation Planning Process. Because of differences in the timeline for this SR-12 project and the development of regional plans that comply with the SCS, the specific computational methodology used here is generally consistent with, but not identical to, the evolving methodologies that will be used in regional plans. The metrics used are based on the information specifically developed at the corridor level for SR-12. Each is described as follows:

- Transportation System Effectiveness (TSE): The TSE measure focuses both on mobility in the corridor and the state of the transportation asset. The primary metric of mobility for the TSE measure is average per-trip travel time for motorized auto and transit modes that use the SR-12 corridor. A second set of metrics – daily and peak hour Vehicle Mile of Travel (VMT) – is also used to compare transportation efficiency of the alternatives. In this case, a lower peak hour VMT indicates congestion and unmet peak hour demand in the SR-12 Corridor.

  The assessment of the physical state of the transportation assets is addressed by identifying lane miles of pavement areas with poor ride-quality or which need rehabilitation. Bridges, which are particularly relevant on the SR-12 corridor, are assessed based on the data in the Federal Highway Administration 2010 National Bridge Inventory. The criterion used is a bridge sufficiency rating of less than 80%.

- Safety: Safety, including reductions in accident frequency and severity, is very important along the SR-12 corridor. With its designation as a Safety Corridor, double fines are assessed on SR-12 and law enforcement has been increased. Roadway improvements that are presented in conceptual alternatives have been developed to enhance safety by including cross-sections that include full-width shoulders, median barriers, enhanced alignments and ITS features. The criteria used to assess the safety features that are proposed in the roadway cross-sections and alignment improvements is centerline miles of safety enhanced roadway.

  Accidents and incidents along SR-12 result in unpredictable and sometimes very long delays which occur when recovering from these incidents and returning the roadway to a safe travel condition. This is referred to as non-recurrent delay which differs from normal recurrent delay due to predictable patterns of traffic congestion. ITS is proposed for all of the conceptual alternatives. ITS can reduce non-recurrent delays and notify motorists of such delays in advance such that, if possible, alternative routes can be taken. Changes in non-recurrent vehicle hours of delay are also used as a measure of safety enhancement in this evaluation.

- Economic Vitality: Highways such as SR-12 contribute to economic vitality by providing reliable travel times to businesses, commuters and recreational travelers. Freight and goods movement, whether by road, rail or water, relies upon efficient, reliable travel times on transportation facilities. SR-12 is a route with a relatively high percentage of truck traffic that serves industry and agriculture.

Three moveable bridges are located along the SR-12 study area. These are 1) Rio Vista Bridge over the Sacramento River, 2) the Mokelumne Bridge over the Mokelumne River in San Joaquin County and 3) the Potato Slough Bridge over Potato Slough, also in San Joaquin County. Whereas the Potato Slough Bridge is seldom operated, the Rio Vista and Mokelumne bridges are operated frequently. These bridge operations are well documented in the previous Existing Conditions and Future Conditions Technical Memoranda where it can be seen that substantial delays to roadway traffic occur at these locations.

The metric used to evaluate economic vitality in this analysis is daily Vehicle Hours of Delay (VHD). This measure includes recurrent delays due to congestion, delays due to bridge operations and non-recurrent delays due to accidents and incidents on the SR-12 corridor.

- Environment: In the SR-12 Environmental Scan, completed in April of 2011, this corridor is identified as being located in a sensitive environmental area that extends through Solano County and the Delta areas of Sacramento and San Joaquin counties. Additionally, the corridor passes through the built up areas of Fairfield, Suisun City and Rio Vista.

  Recent construction projects (such as the recently completed Solano County SR-12 SHOPP project) have shown that environmental impacts are a serious concern even when the project is built within existing right-of-way. Conceptual improvements that require new right-of-way to be acquired for widening or new alignments can be expected to have even greater impacts on the built and natural environments.

  The environmental impacts in this analysis are assessed based on two criteria. The first criterion is areas where proposed construction activity is within existing right-of-way and the second criterion is where new right-of-way is required. Both criteria are measured in terms of acres. In addition, as part of the environmental comparison of alternatives, reductions in greenhouse gases are evaluated in terms of CO_2 emissions.

- Healthy Communities: Transportation improvements can promote a better quality of life by improving air quality and through health benefits gained from increased bicycling and walking. Health can also be improved by reductions in particulate emissions. Estimates of fine and coarse particulate emissions are provided for each of the conceptual alternatives.

  Health benefits associated with walking and bicycling can be encouraged by the provision of adequate facilities that promote these modes. To compare these facilities, three criteria are used. The first is miles of bike friendly roadways which are defined is this analysis as roadway miles that do not have dedicated bicycle facilities, but do have full 12-foot travel lanes and an outside shoulder width of at least 5-feet. The second criterion is miles of dedicated bicycle lanes and the third is miles of dedicated pedestrian pathways, or sidewalks.

Analysis Tools

A variety of analysis tools were used to evaluate the benefits of the proposed mitigation improvements. The selection of the tools was performed to help analyze the urban segments in addition to the segments of the corridor that experience uninterrupted flow. Micro simulation and macro analysis tools were used to conduct capacity evaluation of the various alternatives. For estimation of ITS benefits, the underlying methodologies of the ITS Deployment Analysis System (IDAS) model were used. A summary of the tools used is presented in Exhibit 2.

Exhibit 2: Analysis Tools Used for Developing Benefits

Element	Analysis Tool	MOE
Intersection Improvements	SYNCHRO	Intersection delay/LOS
Capacity Enhancements	CORSIM	Mobility MOEs
Air Quality	MFAC Analysis	Emissions
ITS Systems	IDAS	Non-recurrent Delay

Source: Atkins, 2011.

Evaluation Framework

The 42-mile SR-12 corridor serves a variety of different land uses and travel markets that range from rural, agricultural areas, major traffic generating areas such as the Travis Air Force Base, highly developed suburban communities in Fairfield and Suisun City, developed areas such as Rio Vista and recreational locations in the Delta areas of Sacramento and San Joaquin counties.

To address the needs of the diverse travel market served by SR-12, the evaluation framework divides the corridor into five analysis segments. Benefits are presented for each of these five segments separately. The five segments are presented graphically in Exhibit 3.

For the baseline case and each of the conceptual alternatives, the metrics previously described have been summarized for each of the five analysis segments and for the corridor as a whole. These summaries are presented in separate tables for the baseline and conceptual alternatives. In addition, a single table each for 2015 and 2035 is presented that compares the corridor wide measures of effectives for the baseline and alternatives in a single exhibit.

Cost effectiveness ratings are also prepared in a similar fashion; that is, for each option by analysis segment. These ratings are described in more detail in the next paragraphs. The cost effectiveness ratings are intended to be used to rank projects and guide the future development of a single recommended strategy for the SR-12 corridor.

A. Cost Effectiveness Rating

Cost estimates were prepared for both capital costs and operating costs for components of each of the conceptual improvement strategies. These costs were estimated using unit costs available from Caltrans and other sources and adjusted to 2011 dollars. Capital costs are a onetime estimate of cost to construct. Maintenance costs are the net present value of annual costs over the period from 2011 through 2035. Additional detail and back up on these cost estimates may be found in the Supplemental Report entitled Alternatives Analysis for SR-12 – Conceptual Drawings and Cost Estimates.

A cost effectiveness rating was developed for each of the projects contained within the conceptual improvement strategies. For example, the gap-fill strategy has four basic projects which are 1) corridor wide ITS, 2) bridge approach enhancements, 3) SR-12 shoulder and alignment enhancements from Liberty Island Road to Drouin Drive west of Rio Vista and 4) SR-12 street, pedestrian and landscape enhancements in downtown Rio Vista. Each of these projects was evaluated separately for cost effectiveness based on cost per hour of vehicle delay saved over a simplified and uniformly applied life cycle. The other conceptual strategies (i.e. Barrier Separated Two-Lane and Four-Lane) were similarly sub-divided into segments that are intended to represent potential projects that could be implemented in a phased plan.

The simplified life cycle concept used allows for the inclusion of annual maintenance costs and accounts for changes in vehicle-hours of delay for both the short-term (2015) and the long-term (2035). It also avoids the complication of determining phasing in advance and issues such as value of time and varying actual life cycles depending on the type of infrastructure.

The life cycle method was developed as part of the Freeway Performance Initiative (FPI) conducted by the Metropolitan Transportation Commission (MTC) and more detail on this method can be found in MTC's FPI framework documents. It is an effective and easy to apply planning framework that considers operational cost over a life cycle. Essentially, this method assumes all projects are in place on Year 1 (in this case 2015) and that the life cycle considered is the same as the planning horizon which, for this analysis, is 2035.

Exhibit 3: Analysis Segments for the SR-12 Corridor

Source: Atkins, 2011.

B. Baseline Scenario

The baseline scenario includes a range of projects across the 42-mile corridor. Some are recently completed, are underway, or are programmed by Caltrans or the Regional Transportation Plans. The baseline scenario is well documented in the Future Conditions Technical Memorandum.

In general, the baseline scenario describes a set of improvements that can be expected to be in place by 2015 or underway by that time. These projects will change the physical configuration of SR-12 as compared to conditions present today. For this reason, the baseline is the scenario against which the conceptual improvement strategies are compared.

SR-12 improvements that are included in the baseline scenario include the Jameson Canyon Road widening project, the first phase of I-80/I-680/SR-12 interchange project, and several Caltrans projects that are designed to improve safety and operations along SR-12. The projects included in the baseline scenario are presented graphically in Exhibit 4.

C. Bottlenecks and Queues for the Baseline Scenario

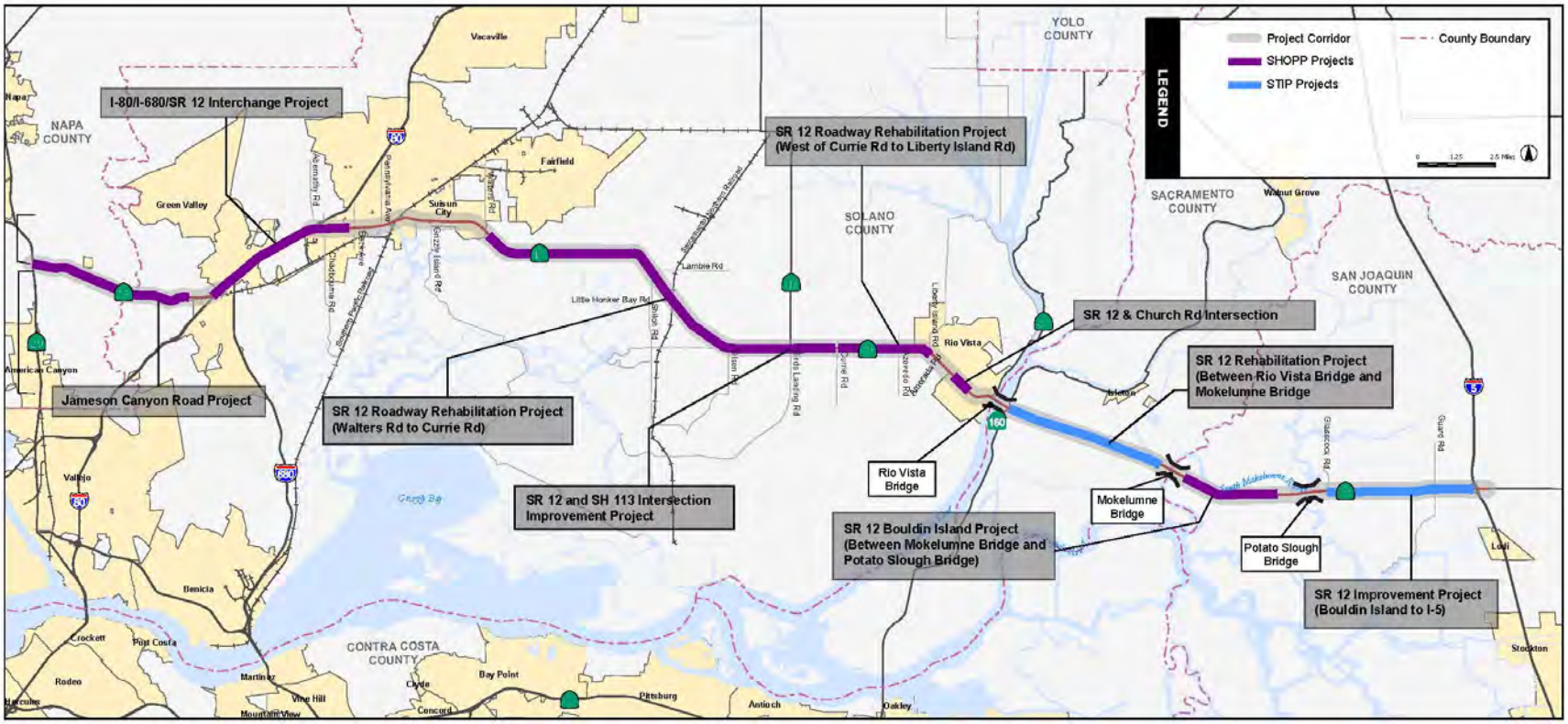
Exhibit 5 presents controlling bottlenecks and the resulting queues for the baseline scenario in 2015 and 2035. This information was originally developed and presented in the Future Conditions Technical Memorandum, but is shown again here so that it can be compared to the bottlenecks and queues that will be presented in this document for the three conceptual alternatives.

For the baseline, bottlenecks are concentrated in Solano County in the vicinity of Suisun City, Fairfield and Rio Vista. Bottlenecks are also present approaching the Rio Vista Bridge in Sacramento County and in San Joaquin County on both the east and west approaches to the Mokelumne Bridge.

D. Evaluation Measures for the Baseline Scenario

Exhibit 6 summarizes the evaluation measures for the baseline scenario. These measures are those outlined earlier to assess Transportation System Effectiveness, Safety, Economic Vitality, Environment and Healthy Communities. The baseline evaluation identifies that two bridges do not meet the sufficiency rating criteria of 80% or greater. These bridges are located at Well Creek, which passes under SR-12 west of Rio Vista in Solano County, and the Rio Vista crossing of the Sacramento River. Many of the other bridges on the SR-12 corridor have either structural deficiencies or have been designated as functionally obsolete, but still have a sufficiency rating greater than 80%.

Exhibit 4: SR-12 Improvements in the Baseline Scenario



Source: Atkins, 2011.

