How 'belvederes' and 'sentinels' helped make the bridge look the way it does

■ *Designers wanted to evoke feelings of lightness and transparency.*

By BRUCE MCKEAN
Helix Design Group


McKean

The overarching design themes for the entire state Route 520 corridor are land, air and water.

For the Floating Bridge and Landings Project, these themes find their expression as we trace the passage from the "land" at the west- and east-side approaches, "air" as the route transitions from high-rise to the low-rise floating bridge, and "water" as the bridge descends to the floating bridge component closest to the lake.

The intent of the bridge design is to harmonize with other corridor projects to create a unified corridor aesthetic along the path between Interstate 5 in Seattle and Interstate 405 in Bellevue.

As the focus of the corridor path, the bridge design must respond to many factors, including bridge users such as motorists, pedestrians, bicyclists and boaters, as well as the adjacent neighborhood and viewers outside of the corridor.

Helix Design Group was a member of Kiewit-General-Manson's design-build team and the architectural design consultant to KPFF Consulting Engineers for all aesthetic design aspects of the bridge.


Sentinels as tall as 115 feet serve as a gateways to the floating bridge.

Images courtesy of Helix Design Group

Gateways to the bridge

The bridge can be seen as a series of thin, horizontal bands signifying the water that is punctuated by the strong vertical elements of the sentinel as well as elements that mark the significant transition points, provide scale and create a rhythmic meter for travelers.

The sentinel elements are designed to respond to a variety of influences in the bridge design. The sentinels must reflect the overall horizontal scale of the bridge from a regional perspective, while also respecting the scale of the pedestrians and motorists on the bridge.

The sentinels form the "gateway" to and from the floating bridge and mark the termination of the floating portion and transition to the land structures. The shape and form of the sentinel element is an expression that captures the energy of the horizontal water and links it to the sky — the source of water — through a thin, lighted pylon celebrating the nature of the floating bridge.

The low-rise structure on the floating bridge was designed to emphasize the transparency and lightness of the water. However, because of the loads imposed by the transition span linking the bridge to the shore, the superstructure of the bridge at this

See **BELVEDERES** — *page*


Crews bolted together three pontoons to create a raft, allowing them to work on multiple bridge portions at once.

Photo courtesy of Kiewit

Building the bridge was an intricate undertaking

■ *KGM had to find creative ways to work around the site's tight spaces.*

By KIEWIT CORP. STAFF

Built in 1963, the first Evergreen Point Floating Bridge served as a critical connector for more than 70,000 vehicles moving across Lake Washington each day.

Spanning 7,578 feet, it represented the world's longest floating bridge, which after 50 years of wear and tear was destined for retirement. As such, the Washington State Department of Transportation enlisted the help of Kiewit/General/Manson (KGM), a joint venture, to build the new state Route 520 floating bridge.

An expanded structure

In many ways, the existing bridge helped influence the approach to construction and design. The old bridge was especially susceptible to closures on windy or stormy days when waves crashed over the edge and spilled onto the roadway. By raising the new bridge 20 feet above water, the roadway is now out of wave range, offering a more reliable transportation corridor.

The SR 520 floating bridge has also been expanded from two to three lanes in each direction, including a high-occupancy vehicle lane, and a separated bicycle and pedestrian path to accommodate the growing demand for alternative transportation options.

Designed and built for a 75-year

See **INTRICATE** — *page*


Belvederes offer cyclists and pedestrians places to stop and admire the views. Windscreens shield visitors from highway noise and wind.

Owner
Washington State Department of Transportation

Design-build contractor
Kiewit/General/Manson, A Joint Venture

Opening
Westbound lanes opened on April 11; eastbound lanes open on April 25

Cost

Design-build contract
$586.6 million

SR 520 Bridge Replacement and HOV Program
$4.56 billion

By the numbers

58: Pontoon anchors
77: Pontoons supporting the bridge
300: Miles of electrical wires inside the pontoons
1,300: People working on SR 520 at the peak of construction
1,600: Weight, in African bull elephants, of each of 21 biggest pontoons
2012: Year bridge construction began
2,624: 16- to 20-foot bolts holding the pontoons together
7,708: Bridge length, in feet
70,000: Tons of ballast rock on the pontoons

Source: Washington State Department of Transportation

How much do you know about the new 520 bridge?

■ *WSDOT answers 11 of your most-asked questions.*

By STEVE PEER
Washington State Department of Transportation

The new floating bridge rests atop 77 concrete pontoons, the largest of which weigh 22 million pounds. Images courtesy of WSDOT

Fifty thousand people walked, ran or biked across the new state Route 520 floating bridge earlier this month during the span's grand opening celebration.

