The Dynamics of the Development of Large-Scale
Public Projects:
A Case Study of the Central Artery/Tunnel Project
by
Michael E. Hesshaus
B.S., Civil Engineering
Worcester Polytechnic Institute, 1994

Submitted to the Department of
Civil and Environmental Engineering in Partial Fulfillment of
the Requirements for the
Degree of
MASTER OF SCIENCE
in Civil and Environmental Engineering
at the
Massachusetts Institute of Technology
February 1995

© 1995 Michael E. Hesshaus
All rights reserved

The author hereby grants to MIT permission to reproduce and
to distribute publicly paper and electronic copies of this
thesis document in whole or in part.

Signature of Author ..................................................
Department of Civil and Environmental Engineering
January 18, 1995

Certified by ......................................................
Charles HeIliewell
Senior Lecturer
Department of Civil and Environmental Engineering
Thesis Supervisor

Accepted by ......................................................
Dr. Joseph M. Sussman
Chairman, Departmental Committee on Graduate Studies
ARCHIVES

MAR 07 1995
THE DYNAMICS OF THE DEVELOPMENT OF LARGE-SCALE
PUBLIC PROJECTS:
A CASE STUDY OF THE CENTRAL ARTERY/TUNNEL PROJECT

by

MICHAEL E. HESSHAUS

Submitted to the Department of Civil and Environmental Engineering on January 18, 1995 in partial fulfillment of the requirements for the Degree of Master of Science in Civil and Environmental Engineering

ABSTRACT

The Central Artery/Tunnel Project of Boston, Massachusetts is the largest ongoing roadway construction project in the United States. The project is not only extremely large and technically complex, but is also very unique. It requires the balancing of special interests and the consideration of many viewpoints such as the environment, communities, downtown Boston businesses, federal, state, and city governments, as well as the general public.

This thesis evaluates the development of the Central Artery/Tunnel Project from conception through design and construction. A history of the political forces which shaped the development of the project sets the background for a discussion of the project's dynamic organizational structure, the role of public relations management during design, and the interaction of the various participating organizations during construction.

Thesis Supervisor: Charles Helliwell

Title: Senior Lecturer,
Department of Civil and Environmental Engineering
# TABLE OF CONTENTS

LIST OF FIGURES ...................................................... 5  
LIST OF TABLES ....................................................... 6  
LIST OF ABBREVIATIONS ............................................. 7  
INTRODUCTION ............................................................ 8  

CHAPTER 1. HISTORY ...................................................... 10  
1.1 Conception ......................................................... 10  
1.1.1 Pro-Highway Atmosphere ...................................... 10  
1.1.2 The Elevated Artery ........................................... 12  
1.1.3 The Third Harbor Tunnel Concept ............................ 13  
1.1.4 The Idea of Depressing the Central Artery ............... 15  
1.1.5 Political Chaos ................................................ 16  
1.1.6 Final Political Support ....................................... 20  
1.2 Project Approval Process ....................................... 23  
1.2.1 Initial FHWA Approval ....................................... 23  
1.2.2 Preliminary Design and Feasibility Studies ............... 24  
1.2.3 Public Approval ............................................... 25  
1.2.4 Final Federal Funding Approval ......................... 26  
1.3 The CA/T: A Unique Project .................................... 28  

CHAPTER 2. ORGANIZATION .............................................. 30  
2.1 Traditional Public Project Organization ..................... 30  
2.2 Central Artery/Tunnel Project .................................. 31  
2.2.1 Decision to Hire a Management Consultant .............. 31  
2.2.2 Management Consultant Selection .......................... 34  
2.2.3 Organizational Structure .................................... 36  
2.2.3.1 Planning & Design Development ......................... 40  
2.2.3.2 Design .................................................... 40  
2.2.3.3 Construction ............................................. 41  
2.2.4 Contract Packages ............................................ 42  
2.2.5 Bechtel/Parson Brinckerhoff's Dynamic Structure ........ 45
CHAPTER 3. THE ROLE OF PUBLIC RELATIONS IN DESIGN .......... 55
3.1 Need for Public Relations on CA/T ............................... 55
3.2 The Charles River Crossing .................................... 57
   3.2.1 Design .................................................. 57
   3.2.2 Resolution ............................................. 59
3.3 The Importance of Public Relations Management ........... 61
   3.3.1 Project Development ................................... 61
   3.3.2 Handling the Media ..................................... 64
   3.3.3 A Plan for the Future ................................. 66

CHAPTER 4. CONSTRUCTION ........................................... 70
4.1 Procurement .......................................................... 70
   4.1.1 Regulation ............................................... 70
   4.1.2 Design and Construction Contracts ..................... 71
   4.1.3 The Current Low-Bid System ............................ 71
   4.1.4 Concept of Best Value .................................. 73
   4.1.5 Investment in Design ..................................... 74
4.2 Improving Field Efficiency .................................... 75
   4.2.1 Field Supervision and Project Control ............... 75
   4.2.2 Contract Package C13A1 Examples ....................... 76
      4.2.2.1 Shotcrete or Forms? .............................. 77
      4.2.2.2 Dorchester Branch Railroad Bridge ............... 79
   4.2.3 Empowering Field Personnel ............................ 82
   4.2.4 Risk Allocation ........................................ 84

CHAPTER 5. THE CA/T PROJECT TODAY AND TOMORROW ........... 88
5.1 Status of Central Artery/Tunnel Project ...................... 88
   5.1.1 Shifting to a Construction Oriented Structure ....... 88
   5.1.2 Public Relations ......................................... 93
   5.1.3 Potential Conflicts of Interest ......................... 94
   5.1.4 Cost Control ........................................... 95
5.2 Trends in Public Construction Projects ...................... 99

CHAPTER 6. CONCLUSIONS ............................................ 102

APPENDIX .............................................................. 105
BIBLIOGRAPHY ......................................................... 114
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Growth of Traffic on Boston’s Central Artery</td>
<td>11</td>
</tr>
<tr>
<td>1.2</td>
<td>The 1983 Central Artery/Tunnel Plan</td>
<td>22</td>
</tr>
<tr>
<td>2.1</td>
<td>Federal Funding Flow Chart</td>
<td>33</td>
</tr>
<tr>
<td>2.2</td>
<td>Overall CA/T Project Organization</td>
<td>37</td>
</tr>
<tr>
<td>2.3</td>
<td>Design Contract Packages</td>
<td>43</td>
</tr>
<tr>
<td>2.4</td>
<td>Construction Contract Packages</td>
<td>44</td>
</tr>
<tr>
<td>2.5</td>
<td>B/PB General Organizational Structure on CA/T</td>
<td>48</td>
</tr>
<tr>
<td>2.6</td>
<td>B/PB Management - Planning &amp; Design Development</td>
<td>50</td>
</tr>
<tr>
<td>2.7</td>
<td>B/PB Management - Design Phase</td>
<td>52</td>
</tr>
<tr>
<td>2.8</td>
<td>B/PB Management - Construction Phase</td>
<td>54</td>
</tr>
<tr>
<td>3.1</td>
<td>Scheme Z</td>
<td>58</td>
</tr>
<tr>
<td>3.2</td>
<td>The New Charles River Crossing Design</td>
<td>60</td>
</tr>
<tr>
<td>3.3</td>
<td>Public Involvement During Development Process</td>
<td>64</td>
</tr>
<tr>
<td>4.1</td>
<td>Location of Dorchester Branch Railroad Bridge and Southampton Street Bridge</td>
<td>77</td>
</tr>
<tr>
<td>4.2</td>
<td>Chipped Reinforced Concrete Piers of the Southampton St. Bridge</td>
<td>78</td>
</tr>
<tr>
<td>4.3</td>
<td>Dorchester Branch Railroad Bridge Extension</td>
<td>81</td>
</tr>
<tr>
<td>5.1</td>
<td>B/PB Original Engineering Management Structure</td>
<td>89</td>
</tr>
<tr>
<td>5.2</td>
<td>B/PB Current Engineering Management Structure</td>
<td>90</td>
</tr>
</tbody>
</table>
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Divided Political Support for Artery Depression and Third Harbor Tunnel</td>
<td>20</td>
</tr>
<tr>
<td>2.1</td>
<td>General Project Responsibilities</td>
<td>39</td>
</tr>
<tr>
<td>5.1</td>
<td>B/PB Current Subconsultants</td>
<td>92</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

ABC .................................................. Artery Business Committee
B/PB ................................................. Bechtel/Parsons Brinckerhoff
CA/T ............................................... Central Artery/Tunnel Project
DEIS ................................................. Draft Environmental Impact Statement
DPW .................................................... Department of Public Works
EIS ...................................................... Environmental Impact Statement
FHWA .................................................. Federal Highway Administration
MBTA .................................................. Massachusetts Bay Transit Authority
MHD ..................................................... Massachusetts Highway Department
MIT ...................................................... Massachusetts Institute of Technology
MTA ..................................................... Massachusetts Turnpike Authority
SEIS ................................................. Supplemental Environmental Impact Statement
INTRODUCTION

The Central Artery/Tunnel Project of Boston, Massachusetts is the largest ongoing construction project in the United States. It includes the construction of Boston’s third harbor tunnel and the depression of Boston’s infamous “elevated artery” which has split downtown in half for the past three decades. Its construction will help reduce congestion and improve traffic flow through the city. With scheduled construction due past the year 2004 and recent cost estimates at over $7.7 billion, the CA/T Project has become a magnet for attention and politics.

The magnitude of the project and its urban location have attracted widespread interest. Its scope affects a wide variety of people, from construction workers to business owners, residents and environmentalists. In one way or another, everyone in the Boston area is directly or indirectly affected by this project. Special interest groups, the state, and the general public have all been involved in its development from conception through design and construction. The consideration of these different perspectives has demanded an innovative organizational structure to successfully manage the project.

This new organization of the Central Artery/Tunnel Project has had to adjust to all phases of the construction process. Focus has been placed on the development of a solid public relations program to accommodate the concerns of local businesses and communities. Effective interaction with
outside groups throughout construction and especially design has been necessary. Efficient methods of field construction are to be implemented to reduce costs, meet schedules, and avoid the bureaucratic pitfalls of typical large public projects. The complex social and technical issues surrounding the Central Artery/Tunnel Project has shaped a new dynamic management approach to the construction of large-scale public construction projects.
CHAPTER 1 - HISTORY

1.1 Conception

1.1.1 Pro-Highway Atmosphere

In terms of transportation, the atmosphere of the decade following World War II could be described as pro-highway. When the federal government began its interstate highway program in the 1950’s, the American economy was booming. Automobiles were becoming a way of life and a household luxury to which many average Americans could aspire to. It represented new levels of personal prestige and freedom. The war had been won, fascism had been defeated, and for the most part Americans and democracy were riding on the top of the wave. The glory days of the huge American automobile symbolized this attitude.

In the path of the bulldozers which were paving the way for this explosion of road construction projects were often small community interests. However, it was determined that local concerns would need to be sacrificed to achieve the greater social good for the community. Old neighborhoods which stood in the way of large construction projects were torn down. Proponents insisted that these communities would be better off in the long term, with the new construction of modern facilities and efficient means of transportation. In general, the protests of small interest groups were greeted with apathy.

It was with this powerful urge to develop that the
existing elevated artery in Boston was completed in 1959. Originally designed to carry 75,000 cars per day, it barely moves 190,000 today (see figure 1.1).

Figure 1.1 Growth of Traffic on Boston’s Central Artery

Despite community protest, it displaced approximately 1,000 residential and commercial structures during its construction. This is an outrageous figure by today’s standards, but consistent with the 1950’s post war philosophy that the greater interest of society prevails. It had a great impact on Boston’s North End, serving as a symbolic divider between this traditionally Italian community and the rest of Boston. It also obstructed the scenic view of Boston Harbor from downtown.

1 "Looking at the Central Artery/Tunnel, you might think we've only scratched the surface." (Boston: Central Artery/Tunnel Project and Artery Business Committee) [1989]
1.1.2 The Elevated Artery

Construction of the elevated artery began in the area of north Boston and proceeded south. During early construction of this new highway structure, many residents of the North End were appalled by this steel monster which divided their neighborhood from downtown Boston. Nevertheless, construction continued well past the North End into the financial district. In the late 1950’s with the election of a new Republican governor, an important decision was made concerning the construction of the remainder of the project. The artery would be depressed under Dewey Square, in the south part of downtown Boston. This was a significant turn for several reasons. Perhaps it was the result of residents’ opposition in the North End or the general realization that an elevated artery was not such a good idea after all.

After the opening of the Central Artery in 1959, it became obvious that this new highway was not as viable a transportation solution as originally thought. The new structure did not encourage smooth traffic flow. An attempt to make the highway highly accessible through many entrances came at the expense of traffic flow. There was a lack of merge and weave lanes to handle the constant exchange of cars heading on and off the artery. Furthermore, a lack of breakdown lanes led to traffic congestion when motor vehicles became disabled. Taking all of these factors into consideration and the alarming rate of increasing traffic demand, the elevated artery as we know it today was practically obsolete by the time it was opened.

In the early 1960’s many solutions to improve the artery
were suggested. Some engineers believed that new ramps to the Sumner and Callahan tunnels would help alleviate congestion. Others proposed that the artery should be widened from six lanes to eight or more. This alternative was socially unpopular and economically unfeasible. The construction of an additional deck was also presented as a solution, but this strategy was deemed socially unacceptable. Proposals for "inner belt" highways within the existing ring of route 128, to siphon off traffic from the artery, were also suggested but met with great opposition. It was clearly evident that anti-highway sentiment was brewing in the greater Boston area, perhaps due to the socially unacceptable transportation "solution" known as the elevated artery.

1.1.3 The Third Harbor Tunnel Concept

Currently, there are two tunnels under Boston Harbor. They connect downtown Boston to East Boston and Logan Airport, and generally carry northbound traffic. In 1934, the Sumner Tunnel was opened to the public. It consisted of two lanes, one in either direction. This was soon found to be inadequate to handle the increasing traffic of America's transportation revolution. Therefore, a second tunnel, the Callahan, was constructed and opened in 1961, only two years after the existing elevated artery was completed. The Callahan, which ran exactly parallel to the Sumner Tunnel, also consisted of two lanes. For the past three decades, these two tunnels have carried traffic between downtown and East Boston.

The location of the Sumner and Callahan tunnels has
limited the flexibility of access to Logan Airport and East Boston from most of the area west and south of Boston. For example, citizens from a suburb south of Boston need to travel through the elevated artery in downtown then cross Boston Harbor via the Sumner and Callahan. The shortcomings of this arrangement became clear during the 1960’s as congestion on the elevated artery increased. The concept of a third harbor tunnel to alleviate congestion on the elevated artery and the existing tunnels was born out of this need.