Exhibit 5: Baseline Scenario: Location of Bottlenecks and Queues for 2015 and 2035

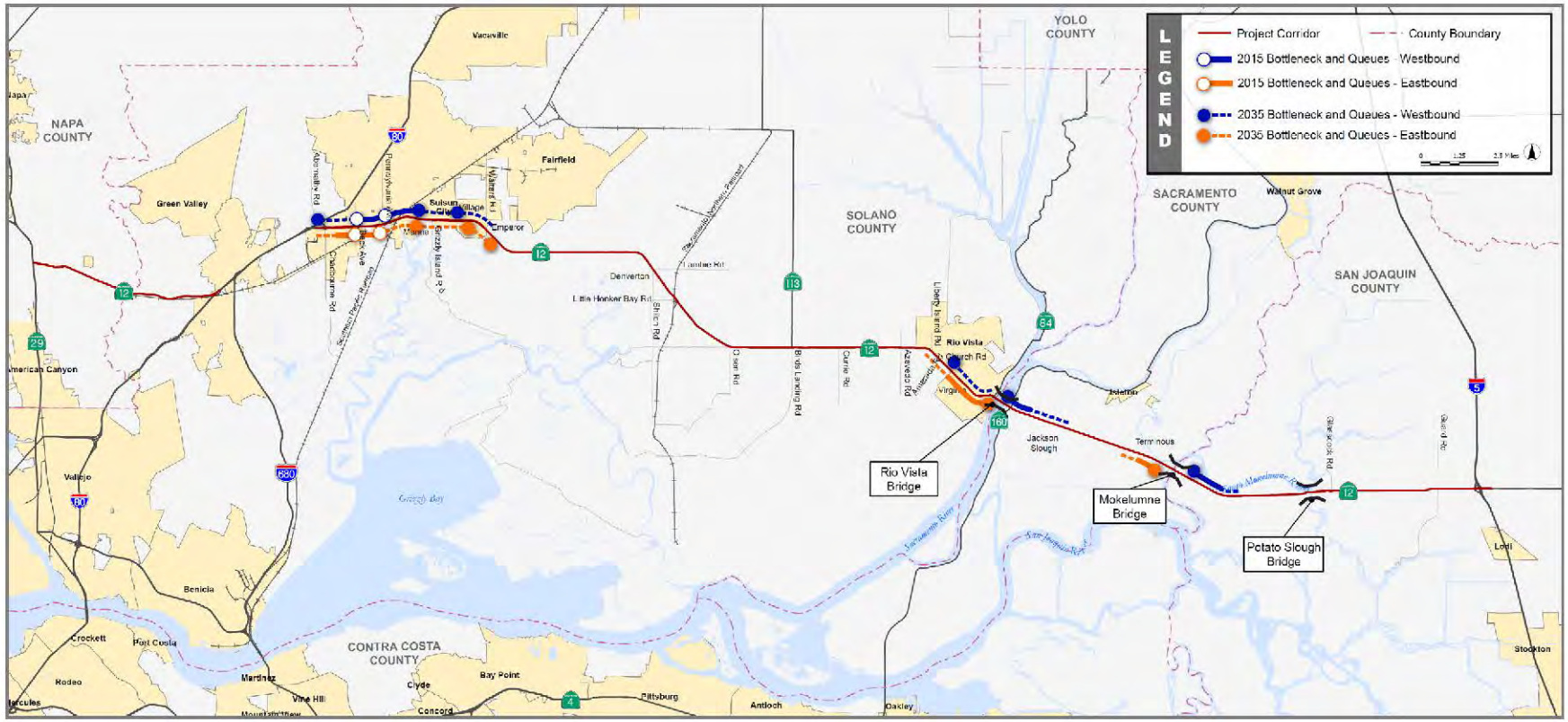


Exhibit 6: Baseline Evaluation Measures

Evaluation Categories	Abernathy to Walters Road		Walters Road to Church Road		Church Road to River Road		River Road to Mokelumne Bridge		Mokelumne Bridge to I-5		Overall Corridor	
	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness												
Average Peak Hour Travel Time (mins)	29	30	18	20	5	6	17	19	10	13	78	87
Daily VMT	147,900	269,100	152,200	254,100	21,600	30,700	55,900	100,500	107,400	176,900	485,000	831,200
Daily VHT	6,000	9,990	3,480	6,230	1,940	2,300	1,980	3,900	3,920	5,610	17,300	28,000
Improved pavement (Centerline miles)	N/A		N/A		N/A		N/A		N/A		N/A	
Number of bridges with Sufficiency Rating < 80%	0		1		1		0		0		2	
Safety												
Safety enhanced roadway (Centerline miles)	N/A		N/A		N/A		N/A		N/A		N/A	
Daily non-recurrent delay (vehicle hrs)	460	1,690	40	2,200	4	170	40	820	40	1,420	584	6,300
Economic Vitality												
Daily non-recurrent delay (vehicle hrs)	460	1,690	40	2,200	4	170	40	820	40	1,420	584	6,300
Daily recurrent delay (vehicle hrs)	3,560	5,390	630	1,050	750	1,160	620	1,150	1,210	1,760	6,770	10,510
Total daily delay (vehicle hrs)	4,020	7,080	670	3,250	754	1,330	660	1,970	1,250	3,180	7,354	16,810
Environment												
Construction within existing ROW (acres)	N/A		N/A		N/A		N/A		N/A		N/A	
Construction outside existing ROW (acres)	N/A		N/A		N/A		N/A		N/A		N/A	
CO2 Emissions (tonnes/year)	16.1		15.1		3.3		4.6		12.4		51.4	
Healthy Communities												
Fine Particulate Emissions (tonnes/year)	2.2		1.9		0.4		0.6		1.7		6.7	
Coarse Particulate Emissions (tonnes/year)	3.2		3.2		0.7		1.1		2.7		10.9	
Bike friendly Roadways (miles)	3.0		15.6		0.0		5.7		9.3		33.6	
Dedicated Bikeways (miles)	2.3		0.0		0.6		0.0		0.0		2.9	
Dedicated pedestrian pathways (miles)	2.3		0.0		0.4		0.0		0.0		2.7	

Source: Atkins, 2011.

Common Elements for All Strategies

Several strategies have been identified that will be included in all, or most of the conceptual alternatives. For instance, all strategies will include a common ITS architecture. Other common elements for the conceptual alternatives include proposed improvements to public transportation, bridge approach improvements, pedestrian and bicycle improvements and provisions for agricultural crossings. These elements are discussed in the sections that follow.

A. Pedestrian and Bicycle Facilities

Separate bicycle and pedestrian facilities are located today on SR-12 between Main Street (Suisun City) and Walters Road. There was no need identified during this study to propose additional dedicated pedestrian and bicycle facilities on SR-12 in the vicinity of Suisun City or Fairfield.

The need for additional pedestrian and bicycle facilities was identified in Rio Vista and these are included in the proposed cross-sections for the all of the conceptual alternatives. In the gap-fill and barrier separated two-lane strategies, the bicycle pedestrian facilities are located on the existing SR-12 corridor, extending from just west of Hillside Terrace to the Rio Vista Bridge – a distance of 0.6 miles.

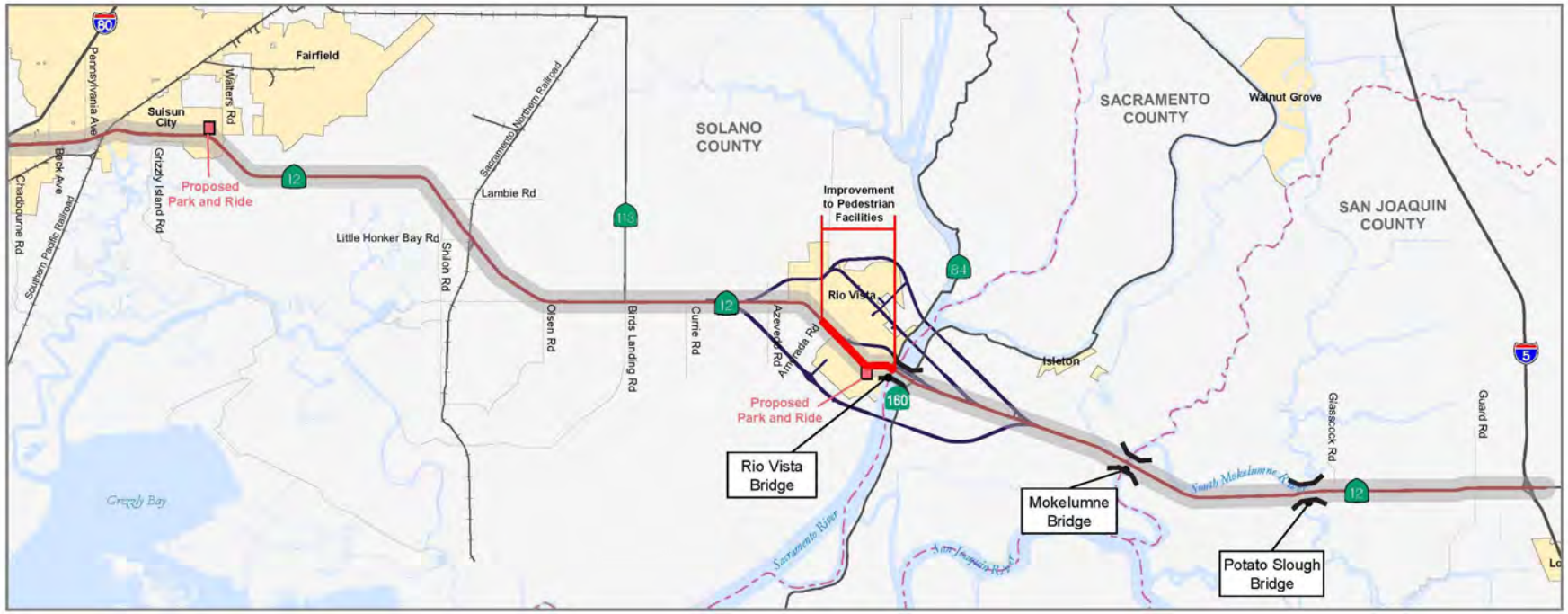
In the case of the four-lane strategy, multiple realignments of SR-12 in the Rio Vista area have been proposed as part of a separate Rio Vista Bridge replacement study. According to this study, these candidate realignments of SR-12 are necessary to accommodate the bridge replacement options which include pedestrian and bicycle facilities.

The four-lane strategy also includes bicycle facilities on new bridges that cross the Sacramento River at Rio Vista, the Mokelumne River and Potato Slough. Additionally, the four-lane option includes new bicycle facilities in the area of Travis Air Force Base.

In addition to the dedicated bicycle facilities identified in the preceding paragraphs, the addition of full width travel lanes and outside shoulders of at least a five-foot width do provide an environment that is more friendly to bicyclists who use SR-12. This is achieved for all proposed improvements in each of the three conceptual alternatives and as previously mentioned, miles of roadway that meet these criteria are identified in the tables that summarize the evaluation measures for each conceptual alternative.

Exhibit 7 presents new dedicated bicycle and pedestrian facilities in the SR-12 corridor along with the locations of potential transit park and ride facilities.

Exhibit 7: Proposed Bicycle, Pedestrian and Transit Facilities



Source: Atkins, 2011.

B. Transit

All three strategies include two new park and ride lots that will enhance transit access along the SR-12 corridor in Solano County. These facilities are indicated in Exhibit 7.

The westernmost park and ride facility is located at the intersection of SR-12 with Walters Road in Suisun City. To implement this facility, bus routes will need to be adjusted and FAST Route 6 will travel further east on SR-12 and connect with the proposed park and ride lot. The proposed park and ride lot accommodates approximately 40 vehicles and the cost to implement the proposed facility is $300,000.

A second park and ride facility is proposed near the intersection of SR-12 and Drouin Drive, west of Rio Vista. This facility will offer better connectivity to the regional transit routes that link Rio Vista with Isleton, Fairfield, Suisun City, the Pittsburg/Bay Point BART Station and Antioch. This proposed park and ride lot is located directly adjacent to transit lines 50 and 52 (operated by the City of Rio Vista transit services). The proposed lot would accommodate approximately 50 vehicles and is included in the cost estimate for all improvement strategies. Construction of this park and ride facility, along with other associated roadway improvements and right-of-way, is estimated at $300,000.

C. Intelligent Transportation Systems

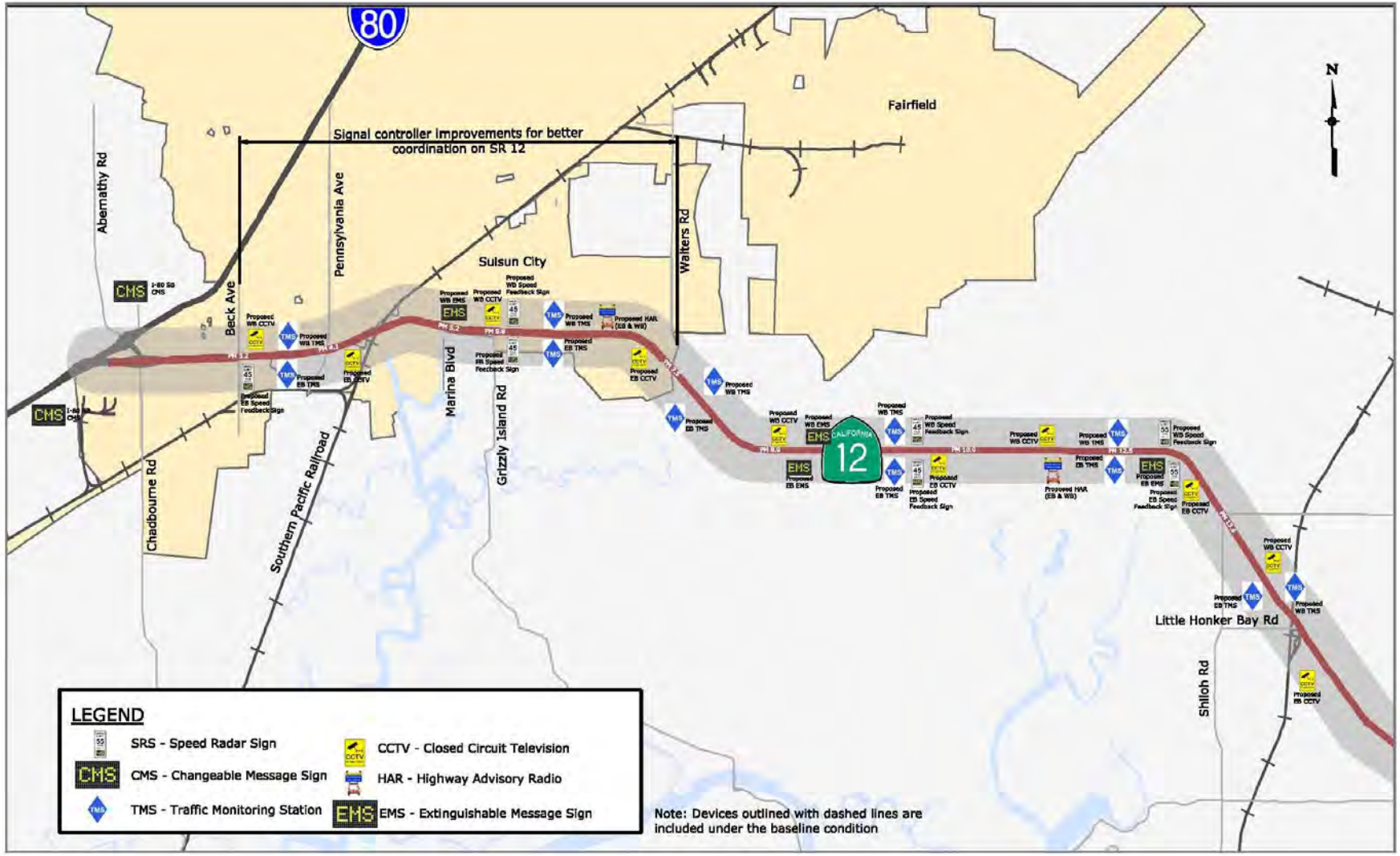
A conceptual ITS architecture was established for the entire SR-12 corridor. This builds upon existing ITS in the corridor and improvements to ITS that are part of the baseline projects previously identified. The benefits and costs of this conceptual ITS architecture are included in each of the three conceptual alternatives that are examined in the analysis.

