

Engineering underwater worlds

■ From leak tests to rebar placement and life support for the aquatic animals within, structural engineers must design aquariums with precision and creativity.

By **MICHAEL LEONARD**
MLA Engineering

Underwater worlds — oceans, seas, lakes and rivers — contain mysteries that exceed our imagination and fuel our human curiosity to explore. Except at aquariums, this spectacle of life is inaccessible to most of the public. Made from enormous concrete vessels, often holding millions of gallons of water, aquariums provide habitats for aquatic creatures and plants from which visitors are separated only by a vast acrylic window. While inspiring awe for the scene within, this experience also grants us a moment to pause and consider the incredible feats of engineering that make the encounter possible on both sides.



Leonard

versatile choice. Concrete can be configured on site to match the organic curves of natural habitats, unlike steel or plastic which would require off-site prefabrication and then could be too large to transport or would require costly bonding in place.

WATERPROOFING TECHNOLOGY AND TESTING

The next question is how a porous material like concrete can be made watertight — ensuring the livelihood of the exhibit's occupants, as well as the durability of the structure and safety of the guests and staff. Instead of simply lining containment pools with a fiberglass reinforced polymer (RFP), designing concrete to be leakproof right from the start means lessening the repairs over time that would disrupt the aquarium's function and involve the costly removal of animals and theming elements within the exhibit.

There is no aquarium design book; however, structural engineers follow the standard ACI Code-350 for environmental engineering of concrete structures, such as water treatment facilities and reservoirs, and then significantly expand upon the basics to accommodate the aquarium-specific detailing required for the acrylic windows. All non-pre-stressed concrete develops cracks throughout its life — even concrete used to contain millions of gallons of water — as the cracking mechanism transfers the internal tension stresses from the concrete into the rebar. What makes the concrete for aquariums distinct is being designed to prevent leaks by keeping the cracks microscopic in width.

Engineers accomplish this in

CONCRETE IS THE KEY

Large aquarium exhibits present many unique, highly specific design challenges that distinguish them from other industrial-scale projects. This is an opportunity for structural engineers to put a new spin on traditional materials and reveal a story about the versatility of concrete. Developed with meticulous innovation, often through nuance, concrete can become a water-tight vessel under relatively high pressures, able to remain strong and durable throughout its design life.

Before delving into more detail, the obvious first question is why concrete is the preferred structural material for aquariums. Regardless of the design's size, shape, and budget, the free-form character of concrete makes it a

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The finished tunnel at the New York Aquarium's Ocean Wonders: Sharks! exhibit welcomes guest into the immersive exhibit space where sea life can be viewed from many perspectives. Photo courtesy of MLA Engineering



A reinforced concrete walkway and walls provide structural support for the half-cylinder acrylic window at the New York Aquarium's Ocean Wonders: Sharks! exhibit. Photo courtesy of MLA Engineering

Seattle's Woodland Park Zoo debuts Forest Trailhead, catalyzing conservation and community

■ Forest Trailhead's immersive exhibit highlights forest ecosystems and the animals and plants that call them home, encouraging each visitor to assemble their own story of the world's forests — and find their personal place within it.

By **SCOTT CRAWFORD and JENNIFER DUHAMEL**
LMN Architects

The first major new exhibit to be constructed at Seattle's Woodland Park Zoo in nearly a decade, Forest Trailhead establishes a new center of gravity at the zoo — one bringing conservation awareness to the forefront. As the final capital anchor of the zoo's Forests for All campaign, an ambitious seven-year, \$110 million comprehensive fundraising effort to rally communities together to reimagine what a zoo can be and save the world's forests, Forest Trailhead brings the global movement to Seattle with immer-



Crawford

sive exhibits highlighting forest ecosystems and the animals and plants that call them home. With connection as its watchword, the new pavilion and 1-acre forested grounds signal the future of zoo experiences, where visitors are given agency to find their own paths, uncovering the inherent interconnectedness of the world's forests.