In 1967, under authorization of the state legislature, the Massachusetts Turnpike Authority conducted a feasibility study for a proposed third harbor crossing. The MTA reached several conclusions. First of all, the disturbance of residential properties would be inevitable, although not necessarily to the degree which the elevated artery had caused a decade earlier. Secondly, the tunnel would need to be linked into a much larger transportation system in order to be most effective. The MTA also concluded that further studies should be conducted because increasingly higher levels of congestion might eventually choke the business district in downtown Boston.

High levels of traffic congestion have been a major concern of businesses in the downtown area. For this reason, the concept of a third harbor tunnel has traditionally been supported by business owners and pro-business Republican politicians. They believe that traffic problems discourage potential customers or investors. This may eventually lead to a decline in economic activity in the Boston area.
1.1.4 The Idea of Depressing the Central Artery

In 1971, an MIT engineer named Bill Reynolds introduced the concept of taking the elevated artery and putting it underground. Although an extremely difficult and costly task, Reynolds felt that it was a feasible solution to Boston's transportation problem. He also argued that it would vastly improve the standard of living in Boston, especially downtown. Depression of the artery could be designed to handle Boston's traffic through an increase in the carrying capacity and proper traffic engineering. It would also serve to improve the environment in downtown Boston. Disassembly of the existing artery would create over 20 acres of new land which could be developed into parks or real estate. It would not affect the community of the North End which had been isolated from downtown by the construction of the elevated artery in the 1950's. Central artery depression would also present an opportunity to explore a rail link between Boston's North and South Stations. From a political point of view, it would be able to attract support from traditionally anti-highway forces due to the environmental improvements which it would bring.

There seemed only one problem with this new concept. Everybody knew that depression of the central artery and removal of the existing one would be very expensive. According to the Federal Highway Administration, the proposed depression provided minimal benefits at a very high cost. It was coined as an expensive beautification project with limited transportation benefits and prompted one state representative to ask, "Wouldn't it be cheaper to raise the
city than to depress the artery?" Furthermore, skeptics pointed out that during the construction of the project, traffic congestion would be even greater. This would clearly discourage short-term economic growth. Advocates maintained that the long-term economic benefits of a functional central artery would outweigh the few difficult years of construction.

1.1.5 Political Chaos

The struggling development of the Central Artery/Tunnel Project from the late 1960's to its finalization in the mid 1980's is best demonstrated by an analysis of the political chaos over these two decades. With the election of new Massachusetts governors and Boston mayors, the third harbor tunnel and artery depression have been met with varying levels of support and criticism.

The 1960's were an age of revolution, when many of America's institutions were challenged. Protests were common in the era of civil rights and the search for equality. Ethics in transportation development were similarly questioned. In the Boston area, anti-highway sentiment was riding high, perhaps magnified by the unpopularity of the recently completed elevated artery. Proponents of continued highway construction within the greater Boston area were criticized and proposals were rejected. This new anti-highway movement consisted of residents and educated

---

activists. Their early attacks focused on the localized displacement of buildings and people in the North End during the construction of the elevated artery. Eventually, their approach matured to address more basic transportation policies, claiming that the further construction of roads would be counterproductive. Rather than reducing congestion on the streets, they would simply shift bottlenecks or highly congested areas, and encourage more traffic. They also pointed out environmental drawbacks such as increased noise and air pollution which would be associated with an increase in the number of automobiles. The anti-highway coalition pressed for an increase in the use and funding of mass transit and public transportation.

In 1967, the newly elected mayor of Boston, Kevin White, responded to anti-highway activists and neighborhood concerns by developing little city halls throughout the city. The manager of East Boston’s little city hall, Fred Salvucci, was an MIT educated engineer and neighborhood activist. In an attempt to protect his own neighborhood from an expansion of Logan Airport, Salvucci often led battles against the MassPort Authority. The late 1960’s also saw the emergence of a young Brookline State Representative named Michael Dukakis. He vehemently opposed the third harbor tunnel project and challenged the reliability of the MTA’s feasibility study.

Only a year later, in 1968, the election of Republican Richard Nixon to the presidency of the United States, and his subsequent appointment of former Massachusetts governor and highway advocate John Volpe as Secretary of Transportation,
set back the agenda of the anti-highway movement. They symbolized a decline of influence at the federal level for activists.

In Massachusetts, Governor Frank Sargent appointed a task force to evaluate all existing highway plans. Influenced by local opposition, he denounced any plans for highway construction in the greater Boston area. However, he did support a two-lane special purpose tunnel to Logan for buses and limousines, the linking of the North and South Railroad Stations, as well as the possible depression of the central artery.

With the election of Michael Dukakis as governor in 1974, hope for any sort of highway construction was slim. Upholding a pro-environment image, Dukakis opposed any highway construction inside route 128, an expressway ring which encircles the greater Boston area. Furthermore, he rejected all third tunnel ideas, citing that it would encourage expansion of Logan Airport and the eventual decline of East Boston neighborhoods. However, he did allow for planning of the artery depression on the basis that it would create new parkland in Boston and improve air quality as well. Dukakis also firmly supported the expansion and creation of the "blue line", a branch of the MBTA's subway system which connected Logan Airport to downtown Boston.

The political tide completely changed just four years later with Edward King as governor of Massachusetts. His pro-highway, pro-business outlook sharply contrasted with that of the previous Dukakis administration. He supported a general purpose third harbor tunnel, but outright rejected
any plans for depression of the artery, dismissing this idea as having a low benefit to cost ratio. The design of a new Charles River Crossing known as the Leverett Connector to join Charlestown and Beacon Hill also received his support during this term, but was eventually rejected.

It was not until the second Dukakis administration in 1982 that true headway was made concerning the Central Artery/Tunnel Project. Fred Salvucci, the Secretary of Transportation, persuaded Governor Dukakis to remain open-minded on the issue of a third harbor tunnel. He assured the governor that any tunnel alignment would not take a single residence, would not have any great impact on any commercial properties, and would surface only on airport land. Furthermore, the tunnel could be designed in a way which would also encourage the expansion of public transportation to Logan Airport in the future. By the end of the summer of 1983, Fred Salvucci had convinced Governor Michael Dukakis to support the plan of one single project, a combined artery depression and third harbor tunnel. See table 1.1 for a summary of the division of political support for a third harbor tunnel and depressed artery from 1967 to 1982.
Table 1.1

Divided Political Support for Artery Depression and Third Harbor Tunnel

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Year</th>
<th>Artery</th>
<th>Tunnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kevin White</td>
<td>Mayor-Boston</td>
<td>1967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Michael Dukakis</td>
<td>State Rep.</td>
<td>1967</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frank Sargent</td>
<td>Governor-MA</td>
<td>1968</td>
<td>X</td>
<td>XX</td>
</tr>
<tr>
<td>Michael Dukakis</td>
<td>Governor-MA</td>
<td>1974</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Edward King</td>
<td>Governor-MA</td>
<td>1978</td>
<td></td>
<td>XX</td>
</tr>
<tr>
<td>Michael Dukakis</td>
<td>Governor-MA</td>
<td>1982</td>
<td>XX</td>
<td>X</td>
</tr>
</tbody>
</table>

X = will consider as possibility  
XX = support

1.1.6 Final Political Support

The packaging of the two sections of the project, the depression of the artery and the third harbor tunnel, eventually led to general overall support. By attaching the two parts to one project, everyone involved was ensured fair treatment. The State of Massachusetts satisfied the FHWA and secured the commitment of funds for the project. Tunnel supporters such as downtown businesses would finally get the tunnel. They accepted the depression of the artery under the premise that advanced construction techniques such as slurry-wall construction would alleviate the effect of construction on the downtown area. The concerns of tunnel opposers such as the East Boston community were addressed in the design of the third harbor tunnel. They were reassured that the tunnel would emerge on land owned by Logan Airport not in their backyards. The project would not take any residential properties in the North End. New construction methods would also minimize the local impact in that area. In addition,
the new land next to the North End which would be created when the elevated artery was taken down, would be co-developed with the community. Environmentalists were also finally convinced that the project would lead to lower levels of noise and air pollution through ventilation buildings and improved traffic flow. Furthermore, the disassembly of the elevated artery after the completion of the depressed artery would create 27 acres of new land, of which most would remain. The project would also provide a stimulus to the economy through the creation of new jobs and increased real estate value in the future. All in all, a compromise had been reached among the major players. Business got the tunnel and accepted the artery. Artery proponents got the artery depression and accepted the tunnel. The FHWA got the tunnel and accepted the artery depression. See figure 1.2 for a configuration of the 1983 depressed artery and third harbor tunnel plan.
Figure 1.2 The 1983 Central Artery/Tunnel Plan¹

¹Luberoff, et al., 54.
1.2 Project Approval Process

1.2.1 Initial FHWA Approval

One of the conditions under which Governor Michael Dukakis agreed to support plans for a third harbor tunnel and a depressed central artery was that it would be funded primarily by federal dollars. Although the Federal Highway Administration had been actively involved in the project from its conception, final FHWA approval and funding from Congress would still need to be secured.

One of the reports required in obtaining federal approval for a public project is an Environmental Impact Statement. In December 1982, at the end of the King administration, a Draft Environmental Impact Statement (DEIS) was released on the third harbor tunnel project. Before the FHWA could give the Dukakis administration permission to begin technical work on the project, it required an expansion of the DEIS. It would have to include the environmental impacts of the most recent artery depression and tunnel plans.

At the same time, Fred Salvucci was campaigning for federal support for the project. Salvucci argued that the Central Artery/Tunnel Project represented the final link in the Federal Interstate Highway system. While other states were completing this major infrastructure program, mounting opposition and concern for environmental issues in the 1960's halted highway construction in Boston. However, in the early 1980's, the Reagan administration in Washington, D.C. was seeking to finish the Federal Interstate Highway Program.
This program offered federal funding for 90% of eligible construction costs. The remaining 10% was the responsibility of the state in which the project was being built. These favorable terms made it extremely attractive for local politicians. This was the reason why Fred Salvucci sought to receive funding for the CA/T under this federal program. However, many FHWA officials believed that it was too late to obtain funding for a project of this magnitude under the old interstate highway program. Despite widespread federal opposition, senior FHWA officials granted Salvucci permission to revise the draft EIS and pursue the necessary technical work.

1.2.2 Preliminary Design and Feasibility Studies

Now that Salvucci was given the opportunity to complete technical work on the project, several basic design decisions had to be made. First of all, the decision was made to widen the artery from six to eight lanes. This represented Dukakis' changing attitude. He and other members of the anti-highway coalition had traditionally argued that an increase in the artery's capacity would simply encourage further use of automobiles. However, widening the artery was necessary for the state to overcome the FHWA's perception of the entire project as an expensive beautification project. This decision reflected an improvement in the project as a transportation solution.

The second major decision made was to drop the idea of a rail link between North and South Station. The technicalities involved with depression of the artery and the
rail link proved to be too involved. First, the combination simply would not physically fit. Secondly, Boston's railway network could not easily be adapted to a tunnel because of the pollution emitted by diesel locomotives. A rail link would require a self-ventilating partially covered tunnel. The depressed artery would be a pure tunnel. Furthermore, the Reagan Administration had virtually eliminated all funding for railway work.

1.2.3 Public Approval

Support for the project from business and local communities was also necessary to realize artery depression and a third tunnel. Earlier attempts to sell the project during its conceptual stages were often plagued by vague ideas and many questions. With the support of the governor, it was now becoming clear that the project might actually be built. With the scope of the project now defined, it was necessary to gather support, listen to recommendations, and work with the public on the design of the project.

Central Artery/Tunnel officials led by Fred Salvucci adopted an offensive strategy to deal with this important issue. Highly skilled politicians campaigned for the Department of Transportation along with Salvucci. There were three major themes to their campaign. First, the CA/T Project is first and foremost a transportation solution and not an expensive beautification project. Secondly, the project would have minimal negative impacts and would actually improve the living standards for everyone. Lastly,

---

*Luberoff, et al., 69.
state officials contended that there were no other alternatives to solving Boston's traffic problem. Upgrading the existing elevated artery would be expensive with no increase in carrying capacity. Inaction by the state would eventually choke the city, and result in a loss of economic activity. Central Artery/Tunnel officials also continued to reassure communities and businesses of the benefits of the project as they had been doing since its' conception.

1.2.4 Final Federal Funding Approval

Obtaining federal funding under the interstate program would prove to be one of the CA/T Project's greatest hurdles. If accepted as part of this program, the 90% of the project would be funded by the federal government, the rest would come from Massachusetts. This was one of the conditions under which Governor Dukakis had agreed to support the project.

In 1983, the second Dukakis administration and Central Artery/Tunnel proponents were confident that they would be able to receive federal funding for the project. Salvucci had secured the support of Tip O'Neill, a Massachusetts Congressman and Speaker of the House. However, the opposition of the Reagan administration and the FHWA led to an uphill battle for the Central Artery/Tunnel.

In November 1983, President Reagan won re-election easily. Shortly thereafter, FHWA responded to the expansion of the draft environmental impact statement of the project submitted by Massachusetts. FHWA rejected depression of the artery, but accepted the third harbor tunnel. Securing
federal funding would seemingly require more campaigning and political clout than O'Neil could offer.

After the results of the EIS, the state of Massachusetts started to search for new support for the project. At the advice of a high-profile Republican lawyer, Roger Allan Moore, the state continued to focus its efforts on lobbying FHWA. It also asked the FHWA to document the problems that it had with the project plan so that it could be revised. Benefit cost analyses and additional cost studies were also conducted to shed favorable light on the project. Massachusetts lobbied other states to support the project, citing that CA/T acceptance would lead to more funding for their states as well.

In late 1985, after additional studies of alternatives were conducted, the FHWA finally agreed to discuss ways on how project elements might be eligible for Interstate Highway Program funding. A compromise between the FHWA and Massachusetts had finally been reached.

Funding for the project was still in jeopardy in 1987, when President Reagan vetoed the Transportation Bill. He cited the bill as an example of overspending catering to a few special interest projects, one of which was the Central Artery/Tunnel. The CA/T team's campaign focus quickly turned towards the Capitol. On March 31, 1987, the House voted to override Reagan's veto. After an intense campaign and several voting changes by several senators, Reagan's veto was also overridden in the Senate, by one vote. The Central Artery/Tunnel Project had dodged the final bullet. It would be primarily funded by federal dollars after all.
1.3 The CA/T: A Unique Project

The Central Artery/Tunnel Project is an extremely large infrastructure project. It has had to deal with a totally different atmosphere towards large scale construction projects than previous Federal Interstate Highway Program projects. The heightened sensitivity of Massachusetts' citizens towards large construction projects has had a tremendous impact on the development of the project. The Central Artery/Tunnel Project is very unique because of this combination of size, complexity and consideration of numerous viewpoints.

