STATE OF CALIFORNIA

BUSINESS, TRANSPORTATION AND HOUSING AGENCY

Historical Review of San Francisco-Oakland Bay Bridge East Span Seismic Retrofit Cost Increases

Final Report

Submitted January 19, 2005

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Table of Contents

Executive Summary **1**

Part One: Project Scope and Approach **6**

Part Two: Findings **7**

Introduction 7

Section 2A. 1997 – 2001: A Different Bridge 8

Section 2B. 2001 – 2004: Four Primary Cost-Increase Factors 10

1) Fabricated Steel
2) Time Related Overhead and Mobilization
3) Capital Outlay Support Costs
4) Contingency

Section 2C. Other Factors Underlying the Cost Increases 23

5) Bonding and Insurance
6) Federalization
7) Single Bidder for the SAS Contract

Section 2D. Contribution of the SAS and MTC to Cost Increases 31

Section 2E. Commentary on Project Management and Risk Management 33

Part Three: Cost Increases: A Worldwide Norm **40**

Part Four: Summary of Conclusions **41**

Appendices **42**

A. Timeline of Events Impacting the San Francisco-Oakland Bay Bridge Project
B. Legislative History
C. Caltrans District 4 – Samples of Implemented Changes
D. Glossary

Notes to the Text **58**

Executive Summary

The 1989 Loma Prieta and 1994 Northridge earthquakes prompted California to enact the State Toll Bridge Seismic Retrofit Program (TBSRP) in August 1997. By far the largest of the program's bridge projects is the East Span of the San Francisco-Oakland Bay Bridge (SFOBB). This bridge is three times more costly than any previous Caltrans construction project. In fact, the East Span is one of the most costly, complex, and challenging bridge projects in U.S. history:

- The asymmetrical Self-Anchored Suspension (SAS) feature, with its short tower height and other restrictions, has never been attempted before. Its designers indicated that "this would be the first mono-cable, deck-anchored, vehicular-carrying suspension bridge in the world."[1] Thus, no design or construction experts have experience building such a bridge.
- No bridge has ever been required to meet such a demanding combination of environmental, seismic, and aesthetic requirements.

Since 1997, cost estimates to build the East Span have escalated from $1.29 billion to $5.13 billion. To better understand the factors that led to these cost estimate increases, the California Business, Transportation and Housing Agency (BTH) engaged The Results Group to conduct a historical review focusing on the following four questions:

1. What factors have contributed to the cost increases for the East Span of the San Francisco-Oakland Bay Bridge Seismic Retrofit?
2. To what extent, if any, have external factors out of the control of the Department of Transportation and the State of California contributed to the cost increases?
3. Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?
4. To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increase?

The charge to the review team was to consider only increases in cost estimates, not cost overruns, which occur after a contract has been awarded. This report presents the results of that review, which was conducted over a five-week period beginning in December 2004 and ending in early January 2005.

Bay Bridge East Span Cost Increases

The historical review is segregated into two distinct time periods, as shown in the table below:

Two Phases of Cost Increases			
SFOBB East Span Estimate	**1997** (SB 60)	**2001** (AB 1171)	**2004**
Total Estimate Amount	$1.29 B	$2.60 B	$5.13 B
Amount of Increase		*$1.31 B*	*$2.53 B*
Percentage Increase		*102%*	*97%*

1997 to 2001: A Different Bridge. When Senate Bill 60 (SB 60) passed in 1997, it described a Skyway bridge with a signature "cable suspension" span for which $80 million dollars was allocated, and assigned full responsibility for bridge design selection to the Metropolitan Transportation Commission (MTC). After a comprehensive design process to evaluate multiple design options,

MTC selected to add an asymmetrical Self-Anchored Suspension (SAS) feature with a single tower, which was to be no higher than the towers on the West Span of the SFOBB. This was a fundamentally different bridge than the one envisioned in developing the original estimate for SB 60. In 2001, SAS design work was refined to the 65 percent level, and the Skyway to the 100 percent level; at that time, Caltrans generated an estimate of $2.6 billion in total costs to build the East Span. MTC and its consultant, Bechtel Infrastructure Corporation, reviewed and validated this estimate (suggesting an increase in contingency), which was then established in Assembly Bill 1171 (AB 1171), statutes of 2001.

2001 to 2004: Four Primary Cost-Increase Factors. From the $2.6 billion estimate in 2001, cost estimates continued to escalate until August of 2004. At that time, several factors converged to make it obvious that the East Span could not be built within the amount allocated in AB 1171, including a sole bid of $1.4 billion (using materials from foreign suppliers) to build the SAS. On August 16, 2004, Caltrans presented a new cost estimate of $5.13 billion to the State Legislature. The Results Group's review focused on the primary cost factors that drove this increase. These factors are summarized below and examined in greater detail in the full report, which follows this Executive Summary. Because the effect of these factors can be interactive, the discreet dollar amounts attributed to each factor are to be considered only as an indicator of the magnitude, not a refined estimate, of that factor's impact on the cost increases from 2001 to 2004.

1. **Fabricated Steel**. From 2001 to 2004, the amount included for steel in the East Span increased by more than $500 million. This increase has two drivers. The first is the market cost to purchase steel, which increased in this time period. The second and much more significant driver is the cost of steel *fabrication*. Most of the steel components of the SAS must be manufactured to tight tolerances, then transported to Oakland to be assembled into the suspension structure somewhat like a jigsaw puzzle. Fabrication represents the vast majority of the steel cost, rather than the purchase price of the steel itself. In 2002, Caltrans commissioned a study by respected industry experts to assess both foreign and domestic sources of these fabricated steel components and determined that there would be little probability of obtaining them domestically. In 2004, the Department explored the possibility of a federal waiver of the Buy America provision for the East Span project, and concluded that such a waiver would not be forthcoming. The 2004 Caltrans estimate takes all of these factors into account. It is presumably a more reliable estimate given that it incorporates a much higher contingency and is informed by both the actual bid to build the SAS superstructure, an independent review by Bechtel Infrastructure Corporation, knowledge gained by working with foreign steel suppliers on other bridges, and the experience thus far of building approximately half of the East Span Skyway.

2. **Increased Capital Outlay Support Costs**. Caltrans Capital Outlay Support (COS) costs, which include the Department's project staffing and overhead costs, rose by nearly $500 million between the 2001 and 2004 cost estimates. Typically, COS on mega-projects across the United States run in the millions of dollars per day. As the East Span project's estimated completion date moved from 2007 to 2011, additional days rapidly increased COS cost estimates. While the schedule was developed by Caltrans, not all of the factors driving schedule changes were within its control. For example, the construction industry requested additional time as design work progressed and the complexity and difficulties of building this bridge became more apparent. In some cases, Caltrans chose to trade increases in COS for the potential of larger cost savings in other areas (for example, by dividing the East Span contract into 16 smaller projects, Caltrans risked cost increases from schedule delays against the possibility of even greater reductions in construction costs by garnering more competitive bids).

3. **Contractors' Time-Related Overhead and Mobilization.** The 2004 estimate for contractors' time-related overhead (TRO) increased by over $350 million, and contractor's mobilization (which includes costs to bring project workers and equipment to the job site) increased by $250 million. Thus, together these two factors contribute over $600 million. Similar to Capital Outlay

Support (COS), the contractors building the project have time related overhead (TRO) costs. This factor is outside the control of Caltrans, and must be accounted for in any cost estimate.

4. **Contingency.** Cost estimates for all mega-projects include a significant contingency factor, based on the amount of risk and uncertainty associated with the project. The contingency estimate in 2004 exceeded the 2001 amount by over $250 million. This increase was determined by Caltrans based on the growing awareness of the complexity of the project, and the worldwide absence of any design or construction experience building a large, asymmetrical SAS (much less doing so with the unprecedented combination of aesthetic, environmental and seismic requirements of the East Span). In addition to the contingency amount included with the cost estimate for each Toll Bridge project, the TBSRP has an overall contingency factor in its budget. In both 2001 and 2004, Caltrans estimates for contingency were in line with the recommendations of industry experts for both project-level and program-level contingencies.

Other Factors Underlying the Cost Increases

The following factors had significant bearing on cost increases, but because they underlie the above factors, their impact is less directly quantifiable.

- **Bonding and Insurance**. Major changes in bonding and insurance practices occurred between 2001 and 2004, driven largely by the September 11, 2001 attacks and a series of large corporate bankruptcies in the early 2000's. Contractors were required to demonstrate greater financial strength than before, reducing the number of competitors able to obtain a large enough bond to bid on major East Span contracts. Also, since rates are affected by the length of the project schedule and the total project cost, bonding and insurance costs are to some extent a secondary factor driven by other cost increase factors. These considerations caused The Results Group to classify bonding and insurance as an underlying factor, and lack of 2001 data caused the review team not to develop an estimate of the cost increases. It can be deduced, however, that a major portion of the $250 million included in the 2004 estimate for bonding and insurance was an increase over the amount that would have been included in the 2001 estimate.
- **Federalization**. In 2000, Governor Gray Davis announced that federal funds would be applied to three TBSRP projects. "Federalization" added several new requirements to the East Span project. Most significant is the requirement to give preference to American suppliers of materials and services, known as the "Buy America" provision. This decision was outside the control of Caltrans, but to address its implications, between 2001 and 2004 the Department and its expert consultants identified major federalization issues (e.g., steel prices, project delays, and lack of bidder competition) and developed strategies to mitigate their effect on the East Span project.
- **Single Bidder**. Given consolidation within the construction industry and changes in the bonding market (described above), Caltrans recognized the possible lack of competitors to bid on large projects, in particular the SAS. The Department took numerous steps to maximize the number of bidders on the SAS project, including implementing recommendations from numerous studies and suggestions from construction industry leaders. Nonetheless, only one bid was received. The President and CEO of American Bridge, the sole bidder, indicated in a meeting convened by Caltrans that a re-bid, if it garnered multiple bids, should yield at least a five to ten percent cost savings, simply because there is "now a number out there that everybody knows."[2] Thus, while the single bid appears to be a factor in higher costs for the SAS, there is no industry standard for quantifying the effect of a single bid on a unique mega project like the SAS, so any attempt to quantify the impact of the single SAS bid would be highly speculative.

Commentary on Project Management and Risk Management

It is difficult to quantify the impacts of Caltrans project management practices on the estimated cost of the East Span project. On the one hand, there were several problems in the project management arena. District management and project-level management staffing changes were frequent; primary project responsibility alternated between the district and headquarters; and the project lacked a high-level single point of authority until very recently, despite numerous consultant reports calling for it. Thus, at times responsibility appears to have been diffuse and undefined, and communication among Caltrans units poorly coordinated. Typically, these project management problems can hamper decision making and impede progress, which in turn can affect the project timeline and costs.

On the other hand, the Department took a number of important, positive steps in project management and risk management. Throughout the project, Caltrans proactively sought guidance and scrutiny from industry experts and review panels regarding virtually all major project decisions. Caltrans obtained the Pier 7 Campus for a joint project management facility (for Caltrans and contractor staff) to enhance communication and accelerate approval processes, and thus avoid unnecessary delays. The East Span project was divided into multiple contracts, which may have increased initial costs but should ultimately achieve much greater savings by addressing risk issues (including several identified in this report). Over the life of the project, various Caltrans risk management and project management practices will undoubtedly impact positively on the East Span timeline and costs.

Weighing the positives and negatives, the review team concludes that the effects of Caltrans project management practices cannot be readily quantified. However, within the limited scope of this project and without more data to the contrary, it appears that Caltrans project management practices were unlikely to have contributed significantly to cost increases (i.e., on the order of magnitude of hundreds of millions of dollars, as is the case with the cost factors discussed above). Caltrans has recently elevated project leadership to the Chief Deputy level, and is developing a comprehensive project management and risk management plan. If these plans include specific action steps and an ongoing monitoring process, and senior management ensures consistent implementation across work units, Caltrans project management will undoubtedly continue to improve.

Contribution of the SAS and MTC to Cost Increases

Prior to the passage of SB 60, the replacement planned for the East Span was a standard freeway viaduct bridge. It was designed to fulfill a need to provide equivalent transportation capacity as the existing bridge, while allowing for economical, rapid construction. As indicated throughout this report, the decision to incorporate into the East Span an unprecedented SAS signature feature appears to have been the single largest driver of the cost increases for this bridge.

Context: The Worldwide Norm is to Underestimate Costs of Large Public Works Projects

The SFOBB East Span is not unusual in experiencing increases in project cost estimates. Numerous studies in recent years point to the fact that most estimators – including public and private sector experts worldwide – generate estimates for large public works projects that ultimately turn out to be low. A European study found that cost underestimation occurs in nine out of 10 projects, and is found in 20 nations on five continents. Another study shows that the problem of underestimation dates back to at least the Holland Tunnel, which connects New York and New Jersey. The tunnel was first proposed in 1919 to be constructed for $12 million over a three-year time period, but finally opened 8 years later and cost over $48 million. A more recent example is Boston's "Big Dig," which included an elevated roadway, a tunnel, and a bridge, was originally

estimated to cost $2.6 billion and be completed in 1998. The current estimate is $14.6 billion with completion in 2005.

Typically on very large public works projects, cost estimates become more accurate, and much larger, as projects unfold, the unknowns and complexities become clearer, and estimators are better able to assess project risks and costs. One study indicates that major changes affecting cost estimates are to be expected in highly complex and technologically challenging mega projects. Numerous factors can cause estimates to increase, including: changes in project scope, local governmental pressures, a transformation of community expectations, unforeseen engineering complexities and constructibility issues, and changes in market conditions. All of these factors affected the East Span.

Conclusions

The Results Group's review team has concluded that the three fundamental factors caused cost estimates for the East Span to double in 2001, then nearly double again in 2004:

- *External Market Conditions*. These conditions include increases in the cost for steel and its fabrication, as well as industry consolidation and other construction industry dynamics that limited the number of potential competitors to build the components and erect the bridge.
- *Design Complexity*. The design for the East Span replacement calls for a relatively long asymmetrical SAS span. Nothing like this has ever been built before. The initial optimism in 1998 that it could be built for a few hundred million dollars was highly unrealistic. Cost estimates for the entire East Span project have been driven steadily upward by a growing realization of the cost and complexity of the SAS.
- *Time*. The projected schedule for the East Span lengthened from 48 to 84 months, and the proposed completion date slipped from 2007 to 2011. This escalated project cost estimates due to inflation and increases in Caltrans and contractor overhead.

The East Span is at least three times more costly than any project ever built by Caltrans before, and the SAS span, according to its initial designers, "would be the first mono-cable, deck-anchored, vehicular-carrying suspension bridge in the world." In June 1998 when the SAS design was selected, none of the parties – from State government to local entities to the public – fully comprehended the cost implications of the enormity of this project, in particular the complexity of the SAS.

Each of Caltrans' major project cost estimates were developed in conjunction with or validated by leading international engineering and design companies. Nonetheless, at each juncture, the previously developed project schedules and cost estimates fell short. This project is not unlike most mega-projects around the world in suffering cost increases and schedule extensions. As studies of these projects reveal, the largest single factor may be the inability of the human mind to grasp, or perhaps to accept, the magnitude of the undertaking and the time and resources required to complete it.

Part One – Project Scope and Approach

The Business Transportation and Housing Agency engaged The Results Group to review the history of the Bay Bridge East Span replacement project and determine what events lead to the significantly increased cost estimates between 2001 and 2004. Specifically, The Results Group was tasked with answering four basic questions:

1. What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?

2. To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?

3. Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?

4. To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increases?

This report focuses on these four questions. In priority, emphasis was to be given to questions one, two, and four, with question three as a secondary focus.

Rather than addressing each question independently, the format of the report recognizes the interconnection between questions one, two, and three. These questions are addressed under each individual cost factor. Question four is addressed separately in Section 2D, "Contribution of the SAS and MTC to Cost Increases."

The Project Methodology used in our assessment is based on four primary steps:

- Review and compare cost estimates for 1997, 2001, and 2004
- Identify and categorize the primary and secondary factors leading to cost increases
- Assess whether the cost increases should have been anticipated and addressed
- Examine the extent of contribution to cost increases by the SAS and MTC

The project timeline was very short: approximately three weeks to prepare initial findings and an additional two weeks to prepare the final report. Thus, the focus of the review team's work was the collection and analysis of existing data and gathering of information from informed sources, not performing independent detailed checks of engineering or estimating practices.

In all, nearly 50 documents comprising more than 4,000 pages have been gathered and reviewed by The Results Group's team. Individual interviews or group meetings have been conducted with more than 40 individuals, including representatives from Caltrans, Metropolitan Transportation Commission, Bay Area Toll Authority, County Transportation Authorities, Golden Gate Bridge Highway and Transportation District, contractors, legislative staff, local government agencies, private sector entities, and independent consultants. Documented information was deemed of primary importance, whereas conversations and discussions were generally given less consideration in the determination of findings and conclusions.