Peer

The event gave the public the chance to experience the bridge, by foot power and pedal power, before it opened to vehicles on April 11. The celebration also allowed visitors to learn something about the science, technology, engineering and math behind construction of the world's longest floating bridge.

A lot of questions were asked, and answered, during the bridge festivities. Here are some of the most frequent questions about the new World's Longest Floating Bridge.

Why do we have *floating* bridges on Lake Washington?

Geology and topography are the main reasons Lake Washington doesn't have suspension bridges a la the Tacoma Narrows or Golden Gate bridges.

Lake Washington is deep, with depths exceeding 200 feet. What's more, beneath the lake's floor lie thick layers — another 200 feet or so — of soft silt and mousse-like glacial sediment called diatomaceous soil. Because of the lake's deep waters and gooey bottom, the foundations for a fixed bridge's support towers would have to be extremely deep to reach dense soils.

What keeps a floating bridge afloat?

A floating bridge is held above the surface by pontoons — basically large, watertight concrete boxes. For the SR 520 floating bridge, resting atop its 77 pontoons are 772 concrete columns, 331 concrete girders, and 776 precast roadway deck sections.

Each of the bridge's 21 biggest pontoons is longer than a football field, as tall as a three-story building, and as heavy as 1,600 African bull elephants (about 22 million pounds). They are the heaviest, widest, deepest and longest floating-bridge pontoons ever built.

The pontoons' many individual cells have electronic sensors for detecting a leak and sending an alarm to WSDOT offices in Medina and Shoreline.

Where were the pontoons constructed?

WSDOT contractors built all of the bridge's jumbo pontoons along Grays Harbor in Aberdeen. Most of the smaller, "supplemental stability" pontoons, which provide added buoyancy and stability, were built along Commencement Bay in Tacoma.

What keeps a floating bridge from floating away?

The new SR 520 bridge is, in a sense, a 1.5-mile-long concrete boat. Left unsecured, it could indeed float away.

Part of what keeps the bridge in place is hinged connections, at the east and west ends, to fixed bridges — the land-linking "approach" bridges. The floating bridge's primary fasteners, though, are 58 huge, concrete anchors. The largest ones weigh nearly 600 tons when filled with ballast rock.

Steel cables, more than 3 inches thick and up to 1,000 feet long, cinch the bridge's pontoons to the anchors.

Are earthquakes a threat to the floating bridge?

Not really. Earthquakes pose more of a risk to fixed bridges with support piers embedded in the ground.

High winds and strong waves are the biggest threat to floating bridges. Wind-fueled waves can cause bridge pontoons to bend, heave and twist. The movement creates stress in the pontoons and their anchor system.

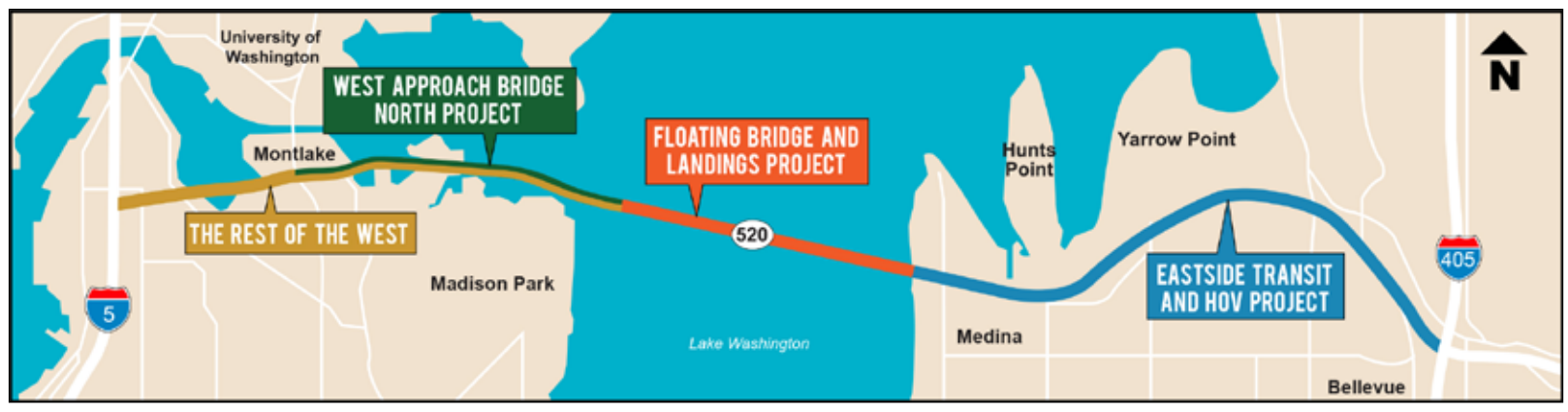
Past storms sheared off components on the old SR 520 floating bridge and caused pontoon cracks and leaks that required significant maintenance and retrofits.