Balancing the interests of communities, businesses, politicians, special interest groups, and others requires a new, innovative approach to public construction. This includes all stages of the construction process from conception and preliminary design through final design, procurement and construction. The first step in tackling the many technical and social issues presented by the CA/T Project was to develop a suitable organization. This organization would have to be dynamic throughout the entire life of the project. It would have to have a strong public relations management program to create public support for the job and to encourage constructive criticism. The Central Artery/Tunnel would need an experienced team of design professionals to deal with the technical complexity of the third harbor tunnel and new artery design. Costs would need to be controlled at all times and schedules would need to be maintained. As a public project, equal job opportunities for
all people would have to be emphasized. A public construction highway project in Massachusetts would normally be managed by a state agency. However, the CA/T Project would require a new management structure to deal with the scope and complexity of the task at hand.
2.1 Traditional Public Project Organization

The Department of Public Works (DPW) has traditionally been responsible for the management of public construction projects in Massachusetts. Before World War II, the DPW was a healthy agency and undertook all design responsibilities. Although actual construction was contracted out, the DPW maintained close supervision over projects through well qualified engineers. The state continued to attract young, educated engineers through World War II because opportunities in the private sector were limited at the time. The growth of public highway construction during this era also encouraged talented engineers to work for the state.

After the world war, the Department of Public Works began contracting out design work for some of their complex projects. One of these was the design of the elevated artery during the 1950's. Over the next two decades, the role of the agency in the design of its projects began to dwindle. This trend toward privatization of public jobs began the decline of the DPW. Young graduating engineers and qualified state engineers started to look towards the private sector for challenging work. The DPW completed only the simplest, most common designs. The state civil service system did not encourage quality designs either. Wages were generally equal regardless of an employee's performance on the job. All in all, the private sector offered more opportunity than the
public sector.

The Department of Public Works started to shrink in size during the 1970's. The anti-highway atmosphere of the 1960's had finally taken its toll on the department. Major highway construction in the greater Boston area had practically come to a standstill. As the staff was steadily reduced through the early 1980's, routine assignments as well as complex ones, were contracted out.

2.2 Central Artery/Tunnel Project

2.2.1 Decision to Hire a Management Consultant

After the Central Artery/Tunnel Project was approved, Secretary of Transportation Fred Salvucci had to decide who would be responsible for carrying out the project. The DPW was the state's highway department and had historically managed all highway construction projects in Massachusetts, even though they had recently been looking toward the private sector for help. For this reason, Salvucci decided to put the Department of Public Works in charge of the CA/T Project. However, he knew that a radically new organizational structure would need to be adopted.

The DPW did not have the number of staff or qualified officials to effectively manage all aspects of the new project. They also did not have the capability of tackling most of the complex technical issues of building a third harbor tunnel or depressing a roadway in a major city. The scope of the project was well beyond the capacity of the state's transportation department. Nevertheless, Salvucci
wished to have a state agency in charge of a public construction project.

Consideration was given to assigning the project to a state agency other than the DPW. The three other candidates included the Massachusetts Port Authority (MassPort), the Massachusetts Bay Transit Authority (MBTA), and the Massachusetts Turnpike Authority (MTA). Although MassPort had a good reputation for construction, Salvucci did not believe that it had any experience with large projects. The MTA was often criticized for its maintenance of the current two harbor tunnels, and therefore was also eliminated as an option. Although Salvucci believed that the MBTA was the state agency most able to handle the project, he decided to go with the DPW for political reasons. First of all, a highway construction project traditionally belonged to the DPW. Secondly, federal law required that the flow of funding for highway projects go through the Department of Public Works. This is shown in figure 2.1. Lastly, the Federal Highway Administration (pro-highway) preferred to deal with the DPW as opposed to the MBTA, a pro-transit organization.

The decision was therefore made to place responsibility for the project with the DPW. An experienced construction management team would then be hired to help oversee the project. The duty of the private consultant would simply be to act as an advisor to the state. The normal risks of construction would be the responsibility of the state. The Department of Public Works would then supervise the work of the management consultant on behalf of the state and the taxpayers.
Figure 2.1 Federal Funding Flow Chart

The allocation of all of the risk upon the owner (the state) is inherent with the use of a management consultant. If the state had decided to hire a construction manager, then some or all of the risk could be contractually transferred to the private consultant. However, the use of a management consultant by the DPW asserts the position that the state is clearly in control of the project and is simply receiving advice from a consultant.

Salvucci also decided to develop an additional project team of approximately forty individuals within the DPW to handle the CA/T Project. This would avoid conflict within the department and would clearly assign certain individuals

---

Adapted from Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel Parsons Brinckerhoff, August 1993), 20.
to the project full time. With this type of approach, the needs of smaller, more traditional DPW projects would not be neglected in favor of the CA/T.

2.2.2 Management Consultant Selection

The most important criteria used in selecting the management consultant for the project was experience and quality. The size of the project and its social implications would become a magnet for attention. Politicians, the media, and special interest groups would be monitoring the project closely at all times. It was crucial that an organized, experienced, and qualified consultant be chosen to manage all aspects of this huge project. The complexity of subsurface construction involved in the plans for depression of the artery and an underwater tunnel also called for experience in these areas. Seven joint venture firms responded to the initial search. Only five of them submitted proposals on the project.¹ A nine member committee of senior Executive Office of Transportation and Construction officials and DPW staff unanimously selected the team of Bechtel/Parsons Brinckerhoff to manage the project.

Bechtel is one of the world's largest engineering and construction firms and is based in San Francisco. In the greater Boston area, its' Civil Division participated in the design of the MBTA's extension of the red line into Cambridge. This public mass transit job used slurry walls

¹ The five joint ventures were: Bechtel/Parsons Brinckerhoff; De Leuw Cather & Co./The Ralph Parsons Co./Ammann & Whitney; Howard Needles, Tammen & Bergendorf/Sverdrup & Parcel/Raymond Kaiser; Planning Research Corp.; and Stone and Webster/Tippetts, Abbott, McCarthy & Stratton.
extensively. Internationally, Bechtel has constructed the major airports for the new city of Jubail in Saudi Arabia. Parsons Brinckerhoff is a large engineering design firm with headquarters in New York. Parsons has recently completed a complex highway through difficult terrain in Jordan. The Sunshine Skyway Bridge in Tampa Bay, Florida has received twelve awards for excellence. Parsons Brinckerhoff is known for its expertise in all stages of project development, from planning, engineering, and construction management, to environmental services and finance. Together, Bechtel and Parsons Brinckerhoff have also successfully constructed public transportation projects. Their joint venture accomplishments include the Metropolitan Atlanta Rapid Transit Authority mass transit project and the Bay Area Rapid Transit (BART) project of the San Francisco region. Most importantly, they have had extensive experience in slurry wall construction, the method which was to be used in construction of the depressed artery.

Politics seemed to have played a role in the decision as well. Bechtel had influence in Washington, D.C. Secretary of State George Schultz and Defense Secretary Casper Weinberger were former Bechtel president and general counsel. The selection committee may have realized that this might prove to be helpful in securing funding over the entire life of the project. Bechtel's political connections would eventually prove to be a source of controversy in the years to come.

The joint venture was not limited to just Bechtel and Parsons Brinckerhoff. The original team also consisted of
twelve smaller private firms.' They acted as consultants to B/PB in their respective areas of specialization.

2.2.3 Organizational Structure

In organizing a formal structure for the Central Artery/Tunnel Project, officials found it necessary to balance the interests of the private management consultant and the state. The consultant would naturally prefer to control the project on its own, and develop a structure which facilitates their role in the completion of the project. The state would rather control the entire project as much as possible. The size and complexity of the task inherently limited the power of the state. However, as a public project it was necessary for a public agency to formally control the project in the public's eye.

The Department of Public Works is the state agency which originally directed the CA/T Project. In the spring of 1992, the name was officially changed to the Massachusetts Highway Department.' Therefore, the MHD is the official director of the project today. It operates on behalf of the state of Massachusetts' Executive Offices of Transportation and


" This was probably a public relations move to symbolize a new beginning for the project and to improve the CA/T's image. A few years earlier, the official logo for the project was also changed for similar reasons. The original one was simple, with only the letters CA/T. The new environmentally friendly logo contains colorful water, trees, and buildings, symbolizing the interaction of construction and the environment.
Construction. The joint venture of Bechtel/Parsons Brinckerhoff is the MHD's management consultant and advisor. Regulatory groups such as environmental agencies, archaeological societies, communities, the U.S. Army Corps of Engineers, and the Federal Highway Administration also participate in the project throughout the process. Figure 2.2 illustrates these relationships.

![Diagram of project organization]

Figure 2.2 Overall CA/T Project Organization'

During the course of the project, the responsibilities of the MHD and management consultant change. Communication and teamwork is required to meet the unique demands of the distinct phases of a project's life cycle. The general project responsibilities of the MHD, B/PB, section design

---

'Adapted from Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel/Parsons Brinckerhoff, August 1993), 18.
consultants, and general contractors during the three stages of planning and design development, design, and construction are listed in table 2.1.
Table 2.1 General Project Responsibilities

<table>
<thead>
<tr>
<th>ORGANIZATIONAL GROUP</th>
<th>PLANNING &amp; DESIGN DEVELOPMENT</th>
<th>DESIGN</th>
<th>CONSTRUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION DESIGN CONSULTANT</td>
<td>Submit Qualifications and Proposals</td>
<td>Provide Final design Technical Bid Documents Estimating and Reporting</td>
<td>Provide Technical Support as Requested Review Shop Drawings</td>
</tr>
<tr>
<td>CONSTRUCTION CONTRACTORS</td>
<td>Bid on Contracts</td>
<td>Perform Construction Start-up and Testing</td>
<td></td>
</tr>
</tbody>
</table>

---

10 Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel/Parsons Brinckerhoff, August 1993), 16.
2.2.3.1 Planning & Design Development

The MHD is responsible for establishing policies and objectives in the first part of the development of CA/T Project elements. It approves all plans for management and implementation of designs. Financing and payment authorization are also handled by the state. The MHD also monitors the management consultant to ensure compliance with contracts and schedules. The Massachusetts Highway Department is generally responsible for setting the course of the CA/T Project and approving all basic designs. The B/PB team then develops the plans and directives of the MHD. It submits preliminary design concepts to the state for approval. Additional consultants are also invited to submit proposals during this stage to expand on B/PB's basic designs and to prepare for the next stage of the project.

2.2.3.2 Design

Distribution of responsibilities during design is similar to the planning phase. The MHD further acts as an overall director, approving plans, budgets, and schedules produced by the management consultant. It also sets up the selection and bidding process for contracts. It later approves and executes these section design and consultant contracts. It continues to authorize payments and monitor the management consultant's compliance with the contract terms. Bechtel/Parsons Brinckerhoff continues to develop designs for submission for state approval. In fulfilling the role of construction manager, it implements control programs and participation programs to encourage public involvement in
the design process. Section design consultants selected through the public bidding process provide final designs, technical documents, estimates, and appropriate reports on design packages. Once the final design has been approved by the MHD, contractors are invited to bid on the appropriate construction contracts.

2.2.3.3 Construction

The stage of construction involves the greatest level of interaction between the separate groups of the project. The MHD now approves and executes construction and procurement contracts instead of design and consultant contracts. It continues to authorize payments and provides authorization for construction to begin. After construction, the state agency must officially accept the work completed. The MHD also continues to monitor the management consultant for compliance with contracts. Bechtel/Parsons Brinckerhoff is responsible for providing contract administration and project control over quality, cost, and schedule. During the start of construction, it provides supervision and guidance. When construction is complete, B/PB must test and evaluate the contractor's work. Throughout this process, the design consultants are available to clarify the contract drawings and to redesign elements due to change orders. They also review the shop drawings of the fabricators for compliance with their final designs. The contractor selected for the job must perform the actual construction according to the contract drawings and specifications.
2.2.4 Contract Packages

The three different stages of development often occur concurrently. This is one of the reasons why the Central Artery/Tunnel Project is broken up into many design and construction packages. All of the elements of the project do not pass through the same phase at the same time. The magnitude of the project also deems it necessary to divide the project. This also allows numerous opportunities for different contractors and designers to bid on the contract packages. All in all, there are 76 design and 128 construction packages which comprise the CA/T Project.

The design packages range from structural engineering and geotechnical engineering to archaeological services. The construction packages include typical construction and installation of various electrical and mechanical systems, to environmental services and geotechnical borings. For a complete listing and description of all the CA/T contract packages, consultants, and contractors, see the appendix. Figures 2.3 and 2.4 show the major structural design and construction packages on the project.
Figure 2.3 Design Contract Packages

Central Artery/Tunnel Project (Massachusetts Highway Department, October 1993)
Figure 2.4 Construction Contract Packages

Central Artery/Tunnel Project (Massachusetts Highway Department, October 1993)
2.2.5 Bechtel/Parson Brinckerhoff's Dynamic Structure

The implementation of a dynamic organizational structure is required for the management consultant to effectively manage all of the contract packages during all of their development stages. It needs to be able to handle design, construction, and public affairs management simultaneously. It must also conform to the overall development of the project. In the early stages it must be design oriented. After most design work is complete, it must handle construction efficiently.

At the apex of the management consultant’s hierarchy is the Project Executive. He serves as the formal link between B/PB and the MHD. He is also responsible for upholding the general conditions of the consultant’s contract with the state. This includes monitoring the project’s progress and advising the MHD on budget and scheduling issues. The project executive is assisted in his duties by a project manager and four deputy project managers. The deputy project managers are responsible for four main areas: engineering, the environment, general services, and construction. It is the project manager’s job to coordinate the efforts of these deputy managers.

The engineering branch of the organization is primarily responsible for developing preliminary design services, reviewing the final designs of section design consultants, and providing technical support during construction. Managers of preliminary design, engineering services, architectural services, automation services, and project engineering carry out these functions.
Another section performs duties concerning environmental issues. For this purpose, positions for managers of environmental services, right of way, urban design, transportation planning, and mitigation planning have been designated.

The services group on the project consists of managers and support staff in eight major areas: controls, finance and insurance, human resources, procurement, administrative services, claims and changes, equal employment opportunity, and MHD support.

The construction core of B/PB's organization also consists of several parts. Five area managers are responsible for supervising the resident engineers in their geographical areas. They must also perform contract administration, coordinate the work of construction contractors, monitor project quality control programs, and make decisions regarding differing site conditions. The resident engineer is responsible for items specific to his/her contract package such as interpretation of technical specifications, coordination of special resources, initiation of change order documentation, development of quality control standards, and recommendations to area managers. The other divisional managers of the construction core provide general services to the construction branch. They include quality assurance, technical services, and operations management.

The general project manager at the apex must also integrate a public relations program into the overall organizational structure. The public affairs manager must coordinate the work of several managers in the areas of
community relations, external affairs, audio-visual graphics, and public information. It is the responsibility of the public affairs manager to work with the MHD in effectively managing the public relations of the project. The overall organizational structure of Bechtel/Parsons Brinckerhoff on the CA/T Project is illustrated in figure 2.5.
Figure 2.5 B/PB General Organizational Structure on CA/T

Central Artery/Tunnel Project; Project Management Plan Revision 04 (Bechtel/Parsons Brinckerhoff, August 1993), 24.
This organizational structure is not static. Although the basic structure of the apex and middle line management remains intact throughout the development of the project, responsibilities of the operating core and support staff often change. The dynamic management functions of the joint venture can be broken down into five basic areas: environmental services, engineering services, construction services, general services, and public affairs.