Part Two – Findings

Introduction

The cost increases under consideration in this review ultimately come down to two numbers:

- The $1.31 billion difference between the cost estimate of 1997 (reflected in SB 60) and the cost estimate of 2001 (reflected in AB 1171)
- The $2.53 billion difference between the cost estimate of 2001 (reflected in AB 1171) and the cost estimate reflected in the August 2004 Caltrans report to the Legislature

These cost estimates and cost increases are illustrated in the following table.

Two Phases of Cost Increases: 1997-2001 and 2001-2004			
	1997 (SB 60)	**2001** (AB 1171)	**2004**
Total Estimate Amount	$1.29 B	$2.60 B	$5.13 B
Amount of Increase		*$1.31 B*	*$2.53 B*
Percentage Increase		*102%*	*97%*

The Results Group review team's findings are presented in the following five sections:

Section 2A considers the first cost increase (between 1997 and 2001).

Section 2B identifies four primary factors driving the second cost increase (between 2001 and 2004). For each, it answers three of the four questions that are the focus of this review:

1. *What factors have contributed to the cost increases for the East Span of the San Francisco Oakland Bay Bridge?*
2. *To what extent have external factors out of control of Caltrans and the State of California contributed to the cost increases?*
3. *Which cost increases should have been anticipated and what additional practices should have been employed to better estimate costs?*

Section 2C considers underlying factors that contributed to some or all of the cost increases.

Section 2D discusses Caltrans Project Management and Risk Management practices.

Section 2E addresses the fourth of the four questions that are the focus of this review:

4. *To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increase?*

Section 2 A

1997 to 2001: A Different Bridge

It is often stated in the media that the cost of the East Span project has ballooned from $1.3 billion in the SB 60 estimate to more than $5 billion in current estimates.[3] However, these statements overlook the fact that the current bridge, now under construction, is not an evolution of the original SB 60 design. It is a different bridge.

The SB 60 Bridge. The language and budget in SB 60, passed in August 1997, called for a standard freeway viaduct bridge with a "cable-suspension span." SB 60 did not envision a bridge rich in architectural features and amenities; rather, it was intended to provide a solution to the public safety concerns surrounding the existing bridge, which had suffered a partial collapse in the Loma Prieta earthquake. It was a straightforward design to fulfill the need for transportation capacity equivalent to the existing bridge, with an emphasis on economical, rapid construction.[4]

The MTC Bridge. With the passage of SB 60, the authority to select the bridge desing was granted to the Metropolitan Transportation Commission (MTC). In light of that responsibility, MTC established the Engineering and Design Advisory Panel (EDAP), comprised of expert architects, geologists, and bridge engineers, to evaluate the viability of various bridge alternatives. The EDAP began by considering a variety of conceptual bridge types based on design work developed to about the 10 percent level. Out of those evaluations came 17 design recommendations that were adopted by MTC on July 30, 1997.[5] These recommendations became the guidelines for the new bridge design. The following is a partial list of those recommendations that fundamentally changed the SB 60 bridge design:

- The new eastern span should have a cable-supported main span with a single vertical tower with single or multiple legs in the transverse direction and single or multiple planes of supporting cables.
- The tower on the eastern span should be no taller than the suspension towers on the existing western span.
- The "diamond" shape for the tower should not be employed on the eastern span.
- The new eastern span should be built on the northern adjacent alignment.
- The new eastern span should have two parallel separated decks on the causeway section and either parallel separated deck or a single deck on the cable-supported section.
- The new eastern span should have 10 traffic lanes, five in each direction, with two standard 10' shoulders in each direction.
- The Skyway section should have long, equal span lengths.
- The new eastern span should be designed to accommodate the possibility of future rail service.

A further recommendation was for Caltrans to select two design teams, each of which would develop a cable-supported alternative to approximately the 30 percent level of design. This was intended to provide reliable information as to seismic performance, cost, visual design, and other issues, which could be used in making a final selection. The joint venture of TY Lin, International (TYLI)/Moffat & Nichol was selected to perform this work. By May 1998, TYLI had completed 30 percent design for a Cable Stay bridge and Weidlinger Associates, Inc. (WAI), as a subconsultant to the joint venture, had completed 30 percent design for the SAS bridge option. On June 24, 1998, the SAS design was selected by MTC.[6]

Rapid Increases in Cost Estimates. Once the preliminary design of the SAS was selected, based on a modified 30 percent level of design, further design work proceeded and cost estimates escalated rapidly, as shown in the table below.

Evolution of East Span Design and Cost Estimates			
Date	**Design Level or Document**	**Prepared By**	**East Span Cost Estimate**
August 1997	SB 60 [7]	Caltrans/State Legislature	$1.3 B
May 1998	30% Design Report Draft[8]	Caltrans/ TYLin/ M&N	$1.5 B
June 1998	30% Modified Design – SAS Selected [9]	Caltrans/ TYLin/ M&N	$1.6 B
July 1999	45% Design [10]	Caltrans/ TYLin/ M&N	$1.7 B
December 1999	65% Design [11]	Caltrans/ TYLin/ M&N	$2.0 B
April 2001	100% Design for Skyway, 65% Design for SAS [12]	Caltrans/ TYLin/ M&N	$2.6 B
July 2001	TBSRP Cost Review Report[13]	Bechtel	$2.6 B - $3.0 B
September 2001	AB 1171[14]	Caltrans/ TYLin/ M&N	$2.6 B

As can be seen in the table, the costs for the East Span increased steadily between 1997 and 2001. Some of these increases can be attributed to the following:

- In May 1998, the SAS was asymmetric having a 215 meter (705 foot) reach to the west and a 275 meter (902 foot) reach to the east of the main tower. In June 1998, the SAS design was modified to increase the asymmetry of the bridge. The reach to the west of the tower was reduced to 180 meters (591 feet) and the reach to the east was increased to 385 meters (1263 feet).
- Steel quantities for the deck, towers and cables experienced approximately a 30 percent increase between 30 percent and 65 percent levels of design. This appears to be due, in part, to new seismic ground motion information that was incorporated in the post-30 percent designs.[15]

By September 2001, the SAS design work was refined to the 65 percent level, and the Skyway to the 100 percent level. At that time, Caltrans generated an estimate of $2.6 billion to build the bridge. MTC and its consultant, Bechtel Infrastructure Corporation, reviewed and validated this $2.6 billion estimate, which was then incorporated into AB 1171, and approved by the legislature on September 15, 2001.

Conclusions

Between 1997 and 2001, the East Span of the Bay Bridge was fundamentally redesigned to incorporate design recommendations put forth by the EDAP and MTC. The Skyway portion was modified, and the unique and complex SAS design was selected as the “cable suspension span” called for in SB 60. Today, the SB 60 estimate is frequently cited as a “baseline” for cost increases to build the current East Span. This is misleading, in that the difference between the SB 60 cost estimate and the AB 1171 cost estimate is largely attributable to the fact that it is a fundamentally different bridge.

Section 2 B

2001 – 2004: Four Primary Cost-Increase Factors

This section examines the factors that drove increases in costs between the 2001 estimate reflected in AB 1171, and the 2004 estimate reflected in the Caltrans report to the Legislature. The following table presents the total cost increases for the East Span and its component parts.

Estimated East Span Costs [16]
Increases from 2001 to 2004
In millions

2001 Estimate	2004 Estimate	Cost Increase	Percentage Increase
$2,602	$5,131	$2,529	97.2%

The Results Group review team has identified four primary factors that contributed substantially and directly to these cost increases:

1. Fabricated Steel
2. TRO and Mobilization
3. Capital Outlay Support Costs
4. Contingency

The following pages discuss these cost factors and answer the following questions regarding each:

- Did this factor contribute significantly to the cost increases for the East Span between the 2001 estimate and the 2004 estimate?
- To what extent was this an external factor out of the control of Caltrans and the State?
- To what extent should this cost increase have been anticipated, and what additional practices should have been employed to better estimate costs?

In answering the first question, some attempt has been made to quantify the amount that factor may have contributed to the overall cost increases. However, this amount is to be considered only as an indicator of the magnitude of these cost increases, not a precise calculation. These factors, as well as those discussed in the next section, are interactive and interdependent. Assigning dollar amounts to each is a matter of judgment, including how to categorize various expense components.

Cost-Increase Factor 1: Fabricated Steel

Question 1: Did this factor contribute significantly to the cost increases for the East Span between the 2001 estimate and the 2004 estimate?

Fabricated steel is a major factor in the total cost of the bridge. It is also a major factor in the increases in cost estimates between 2001 and 2004, as shown in the following table.

***East Span Cost of Fabricated Steel*[17]**
Increases from 2001 to 2004

In millions	2001 Estimate	2004 Estimate	Cost Increase	Percentage Increase
Entire East Span	**$566**	**$1,110**	**$544**	**96.1%**
Skyway	$287	$364	$77	26.8%
SAS/YBI*	$241	$698	$457	189.6%
East Span Other	$38	$47	$9	23.7%
**SAS Breakdown:*				
SAS Superstructure	$159	$610	$451	283.6%
SAS Other	$82	$88	$6	7.3%

Steel is an important component in determining the cost of the East Span, and particularly the SAS, for several reasons. First, the SAS requires over 60,000 tons of fabricated steel,[18] thus per-unit market price is a significant factor. Second, the requirements for the steel in the SAS are unusual:

- The single 525-foot tower is constructed of steel fabricated into separate pre-formed sections, which must be transported to Oakland where the component pieces will be assembled into the suspension superstructure. This presents potential challenges in fabrication, transport, and erection. "The tower is a complex structure, tapered over its height, and requiring precise alignment between adjoining sections."[19]
- The steel suspension cabling must meet high quality and tight strength tolerances, presenting potential fabrication challenges. For example, the diameter of the main cables is approximately equal to that required for a conventional suspension bridge with twice the span of the SAS.[20]
- The bridge deck also has substantial steel requirements, more than is typical because of the extreme stress the SAS design places upon the roadway.[21]

It is important to emphasize that the SAS requires over 60,000 tons of *fabricated* steel. According to a 2002 study conducted for Caltrans by Aecom Consulting and Metal Strategies, the cost of fabricated steel is determined less by the per-unit purchase price of the steel, and more by fabrication, which can represent up to 75-80 percent of the cost of the delivered price of steel. "Bridge plate fabrication is the most costly component of structural steel used in large bridges, due to its high labor-intensity."[22]

Question 2: To what extent was this is an external factor out of the control of Caltrans and the State?

The State does not control the price of steel on the world market, or the cost of fabricating complex bridge components. In the case of the SAS, Caltrans also did not control the selection of the bridge design (and thus its unique steel requirements), as that authority was granted to MTC by SB 60.

Question 3: To what extent should this cost increase have been anticipated, and what additional practices should have been employed to better estimate costs?

World Market Factors. At the time of the 2001 estimate, it would have been difficult to predict that the cost of steel would increase dramatically over the next three years. A number of factors drove steel prices upward World demand for steel increased as a result of the September 11th terrorist attacks that occurred four days before AB 1171 was approved by the legislature, the war in Iraq driving the military's need for steel, and the tremendous demand created by a surge in construction in China. These increases have recently been highlighted in industry publications, including a September 2004 article entitled "Steel Prices Unparalleled in Recent History."[23] The popular press also carried the story, such as a USA Today article dated February 2, 2004, entitled "Steel Prices Soar 66 percent in a World Market Gone Mad," which states that "the price of a ton of hot-rolled coil steel in the USA hit $482 this month, up 66 percent from the recent low set in June. Prices rose because of a variety of factors, most notably skyrocketing demand from China's rapidly expanding economy."[24]

Limited Domestic Suppliers. There is limited market capacity to compete for the contract to provide the steel for the SAS, particularly in the United States. As noted above, the SAS superstructure (tower and orthotropic steel structure) will require over 50,000 tons of fabricated structural steel. Caltrans indicated in a letter to the federal government in April of 2004 that there is no steel fabricator in the United States able to provide this to Caltrans' standards. To be able to provide the steel for the SAS would require the formation of a consortium of companies who would build new fabrication facilities and hire staff just for this project; and since this capacity is not likely to be needed again, the consortium could be expected to allocate 100 percent of the cost to the SAS.[25]

The number of potential American companies available to join such a consortium is limited. In fact, as stated in an assessment of the SAS by Booz-Allen Hamilton, "the capacities of individual domestic steel suppliers may be insufficient to satisfy the material delivery requirements of the project, either individually or collectively."[26]

The foreign market has much greater capacity to provide the fabricated steel for the SAS. As stated in the 2002 report from Aecom Consulting, "the Pacific-Rim countries of Japan, South Korea, and China have made the most significant gains in market share of world-wide steel production. South Korea currently dominates the import market for structural steel components for bridges in the Unites States, comprising over 50 percent of this market."[27] The report concludes: "in our opinion, there will be ample foreign steel mill capacity to supply structural and other bridge-related steel products for the very large steel bridge projects that are planned in the near future ... there is ample

capacity and expertise within the foreign steel industry to fabricate and deliver complex structural steel bridge sections to U.S. markets."[28]

Obtaining a Reliable Estimate. When the 2001 estimate was developed, it would have been very difficult to obtain a highly reliable estimate of costs to build the SAS. Only one other SAS bridge had been built in the previous 40 years, and none had ever been built with the asymmetrical design and other features of the East Span SAS. As is still the case today, no fabricator or contractor was in a position to make a firm estimate based on actual experience of the cost to produce the required steel components for the SAS.

Caltrans Practices. While Caltrans could not be expected to have predicted world events leading to a rapid rise in steel costs, much of the cost of the steel in the SAS was not determined by world prices, but by fabrication costs. Given the complexity of fabrication and the stringent requirements for the SAS components, it would have been prudent to include a higher level of contingency in its 2001 estimate of steel costs. However, the 2004 estimate brought forward to the Legislature includes a significant increase in contingency, as recommended by Bechtel Infrastructure Corporation.[29] Furthermore, that estimate is based on a great deal of information that was not available in 2001. An actual bid has been submitted to build the SAS, presumably reflecting an adequate estimate of steel fabrication costs. Also, the Skyway portion of the bridge is well on its way to completion, and engineering design has progressed on aspects related to the SAS. Thus, it is reasonable to expect that the current estimate for the East Span much more accurately projects costs the State would incur in completing the bridge as it was designed in 2004.

Regarding the lack of domestic producers, Caltrans has also taken steps to address this issue. Several representatives of the State, including staff from BTH and Caltrans, reported to review team members that they traveled to Japan to explore the State's options for procuring fabricated steel components on the world market (primarily in the context of monitoring contracts Caltrans had with suppliers at the time).[30] Furthermore, in 2002 Caltrans engaged Aecom Consulting to conduct two studies. The first examined foreign, and the second domestic, sources of structural steel components for large steel bridge projects in California.

Thus, the review team has concluded that Caltrans does not appear to have overlooked or neglected standard practice in developing its 2004 cost estimates for the price of steel.

Conclusions

Increased steel costs account for more than $500 million of the difference between the 2001 and 2004 East Span cost estimates. Caltrans could not have been expected to anticipate external factors such as the September 11th, 2001, attacks or the level of demand on the part of the Chinese that drove up steel prices, but nonetheless included insufficient contingency in its 2001 estimates. The 2004 estimate can be expected to much more accurately project costs the State would incur to complete the bridge as designed in 2004; this estimate includes a much higher contingency and reflects the experience of building a significant portion of the East Span.

Cost-Increase Factor 2: Time Related Overhead and Mobilization

Question 1: Did these factors contribute significantly to the cost increases for the East Span between the 2001 estimate and the 2004 estimate?

Two separate factors – time related overhead (TRO) and mobilization – are being addressed together in this section because they bear a close relationship to each other. Both are overhead costs incurred by the contractor who is building a Caltrans project. However, they are determined by a different set of forces. As its name implies, TRO is driven by time, particularly the length of the project. It consists of the salaries, benefits, and other overhead costs incurred by the contractor for management and clerical personnel, both on and off the job site, on a daily basis during the course of the project. Mobilization is the cost a contractor incurs bringing project resources to the site, setting up, and preparing to begin work.

Each of these factors contributed significantly to the cost increases between the 2001 and 2004 cost estimates for the East Span. TRO added over $350 million, as shown in the following table.

East Span Cost of TRO[31] Increases from 2001 to 2004

In millions	2001 Estimate	2004 Estimate	Cost Increase	Percentage Increase
Entire East Span	**$222**	**$580**	**$358**	**161.3%**
Skyway	$80	$208	$128	160.0%
SAS/YBI*	$98	$305	$207	211.2%
East Span Other	$45	$67	$22	48.9%
**SAS Breakdown:*				
SAS Superstructure	$59	$206	$147	249.2%
SAS Other	$39	$99	$60	153.8%

Similarly, contractor mobilization contributed over $250 million in cost increases, as shown in the following table.