The conceptual ITS architecture is illustrated in Exhibits 8, 9 and 10 that follow. The elements of this architecture include:

- Traffic Monitoring Stations (1 mile spacing)
- Changeable Message Signs (Approximately 2 miles upstream of major intersecting routes)
- Surveillance Cameras (1 mile spacing)
- Speed Feedback Radar Signs (3 mile spacing)
- Highway Advisory Radio Transmitters (5 mile spacing)
- Fiber Optics Communications Backbone (Corridor wide)
- Traffic Responsive, Coordinated Traffic Signals (I-80 to Walters Road)

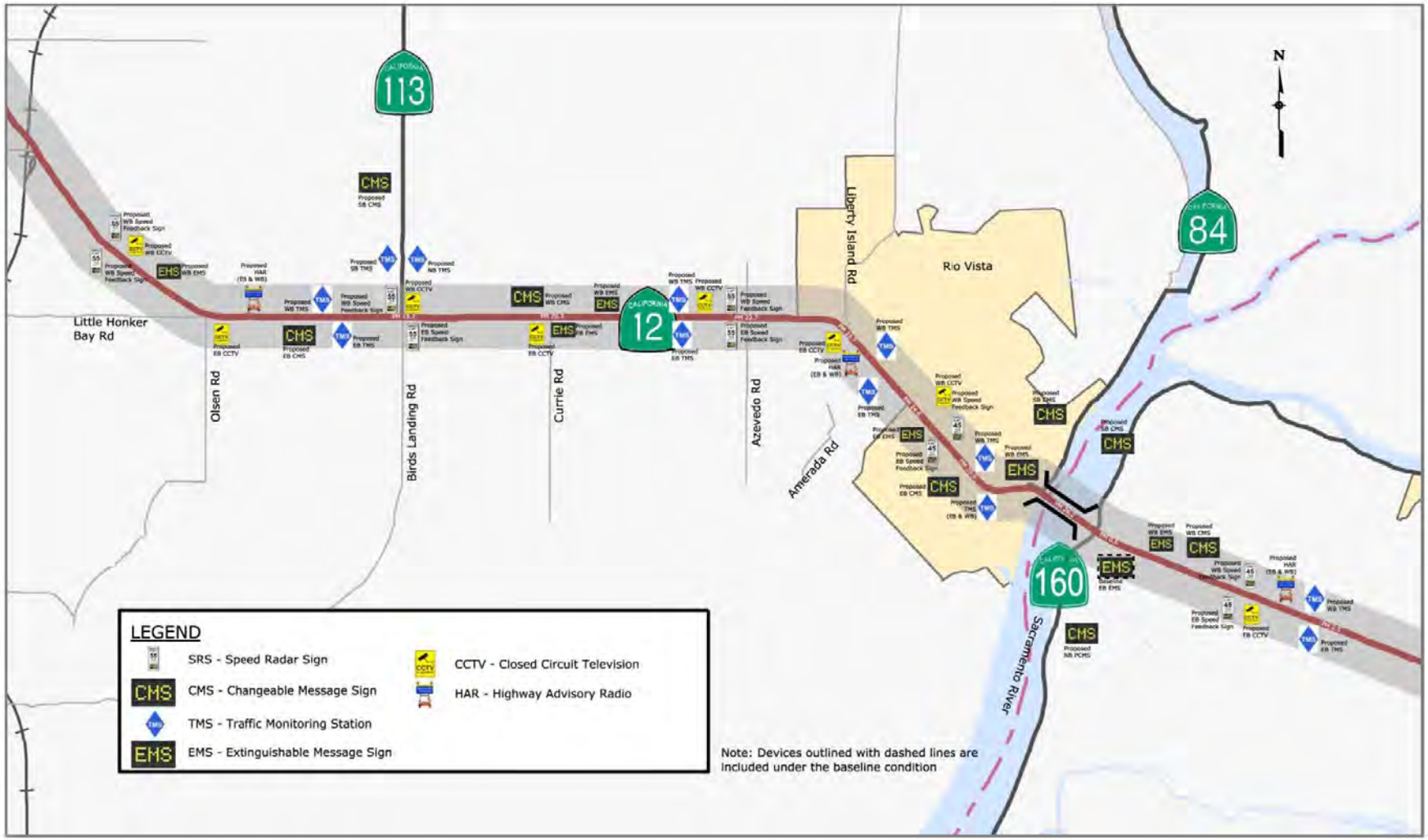
It should be noted that ITS systems use information and telecommunications systems that are rapidly evolving. For this reason, the architecture listed above may be different when these systems are actually installed. For instance, the fiber optic communication backbone assumed here may be replaced with a wireless technology using cellular networks.

Exhibit 8: Conceptual ITS Architecture



Source: Atkins, 2011.

Exhibit 9: Conceptual ITS Architecture



Source: Atkins, 2011.

Exhibit 10: Conceptual ITS Architecture

Source: Atkins, 2011.

The addition of these new ITS elements will enhance traffic enforcement (e.g.: radar controlled speed limit signs), help with incident detection and management, provide better driver information and promote safety. The primary quantifiable benefit of ITS systems such as those proposed here is a reduction of delay due to faster incident detection and recovery. The benefit of this conceptual ITS architecture is a $335,000 annual reduction in person hours of delay due to non-recurrent accidents and incidents on SR-12. The cost to implement is $4.1 million and the annual cost to maintain this infrastructure is $535,000.

D. Bridge Operations

The moveable bridges at Rio Vista and the Mokelumne rivers create significant delay due the long cycle times at Rio Vista and the very frequent openings at Mokelumne. In addition, the equipment used to operate these bridges is quite old and in need of updating. Additional detail on these bridges and the associated traffic impacts may be found in the Existing Conditions and Future Conditions Technical Reports.

Exhibit 11 depicts a concept for providing bridge specific ITS elements and safety warnings in advance of all three movable bridges on the SR-12 corridor at Rio Vista, Mokelumne and Potato Slough. These bridge-specific features are not included in the corridor wide ITS elements discussed in the previous section, but will be coordinated with these elements and share the communications backbone. The additional elements of the bridge specific features include:

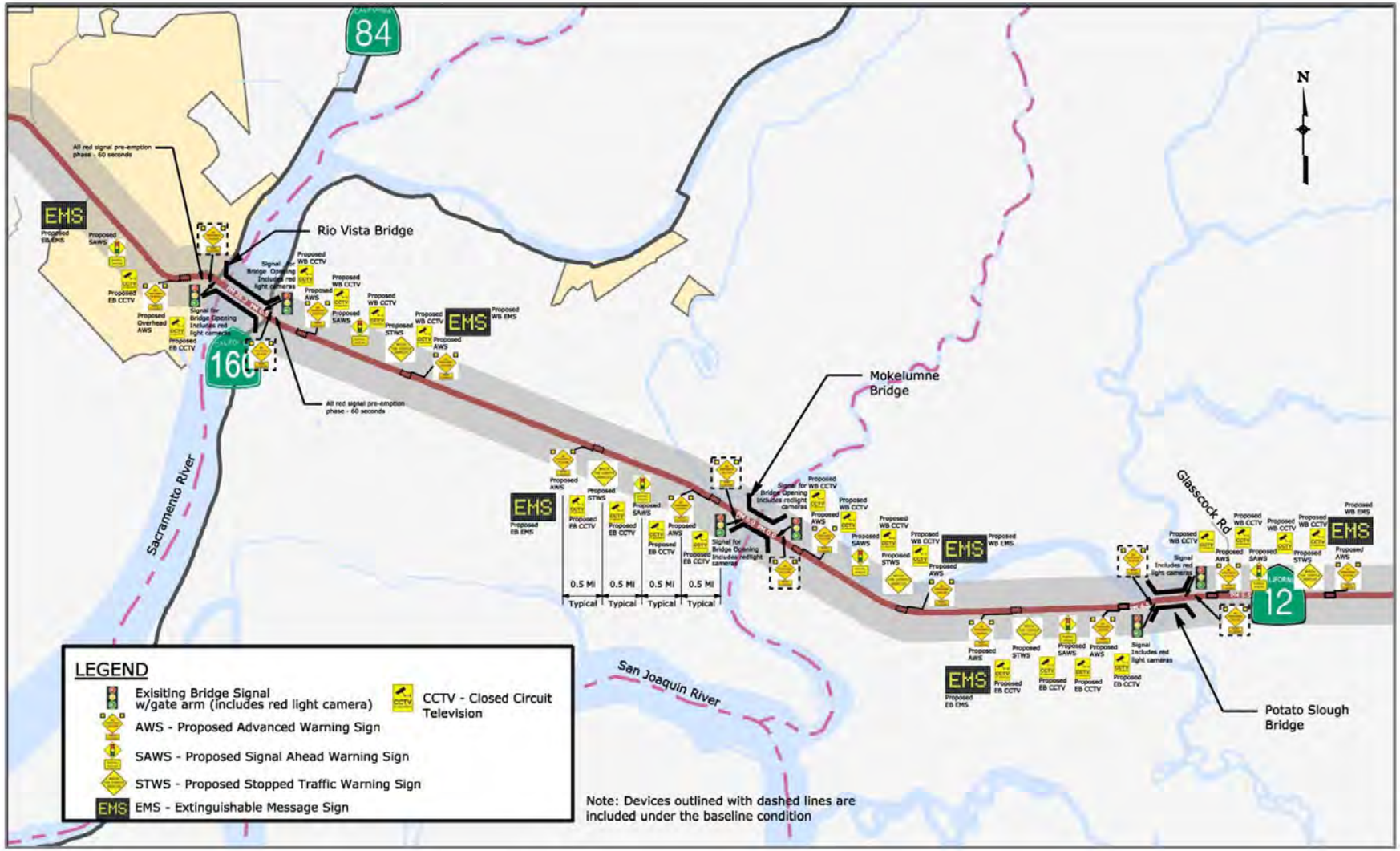
- Advance warning signs with flashing beacons
- Advance message signs that notify of a bridge opening
- Surveillance cameras on each approach
- Signal pre-emption at the Rio Vista Bridge to clear nearby intersections of traffic

The bridge-specific features shown in Exhibit 11 are included in both the gap-fill and barrier separated two-lane concepts. The four-lane strategy includes roadway realignments and new, high level bridges at each of the three crossings that will eliminate the need for these advance warning features.

The cost to implement the bridge specific advance warning features is estimated to be $11.7 million. Estimates for annual maintenance for the bridge specific warning devices are $99,000 for the gap-fill and two-lane strategies. The four-lane strategy proposes new high-level bridges eliminating the need for bridge specific advance warning devices. For the purposes of this analysis, these measures should result in a 20 percent reduction in total bridge cycle times which results in an annual reduction of vehicle delay of 919,000 hours at the moveable bridge approaches.

As previously mentioned, the bridges at Rio Vista and Mokelumne are both the oldest and most actively used bridges on the SR-12 Corridor. There are problems with the equipment and controls that are used to operate the moveable elements of these bridges. The scope of repairs necessary to update equipment and controls is not known at this time. For the purposes of this study, an allowance of $5 million is provided towards these repairs. This allowance is only applied to the gap-fill and barrier separated two-lane strategies.

Exhibit 11: Advance Warning Features at Moveable Bridges



Source: Atkins, 2011.

E. Agricultural Crossings

The agricultural characteristics along SR-12 are quite different when Solano County is compared to the Delta areas of Sacramento and San Joaquin counties. Rural areas of Solano County tend to consist of marshes and field areas that in some cases could support livestock. The Delta areas are rich farmland with crops that need to be planted and harvested with agricultural machinery. Inevitably, this machinery needs to travel either across or along SR-12 in these Delta areas.

The Bouldin Island project (presently in design) located in San Joaquin includes one crossing for agricultural traffic. It is reasonable to assume that as other projects are implemented in the Delta, additional agricultural crossings may be needed. It is also possible that crossings could be needed in Solano County. For the purposes of this study, two additional agricultural crossings are assumed although the exact locations cannot be determined at this time. A rough estimate of cost for these crossings is $1 million each, or $2 million total.

F. Other Corridor Wide Considerations

There are two other considerations that have an impact on the conceptual alternatives for the SR-12 corridor. These are 1) soil conditions and 2) sea level rise. Each of these is discussed separately in the sections that follow.

Soil Conditions

To understand the implications of soil conditions on pavement design, with regard to cost and construction staging, two resources were evaluated. The first was soil survey information from the United States Department of Agriculture and the second was pavement designs used by Caltrans for the existing and pending SHOPP projects in the SR-12 corridor. In addition, the basic findings of these reviews and the implications on this study were communicated to staff at Caltrans Districts 4 and 7 to determine if the conceptual conclusions were reasonable for a study of this type and level of detail. These communications confirmed the assumptions to be reasonable and affirmed that, at a conceptual level, the approach used to address the design and cost implications of soil conditions on pavement design and construction staging were reasonable.

The geographic and soils data from the United States Department of Agriculture (and other sources) was previously summarized in the SR-12 Environmental Resources Scan (April 2010) prepared as a source document for this study. The most relevant discussion of soils and the implication of soils on planning for improvements to SR-12 are quoted from the scan as follows:

> "From Fairfield to Rio Vista Junction, the corridor skirts soils (south of the corridor) with high organic content that may contain peat deposits. Between Rio Vista Junction and Rio Vista Bridge are three areas of clayey soils subject to ponding, but these areas do not contain peat. From Rio Vista Bridge to Mokelumne Bridge, the floodplain soils have high organic content in the form of peat and muck; they are subject to subsidence. East of Mokelumne Bridge to about midway between Potato Slough Bridge and I-5, the delta islands and tracts are mostly peaty muck. The valley plain soils to the east do not contain peat."