During the planning and design development stage, the focus of the consultant is on environmental services and project planning. Environmental reports are submitted and permits issued. Traffic studies are conducted. If necessary, right of way is obtained so that construction is possible. Basic conceptual designs are created to define the overall scope of the project element. A great deal of general administration is also required to establish the budget and framework for the job. Project control measures such as scheduling, estimating, and accounting are introduced. Contract standards and procurement methods are determined. The general public is also informed of the plans through the distribution of information. For construction in sensitive neighborhoods, a solid public relations is devised. This includes the development of relationships with local media such as newspapers and television, and with the local community. Through outreach programs, the community is invited to help during this planning process. The management functions of B/PB during the planning and design development phase are summarized in figure 2.6.
Figure 2.6 B/PB Management - Planning & Design Development

---

"Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel/Parsons Brinckerhoff, August 1993), 37."
After the planning stage is complete, the functions of the management consultant must meet the demands of the design stage. The B/PB design core develops preliminary designs which, after MHD approval, are submitted to a design consultant for final design. When the final design is complete, B/PB reviews the design and checks for its conformance with the section's specifications and standards. Mitigation planning, quality assurance, and actual construction also begins during the design stage. The project control measures which were introduced during the first stage and the public relations program are continually developed as well. Community involvement is also encouraged. The construction contracts are then written and sent out for bidding. The services provided by the management consultant during design are presented in figure 2.7.
Figure 2.7  B/PB Management - Design Phase

---

52

*Central Artery/Tunnel Project: Project Management Plan Revision 04* (Bečić/Parsons Brinckerhoff, August 1993), 38.
The construction phase requires a high level of interaction among the divisions of the organizational structure. The responsibilities of B/PB's environmental and engineering service divisions are basically limited to permit and design support and review of construction for compliance with applicable standards and specifications. The public affairs department plays a key role in mitigating construction and serving as a link between local communities and the job site. The typical duties of the general services department continue to be overall project control and contract administration. This division also constantly seeks to reduce overhead and general construction costs. The construction services branch oversees the actual construction of the contract. Field administrators such as resident engineers and field engineers supervise the daily work performed by the contractor on the job site. This division also handles quality assurance, testing and start-up, and contractor claims and change orders. These responsibilities are shown in figure 2.8.
Figure 2.8 B/PB Management - Construction Phase

- MHD
- MANAGEMENT CONSULTANT
- PUBLIC AFFAIRS
  - MEDIA RELATIONS
  - PUBLIC INFORMATION
  - EXTERNAL AFFAIRS
  - COMMUNITY RELATIONS
  - COMMUNITY LIAISON
  - CONSTRUCTION MITIGATION
- ENVIRONMENTAL SERVICES
  - PERMIT SUPPORT
  - AGENCY LIAISON
  - ENVIRONMENTAL COMPLIANCE
- ENGINEERING SERVICES
  - DESIGN
  - SUPPORT MANAGEMENT OF SDC's
- CONSTRUCTION SERVICES
  - FIELD ADMINISTRATION
  - CONSTRUCTION CONTRACTS
  - CLAIMS & CHANGE ORDERS
  - TESTING AND START-UP
  - QUALITY ASSURANCE
  - O&M PROGRAM
  - SHOP INSPECTION
- SERVICES
  - PLANNING
  - EXPEDITING
  - SCHEDULING
  - CONTRACT ADMIN.
  - ESTIMATING
  - AA/EO
  - FORECASTING
  - COST ENGINEERING
  - ACCOUNTING
  - OFFICE MANAGEMENT
  - PROJECT SERVICES
  - PERSONNEL
  - INSURANCE

---

Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel/Parsons Brinckerhoff, August 1993), 39.
CHAPTER 3 - THE ROLE OF PUBLIC RELATIONS IN DESIGN

3.1 Need for Public Relations on CA/T

Public relations play a critical role for the Massachusetts Highway Department and Bechtel/Parsons Brinckerhoff throughout all the stages of the construction process. It is one of the most crucial factors for successful execution of the overall project and the individual sections. Developing and eventually constructing a successful contract package requires careful attention to this sensitive area. Mismanagement of public relations can prove to be detrimental to the ultimate completion of a section or an entire project. The growing need for proper management of public relations stems directly from the new transportation paradigm which surrounds the Central Artery/Tunnel Project.

This new transportation paradigm stresses environmental awareness. Its growth is exemplified through the general attitude towards the development of transportation and the construction of new highways from the end of World War II to the present. During this era, our society has become increasingly sensitive to environmental issues. This shift in attitude has had a profound effect upon construction. People place more value on enhancing the natural environment of their neighborhoods and no longer tolerate the bulldozing mentality which shaped the existing elevated artery.

The magnitude of the CA/T Project and its location in
the heart of downtown Boston has called for unprecedented attention towards public relations management and environmental issues. This project reflects the new approach towards large highway projects. Rather than sacrificing local residents for the good of the general public, the new way of thinking attempts to improve everyone's standard of living, locally and regionally. These benefits are generated without any significant local impacts. This new attitude is at the core of the CA/T Project. In the official project management plan for the Central Artery/Tunnel Project, one of the objectives is to "improve the urban design and overall environment in the City of Boston by reuniting neighborhoods, improving visual aesthetics, creating new parcels for joint development and recreational/open space use, improving regional air quality, and reducing noise levels."

The increasing roles of public agencies and special interest groups in the construction process demonstrates the new paradigm. Although the presence of these new players has undoubtedly improved several environmental aspects of the project, the revisions of the project plans required to meet new criteria has also led to enormous delays and cost increases. This has been the single greatest factor in the extremely slow development of the Central Artery/Tunnel Project. However, well defined project goals and a solid public relations base enable a project to utilize the valuable resources provided by outside groups and to help avoid cost and schedule overruns.

"Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel Parsons Brinckerhoff, August 1993), 11.
3.2 The Charles River Crossing

3.2.1 Design

The most recent challenges presented by the design of the Charles River Crossing, the most northern section of the CA/T Project, exemplify the need for a well-defined public relations management program. The Charles River Crossing, which will connect the new depressed artery with the existing interstate highways north of Boston, was not a major issue in the early development of the project. The design of a new crossing would simply serve as an efficient link to reap the benefits of the artery depression, and would also eliminate one of the worst bottlenecks in the nation. This element of the project was therefore hinged on the development of the artery itself. However, when plans to go ahead on the design of the depressed artery were final, the issue of the Charles River Crossing emerged. The lack of proper public relations management of this element of the project during the past few years has actually threatened the feasibility of the entire project.

The development of designs for the Charles River Crossing began during the mid and late 1980s. The engineering division of Bechtel/Parsons Brinckerhoff prepared over thirty preliminary designs for a crossing over the Charles. In mid-1988, under pressure from the FHWA to complete a Supplemental Environmental Impact Statement, the state threw its support behind a version known as Scheme Z. (see figure 3.1) When the design was unveiled in August of 1989, the response was overwhelmingly negative. Community
activists, environmentalists, and government agencies such as the Environmental Protection Agency, were equally disappointed that this element was developed without any regard for the public. They believed it violated the basic fundamentals of the entire project by eliminating the open, participatory decision-making which had been used for other elements of the project. East Boston residents had been actively involved in the design of the third harbor tunnel. This was not the case at all with the Charles River Crossing. Many felt that the massive highway structure of 18 lanes and spiraling ramps from as low as the riverbanks to a high of 110 feet was worse than the current elevated artery. Proponents argued that Scheme Z was a cost effective solution to the transportation problem, but it was obvious that little attention had been paid to aesthetics, the environment, or the objections of affected communities such as historic Charlestown.

Figure 3.1 Scheme Z"
3.2.2 Resolution

Despite approval of Scheme Z in early 1991, designers were asked to improve the plan and ultimately reduce the visual impact of the highway intersection. A bridge design review committee was formed to evaluate the alternatives to Scheme Z. By this time, all sorts of special interest groups had developed an opinion on the crossing.

In 1992, the project took a huge step towards resolving the issue when the Massachusetts Highway Department's new project director, Peter Zuk, went on the offensive by appointing Mike Lewis as director for the resolution of the Charles River Crossing. This was a critical move because the project was being threatened by continuing criticism of the crossing. The appointment of a separate committee to handle the situation demonstrated strength, defused public and media criticism, and enabled the entire project to move past the obstacle. Selection of the new revised final design (see figure 3.2) was presented on November 16, 1993 by Massachusetts Secretary of Transportation James J. Kerasiotes.

"The new Charles River Crossing is a vast improvement over Scheme Z. The new design provides the best balance among the aesthetic, environmental, traffic, and cost issues that must be addressed in designing a complex traffic interchange in an environmentally sensitive urban area. The Non-River-Tunnel [alternative design to Scheme Z] will deliver a river crossing that is aesthetically pleasing, environmentally responsible, and cost-conscious."

James J. Kerasiotes"

Figure 3.2 The New Charles River Crossing Design

Charles River Crossing Pamphlet distributed by the Central Artery/Tunnel Project. For a more detailed and technical plan of the new crossing, refer to the appendix.
The new design, which was approved by the state in March of 1994 and approved by the FHWA in December of 1994, is evidence that an offensive management style produces results in pressure situations. A Boston Globe editorial clearly supports this approach.

"Consideration of the crossing design has already delayed completion of the entire project by two to four years. After the six-month period to give all interested persons an opportunity to express their views, the time for argument will have passed. Priority must be given to completion of the final plans as a prelude to construction. The artery-tunnel project is too important for the transportation needs of eastern New England to be delayed any longer."

3.3 The Importance of Public Relations Management

3.3.1 Project Development

The lack of an effective public relations program for the Charles River Crossing in the early stages of its design has clearly cost the project lots of time, money, and effort. Unlike other elements of the project, public opinion was not considered in the initial development of the crossing. This opened up a Pandora's box of problems which has delayed the project considerably. What can be done to avoid such public relation setbacks in the future?

First of all, it is very important that clearly defined goals are set, even if they are simple. The lack of such a defined goal has, until recently, handicapped the entire project on the whole already. The development of the CA/T

---

Project has been extremely slow, almost three decades to date. Although it is important to involve the general public and special interest groups in such a large-scale project, there must be an assertive approach from the developers, or else a project may never get off the ground. If given the opportunity, special interests groups will always put their agenda first and attempt to dictate the course of a project. This usually counters the goals and the general purpose of the project. However, a clearly stated goal which encourages the involvement of the public in a project can avoid the public relations pitfalls experienced by the Charles River Crossing design team.

The steps towards developing a dynamic, effective, public relations management strategy are directly linked to the stages of a project's development. During the start-up phase of the design of the Charles River Crossing for example, the circulation of knowledge and purpose concerning the crossing should have been important. It is crucial to inform the public accurately as to the purpose of the design. For the most part, this has been done effectively on the CA/T Project. Through the distribution of professional, official CA/T pamphlets in Boston newspapers, the CA/T has managed to define the scope of the project well.

Once the general public and concerned individuals obtain an understanding of the goals, basic designs can be created. Outside groups can even provide insight on a reasonable solution, not only criticize designs. This early stage calls for increased participation and brainstorming of ideas. However, the design of the Charles River Crossing and
subsequent approval by the federal government was covertly conducted to achieve political agendas and timelines. Today's citizen is far too sophisticated and sensitive towards environmental issues for a project to risk taking this approach. It creates an aura of suspicion which is poor for future public relations. In effect, a lot of time could have been saved during the approval process if Scheme Z had been shown to the public before it was submitted for state and federal acceptance. Community meetings, newsletters, and presentations would have helped to inform the public well during this phase.

The role of the public and special interest groups should begin to wind down during the final design phase. It is at this point in the project when everyone should have had the opportunity to have played a role in the design. To help avoid unnecessary delays, it is important that a final design be drawn and construction begin, even if all the minor details have not yet been worked out. Minor problems are inevitable and any attempt to solve each and every one before moving the project along at full speed would be foolish. Even if all problems could be resolved before construction, opinions are sure to change within time, and new challenges will always present themselves. During initial construction it may be necessary to maintain close communication with the surrounding communities to alleviate the impact of mobilization of construction machinery. Figure 3.3 illustrates the role of the public and outside agencies throughout the development process.
3.3.2 Handling the Media

Effective handling of the media is the best way to achieve a positive image in the public forum, because the media is the single greatest communications link between a project and the general public. In managing the media, the biggest challenge is to provide clear, easily understandable information." In the rush of attempting to sell newspapers and create headline stories, the media often finds ways of interpreting information in its favor, that is, controversial interpretations. Therefore, a public relations team on a project must make every attempt to maintain a positive

22 Media Relations Director P.A. Carr of the Central Artery/Tunnel Project, interview by author, 26 April 1994.
relationship with the media and ensure that they have a thorough understanding of the project before they print a story.

Newspapers with inaccurate information can also affect the project indirectly by affecting the performance of employees who may read an article. An example might be an employee who reads that funding towards his/her company is being cut. Even though this rumor may not be true, it may affect his/her sense of job security and eventually performance on the job. Uninformed reporters can also undermine a project. Another example of this concerned a reporter who phoned the CA/T media relations director for information on the unpopular design of "that thing over there to the north." When the reporter was asked if he/she had ever visited the site where the proposed Charles River Crossing Design was to be built, the answer was no. The CA/T media director thereby requested that he/she visit the abandoned industrial area before writing negative articles about how the design would supposedly inflict visual and aesthetic damage to the surrounding area.

During the early stages of a project, it is a good idea to stay on the offensive by volunteering information during regular press meetings. Once the designs are well underway, and the reporters are adequately informed, it is best to limit the number of meetings, because there are sure to be additional questions which may jeopardize or delay the

---

23 Peter Zuk, director of the CA/T Project, used this example during a M.I.T. lecture on public relations management.

24 P.A. Carr, Media Relations Director of the CA/T Project, used this example during an interview by the author on 26 April 1994.
project. At this point it is also mandatory for the project to assume control, or else the media may drag a project down and cause significant delays. If controversies should arise, and the project is put on the defensive, it is also best to remain composed, avoid counter-attacking vehemently, yet remain assertive if its counter-arguments are well-founded.

3.3.3 A Plan for the Future

The Central Artery/Tunnel Project is extremely complex due to its technical nature, but even more so because of its location in the downtown area of a major city. Opposition to a project of this size is inevitable, taking into consideration the amount of people which it will affect. When approaching elements of a project of this size, it is vital that the community and special interest groups be involved in the design from the beginning. Even though it is nearly impossible to satisfy everyone's needs, a reasonable solution is certainly achievable in most cases. At that point it is important for directors to take control and move the project along. Attempting to solve each and every minor issue can only lead to more problems and additional opportunities for confrontation.

