Young Consultants Award: Successful Transportation Management Planning for the Unprecedented Full Closure of the San Francisco–Oakland Bay Bridge

In the 2008 Young Consultants Award paper, the author outlines transportation management planning for the unprecedented 70-hour planned full closure of the San Francisco–Oakland Bay Bridge to accommodate the demolition and replacement of a portion of the bridge for a seismic upgrade. The recurring traffic congestion, compounded with the additional demand generated by the numerous special events, presented major traffic concerns. Extensive transportation management planning involving advanced system-wide consideration and management of the expected impacts, as well as the development and implementation of strategies to minimize them, was critical to the overall success of the closure.

BY JOANNE C.W. NG, E.I.T.

OVERVIEW

Spanning 8 miles across, the San Francisco–Oakland Bay Bridge is a vital regional transportation link serving approximately 285,000 vehicle trips each day between San Francisco and Oakland, CA, USA, in the East Bay. To bring the bridge to current seismic design standards, the California Department of Transportation (Caltrans) began retrofit work in summer 1998, which is expected to be completed by winter 2014.

As part of the seismic upgrade, a portion of the original viaduct located to the east of the Yerba Buena Island (YBI) Tunnel needed to be demolished and replaced with a new structure—a 6,500-ton transversely post-tensioned concrete box girder measuring 350 feet long, 95 feet wide and 4 feet deep. In the absence of an alternate detour to the original viaduct, the demolition and replacement operation could only be accommodated through a complete bridge closure. Over the Labor Day weekend in 2007, the entire Bay Bridge was shut down during an unprecedented 70-hour planned full closure.

Due to the significance of the bridge in the regional transportation network, the foremost challenge of the retrofit was to minimize the anticipated transportation impacts. The normal recurring traffic congestion, compounded with the additional demand generated by the numerous major sports and cultural events planned for the same weekend, was expected to cause traffic disruptions and potential gridlocks in other locations of the network.

In addition, the risks involved in the construction activities exacerbated the challenge because once the demolition began, the bridge could not be re-opened until the replacement viaduct was successfully rolled into place. Any delay to the re-opening was expected to bring detrimental impacts to the Tuesday morning commute.

Transportation management planning (TMP), which was a comprehensive approach aimed to address the complex challenges of maintaining mobility and safety, was critical to the overall success of the full closure. It involved the advanced system-wide consideration of the expected impacts, and management of such impacts through the development and implementation of traditional traffic handling practices as well as other innovative strategies such as public outreach and incident management.

Representing Parsons Brinckerhoff, engineering consultant of the $5.6-billion East Span Seismic Safety Project, the author had the privilege to be part of a large multi-disciplinary, multi-agency TMP team. She participated in the process from planning and development to coordination and implementation of the various strategies, which included elements in public information, traveler information strategies, incident management, construction strategies, demand management and alternate route strategies.

To lay the foundation for and guide the entire TMP process, the author developed the initial work plan. Then, to establish the framework for the development of the plan and facilitate the ongoing multi-disciplinary coordination efforts, she initiated and managed the TMP presentation. Instead of documenting the TMP in the conventional report format, a slideshow format was adopted, which proved an effective way to present key information.

The TMP presentation document expedited inter-disciplinary communication, which in turn enhanced the high-knit collaboration required of the team. It also served as an excellent visual tool for use in various meetings and was used as the predecessor for the media presentation, which was widely used on television and in newspapers to explain the viaduct demolition and replacement operation to the public.

In addition, the author initiated and performed transportation impact analyses that estimated traffic conditions along the regional detour routes and provided justifications for temporary localized capacity improvements at bottleneck locations. In particular, Caltrans temporarily widened a freeway-to-freeway connector from one traffic lane to two traffic lanes specifically for the Labor Day weekend.

Furthermore, the author developed and managed the TMP binder, which made available the comprehensive documentation of the detailed implementation plans for the various strategies in one central location and will serve as an important reference for future TMP efforts of major planned bridge closures.