East Span Cost of Mobilization[32] Increases from 2001 to 2004

In millions	2001 Estimate	2004 Estimate	Cost Increase	Percentage Increase
Entire East Span	**$163**	**$417**	**$254**	**155.8%**
Skyway	$62	$93	$31	50.0%
SAS/YBI*	$55	$257	$202	367.3%
East Span Other	$45	$67	$22	48.9%
**SAS Breakdown:*				
SAS Superstructure	$44	$204	$160	363.6%
SAS Other	$11	$53	$42	381.8%

Combined, these two factors contributed approximately $600 million to the cost increases:

East Span Cost of TRO and Mobilization[33] Increases from 2001 to 2004				
In millions	2001 Estimate	2004 Estimate	Cost Increase	Percentage Increase
Entire East Span	$385	$998	$613	159.2%
Skyway	$142	$300	$158	111.3%
SAS/YBI*	$153	$562	$409	267.3%
East Span Other	$89	$134	$45	50.6%
**SAS Breakdown:*				
SAS Superstructure	$103	$409	$306	297.1%
SAS Other	$50	$153	$103	206.0%

Question 2: To what extent was that an external factor out of the control of Caltrans and the State?

Both of these factors are ultimately controlled by the contractor, who allocates resources to the project and thus determines the amount he will spend on administrative overhead and mobilization. However, in this case a comparison is being made between two estimates of TRO developed by Caltrans, along with industry experts who participated in development of the estimates and others who reviewed them. Thus, Caltrans had a limited amount of control, in that it determined how best to estimate contractor expenditures for TRO and mobilization.

Question 3: To what extent should this cost increase have been anticipated, and what additional practices should have been employed to better estimate costs?

Time Related Overhead. Contractors' bids specify only a total for TRO. Caltrans cannot be certain what specific factors are included at what rate in any particular bid. Thus, although a contractor's actual cost for daily administrative overhead is driven by time, Caltrans utilizes a percentage of project capital outlay costs to establish a cost estimate for TRO. Typically, this amount is five percent. However, given the complexity of the East Span project, the Department doubled its normal rate, factoring in 10 percent for TRO into the 2001 cost estimate.[34]

Within a few months, Caltrans had several indications that even this larger TRO percentage was insufficient. One such indication was in December of 2001, just months after the 2001 estimate was finalized and AB 1171 was enacted, Caltrans accepted a bid for the Skyway portion of the East Span in which TRO was $208 million and 235 percent higher than the AB 1171 estimate.[35] During the same time period, Caltrans was receiving information from contractors, as part of its contractor outreach program that the proposed construction schedule for the SAS needed to be extended.[36]

The 2001 estimate for TRO on the SAS more than doubled in the 2004 estimate. This is a clear indication that simply doubling the five percent formula for approximating TRO was not adequate. In establishing its 2004 cost estimate, Caltrans had contracts or bids in place for the majority of the components of the East Span, including a single bid for the SAS. The following table indicates that estimators did not base their estimates on a fixed percentage of capital outlay cost, and that the major components of the bridge significantly exceeded the 2001 estimate of ten percent of capital outlay costs.

2004 East Span Cost of TRO[37]
As a Percentage of Capital Outlay Costs

In millions	2004 Capital Outlay	2004 TRO	TRO as Percentage of CO
Entire East Span	$4,252	$580	13.6%
Skyway	$1,293	$208	16.1%
SAS/YBI*	$2,287	$305	13.3%
East Span Other	$672	$67	10.0%
* *SAS Breakdown:*			
SAS Superstructure	$1,682	$205	12.2%
SAS Other	$605	$99	16.4%

In total, TRO estimates for the East Span increased by $358 million and more than 160 percent between 2001 and 2004. It appears that Caltrans and the many consultants and industry experts who reviewed its estimates underestimated the scope and complexity of the East Span, particularly the SAS.

Mobilization. This item consists of the costs the contractor incurs in bringing to the job site all of the materials, equipment, and other resources necessary to begin the specific project. Mobilization is an early work item, so the contractor will begin receiving payment shortly after the contract is signed. Unlike TRO, the contractor's mobilization cost is not driven by the length of the project schedule, but like TRO, it is bid as a single total amount.

In estimating mobilization, Caltrans utilizes a formula that applies a percentage to the project capital costs, similar to the approach for estimating TRO. For the Skyway, Caltrans expected mobilization to represent approximately 10 percent of the capital costs. The mobilization amount estimated in 2001 had increased by $30.8 million in 2004. The increase of $30.8 million reflects an overall higher capital cost for the Skyway project, and the overall percentage is in line with estimates.

For the SAS Caltrans expected mobilization to also be approximately 10 percent. However, in the single bid received on the SAS mobilization was 15 percent. That higher percentage, coupled with the single bid, 100 percent higher than estimated, (in AB1171), resulted in increased mobilization costs. In response to contractors' input, in AB 1171, Caltrans increased contractual mobilization payments in order to relieve cash flow constraints and mitigate the costs of project financing.[38] Additionally, there is not a crane in the United States that can lift the tower sections. A marine crane of sufficient capacity,

(whose movement meets the requirements of the Jones Act), would have to be procured and provided to the construction site. This crane would represent an exceptional and unique mobilization factor. For a project of this complexity, mobilization costs may also have included steel fabrication shop preparation to set all of their machines to be able to construct the deck and tower segments. .

Conclusions

The 2004 estimate for contractors' time-related overhead (TRO) increased by over $350 million, and contractor's mobilization increased by $250 million. Thus, together these two factors contribute over $600 million to the increase in costs estimated by AB 1171 and by Caltrans in August 2004. Similar to the department's Capital Outlay Support (COS), the contractors building the project have time related overhead (TRO) costs. This factor is outside the control of Caltrans, and must be accounted for in any cost estimate.

Cost-Increase Factor 3: Capital Outlay Support Costs

Question 1: Did this factor contribute significantly to the cost increases for the East Span between the 2001 estimate and the 2004 estimate?

Capital Outlay Support (COS) consists of Caltrans costs to design and mange the project, including salaries, benefits, and operating expenses of its staff. It also includes the costs of consultants who perform a portion of this work (such as design, project, oversight). The COS budget does not, however, include the salaries and benefits of the contractors who construct the actual projects. Rather, these costs are part of TRO (see Cost Increase Factor 3 above) and are included in the capital outlay budget. The Department requests capital outlay support resources through the legislative budget process each year. The Legislature provides a level of COS resources in its budget approval.

In 2001, the estimated COS for the East Span project was $382 million; this rose to $878 million in the 2004 estimate, an increase of $496 million. Of this, $202 million is allocated to the SAS.

The following table shows the change in COS from 2001 to 2004.

East Span Capital Outlay Support[39] Increases from 2001 to 2004

In millions	2001 Estimate			2004 Estimate		
	Capital Outlay Support (COS)	Capital Outlay (CO)	COS as % CO	Capital Outlay Support (COS)	Capital Outlay (CO)	COS as % CO
Entire East Span	**$382**	**$2,219**	**17.2%**	**$878**	**$4,252**	**20.7%**
Skyway	$130	$796	16.3%	$197	$1,293	15.2%
SAS/YBI*	$113	$718	15.7%	$259	$1,919	13.5%
East Span Other	$140	$705	19.8%	$423	$1,039	40.7%
**SAS Breakdown (includes Superstructure, Foundations, and YBI work):*						
SAS Superstructure	$92	$589	15.7%	$202	$1,682	12.0%
SAS Fndn/YBI	$20	$128	15.7%	$57	$237	23.8%

Question 2: To what extent was this an external factor out of the control of Caltrans and the State?

COS is estimated and controlled by Caltrans.

Question 3: To what extent should this cost increase have been anticipated, and what additional practices should have been employed to better estimate costs?

COS is affected by many aspects of a project, including capital outlay, complexity, and time. Caltrans estimates COS utilizing a combination of methodologies, including a computerized cost estimating system, experience

on previous projects, and professional judgment, to incorporate these factors into its COS estimates.[40]

Capital Outlay. As the table above shows, COS estimates in 2001 were all similar as a percentage of capital outlay costs. However, in 2004 the ratio of COS to capital outlay varied significantly among components of the East Span project. Most notably, COS for the SAS Superstructure represents 12 percent of its capital costs. For the next largest capital item, the Skyway, COS represents 15 percent of capital costs.

Project Complexity. COS costs are determined in part by the size and complexity of the project, which impacts the need for project management resources. As described elsewhere in this report, the East Span project is the largest and most complex ever undertaken by Caltrans. The SAS portion of the design is unique and involves many unknowns. Building it will require the participation of multiple contractors and providers of specially-fabricated materials. Were it to move into construction, it is reasonable to expect that it would require greater project management resources than the typical Caltrans project. It is far more complex and involves greater risks and uncertainties than the Skyway, which utilizes a type of construction with which Caltrans has extensive experience. Furthermore, construction of the Skyway is more than half way to completion.

Time. Because COS is an ongoing cost for the duration of the project, it is also directly impacted by the length of the project schedule. Regarding the East Span project, since the enactment of AB 1171 a growing realization of the complexities and challenges of delivering the project, particularly the SAS component, has lead to expansion of the project timeline. In addition, Caltrans conducted an extensive outreach program to the construction industry and expanded the schedule for the SAS in response to feedback from this outreach.[41] The estimated schedule for construction of the SAS has lengthened from 36 months, whereas the schedule for the Skyway, which is much further along in the process and thus will have experienced the majority of schedule delays, increased by three months.[42]

The SAS is more complex and has experienced much greater schedule delays than the Skyway. Thus, it is not surprising that from 2001 to 2004 the total amount of COS for the Skyway has increased by $67 million, whereas COS for the SAS has increased by $146 million. Noteworthy is that as a percentage of capital outlay costs, the COS for the Skyway increased from 14 to 15 percent, whereas the COS for the SAS decreased from 14 to 12 percent.

Conclusions

Caltrans Capital Outlay Support (COS) costs rose by nearly $500 million between the 2001 and 2004 cost estimates. As the East Span project's estimated completion date moved from 2007 to 2011, additional days rapidly increased COS cost estimates. While the schedule was developed by Caltrans, not all of the factors driving schedule changes were within its control. For example, the construction industry requested additional time as design work progressed and the complexity and difficulties of building this bridge became more apparent. In some cases, Caltrans chose to trade increases in COS for the potential of larger cost savings in other areas (for example, by dividing the East Span contract into 16 smaller projects, Caltrans risked cost increases from schedule delays against the possibility of even greater reductions in construction costs by garnering more competitive bids).

Cost-Increase Factor 4: Contingency

Question 1: Did this factor contribute significantly to the cost increases for the East Span between the 2001 estimate and the 2004 estimate?

Cost estimates for mega-projects like the East Span include a significant contingency factor, based on the amount of risk and uncertainty associated with the project. The following table presents the contingencies that were applied to the East Span and its component structures, both in dollar amounts and as a percentage of the total estimated capital outlay cost for those structures. The columns on the right compare the cost increase between the 2001 and 2004 estimates, showing that contingency added over $250 million to the increase.

Contingency as a Cost Increase Factor from 2001 - 2004[43]

In millions	2001 Estimate			2004 Estimate		
	Total Capital Outlay (CO)	Contin-gency (CY)	CY as % of Total CO	Total Capital Outlay (CO)	Contin-gency (CY)	CY as % of Total CO
Entire East Span	**$2,219**	**$345**	**15.5%**	**$4,252**	**$608**	**14.3%**
Skyway	$796	$98	12.3%	$1,293	$239	18.5%
SAS/YBI*	$976	$202	20.7%	$2,287	$305*	13.3%*
East Span Other	$447	$48	10.7%	$672	$67	10.0%
**SAS Breakdown:*						
SAS Superstructure	$589	In YBI/SAS	$147	$1682	$238	14.1%
SAS Other	$387	In YBI/SAS	$60	$605	$67	11.1%

* Caltrans indicates, and the Bureau of State Audits report supports, that more than $450 million of the separate contingency fund for the entire TBSRP can be attributed to the uncertainties of the SAS. Thus, adding $450 million to the $305 million shown in this table, SAS contingency would be in excess of $750 million, which would increase the percentage in this table from 13.3 percent to 33.0 percent.

Question 2: To what extent was that an external factor out of the control of Caltrans and the State?

Contingency is an internal factor that is included in the cost estimate to account for unknowns in the design of the bridge as well as in-field conditions.

Question 3: To what extent should this cost increase have been anticipated, and what additional practices should have been employed to better estimate costs?

Contingency Factor in 2001. According to Caltrans' estimating procedures,[44] the contingency on a typical project is 20 percent when the design is at the 30 percent stage of development, and is reduced to five percent when design is completed. In April 2001, when the cost estimate for AB 1171 was developed,

the Skyway and YBI/SAS were at a design level of 100 and approximately 65 percent, respectively.[45] Rather than lower contingency on the Skyway to five percent, it was only reduced to 12.3 percent, recognizing the potential for additional cost increases.

The SAS portion of the East Span is far from a typical project. Caltrans estimating procedures indicate that unusual or difficult bridge designs could require a much higher contingency. Thus, the contingency on the SAS at the 65 percent design level was set at just over 20 percent.

Contingency Factor in 2004. In the 2004 cost estimate, Caltrans used an 18.5 percent contingency for the Skyway, the construction of which was near the midpoint. This unusually large contingency allows for cost overruns during construction, based on the fact that overruns occurred during the construction of the first half of the Skyway.

For the SAS, Caltrans included a contingency of 14.3 percent. This is significantly lower than the contingency rate for the Skyway, which is a known bridge type, whose construction is approximately half completed. The complex and unprecedented SAS design presumably has a far greater level of uncertainty and need for contingency allowance. This raises the question why the SAS contingency rate is lower than that of the Skyway. Caltrans provides two answers to this question.[46] First, the Department has awarded the SAS foundation contracts, has received a bid to build the SAS superstructure, and only the YBI Structures contract remains to be advertised. Second, $452 million was added to the *program* contingency (for the entire TBSRP) in 2004 specifically because of the uncertainties related to the SAS, which constitutes approximately half of the remaining expenditures for the entire Toll Bridge program. Adding $452 million of *program* contingency to the $305 million SAS *project* contingency yields a total SAS contingency of $757 million, representing 33.0 percent of the SAS capital outlay cost. This appears to be a more reasonable contingency rate for the SAS.

Contingency Practices. In summary, Caltrans contingency estimates for both 2001 and 2004 exceeded the levels established for typical projects in Caltrans procedures, and were in line with the recommendations from industry experts.

Conclusions: Contingency for the East Span in the 2001 estimate increased by more than $250 million in the 2004 estimate. The 2001 projection was consistent with Caltrans standards and was reviewed by industry experts.[47] Nonetheless, the 2004 estimate increased the Skyway portion contingency by more than $140 million. While Skyway construction is more than half completed, the project has experienced cost overruns. Regarding the SAS, the 2001 contingency also proved to be inadequate. It was increased by over $100 million in the 2004 estimate, based on the growing awareness of the complexity of the SAS, including the worldwide absence of any design or construction experience building a large, asymmetrical self-anchored span. In addition, in 2004 Caltrans increased the total contingency factor for the entire TBSRP program by more than $450 million in consideration of the uncertainties associated with the SAS.

Additional Cost Factors

A number of other factors contributed directly to the 2001-2004 cost increases (such as building materials other than steel, marine access, mobilization, and a host of other miscellaneous items). Because their individual contribution was less significant, they were not given as full consideration as the above four factors.

The factors examined in the following section had significant bearing on the cost increases between 2001 and 2004. However, their impacts are less directly and distinctly quantifiable, because they underlie and interact with the cost factors identified above.

Section 2 C

Other Factors Underlying the Cost Increases

Bonding and Insurance

Major changes in bonding and insurance practices occurred between the time in 2001 that the East Span cost estimate was developed and the time that the 2004 estimate was finalized. These changes were driven in large part by insurance company losses resulting from two world events. The first is the destruction of the World Trade Center in New York City on September 11, 2001. The second is the series of major corporate bankruptcies that occurred in the early 2000's (e.g., Enron, WorldCom, and Global Crossings). The resulting changes in bonding and insurance practices had a significant impact on the East Span project.

Bonding Industry Changes. The most significant change in bonding practices was that construction companies were required to meet much higher standards to qualify for a large bond. For example, construction companies needed to show much greater financial strength, limiting the number of firms with sufficient hard assets to qualify.[48] This has reduced the number of contractors who can secure a bond as large as that required for the very large projects such as the East Span SAS.[49] This is exemplified by the fact that the advertisement of the SAS contract, despite a 16-month process of interaction with the industry and numerous changes to the project requirements to make it more attractive to bidders, resulted in a single bid.

Insurance Industry Changes. As a result of the large losses insurers suffered from the two world events described above, insurance rates for large construction projects escalated, as much as 15 to 30 percent.[50]

How Industry Changes Affected the East Span Project. Bond cost increases can result from three factors: increases in premium rates being charged for the bond, a surcharge for projects exceeding 24 months in duration, and increases in the total project cost to which the premium rates are applied. According to Caltrans and insurance industry sources, between 2001 and 2004 increases have been negligible for Class A (bridge rate) bond premiums. However, these bridge rates include a surcharge if the project duration exceeds 24 months, at a rate of one percent of the basic bond premium for each month in excess of 24. Thus, project schedule changes would drive increases in bond costs for the project. Finally, bond rates are calculated in relationship to the total project cost (a percentage is applied to the first $100,00 of the project cost, then a slightly reduced percentage rate is applied to various increments of project costs, usually reaching the lowest percentage rate at approximately $7.5 million). Thus, as the East Span project cost estimates rose, estimators needed to factor in a larger amount for bonding costs.[51] Thus, bonding costs for the East Span project could be expected to increase from 2001 to 2004 because of the expanded duration of the project and the escalation of the total project cost estimate. Insurance costs increases would result from two factors. One is the fact that, as is the case with bonding, rates are tied to the total cost of the project. Thus, as the East Span cost estimates grew, the insurance cost estimate needed to be increased proportionally. The second factor in insurance cost increases is the increase in

rates. Taken together, these two factors could account for significant increases in insurance costs.