Duhamel

SHIFTING PERSPECTIVES

Situated adjacent to the zoo's main entrance at the West Plaza, Forest Trailhead is an immersive forest exhibit highlighting the wildlife of the world's forests alongside conservation efforts by the zoo and its partners to pre-



Unlike typical zoo exhibits, there is no single, linear pathway to Forest Trailhead. Visitors are offered multiple access points to the building and the surrounding habitats. Renderings by LMN Architects

serve those habitats. The exhibits are designed to present a hopeful perspective on the future of the world's forests by immersing visitors in the wildlife and plant habitats of these ecosystems, with interpretive exhibits spotlighting communities leading conservation efforts.

Global in its scope, the building's exhibits include habitats for tree kangaroos and red pandas—key animal populations for which the zoo supports conservation efforts, including a quarter century's investment in Papua New Guinea and emerging efforts in Nepal. With the success of this conservation work being its interconnected nature across scales, the design of Forest Trailhead sets up an experience where zoo visitors can see both the animals and their forested habitats from multiple shifting perspectives.

Beginning on an elevated Canopy Path winding through the trees, visitors experience the forest canopy from the perspective of the tree kangaroos and red pandas. Inside, the pavilion's upper level has additional viewing spaces for those animals, with a fully accessible path leading down to the mid-level housing another forest creature: kea parrots. The lower level includes tree-dwelling reptiles, colorful amphibians, fish, and invertebrates in mixed-species groups. Here, paths leading back out to the forest through the landscape highlight the critical role of the forest floor in the health of the ecosystem.

AN ACCESSIBLE PATH

Just as the zoo's conservation



Multiple indoor and outdoor viewing spaces allow visitors to experience the forest canopy from the perspective of tree kangaroos and red pandas, key animal populations for which the zoo supports conservation efforts.

mission functions globally across scales, Forest Trailhead was designed to encourage visitors to engage with the forest habitat on multiple levels. Unlike typical zoo exhibits, there is no single, linear pathway and instead, visitors are offered multiple access points to the building and the surrounding habitats. Weaving in and out of the pavilion, through the tree canopy and forest floor, visitors come to understand the interconnectedness of animals with their habitats, and humans with our environments. Similarly, instead of proposing one overarching biome narrative, the exhibits incorporate multiple points of view from different global per-

spectives. In experiencing Forest Trailhead, visitors are invited to assemble their own story of the world's forests and find their personal place within it. This can be seen in its unique, fully accessible visitor path. Although the building has three levels inside with an upper Canopy Path and lower Forest Floor walkway outside, there are no elevators or stairs in the building. Instead, the accessible path unfolds inside via a series of gradually sloped walkways. Outside, the weathering steel of the Canopy Path will patina over time, blending into the trees. Much like the experience of arboreal animals

that climb and fly through the forest, the building itself creates an experience of changing viewpoints.

A SUSTAINABLE BUILDING

Building on the zoo's conservation mission, the building is designed with environmental consciousness at the forefront. Inspired by organic shapes found in nature, the pavilion takes a fluid and dynamic form evoking naturally occurring fractal patterns. The pavilion's dark exterior cladding is made from

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Celebrating 25 years in Seattle: 1999-2024



At the Toledo Zoo Aquarium, EHDD created a transformed visitor experience within a beloved, historic building shell. Photo by Bruce Damonte



The Tropical Shallows hands-on experience welcomes guests to the aquarium. Photos courtesy of Point Defiance Zoo & Aquarium

Designing the aquarium of tomorrow: lessons from four unique projects

By elevating the unique culture and context of each project, architects can build curiosity, connection, and a passion for conservation into their designs.

By LYNNE RIESELNMAN
EHDD

It came earlier than I anticipated — a phenomenon I suspect is felt by architects around the world who step both feet into a specialized building type. You visit the precedents, and you start to see the patterns. The “best practices” and “must haves” of the past become overbearing trends. Every time you visit that type of project and see the same design ideas repeated, you feel a building sense of urgency to do something different. For me, as I worked on aquarium projects, it was two things. One was the tension between these institutions that champion environmental stewardship, while most of the facilities use more energy than any other building type. The other was the relentlessness of the black box experience.