THE SAN FRANCISCO–OAKLAND BAY BRIDGE

The San Francisco Bay Area, comprising nine counties around the San Francisco Bay, is the fifth-most populous U.S. metropolitan area with 7.1 million people. The region's transportation network consists of 1,420 miles of freeways and state highways as well as 19,400 miles of local streets and roads. The residents of the Bay Area make more than 21 million trips on an average weekday, more than 84 percent of which are by automobile.[1]

Spanning 8 miles across the bay, the San Francisco–Oakland Bay Bridge was built in 1936 to provide a link between San Francisco on the San Francisco Peninsula and Oakland on the East Bay. The double-decked bridge consists of two spans (the east span and west span) that are connected by the tunnel on YBI. With five traffic lanes in each direction, the vital transportation link serves approximately 285,000 vehicle trips daily. Due to its strategic location in the regional freeway network, the bridge and its approaches account for three of the Bay Area's 10 worst congestion locations.[2]

Figure 1. East Span Seismic Safety Project limits.

In October 1989, the 7.1-magnitude Loma Prieta earthquake caused a 250-ton section of the upper deck of the east span to collapse. As a result, the Bay Bridge was closed for almost 1 month for repairs. The collapse prompted the need to assess and improve the seismic safety of the entire bridge, upgrading it to a lifeline facility that would provide for post-earthquake relief access linking San Francisco, Oakland and regional emergency relief routes.[3]

Since the summer of 1998, Caltrans has implemented various projects to replace and/or retrofit sections of the bridge. The retrofit of the west span, the west YBI viaduct and the YBI Tunnel, as well as the interim retrofit of the east span, are now completed. The replacements of the west approach and of the east span (the East Span Seismic Safety Project) are currently in progress.

THE EAST SPAN SEISMIC SAFETY PROJECT

Construction of the $5.6-billion East Span Seismic Safety Project began in January 2002 and is expected to be completed by fall 2014. The project will completely replace the existing east span with two side-by-side bridge structures, as shown in Figure 1. The parallel elevated roadways will be transitioned to the upper and lower decks of the existing bridge at the YBI Tunnel through the YBI Transition Structures (YBITS).

To allow for the construction of the YBITS while maintaining traffic on the existing east span, a 900-foot temporary two-level bypass structure, commonly referred to as the South-South Detours, will be constructed to connect the YBI Tunnel and the existing east span.

To enhance the structural safety of the portion of the existing bridge where the South-South Detours will connect, the demolition and replacement of the original YBI viaduct was required. During the Labor Day weekend of 2007, the original YBI viaduct was demolished and replaced with a 6,500-ton transversely post-tensioned concrete box girder measuring 350 feet long, 95 feet wide and 4 feet deep, which was constructed on an adjacent site to the south of the bridge away from traffic.

Various construction activities took place: disconnecting the utilities on the original YBI viaduct; placing a protective pad and plates on the lower deck; saw-cutting the original viaduct into 63 90-ton slabs; hoisting them using a giant ringer crane and hauling them away by trucks to Oakland; cleaning up the rubble on the lower deck; installing the roll-in tracks on the lower deck; lifting the replacement viaduct on 16 computer-controlled hydraulic jacks; gliding it into place; lowering it onto permanent columns that had already been built; connecting it to the existing bridge on either end; and preparing it for the often heavily congested Tuesday morning commute.

TRANSPORTATION MANAGEMENT PLANNING

In the absence of a detour section to the original YBI viaduct, the aforementioned