Bonding and Insurance Costs in the 2001 and 2004 Estimates. The amount included in the 2004 cost estimate is undoubtedly much greater than that in the 2001 estimate, for the reasons noted above. However, pinpointing the exact amount of the increase is difficult given the data available regarding the 2001 estimate. Apparently, with bonding and insurance prices in 2001 being much less than they are today, Caltrans did not make it a practice to categorize these costs separately in its project cost estimates, but included them as part of other cost items.[52] In 2004, given that the bond and insurance markets changed dramatically as described above, Caltrans identified bonding and insurance costs in information provided to the review team. These costs contributed in excess of $250 million to the 2004 estimate.[53] Given that the project cost nearly doubled, and this is a factor in both the bonding and insurance costs, it is clear that this cost factor increased significantly. However, given that the more significant aspect of the bond market changes may be the effect of limiting competition on Caltrans' large projects, and the lack of specific 2001 data, this factor is being considered as an underlying factor and the review team has not quantified the cost increases related to bonding and insurance.

Conclusions

Major changes in bonding and insurance practices occurred between 2001 and 2004, driven largely by the September 11, 2001 attacks and a series of large corporate bankruptcies in the early 2000's. Contractors were required to demonstrate greater financial strength than before, reducing the number of competitors able to obtain a large enough bond to bid on major East Span contracts. Also, since rates are affected by the length of the project schedule and the total project cost, bonding and insurance costs are to some extent a secondary factor driven by other cost increase factors. These considerations caused The Results Group to classify bonding and insurance as an underlying factor, and lack of 2001 data caused the review team not to develop an estimate of the cost increases. It can be deduced, however, that a major portion of the $250 million included in the 2004 estimate for bonding and insurance was an increase over the amount that would have been included in the 2001 estimate.

Federalization

In January 2000, Governor Gray Davis announced[54] that federal funds would be used for the first time to improve the seismic strength of three Bay Area bridges – San Francisco-Oakland Bay Bridge, Richmond-San Rafael Bridge, and a new Martinez-Benicia Bridge. The use of federal funds was also recommended by Caltrans in an April 2001 report titled, "Toll Bridge Seismic Retrofit Program Annual Report."[55] In that report, Caltrans recommended that the State utilize federal funds to finance the $557 million shortfall on the six toll bridges over which the State has sole responsibility for the retrofit design. Caltrans also called upon the Bay Area region to identify ways to allow the SFOBB work to move forward in a timely fashion.[56] The Legislature responded to this report by passing AB 1171 on September 15, 2001. AB 1171 was signed by Governor Davis on October 14, and allocated $642 million in federal Highway Bridge Replacement and Rehabilitation (HBRR) funds.

Federalization of the seismic retrofit and replacement of the State's toll bridges was formalized with the passage of AB 1171 in 2001, which was prompted by the department's release of the April 2001 Report. In its "2001 Annual Report to the Legislature," the California Transportation Commission (CTC) states that it has been Caltrans' strategy to utilize federal HBRR funds available through the State Highway Operation and Protection Program (SHOPP) to contribute funds to projects where bridge replacement is the most cost-effective long-term retrofit and bridge rehabilitation solution.[57] The table on the following page shows federal expenditures to date on the SFOBB East Span project.[58]

Generally, using federal funds for one East Span contract invokes the application of federal laws and regulations to the entire project. The primary provisions that would affect the East Span project are the disadvantaged business enterprises (DBE) goals and Buy America Requirements.[59]

Disadvantaged Business Enterprise Requirement. The Disadvantaged Business Enterprise (DBE) provision of federalization has had minimal impact o the East Span project. The original advertised SAS superstructure contract contained a DBE goal of eight percent. Potential bidders informed the Department that due to the highly specialized nature of the work and the size of the contract items to be subcontracted, the eight percent DBE goal could not be met. With that information, the Department evaluated the original goal determination, reviewed the items of work to determine DBE availability against the potential subcontractable items, and determined that a goal of five percent was appropriate.[60]

Thus, the primary impact of federalization on the East Span project was the Buy America provision. Therefore, the remainder of this discussion of federalization will focus on the Buy America requirement.

Federal Expenditures – TBSRP Bridges[61]							
Contract EA	**Contract Description**	**2000-01**	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**Total**
San Francisco-Oakland Bay Bridge, East Span							
04-012024	Skyway	$0	$1,071,000	$0	$6,275,260	$6,347,425	$13,693,685
04-012054	Oakland Touch Down (Geo)	$0	$0	-$10,797	$899,997	$0	$889,200
04-012074	YBI/SAS (Archeology)	$0	$0	$0	$900,000	$0	$900,000
04-0120C4	SAS W2 Structures	$0	$0	$0	$772,871	-$594,008	$178,863
04-0120E4	SAS E2/T1 Structures	$0	$0	$0	$639,149	$0	$639,149
04-0120F4	Self Anchored Suspension (SAS)	$0	$0	$0	$0	$0	$0
04-0120G4	YBI Substation and Viaduct	$0	$0	$17,171	-$12,574	$12,313	$16,910
04-0120Q4	YBI-USCG Access Roadway	$0	$0	$0	$741,514	$258,486	$1,000,000
04-0120R4	YBI South Detour	$0	$0	$0	$429,248	$440,908	$870,156
		$0	$1,071,000	$6,374	$10,645,465	$6,465,124	$18,187,963
Richmond-San Rafael Bridge							
04-0438U4		$36,498,278	-$5,752,321	$198,666,262	$41,047,790	$49,105,284	$319,565,293
Benicia-Martinez Bridge							
04-006034		$0	$1,563,581	-$746,855	-$282,727	$3,812,042	$4,346,041
		$36,498,278	-$3,117,740	$197,925,781	$51,410,528	$59,382,450	$342,099,297

1. "Fiscal Year" of expenditure represents the fiscal year the expenditure was recorded... NOT the fiscal year appropriation that was charged.
2. Negative expenditures are recorded because Federal funds are allocated to projects/contracts piecemeal as Federal obligation authority becomes available. This requires the Department to make retroactive adjustments to convert Toll Bridge Seismic Retrofit Account expenditures to Federal expenditures

Source: California Department of Transportation

Buy America Requirement

To conform with federal laws and regulations pertaining to "Buy America," all manufacturing processes for steel and iron material furnished for incorporation into the work on the project must occur in the United States. The application of coatings, such as epoxy coating, galvanizing, painting, and other coatings that protect or enhance the value of steel or iron materials are considered manufacturing processes subject to the "Buy America" requirements as well."[62] However, if it can be shown that no American supplier can provide the required goods or services within a 25 percent additional cost over the price quoted by a foreign supplier, the use of the foreign supplier is allowed.

Applying the Buy America Requirement to the East Span project had significant ramifications, contributing to or driving several of the cost factors described in the previous section of this report. It extended the project design schedule, contributing to increased TRO and COS. It also played a significant role in the reduction of competition in the bidding process.

Since federalization of the SFOBB East Span project was announced on January 28, 2000, numerous studies and documents have commented on the effect of the Buy America provision on the East Span project. The following is a sample of the commentary, giving a range of perspectives on the issues.

TY Lin International/Moffatt Nichol. The State's East Span Design Team — TY Lin International/Moffatt & Nichol— sent a letter to Caltrans on December 30, 2002, indicating that atypical arrangements would need to be made to even entice one bidder. "It is very difficult [for us] to be definitive about the construction cost and schedule when such radical business arrangements are necessary just to arrive at a single viable bidder…." The letter goes on to address project costs and time delays, "but we can at least note that the cost of the project with the Buy America Requirement will be substantially higher than previously estimated (without Buy America Requirement) and it will take substantially longer (perhaps two years longer) to construct the bridge. It should also be noted that if a consortium of fabricators is utilized, the construction process would entail significantly more effort (and time) for auditing, inspection and approvals."

Booz-Allen & Hamilton. Issues of higher cost, domestic fabrication limitations, and risk of delays were identified in the "Assessment of the Effect of 'Buy America' Provisions on the Procurement of Fabricated Steel" (Assessment) prepared for the Business, Transportation and Housing Agency in June of 2002.[63] The purpose of this study was to assess the potential risks associated with FHWA Buy America requirements. According to the authors, the data used in the analysis were from May 2001. Thus, this data taken into account in the Bechtel July 2001 estimates and the final AB 1171 estimates, the latter of which was passed by the legislature and sent to the Governor on September 15, 2001.

Mock Bid by Parsons Brinckerhoff Construction Services. The Mock Bid prepared by Parsons Brinckerhoff (PB) and submitted to Caltrans on July 26, 2002, underscores the concerns expressed by Booz, Allen & Hamilton regarding domestic capacity.[64]

TYLin International/Moffatt & Nichol Engineers Letter. Higher costs, delays, and reduced competition were anticipated by and communicated to Caltrans five months later in a December 30, 2002, letter from the State's East Span Design Team – TYLin

International/Moffatt & Nichol Engineers, less than two months before the SAS superstructure contract was advertised for bid.

Caltrans Bidder Inquiry Process. Throughout the SAS Superstructure bidder inquiry process potential bidders also raised concerns about the "Buy America" requirements affecting contractors ability to procure the necessary steel required for the SAS. To address potential bidders' concerns, Caltrans issued a number of addenda to the original advertised Invitation for Bid (IFB). Perhaps most significant was Addendum 9, issued June 25, 2003. Addendum 9 allowed bidders to submit an alternative foreign bid along with their domestic bid. In other words, each potential bidder was allowed to submit an alternative proposal on the basis that the Buy America provisions did not apply to the contract. However, competition was still limited by the fact that bidders could not submit a "foreign" bid without also submitting a domestic bid.

Caltrans Letter to FHWA. On April 7, 2004, Caltrans sent a letter to the FHWA Division Administrator requesting exploration of several options due to bidder feedback that procuring a competitive, cost-effective domestic bid would be challenging. The options suggested were:

- Pre-bid waiver of the Buy America provisions.
- Post-bid, pre-award waiver of the Buy America provisions.
- De-federalize the SAS contract while still retaining federal status on the current and remaining SFOBB contracts.

Caltrans reports that it received verbal indication at the time of the letter that the FHWA was not interested in discussing any of the three options. Recently, BTH and Caltrans leadership are pursuing the matter to clarify what options, if any, could be pursued with the federal government.

Conclusions

In 2000, Governor Gray Davis secured federal funding for the TBSRP, which added several new requirements to the East Span project. Most significant is the requirement to give preference to American suppliers of materials and services, known as the "Buy America" provision. This decision was outside the control of Caltrans, but to address its implications, the Department and its expert consultants identified major federalization issues (e.g., steel prices, project delays, and lack of bidder competition) and developed strategies to mitigate their effect on the East Span project

Single Bidder for the SAS Contract

For the SAS component of the East Span project, a single bid was received long after the 2001 cost estimate, and shortly before the August 2004 cost estimate was developed. Obviously, the single bid did not influence the earlier estimate, which preceded the single bid. However, to the extent the prices included in the single bid affected the development of the 2004 estimate, it can be deemed to be a factor.

It is reasonable to expect that staff took the bid into account, since it was the first actual estimate provided by a contractor who was committing to build the bridge. Furthermore, Caltrans estimating staff indicated to the review team that the bid was considered in developing some aspects of the 2004 cost estimate, although other sources of information were utilized as well.[65] Staff indicated that it may be possible that some aspects of the bid, for example some "front loaded" items for which the contractor would receive payment early in the project, may have been interpreted more broadly by the contractor than they are by Caltrans estimating staff. Thus the component items in the bid may differ from the amounts calculated for those same components by Caltrans. Nonetheless, the amount of the single bid is in line with the Caltrans estimate of 2004. The single bid price is $1.4 billion assuming the use of foreign steel, and $1.8 billion assuming domestic steel; the Caltrans estimate for the project (excluding Caltrans own overhead costs, which would not be contained in the bid) – is $1.68 billion.

Any attempt to assign a dollar amount to the potential contribution of this single bid would be speculation. However, those most familiar with the bidder's perspective on the process – the bidders themselves – provided some information. Following the bid opening, Caltrans conducted a Post-Bid Industry Consultation Program, which included meetings with three firms that were considered most likely to bid on the SAS project. In a meeting on October 27, 2004, Robert Luffy, President and CEO of American Bridge (the sole bidder), is cited as stating that a re-bid of the SAS should yield at least a five to ten percent cost savings, simply because there is "now a number out there that everybody knows."[66]

The fact that multiple bids can yield lower prices is supported by recent information gathered by TY Lin[67] for two major U.S. bridge projects that had received single bids, then upon re-bid received multiple bids. In one case, the Woodrow Wilson Bridge in Washington, D.C., the single bid price was $860 million. Upon re-bid, the lowest of the multiple bids was $492 million, a 43 percent decrease. In the case of the East Span itself, the single bid for the SAS E2/T1 contract was $220 million, whereas the lowest of the multiple bids was $174 million, a 21 percent decrease. It is important to recognize, however, that in both cases, the projects were repackaged with substantive changes intended to lower the bid price. Thus, the subsequent low bid was not directly comparable to the single bid.

Caltrans fully recognized the potential risk of receiving a single bid on the SAS project and employed several strategies to avoid this risk, including drawing upon industry experts. In 2002, the Department engaged Value Management Strategies to perform a "constructibility review." The Constructibility Review Report[68] addressed a number of issues related to limited competition, and made several recommendations specifically intended to increase the number of potential bidders. One recommendation was to split the SAS into three separate contracts – for the SAS foundation work, the SAS tower and superstructure, and the YBI construction work. This recommendation resulted in the splitting of the SAS project into multiple contracts, which as noted

elsewhere in this report caused the Department to adjust project plans and conduct procurement processes. The resultant delays in the project timeline were traded off against the more significant concern that limited competition might result in one or no bids, which ultimately was proven to be a legitimate apprehension. Another recommendation was to allow 15 weeks for the bidding period. Caltrans ultimately extended the bidding period to 16 months.[69]

Caltrans conducted several studies to better understand and address the effect of the Buy America provision triggered when Governor Davis federalized the TBSRP in 2000[70] (see the Federalization section of this report, above),. In 2002, Booz Allen and Hamilton, Inc. performed a study and produced a report entitled "Assessment of the Effects of 'Buy America' Provisions on the Procurement of Fabricated Steel for the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project."[71] This report pointed to the risks of a lack of domestic producers able to meet the requirements of the East Span, in particular the SAS. Furthermore, Caltrans commissioned a study by Aecom Consulting in association with Metal Strategies regarding the issue of foreign versus domestic steel. Aecom produced two reports, one entitled "Economic Study of *Domestic* Sources of Structural Steel for Components for Large Steel Bridge Projects in California,"[72] and the second entitled "Economic Study of *Foreign* Sources of Structural Steel for Components for Large Steel Bridge Projects in California."[73] *[Emphasis added.]* In response to the concerns raised by these analyses, Caltrans sought, but was unable to obtain, a waiver from the federal government of the Buy America requirement for the SAS component of the East Span project.[74]

Caltrans also undertook an extensive public outreach program that is still underway, including numerous meetings with potential contractors and suppliers. The information received from the contractors[75] focused largely on two areas:

- Because of the large size of the SAS project, many potential bidders would be unable to secure bonding up to the full amount of the project
- The high construction costs of the SAS and the need for experience in erection of an all-steel bridge erection experience for an all steel bridge would result in only a few firms having the necessary skills and resources to bid on it

The contractor outreach sessions were also a factor in the above-mentioned decision to split the project into multiple contracts. Bonding requirements for the project were also reduced to accommodate the construction industry.

Conclusions

Caltrans took numerous steps to maximize the number of bidders on the SAS project, including implementing recommendations from numerous studies and suggestions from construction industry leaders. Nonetheless, a single bid was received. Because the costs stated in that bid were considered when Department estimators developed the 2004 estimate, the single bid can be considered to be a factor in the difference between the 2001 and 2004 estimates. The President and CEO of American Bridge, the sole bidder, indicated in a meeting convened by Caltrans that a re-bid, if it garnered multiple bids, should yield at least a five to ten percent cost savings, simply because there is "now a number out there that everybody knows."[76] However, any attempt to quantify the impact of the single SAS bid would be highly speculative.