One of the most important issues in effective public relations management is handling the media and preventing the spread of inaccurate information. Criticism based on false data can severely destroy the image of a project in the public eye. Although free media sources such as newspapers and television stations are free to criticize, project officials can take steps to present their cases using clear,
not bombastic or technically extravagant language. Based on such a foundation, a project with solid merit should be editorialized favorably in local newspapers. It is also the responsibility of a project’s officials to organize its own paid media to inform the public positively. The CA/T Project’s media division has accomplished this goal through sophisticated pamphlets and professional presentations. However, the danger of excessive propaganda is that it often raises questions of substance and possible cover-ups of other problems. Therefore, it is best to generate understanding of the project’s objectives through heavy distribution of media during the initial design phase.

On a much more personal level, the concerns of businesses and community residents can be addressed through newsletters or meetings. The CA/T Project has also handled these issues very well for the most part, evident by the fact that it has managed to gain the support of communities in Boston which vehemently opposed elements of the project for almost two decades. The “Community Safeguards” pamphlet issued by the CA/T public relations department addresses topics such as traffic management, replacement parking, pedestrian access, construction site housekeeping, environmental protection, archaeological resources, rodent control and pest management, community and business outreach programs. In addition to hosting official business meetings biannually to inform downtown business owners, the project has set up CA/T centers in different communities such as East Boston, as well as provided a telephone hotline and a quarterly newspaper entitled, “Artery Express.” In 1988, the
Artery Business Committee was created to support the project, and offer businesses an additional means of articulating their interests and concerns. The ABC consists of over 150 executives from member companies who participate in the committee's divisions of design, operations, and marketing. Further subcommittees address more detailed areas such as utility relocation in the downtown area.

"ABC is committed to attaining the long term transportation, environmental, and economic benefits of the Project while working to keep the city open for business during Artery construction."

The Massachusetts Highway Department and the Federal Highway Administration have also prepared a program named Caravan for Commuters, Inc., which provides incentives for businesses to encourage employees to seek alternate means of transportation to work. The use of shared-ride commuting and transit are being offered to companies at a low cost so that they can provide their employees with this valuable benefit.

Good public relations play an important role in the success of large scale projects which merit a high degree of public interaction from design to construction. It is advantageous for a project to involve the community and interest groups early in the project so that highly offensive designs can be immediately abandoned. During the progress of a project such as the final design stage, it is important that external forces such as the public do not ultimately control the direction and fate of a project. Most
importantly, the foundation for good public relations involves an offensive approach during the start-up of a project whereby accurate information is made available to the public and participation is encouraged.

"Public officials must understand that projects must be built and that the vocal community groups must be carefully heard but not allowed to dominate the greater public good..."

James Carlin, Commerce Secretary, 1982

---

Luberoff, et al., 50.
CHAPTER 4 - CONSTRUCTION

4.1 Procurement

After a design has been finalized and contract drawings have been developed, a contractor must be chosen for construction. This process of selection, known as procurement, is crucial because of the dependency on the complex relationships which are formed between Central Artery/Tunnel Project officials (MHD and B/PB), section design consultants, and construction contractors.

4.1.1 Regulation

The procurement process for public construction projects is highly regulated to provide equal opportunity for bidders of all backgrounds, big and small. The guidelines are set by the government and agencies such as Equal Employment Opportunity (EEO). They encourage the participation of many companies and individuals in the bidding process. Procurement laws set a healthy environment for competition and a level playing field for all bidders. Bids must be sealed and submitted before the deadline, without exception. Through the strict enforcement of these rules, an open bidding process free of corruption is ensured. When dealing in a public forum, maintenance of an open atmosphere is important for good public relations.
4.1.2 Design and Construction Contracts

The procurement approach for construction contracts is different than it is for design contracts. Design is inherently variable. It is often difficult to assess how long development will take. Most of the designs on the Central Artery/Tunnel Project are complex and involve a great deal of interaction with the public. This introduces variance which cannot be forecasted. The controversy over the design of the Charles River Crossing as discussed in the previous chapter exemplifies this uncertainty. Final design contracts are therefore usually awarded on the basis of a consultant’s reputation, expertise in a specialized area, and ability to work within a designated budget.

The procurement approach for public construction contracts is quite different. With construction, the plans are already available. Although there remains variability during construction due to weather or design changes, it is much more predictable than design. All of the conditions and requirements of a contract are stated in the contract drawings. The parameter of the task is thereby well defined. It is on this basis that construction contracts are awarded to the contractor who submits the lowest bid for completing the work stated in the contract drawings.

4.1.3 The Current Low-Bid System

This method of procurement which awards contracts to the lowest bidder is known as lump-sum bidding. It is an open competition to any qualified bidder who submits a reasonable proposal by the deadline. A qualified contractor can be
defined as one that has the following characteristics: adequate financial strength to perform the contract; ability to comply with the schedule for the work; past satisfactory performance; a record of honesty, sincerity, and ethics; technical, accounting, and operational competence; access to the necessary equipment and facilities; and qualification under applicable laws and regulations to perform the work."

The winning contractor is then obligated to perform the work described in the contract documents for the proposed price. On a project as complex and large as the CA/T, changes in the contract are inevitable. These alterations or additions to the contract are known as change orders. With a change order, the contractor offers a lump-sum proposal for the additional work. If this is rejected, the work is done on a time and materials basis. With "time and materials" the owner reimburses the contractor for the cost of labor and materials. Time and materials tends to require extensive supervision of the contractor to validate the amount of material and labor required to complete the change order. Contractors usually estimate this cost in their favor. This may lead to an adversarial relationship. Therefore, a lump-sum is usually the best choice in this situation for both parties.

---

77 John B. Miller, "Project Competitive Bidding and Award: The 'Square Corners' of Public Procurement" (Boston: Gadsby & Hannah, April 1990), 30.
4.1.4 Concept of Best Value

The current method of procurement does not always result in the best value for the taxpayers. Depending on the nature of a project element, final cost may not always be the priority. Although cost control and quality assurance should always meet acceptable standards, the variability of complex packages often makes it inappropriate to award a contract on a lump-sum basis. In order to honor their bids, contractors often sacrifice the quality of their work to reduce their cost. Sometimes, the contract is knowingly accepted even though the profit is minimal. It is commonly known that contractors must often rely on changes in the contract to make money on public projects. Therefore, contractors see change orders as an opportunity to obtain their profit. Owners are usually resentful when they feel they might be overcharged. It is not uncommon that heated arguments ensue following a contractor's lump-sum proposal for a change order. These types of problems are a direct result of the procurement process. Low-bidding encourages bidding wars among contractors. In an attempt to have the lowest bid and subsequently be awarded the contract, contractors intentionally reduce the profit margin on their bids, in the hopes that they will be able to recover their losses on change orders.

Contracts awarded on best value would help alleviate this problem. Contractors would have an incentive to accurately estimate their original bid proposals without the fear of losing a job simply because a different contractor was willing to submit a bid under cost.
4.1.5 Investment in Design

One of the most effective methods of cost control during construction requires an investment in quality designs. The saying, "an ounce of prevention is worth a pound of cure" holds true for construction. It is much easier to erase a pencil mark on a design than it is to correct problems out in the field. The value to cost ratio of quality designs is favorable. Design costs account for a small fraction of a project's overall cost. However, a little extra investment in design can save a lot of money. Design investment might involve a decision to hire a more experienced design consultant. It may include greater incentives for efficient communication with the general public. If possible, it may require a schedule extension. All in all, greater focus on design might simply mean a greater allocation of the budget.

The tendency in the government has been to disregard this advice. During the past year, engineering societies such as the American Society of Civil Engineers have managed to block attempts by the U.S. Congress to undermine the use of qualifications-based-selection (QBS) procedures for federal engineering design projects." The Brooks Architect-Engineers Act of 1972 ensured that QBS would be the principal method of obtaining design work from private firms. Under this act, the federal government is required to employ private engineers solely on the basis of their qualifications to fulfill the particular contract. A fair price would then be negotiated between the government and the engineer. The

---

new bill which Congress attempted to pass would not have guaranteed QBS. It would have placed more emphasis on faster designs and presumed cost savings, and less focus on hiring the best engineers. A move to formally set a budget for public designs would not be in the best interest of the general public. Furthermore, the presumed time and initial cost savings would most likely be offset by problems in the field later.

4.2 Improving Field Efficiency

After the contractor is selected and the designs are complete, field construction can begin. Successful field construction requires a high level of efficient interaction among several groups. On the Central Artery/Tunnel Project, the contractor, subcontractors, MHD, B/PB, and outside groups such as the community must communicate to complete a contract package.

4.2.1 Field Supervision and Project Control

During the construction phase of a project element, Bechtel/Parsons Brinckerhoff is responsible for monitoring the activities of the contractor and subcontractor. The supervision of the field work is done by a field team which includes a resident engineer, field engineers, and office engineers. The day to day activities on the job site are documented by field engineers in daily reports. These are then compiled by the lead field engineer. The resident engineer is the top field director on the job site. He/she
reports to one of the project's five construction area managers. Office engineers and secretaries handle much of the paper work throughout the construction process. Although there is often informal communication across the hierarchical structure, the massive flow of paper and official approvals is highly regulated.

Besides the daily reports, material receiving reports, and contractor deficiency reports written by field engineers, there is also a great deal of paper work which originates at sources outside of the CA/T field office. Contractors and subcontractors seeking clarifications on the specifications of the contract documents submit requests for information (RFI) to the field office. These are then answered by the resident engineer or passed on to the design consultant. Responses are received along a similar route. This shuffle of paper work often causes delays. However, the need for total project control of the flow of information on a public project deems this sort of formal communication necessary.

4.2.2 Contract Package C13A1 Examples

Central Artery/Tunnel Project construction package C13A1, the construction of the South Boston Bypass Road which will link the southeast expressway with the third harbor tunnel, has experienced delays due to the highly regulated lines of formal communication. Two elements of this contract package include the repair of damage on a local bridge and the extension of a railroad bridge. These two examples illustrate different points concerning field efficiency and management. See figure 4.1 for a map of these locations.
Figure 4.1 Location of Dorchester Branch Railroad Bridge and Southampton Street Bridge

4.2.2.1 Shotcrete or Forms?

The Southampton St. Bridge is a two-lane motor vehicle bridge which crosses the southeast expressway two miles south of downtown Boston. One of the provisions of contract C13A1 called for the chipping of spalled concrete on the bridge’s square reinforced concrete piers. The piers were then to be repaired by the placement of fresh concrete into forms around the chipped areas (see figure 4.2).

In July 1994, the subcontractor, Jacor, began chipping the foul concrete off the bridge piers. While the work was underway, Jacor suggested to the local field office that a
method other than that which was specified in the contract documents be used to place fresh concrete. Rather than placing forms around the broken areas and then pouring concrete, the subcontractor wanted to shoot fresh concrete from a hose onto the columns. This method of concrete placement is known as shotcrete and is often used in tunnels and other applications where it is difficult to build concrete forms.

![Diagram of cracks in concrete with exposed re-bar and pier columns]

Figure 4.2 Chipped Reinforced Concrete Piers of the Southampton Street Bridge

This suggestion was quickly relayed from the B/PB field office to the design consultants and MHD structural engineers for approval. For several weeks, the foreman of Jacor anxiously waited for approval. Unable to plan for the method of fresh concrete placement, the chipping of the supports continued. During this time, productivity of the chipping crew noticeably decreased due to the uncertainty. Although the field engineers²³ stationed at the job site informed

²³ The author of this thesis was one of the field engineers responsible for monitoring the activities of Jacor during chipping of the bridge piers. Due to the high level of traffic during the day, this job was completed during the night shift. The field engineers of C13A1 served as the link between the field office and Jacor’s foreman.
their resident engineer of Jacor's position, there was little
the field office could do but wait for the appropriate paper
work to be approved by one of the MHD's structural engineers.
When all of the chipping was complete, Jacor left the job
site and continued to wait for approval for the use of
shotcrete.

Approval was finally given to proceed with testing of
the shotcrete method after the chipped concrete piers stood
exposed for several additional weeks. A demonstration test
was set up outside of the C13A1 field office in South Boston,
and within a few weeks the bridge piers were repaired in
conformance with contract performance specifications by the
shotcrete method.

4.2.2.2 Dorchester Branch Railroad Bridge

The Dorchester Branch Railroad Bridge (DBRB) is a two
track bridge which carries MBTA commuter trains over the
southeast expressway. It is located a few hundred feet north
of the Southampton St. Bridge. One of the future CA/T
construction contracts calls for the expansion of the
southbound lanes of the southeast expressway from three to
five. However, the west support of the bridge needs to be
modified into a pier and a new abutment needs to be built
(see figure 4.3). This task requires the driving of
foundation piles underneath the existing railroad tracks. To

*It is interesting to note that the piers were substantially chipped
at depths from 1 in. to 1/2 ft. and that decaying steel reinforcing bars
were exposed. Daily commuters into Boston must have noticed the
condition of the bridge every morning. Surely, this did not invite
public confidence in the structural integrity of the bridge and the
efficiency of its repair.
maintain the operation of the railroad tracks during the week, temporary removable bridges were designed so that piles could be driven on weekends when commuter trains would not need the use of both tracks. The installation of these removable bridges over the course of several weekends required that work be performed 24 hours around the clock.

In the summer of 1994, construction of the temporary bridges began. Walers and struts were installed to resist the force of passing trains and to prevent the collapse of the cofferdam into which the piles were to be later driven. During the installation of one of these systems, a field problem arose. One of the superintendents of the pile driving subcontractor, Sutton Corporation, informed the C13A1 field engineer\(^3\) that installation of the struts according to the contract specifications would not be necessary and perhaps impossible. According to the contract documents, the struts were to be placed approximately every three feet and pre-jacked to a load of 75,000 pounds. The sub claimed that the load was unreasonable and would only damage the surrounding sheeting, and that the redundant installation of struts every three feet would be statically unnecessary and would only cost more time and money.

\(^3\) The field engineer, the author, was a summer intern on the Central Artery/Tunnel Project contract C13A1, and has an educational background in structural engineering.
(a) Old rail bridge

(b) Construction of new abutment for bridge extension

(c) Completed bridge extension

Figure 4.3  Dorchester Branch Railroad Bridge Extension

*The diagram has been simplified to illustrate the concept clearly.*
The superintendent informed the field engineer of his intentions to omit the installation of some of the struts. Even though it was a Saturday night, the field engineer phoned C13A1's resident engineer for advice. As it was a structural question, the resident engineer noted that any deviations from the contract drawings would require the approval of the design consultant, who was not available on weekends. Therefore, the resident engineer requested that the field engineer urge the contractor to conform to the original contract drawings as closely as possible.

Several hours later, installation of the struts began. After a discussion of the problem, and further explanation by the subcontractor, the field engineer agreed that exact construction according to the contract drawings would in fact be impossible for some of the struts, and statically useless in other locations. Despite these concessions, the installation was successfully completed and the temporary bridges were constructed. A few months later, the permanent railroad bridge extension was placed and the walers and struts were removed.