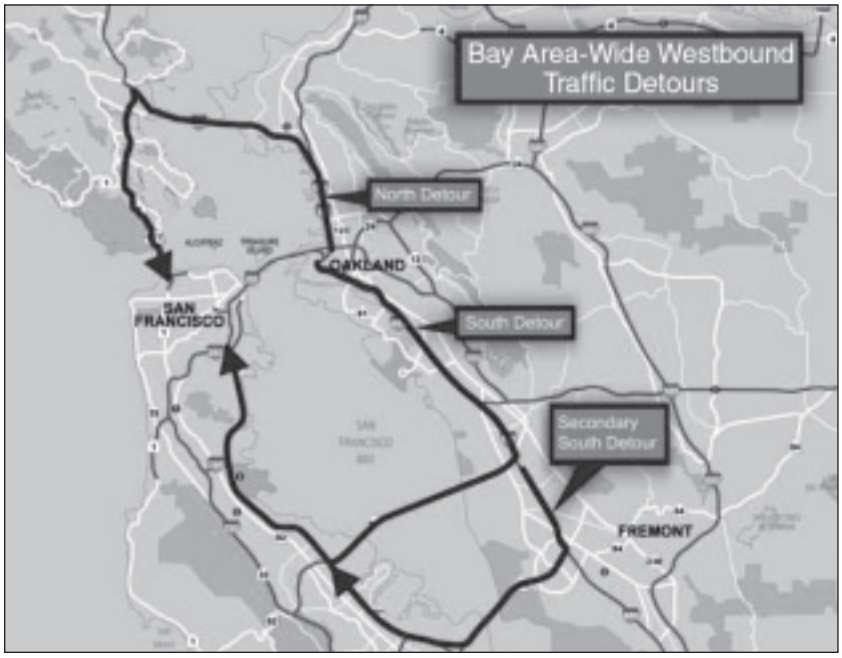


Figure 2a. Bay Area-wide westbound traffic detours.

Figure 2b. Bay Area-wide eastbound traffic detours.

construction activities, which were estimated to require 81 hours to complete, could only be accommodated through a complete bridge closure. Extensive TMP that involved the advanced system-wide consideration and management of transportation impacts, as well as the development and implementation of strategies to minimize such impacts, was critical to the overall success of the viaduct demolition and replacement operation.

Defined as "a method for minimizing activity-related traffic delay and accidents by the effective application of traditional traffic handling practices and an innovative combination of public and motorist, bicyclist and pedestrian information, demand management, incident management, system management, construction strategies, alternate routes and other strategies," TMP is an effective technique developed to address the complex challenges to maintaining mobility and safety while performing rehabilitation and reconstruction work on existing roads.[4]

The Federal Highway Administration (FHWA) recognizes the importance of TMP in all phases of project development. Through establishing the Rule on Work Zone Safety and Mobility in September 2004, FHWA mandates the development and implementation of transportation management plans for all projects. The rule applies to all state and local governments that receive federal-aid highway funding and required compliance by October 2007.

THE CHALLENGES

There were two key challenges to successful TMP for the viaduct demolition and replacement operation. First, due to the significance of the Bay Bridge in the regional transportation network, the foremost challenge of the seismic retrofit efforts was to minimize transportation impacts. The closure considered was the first-ever planned complete closure of the Bay Bridge since its inception in 1936. It was expected to cause traffic disruptions and potential gridlocks in other locations of the regional transportation network, which was a major concern.[5]

Compounding the recurring traffic congestion was the additional demand generated by the numerous major sports events planned for Labor Day weekend. In addition, several large cultural events also took place.

Second, several construction trials added to the challenge of the retrofit work, including the precision required of the construction activities, the narrow timeframe and the risk involved. The demolition of the original viaduct and columns had to be performed meticulously to avoid damaging the new columns of the permanent viaduct located only a few feet away. Also, unforeseen events such as weather, earthquakes, work zone incidents, or equipment failure could delay the re-opening of the bridge. The narrow timeframe could not accommodate too much delay. Most important, once the demolition began, the bridge could not be re-opened until the replacement viaduct was successfully rolled into place. Any

delay to the re-opening was expected to bring detrimental impacts to the Tuesday morning commute.

MY ROLE AND CONTRIBUTIONS

Parsons Brinckerhoff serves as the engineering consultant for Caltrans on this project, providing various consulting services that include TMP. Representing Parsons Brinckerhoff, the author had the privilege to be involved in all stages of the TMP process, from planning and development to the coordination and implementation of the different strategies.