Soils with peat and muck (which are subject to subsidence) are addressed by either by removal of the soils if the pockets are small enough, or by preloading with extra soil over time (i.e. surcharge) or by other methods. On SR-12, Caltrans has addressed these areas that are substantially composed of peat and muck soils by using the surcharge method followed by specially engineered roadway bases that includes wick drains. This adds additional cost and complexities in terms of construction sequencing.

Simply put, in areas that require this treatment, the new roadway must be surcharged with an additional soil preload adjacent to the existing roadway. When this phase is completed (often 12 to 18 months), the new roadway is constructed with special base construction including wick drains before the existing roadway is removed from service. This approach adds both cost and phasing complexity to the work in areas with these soil characteristics. At the conceptual planning phase, a premium needs to be accounted for and additional right-of-way may be required to account for the offset of the new pavement.

From the soils survey cited above, special treatments for peat and muck are not needed in Solano County although there may be small pockets of this unstable soil type that can be addressed through removal, or localized surcharge. For the purposes of this study, no significant issues with peat/muck soils are assumed in Solano County.

Also identified in the soils survey, the soils in Sacramento County, from the Rio Vista Bridge to a point approximately midway between the Potato Slough Bridge and I-5, are peaty muck. Through these areas, surcharging, specially engineered pavement base courses and wick drains are assumed to be required and are considered in the conceptual designs for the two- and four-lane improvements considered in this analysis. These findings and assumptions are consistent with the Caltrans pavement designs for the Bouldin Island to I-5 SHOPP and STIP project which is 10.1 miles overall along SR-12. The westernmost 4.3 miles of these projects include the surcharge, special base and wick drain approach to dealing with these peaty muck soils, while the remaining 5.8 miles to the east do not utilize this strategy. The basic finding is that these techniques of soil surcharge and specially engineered pavements need to be incorporated in this analysis from the Rio Vista Bridge to the western terminus of the Bouldin Island project.

Sea Level Rise

Sea level rise is a well documented impact of climate changes and the California coastline will experience rising sea levels over the next century unless emissions of greenhouse gases are dramatically reduced from current levels. Exhibit 12 presents the estimated impacts of sea level rise along the SR-12 corridor. Additional discussion of sea level rise and the information contained in the Exhibit may be found in the previously issued Environmental Scan for the SR-12 corridor.

Exhibit 12 shows SR-12 inundated due to rising sea levels towards the western end of the corridor in the vicinity of Suisun City and Fairfield. Sea level rise, unless mitigated, is also expected to inundate the Delta areas of Sacramento County and San Joaquin County.

In the area of Suisun City itself, adjustments to the elevations of SR-12, to address rising sea levels, may be achieved, but much more detailed evaluations need to be undertaken. Raising the elevations of SR-12 in Suisun City may not be achievable while maintaining connections to intersections that serve the developed residential areas that border SR-12.

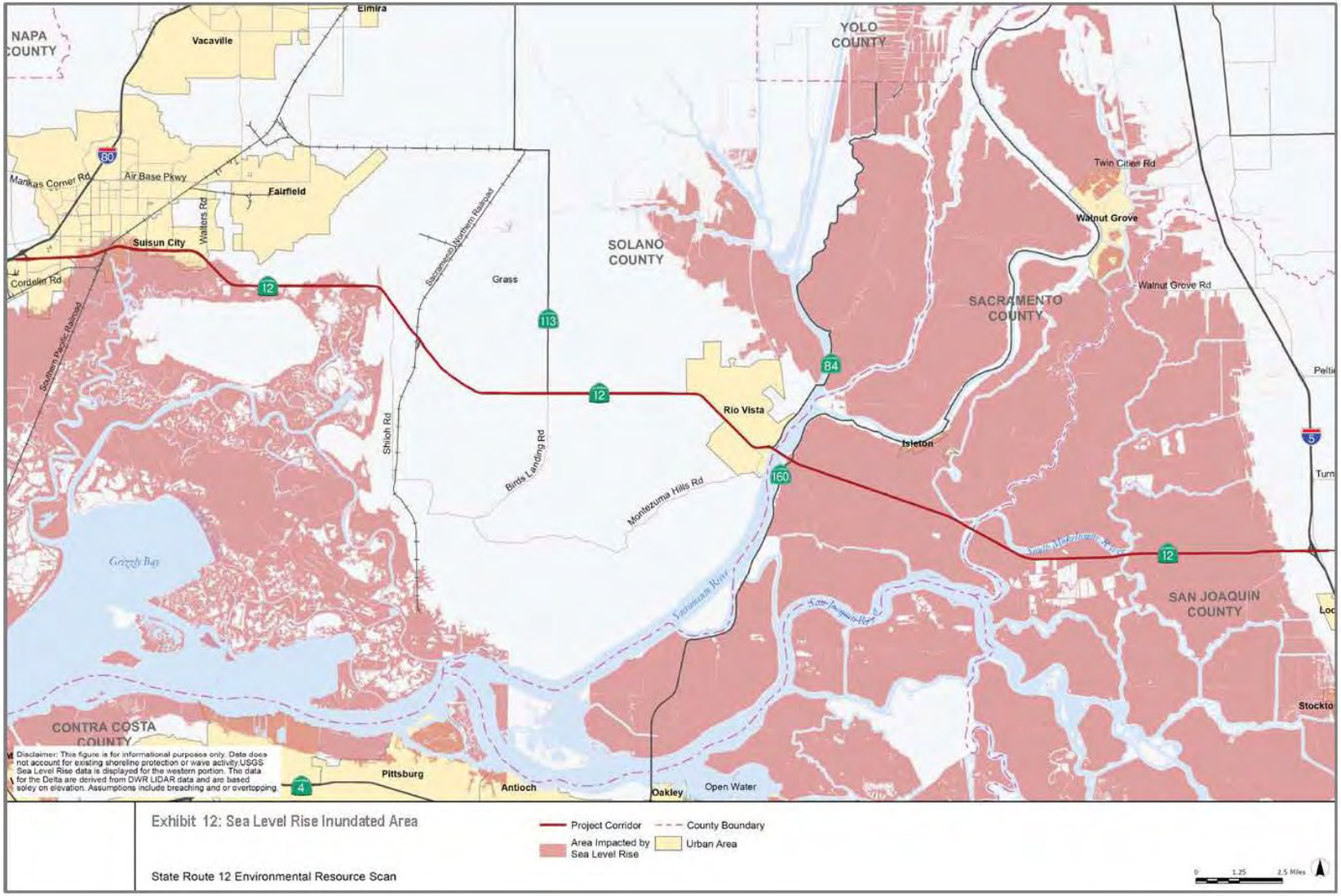
There are isolated areas of potential inundation that may impact SR-12 east of Suisun City and South of Fairfield. This could possibly be addressed by changes in roadway elevation or realignments to the north. But again, this needs more detailed evaluation that is beyond the scope of this effort.

The Delta areas of Sacramento and San Joaquin counties are an entirely different situation. These areas are below the existing sea level due to subsidence and they are protected by levees that protect this area as prime agricultural land, an environmental resource that is important to the California water supply, and a vibrant recreational area.

Managing the issue and consequences of sea level rise in the Delta is much bigger than addressing elevation of SR-12 and needs to be addressed comprehensively through plans for levee improvements that will address the long term viability of this area for both existing and projected sea levels.

Climate change science is evolving as are the methods, best practices and justifications for addressing sea level rise as it is related to transportation infrastructure. In May 2011, Caltrans issued Guidelines on Incorporating Sea Level Rise which provides a comprehensive method to address sea level rise in Project Initiation Documents (PID). Projects that result from this study of SR-12 will need to have PIDs prepared and at that time, the methodologies set forth in the Caltrans guidance on this subject will need to be followed to determine and justify whether and to what extent mitigation for sea level rise is applicable to specific projects.

Exhibit 12: Sea Level Rise



Source: Atkins, 2011.

Evaluation of Conceptual Improvement Strategies

The strategies identified in the Conceptual Strategies Considered section were evaluated against the baseline scenario for future 2015 and 2035 conditions. Evaluation measures developed by the PDT and documented in the Evaluation Methodology section of this document were used to perform the analysis. Detailed cost estimates and concept drawings for all strategies are included as supplemental reports to this document. A brief discussion of the performance of each conceptual strategy follows.

Gap-fill Strategy

The gap-fill strategy builds upon the currently planned SHOPP and STIP projects for SR-12. System-wide ITS improvements provide for better travel time reliability. Safety is enhanced by the implementation of standard 8-foot shoulders, channelizers, and 12-foot wide travel lanes in the vicinity of the Liberty Island Road and Drouin Drive intersections. Street improvements through downtown Rio Vista enhance the curb definition through this section as illustrated in Exhibit 13, provide an enhanced buffer between pedestrian facilities and travel lanes in the form of landscaping, and improve the roadway for all modes of travel in general. The capital cost for implementation of these improvements is projected to be $84 million.

Bottlenecks and Queues for the Conceptual Gap-fill Strategy

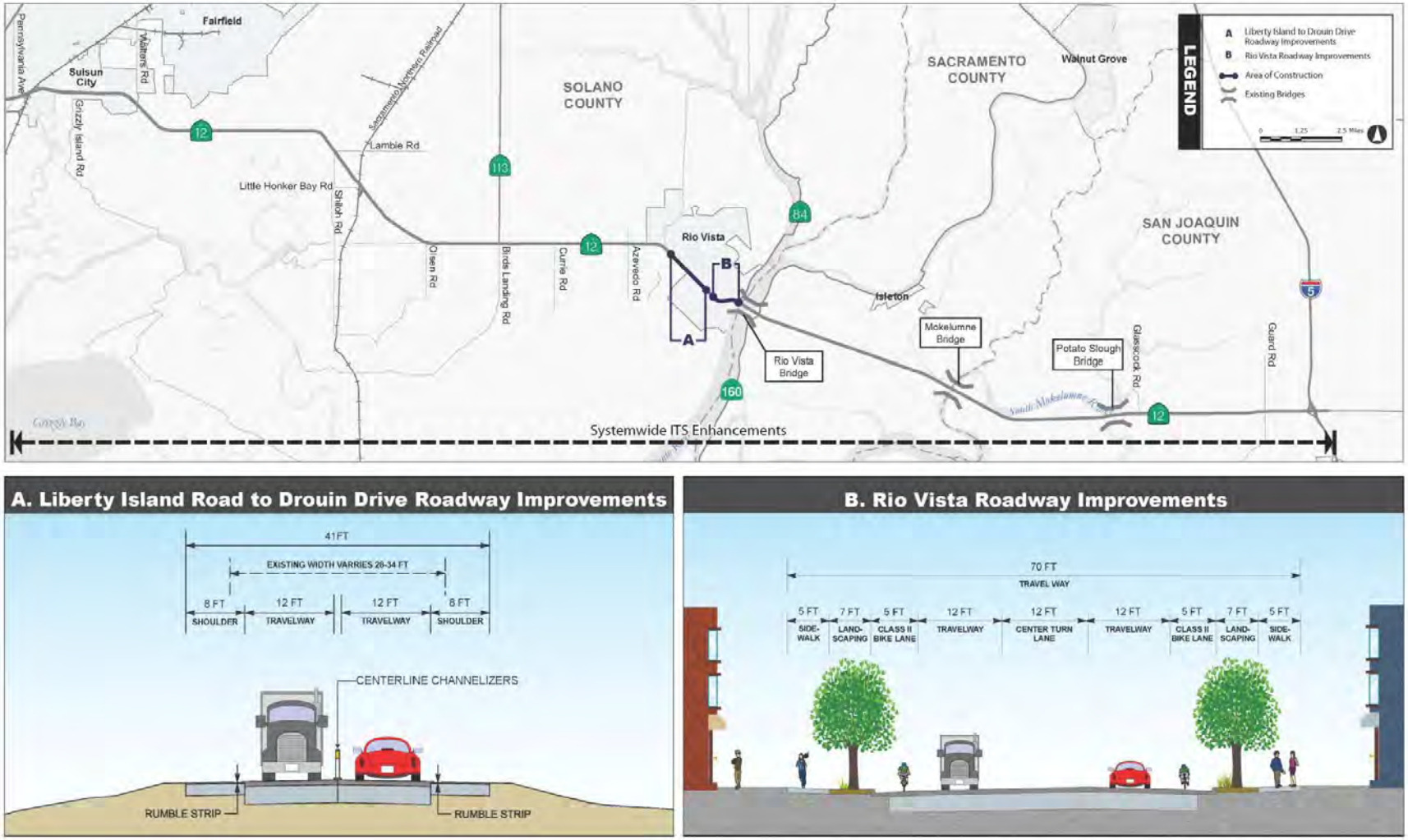
Bottlenecks and queues resulting from the gap-fill strategy are presented in Exhibit 14. Similar to the baseline scenario, bottlenecks are observed on the two urban segments of SR-12 in Solano County, in Suisun City and Rio Vista. Bottlenecks are also present in Sacramento County approaching the Rio Vista Bridge and in San Joaquin County on both the east and west approaches to the Mokelumne Bridge. Although improvements to the moveable bridges reduce congestion at these locations, queues and bottlenecks are not completely eliminated. An in-depth evaluation of the conceptual gap-fill strategy was conducted to determine the benefits and impacts of this strategy. A summary of this evaluation follows.

Evaluation of the Gap-fill Strategy

Exhibit 15 summarizes the evaluation measures for the gap-fill scenario. Noticeable gains in travel times are achieved due to bridge operation improvements as compared to the baseline scenario. Similar gains are reflected by the improvement in vehicular miles of travel during the peak hour for the moveable bridge segments. Reduction in delay at the moveable bridge approaches contributes positively to the economic vitality of the region.

Enhancements to bicycle and pedestrian facilities in downtown Rio Vista along with implementation of centerline channelizers contribute positively to safety and community health in the vicinity of Rio Vista. Implementation of the gap-fill strategy has minor impacts to the physical environment due to the widening of the corridor. In addition, reduction in delay and improvements to travel times results in reduced emissions. The gap-fill strategy results in improvements to the baseline scenario and shows promise as a short-term improvement strategy that provides localized relief in the vicinity of Rio Vista while bridging gaps in improvements proposed as a part of the baseline scenario.

Exhibit 13: Conceptual Gap-fill Strategy



Source: Atkins, 2011.

Exhibit 14: Gap-fill Strategy: Location of Bottlenecks and Queues for 2015 and 2035

Source: Atkins, 2011.