4.2.3 Empowering Field Personnel

The shotcrete and rail bridge extension examples represent different situations typically encountered on the CA/T Project. They exemplify two fundamental approaches towards handling field construction problems and illustrate the processes involved in handling deviations from contract documents.

With the shotcrete example, none of the CA/T field
personnel (resident engineers, field engineers, etc.) were able to authorize the subcontractor's alternative method. This led to extensive delays and paper work between the subcontractor, contractor, B/PB field team, and the MHD. As a result of the delay, productivity of the subcontractor's labor force decreased during this time, and the time required to finish chipping the bridge piers increased. The cost of the loss of productivity and the extra overtime labor was substantial for this small portion of the overall contract.

The field problem encountered on the Dorchester Branch Rail Bridge was not as critical as the shotcrete question because installation of the struts was only temporary. However, the decision of how to approach the impossibility of constructing in accordance with the contract drawings was a significant safety issue. A collapse of the walers, struts, and sheeting of the cofferdam under the load of passing trains might have led to a serious safety hazard. In this case, a field decision had to be made immediately on the job site. This problem was encountered late on a Saturday night, and the job was completed very early the following morning. The suspension of the job would have been impossible because the site would have to be cleaned and the track opened by Sunday night for commuter traffic on Monday morning.

Empowering field personnel to make decisions in the field involves a level of risk. Some problems such as the strut installation on the rail bridge can be handled by qualified field engineers if necessary. Others require the interaction of structural engineers and design consultants. When considering the appropriate course of action for field
personnel in handling field deficiencies on the Central Artery/Tunnel Project, it is important to consider how the risk is allocated in the management contracts between the field personnel, the contractors, and the Massachusetts Highway Department.

4.2.4 Risk Allocation

As a management consultant to the Massachusetts Highway Department, the authority of the field team of Bechtel/Parsons Brinckerhoff is limited. Field engineers and resident engineers can make simple decisions concerning field construction. However, B/PB field personnel can only offer suggestions to the MHD and the contractor on complex design and construction issues. If the contractor fails to conform to the contract documents and specifications in an acceptable manner, the B/PB field team can only issue deficiency reports and inform the MHD.

This delegation of field authority is supported by the contractual allocation of risk between the state and private management consultant. Basically, B/PB acts as an advisor to the state for a period of several years with a fixed salary. The Massachusetts Highway Department monitors the private consultant to ensure that it is advising the state according to their contract. Bechtel/Parsons Brinckerhoff is not liable for any of the construction risk in the project. Their only risk is to perform the specifications of their contract to the satisfaction of the MHD.

The Massachusetts Highway Department has attempted to control all of this risk by maintaining a high level of
control over construction. This is done through the procurement of additional consultants such as environmental companies. The CA/T Project team of the MHD itself is too small to handle all of these issues. On a CA/T construction site and other public construction jobs, it is not uncommon to see more officials supervising the work being done than there are construction workers actually doing the work. This view is also shared by a professor at the University of California at Berkeley, where studies are being conducted on how construction companies can reconfigure their work processes to reduce costs substantially.

"... we frequently see situations where an overabundance of people are reviewing work and an underabundance of people are actually producing work."

C. William Ibb, Professor of Civil Engineering

Shifting some of the construction risk to the private management consultant may avoid this type of scenario. In the B/PB field offices on the CA/T, employees are often frustrated by their lack of authority in the field. They are held back by the MHD's control over the project and may feel unable to do their job to the best of their ability." A solution to this problem would require that the field team (B/PB) assume construction risk. Allocation of construction risk to a private consultant on a public job may not be

---

2 Field Engineer on Central Artery/Tunnel Project Construction Package C13A1, interview by author, 18 September 1994. It is the author's experience as a field engineer on the CA/T Project that this view is commonly shared by B/PB field personnel.
viewed favorably by the general public. A private consultant at risk may not be willing to provide the extra funds to exert the level of control which the general public demands on a public construction project. This is one of the reasons why the state is responsible for most of the construction risk on the project.

The present allocation of risk on the CA/T Project is very attractive for B/PB from both financial and strategic perspectives. The management consultant is basically paid by the hour. The current contract does not hold B/PB liable for schedule overruns. B/PB does not have any incentive to shorten the life of the project, and will actually gain through project delays. The CA/T has also offered B/PB an opportunity to maintain its workforce. When a recession hit the United States in the late 1980's, many construction firms were unable to provide their highest qualified personnel with work. In an attempt to reduce costs, high profile engineers were laid off. B/PB's contract with the MHD on the CA/T helped the consultant avoid this problem. The contract is on a "cost plus fee" basis. It currently totals $160 million per year."' B/PB submits their costs for management on the project and then receives a flat fee as well. As the cost of the project increases, their actual profit margin may decrease. However, they are able to maintain employment of their best personnel through high salaries and benefits." The project is therefore strategically important to the


" The state and taxpayers cover many of B/PB's indirect costs for the project. For example, the relocation of B/PB employees to Boston is considered to be part of B/PB's cost submittal to the MHD.
management consultant.

It would be attractive for Bechtel/Parsons Brinckerhoff to assume a greater share of the construction risk only if its contract with the MHD provided incentives for performance. However, the fees and bonuses would have to be considerably greater than the present for the management consultant to agree to a greater share of the risk.
CHAPTER 5 - THE CA/T PROJECT TODAY AND TOMORROW

5.1 Status of Central Artery/Tunnel Project

Construction of the Central Artery/Tunnel Project is progressing rapidly. Total design of the project is over 66% complete. Construction is approximately 16.5% complete with 25 major construction packages worth $1.5 billion having already been awarded.7 The twelve immersed tube tunnel sections under Boston Harbor are approaching completion. The South Boston Bypass Road and the tunnel approaches at Logan airport and South Boston are also under construction and should be ready for the scheduled opening of the third harbor tunnel in late 1995. Most of the construction in downtown Boston to date has involved utility relocation contracts. However, this will change in 1995 when actual "depression" of the artery begins and downtown construction activity increases. The largest contract on the project to date is scheduled to begin by the spring of 1995. It involves the construction of four northbound lanes underground from Kneeland St. to Congress St. in downtown Boston.

5.1.1 Shifting to a Construction Oriented Structure

To meet the demands of construction, the structural organization of Bechtel/Parsons Brinckerhoff has undergone several changes. These are most apparent in engineering management. When the original hierarchy was developed in

1987, the CA/T team was design oriented. Conceptual and preliminary designs were drawn and basic engineering problems were being solved. At this time, most engineering management on the project dealt with design. A formal design manager was therefore appointed. This individual was responsible for coordinating the efforts of several additional managers and reporting to the overall B/PB project manager. The specialized divisions included automation services, preliminary design, project engineering, engineering services, and architectural services (see figure 5.1).

---

Figure 5.1 B/PB Original Engineering Management Structure

Adapted from a handout distributed by Anthony Lancellotti, Deputy Project Manager of Engineering for B/PB on the CA/T Project during a guest lecture at M.I.T., March 1994.
Figure 5.2 B/PB Current Engineering Management Structure

B/PB's engineering management structure of today is quite different. Most preliminary designs on the project have already been completed. In general, the entire project has become construction-oriented. On February 15, 1994, a new engineering organizational structure was approved by Tad Weigle, Project Executive for B/PB on the CA/T (see figure 5.2). The shift in focus by B/PB from design to construction is clear from a comparison between the original and current hierarchy of engineering management. The position of design manager was replaced by a deputy project manager of

---

Adapted from a handout distributed by Anthony Lancellotti, Deputy Project Manager of Engineering for B/PB on the CA/T Project during a guest lecture at M.I.T., March 1994.
engineering. The architecture services managerial position was replaced by a traffic and transportation manager to alleviate the effect of construction on traffic flow. The preliminary design manager was transferred to one of the four area manager openings. All in all, today's engineering management provides services geared towards technical support for construction.

The number and specialty areas of Bechtel/Parson Brinckerhoff's subconsultants on the project also reflect a shift towards construction. Many of the new consultants provide expertise in quality control. This includes inspection of mechanical construction, concrete, underwater construction, electrical construction, and general construction. One firm provides assistance in obtaining permits so that construction can begin, while another offers traffic surveillance to monitor and minimize the effect of construction on daily traffic flow. Of the original twelve subconsultants to B/PB, only five continue to advise the project. Most of these offer architectural, planning, and surveying services to finish the design work which remains and to provide technical support and assistance during construction. Table 5.1 lists the current subconsultants to B/PB on the CA/T Project and their areas of specialization.

---

40 See page 35 for a list of the original subconsultants to B/PB.
### TABLE 5.1

**B/PB Current Subconsultants**

<table>
<thead>
<tr>
<th>Firm Name</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASEC Corp. (DBE)</td>
<td>Surveying/Mapping</td>
</tr>
<tr>
<td>BSC Cullinan*</td>
<td>Surveying</td>
</tr>
<tr>
<td>BSC Group</td>
<td>Permitting Assistance</td>
</tr>
<tr>
<td>Cambridge Systematics, Inc.*</td>
<td>Transportation Planning, Economics Evaluation</td>
</tr>
<tr>
<td>Carol R. Johnson &amp; Assoc., (DBE)*</td>
<td>Landscape Architecture</td>
</tr>
<tr>
<td>DMC Engineering</td>
<td>Mechanical Construction Inspection</td>
</tr>
<tr>
<td>Dunn Engineering</td>
<td>Traffic Surveillance and Control System</td>
</tr>
<tr>
<td>R.D. Kimball Associates</td>
<td>Mechanical/Electrical</td>
</tr>
<tr>
<td>Mistry Assoc., Inc. (DBE)*</td>
<td>Civil/Structural</td>
</tr>
<tr>
<td>NFE Consultants</td>
<td>Concrete Inspectional Services</td>
</tr>
<tr>
<td>H2O Consulting</td>
<td>Construction Inspectional Services</td>
</tr>
<tr>
<td>Land &amp; Sea Consulting</td>
<td>Marine Diving</td>
</tr>
<tr>
<td>Project Management Associates (DBE)</td>
<td>Construction Inspection Services</td>
</tr>
<tr>
<td>SBI/Stowee, Inc.</td>
<td>Scheduling and Claims/Changes Support</td>
</tr>
<tr>
<td>Shah Associates</td>
<td>Electrical Construction Inspection</td>
</tr>
<tr>
<td>Synetics Corporation (DBE)</td>
<td>Underpinning</td>
</tr>
<tr>
<td>Stull and Lee, Inc. (DBE)*</td>
<td>Management Information System Support</td>
</tr>
<tr>
<td>Wallace, Floyd, Assoc. Inc.*</td>
<td>Architectural/Design Urban</td>
</tr>
<tr>
<td></td>
<td>Urban Planning; Community Participation; Architecture</td>
</tr>
</tbody>
</table>

* original subconsultant (see page 35)

---

41 Central Artery/Tunnel Project: Project Management Plan Revision 04 (Bechtel/Parsons Brinckerhoff, August 1993), 22.
5.1.2 Public Relations

Public relations continues to be an area which demands the attention of Central Artery/Tunnel officials. Despite acceptance of the new Charles River Crossing design this past year by state and federal officials, some community groups continue to favor more expensive alternatives involving several tunnels under the Charles River rather than fourteen lanes of bridge. A North End antique store owner who has been an outspoken opponent of artery depression since 1982 has recently sued 43 federal, state and city agencies alleging violation of state and federal environmental laws.\textsuperscript{2} The public relations managers of the CA/T must deal with current design issues as well as opponents who refuse to accept finalized project plans.

Strong public affairs management is also necessary for the CA/T Project during the height of construction activity over the next few years. Daytime traffic congestion and tight scheduling may often require 24 hour construction at some job sites. The noise of construction during nighttime hours may irritate neighborhood groups. Good public relations can help avoid adversarial relationships, encourage community understanding of project schedules, and lead to overall greater cooperation and more efficient construction.

5.1.3 Potential Conflicts of Interest

A possible conflict of interest has scarred the procurement of the CA/T's largest contract thus far, depression of the artery along a 2,200 foot stretch under South Station. On November 15, 1994, bids were accepted for the contract estimated at $430.7 million. The low bidder, a venture between Perini Corp., Kiewit Construction Co., and Jay Cashman, Inc., projected the cost of the 5 1/2 year contract to be $378 million. However, the awarding of the contract has been delayed due to an alleged conflict of interest involving a fourth firm. Guy F. Atkinson Co. had originally intended to join the three other construction companies in a joint venture but dropped its involvement during the bidding process. A construction consultant which had been hired by B/PB in February 1994 to help develop the estimate for the contract was hired seven months later by Atkinson to help develop an estimate for the same contract. Atkinson was dropped from the joint venture when it was discovered that it may have had an edge to inside information regarding the contract. The four companies of the original joint venture have denied any knowledge of the consultant's previous experience on the CA/T contract. The proximity of the second lowest bid, only a half million dollars more at $378.5 million, suggests that the competition was nevertheless fair. State officials are currently investigating the "coincidence" of this conflict of interest.

The project's public image has also been marred by recent controversies concerning Bechtel/Parsons Brinckerhoff and the state. Governor William Weld allowed Peter J.
Berlandi to hold positions as his chief fund raiser and as a representative for B/PB. During the gubernatorial race of 1994, Berlandi's connection to Bechtel and the state was exploited by political opponents of Weld as a conflict of interest.

Bechtel/Parson Brinckerhoff's involvement as a manager of the project and as a designer is also seen by many as a conflict of interest. Local consulting firms believe that the private management consultant has extended itself beyond the scope of its contract with the state, and is taking away design contracts which were originally intended for other design consultants, not B/PB.

5.1.4 Cost Control

Cost control has presented a problem for the project since it began. In 1985, the original estimate for construction of the third harbor tunnel and depression of the central artery was $2.5 billion. By the end of the Dukakis administration the cost estimate had risen to $5.2 billion. The current cost is estimated to be $7.7 billion. New design features to accompany community and special interest concerns account for a great deal of the cost increases. For instance, much of the $2.5 billion increase since the Weld administration took over the project in 1991 can be attributed to the new $1.3 billion Charles River Crossing, almost a billion dollars more than the original estimate of $500 million for that element. Inflation has also contributed considerably to the overall cost of the project. Officials estimate that inflation since 1985 has cost the
project $2.5 billion and that the current projected cost will rise to $8.8 billion by the scheduled completion of the project in 2004."