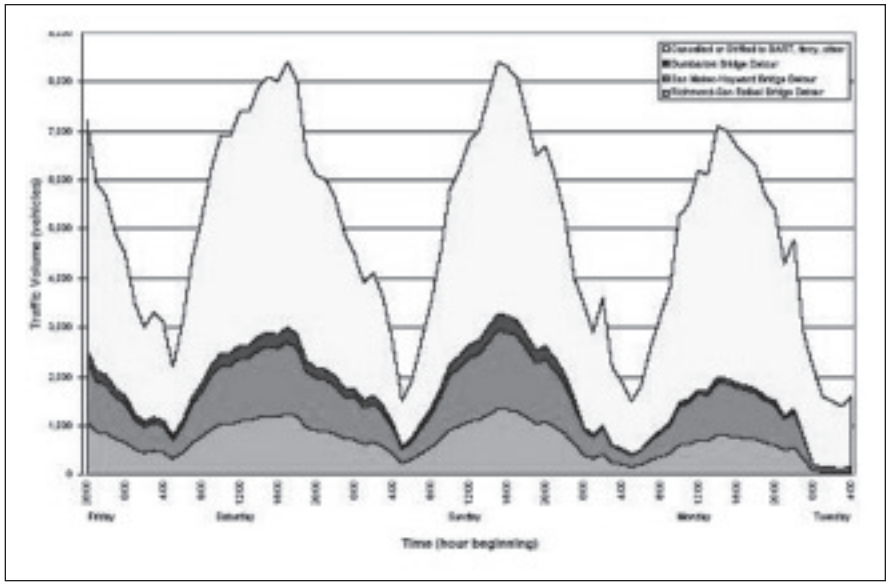
Initial Work Plan—The Foundation

Given the significant challenges associated with the bridge closure, Caltrans began the planning efforts approximately 1 year in advance of the actual closure. As in the case of any planning process, establishing a clear understanding of the course of action required to develop and implement a comprehensive plan was necessary for success. Due to the anticipated significant transportation impacts of the viaduct demolition and replacement operation, full bridge closure approvals by the Caltrans District and Headquarters Lane Closure Review Committees had to be obtained, in compliance with Caltrans Transportation Management Plan Guidelines (May 2004). Hence, the first task of the TMP process was to prepare an initial work plan outlining the efforts involved in obtaining such approvals, including the specific tasks, estimated schedule, coordination team and stakeholder requirements.

Building on Parsons Brinckerhoff's past experience of successfully assisting Caltrans in obtaining similar approvals, the author developed the initial work plan based on inputs from the previous internal TMP task lead. Also, benefiting from the 77-hour eastbound closure of the bridge during Labor Day weekend in 2006, she and her project manager, Brady Nadell, interviewed two key Caltrans personnel—Alec Melkonians, regional project manager, and Raoul Maltez, construction traffic manager—for further input to tailor the work plan for the uniqueness of the viaduct demotion and replacement operation.

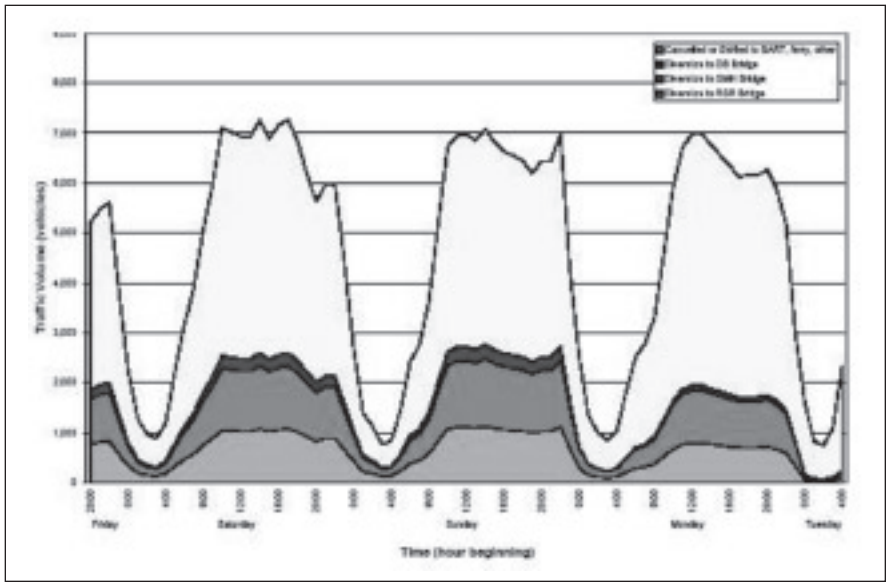
With the initial work plan in place, the first in a series of regular coordination meetings was held. The goals to obtain full bridge closure approvals from the Caltrans District and Headquarters Lane Closure Review Committees as well as to develop a plan specific for the YBI viaduct demolition and replacement operation were identified. The tailored work plan was used as a cornerstone to initiate the process and schedule.