Riesselman

Today’s institutions feel it, too. They ask, “What is the future of aquarium design?” I would suggest that the answer is twofold: getting serious about climate change and leaning into the unique aspects of institutional culture and context. Comparing four of EHDD’s recent aquarium projects shows how leveraging the unique culture and context of each project allows it to self-differentiate and break away from the tired black box formula.

THE TOLEDO ZOO AQUARIUM IMPROVEMENT PROJECT

The first aquarium I worked on was a renovation of an existing facility in Toledo, Ohio, embedded in their local zoo. As we wrapped our arms around the project’s ambitions, exploring building sites alongside the Maumee River, we learned that while the exhibit itself was an outdated, repetitive row of small blue boxes, literally falling to pieces after years of unmitigated corrosion, the building itself was a beloved heirloom to the local community. It quickly became clear that this was the key to the project. Revitalizing the existing building offered benefits across a triple bottom line: it would help us shift the slim \$20 million budget from construction sitework to creating more dynamic exhibits; it would reduce the project’s embodied carbon; and it would send a clear message of reinvestment in the community and the heart of the Works Progress Administration-era zoo campus.

While the shell had become sacred, the interior was anything but. We looked to create a completely transformed visitor path, restoring the long-abandoned central entry, quadrupling the volume of the exhibits, creating larger tanks that offered multiple viewing experiences, and introducing variety and hands-on experiences. Delivering this level of visitor experience within a defined envelope was like working on a Swiss watch, but



The Point Defiance Zoo set ambitious sustainability goals for the Pacific Seas Aquarium, pushing the design team to reimagine one of the most energy-intensive building types. Photo by Ed Sozinho

our space constraints allowed us to explore a low-energy drum filtration technology, due to the reduced footprint it required.

PACIFIC SEAS AQUARIUM

At our next aquarium project, we built on the low-energy technology we beta-tested in Toledo. Tacoma’s Point Defiance Zoo wanted to set a new bar for sustainability in aquarium design. This group’s commitment to conservation was unparalleled, and they wanted to walk the walk as we approached the design of their new Pacific Seas Aquarium.

Achieving these significant ambitions meant leaning in to the vertical nature of our steeply sloped site. Our design arranged the water treatment systems to take advantage of gravity, instead of expending energy by pumping multiple times. Beyond this, we used every tool in the book — onsite rainwater capture and re-use, a mass-timber structural system to reduce embodied carbon, and of course, all-electric systems — to deliver the most sustainable aquarium in the country. The project uses digital person-

alized engagement at the start and finish of the experience to compel visitors to make individual commitments to actions that help them support ocean health. To emotionally anchor these commitments, and to help visitors register the mostly regional aquatic collection as part of their local environment, we interlaced the visitor path with views to the pine-fringed hillside.

SEATTLE AQUARIUM CONCEPT DESIGN

Leveraging the immediate context to flavor the visitor experience played heavily in the campus plan and concept design work we completed for the Seattle Aquarium in 2016. Looking out toward the Olympic range, the Seattle Aquarium has perhaps the most spectacular waterfront view of any existing aquarium. But despite the beauty of its waterfront location, the building is sited in a deeply urban context. Still, we saw this as an opportunity to tell an enhanced story of

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Needed structural updates to the aging exhibit gave designers a chance to revitalize the exhibit with new coral reefs, tropical vegetation and mangroves for an integrated design that better mirrors the tropical reef ecosystem.

By GEOFF E. ANDERSON
Schemata Workshop

The Tropical Reef Aquarium at the Point Defiance Zoo and Aquarium reopened to the public in June 2024 following 2-1/2 years of restorations and repairs. The \$7.09 million renovation project, which included structural and system repairs to the Outer Reef shark tank, provided the opportunity for new exhibit features and an enhanced visitor experience.