Exhibit 15: Evaluation Measures for the Gap-fill Strategy

Evaluation Categories	Abernathy to Walters Road		Walters Road to Church Road		Church Road to River Road		River Road to Mokelumne Bridge		Mokelumne Bridge to I-5		Overall Corridor		Overall Corridor - Baseline	
	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness														
Average Peak Hour Travel Time (mins)	29	30	18	20	5	5	14	17	10	12	75	83	78	87
Daily VMT	148,900	269,100	152,200	254,100	21,300	30,700	56,900	100,500	106,200	176,900	485,500	831,300	485,000	831,200
Daily VHT	5,810	9,860	3,600	6,300	1,150	1,620	1,900	2,950	2,970	3,950	15,430	24,680	17,300	28,000
Improved pavement (Centerline miles)	0		1.1		1.4		0		0		2.5		N/A	
Number of Bridges with Sufficiency Rating < 80%	0		1		1		0		0		2		2	
Safety														
Safety enhanced roadway (Centerline miles)	0		1.1		1.5		0		0		2.6		N/A	
Daily non-recurrent delay (vehicle hrs)	390	1,440	20	1,700	10	120	30	630	20	910	470	5,200	584	6,300
Economic Vitality														
Daily non-recurrent delay (vehicle hrs)	390	1,440	20	1,700	10	120	30	630	20	910	470	4,800	584	6,300
Daily recurrent delay (vehicle hrs)	3,510	5,380	720	1,290	550	690	500	1,020	1,080	1,530	6,360	9,910	6,770	10,510
Total daily delay (vehicle hrs)	3,900	6,820	740	2,990	560	810	530	1,650	1,100	2,440	6,830	14,710	7,354	16,810
Environment														
Construction within existing ROW (acres)	0		13.4		6.6		0		0		20.0		N/A	
Construction outside existing ROW (acres)	0		5.9		0		0		0		5.9		N/A	
CO2 Emissions (tonnes/year)	14.2		14.8		3.7		4.7		12.1		49.2		51.4	
Healthy Communities														
Fine Particulate Emissions (tonnes/year)	1.8		1.8		0.5		0.6		1.5		6.2		6.7	
Coarse Particulate Emissions (tonnes/year)	2.9		3.1		0.7		1.0		2.5		10.3		10.9	
Bike friendly Roadways (miles)	3.0		16.7		0.7		5.7		9.3		35.3		33.6	
Dedicated Bikeways (miles)	2.3		0.0		1.0		0.0		0.0		3.3		2.9	
Dedicated pedestrian pathways (miles)	2.3		0.0		0.9		0.0		0.0		3.3		2.7	

Source: Atkins, 2011.

Conceptual Barrier Separated Two-Lane Strategy

The barrier separated two-lane strategy provides significant safety improvements in the form of an enhanced cross-section with median barriers and operational improvements in the form of passing zones as shown in Exhibit 16. Median barriers help prevent errant vehicles from entering opposing lanes thus minimizing potential for accidents that lead to injuries or fatalities along the corridor. Passing zones located in the vicinity of major intersections allow for separation of slow moving vehicles, improve lane usage at intersections and improve overall corridor travel speeds.

System-wide ITS improvements provide for better travel time reliability. Bicycle friendly roadways are provided as a part of this strategy through the inclusion of 10-foot shoulders along with enhancements to pedestrian facilities through streetscape improvements in downtown Rio Vista. The capital cost for implementation of these improvements is projected to be $354 million.

Bottlenecks and Queues for the Conceptual Two-Lane Strategy

The two-lane strategy primarily provides operational enhancements in the form of passing zones. While these passing zone areas help improve travel speeds, they do not offer throughput capacity improvements required to alleviate bottlenecks observed for the baseline scenario. Improvements to bridges and resultant reductions in opening and closure times also has a similar effect in that it reduces wait times and delays for traffic on SR-12 but does not eliminate bottlenecks. As a consequence, bottlenecks and queues for the two-lane strategy are similar to those observed for the gap-fill strategy and are shown in Exhibit 14. An in-depth evaluation of the conceptual two-lane strategy was conducted to determine the benefits and impacts of this strategy. A summary of this evaluation follows.

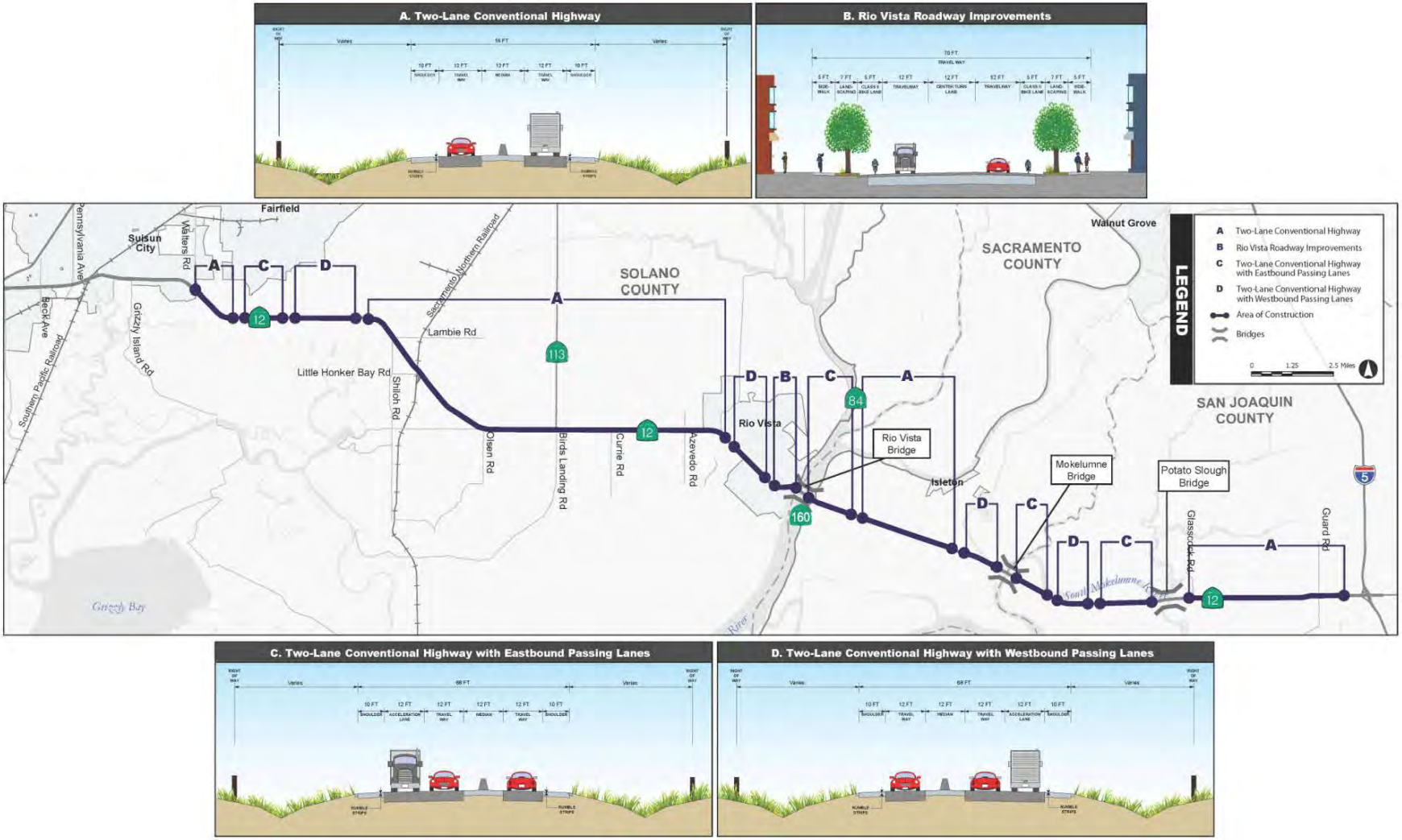
Evaluation of the Barrier Separated Two-Lane Strategy

Results of the evaluation of the two-lane strategy indicate that the strategy offers superior safety and operational benefits when compared to the gap-fill strategy and the baseline scenario. Results of the evaluation are summarized in Exhibit 17.

Significant improvements are observed for travel time, peak hour vehicle miles of travel and pavement surface quality measures. These improvements are accompanied by a corresponding reduction in travel delay which enhances the economic vitality of the region and results in a positive change to the transportation effectiveness of the roadway system. These improvements are a direct result of the inclusion of passing zones, pavement rehabilitation and bridge operational improvements. Enhancements to the cross-section of the roadway to include wider shoulders along with a median barrier help improve safety significantly.

The two-lane strategy contributes to community health through the reduction of particulate emissions and through the provision of enhanced pedestrian facilities. This strategy, however, results in adverse impact to the physical environment. Roadway widening will not only impact environmental resources inside the existing right-of-way but will also require additional right-of-way to implement. In summary, the two-lane strategy provides significant safety benefits, reduces delays and improves travel time for future conditions (2015 and 2035). This conceptual strategy will enhance the performance of the corridor but also includes environmental impacts associated with roadway widening.

Exhibit 16: Conceptual Barrier Separated Two-Lane Strategy



Source: Atkins, 2011.

Exhibit 17: Evaluation Measures for the Barrier Separated Two-Lane Strategy

Evaluation Categories	Abernathy to Walters Road		Walters Road to Church Road		Church Road to River Road		River Road to Mokelumne Bridge		Mokelumne Bridge to I-5		Overall Corridor		Overall Corridor - Baseline	
	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness														
Average Peak Hour Travel Time (mins)	28	30	18	19	5	5	13	14	10	11	73	78	78	87
Daily VMT	148,400	271,200	151,100	261,700	21,800	34,000	57,400	103,900	101,100	177,800	485,800	848,600	485,000	831,200
Daily VHT	5,870	9,740	3,640	6,370	1,100	1,690	1,709	2,904	2,841	3,890	15,240	24,600	17,300	28,000
Improved pavement (Centerline miles)	0		4.1		1.4		5.7		2.2		13.4		N/A	
Number of Bridges with Sufficiency Rating < 80%	0		0		1		0		0		1		2	
Safety														
Safety enhanced roadway (Centerline miles)	0		16.9		1.5		5.7		7.0		31.1		N/A	
Daily non-recurrent delay (vehicle hrs)	390	1,440	20	1,700	10	120	30	630	20	910	460	5,210	584	6,300
Economic Vitality														
Daily non-recurrent delay (vehicle hrs)	390	1,440	20	1,700	10	120	30	630	20	910	460	4,800	584	6,300
Daily recurrent delay (vehicle hrs)	3,230	5,230	680	1,240	560	650	430	990	1,390	1,550	6,290	9,660	6,770	10,510
Total daily delay (vehicle hrs)	3,620	6,670	700	2,940	570	770	460	1,620	1,410	2,460	6,760	14,460	7,354	16,810
Environment														
Construction within existing ROW (acres)	0.0		118.3		6.6		47.5		25.3		197.7		N/A	
Construction outside existing ROW (acres)	0.0		23.2		0.0		18.8		2.1		44.2		N/A	
CO2 Emissions (tonnes/year)	13.8		14.8		3.6		4.7		12.1		48.9		51.4	
Healthy Communities														
Fine Particulate Emissions (tonnes/year)	1.8		1.8		0.5		0.6		1.5		6.2		6.7	
Coarse Particulate Emissions (tonnes/year)	2.9		3.1		0.7		1.0		2.5		10.3		10.9	
Bike friendly Roadways (miles)	3.0		16.9		0.7		5.7		9.3		35.6		33.6	
Dedicated Bikeways (miles)	2.3		0.0		1.0		0		0		3.3		2.9	
Dedicated pedestrian pathways (miles)	2.3		0.0		0.9		0		0		3.3		2.7	

Source: Atkins, 2011.

Conceptual Four-Lane Strategy

The four-lane strategy provides the highest capacity enhancements and the best operations as compared to other strategies. The enhanced four-lane cross-section (refer to Exhibit 18) includes 8-foot shoulders along with a median barrier and 12-foot travel lanes. This strategy replaces the moveable bridge at Rio Vista with a high-level bridge on a re-aligned SR-12 which will result in elimination of travel delay on SR-12 due to moveable bridge operations. Operational improvements will be realized at the Mokelumne and Potato Slough bridges since this strategy includes a re-aligned SR-12 located on a via-duct through this section along with mid-level bridges that minimize the need to open/close bridges.

For the purpose of this study it was assumed that access to local properties and recreational facilities that will be impacted due to the realignment will access SR-12 via a new connector that will be located on the existing alignment of SR-12. These connector roads will in-turn provide access to the re-aligned segments of SR-12 via hook ramps. The ramp in Sacramento County is located 0.8 miles west of Brennan Island Road. The ramp in San Joaquin County is located 0.3 miles west of the existing Potato Slough Bridge. Conceptual improvement drawings of these accesses can be found in the supplemental report entitled Alternatives Analysis for SR-12 – Conceptual Drawings and Cost Estimates.

In addition, this strategy includes enhancements to major intersections in the urban section of Solano County and includes interchanges at Beck and Pennsylvania Avenue which is a part of phase II of the I-80/I-680/SR-12 Interchange project. These improvements will minimize congestion between Walters Road and I-80. The capital cost for implementation of these improvements is projected to be $2.8 billion.