Section 2 D

Contribution of the SAS and MTC to Cost Increases

In this historical review of East Span cost increases, The Results Group was tasked with answering four questions. This section addresses the Question 4, which consists of two parts:

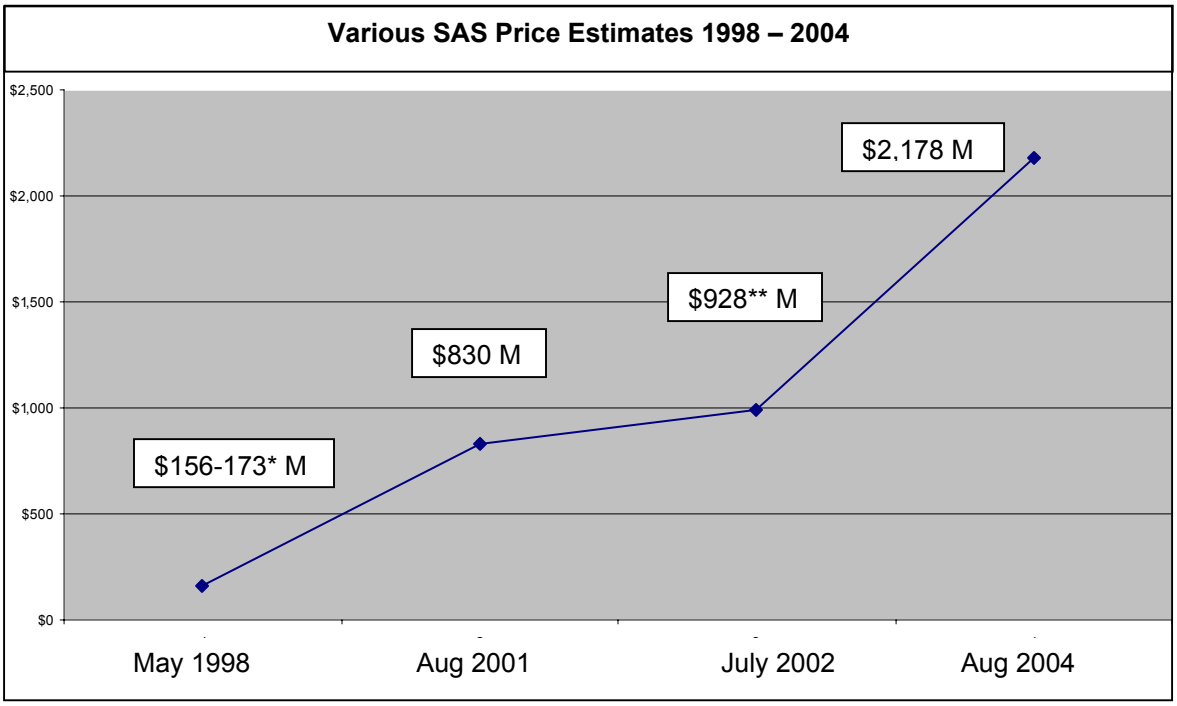
> ***To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases? To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increase?***

4A. To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases?

History of Cost Increases. Prior to the passage of SB 60, the replacement planned for the East Span was a standard freeway viaduct bridge. It was designed to fulfill a need to provide equivalent transportation capacity as the existing bridge, while allowing for economical, rapid construction.[77]

As indicated throughout this report, the decision to incorporate into the East Span an unprecedented SAS signature feature appears to have been the single largest driver of the cost increases for this bridge. When it was first proposed, the designers noted that "this would be the first mono-cable, deck-anchored, vehicular-carrying suspension bridge in the world."[78] There had not been an SAS built in the United States since 1939, and only two in the world since 1960.

At the time it was selected, it appears that the magnitude and complexity of this bridge was not fully appreciated by any of the parties involved in its selection and design. This is evidenced by the difference between the initial estimated costs to build the SAS and later estimates, as illustrated in the following graph. The entries on this graph are explained on the following page.



* The lower estimate is for a Haunched Concrete Skyway; the higher a Uniform Concrete Skyway.
**Does not include SAS foundations.

1998 The SAS design was developed to the 30 percent level in May of 1998. TY Lin/Moffat & Nichol performed this design work, and worked with MTC and Caltrans to develop an estimate of the cost to build a skyway bridge with an SAS signature feature. They also compared the cost to that of a simple skyway design, and estimated the cost to add the Single-Tower SAS would be approximately $156 million for a Haunched Concrete Skyway. This design was described as ""a traditional scheme with two portals inspired by the Bay Bridge". The higher-cost Uniform Concrete Skyway, was described as "A state-of-the-art design with a single tower, a single cable, and sloping suspenders." It was projected to add $173 million to the cost of a simple skyway design.[79] This estimate was developed relatively early in the design process

2001 As it became clear that the costs to complete the TBSRP would exceed the authorized expenditure levels in SB 60, the Legislature authorized additional funding and codified the SAS design in statute. Of the total increase for the seven bridges in the program, the SAS portion of the East Span contributed nearly one-third. The East Span project budget increased by $1.3 billion, of which the SAS portion was $830 million, or 64 percent.

2002 Caltrans engaged Parsons Brinkerhoff to produce a "mock bid" to build the SAS. The cost estimate was $928 million. However, it is important to note that this bid, like the single bid received in repose to the official IFB, did not including foundation work, which had been segregated into a separate contract. Thus, this is not intended to be a direct comparison to the 2001 and 2004 estimates, but rather another point-in-time indication of the rising cost estimates for the SAS.

2004 Following the opening of the single bid for the SAS, Caltrans revised its cost estimates for the SAS and the East Span as a whole. The Department engaged Bechtel Infrastructure Group to review its cost projections; other than recommending that the amount of overall contingency in the TBSRP program be increased (largely because of the risks associated with the SAS), Bechtel validated the Caltrans estimate.

Assessment of Cost Increases Attributable to SAS. In answering the question "*To what extent has the Self-Anchored Suspension design chosen by the Bay Area contributed to the cost increases*?" the review team calculated the cost increases attributable only to the SAS – a total of $1.348 billion. The following table illustrates this calculation.

East Span Cost of TRO and Mobilization Increases from 2001 to 2004

In millions	2001 Estimate	2004 Estimate	Cost Increase	SAS Increase as Percentage of Total E-Span Increase
Total East Span	$2,600	$5,130	$2,532	
SAS Only[80]*	$830	$2,178	**$1,348**	**53.2%**

* Includes SAS Superstructure and foundations only; excludes YBI contracts.

This represents just over half – fifty-three percent – of the total cost estimate increases for the East Span project as a whole.

4B. To what extent did additional decisions by the Bay Area's Metropolitan Transportation Commission contribute to the cost increase?

Compared to the decision to select the SAS design, no other action taken by MTC had a significant impact on cost increases.

Section 2 E

Commentary on Project Management and Risk Management

Project Management

Project Management is defined by the American Society for Quality as:

> "The application of knowledge, skills, tools and techniques to a broad range of activities to meet the requirements of the particular project. Project management knowledge and practices are best described in terms of their component processes. These processes can be placed into five process groups (initiating, planning, executing, controlling and closing) and nine knowledge areas (project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management and project procurement management)."[81]

Clearly, it is beyond the scope of this review to conduct a thorough analysis of project management practices on a multi-billion dollar mega-project that has been ongoing for eight years. However, The Results Group was tasked with reviewing project management at a high level and rendering a professional opinion regarding:

- How project management could have been more effective.
- Whether deficiencies in project management, in and of themselves, were likely to have contributed substantially to increases in cost estimates for the East Span, or if strengths in some areas of project management may have actually mitigated those cost increases.

To address these questions, it is important to consider the three distinct periods in the history of East Span project management. Based on interviews with Caltrans staff and a review of project management documents, there appear to be three different approaches and styles of management used during the life of this project, correlated to changes in leadership. The three phases are the Denis Mulligan leadership period, the Headquarters leadership period and the McPeak/Kempton Leadership period.

Documentation for the Denis Mulligan period was requested but does not appear to be available and was not provided. In interviews with current and former staff, it was reported that there was a specific project management plan developed for the project during this period. There was a concerted effort to maintain control through the use of "extreme project ties." Resources were tied to the project rather than to the district or headquarters. It was reported to us that this was difficult to maintain, however, Denis Mulligan made this a high priority and fought to maintain tight control over resources, responsibility and project tasks.

Upon the departure of Denis Mulligan, the style of responsibility and control of the project changed. This period, which for the purposes of this report is referred to as the Headquarters period, shifted to a more traditional Caltrans approach to project management. Longstanding Caltrans Project Management techniques were formally utilized. During this period, responsibility is distributed among the individual units, and no one person rises as responsible for the overall success of the project. During the Headquarters period, East Span project management structure is an identification of management staff spread throughout District 4. It can be characterized as a diffused reporting level with conflicting and multiple responsibilities for staff. Various staff members report to managers in both the District and Headquarters. Functional and organizational managers have multiple project and management responsibilities. Many members of the project management team are on equal classification levels, which can lead to reporting relationship breakdowns. There is not an identified dedicated "one-hat" project manager or project management team for the East Span project. The most significant historical weaknesses on the project include Project Management Structure, Control of Resources, and Process breakdowns.

Caltrans has an extensive array of documents and manuals related to the management of projects, however, it does not appear that there was a comprehensive project specific management plan for the East Span project developed at the outset of the project, however, one is being developed at this time. On a project of this size and scope, lack of a written project management plan could be viewed as a major deficiency.

Under the McPeak/Kempton leadership period, changes are being implemented to improve Project Management, a specific project management plan is being developed, and tighter controls and responsibility for work are being defined.

The Results Group was provided three documents to review in response to requests for a copy of the project management plan:

1. Seismic Retrofit Toll Bridge Program – Toll Bridge Project Management Implementation Plan – October 15, 1998,
2. Caltrans Toll Bridge Program – Project Management Improvement Implementation Plan – revised Draft April 15, 2002, and
3. Confidential SFOBB East Span Project Management Plan.

Seismic Retrofit Toll Bridge Program – Toll Bridge Project Management Implementation Plan – October 15, 1998. This is the first project management plan for the project that was made available to The Results Group. It was developed in concert with Bechtel Infrastructure Corporation, which was retained to provide project management support services skills that the Caltrans staff did not have. The Executive Summary of the report mentions the need for "new approaches in the areas of organization and staffing; project development and construction management processes; and tools and techniques used to collect, analyze, and report project data. These new approaches build on current Caltrans project management practices, including "projectized" organization structure where project managers are responsible for the successful implementation of their project during its entire life cycle." The information contained in that plan only describes a Project Management Information System. We have not been provided with a project management plan from that time period that identifies staffing, processes, responsibilities and reporting relationships.

Caltrans Toll Bridge Program – Project Management Improvement Implementation Plan – revised Draft April 15, 2002 . This plan also was developed in concert with Bechtel Infrastructure Corporation. The information contained in this 2002 plan only describes a detailed modification to the Project Management Information System. We have not been provided with a project management plan from the 2002 time period that identifies staffing, processes, responsibilities and reporting relationships.

Confidential SFOBB East Span Project Management Plan – undated but believed to be prepared in late 2004. The Department recently provided us with a Confidential SFOBB East Span Project Management Plan[82]. This plan focuses on three areas:

1. Project Communication Plan
2. East Span Risk Management Plan
3. East Span Quality Assurance Management Plan

Some general comments on that proposed plan are:

- The creation of the management plan is an excellent step to streamline processes and control cost and schedule. It is recognized that this is a "living" document that must be continuously updated and that no management plan is perfect or complete.
- Communication is internally focused and does not adequately address communications with other State Agencies, the governors' office, the legislature, outside stakeholders or other interested parties. Other than statutorily required reports, there is limited mention of communication to external stakeholders and other interested parties.

- The Risk Management Plan primarily addresses steps taken to date on the project and there is little emphasis on the steps proceeding forward.
- The Quality Assurance section of the plan appears to be more comprehensive than the other sections of the document.
- There are notable areas of management that are not addressed in the draft management plan, specifically: human resource, scope, schedules and budget control are not addressed.
- While the plan incorporates lessons learned and accomplishments to date, it also needs to provide the plan for managing the project forward through completion of construction.

Conclusions

It is difficult to quantify the impacts of Caltrans project management practices on the estimated cost of the East Span project. On the one hand, there were several problems in the project management arena. District management and project-level management staffing changes were frequent; primary project responsibility alternated between the district and headquarters; and the project lacked a high-level single point of authority until very recently, despite numerous consultant reports calling for it. Thus, at times responsibility appears to have been diffuse and undefined, and communication among Caltrans units poorly coordinated. Typically, these project management problems can hamper decision making and impede progress, which in turn can affect the project timeline and costs.

On the other hand, the Department took a number of important, positive steps in project management and risk management. Throughout the project, Caltrans proactively sought guidance and scrutiny from industry experts and review panels regarding virtually all major project decisions. Caltrans obtained the Pier 7 Campus for a joint project management facility (for Caltrans and contractor staff) to enhance communication and accelerate approval processes, and thus shorten the project timeline. The East Span project was divided into multiple contracts, which may have increased initial costs but should ultimately achieve much greater savings by addressing risk issues (including several identified in this report). Over the life of the project, various Caltrans risk management and project management practices will undoubtedly impact positively on the East Span timeline and costs.

Weighing the positives and negatives, the review team concludes that the effects of Caltrans project management practices cannot be readily quantified. However, within the limited scope of this project and without more data to the contrary, it appears that Caltrans project management practices were unlikely to have contributed significantly to cost increases (i.e., on the order of magnitude of hundreds of millions of dollars, as is the case with the cost factors discussed above). Caltrans has recently elevated project leadership to the Chief Deputy level, and is developing a comprehensive project management and risk management plan. If these plans include specific action steps and an ongoing monitoring process, and senior management ensures consistent implementation across work units, Caltrans project management will undoubtedly continue to improve.

Risk Management

Caltrans management stated that they have begun the preparation of a Risk Management plan for the SFOBB project. The Results Group has reviewed a copy of the plan, which is included in the SFOBB East Span Project Management Plan (pages seven through nine). In June 2003, substantially into the project efforts, Caltrans published a Project Risk Management Handbook (PRMH). Current Agency and Caltrans management are implementing Risk Management more formally than did previous administrations. The Results Group reviewed steps that Caltrans took which would be consistent with Risk Management to determine if the actions taken were the same actions which would have been taken if a formal plan were in place. The review of Caltrans actions is measured against the PRMH with the assumption that the handbook was prepared based on the existing culture of the organization and that the risk management objectives adopted in the PRMH were the same objectives that Caltrans held prior to publication of the handbook.

The objective of Caltrans Risk Management as stated in the PRMH includes minimizing adverse impacts to project scope, cost, and schedule, and minimizing management by crisis.

The PRMH outlines a 6-step procedure for risk management:

Step 1: Risk Management Planning
Step 2: Risk Identification
Step 3: Qualitative Risk Analysis
Step 4: Quantitative Risk Analysis
Step 5: Risk Response Plan
Step 6: Risk Monitoring and Control

Step 1: Risk Management Planning

According to the PRMH, there are two main steps in Caltrans' approach to Risk Management, the first being Risk Management Planning, the second being Risk Monitoring and Control. It is evidenced that many of the sub-steps to risk management planning were accomplished in part, but the development of the plan was not completed until recently. One of the risks identified in the Kimley-Horn Risk Assessment of the SFOBB was the lack of a risk management team fully dedicated to the project. That report states: "An essential part of the risk mitigation will be to form a risk management team (RMT) fully dedicated to this project, that not only manages risk associated with the SAS, but coordinates and manages risk for the overall project."[83]

While it has not been evidenced that a specific risk management team is being dedicated to the project, under the current administration, Risk Management Planning has been elevated to a high priority. The Agency Secretary, along with the Director of Caltrans, has directed Caltrans staff to prepare the project's specific risk management plan. Plan preparation is in its final stages and is included in the SFOBB East Span Project Management Plan.

Based on interviews with Caltrans management, it was determined that a key risk management planning effort that was performed was the assignment of key staff to the project. Caltrans assigned its best and most qualified staff to the SFOBB project.

Step 2: Risk Identification

The risk identification process was extensive. Caltrans has taken many steps with respect to risk identification including but not limited to:

- Development of Project Risk Management Handbook, June 2003
- Kimley-Horn and Associates Risk Assessment – February 2003

- Caltrans Management Quarterly Review Meetings
- Value analysis
- Constructability reviews
- Quality Assurance reviews
- Peer Reviews
- Risk Assessment
- Cost reviews by Bechtel
- Bureau of State Audits project reviews

Specific **value analysis and outreach programs** undertaken to identify risk include:

July 17, 2002:	Steel Fabricator Outreach
March 2002:	Value Analysis/Constructability Report for the SAS/YBI contracts by Value Management Strategies
September 12, 2002:	Value Analysis Report by Parsons Brinckerhoff
November 17, 2003:	Value Analysis Report on the SAS and E2/T1 by the Independent Review Committee

Constructability Reviews/Workshops/Outreach were undertaken during the planning, design and bidding of the project. During the bidding process nearly 800 bidder questions were responded to and 26 addenda were issues. Constructability reviews included:

May 12 and 13, 2002:	Constructability Workshop with potential contractors and fabricators
October 30, 2002:	Construction Peer Review Workshop
November 20, 2002:	SAS Constructability Workshop with potential contractors and fabricators
March 5, 2003:	Contractor Focus Group Meeting on the SAS On-Going Bidder Inquiries
August 28, 2003:	Public SAS Bidder Inquiry Meeting
December 16, 2003:	Public SAS Bidder Inquiry Meeting

Independent Quality Assurance Review included:

December 5, 2002:	Quality Assurance Review by Caltrans Central Region Team

In addition to the constructibility reviews, Caltrans utilized a **Construction Administration Process Evaluations (CAPE)**.