A highly collaborative, multi-disciplinary and multi-agency team was essential to successfully delivering the process and schedule that addressed the aforementioned challenges. The team for the viaduct demolition and replacement operation consisted of the east span seismic safety project manager, regional project manager, construction traffic manager and representatives from various Caltrans departments and offices, including district traffic management, transportation management center, highway operations, electrical systems, traffic signing, design, structures, construction, transit and community planning, public information and scheduling. The team also included representatives from the California Transportation Commission, the Metropolitan Transportation Commission, various cities, law enforcement agencies (such as the California Highway Patrol and city police departments) and transit agencies.



Source: Draft WTI Phase I Full Bay Bridge Closure—Transportation Impact Analysis (For Planning Purposes)—Revision 3, Parsons Brinckerhoff, August 16, 2007.

Figure 3. 2007 Labor Day weekend full closure—estimated eastbound trip distribution.

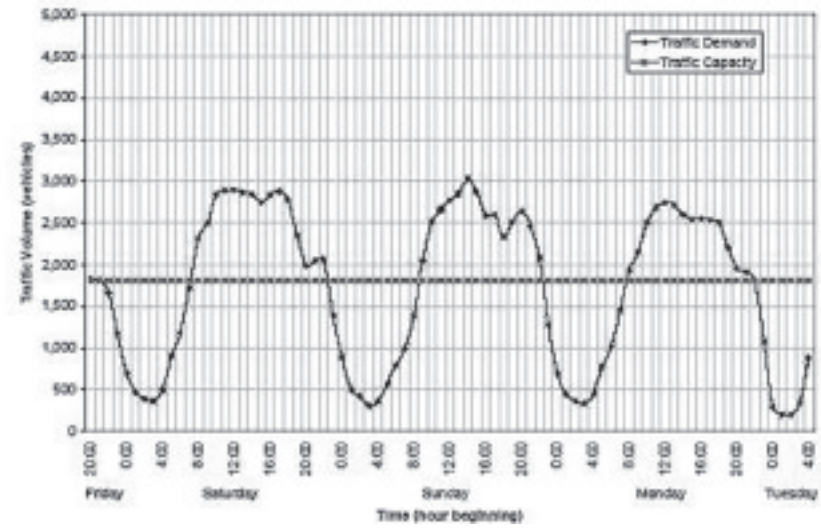


Source: Draft WTI Phase I Full Bay Bridge Closure—Transportation Impact Analysis (For Planning Purposes)—Revision 3, Parsons Brinckerhoff, August 16, 2007.

Figure 4. 2007 Labor Day weekend full closure—estimated westbound trip distribution.