Bottlenecks and Queues for the Conceptual Four-Lane Strategy

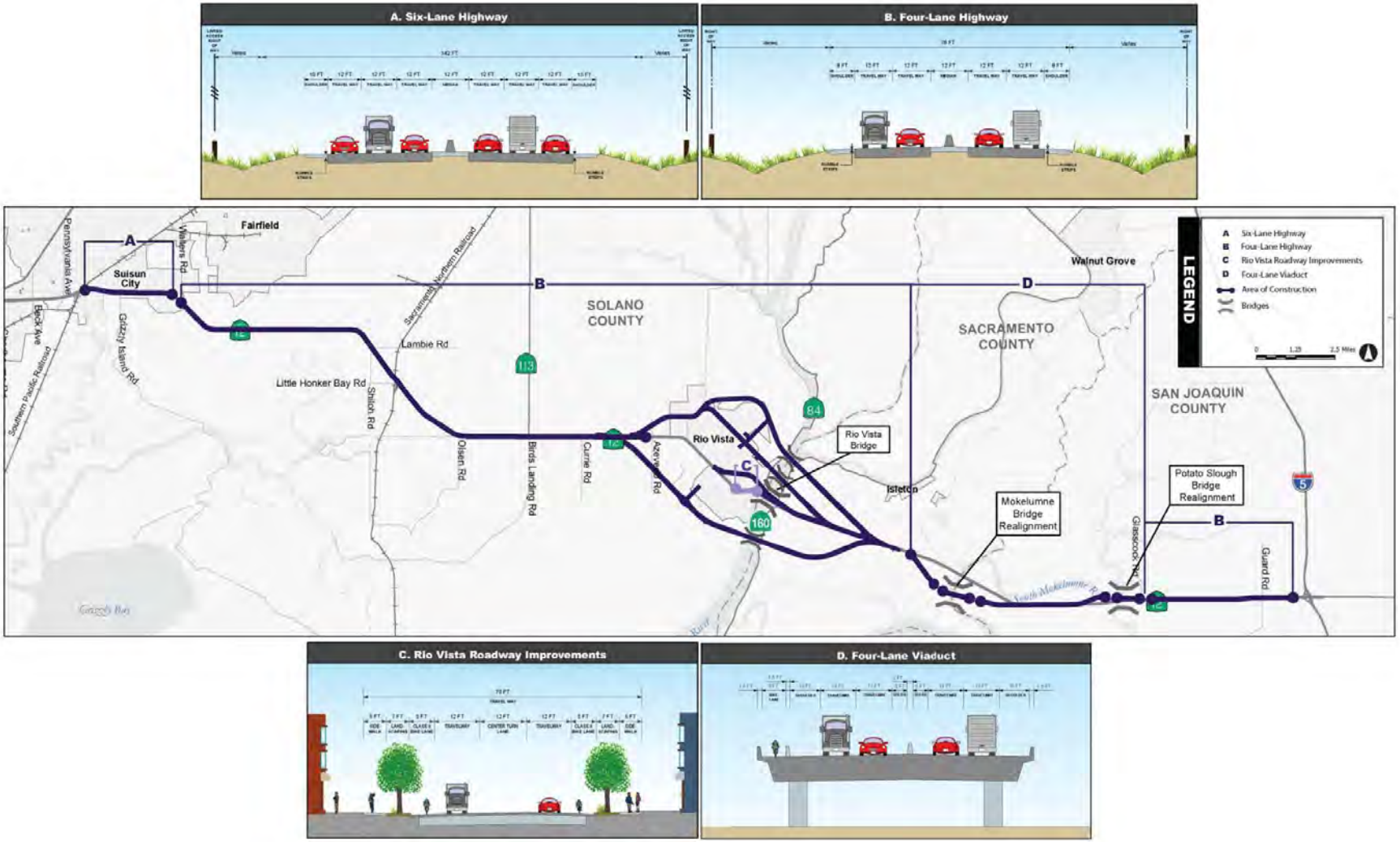
The four-lane strategy provides significantly improved throughput capacity enhancement since the strategy adds one additional lane in each direction throughout the corridor. In addition, this strategy provides enhanced intersection capacity between Civic Center Boulevard and Walters Road and eliminates delays due to moveable bridges. These improvements result in the elimination of all bottlenecks on SR-12. Segments of SR-12 in the vicinity of signalized intersections between Civic Center Boulevard and Walters Road experience minor reductions in travel speeds due to signal control delay but none of the observed queues exceeded available storage. This strategy functions without any bottlenecks or queues. An evaluation summary of the conceptual four-lane strategy follows.

Evaluation of the Four-Lane Strategy

Results of the evaluation of the four-lane strategy indicate that the strategy offers significant improvements to capacity and safety, and improves the quality of travel on SR-12. Results of the evaluation are summarized in Exhibit 19.

Travel times are reduced by 31 minutes as compared to baseline scenario 2035 conditions. The four-lane strategy adds throughput capacity which results in SR-12 being able to serve all demand as evidenced by the change in peak hour to daily vehicle miles of travel ratio. A higher ratio for this metric indicates the ability of the system to process higher demand in a short period of time thus minimizing peak periods and reducing overall delay for the corridor. These reductions in travel times and improved peak hour VMT are accompanied by a corresponding reduction in travel delay which enhances the economic vitality of the region. In addition, this strategy enhances the effectiveness and contribution of the SR-12 corridor to regional economic vitality. Safety on SR-12 is significantly improved due to the 8-foot shoulders, median barriers and reduced congestion along SR-12. Implementation of the ITS system will help reduce non-recurrent delay and reduce occurrence of secondary incidents during accident events.

Exhibit 18: Conceptual Four-Lane Strategy



Source: Atkins, 2011.

Exhibit 19: Evaluation Measures for the Four-Lane Strategy

Evaluation Categories	Abernathy to Walters Road		Walters Road to Church Road		Church Road to River Road		River Road to Mokelumne Bridge		Mokelumne Bridge to I-5		Overall Corridor		Overall Corridor - Baseline	
	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2015	2035	2035	2035
Transportation System Effectiveness														
Average Peak Hour Travel Time (mins)	13	14	17	18	3	3	9	10	10	11	53	56	78	87
Daily VMT	149,900	283,800	152,400	276,700	27,000	33,000	59,100	107,200	106,700	181,300	495,000	882,000	485,000	831,200
Daily VHT	6,040	8,640	3,630	6,040	860	1,080	1,430	2,040	2,300	2,420	14,240	20,220	17,300	28,000
Improved pavement (Centerline miles)	3		17.8		2.3		6.4		10.5		25.3		N/A	
Number of Bridges with Sufficiency Rating < 80%	0		0		0		0		0		0		2	
Safety														
Safety enhanced roadway (Centerline miles)	3.0		17.8		2.3		6.4		10.5		39.0		N/A	
Daily non-recurrent delay (vehicle hrs)	50	630	0	330	0	15	0	270	0	120	50	1,365	584	6,300
Economic Vitality														
Daily non-recurrent delay (vehicle hrs)	50	630	0	330	0	15	0	270	0	120	50	1,365	584	6,300
Daily recurrent delay (vehicle hrs)	2,260	3,990	609	987	145	227	134	220	264	964	3,412	6,388	6,770	10,510
Total daily delay (vehicle hrs)	2,310	4,620	609	1,317	145	242	134	490	264	1,084	3,462	7,753	7,354	16,810
Environment														
Construction within existing ROW (acres)	16.4		118.3		6.6		47.5		25.3		214.1		N/A	
Construction outside existing ROW (acres)	0.4		133.5		29.9		147		88.4		399.2		N/A	
CO2 Emissions (tonnes/year)	12.4		14.6		2.9		4.3		12.2		46.8		51.4	
Healthy Communities														
Fine Particulate Emissions (tonnes/year)	1.6		1.7		0.4		0.5		1.4		5.6		6.7	
Coarse Particulate Emissions (tonnes/year)	2.6		3.0		0.6		0.9		2.4		9.5		10.9	
Bike friendly Roadways (miles)	3.0		17.8		2.1		6.4		10.5		39.7		33.6	
Dedicated Bikeways (miles)	2.3		4.4		1.9		6.4		8.0		23.1		2.9	
Dedicated pedestrian pathways (miles)	2.3		0.0		0.9		0.0		0.0		3.3		2.7	

Source: Atkins, 2011.

The four-lane strategy includes re-alignment of SR-12 in the vicinity of downtown Rio Vista which will reduce the intensity of traffic through the downtown area. The combination of streetscape and pedestrian facility improvements and reduced through traffic in downtown Rio Vista will promote community health. Re-alignment of SR-12 around downtown Rio Vista may have some impact on the economic dynamics of the downtown region since traffic is being diverted from this area.

Reduced congestion and delay will result in reduced particulate emissions and will improve air quality. Implementation of the four-lane strategy will require additional right-of-way, some of which are located in environmentally sensitive areas. The four-lane strategy has the widest cross-section amongst all strategies and will impact the physical environment adversely. In summary, the four-lane strategy meets the long term needs of SR-12 since it offers the best traffic operations for SR-12 by eliminating all bottlenecks and queues, reduces travel times by a third and improves safety as compared to the baseline scenario. However, this strategy has adverse impacts to the physical environment due to its wider footprint and re-aligned mainline segments.

Four-Lane Expressway Variant

The four-lane option developed for evaluation in this analysis was not specifically developed as an expressway. In the course of preparing this document, it was agreed through the Project Development Team that while an expressway variant could not be as fully developed as the other three conceptual strategies, an analysis would be undertaken to develop a general understanding of what might be required to bring the four-lane strategy to expressway standards.

An expressway to Caltrans adds several design elements and standards to what otherwise is a standard four-lane facility. These can be broadly described as follows:

- Alignments based on a higher design speeds that require flatter curves and more gentle vertical grades
- Wider shoulders
- Intersections that include channelization, acceleration and deceleration lanes
- Control of access from abutting properties

Exhibit 20 presents an assessment of the corridor that has been used to develop that incremental cost of improving the four-lane option to expressway standards. In this graphic, the segments labeled 'A' do not meet expressway standards under the four-lane conceptual standards. The other segments generally meet these standards, or can meet these standards with minimal modifications to the four-lane concept. Each segment is summarized as follows:

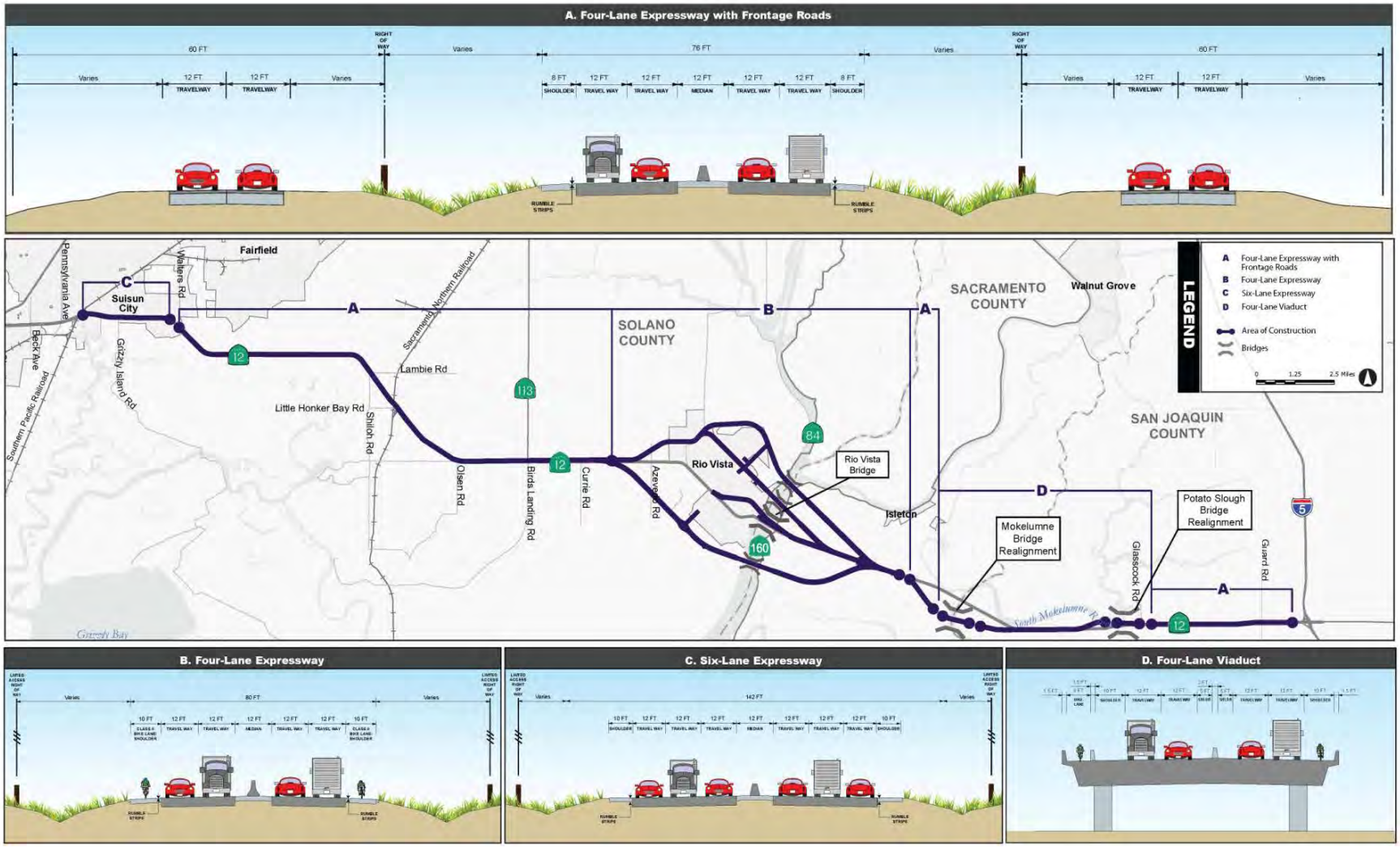
Segment B

These segments are possible new alignments that may be required to replace the Rio Vista Bridge. Segment 'B' passes through downtown Rio Vista where an expressway option is not a viable alternative due to the development and existing speeds in the downtown area.

Segment C

Under the four-lane conceptual option, this segment in the area of Suisun City and Fairfield includes the interchange and intersection improvements associated with Phases 1 and 2 of the I-80/I-680/SR-12 Interchange project. In this project, intersections are either replaced with grade separated interchanges, or the already widely spaced intersections improved with additional turning lanes. For the purpose of this study, this section of SR-12 meets the expressway standard.

Exhibit 20: Four-Lane Expressway Variant



Source: Atkins, 2011.

Segment D

These are alignments that either bypass downtown Rio Vista, or are new alignments to facilitate replacement of the Mokelumne and Potato Slough bridges. These new alignments are planned to expressway standards with wider shoulders, a limited number of intersections spaced to meet expressway standards and alignments that can support expressway design speeds. Segments 'C' and 'D' do not need additional modifications to bring the SR-12 corridor to expressway standards.

To upgrade those segments labeled 'A' to expressway standards, two curves in Solano County require realignment, outside shoulders need to be widened from 8-feet to 10-feet and acceleration / deceleration lanes added at intersections. These changes address most of the requirements to upgrade to expressway standards except access control.

Access control can be implemented by adding interchanges, limiting intersections based on spacing criteria, identifying alternative access points on cross-streets or by adding frontage roads. It is beyond the scope of this study to develop specific solutions that address the needs of parcel specific access control.

To indicate what the cost might be to convert the 18 miles of SR-12 labeled as segment 'A' in Exhibit 20, a frontage road section was applied and used as a basis for estimate. It should be noted that this solution is not recommended, but merely used as an indicative option to illustrate what the cost would be to upgrade the four-lane conceptual option to a full expressway standard. For the 18 miles described in this section, the cost to upgrade to an expressway alternative is $323 million including the realignments, intersection, cross-section and access control modifications described in these paragraphs.