September 1, 2003:	2002 CAPE
January 1, 2004	Toll Bridge CAPE

In addition, Caltrans developed a Quality Specification Development Team and Dispute Review Board Peer Review and lessons-learned process from other Toll Bridges contracts to further ensure identification of risks and quality.

Step 3: Qualitative Risk Analysis

Qualitative risk analysis prioritizes the risks based on high, moderate, or low risk. Caltrans contracted with Kimely-Horn and Associates to perform specific risk analysis with respect to project schedule. The Kimely-Horn Assessment identifies risks based on levels of risk. Risks which were identified as high risk, along with Caltrans actions, are summarized in the following table:

Kimley-Horn and Associates
San Francisco-Oakland Bay Bridge
Quality Assurance & Risk Assessment Final Report, February 28, 2003
Summary of Risk Assessment

Identified Risk	Possible Strategy(ies)	Caltrans Action Taken
Buy America Requirements	1. Allow bid alternate with foreign materials 2. Waiver for structural steel 3. Combination of 1 and 2	Alternate bids were allowed
Lack of resources will expose the SAS project to potentially significant delays	1. Exempting the project from budget cuts 2. Exemption from hiring freezes 3. Exemption from outside consultant contract freezes, 4. Exemption from travel restrictions 5. Design modifications 6. Develop a high-level risk management team	The program was fully funded for resources. Caltrans assigned its most qualified individuals to the bridge team.
Submittal review and approval procedure is lengthy and uncoordinated	1. Develop formal shop drawing submittal review	Shop drawing approvals process was updated and streamlined. Caltrans obtained a "campus" at the project site for coordination between contractor and designers and to improve the submittals review and approval process
Cable Erection Construction	1. Allow cable spinning techniques 2. Construction of the strands on the Skyway Bridge 3. Complete a computer analysis of cable erection and load transfer	Studies were undertaken
Non Constructible Design Elements	1. Reconsider and possible modify design details	Designs were continuously reviewed for modifications
Delays in erection of temporary structures	1. Complete additional test borings 2. Provide a stipend to contractors	Borings were undertaken
Construction Interfaces • Multiple contractors • discontinuities	1. Establish a risk Management Team 2. Assure adequate design review for interfaces between contracts 3. Complete an area staging plan	Outreach program was utilized for contractor input. Staging area was provided
Traffic Detours	1. Consider alternate construction staging plans 2. Implement the South-South detour at YBI	Staging was revised

Step 4: Quantitative Risk Analysis

Evidence was found related to a Quantitative Risk Analysis. However, tasks related to quantitative risk analysis were preformed throughout the design of the project through the use of value engineering studies. Each of the studies identified the major cost impact areas within the project and recommended strategies for addressing high cost items of work. Quantitative Risk Analysis is not required by the PRMH, but it is recommended for projects with VA studies or high risk.

Step 5: Risk Response Plan

Risk response planning includes strategies and actions including Avoidance, Transference, Mitigation, and Acceptance.

The avoidance of risk and mitigation of risk is evidenced through the many studies undertaken. In each of the QA/VA studies, recommendations were developed and alternate strategies proposed to allow Caltrans options in the decision making process. One area developed by Caltrans to address each of the strategies is the Lessons Learned Program developed for the toll bridge program. This is an on-going program, which reviews work performed on the other toll bridges in the State and uses the information to improve the quality and reduce risk on the SFOBB project.

Step 6: Risk Monitoring and Control

Risk Monitoring and control was realized through two primary methods:

1. Semi-monthly Executive Quality/Risk Assessment/Oversight Meetings
2. Executive Decision Making Process Provisions

Senior management within Caltrans regularly met to discuss areas of risk. Risk was monitored continuously and response strategies were implemented. As mentioned previously in this section of the report, Caltrans instituted a wide variety of efforts to monitor and control risk on the project ranging from outreach programs to Value Analysis, Quality Assurance and other means. The strategies for responding to risk were selected based on each risk item. Corrective actions were taken and re-planning was implemented. Appendix C presents an extensive list, which was provided by District 4 project management staff, of examples of changes that were implemented as a result of the monitoring and response efforts.

Conclusion

Caltrans has undertaken the majority of risk management steps that would normally be expected to occur on a project of this magnitude. Caltrans implemented many of the recommendations that came from the project reviews and industry experts. Risk Management activities such as obtaining the Pier 7 Campus to enhance communication with the contractor and streamline the approval process, as well as the project changes resulting from value engineering studies, could be expected to result in cost savings to the project and reduce project risk. The preparation of a formal Risk Management Plan at the beginning of the project may have streamlined the process, but it cannot be shown that there would have been significant improvements or cost savings to the project if this had been accomplished.

Part Three – Cost Increases, A Worldwide Norm

The SFOBB East Span is not unusual in experiencing increases in project cost estimates. Accurately estimating the cost of large public works projects has been a problem for decades. While the literature documents many examples, the following illustrate the problem in projects representing different sizes and timeframes:

- The Holland tunnel was first proposed in 1919 to be constructed for $12 million over a three-year time period. The tunnel finally opened 8 years later and at a total cost of over $48 million.[84]
- Boston's "Big Dig," a project to replace an elevated roadway, extend the highway through a tunnel, and replace a bridge over the Charles River, was originally estimated to cost $2.6 billion and be completed in 1998. The current estimate is $14.6 billion with completion in 2005.[85]

Numerous studies in recent years point to the fact that most estimators – including public and private sector experts worldwide – underestimate the cost to construct large public works projects. Although the problem often increases with project size, the studies indicate that the problem cuts across project sizes, types of project, and international borders:

- The U.S. General Accounting Office (GAO) has found that "cost growth has occurred on many major highway and bridge projects. For example, on 23 of 30 projects initially expected to cost over $100 million, our 1997 report identified increases ranging from 2 to 211 percent – costs on about half these projects increased 25 percent or more. (GAO/RCED-97-47)."[86]
- A European study concludes that "cost underestimation (and overrun) is found in 20 nations on five continents… Nine out of 10 projects have underestimated costs and cost overrun…underestimation (and overrun) is constant for the past 70 years, estimates have not improved." This study concludes that size does matter: "for bridges and tunnels, larger projects have larger percentage overruns."[87]

As noted in a 2003 by Schexnayder and colleagues, "Over the time span between project initiation (concept development) and the completion of construction many factors may influence the final project costs. This time span is normally several years in duration but for the highly complex and technologically challenging mega projects it can easily exceed 10 years. Over that period major changes to the project scope and its setting (the macro environment) can occur." Among the factors listed are:

- Changes in project scope.
- Unforeseen engineering complexities and constructibility issues
- Changes in economic and market conditions
- Local governmental pressures
- A transformation of community expectations.[88]

All of these factors affected the East Span at one or more points from the adoption of SB 60 in 1997 to the revised cost estimate submitted by Caltrans to the Legislature in 2004.

Part Four – Summary of Conclusions

The Results Group's review team has concluded that the three fundamental factors caused cost estimates for the East Span to double in 2001, then nearly double again in 2004:

- External Market Conditions. These conditions include increases in the cost for steel and its fabrication, as well as construction industry dynamics that limited the number of potential competitors to build the components and erect the bridge.

- Design Complexity. The design for the East Span replacement calls for a long asymmetrical SAS. Nothing like this has ever been built before. The initial optimism in 1998 that it could be built for a few hundred million dollars was obviously unrealistic. Cost estimates for the entire East Span project have been driven steadily upward by a growing realization of the cost and complexity of the SAS.

- Time. The above two factors drove design changes that lengthened construction schedules; this, in turn, escalated the cost estimates due to inflation and increases in Caltrans and contractor overhead.

The East Span is at least three times more costly than any project ever built by Caltrans before, and according to industry experts, the inclusion of the SAS makes it one of the most complex and challenging bridges ever undertaken in the United States. In June 1998 when the SAS design was selected, none of the parties – from State government to local entities to the public – fully comprehended the enormity of this project, particularly the complexity of the SAS.

Each of Caltrans' major project cost estimates were developed in conjunction with or validated by leading international engineering and design companies. Nonetheless, at each juncture, the previously developed project schedules proved to be overly optimistic given all of the challenges in designing and constructing the SAS. In short, this project is not unlike most mega-projects around the world in suffering cost and time increases. And as studies of these projects reveal, the largest single factor is often the inability of the human mind to grasp, or perhaps to accept, the magnitude of the undertaking and the time and resources required to complete it.

Appendices

Appendix A: Timeline of Events Impacting the San Francisco-Oakland Bay Bridge Project

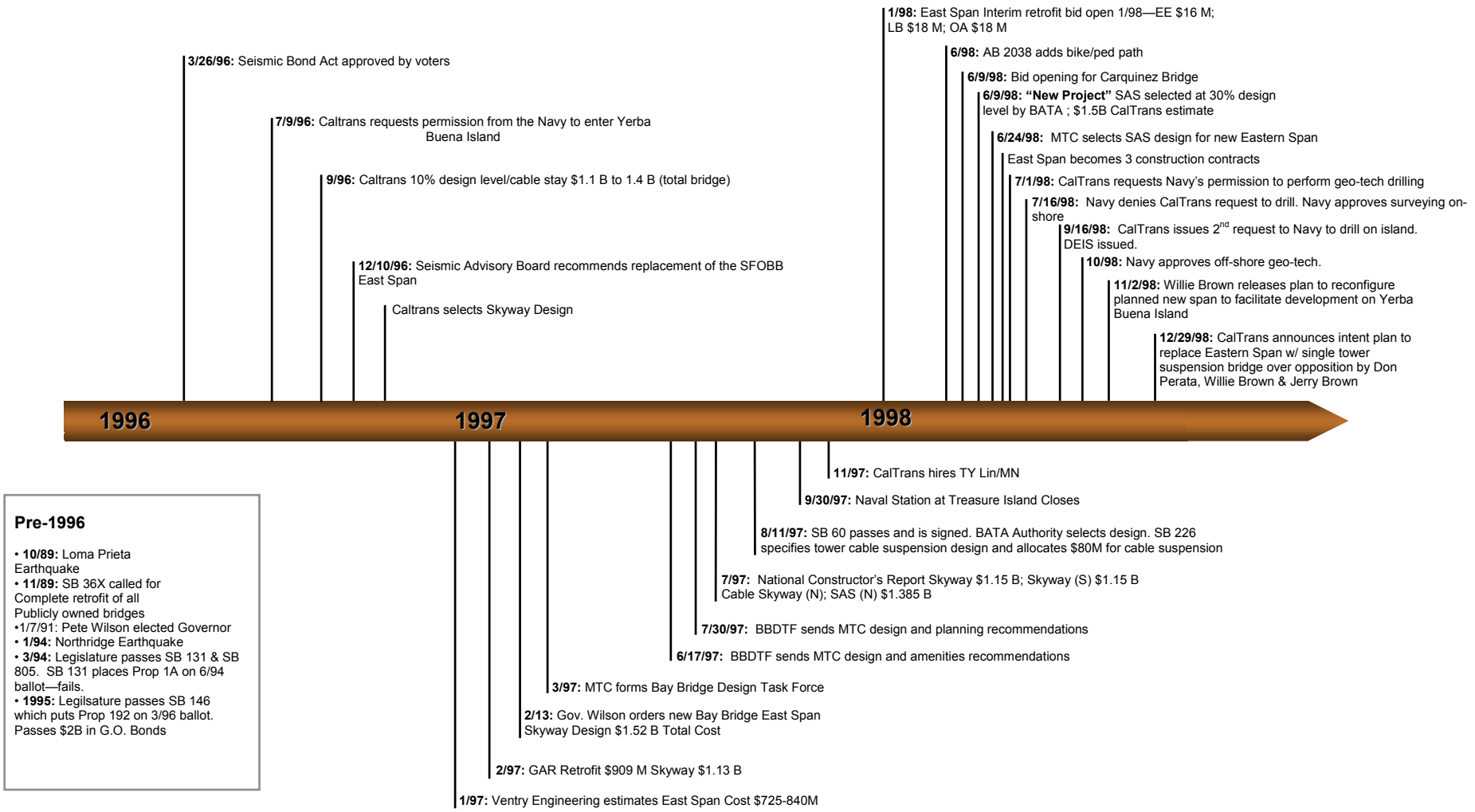
Appendix B: Legislative History

Appendix C: Caltrans District 4 – Samples of Implemented Changes

Appendix D: Glossary

Appendix A

Timeline of Events Impacting the San Francisco-Oakland Bay Bridge Project

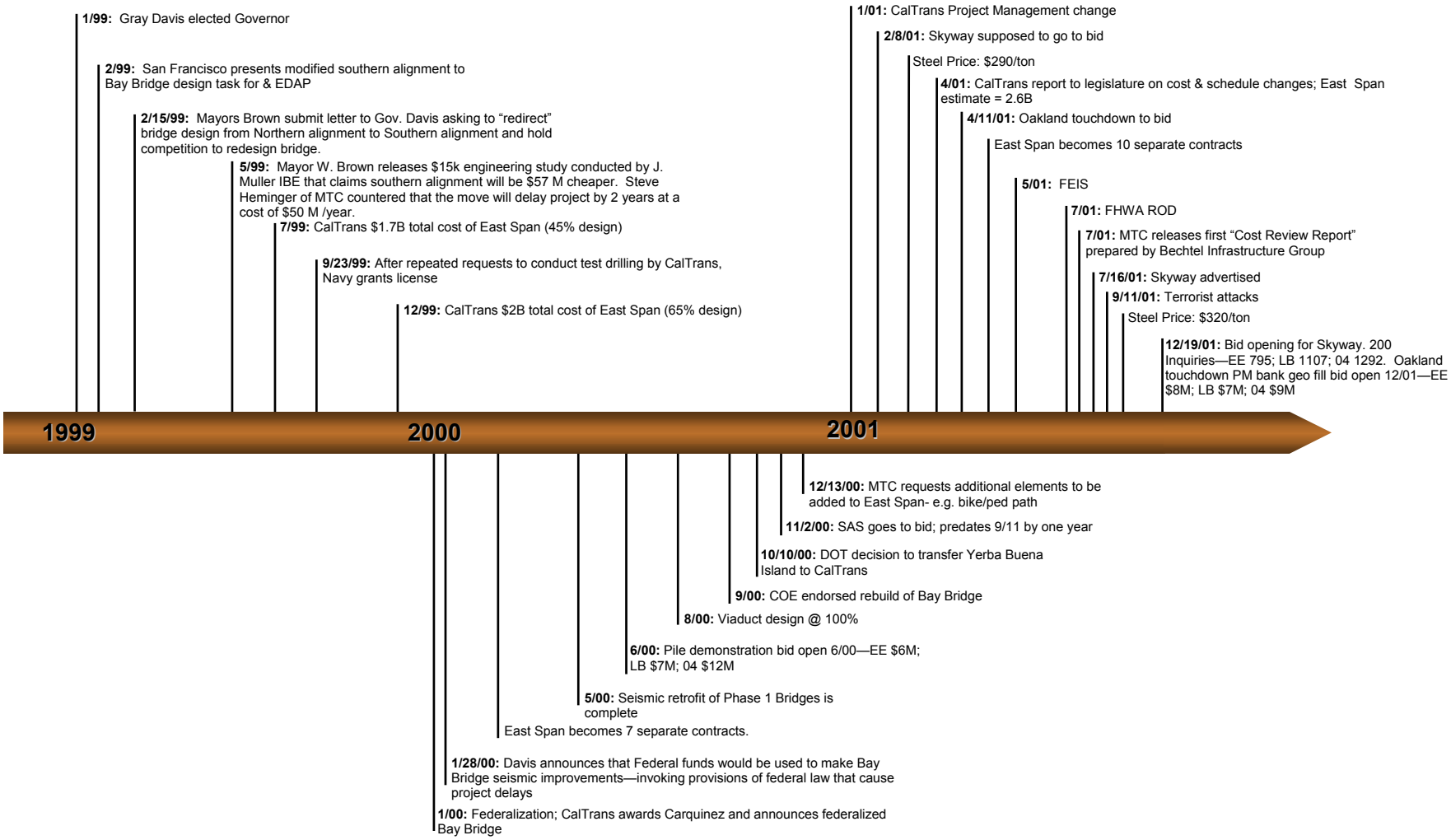


Pre-1996

- **10/89:** Loma Prieta Earthquake
- **11/89:** SB 36X called for Complete retrofit of all Publicly owned bridges
- 1/7/91: Pete Wilson elected Governor
- **1/94:** Northridge Earthquake
- **3/94:** Legislature passes SB 131 & SB 805. SB 131 places Prop 1A on 6/94 ballot—fails.
- **1995:** Legilsature passes SB 146 which puts Prop 192 on 3/96 ballot. Passes $2B in G.O. Bonds

