Submitted to:

City of Tempe

Project Number 6504221

Tempe Town Lake Downstream Dam Replacement
Alternatives Evaluation Report
Executive Summary

Submitted by:

Gannett Fleming

*Excellence Delivered **As Promised***

January 12, 2012

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Executive Summary

Background and Scope

Tempe Town Lake is a 220-acre urban lake located in Tempe, Arizona. The lake is formed by two Bridgestone inflatable rubber dams constructed across the Salt River bed at the upstream and downstream ends of the lake. The downstream dam consists of four rubber bladders anchored between the abutments and three reinforced concrete piers. The downstream bladders were replaced after a failure of one of the bladders in 2010. The replacement bladders were provided by Bridgestone under a five-year lease agreement to the City of Tempe. The replacement bladders are scheduled to be decommissioned at the end of the lease period (December 2015) per Schedule C of the lease agreement between the City and Bridgestone.

The City of Tempe has initiated this Project to select, design and construct the replacement of the Town Lake downstream dam, based on the viable technologies available, location, environmental and social considerations, and cost, including upfront cost as well as life cycle costs. Phase 1 of the Project includes validating the concept and selecting appropriate dam technology for the replacement.

The City assembled a Project team including City staff, its consulting engineer, Gannett Fleming, Inc., and the Arizona Department of Water Resources, the Flood Control District of Maricopa County, Salt River Project and the U.S. Army Corps of Engineers, with the goal to provide a safe, cost-effective and aesthetically pleasing replacement for the downstream dam rubber bladders.

Evaluation of Alternatives

The replacement dam selection process included a rigorous review of possible technologies and comparison of each technology to a defined set of criteria considered to be necessary for success of the Project. The City and members of the Project team met for an all day workshop to review a long list of dam replacement alternatives. In that workshop meeting, the team refined the Project criteria developed for previous studies to develop a final, categorized list of criteria against which to compare potential alternatives and then evaluated the alternatives relative to the criteria. Each individual Project criterion was categorized by the Project team as “must have” or “should have” based on its importance, with the “must have” criteria considered essential to the acceptable performance of the Project and the “should have” criteria considered important desired characteristics that every effort possible should be made to meet.

The Project team reviewed the project history, goals, objectives, and hydrologic and hydraulic modeling to establish context for the technical evaluations and to develop an understanding of the potential impacts of the various alternatives. A long list of nearly twenty potential alternative configurations was discussed and evaluated relative to the Project criteria. The long list included alternatives considered prior to the original design of the Town Lake dam, alternatives evaluated during an alternatives study performed in 2008 and additional alternatives proposed since the 2008 study. All project alternatives were discussed by the Project team to assess their ability to meet the criteria, based on preliminary hydraulic analyses and on other technical considerations associated with the structure.

When alternatives were determined not to meet the “must have” project criteria, they were considered fatally flawed and were not considered further. Because the hydraulic impact of an alternative is a

controlling and critical factor affecting the potential for the alternative to meet several of the "must have" project criteria related to flood control and upstream impacts, some of the alternatives were considered fatally flawed on the basis of the preliminary hydraulic analysis. Other potential alternatives were considered fatally flawed based on other technical or cost considerations. After further engineering analyses and consideration by the Project team and City staff at several meetings, three viable alternatives were identified for the replacement of Tempe Town Lake Dam.

Viable Alternatives

The following are viable Project alternatives for the replacement of the Town Lake downstream dam:

Hydraulically Operated Steel Hinged Gate
Inflatable Rubber Dam
Obermeyer Gate

Additional hydraulic and structural engineering analyses were performed on the viable alternatives. These analyses were used to develop a more detailed understanding of the requirements for designing and constructing each of the alternatives. The analyses indicated that in order to meet the "must have" project criteria related to flood capacity, flood passage and upstream impacts, the selected alternative must not increase the upstream water surface elevation during the design flood over the existing condition and therefore, must not cause any reduction in the existing spillway flow area. Construction considerations indicated that any alternative requiring modifications to the existing piers would have to be completed after removing the pedestrian bridge and draining the lake.

<u>Hydraulically Operated Steel Hinged Gate</u>

The hydraulically operated steel hinged gate can be constructed at the existing dam location, however, due to upstream flooding impacts it would require removal of the bridge during construction so that the existing piers could be reconstructed and additional piers could be added. This violates several of the "should have" project criteria, most notably, maintaining the lake during construction, maintaining the existing pier configuration and minimizing structural modifications as much as possible. The hydraulically operated steel hinged gate could also be constructed approximately 100 feet downstream from the existing dam and at this location could be constructed while the existing dam is left in place, therefore not requiring that the lake be drained. Constructing the gates downstream would require constructing a new foundation and new piers, widening the river channel approximately 20 feet on the north and south sides and relocating the South Bank Interceptor outfall. This approach meets all of the "must have" Project criteria. This configuration would also meet all of the "should have" Project criteria except maintaining the existing pier configuration and minimizing structural modifications.