Comparative Evaluation of Strategies

The previous section presented evaluation metrics for each of the conceptual strategies – Gap-fill, Barrier Separated Two-Lane and Four-Lane – across the entire 42 mile SR-12 corridor. This section provides comparisons for each of the alternatives against the baseline case.

These comparisons are first made by looking at each segment along the corridor as these were earlier defined and presented in Exhibit 3. Each alternative is compared to the baseline for each of the five analysis segments across the corridor. For instance, Exhibit 21 shows how the baseline and each conceptual alternative compare for the segment from Abernathy Road to Walters Road in the area of Suisun City and Fairfield.

The evaluation summary also includes an overall evaluation of the alternatives against the baseline that compares each scenario for the overall length of the corridor. This evaluation and the previously described segment level evaluations have been prepared focusing on the mobility, safety, economic vitality, environmental and healthy communities criteria that were documented earlier. The reviewer is cautioned that in order to evaluate what makes sense for the SR-12 corridor, all of these factors, including cost, must be considered and the often subtle differences between alternatives taken into account.

In general, the four-lane conceptual alternative ranks highest in the categories of efficiency, safety (based primarily on the inherent advantage that a high capacity solution has on reducing non-recurrent delay due to accidents and incidents) and economic vitality. All of these categories are primarily ranked based on delay reductions and, in the case of efficiency, faster travel times. The differences in the healthy communities category are not particularly compelling when comparing the options at the segment level.

Exhibit 21: Conceptual Improvement Strategies – Abernathy to Walters Road

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness								
Average Peak Hour Travel Time (mins)	29	30	29	30	28	30	13	14
Daily VMT	147,900	269,100	148,900	269,100	148,400	271,200	149,900	283,800
Daily VHT	6,000	9,990	5,810	9,860	5,870	9,740	6,040	8,640
Improved pavement (Centerline miles)	N/A		0		0		3	
Number of Bridges with Sufficiency Rating < 80%	0		0		0		0	
Safety								
Safety enhanced roadway (Centerline miles)	N/A		0		0		3.0	
Daily non-recurrent delay (vehicle hrs)	460	1,690	390	1,440	390	1,440	50	630
Economic Vitality								
Daily recurrent delay (vehicle hrs)	3,560	5,390	3,510	5,380	3,230	5,230	2,260	3,990
Total daily delay (vehicle hrs)	4,020	7,080	3,900	6,820	3,620	6,670	2,310	4,620
Environment								
Construction within existing ROW (acres)	N/A		0.0		0.0		16.4	
Construction outside existing ROW (acres)	N/A		0.0		0.0		0.4	
CO2 Emissions (tonnes/year)	16.1		14.2		13.8		12.4	
Healthy Communities								
Fine Particulate Emissions (tonnes/year)	2.2		1.8		1.8		1.6	
Coarse Particulate Emissions (tonnes/year)	3.2		2.9		2.9		2.6	
Bike friendly Roadways (miles)	3.0		3.0		3.0		3.0	
Dedicated Bikeways (miles)	2.3		2.3		2.3		2.3	
Dedicated pedestrian pathways (miles)	2.3		2.3		2.3		2.3	
Cost Effectiveness								
($/veh-hr of delay saved)	-		-		-		1.6	

Source: Atkins, 2011.

Good Better Best

The four-lane option always ranks as the least desirable option when the impacts of construction in new or existing right-of-way are considered. Also, in some cases for some segments, the two-lane alternative can produce travel times and delay reductions that, while less than the four-lane, show differences that may not be considered significant. When combined with the cost and cost effectiveness criteria presented later in the technical memorandum, these comparative changes can inform the development of an improvement plan for the SR-12 corridor that balances efficiency, environmental consequences and effectiveness. The development of a draft recommendation based on these often competing criteria will be developed in the next deliverable of this project.

Evaluation of Segment 1 – Abernathy Road to Walters Road

Segment 1 is from Abernathy Road just east of the I-80 interchange to Walters Road which passes north/south at the eastern limits of Fairfield. The segment is six miles long and today is a suburban, multi-lane arterial constructed to expressway, or near expressway, standards.

The baseline case assumes that Phase 1 of the I-80/I-680/SR-12 Interchange project will be constructed within this segment. This baseline improvement is from I-80 to the general vicinity of Beck Road. The four-lane option includes Phase 2 of the I-80/I-680/SR-12 Interchange project, additional through lanes, and intersection improvements for this segment.

The comparison for the various options along this segment is shown in Exhibit 21 where it can be seen that travel times for the four-lane improvement are substantially less than the gap-fill and two-lane strategies. There are also significant reductions in non-recurrent delay for the four-lane as compared to the other strategies. At the same time, the environmental impact of the four-lane strategy in terms of construction within the existing right-of-way and the need for new right-of-way is relatively modest.

Evaluation of Segment 2 – Walters Road to Church Road

This 17 mile segment of SR-12 traverses rural Solano County. The gap-fill strategy provides median channelizers, alignment enhancements and shoulder improvements from Liberty Island Road to Drouin Drive. The barrier separated two-lane strategy provides median barriers, full shoulders for the entire length of the segment and acceleration style passing lanes at key intersections. The four-lane strategy provides additional lanes – one in each direction – and effectively doubles the capacity of this segment.

Exhibit 22 summarizes the comparison of metrics for the segment between Walters Road and Church Road. In terms of transportation system effectiveness, the four-lane strategy provides travel times that are about one minute quicker than the two-lane options and small (5% more, or less) reductions in recurrent vehicle hours of delay. At the same time, the four-lane option requires significantly more acres of new right-of-way (over 100 acres) than the barrier separated two-lane strategy.

As is the case for all segments of four-lane improvement, this option produces the most significant reductions in non-recurrent delay of the options evaluated. This is because the four-lane option has twice the capacity of a two-lane section and allows for accident recovery that in most cases can avoid the need to shut down all traffic in a direction of travel. For this segment, non-recurrent delay for the four-lane option in 2035 is 330 hours per day verses 1,700 for the barrier separated two-lane alternative.

Exhibit 22: Conceptual Improvement Strategies – Walters Road to Church Road

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness			○		◉		●	
Average Peak Hour Travel Time (mins)	18	20	18	20	18	19	17	18
Daily VMT	152,200	254,100	152,200	254,100	151,100	261,700	152,400	276,700
Daily VHT	3,480	6,230	3,600	6,300	3,640	6,370	3,630	6,040
Improved pavement (Centerline miles)	N/A		1.1		4.1		17.8	
Number of Bridges with Sufficiency Rating < 80%	1		1		0		0	
Safety			○		◉		●	
Safety enhanced roadway (Centerline miles)	N/A		1.1		16.9		17.8	
Daily non-recurrent delay (vehicle hrs)	40	2,200	20	1,700	20	1,700	0	330
Economic Vitality			◉		◉		●	
Daily recurrent delay (vehicle hrs)	630	1,050	720	1,290	680	1,240	609	987
Total daily delay (vehicle hrs)	670	3,250	740	2,990	700	2,940	609	1,317
Environment			●		◉		○	
Construction within existing ROW (acres)	N/A		13.4		118.3		118.3	
Construction outside existing ROW (acres)	N/A		5.9		23.2		133.5	
CO2 Emissions (tonnes/year)	15.1		14.8		14.8		14.6	
Healthy Communities			◉		◉		●	
Fine Particulate Emissions (tonnes/year)	1.9		1.8		1.8		1.7	
Coarse Particulate Emissions (tonnes/year)	3.2		3.1		3.1		3.0	
Bike friendly Roadways (miles)	15.6		16.7		16.9		17.8	
Dedicated Bikeways (miles)	0.0		0.0		0.0		4.4	
Dedicated pedestrian pathways (miles)	0.0		0.0		0.0		0.0	
Cost Effectiveness								
($/veh-hr of delay saved)	-		-		174.6		66.4	

Source: Atkins, 2011.

○ Good ◉ Better ● Best

Evaluation of Segment 3 – Church Road to River Road

This segment extends from Walters Road on the west, through the downtown area of Rio Vista, to River Road which follows the west side of the Sacramento River. Results of the comparative analysis for this segment are shown in Exhibit 23.

All strategies -- the Gap-fill, Barrier Separated Two-Lane and Four-Lane -- include improvements to SR-12 through the downtown areas of Rio Vista that include streetscape enhancements, pedestrian and bikeway improvements. The gap-fill and two-lane options also include ITS at the Rio Vista Bridge approaches to improve efficiency.

The four-lane strategy includes a realignment of SR-12 as a four-lane expressway facility around Rio Vista in order to provide a new, more efficient crossing of the Sacramento River. For this study, a representative alignment from the Rio Vista Bridge Study was chosen to represent all of the options now under consideration. The study does not specifically recommend one candidate realignment option over another.

Overall, this is a short, two-mile segment along SR-12. The four-lane strategy does reduce travel times from six minutes over the two miles to three minutes and shows an 80% reduction in vehicle hours of daily recurrent delay. Much of this reduction in delay occurs at the eastbound approach to a proposed high-level Rio Vista Bridge crossing that is part of the four-lane alternative. As is typical for each of the four-lane segment options, non-recurrent delay due to accidents and incidents is substantially improved under the four-lane option for the reasons explained previously.

From the standpoint of the environment, the four-lane option reduces emissions due to delay, but more significantly it requires a great deal of new right-of-way that has potential environmental impacts. The new right-of-way required for the four-lane option is 30 acres.

Exhibit 23: Conceptual Improvement Strategies – Church Road to River Road

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness								
Average Peak Hour Travel Time (mins)	5	6	5	5	5	5	3	3
Daily VMT	21,600	30,700	21,300	30,700	21,800	34,000	27,000	33,000
Daily VHT	1,940	2,300	1,150	1,620	1,100	1,690	860	1,080
Improved pavement (Centerline miles)	N/A		1.4		1.4		2.3	
Number of Bridges with Sufficiency Rating < 80%	1		1		1		0	
Safety								
Safety enhanced roadway (Centerline miles)	N/A		1.5		1.5		2.3	
Daily non-recurrent delay (vehicle hrs)	4	170	10	120	10	120	0	15
Economic Vitality								
Daily recurrent delay (vehicle hrs)	750	1,160	550	690	560	650	145	227
Total daily delay (vehicle hrs)	754	1,330	560	810	570	770	145	242
Environment								
Construction within existing ROW (acres)	N/A		6.6		6.6		6.6	
Construction outside existing ROW (acres)	N/A		0.0		0.0		29.9	
CO2 Emissions (tonnes/year)	3.3		3.7		3.6		2.9	
Healthy Communities								
Fine Particulate Emissions (tonnes/year)	0.4		0.5		0.5		0.4	
Coarse Particulate Emissions (tonnes/year)	0.7		0.7		0.7		0.6	
Bike friendly Roadways (miles)	0.0		0.7		0.7		2.1	
Dedicated Bikeways (miles)	0.6		1.0		1.0		1.9	
Dedicated pedestrian pathways (miles)	0.4		0.9		0.9		0.9	
Cost Effectiveness								
($/veh-hr of delay saved)	-		2.2		2.2		121.6	

Source: Atkins, 2011.

Good Better Best

Evaluation of Segment 4 – River Road to Mokelumne Bridge

This six-mile segment extends from Rio Vista on the west side of the Sacramento River to the Mokelumne Bridge. The summary evaluation of segment 4 is presented in Exhibit 24.

Other than ITS improvements, there are no physical improvements to SR-12 along this segment under the gap-fill option. The two-lane scenario provides a fixed median barrier with standard inside shoulders next to this barrier, shoulders along the outside edge of the roadway and strategically placed acceleration/passing lanes. The gap-fill and the two-lane strategies include improvements to the bridge operations for the Mokelumne Bridge in the form of ITS equipment and bridge machinery upgrades.

The four-lane strategy for this segment includes a new high-level bridge over the Sacramento River, a realigned SR-12 in Sacramento County to connect the new bridge to the existing SR-12 alignment, a two-mile elevated viaduct to the Mokelumne Bridge and a new, four-lane, mid-level movable bridge over the Mokelumne River.

The four-lane strategy improves travel time along this segment from 14 minutes for the two-lane alternative to 10 minutes and reduces the daily vehicle hours of travel by 30% from 2,904 hours to 2,040 hours per day. Most of the travel time reductions are due to the new high level bridge at Rio Vista and the mid-level bridge at Mokelumne. These differences are meaningful, but also indicate that replacing the movable bridges with high or mid-level crossings is more important than implementing four-lanes throughout this segment.

From an environmental standpoint, the four-lane improvement requires much more right-of-way due to the realignments necessary to construct new bridges at Rio Vista and Mokelumne. For this segment, approximately 147 acres of new right-of-way are required for the four-lane option.

As is typical throughout this evaluation, substantial reductions in delay – both recurrent and non-recurrent – are projected for the four-lane option which has 70% less total delay than the two-lane scenario.

Exhibit 24: Conceptual Improvement Strategies – River Road to Mokelumne Bridge

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness			○		◉		●	
Average Peak Hour Travel Time (mins)	17	19	14	17	13	14	9	10
Daily VMT	55,900	100,500	56,900	100,500	57,400	103,900	59,100	107,200
Daily VHT	1,980	3,900	1,900	2,950	1,709	2,904	1,430	2,040
Improved pavement (Centerline miles)	N/A		0		5.7		6.4	
Number of Bridges with Sufficiency Rating < 80%	0		0		0		0	
Safety			○		◉		●	
Safety enhanced roadway (Centerline miles)	N/A		0		5.7		6.4	
Daily non-recurrent delay (vehicle hrs)	40	820	30	630	30	630	0	270
Economic Vitality			○		◉		●	
Daily recurrent delay (vehicle hrs)	620	1,150	500	1,020	430	990	134	220
Total daily delay (vehicle hrs)	660	1,970	530	1,650	460	1,620	134	490
Environment			●		◉		○	
Construction within existing ROW (acres)	N/A		0.0		47.5		47.5	
Construction outside existing ROW (acres)	N/A		0.0		18.8		147	
CO2 Emissions (tonnes/year)	4.6		4.7		4.7		4.3	
Healthy Communities			●		●		●	
Fine Particulate Emissions (tonnes/year)	0.6		0.6		0.6		0.5	
Coarse Particulate Emissions (tonnes/year)	1.0		1.0		1.0		0.9	
Bike friendly Roadways (miles)	5.7		5.7		5.7		6.4	
Dedicated Bikeways (miles)	0.0		0.0		0.0		6.4	
Dedicated pedestrian pathways (miles)	0.0		0.0		0.0		0.0	
Cost Effectiveness								
($/veh-hr of delay saved)	-		2.2		310.9		266	

Source: Atkins, 2011.