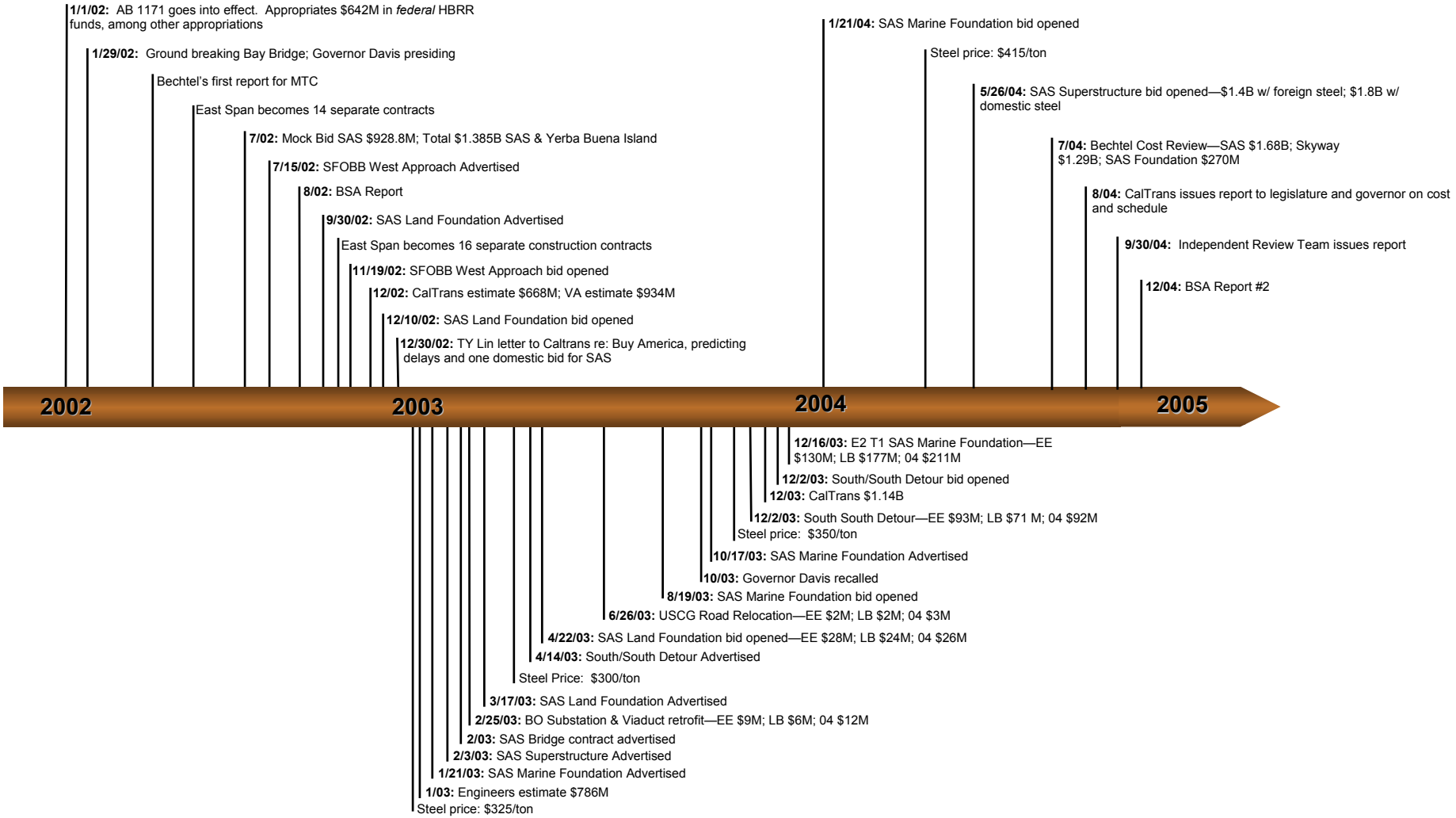
Appendix A

Timeline of Events Impacting the San Francisco-Oakland Bay Bridge Project



Appendix A

Timeline of Events Impacting the San Francisco-Oakland Bay Bridge Project



Appendix B

Legislative History

LOCAL MEASURES AND STATE LEGISLATION

The damage suffered by California highway bridges during the 1989 Loma Prieta earthquake and the 1994 Northridge earthquakes has made the seismic retrofitting of California's bridges the State's leading transportation priority. Since the Loma Prieta earthquake fifteen years ago, the State's seismic retrofit program has focused on those bridges deemed most vulnerable or critical to emergency response capability. The California Department of Transportation (Caltrans) initiated research projects to better understand the vulnerabilities of the State-owned toll bridges in particular, since they are very complex, unique structures. State, federal, and local government agencies and legislative bodies have responded by providing the necessary financing and statutory framework. The following summary reviews the history of various State and local measures supporting the seismic retrofit and replacement of the Bay Area's toll bridges.

SB 45 (Lockyer) – Chapter 406, Statutes of 1988 (also known as Regional Measure 1)

Chapter 406, Statutes of 1988 authorized the placement of Regional Measure 1 (RM 1) on the November 1988 ballot for the seven Bay Area counties. Bay Area voters approved RM 1, which authorized a uniform toll of $1 for all seven State-owned Bay Area toll bridges. The revenue derived from this toll increase was to be used to finance capital outlay for bridge construction, certain highway and bridge improvements, public transit rail extensions, and a variety of other projects designed to reduce congestion in the bridge corridors or provide improved services to bicyclists, pedestrians, and the water transit (ferry) system. Some of the projects for which the Metropolitan Transportation Commission (MTC) has used RM 1 funds include a second Benicia Bridge, replacing the westbound span of the Carquinez Bridge, resurfacing the Richmond-San Rafael Bridge, widening the trestle section of the San Mateo Bridge, and related projects.

State law allows the Bay Area Toll Authority (BATA) to issue toll revenue bonds backed by these base toll revenues. The MTC states that the RM 1 toll currently yields about $145 million annually.

SB 36X (Kopp) – Chapter 18X, Statutes of 1989

Chapter 18X called for complete retrofit or replacement of all "publicly owned" bridges to meet current seismic safety criteria by December 31, 1991. The legislature provided $80 million in a funding transfer from the Disaster Relief Fund to match federal funds and accelerated the seismic retrofit program for State and local bridges,

SB 131 (Roberti) and SB 805 (Bergeson) – Chapters 15 & 16, Statutes of 1994

In March 1994, the legislature passed and the governor signed SB 131/94, known as the Earthquake Relief and Seismic Retrofit Bond Act of 1994 along with SB 805/94, a companion measure to expedite State contracting and local permitting processes. SB 131 was placed on the June 7, 1994 ballot for voter approval as Proposotion 1A. Propositon 1A would have authorized the State to issue $2 billion in State general obligation bonds for a variety of activities, including 1) the seismic retrofit of State-owned highways and bridges throughout California ($950 million); 2) the repair, renovation, reconstruction, replacement, or retrofit of transportation facilities, roadways, structures, and equipment ($145 million); 3) earthquake hazard mitigation projects for the replacement or repair of public buildings, facilities, and infrastructure in southern California ($330 million); and 4) housing repair loans to address the effects of the January 17, 1994 Northridge earthquake ($575 million).

Proposition 1A was defeated by voters, 46 to 54 percent. The following year, the legislature and governor responded by placing a modified measure - SB 146/Chapter310 - on the ballot as Proposition 192.

SB 146 (Maddy, Lockyer, Brown, Allen, Brulte) – Chapter 310, Statutes of 1995

SB 146 was enacted the following year and placed on the ballot as Proposition 192 in the March 26, 1996 primary election. Proposition 192 passed easily, winning 60 percent voter approval. Proposition 192 differed from Proposition 1A in that it authorized $2 billion in general obligation bonds solely for transportation purposes. Funds could be used to reconstruct, replace, or retrofit State-owned toll bridges and highway bridges in phase two of the Seismic Retrofit Program. The measure provides that of the $2 billion authorized, $650 million was exclusively dedicated to seismic retrofit of State-owned toll bridges – the estimate of the total need at that point in time. Proposition 192 also required that expenditures for phase two seismic retrofit of State highway bridges, as well as for toll bridges, be funded exclusively from bond funds and not from other State funds such as toll revenues or revenues from the State gas tax.

SB 60 (Kopp) and SB 226 (Kopp) - Chapters 327 & 328, Statutes of 1997

In 1997, the Legislature enacted SB 60 and SB 226 which identified the following toll bridges as needing seismic retrofit or replacement at a total cost of $2.62 billion:

- Benicia-Martinez Bridge ($101 million),
- Carquinez Bridge (retrofit eastbound span - $83 million; replace westbound span pursuant to and funded by RM 1),
- Richmond-San Rafael Bridge ($329 million),
- San Mateo-Hayward Bridge ($127 million),
- San Pedro-Terminal Island Bridge (Vincent Thomas Bridge) ($45 million),
- San Diego-Coronado Bridge ($95 million),
- San Francisco-Oakland Bay Bridge (SFOBB) (retrofit west span - $553 million; replace east span - $1.285 billion of which $80 million was for “cable suspension”).

These bills also established the financing mechanisms for the seismic retrofit/replacement of these toll bridges using a variety of funding sources. More specifically, the bills first allocated $790 million from the Proposition 192 bond funds:

- $650 million from the Seismic Retrofit Account, and
- $140 million from excess funds remaining from the Prop. 192 Phase 2 Seismic Retrofit Program.

The remaining need was financed 50/50 by the State and local entities as follows:

State Contribution ($875 million):

- State Highway Account (SHA) -
    1. $200 million from a 1998-99 State-local transportation partnership program,
    2. unspecified funds remaining from 1 above,
    3. $75 million from reducing specified traffic system management program,
- $300 million in accumulated savings by improved efficiency and lower costs to be achieved by Caltrans; and
- Up to $130 million from the Transit Capital Improvement Program funded by the Transportation Planning and Development Account in the State Transportation Fund.

Local Contribution ($875 million):

- $827 million from a new $1 seismic surcharge on Bay Area Bridges (1/1/98 until 1/1/08) and deposits the funds in the newly created Toll Bridge Seismic Retrofit Account (TBSRA) (this “second” dollar currently raises about $120 million annually),
- $33 million from the San Diego-Coronado Toll Bridge Revenue Fund, and
- $15 million from the Vincent Thomas Toll Bridge Revenue Account.

These allocations were made through fiscal year 2004-05. The bills specify that of the $2.62 billion estimate, $80 million was for “cable suspension,” and left design selection to the MTC. The bills also

state that the estimated $1.285 billion cost of replacing the east span of the San Francisco-Oakland Bay Bridge was based on the following assumptions:

- The new bridge would be located north adjacent to the existing bridge
- The main span of the bridge would be in the form of a "single tower cable suspension design," and
- The roadway in each direction would consist of five lanes (each 12 feet wide) and would contain 10-foot shoulders as an emergency lane for public safety purposes on each side of the main-traveled way.

SB 60 allows the newly created Bay Area Toll Authority (BATA) to add the following "amenities" if sufficient funds could be generated (i.e., via extension of the $1 seismic surcharge) at the *local* level to cover the added costs :

- If after completing 30 percent design, BATA selects a design that costs more than the cost of a single tower cable suspension bridge selected by Caltrans;
- BATA requires funding for the replacement or relocation of the transbay bus terminal in San Francisco; and/or
- BATA requests funding for bicycle or pedestrian access to be added to the new bridge

SB 226 *prohibits* use of SHA funds to finance a cable suspension bridge, bicycle facility, a transbay terminal or to cover shortfalls in the TBSRA for the amenities.

Last, the bills required Caltrans to report to the Legislature within 60 days of determining the total costs of the program exceed the $2.62 billion allocation, and to include a proposed financing plan for any additional costs. The bills also required Caltrans to submit annual updates on the program's costs, revised estimates, and the amount of funds used from each source specified above.

AB 2038 (Migden) – Chapter, Statutes of 1998

AB 2038 revised the provisions of SB 60 to allow revenues generated from the $1 seismic surcharge to exceed the $907 million limit if BATA requests funding for bicycle or pedestrian access to be added to the new east span of the SFOBB or the retrofitted west span, or both – rather than just the new east span bridge.

AB 1171 (Dutra) - Chapter 907, Statutes of 2001

In 2001, the legislature enacted AB 1171 in response to an April 2001 Caltrans report identifying about $2 billion in costs over and above those identified in SB 60 and SB 226 to the Toll Bridge Seismic Retrofit Program. The report identified a number of factors raising the costs beyond those estimated in SB 60 and SB 226 including:

- Inadequate estimates with unrefined environmental, engineering, and planning support costs, and the omission of escalation (inflation) and project contingency costs;
- A significant rise in construction costs, including an 18 percent increase in the federal construction costs index in 199-200 alone;
- Accelerated design work;
- The MTC's choice of bridge design;
- A one-year delay in securing Navy permission to conduct sample drillings on Yerba Buena Island; and
- Another year delay in completing environmental analyses in concert wit federal highway, environmental, and engineering agencies.

The department's report included a plan for resolving the cost overruns that it attributed to its own more comprehensive estimates (about $557 million at the time), but left the remaining costs – which it attributed to factors outside its control – unaddressed. Caltrans proposed that the $557 million portion of the increase be covered by using the State's share of unprogrammed federal HBRR funds. In August 2001, Caltrans submitted a letter to the legislature outlining a proposal for this portion of the cost increase.

In total, AB 1171 raised cost estimates for the Toll Bridge seismic retrofit program from $2.62 billion to $4.637 billion, and granted Caltrans "full and sole responsibility for completion of all seismic retrofit projects on the bay area bridges." The estimates for each toll bridge increased over the four-year period from 1997 to 2001 as follows:

- Benicia-Martinez Bridge (from $101 million to $190 million),
- Carquinez Bridge (retrofit north span – from $83 million to $125 million),
- Richmond-San Rafael Bridge (from $329 million to $665 million),
- San Mateo-Hayward Bridge (from $127 million to $190 million),
- San Pedro-Terminal Island Bridge (Vincent Thomas Bridge) (from $45 million to $62 million),
- San Diego-Coronado Bridge (from $95 million to $105 million),
- San Francisco-Oakland Bay Bridge (retrofit west span – from $553 million to $700 million; replace east span – from $1.285 billion to $2.6 billion).

In order to finance the added costs, the following provisions were included in AB 1171:

- Extension of the $1 seismic surcharge for earnings of up to $2.82 billion (plus financing costs) for up to a maximum of 30 years, and
- Reprogramming of $642 million in *federal* Highway Bridge Replacement and Rehabilitation (HBRR) funds.

AB 1171 also authorized Caltrans to address the funding deficiency through a combination of financing options, including but not limited to:

- Federal loans (via the Transportation Infrastructure Finance and Innovation Act (TIFIA) of 1998), and
- Revenue bonds and/or commercial paper issued by the California Infrastructure and Economic Development Financing Bank (CIEDFB), California Transportation Commission (CTC), or other appropriate entities.

AB 1171 prohibits any increase in tolls beyond the level needed to complete the seismic retrofit and replacement of bay area bridges unless the CIEDFB and Department of Finance (DOF) agree that:

Anticipating possible cost increases over the $4.637 billion estimate, the bill allowed Caltrans to program up to an additional $448 million (contingency) from project savings, resources from the Interregional Transportation Improvement Plan (ITIP), the State Highway Operation Protection Plan (SHOPP), and/or federal bridge funds. However, the expenditure of these funds was limited to the following conditions and design features of the SFOBB East Span

- The new bridge would be located north adjacent to the existing structure per Replacement Alternative N-6 Suspension Structure Variation,
- The main span of the bridge would be in the form of a "single tower cable suspension design," and
- As in SB 60, the roadway in each direction would consist of five lanes (each 12 feet wide) and would contain 10-foot shoulders as an emergency lane for public safety purposes on each side of the main-traveled way

The bill contained a number of other provisions including 1) protecting projects in the State Transportation Improvement Program (STIP) prior to 1/1/02, and 2) requiring Caltrans to annually transfer to BATA any annual excess toll revenues beyond the amount needed for financing and debt service of the retrofit work, to be used for Bay Area transportation purposes and other toll bridge improvements.

Last, the bill required Caltrans to report to the legislature - within 90 days of a determination that the actual costs would exceed the AB 1171 projections - as to the difference and reasons for the cost increase.

SB 916 (Perata) – Chapter 715, Statutes of 2003

In 2002, the California Legislature initiated hearings on the subject of Bay Area traffic congestion. More specifically, the Senate Select Committee on Bay Area Transportation reviewed traffic forecasts, and

determined that new investments in the bridge corridors - particularly mass transit options - were needed, along with a new revenue source. The Committee concluded that a toll increases was the most appropriate funding mechanism and formed a public advisory committee to develop an expenditure plan.