Is the new floating bridge stronger than the old one?

Yes, its design and construction, with bigger and stronger pontoons, heavier anchors and thicker anchor cables, combine to make it more resistant to storms.

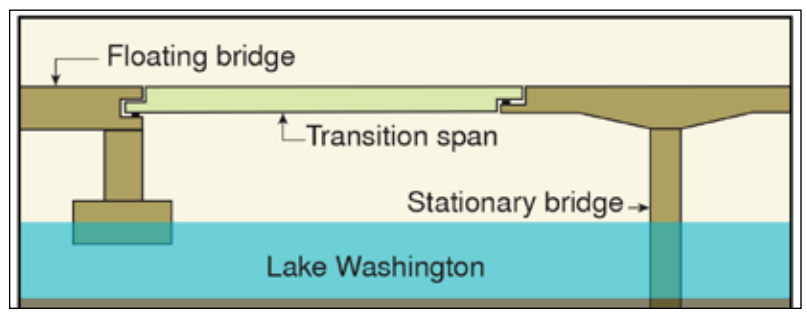
The new bridge is built to withstand winds up to 89 mph — a once-in-a-century storm. In contrast, the old bridge was built to handle 59-mph winds, and frequently had to be closed when

See QUESTIONS — *page*



The 520 work is unfolding over several phases. The Eastside Transit and HOV Project finished last year. The West Approach Bridge North Project is underway and slated to finish in mid-2017. The "Rest of the West" could begin in 2018.

Contractors built all the bridge's jumbo pontoons in Aberdeen, then hauled them to Lake Washington.



Transition spans connect the floating bridge to fixed bridges in Seattle and Medina.

WSDOT 'nerve center' keeps watch over the bridge

■ *The four-story maintenance building is tucked into a steep Medina hillside, where it keeps a low profile amid its residential neighbors.*

The office level has a full-width view of the bridge so staff can always keep tabs on the structure.
Image courtesy of Helix Design Group

By LOWELL CATE
Helix Design Group

The state Route 520 Floating Bridge Maintenance Facility is a 19,600-square-foot, four-story building designed to support the maintenance needs of the new floating bridge across Lake Washington. Because of its location, tucked under the east side bridge span, and unique requirements, the project resulted in an unusual and interesting facility design.

The building's primary role is to serve as the nerve center of the bridge, which includes communications, maintenance and emergency response functions. The facility staff maintain the floating pontoons that form the bridge's structural base. All sensors come into the reporting system inside the maintenance facility, which relays this data to multiple monitoring locations for the Washington State Department of Transportation.

Blending in

One of the challenges of this project was the site. Located directly below the bridge on the east shoreline, it is embedded in a very steep hillside with a vertical distance of 45 feet between the shop level and the parking/entrance level.

Vehicle access is provided from Evergreen Point Road by a steep driveway leading to an enclosed parking lot below the bridge. Vehicle access to the water is not possible at this location, so all materials, equipment and personnel for bridge maintenance must come down through the four-story building via high-speed freight and passenger elevators.

The placement of the elevator was carefully designed to reduce the time required for emergency responses. Minutes matter tremendously in an emergency situation, so the design and function of this elevator was a crucial part of the project. The freight elevator has a capacity of 14,000 pounds and stops at the storage mezzanine and covered shop yard for direct access to both the shop and dock at all times.

The appearance of the facility was also an important factor in the project design. The site is located in a residential area of the city of Medina, so it was important to consider the impact to the neighbors and local community.

The design intention was to blend the building in with the hillside and make a connection with the local community. Materials were selected, and building detailing was designed, to give the building residential cues when viewed from the water, rather than a maintenance facility or utility component of the bridge structure.

Natural colors were chosen to help tie the building in with the colors of the hillside and surrounding landscape. The access drive to the facility includes 30-foot-high concrete walls designed as a natural earth embankment, which was achieved through concrete sculpting and staining techniques.

What's inside

The concept of an enclosed building was a key component to the design and appearance of this facility to ensure that no clutter would be visible on the property from the lake or neighbors. It also helps to minimize noise and light impacts to the neighbors, and protects staff from inclement weather.