○ Good ◉ Better ● Best

Evaluation of Segment 5 - Mokelumne Bridge to I-5

For this segment, the gap-fill option only includes ITS enhancements along this 10-mile section of SR-12. The barrier separated two-lane strategy implements median barriers, shoulders and acceleration/passing lanes as described previously for the segments in the baseline case that do not already meet this standard in San Joaquin County. Both the gap-fill and two-lane options include bridge operational improvements at the westbound approach to the Mokelumne Bridge and for both approaches to the Potato Slough Bridge.

The four-lane strategy continues the elevated viaduct from east of Mokelumne Bridge for six miles to the east including a new, four-lane mid-level crossing over Potato Slough. From there, four-lanes are extended eastward at-grade until matching the existing four-lane cross-section west of Interstate 5. Exhibit 25 presents the evaluation criteria for segment 5.

The two-lane and four-lane scenarios have identical travel times which indicate that four lanes of capacity may not be needed along this section. Vehicle hours of delay (both recurrent and non-recurrent) are significantly reduced when the two- and four-lane options are compared, but this is due primarily to delay reductions at the Mokelumne Bridge and the inherent advantages of a four-lane section to handle delay due to accidents and incidents.

The four-lane scenario requires an additional 88 acres of land in the environmentally sensitive Delta while only two acres are needed to implement the barrier separated two-lane option along this segment.

Exhibit 25: Conceptual Improvement Strategies – Mokelumne Bridge to I-5

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness			○		◉		●	
Average Peak Hour Travel Time (mins)	10	13	10	12	10	11	10	11
Daily VMT	107,400	176,900	106,200	176,900	101,100	177,800	106,700	181,300
Daily VHT	3,920	5,610	2,970	3,950	2,841	3,890	2,300	2,420
Improved pavement (Centerline miles)	N/A		0		2.2		10.5	
Number of Bridges with Sufficiency Rating < 80%	0		0		0		0	
Safety			○		◉		●	
Safety enhanced roadway (Centerline miles)	N/A		0		7.0		10.5	
Daily non-recurrent delay (vehicle hrs)	40	1,420	20	910	20	910	0	120
Economic Vitality			◉		◉		●	
Daily recurrent delay (vehicle hrs)	1,210	1,760	1,080	1,530	1,390	1,550	264	964
Total daily delay (vehicle hrs)	1,250	3,180	1,100	2,440	1,410	2,460	264	1084
Environment			●		◉		○	
Construction within existing ROW (acres)	N/A		0.0		25.3		25.3	
Construction outside existing ROW (acres)	N/A		0.0		2.1		88.4	
CO2 Emissions (tonnes/year)	12.4		12.1		12.1		12.2	
Healthy Communities			◉		◉		●	
Fine Particulate Emissions (tonnes/year)	1.7		1.5		1.5		1.4	
Coarse Particulate Emissions (tonnes/year)	2.7		2.5		2.5		2.4	
Bike friendly Roadways (miles)	9.3		9.3		9.3		10.5	
Dedicated Bikeways (miles)	0.0		0.0		0.0		8.0	
Dedicated pedestrian pathways (miles)	0.0		0.0		0.0		0.0	
Cost Effectiveness								
($/veh-hr of delay saved)	-		-		40.5		204.3	

Source: Atkins, 2011.

○ Good ◉ Better ● Best

Corridor Wide Comparison of Conceptual Alternatives

Results of the comparative analysis for each of the five evaluation strategies are summarized in Exhibit 26 and include the following observations:

Regarding Transportation System Effectiveness, the four-lane strategy provides the most improvement to travel times by reducing the average peak hour travel time by a third. The two-lane strategy shows moderate improvements to travel times (approximately 10 percent reduction for 2035) followed by the gap-fill strategy. The four-lane strategy exhibits the most potential to serve corridor demand indicated by the highest reduction in daily VHT from 28,000 to 20,200. The two-lane and gap-fill strategies are only marginally better than the baseline scenario in their ability to accommodate peak demand. The four-lane strategy includes the highest amount of rehabilitated pavement and includes reconstruction of both structurally deficient bridges. As a result of these factors, the four-lane strategy offers the most improvements to the effectiveness of the SR-12 transportation system.

Along similar lines, the four-lane strategy also provides the highest safety benefit with most number of lanes, reduction in delay and median barriers followed by the two-lane strategy. Safety benefits of the gap-fill strategy are better suited as a short-term improvement rather than a long-term goal.

The four-lane strategy has the potential to improve regional economic vitality the most due to the highest reduction in delay for all auto travel and the elimination of delays for marine traffic at the Rio Vista and Mokelumne bridges. However, it should be noted that many of the Rio Vista Bridge options involve a realignment of SR-12 either north or south of the town of Rio Vista. While not quantified in this study, the realignment of SR-12 around Rio Vista can be expected to have economic consequences in the downtown area business districts.

The two-lane and gap-fill strategies include enhanced driver information and improvements to bridge equipment that offer reduced wait times at moveable bridges and also reduce the bridge opening times for the marine traffic. Even with these enhancements, bridge delays are expected to be significant at the Rio Vista and Mokelumne River bridges.

Reduction in delay due to the four-lane strategy results in the highest reduction in particulate emissions. All of the strategies, four-lane, two-lane and gap-fill, offer similar levels of improvement to bike friendly and pedestrian facilities that promote healthy communities.

The four-lane strategy has the widest footprint of all strategies and as a result has the highest impact on the physical environment. Realignment of SR-12 near Rio Vista and the viaduct option in Sacramento County are significant contributors to this impact. While the two-lane strategy has the highest impact due to construction within the existing right-of-way, impact of the four-lane strategy outside existing right-of-way far outweighs the impact of the two-lane strategy. The gap-fill strategy has the least amount of impact and offers the lowest reductions in emissions.

Exhibit 26: Summary of Evaluation of Strategies

Evaluation Categories	Baseline		Gap-fill		Two Lane		Four-Lane	
	2015	2035	2015	2035	2015	2035	2015	2035
Transportation System Effectiveness			○		◉		●	
Average Peak Hour Travel Time (mins)	78	87	75	83	73	78	53	56
Daily VMT	485,000	831,200	480,500	831,200	485,800	848,600	495,000	882,000
Daily VHT	17,300	28,000	15,950	24,650	15,240	24,600	14,240	20,220
Improved pavement (Centerline miles)	N/A		2.5		13.4		25.3	
Number of Bridges with Sufficiency Rating < 80%	2		2		1		0	
Safety			○		◉		●	
Safety enhanced roadway (Centerline miles)	N/A		2.6		31.1		39.0	
Daily non-recurrent delay (vehicle hrs)	584	6,300	470	5,200	460	5,210	50	1,350
Economic Vitality			○		◉		●	
Daily non-recurrent delay (vehicle hrs)	584	6,300	470	5,200	460	5,210	50	1,350
Daily recurrent delay (vehicle hrs)	6,770	10,510	6,360	9,910	6,290	9,660	3,410	6,390
Total daily delay (vehicle hrs)	7,354	16,810	6,830	14,710	6,760	14,460	3,460	7,755
Environment			●		◉		○	
Construction within existing ROW (acres)	N/A		20.0		197.7		214.1	
Construction outside existing ROW (acres)	N/A		5.9		44.2		399.2	
CO2 Emissions (tonnes/year)	51.4		49.2		48.9		46.8	
Healthy Communities			○		◉		●	
Fine Particulate Emissions (tonnes/year)	6.7		6.2		6.2		5.6	
Coarse Particulate Emissions (tonnes/year)	10.9		10.3		10.3		9.5	
Bike friendly Roadways (miles)	33.6		35.3		35.6		39.7	
Dedicated Bikeways (miles)	2.9		3.3		3.3		23.1	
Dedicated pedestrian pathways (miles)	2.7		3.3		3.3		3.3	
Cost Effectiveness								
($/veh-hr of delay saved)	-		4.1		14.5		38.1	

Source: Atkins, 2011.

○ Good ◉ Better ● Best

Cost Effectiveness Analysis

Cost effectiveness analysis is a systematic evaluation of the cost and benefits of an improvement. The analysis evaluates incremental differences between a base case and an improvement strategy or alternative. The analysis helps determine the cost required to realize the benefits from a proposed strategy or alternative. This type of analysis is typically employed during a planning level study to assess and prioritize system-wide alternatives or a sub set of all improvements (packages) within each alternative.

The cost effectiveness analysis expresses benefits (savings in delay) in a format ($/hour) that can be easily related to a users perception of their value of time which is ephemeral and typically varies by trip purpose. Typically, value of time ranges from $5 to $50 per hour where the lower end of the spectrum represents trips similar to recreational trips and the higher value represents trips similar to commercial vehicle trips. In general, the average value of travel time in the Bay area is between $14 and $15. Improvement strategies with an estimated rating of $14 or less per hour of delay saved can be thought of as cost effective in that the cost to construct and maintain the strategy is offset by user cost benefits.

While this analysis provides an economic evaluation of the proposed benefits, it is but one of the inputs for the decision making process and will be combined with other factors including non-tangible factors, safety benefits and environmental constraints before a list of prioritized projects are developed.

Cost performance measures estimate the total costs associated with the proposed mitigation improvements to the corridor. The two cost performance measures are capital costs (also known as construction costs or upfront costs) and operation and maintenance (O&M) costs (also known as ongoing costs). Capital costs include the construction, right-of-way acquisition, vehicle procurement (transit), and mitigation costs. Construction costs include mainline, ramps, intersections, bridges, signalization, erosion control, drainage, maintenance-of-traffic and mobilization. Unit prices of the construction items were obtained from Caltrans' Contract Cost Database and were applied to the quantity estimates[2]. Capital costs also include costs for engineering, administration, legal services, and a contingency add-in. O&M costs are the annual costs estimated for operating and maintaining the proposed improvement strategies. O&M costs include labor and materials for maintenance and repairs, utilities and financing.

A cost effectiveness analysis was conducted for the three conceptual improvement strategies for SR-12. Each improvement strategy was further sub divided into a logical sub set of improvements or packages based on logical termini, physical proximity, potential implementation timelines and homogeneity of the various packages. Benefits of each of the individual packages were quantified and compared against projected cost of construction, operation and maintenance of such improvements. Exhibits 27 through 29 summarize the results of this analysis.

Findings from the cost effectiveness analysis will serve as input to the next phase of the SR-12 corridor comprehensive study which is the ranking and prioritization of individual packages. The goal of the next phase of the study will be to develop a preferred alternative that draws the most effective elements of the three conceptual improvement strategies presented here.

[2] http://sv08data.dot.ca.gov/contractcost/

Exhibit 27: Life Cycle Cost Effectiveness Analysis for the Gap-fill Strategy

Pkg	Dir.	ID	Mitigation Improvement	Life Cycle Mobility Benefits (Veh-hr of delay saved)	Life Cycle Costs	Cost Effectiveness ($/veh-hr of delay saved)
GP1	Both	1	Implement corridor wide ITS System	18,805,405	$37,000,000	$2.0
GP2	Both	2	Improve bridge operations at the Rio Vista, Mokelumne and Potato Slough bridges including implementation of advance ITS elements	5,613,210	$12,200,000	$2.2
GP3	Both	3	Construct standard width shoulders and improve pavement surface between Liberty Island Road and Drouin Drive	0	$34,800,000	-
GP4	Both	4	Construct streetscaping and pedestrian walkway improvements with curb and gutter improvements for intersections through Rio Vista (Church Road to Rio Vista Bridge)	0	$18,000,000	-
			Total	24,418,615	$102,000,000	$4.2

Source: Atkins, 2011.

Exhibit 28: Life Cycle Cost Effectiveness Analysis for the Barrier Separated Two-Lane Strategy

Pkg	Dir.	ID	Mitigation Improvement	Life Cycle Mobility Benefits (Veh-hr of delay saved)	Life Cycle Costs	Cost Effectiveness ($/veh-hr of delay saved)
BT1	Both	1	Implement corridor wide ITS System	18,805,405	$37,000,000	$2.0
BT2	Both	2	Improve bridge operations at the Rio Vista, Mokelumne and Potato Slough Bridges including implementation of advance ITS elements	5,909,592	$12,200,000	$2.1
BT3	Both	3	Construct standard width shoulders, include passing lanes and improve pavement surface between Walters Road and Rio Vista (Church Road)	1,053,975	$184,100,000	$174.7
BT4	Both	4	Construct streetscaping and pedestrian walkway improvements with curb and gutter improvements for intersections through Rio Vista (Church Road to Rio Vista Bridge)	0	$18,000,000	0
BT5	Both	5	Improve shoulders, pavement and construct median barrier between Rio Vista and Mokelumne bridges	289,755	$90,100,000	$310.9
BT6	Both	6	Improve shoulders, pavement and construct median barrier between Mokelumne and Potato Slough bridges	579,510	$25,200,000	$43.5
BT7	Both	7	Construct standard width shoulders, include passing lanes and address pavement issues between Potato Slough Bridge and I-5	796,650	$30,500,000	$38.3
			Total	27,434,887	$397,100,000	$14.5

Source: Atkins, 2011.

Exhibit 29: Life Cycle Cost Effectiveness Analysis for the Four-Lane Strategy

Pkg	Dir.	ID	Mitigation Improvement	Life Cycle Mobility Benefits (Veh-hr of delay saved)	Life Cycle Costs	Cost-Effectiveness ($/veh-hr of delay saved)
FL1	Both	1	Implement corridor wide ITS system	5,340,000	$49,800,000	$9.3
FL2	Both	3	Construct phase II of the I-80/680/SR-12 interchange which includes interchanges at Beck and Pennsylvania Avenue, Construct intersection improvements from Civic Center to Walters Road Construct six-lane roadway between Abernathy and Walters Road	48,426,495	$75,100,000	$1.6
FL3	Both	4	Construct standard width shoulders, Construct a four-lane roadway between Walters Road and Rio Vista (Church Road)	6,349,713	$249,600,000	$39.31
FL4	Btoh	5	Construct pedestrian improvements, landscaping and the streetscape improvements in downtown Rio Vista (Church Road to Rio Vista Bridge)	733,520	$19,900,000	$27.1
FL5	Both	2	Construct new alignment for the Rio Vista Bridge	8,203,655	$997,500,000	$121.6
FL6	Both	6	Construct new alignment for SR-12 between Mokelumne and Potato Slough bridges and associated changes to access points	5,387,690	$1,433,300,000	$266.0
FL7	Both	7	Construct a four-lane cross-section from Potato Slough Bridge to I-5	2,079,965	$92,600,000	$44.5
			Total	76,521,038	$2,917,800,00	$38.1

Source: Atkins, 2011.

Final Memorandum, March 2012. This memorandum is subject to change with respect to findings and/or conclusions. It should also be noted that these findings and/or conclusions may not ever be programmed due to various reasons, including but not limited to, engineering judgment and/or budget constraints.