<u>Inflatable Rubber Dam</u>

Replacing the existing rubber bladders with similar rubber bladders would meet the "must have" project criteria related to flood protection and upstream impacts. This alternative would require the fewest structural modifications and with this alternative there is a high probability that many of the existing operating systems could be reused with minimal changes, thus reducing the construction costs (but not the cost to procure the bladders).

Durability of rubber under the extreme temperature conditions in Tempe remains a major concern. Based on rubber dam installation records, there are no long-term rubber dam installations in desert environments from which to draw conclusions regarding their durability, except the recent experience in Tempe, which suggests a 10-year service life can be expected. Although mitigation measures are currently in place for the existing rubber bladders, including shading by the pedestrian bridge and spraying with water to reduce surface temperatures, whether these methods will be effective in increasing the service life of the rubber bladders is unknown.

The potential vandalism concern cannot be positively mitigated by the design. Rubber is inherently flammable and although different rubber formulations may have different flammability characteristics, no rubber product can be made to be inflammable. This issue is a particular concern for the Town Lake Dam because the rubber bladders will be readily accessible to the general public from the pedestrian bridge.

Obermeyer Gate

Obermeyer gates have been manufactured in Colorado for over 30 years and have been installed in hundreds of locations throughout the U.S. and the world. The Obermeyer gate system can be constructed to meet all of the Project "must have" and "should have" criteria. Obermeyer Hydro, Inc. has proposed a system intended to address the concerns regarding the reliability of the rubber bladders that includes an outer light-colored rubber layer and inflation with nitrogen. Extended material warranty options are available from Obermeyer and a downstream panel can be incorporated into the design to provide additional protection from the environmental conditions.

Capital Construction and Life Cycle Costs

Capital construction cost estimates and lifecycle cost estimates were developed for the hydraulically operated steel hinged gate (at the existing dam location and 100 feet downstream), the Obermeyer crest gate, and the Sumitomo rubber bladder. The hydraulically operated steel hinged gate constructed at the existing location and approximately 100 feet downstream were both priced out for comparison with the thought that if the hydraulically operated steel hinged gate can be constructed at a much lower cost at the current location then it might be worth draining the lake for construction. Since there were not significant cost savings associated with constructing the hinged gate at the current location that configuration was dropped from consideration.

The construction and lifecycle cost estimates for the three remaining alternatives are summarized in the table below.

- The highest capital and life cycle cost alternative would be the Sumitomo rubber bladder replacement, with capital costs of $41 million and life cycle costs of $138 million totaling roughly $180 million over a 50-year life.
- The capital costs of the downstream Obermeyer gate system would be $33 million and the life cycle costs would be $42 million, totaling $75 million over a 50-year life. The life cycle costs for the Obermeyer gate depend on assumptions made regarding the service life of the inflatable air bladders. If a 10-year service life is assumed, the life cycle costs are comparable to the life cycle costs for the hinged crest gate (approximately $68 vs. $75 million).
- The hydraulically operated hinged crest gate capital cost would be $35 million and the life cycle costs $33 million, totaling $68 million over a 50-year life.

Alternative	Total Project Construction Cost	Total 50-Year Life Cycle Costs (Present Value)	Total Construction and Life Cycle Cost (Present Value)
Hydraulically Operated Steel Hinged Gate	$35,400,000	$32,700,000	$68,100,000
Obermeyer Gates - 10 Year Rubber Life	$32,800,000	$41,600,000	$74,400,000
Sumitomo Rubber Bladders - 10 Year Rubber Life	$40,900,000	$138,300,000	$179,200,000

Recommended Alternative

Both the Obermeyer and hinged gate systems are feasible dam replacement alternatives that satisfy the operation and hydraulic capacity constraints at the existing dam site. Of these two, the Obermeyer gate system requires the least site modifications and has the potential to offer the lowest cost if the rubber bladders have a service life longer than approximately 10 years. Durability of rubber under the extreme temperature conditions in Tempe, however, remains a major concern. Although elements could be incorporated into the dam design to mitigate the potential reliability concerns related to rubber components, the effects cannot be conclusively quantified. Because safety and reliability are paramount concerns for the City of Tempe, and given the recent experience with failure of the rubber bladder, construction of a hinged gate at a location approximately 100 feet downstream from the existing dam is recommended. This dam replacement alternative provides a high degree of certainty with respect to reliability, durability and value and we believe it will provide the City with a successful long-term solution without negatively impacting Tempe Town Lake users.