Recent design problems involving the extension of the Massachusetts Turnpike over the Fort Point Channel exemplify the recent controversies concerning conflicts of interest, cost control, and the consideration of special interests in design. The most cost effective and simplest solution to construct a Fort Point Channel Crossing would have been to construct a bridge over the channel. However, the leading manufacturing company in Boston, Gillette, which has its headquarters next to the channel, argued that a bridge would interfere with the operations of its plant. Furthermore, Gillette threatened to leave Boston if any bridge plans were carried out. Therefore, B/PB designed for a series of tunnels under the channel. After the preliminary design was complete, the consulting firm of Maquire/Harris was chosen to finalize the design. The consultants rejected the B/PB design in January 1992 as inadequate because of the soft soils in the channel. Almost two years later, a new solution primarily developed by Bechtel engineers was selected over a more conservative Maquire/Harris design. Nevertheless, the new B/PB design will add approximately $260 million to the cost of the Fort Point Channel Crossing. Many state officials believe that B/PB was negligent in its assessment of the soil conditions when it created the preliminary design. This controversy has stained the public’s image of

---
B/PB's engineering design work and cost control programs.

The construction contract for the tunnel approach at Logan airport in East Boston has also incurred cost overruns due to unforeseen soil conditions. Temporary walls which were built to excavate the area have failed due to unstable soil. The contractor, a joint venture of Modern Continental Inc. and Obayashi Corp., has filed a claim of $64 million for increased costs. Joseph DeNucci, a democratic state auditor on the CA/T, believes that "this latest finding is another example of additional costs which could have been avoided by better planning and stronger management oversight." However, the auditor's political affiliation and the release of the report during Republican Governor Weld's re-election campaign have questioned the credibility of DeNucci's assessment of the situation.

As a result of these cost problems, state officials ousted the management consultant's project executive, Tad Weigle, this past November. State officials cited his inability to commit to holding down costs." However, it is unlikely that this change is anything more than a public relations move in actuality. The cost of project elements has generally increased as a direct result of the demands of communities and special interest groups, not because of poor management by Bechtel/Parsons Brinckerhoff. In order to accommodate and satisfy project opponents, expensive design changes have been necessary. The complexity of the project

"Charles M. Sennott, "Auditor says miscalculations add $64m more to Artery costs," Boston Globe, 18 October 1994,

in general, and unknown subsurface conditions have also caused cost increases. This can be considered normal for a complex construction project in a major urban area. It can also be assumed that original cost estimates were optimistic to encourage political support for the project so that it would be approved in the first place.

Central Artery/Tunnel officials have also been criticized by state inspectors for passing up on possible savings. Inspector General Robert A. Cerasoli has claimed that CA/T officials have followed through on only $325 million of a possible $2.8 billion estimated savings project wide, as recommended by the project’s own cost control program. MHD Project Director, Peter Zuk, believes that Cerasoli’s charge is out of context when one considers that communities and special interest groups would not accept the design changes which would be necessary to save $2.8 billion."

Many state officials, including Cerasoli, believe that the project is experiencing many of these cost increases because the MHD’s CA/T staff of 40 employees is not large enough to properly monitor Bechtel/Parsons Brinckerhoff’s staff of 1,200 administrative, technical, and professional staff." On the other hand, Secretary of Transportation James Kerasiotes, and other officials of Governor Weld’s Republican administration maintain that the small staff is adequate. Peter Zuk believes that the “CA/T has a lean, well-crafted

---


management team."

The state is considering altering B/PB's contract in response to the Fort Point Channel controversy and other cost overruns. Since Bechtel/Parsons Brinckerhoff joined the project in 1985, they have been paid on a fixed fee, regardless of the duration of the project. State officials want to structure a new contract with the management consultant which would penalize them for poor management during the construction phase of the project. The contract was not structured this way for the design phase because of the variability and uncertainty involved with the complex project elements. Now that most of the design is complete, it is much easier for CA/T officials to forecast cost and schedules and subsequently develop a contract with B/PB which links performance and payment. Modifying the contract in this way would also encourage B/PB to finish the project as quickly as possible.

5.2 Trends in Public Construction Projects

In the United States, there has been a recent trend towards privatization of public construction projects. The underlying theme of this concept is the development of public facilities by the private sector. Privatization has become appealing to the government for several reasons. First of all, the use of private capital to finance a project allows the public to use its money to fund other projects. This is

important because our nation’s infrastructure is in serious need of repair, yet the public is unwilling to pay additional taxes to meet the cost. The private sector is also able to deliver construction projects much more efficiently, for less money and on a tighter schedule." Companies in this sector are not bound by many of the control regulations which bound public construction contracts.

The government has also sought new approaches to handling and avoiding problems in field construction on public jobs. In January 1994, a National Cooperative Highway Research Program survey was released by the Transportation Research Board. It studied the methods used by state transportation agencies in handling construction disputes. The study found that 22% of state transportation departments relied on dispute review boards, 63% relied on partnering, 70% empowered field personnel to handle field disputes, 95% used change orders, and 100% were willing to negotiate with the contractor.49 Partnering is one of the newest and most controversial methods of dispute resolution. In partnering, the overall attitude between two contractors that must work together is changed from “you shall do this” to “we shall attempt to do this.” Even though the parties are still required to meet the terms of the contract, partnering attempts to avoid lengthy court cases by improving communication and establishing a team environment. The


50 “State DOTs Tackle Problem Projects,” Civil Engineering, March 1994, 19.
popularity of partnering among contractors as a tool to solve construction problems is mixed, but has nonetheless become one alternative to handling disputes.

The Federal Highway Administration has also initiated a new program to avoid costly change orders on projects. The QAQC (Quality Assurance Quality Control) program provides contractors with incentives to deliver projects on time and under budget. By providing bonuses directly related to a contract's early completion, contractors have a financial motive to avoid bickering during change order processes. This would help avoid the common problem on public jobs when a contractor bids a job well under cost with the intention of gaining profit on changes in the contract. If change orders are necessary due to fundamental modifications of the contract drawings, time extensions are granted to the contractor. The original bonus incentives are then appropriately shifted to reflect the unexpected change order. All in all, QAQC provides contractors with an opportunity to bid realistically and obtain additional profits through efficient delivery of the project.
CHAPTER 6 - CONCLUSIONS

In order to prepare for the global challenges of the 21st century, the United States must update its decaying infrastructure. The transportation systems of many U.S. cities are overloaded by our nation's growth. The economy of the greater Boston, Massachusetts area has suffered as a result of increasing demands on its roads and highways. Traffic costs the greater Boston area over $1.5 billion a year.\(^1\) Much of this problem starts with the Central Artery in downtown Boston. The development of large-scale public projects such as Boston's Central Artery/Tunnel Project requires the balancing of special interest groups, community interests, state and federal politics, and viable transportation solutions.

The consideration of all of these viewpoints during development requires new and dynamic management methods. The government has continued to look towards the private sector for expertise in construction. Although the Central Artery/Tunnel Project is not truly privatized\(^2\), it exemplifies the growing role of the private sector in the construction of public projects. On the CA/T, the Massachusetts Highway Department is overseeing the project with the help of a private consultant, Bechtel/Parsons Brinckerhoff.


\(^2\) Privatization of a project would require that private funds are involved. Funding for the CA/T is provided entirely by public money.
Together, the MHD and B/PB have successfully managed the first decade of the nation's largest ongoing public construction project. CA/T officials have remained true to their promise and political covenant that the project would not take a single neighborhood or home. Community participation is being encouraged throughout the project. Environmental issues are being addressed at all times during the engineering process. Program management of the extremely complex and unique Central Artery/Tunnel Project has resulted in a successful balance between special interests and engineering.

Central Artery/Tunnel officials must continue to seek new ways of managing the ever-changing construction process more efficiently. Large public construction projects such as the CA/T which rebuild our nation's decaying infrastructure may require us to reconsider old procurement methods, new innovative designs, new materials, and new management methods. As public projects, it may be necessary for states to continue to formally control projects similar to the CA/T. It may be wise however, to expand the role of the private sector throughout the construction process and to draw on the many benefits of privatization. The use of a construction manager could transfer risk from the state to the private sector if the construction manager guarantees a maximum price. This would provide incentives for the construction manager to draw on all of its resources to get a project done as quickly, efficiently, and cost effectively as possible.

Public officials must also find the proper balance between schedule, quality, and cost. On the CA/T, the focus
appears to be on providing quality at any price or schedule. The consideration of neighborhood concerns and special interest groups during design and throughout the construction process has clearly led to cost and schedule overruns. Central Artery/Tunnel Officials have recently committed themselves to controlling cost in the future. Many have vowed that the final cost of the project will not exceed the current estimate of $7.7 billion, excluding inflation. Tighter cost control measures will need to be taken in order to achieve this. CA/T officials will have to pressure contractors to remain true to their bids. The state's contract with Bechtel/Parsons Brinckerhoff may also need to be restructured so that it penalizes poor performance. Most of all, project officials may need to trade off design features to reduce cost. This may include features which are not vital to the project and were only added to satisfy special interests.

As our country heads into the next century, we must realize that the only way that our nation can build a globally competitive infrastructure is with the increasing help of the private sector. Traditional public project management does not offer the flexibility and dynamic management which is required on a unique and complex infrastructure task. It is crucial that the quality and efficiency of the construction of public jobs is not compromised by overbearing and fanatical government control. Public officials must ultimately seek the proper balance between special interests, engineering solutions, public control, and privatization.
APPENDIX

A. Central Artery/Tunnel Project Map ....................... 106

B. List of CA/T Contract Packages .......................... 107

C. The New Charles River Crossing .......................... 113
Appendix A. Central Artery/Tunnel Project Map
Appendix B. List of CA/T Contract Packages

<table>
<thead>
<tr>
<th>Design</th>
<th>Const</th>
<th>Description</th>
<th>Design Firm</th>
<th>GT</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Boston</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D001A</td>
<td></td>
<td>I-90 South Boston Interchange</td>
<td>HDR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C01A1</td>
<td>I-90 South Boston Interchange</td>
<td>HDR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>R01A1</td>
<td>South Boston Building Demos</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C01A2</td>
<td>South Boston Interchange Phase I Surface and Detour Roadways</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C01A4</td>
<td>Fargo St. to “C” St. Connector</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D001B</td>
<td></td>
<td>Vent Building #5 Superstructure</td>
<td>CW/MJ</td>
<td></td>
</tr>
<tr>
<td>D001C</td>
<td></td>
<td>A&amp;P Building Demolition</td>
<td>LIN</td>
<td>MCC</td>
</tr>
<tr>
<td>D002A</td>
<td></td>
<td>South Boston Haul Road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D004A</td>
<td></td>
<td>I-90 BMIP Tunnel and Vent Bldg #6</td>
<td>HDR</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C04A2</td>
<td>I-90 BMIP Tunnel</td>
<td>KPAC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C04A1</td>
<td>South Boston Railroad Relocation</td>
<td></td>
<td>MCC</td>
</tr>
<tr>
<td></td>
<td>C04A3</td>
<td>Vent Building #6</td>
<td></td>
<td>WCC</td>
</tr>
<tr>
<td>D024A</td>
<td></td>
<td>Operations Control Center Complex</td>
<td>EM/WDA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C24A1</td>
<td>Cen. Maintenance Facility Phase I</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C24A2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

East Boston and Third Harbor Tunnel

<table>
<thead>
<tr>
<th>Design</th>
<th>Const</th>
<th>Description</th>
<th>Design Firm</th>
<th>GT</th>
</tr>
</thead>
<tbody>
<tr>
<td>D005A</td>
<td></td>
<td>I-90 Immersed Tube Tunnel</td>
<td>SVC</td>
<td>MKI</td>
</tr>
<tr>
<td></td>
<td>R05A2</td>
<td>Demo Comm. Union, Pappas, Noymer</td>
<td></td>
<td>NASD</td>
</tr>
<tr>
<td>D005B</td>
<td></td>
<td>I-90 Tunnel Finishes</td>
<td>DBK</td>
<td>WCC</td>
</tr>
<tr>
<td>D007A</td>
<td></td>
<td>I-90 Bird Island Flats</td>
<td>GPT</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C07A1</td>
<td>I-90 BIF Tunnel</td>
<td></td>
<td>MCC/OB</td>
</tr>
<tr>
<td></td>
<td>R07A3</td>
<td>Logan Airport Building Demolitions</td>
<td></td>
<td>SOC</td>
</tr>
<tr>
<td></td>
<td>C07A4</td>
<td>Vent Building #7</td>
<td></td>
<td>MMCC</td>
</tr>
<tr>
<td></td>
<td>C07A5</td>
<td>East Boston Electrical Substation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emergency Response Station</td>
<td>SEA</td>
<td>JMC</td>
</tr>
<tr>
<td>D007B</td>
<td></td>
<td>I-90 I-90 Porter St. Outfall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D007C</td>
<td></td>
<td>I-90 Toll Plaza and Facilities</td>
<td>QA/WDA</td>
<td></td>
</tr>
<tr>
<td>D007D</td>
<td></td>
<td>I-90 Logan Airport Interchange</td>
<td>FST/TYL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C07D1</td>
<td>I-90 Logan Airport Egress Ramps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C07D2</td>
<td>I-90 Logan Airport Interchange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D007E</td>
<td></td>
<td>East Boston Maintenance Facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D008A</td>
<td></td>
<td>East Boston Airport/Rte 1A Interchange</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