TMP Presentation—The Framework

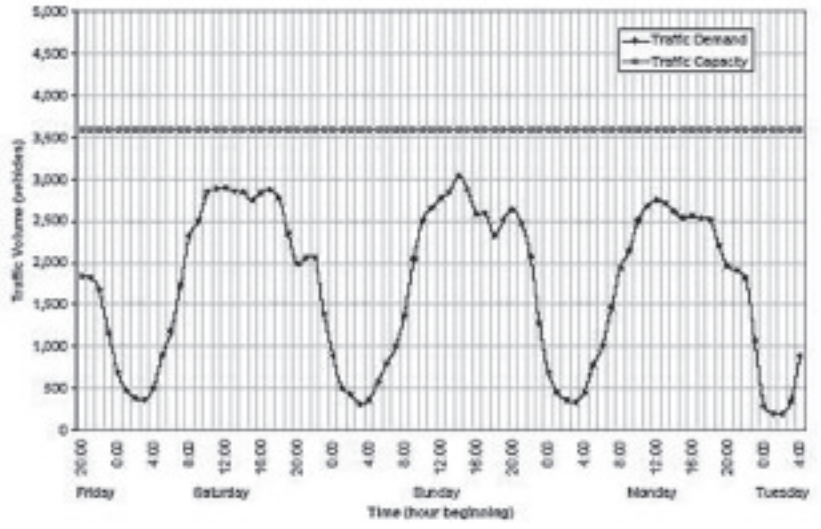
To establish the framework for the development of the TMP and to facilitate the ongoing multi-disciplinary coordination efforts, the author created and managed the TMP presentation document that described the project, illustrated the construction activities, discussed the anticipated transportation impacts and proposed a variety of strategies. A slideshow format was adopted, which proved an effective way to present key information.



Note: Graphs showing traffic demand versus capacity for the potential bottleneck location were produced to highlight general traffic trends and potential delays during the closure period. As the traffic volume data for the demand at bottleneck locations were not collected specifically for the analysis, these graphs were most appropriate for broad, planning purposes.

Source: Draft WTI Phase I Full Bay Bridge Closure—Transportation Impact Analysis (For Planning Purposes)—Revision 3, Parsons Brinckerhoff, August 16, 2007.

Figure 5. Estimated westbound traffic volume at the southbound Interstate 880 off-ramp to westbound Route 92 (existing lane configuration).



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Source: Draft WTI Phase I Full Bay Bridge Closure—Transportation Impact Analysis (For Planning Purposes)—Revision 3, Parsons Brinckerhoff, August 16, 2007.

Figure 6. Estimated westbound traffic volume at the southbound Interstate 880 off-ramp to westbound Route 92 (assumed two lanes).

Although construction details of the viaduct demolition and replacement work were being developed concurrently, creating the TMP presentation in the early planning stage proved beneficial. It fostered and expedited inter-disciplinary communication because it consolidated the work of various team members in one accessible location. With improved communication, it enhanced the tightly-knit collaboration required of the team, which was often difficult to achieve given the large size and the number of disciplines involved.

Furthermore, it served as an excellent visual tool for use in various meetings and stakeholder coordination. The TMP presentation was used as the predecessor to develop the media presentation, which assisted the media in explaining the viaduct demolition and replacement operation to the public. It was welcomed by the media and widely used on television and in newspapers.

Transportation Impact Analyses

Because the Bay Bridge is a critical regional artery, the extended full closure was expected to result in significant transportation impacts, especially along alternate routes, which included the north detour consisting of the famous Golden Gate Bridge and the Richmond–San Rafael Bridge; the south detour consisting of the San Mateo-Hayward Bridge; and the secondary south detour consisting of the Dumbarton Bridge, as shown in Figure 2.

The additional demand resulting from detoured traffic, in conjunction with that generated by the major sports and cultural events around the bay, were likely to cause heavy congestion. In particular, traffic conditions at capacity-constrained or bottleneck locations along the detour routes were of grave concern.

In view of that, the author initiated and performed transportation impact analyses that estimated traffic conditions along the detour routes and provided justifications for temporary localized capacity improvements at bottleneck locations. Because a planned full closure of the Bay Bridge was unprecedented, the author conferred with Caltrans Highway Operations to develop a reasonable methodology based on the data available at the time.

By using travel patterns and traffic conditions observed during the 2006 Labor Day weekend when the Bay Bridge was closed in the eastbound direction, and applying the methodology, the estimated distributions of vehicle trips to the three alternate routes in the eastbound and westbound directions were obtained, as shown in Figures 3 and 4.