Although the exterior is designed to appear more residential, the interior features strong, durable materials designed for longevity and low maintenance, including heavy-duty epoxy flooring.

The administrative level of the building has a full-width, frontal view of the bridge, which is designed to guarantee that staff can visually monitor the bridge from any location on this level. The windows include bullet-resistant glazing for staff safety, and to allow the windows to remain operational under all circumstances. The building is isolated from seismic events by a large retaining wall, which creates a 5-foot gap around the building and has an emergency generator backup in case of power outage.

See **NERVE CENTER** — *page*

The floating bridge opening has been a long time coming

■ *A firm looks back over almost two decades of consulting work, and looks ahead to what's still left to do.*

By JEFF PEACOCK and CAMERON TELLER
Parametrix

Nearly 20 years! That is how long the State Route 520 project has been significant to Parametrix.

Peacock

Teller

Our roles have been diverse and evolving, but through several contracts, beginning with the original Trans-Lake Washington Study, Parametrix has been instrumental in the development of the SR 520 Bridge Replacement and HOV Program.

In 1998, the Washington State Department of Transportation chose Parametrix to lead the legislatively mandated study of the long-range mobility and environmental issues involved in travel across and around Lake Washington. For the next few years, we helped the state analyze a wide variety of options for crossing Lake Washington, including new bridge crossings, expanding existing bridge facilities, and major improvements around the north end of the lake.

More than 100 alternatives were considered and analyzed, resulting in four build options and a no-build option to be studied further through the environmental process. Alternatives involved transit and non-motorized facilities improvements, as the state was committed to making significant improvements to reconnect communities that might have been disrupted in the past.

This initial Trans-Lake Study helped decision-makers representing 47 different entity stakeholders envision how the Evergreen Point Floating Bridge, and movement throughout the Seattle metropolitan area, could be enhanced.

Wide-ranging work

In 2003, WSDOT tasked Parametrix with providing program management services to advance the strategic planning of the SR 520 Bridge Replacement and HOV Program.

Over the next several years, Parametrix continued as the lead firm in a partnership with several other firms to complete the preliminary engineering and environmental impact statement for the program of improvements on SR 520 between Redmond and Interstate 5. Preliminary engineering included extensive work associated with the addition of HOV lanes and significantly wider shoulders in the corridor, as well as conceptual design for lids over the highway on the east and west sides of the lake, and associated bridges across Portage Bay and the Montlake Cut.

As the lead environmental consultant, Parametrix also led the preparation of environmental documentation and permit applications, coordinating with WSDOT's contractors, tribes, and local, state and federal agencies. This included the 2006 EIS for the overall project and preparation of EISs for the pontoon construction and I-5-to-Medina projects (completed in 2011 and 2012, respectively), and the environmental assessment for the Medina-to-SR 202 Eastside Transit and HOV project (completed in 2010).

Parametrix was also a partner with HDR on the general engineer consultant contract for the SR 520 Program's design elements. Under that contract, Parametrix has provided support services and expertise in a wide variety of disciplines, such as urban planning, landscape architecture, wetland ecology, construction management, and structural, transportation and civil engineering.

We also provided survey services to Kiewit Infrastructure West for casting the concrete pontoons that make up the new floating bridge structure.

One challenge has been to marshal the many disciplines needed for the team to smoothly execute changes in the program. An example is the change of the Pontoon Construction project delivery from design-bid-build to design-build in the midst of preparing the project's EIS. We were able to simultaneously dovetail the National Environmental Policy Act (NEPA) process with the design-build delivery method — the first Federal Highway Administration-led project in the U.S. ever to do so.

We have worked with WSDOT and stakeholders from the beginning to listen to their needs and negotiate solutions to meet those needs.

What's ahead

Today, Parametrix continues to play several integral roles in realizing WSDOT's SR 520 goals, as the program advances to designing and constructing the remaining segments, from I-5 to the Portage Bay Bridge and the Montlake Interchange.

Completion of the entire corridor is still years away, but it was exciting to be a part of the recent milestone celebrating the grand opening of the floating bridge across the lake. We look forward to continuing to provide creative solutions, potentially a 10th and Delmar lid, a second bascule bridge over the Montlake Cut, and other features that will continue to reshape motorized and non-motorized travel across this critically-important area rich with history, natural resources, and community participation.

Jeff Peacock is the president and CEO of Parametrix. Cameron Teller is project planning and controls manager at Parametrix.