South Bay

<table>
<thead>
<tr>
<th>Design</th>
<th>Const</th>
<th>Description</th>
<th>Design Firm</th>
<th>GT</th>
</tr>
</thead>
<tbody>
<tr>
<td>D009A</td>
<td></td>
<td>I-93/I-90 Interchange I-93 NB</td>
<td>MH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C09A1</td>
<td>I-93/I-90 Interchange I-90 Marine Tunnel</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>R09A2</td>
<td>Demolish Rapid Service Press</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C09A3</td>
<td>Vent Building #1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C09A4</td>
<td>I-93/I-90 Interchange I-93 NB</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C2305</td>
<td>Soil Stabilization Test Program</td>
<td></td>
<td>JMC</td>
</tr>
<tr>
<td></td>
<td>C2306</td>
<td>Caisson Load Test Program</td>
<td></td>
<td>TBD</td>
</tr>
<tr>
<td>D009B</td>
<td></td>
<td>I-90 Fort Point Channel Crossing</td>
<td>GF</td>
<td></td>
</tr>
<tr>
<td>D009C</td>
<td></td>
<td>I-93/I-90 Interchange I-92 SB</td>
<td>BLS/M</td>
<td></td>
</tr>
<tr>
<td>D009B</td>
<td></td>
<td>I-93/I-90 Interchange Surface Restoration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D009E</td>
<td></td>
<td>Fort Point Channel Restoration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D009F</td>
<td></td>
<td>S. Station Trans. Center Ramps</td>
<td>MBTA</td>
<td>JMC</td>
</tr>
<tr>
<td>D010A</td>
<td></td>
<td>I-93/I-90 Interchange RR Track Relocation</td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td>D012A</td>
<td></td>
<td>I-93 Mass Ave Interchange</td>
<td>AMRV</td>
<td></td>
</tr>
<tr>
<td>C12A3</td>
<td></td>
<td>I-93 Mass Ave Interchange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>Const</td>
<td>Description</td>
<td>Design Firm</td>
<td>QC</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
<td>-------------</td>
<td>-------------</td>
<td>----</td>
</tr>
<tr>
<td>R12A1</td>
<td>Mass Ave Interchange Bldg Demolition Bldg</td>
<td>C12A4</td>
<td>E&amp;K/DRC</td>
<td>CC</td>
</tr>
<tr>
<td>D013A</td>
<td>South Boston Bypass Road</td>
<td>C13A1</td>
<td>M&amp;E</td>
<td>JFW</td>
</tr>
<tr>
<td>D014A</td>
<td>New East Side Interceptor Relocation</td>
<td>C14A1</td>
<td>M/H/M</td>
<td>DOCSI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14A2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Artery</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D011A</td>
<td>I-93 NB Tunnel Atlantic Ave.</td>
<td>C11A1</td>
<td>SS/DC</td>
<td></td>
</tr>
<tr>
<td>D014B</td>
<td>Utility Relocation North to Causeway</td>
<td>C14B1</td>
<td>SEA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14B2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14B3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D014C</td>
<td>Utility Relocation Congress to North</td>
<td>CDM</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14C1</td>
<td>Utility Relocation Congress to Broad</td>
<td>M/H/M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14C2</td>
<td>Utility Relocation Fulton St.</td>
<td>WES</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14C3</td>
<td>30 In. Gas Line Relocation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C14C4</td>
<td>Utility Relocation Broad to State</td>
<td>SVC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C15A1</td>
<td>I-93 Central Artery N to Chardon</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C15A2</td>
<td>I-93 Central Artery Chardon to Causeway</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C15A3</td>
<td>Vent Bldg #4 and Parking Garage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R15A5</td>
<td>Analyse Bldg Demolition</td>
<td></td>
</tr>
<tr>
<td>D015C</td>
<td>Central Artery Surface Restoration</td>
<td>C15C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D016A</td>
<td>I-93 Parcel 7 Parking Garage</td>
<td>C17A1</td>
<td>ASI</td>
<td></td>
</tr>
<tr>
<td>D017A</td>
<td>Central Artery Congress to North</td>
<td>C17A2</td>
<td>FST/HNTB</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C17A3</td>
<td>I-93 Central Artery State to North</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C17A6</td>
<td>I-93 Central Artery State to North</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C17A6S</td>
<td>I-93 Central Artery SB Congress to High</td>
<td>CA/T</td>
</tr>
<tr>
<td>D017B</td>
<td>I-93 Central Artery Blue Line Crossing</td>
<td>C17B1</td>
<td>MBTA</td>
<td></td>
</tr>
<tr>
<td>D017D</td>
<td>Northern Ave On Ramp Replacement</td>
<td>C17B2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D017H</td>
<td>I-93 SB Congress to Kneeland, STS</td>
<td>C18A1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D017B</td>
<td>Dewey Sq. Power System Modification</td>
<td>C18B1</td>
<td>SUF</td>
<td></td>
</tr>
<tr>
<td>Central Artery North</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019A</td>
<td>Cent. Artery CANA Temp. Ramps CT-TC</td>
<td>C19A1</td>
<td>GPI</td>
<td></td>
</tr>
<tr>
<td>D019B</td>
<td>I-93 Viaducts and Ramps N of Charles</td>
<td>C19B1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019C</td>
<td>Charles River Basin Restoration</td>
<td>C19C1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019D</td>
<td>Central Artery Bridges over Charles</td>
<td>C19D1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019E</td>
<td>I-93 Leverett Circle/Storrow Drive Connectors</td>
<td>C19E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019F</td>
<td>I-93 Restoration Charles River Crossing</td>
<td>C19F1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019G</td>
<td>Charles River Tunnel and Tunnels North</td>
<td>C19G1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>D019A</td>
<td></td>
<td>GPI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C19A2</td>
<td>CANA Temp. Ramps Steel Procurement</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C19A3</td>
<td>Temp. Ramps Superstructure (PPCS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C19A4</td>
<td>CANA Permanent Loop Connectors</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>C19A5</td>
<td>Fire Protection System Water Service</td>
<td></td>
</tr>
<tr>
<td>D019H</td>
<td>ANOC Maintenance Facility #2</td>
<td>C19H1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D019E</td>
<td>Studies for Areas N of Causeway</td>
<td>C19E</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

108
<table>
<thead>
<tr>
<th>Design</th>
<th>Const</th>
<th>Description</th>
<th>Design Firm</th>
<th>QC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Project Wide</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D020A</td>
<td></td>
<td>I-90 Mechanical/Electrical Systems</td>
<td>SVC</td>
<td></td>
</tr>
<tr>
<td>C20A1</td>
<td></td>
<td>I-90 Furnish/Install Vent Fans</td>
<td>MEL</td>
<td></td>
</tr>
<tr>
<td>C20A2</td>
<td></td>
<td>I-90 Electrical General Contractor</td>
<td>FBN</td>
<td></td>
</tr>
<tr>
<td>D020B</td>
<td></td>
<td>I-93 Mechanical/Electrical System</td>
<td>SVC</td>
<td></td>
</tr>
<tr>
<td>C20B1</td>
<td></td>
<td>I-93 Furnish/Install Vent Fans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C20B2</td>
<td></td>
<td>I-93 Electrical General Contractor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D021A</td>
<td></td>
<td>Materials Disposal System</td>
<td>CWS</td>
<td></td>
</tr>
<tr>
<td>C21A1</td>
<td></td>
<td>Materials Disposal System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spectacle Offshore Boring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D021B</td>
<td></td>
<td>Materials Processing Operation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D021C</td>
<td></td>
<td>Spectacle Island Surface and Wetland Restoration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C21C1</td>
<td></td>
<td>Runney Marsh Restoration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C21C2</td>
<td></td>
<td>Artificial Fish Reef</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D021D</td>
<td></td>
<td>Long Island Shoreline Restoration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D021F</td>
<td></td>
<td>Bird Island Fish Company/Condor St.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C21F1</td>
<td></td>
<td>Bird Island Fish Company</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C21F2</td>
<td></td>
<td>Condor Street</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D021G</td>
<td></td>
<td>Runney Marsh Restoration - Phase I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D022A</td>
<td></td>
<td>Integrated Project Control Systems</td>
<td>DC</td>
<td></td>
</tr>
<tr>
<td>C22A1</td>
<td></td>
<td>I-90 Furnish/Install IPCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C22A2</td>
<td></td>
<td>I-90 Furnish/Install IPCS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C22A4</td>
<td></td>
<td>Toll System Enhancement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C22A5</td>
<td></td>
<td>IOC Variable Message Signs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C22A6</td>
<td></td>
<td>IOC Highway Advisory Radio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C22A7</td>
<td></td>
<td>IOC Close Circuit TV and VIDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D024B</td>
<td></td>
<td>Central Maintenance Facility - Phase II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D024D</td>
<td></td>
<td>Central Police Facility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D024E</td>
<td></td>
<td>Research Materials Facility (RMF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D026A</td>
<td></td>
<td>Emergency Platforms and Stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C26A1</td>
<td></td>
<td>Emergency Platforms #3, #4, #5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C26A2</td>
<td></td>
<td>Emergency Station #7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C26A3</td>
<td></td>
<td>Emergency Station #8, #9, Platform #10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Geotech</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G023A</td>
<td></td>
<td>Area 01 &amp; 02 Geotech (KB SB TBT)</td>
<td>H&amp;A</td>
<td></td>
</tr>
<tr>
<td>C23A1</td>
<td></td>
<td>Geotech Boring Immersed Tube</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23A3</td>
<td></td>
<td>Geotech Boring South Boston BMIP</td>
<td>GZAD</td>
<td></td>
</tr>
<tr>
<td>C23A4</td>
<td></td>
<td>Geotech Boring East Boston BIF</td>
<td>SEC</td>
<td></td>
</tr>
<tr>
<td>C23A5</td>
<td></td>
<td>Geotech Boring South Boston Interchange</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23A5</td>
<td></td>
<td>Geotech Boring East Boston Airport</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23A6</td>
<td></td>
<td>Geotech Boring East Boston Rte 1A</td>
<td>GZAD</td>
<td></td>
</tr>
<tr>
<td>C23A7</td>
<td></td>
<td>Pump Test/Observation Wells</td>
<td>LAC</td>
<td></td>
</tr>
<tr>
<td>G023C</td>
<td></td>
<td>Area 03 Geotech (I-93, I-90)</td>
<td>G2A</td>
<td></td>
</tr>
<tr>
<td>C23C1</td>
<td></td>
<td>Geotech Boring South Bay NBSI</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23C2</td>
<td></td>
<td>Geotech Boring South Bay Bypass</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23C3</td>
<td></td>
<td>Geotech Boring South Bay/Pt. Pt. Channel Crossing</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23C4</td>
<td></td>
<td>Geotech Boring I-93 Viaduct/South Boston</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>C23C5</td>
<td></td>
<td>Geotech Boring South Bay Mass Ave</td>
<td>GDD</td>
<td></td>
</tr>
<tr>
<td>G023D</td>
<td></td>
<td>Area 04 Geotechnical (CA)</td>
<td>GEI</td>
<td></td>
</tr>
<tr>
<td>C23D1</td>
<td></td>
<td>Geotech Boring CA Utility Relocation</td>
<td>CRD</td>
<td></td>
</tr>
<tr>
<td>C23D2</td>
<td></td>
<td>Geotech Boring CA Atlantic Ave</td>
<td>GZAD</td>
<td></td>
</tr>
<tr>
<td>C23D3</td>
<td></td>
<td>Geotech Boring CA North - Causeway</td>
<td>LAC</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td>Const</td>
<td>Description</td>
<td>Design Firm</td>
<td>QC</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
<td>-------------------------------------------------------</td>
<td>-------------</td>
<td>-----</td>
</tr>
<tr>
<td>C23D4</td>
<td></td>
<td>Geotech Boring CA Northern - North</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C23D5</td>
<td></td>
<td>Geotech Boring CA Dewey Square</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G023E</td>
<td></td>
<td>Area 05 Geotechnical (CA North)</td>
<td>SWEC</td>
<td></td>
</tr>
<tr>
<td>C23E1</td>
<td></td>
<td>Geotech Boring CA North CANA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C23E2</td>
<td></td>
<td>Geotech Boring CA North of Causeway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2301</td>
<td></td>
<td>Projectwide Ancillary Geotech Driller</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2302</td>
<td></td>
<td>Tension Element Testing Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2303</td>
<td></td>
<td>Projectwide Ancillary Test Pit Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2304</td>
<td></td>
<td>Projectwide Ancillary Geotech Driller 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2307</td>
<td></td>
<td>Projectwide Ancillary Geotech Driller 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>General</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025A</td>
<td></td>
<td>ROW Assessment and Remediation Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025B</td>
<td></td>
<td>Remediation South Boston Baul Road</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C25A1</td>
<td></td>
<td>Oil and Hazardous Incident Response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C25A2</td>
<td></td>
<td>Dewey Square Tunnel Cleaning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C25A3</td>
<td></td>
<td>Phase I/II Archaeology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025C</td>
<td></td>
<td>Project Conservator - 1st work program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025D</td>
<td></td>
<td>Project Conservator - 2nd work program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025E</td>
<td></td>
<td>Archaeological Services Phase III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025G</td>
<td></td>
<td>CANA Land Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025H</td>
<td></td>
<td>Project Conservator - 3rd Work Program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025J</td>
<td></td>
<td>Community-Based Training - Boston</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025K</td>
<td></td>
<td>Community-Based Training - Cambridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025M</td>
<td></td>
<td>Interim Operations Control Center Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025Q</td>
<td></td>
<td>Community-Based Training II - Boston</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025R</td>
<td></td>
<td>Community-Based Training II - Cambridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025S</td>
<td></td>
<td>Projectwide Safety Consultant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M025U</td>
<td></td>
<td>Old Colony Railroad Bridge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

110
### Construction Firms Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABT</td>
<td>Another Building Inspecting Company</td>
</tr>
<tr>
<td>BCI</td>
<td>Building Construction Inspectors</td>
</tr>
<tr>
<td>CBI</td>
<td>Construction Building Inspectors</td>
</tr>
<tr>
<td>CBC</td>
<td>Commercial Building Contractors</td>
</tr>
<tr>
<td>DFI</td>
<td>Design-Construct Inspectors</td>
</tr>
<tr>
<td>GCI</td>
<td>General Construction Inspectors</td>
</tr>
<tr>
<td>HIC</td>
<td>High-impact Construction Inspectors</td>
</tr>
<tr>
<td>ICI</td>
<td>Industrial Construction Inspectors</td>
</tr>
<tr>
<td>PCI</td>
<td>Professional Construction Inspectors</td>
</tr>
<tr>
<td>RCI</td>
<td>Residential Construction Inspectors</td>
</tr>
<tr>
<td>TCI</td>
<td>Technical Construction Inspectors</td>
</tr>
<tr>
<td>UCI</td>
<td>Utility Construction Inspectors</td>
</tr>
</tbody>
</table>

*Note: This list is not exhaustive and may vary by region and industry.*
BIBLIOGRAPHY


Angelo, William J. "State officials claim artery management is clogged." Engineering News Record, 12 December 1994, 10.


"Bring the project to an end." Boston Herald, 18 November 1993, 40.


"CARAVAN for Commuters, Inc.: Ensuring Mobility During CA/T Construction." Boston: Caravan for Commuters, Inc.

Carr, P.A., Media Relations Director of the Central Artery/Tunnel Project. Interview by author, 26 April 1994.


"Crossing the Charles: A Closer Look at the Alternatives." Artery Express: CA/T Project Newsletter, Fall 1993.

Flynn, Bill, Deputy Project Director of the Central Artery/Tunnel Project. Guest Lecture at Massachusetts Institute of Technology, February 1994.


Lewis, Mike, Director of the Charles River Crossing Resolution Team on the Central Artery/Tunnel Project. Guest Lecture at M.I.T., 12 April 1994.

"Looking at the Central Artery/Tunnel, you might think we've only scratched the surface." Boston: Central Artery/Tunnel Project and Artery Business Committee.


"Megaproject Milestones." Parsons Brinckerhoff: Notes, Fall 1994.

Miller, John B. "Project Competitive Bidding and Award: The "Square Corners" of Public Procurement." Boston: Gadsby & Hannah, April 1990.


________. "Big Dig solution has $260m price tag." Boston Globe, 11 December 1994, 41.


________. "Honk if you don’t believe this." Boston Globe, 23 November 1994, 17,22.

________. "Artery project official is replaced." Boston Globe, 22 November 1994, 19, 23.


Sennott, Charles M. "Auditor says miscalculations add $64m more to Artery costs." Boston Globe, 18 October 1994.


________. "Project Poses a Test for Privatization." Boston Globe, 12 September 1994, 1, 8-9.

116


Zuk, Peter, Project Director of the Central Artery/Tunnel Project. Lecture at M.I.T., 3 May 1994.