SB 916 embodies the expenditure plan developed by the Committee, which became better known as "Regional Measure 2" (RM 2). RM 2 was placed on the ballot for approval by voters in the seven county area during the March 2, 2004 Statewide primary election. The measure won approval with a margin of 57 percent supporting to 43 percent opposing. RM 2 increased tolls on Bay Area toll bridges by $1 per vehicle, bringing the total toll to $3 for 2-axle vehicles, effective July 1, 2004. The MTC estimates that this "third" dollar currently raises about $120 million annually.

New revenues generated by RM 2 are dedicated to a variety of projects in bridge corridors, including new mass transit options and critical highway bottleneck improvements. BATA would be authorized to fund 36 specified projects deemed to reduce congestion or improve travel. RM 2 specifies the dollar amounts and lead agency or project sponsor for each project. The list of authorized projects is extensive and is known as the "Regional Traffic Relief Plan."

The measure also authorizes BATA to further increase the amount of the adopted toll schedule only if required to meet its obligations on any bonds or to satisfy any bond covenants. BATA would be required to provide notification to and receive approval from the legislature prior to changing the toll.

Appendix C

Caltrans District 4

Samples of Implemented Changes

Welding - Extensive review of welding specifications resulted in many revisions to improve constructibility and incorporate lessons learned from claims on other projects.
Paint Specifications Improvements - Revised specifications to improve constructibility and incorporate lessons learned from claims on other projects. See attached for list of specific changes. Some of these changes are currently undergoing evaluation for incorporation into statewide specifications.
Design Campus - An engineering campus was formed on site at Pier 7 in Oakland to partner, minimize exchange time, and improve technical communications between owner and contractor's engineering teams to resolve technical conflicts, thus minimizing delay time and capital cost increases. Delays in the resolution of technical issues can directly result in delays to construction operations. As an example of its success, the turnaround of shop drawings on the Skyway project is currently about 2.5 days, as compared to 28 days when the contract started. Delays during construction translate into significant costs to the contractor, for which reimbursement from the owner would be sought by the contractor. These costs include overhead, equipment, and inefficiencies to the construction activities. Delay costs on the Skyway contract range from $250,000 to $500,000/day.
Contractor Cash flow - Additional payment items and specification language to facilitate payment for early costs to contractors for this large and complex contract. Also capped some items to limit Department's risk due to front-loading of the bid. Design campus, working drawings, marine access, and general mobilization.
Modified the Material-on-Hand Provisions - Payment method changes were made in specifications for many of the contracts to allow contractors to obtain payment for materials on hand at international facilities and for marine equipment mobilization, minimizing the contractor bidding in the higher risk.
Integrated Shop Drawings - Provides for extensive Contractor preplanning through 3-dimensional CADD drawings and actual mockups of key sections to be constructed to resolve design congestion or conflicts before they can become delays in the field.
Mock-ups - A bid item was added for SAS contracts to allow the contractor to build a scaled mock-up of portions of complicated actual work components off-site to ensure methods and constructibility issues are resolved prior to on-site construction. This process was very effective on the Skyway contract to identify rebar congestion and other constructibility issues. Including this item helps reduce contractor risk and, hence, lowers cost.
Cost Reduction Incentive Proposal (CRIP) - Contract specifications were modified to allow for greater flexibility in what could be included in a CRIP on SAS and future East Span contracts to encourage proposals by the contractor. The goal of these changes was to further encourage contract innovations to produce cost savings and reduce risks in construction.
Corridor Value Analysis Specifications - Because of the potential communication and coordination issues associated with 16 separate contracts for the East Span, a Corridor Value Analysis specification was added to the East Span contracts so that contractors from projects along the whole corridor can meet with Caltrans to propose and discuss ways to accelerate the overall project and reduce costs.
An Independent Review Committee (IRC) - With experts in transportation management, public contracting, bonding and insurance, the steel industry and structural engineering, the IRC examined the Bay Bridge East Span contracts to recommend changes that would encourage competitive bidding while managing risk. A few examples of changes made as

a result of their feedback include: • Advanced payment bond for materials on hand at foreign locations • Eliminated A+B bidding in order to level the foreign and domestic bids
Stipend Payments - The Department recognized that assembling a bid for a project of the magnitude of SAS would be very costly which could discourage contractors from even competing. As a result, stipends for second and thirdbidders as partial compensation for bid development costs were added to many of the East Span contracts to encourage additional bidders to participate.
Steel Tolerances Modifications - In order to improve constructibility, modifications were incorporated into steel tolerances. These changes did not jeopardize the strength or minimum quality of the structure, but did increase flexible to encourage fabrication competition and reduce risk.
Payment Bonding Requirements Reduced - Payment bonding requirements were reduced to improve contractor ability to obtain bonding. Caltrans advocated legislation (AB1745 - 2003), which allowed the Department to consider lowering the bonding requirement on large construction projects ($250 million +) from 100 percent of bid amount to 50 percent in order to improve bid competition. As indicated in the presentation materials, the ability to obtain bonding was a significant factor in contractors' ability to assemble a bid for these contracts.
Payment Item for Working Drawings - Typical Caltrans contracting procedures require contractors to provide contract-working drawings (details on specifically how particular project features will be built) as a part of the actual work. No separate compensation is provided for this work. Additional payment item specifications were added to separate the cost of preparing working drawings from the various items, thus reducing contractor costs and expediting their submittal to keep the review and approval of the working drawings off of the critical path.
Pier 7 Property - In addition to its use as an engineering campus (as described in the first bullet), Caltrans obtained Pier 7 property from Port of Oakland for contractor's use as a concrete plant, access yard, and areas for contractor's use to minimize distance to the marine work site. By providing this area, Caltrans has reduced contractor costs as well as provided for increased communication with the contractor for faster resolution of technical issues.
Performance-Based Contract Specifications - Performance-based contract specifications were initiated for the Bay Bridge East Span south side detour structure contract that will be a contractor-designed temporary bypass structure based on bridge type selected by the contractor, resulting in bid and time savings. This contract came in significantly under budget and the contractor has identified numerous innovative design approaches.
Business Outreach Meetings - Business outreach meetings were held in conjunction with FHWA/USDOT and local business leaders to inform small and disadvantaged businesses of the upcoming work, and to introduce them to prime contractors potentially bidding on the contract.
Structural Steel - Extensive review of structural steel specifications resulted in many revisions to improve constructibility and incorporate lessons learned from claims on other projects. See attached for list of specific changes.
Critical Path Method Scheduling - Took the statewide contract schedule specification and expanded requirements and definitions to better control the schedule of the project.
Pre-award Shop Audit - Pre-award shop audits were performed by Caltrans prior to bid, thus lowering bidder risk and saving time during construction. This process helped bidders identify whether a facility was likely to be able to produce materials that met project specifications before fabrication was actually initiated. This resulted in lower contractor risk.
Submittals with the Bid - Requires preliminary versions of some submittals with the bid to ensure bidders are qualified and accelerate Department review. An additional benefit of this process is that bidders were able to provide constructive input into the formation of the contract in the form of bidder inquiries that resulted in changes to the contract.

Areas for Contractor's Use - Layout plans were added to identify land areas available to the contractor and facilitate coordination between contractors on other projects.

Foreign Fabrication Provisions - Requires the contractor to provide a translator at foreign fabrication sites to increase communication with Department representatives.

Alternative "C" Bidding - The Department obtained approval to use "Alternative C" bidding, which allowed for the use of a foreign and domestic steel bid, on the SAS project. This process had never used prior to this project by the Department. It resulted in a $400M cost savings on the SAS contract. This savings is due to the required Domestic bid (in accordance with the Buy America Provisions, whereas the materials must be purchased domestically) had a difference in the total bid cost with the optional International bid (whereas materials may be fully or partially purchased internationally) by 25 percent of the total bid. Based on the May 26, 2004, bid for the SAS contract, this would have resulted in a savings of $400M because the International bid was 25 percent less than the Domestic bid.

Demonstration Installation Demonstration Pile Project - Performed a separate contract to demonstrate constructibility of piles to reduce bidder risk.

Steel Piling - The source inspection of steel pipe piling for Toll Bridge projects has resulted in improved specifications. The Department implemented new steel pipe piling specifications in 2002 that:

- Differentiated Quality Control Requirements - For redundant and non-redundant piling differentiated quality control requirements were made to reduce requirements.
- Implemented a Quality Control (QC) Ultrasonic Testing Training Program - Implemented a Quality Control (QC) Ultrasonic training program to allow for the greater use of technicians for field testing of piles.
- Modified Specifications to allow more "off-the-shelf" material purchases - An extensive review of available materials readily available was made to reduce the fabrication costs of specialized materials, such as bolts.

Reinforcement Bar Splices - The Department improved specifications of reinforcing bar splices as a result of the work on toll bridge projects. Stricter QC requirements coupled with innovative QA testing have resulted in a specification that satisfies both the designers and fabricator's concerns.

Welding - The Department's recent improvements to welding specifications also resulted from Toll Bridge work. Highlights of some of the changes include:

- Welding QC plan submittal requirement helps to resolve issues before welding begins. (http://www.dot.ca.gov/hq/esc/Translab/smbresources.htm)
- QC requirements that allow more efficient use of QA resources
- Clear certification requirements for inspecting personnel
- Documentation requirements for weld tracking and QC inspections

The Department's current source inspection procedures and processes were revamped to as a result of the changes made through the Toll Bridge program, which have also been changed through the Department as a result. Some of the most effective recent improvements include:

- QA Inspection Procedure Manual (364 pages) re-written to provide Department's inspection staff with clear inspection guidelines and criteria.
- Implementation of certification and qualification requirements of personnel performing quality assurance (QA) role and NDT.
- Implementation of a Department written practice for the certification and qualification of NDT personnel consistent with industry standards.

• Comprehensive training program to qualify inspectors and engineer.
• The Department's experience and success utilizing Structural Materials Representatives (SMRs) on the Toll Bridge Program has resulted in Department-wide implementation. SMR's fabrication experience, knowledge of industry practice, and materials engineering recommendations accelerated project delivery on Toll projects. As a result the Department has designated SMRs for all projects. This has resulted in the following: • Internal procedures to ensure realistic and timely materials engineering recommendations are provided to Construction. • Effective management tools to assess regulatory compliance for all jobs. • Expedited resolution of material issues and shipment of materials to the jobsite. • Realistic inspection forecasts that help the Department comply with QA laws and regulations. • Provide a single point of contact for materials engineering issues.
• The Department is in the process of analyzing the benefits of implementing improved material release procedures Department-wide. Results from the use of the innovative procedures on one of the Toll Projects demonstrated accelerated project delivery and streamlined materials engineering recommendations.

Appendix D

Glossary

AB1171 – Chapter 907, Statutes of 2001, sets the budget to retrofit the State owned bridges and replace the east span of the SFOBB at $4,637,000,000 of which $2,600,000,000 is for replacing the east span of the SFOBB.

ACTIA – Alameda County Transportation Improvement Authority

BATA – Bay Area Toll Authority – separate legal entity with jurisdictional responsibility for toll bridge revenues, comprised of the same members as the Metropolitan Transportation Commission (MTC).

Bay Bridge Design Task Force – MTC advisory body on the SFOBB east span project

Buy America – CFR, Title 23 – Highways, Volume 1, Part 635, Section 635.410, April 2000 – " if steel or iron materials are to be used, all manufacturing processes, including the application of a coating, for these materials must occur in the United States".

CAPE – Construction Administration Process Evaluations

CCTA – Contra Costa Transportation Authority

Constructability review – an independent review of project documents to determine areas of potential risk or cost savings and ability of contractors to construct the project.

Corps – United State Army Corps of Engineers – has jurisdiction over all "navigable waters of the United States."

Cost increase – a cost for a component that exceeds the original estimate for the project.

Cost overrun – a contracted bid item cost that exceeds the amount in the bid.

CRIP – Cost Reduction Incentive Proposal

Critical Path –series of tasks within a schedule that controls completion dates.

DEIS – Draft environmental impact statement – first publication of environmental findings under NEPA.

East Span –see SFOBB East Span

EDAP– Engineering and Design Advisory Panel – 34-member MTC advisory body on the SFOBB east span project.

EPA – United States Environmental Protection Agency

FEIS – Final environmental impact statement – final issuance of findings and mitigation regarding environmental impacts of a proposed project

Federalization/Federalized – means the responsible agency has decided to use USDOT funds on the project, bringing federal requirements with those funds.

FHWA – Federal Highway Administration

GGBHTD – Golden Gate Bridge Highway and Transportation District

HBRR – Highway Bridge Replacement and Rehabilitation – an FHWA funding program for bridge improvement projects.

IFB – Invitation for Bid – similar to a "request for proposals;" one example is the IFB for the SAS which yielded a single bidder.

Independent Review Committee – panel of experts unrelated to project planning, design and construction that perform a review of the project and make recommendations related to scope, schedule and cost.

Jones Act – Section 27 of the Merchant Marine Act of 1920 (46 U.S.C. 883; 19 CFR 4.80 and 4.80b). – Enacted to promote a healthy U.S-Flag fleet and protect that fleet from unfair foreign competition, the Jones Act requires that cargo moving between U.S. ports be carried in a vessel that was built in the United States and is owned (at least 75 percent) by American citizens or corporations. Since Jones Act vessels are registered in the United States, our general labor and immigration laws require that crewmembers be American citizens or legal aliens.

LEDPA –Least Environmentally Damaging Practicable Alternatives

Marine Foundations – see T1/E2

MTC – Metropolitan Transportation Commission – the metropolitan planning organization/regional transportation-planning agency for the nine county San Francisco Bay Area.

NEPA – National Environmental Policy Act – the US environmental protection laws.

PRMH – Caltrans Project Risk Management Handbook, First Edition, Revision 0 dated June 2003

Peer Review – panel of technical experts reviewing specific items of work, i.e. seismic experts review of seismic design criteria.

Qualitative Risk Analysis – prioritized list of risks classified as high, moderate, or low.

QA/QC – Quality Assurance/Quality Control

Quantitative Risk Analysis – an analysis of the project's likelihood of achieving it's cost and time objectives.

Risk Management – the systematic process of planning for, identifying, analyzing, responding to, and monitoring project risk. It involves processes, tools, and techniques that will help the project manager maximize the probability and consequences of positive events and minimize the probability and consequences of adverse events.

SAS – self-anchored suspension. In the case of the SFOBB, this is a 1,885+ foot long all steel bridge. It is composed of a prefabricated all steel tower rising 165 meters (541 feet) above sea level and two prefabricated steel road decks, each with 5 –12 foot traffic lanes, and 2 – 10 foot shoulders. The steel sections will be fabricated elsewhere and shipped to the work site for assembly into the bridge. It is called a self-anchored suspension because normally a cable suspended bridge, has two large cables anchored into a foundation on either end of the bridge. Suspender wires from the cables hold up the bridge deck. In the case of this SAS, there is one cable. It connects to one end of the road deck, goes over the tower, down to the other end of the deck, wraps around under the deck, back up over the tower, then attaches to the opposite side of the bridge deck, hence it is self anchored. The tower supports the cable, which holds up the deck.

SB60 Senate Bill 60 – Chapter 327 Statutes of 1997 – sets the budget for the retrofit of the State owned toll bridges and replacement of the SFOBB East Span at $2,620,000,000. Also gave BATA authority to choose the bridge design.

SFCTA – San Francisco County Transportation Authority

SFOBB East Span – San Francisco-Oakland Bay Bridge East Span, a 3,513 meter (11,525 foot) bridge between Oakland and San Francisco, terminating on Yerba Buena Island

SHOPP – State Highway Operations and Protection Plan – STIP funding for highway maintenance projects

SKYWAY - .8-mile concrete box viaduct bridge section between the Oakland Touchdown and the SAS bridge.

SMR - Structural Material Representative

STIP – State Transportation Improvement Program

T1/E2– these are the SAS underwater foundations for the tower (T1) and the eastern end of the SAS E2

TBSRP – Toll Bridge Seismic Retrofit Program

TYLin – TYLin International – an international bridge design firm, retained by Caltrans to design the SFOBB east span bridge

VA – Value Analysis

YBI – Yerba Buena Island – western terminus of the SFOBB East Span.

YBI Transition – the SAS is a 10-lane bridge with two 5-lane sections side by side. The roadway goes thru a tunnel in the mountain of YBI. The tunnel is a double deck tunnel, with each level having 5 lanes for traffic. This structure transitions the single level bridge traffic decks into a double deck configuration so the bridge roadway matches up with the double deck tunnel.

Notes to the Text

Executive Summary

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Other Factors Underlying the Cost Increases

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Contribution of the SAS and MTC to Cost Increases

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80 Includes SAS Superstructure and foundations only; excludes YBI contracts. Note that elsewhere in this report, some tables refer to "SAS/YBI," which includes the YBI work. All three components were contained in one contract until mid-2002, when in response to a recommendation from the Kimley-Horn Constructibility Review, the SAS contract was split into separate contracts.

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