As mentioned above, analysis results of the potential bottleneck locations provided justifications for temporary localized capacity improvements during the full closure. In particular, the southbound Interstate 880 off-ramp to westbound Route 92, which was a freeway-to-freeway connector on the alternate south detour, was expected to experience large delays. To mitigate such delays, Caltrans temporarily widened the connector from one traffic lane to two traffic lanes specifically for the Labor Day weekend in 2007. Analysis results for a single-lane and a double-lane configuration are presented in Figures 5 and 6. Widening the connector to two lanes improved traffic operations and provided adequate capacity to meet the increased traffic demand during the full closure.

Strategies Coordination

Various strategies were implemented and were effective in reducing the number of trips made around the Bay Area during Labor Day Weekend, making the full bridge closure a success. Close to $1 million was spent on the statewide public outreach alone to ensure residents and out-of-town travelers were well aware of the closure, notifying them more than 4 months in advance. To encourage motorists to choose alternative travel options, the team coordinated with various transit agencies to develop and implement travel demand management strategies. Such strategies included the arrangements for additional services by Bay Area Rapid Transit (BART) and several ferry operators.

BART observed the highest daily ridership in its history, with approximately 389,400 riders on Friday, 278,600 on Saturday and 208,700 on Sunday during the Labor Day weekend. For those motorists who still opted to drive, the team set up real-time traffic detour monitoring and performed near real-time traffic analyses. The team also deployed existing permanent changeable message signs (CMS) throughout the freeway system and positioned more than 100 portable CMS on local streets to provide real-time travel and incident information to motorists. In addition, a number of alternate route strategies were implemented, including the temporary localized capacity improvements at the southbound Interstate 880 off-ramp to westbound Route 92.

Many meetings were held to coordinate and implement these strategies. The author participated in TMP team coordination meetings, TMP regional plan/local plan development meetings, as well as the transit agency coordination meetings. She worked closely with the construction traffic manager, who chaired these meetings, and prepared meeting minutes that served as important documentation for future reference.

She also developed and maintained the TMP binder about 3 months in advance of the closure, which contained detailed implementation information, such as the communication plan for public outreach, the long-term emergency transportation response plan and details of the additional BART and ferry services. In addition to the benefits that the TMP presentation offered, the TMP binder served as an excellent documentation tool and will be an important reference for future TMP efforts of major planned bridge closures.

THE NEXT PHASE

Construction of the South-South Detours is currently underway, which, once complete, will accommodate all existing traffic to allow for the construction of the YBITS that transition the parallel elevated roadways to the upper and lower decks at the YBI Tunnel. The South-South Detours are expected to be connected to the existing bridge in summer 2009, which will require a series of closures including a 24-hour full bridge closure. The author is looking forward to participating in upcoming TMP efforts.

ACKNOWLEDGMENTS

As the author of this paper, Joanne was grateful for the opportunity to participate in such a unique and meaningful endeavor for the people of the San Francisco Bay Area. She would like to thank Caltrans, especially Ken Terpstra, Alec Melkonians, Raoul Maltez and Koohong Chung for their support. She would also like to thank Parsons Brinckerhoff, especially Brady Nadell, John Chirco, Al Schaufler, John Chow and Micky Hingorani for their assistance. The author can be reached at ngjo@pbworld.com; 415-243-4769; or Parsons Brinckerhoff, 303 Second Street, Suite 700 North, San Francisco, CA 94107-1317. ■

References

1. *Bay Area Transportation: State of the System 2006,* Metropolitan Transportation Commission and Caltrans District 4, May 2007.

2. Ibid.

3. Final Environmental Impact Statement/ Statutory Exemption—SFOBB East Span Seismic Safety Project, Caltrans, May 2001.

4. *Transportation Management Plan Guidelines,* Caltrans, originally prepared in June 2001 and revised in May 2004.

5. Although the bridge was closed in the eastbound direction for 77 hours during the Labor Day weekend in 2006 as part of the west approach project, the closure in 2007 was more complex because it involved both directions and there were more planned events around the Bay Area.

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