The original 15,000-square-foot aquarium exhibit, previously known as the South Pacific Aquarium, was built in 1989. For the restoration project, MLA Engineering performed a structural evaluation and defined the scope of repairs needed for the concrete tank. Schemata Workshop led the design and engineering efforts, which included essential roof repairs, preparation of concrete cracks and spalling, and improved walkways and interior spaces used by aquarists to feed and care for sharks and other animals. Other upgrades included a new heat pump, ventilator, industrial dehumidifier, electrical updates and improvements to life support systems for the animals. The project updates allowed the



Anderson



Beyond the reef, visitors encounter the Outer Reef shark viewing area.

opportunity to refresh the aged exhibit elements, including new coral reefs, rockery and plants.

The original design concept for the aquarium remains core to the visitor experience, guiding visitors from a tropical beach, through the coral reefs and beyond to the deep ocean. “When our guests step inside, they will be transported to a colorful, tropical coral reef environment, complete with a beach, lagoon and outer reef habitats,” said Alan Varsik, director of Point Defiance Zoo & Aquarium, a facility of Metro Parks Tacoma.

The revitalized Tropical Shallows habitat, with a hands-on, up-close marine animal experience in the shallow waters exhibit, is now surrounded by new artificial mangrove trees to simulate a silty mud bank. Guests are encouraged to touch invertebrates like tropical sea stars, crabs, urchins, snails and shrimp. The space is now brightened by a new overhead translucent skylight and custom artwork.

Continuing through the aquarium, guests step down into the edges of a coral reef and come

Project Team

- Owner:**
Point Defiance Zoo & Aquarium
- Architect:**
Schemata Workshop
- Structural Engineer:**
MLA Engineering
- Materials Testing:**
WJE
- Exhibit Design:**
MIG
- Life Support Systems (LSS):**
TJP
- Mechanical, Electrical, Plumbing:**
PAE
- Cost Estimating:**
RC Cost Group

eye-to-eye with colorful fish and corals at the Lagoon tank. Further on, guests experience the Blue Hole, representing the deep caverns of a reef with all-new vibrant coral and rockery. The portal view through this tank offers a glimpse of what is to

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Worlds

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several ways, such as by adding more closely spaced rebar, perhaps fifty percent more than for comparable loads that do not involve water. Engineers also tightly control heat gain during cement hydration by substituting cement with pozzolans (fly ash or ground granulated blast furnace slag), using water-reducing admixtures, and specifying wet-curing methods that reduce the rate of water evaporation immediately after pouring — the time when the concrete is gaining significant strength. The key is to maintain the proper balance between all the variables, avoid causing an unwanted reaction between incompatible ingredients, and provide consistent results that allow placing the concrete with excellent consolidation.

Further distinguishing aquarium projects is the repair and testing phase built into their construction schedules. Water proactively finds a vulnerable path, so any defects typically present themselves. Ensuring that a leak test of the pools is conducted at the critical point in the schedule provides the ability to repair any leaks before costly theming is installed and gives the construction team the best chance of meeting the higher performance levels required.

LOCATION, LOCATION, LOCATION

Large aquariums regularly take specialized designers and engineering consultants far from home, across the country, and anywhere in the world where

such projects are constructed. Accordingly, knowing the availability of materials and differences in construction practices nationally and internationally is integral to the work. For example, understanding variations in the availability of local aggregates used in the concrete is critical, as their density, strength, and porosity affect the potential for leakage in the finished vessel. Researching the availability of local materials allows the engineer to specify products that local batch plants can readily procure and, thereby, promote a cost-effective mix design with the durability and water-tightness required for water-holding concrete vessels.

MANAGING DESIGN LOADS

Another critical factor in aquarium construction is that the maximum design load, except for seismic conditions, is there all the time. Unlike most buildings, designed for a transient live load, aquarium water is exerting design-level forces continuously from all directions.

When an aquarium requires large acrylic windows and acrylic tunnels for viewing exhibits, the vessel design must consider the transfer of large forces at the points where the acrylic panels bear against the concrete framing. This is where the structure is most vulnerable to leakage and where the detailing of rebar and placement of the concrete must provide a crack-resistant, well-consolidated, and watertight system.

The windows and tunnels are held in place largely by the pressure of the water itself, although waterproofing sealants can help secure this glazing. Temporary interior clamps are often used to hold the window and tunnel acrylic sections when filling or draining the exhibits. Also, engineers must design for potential buoyancy and uplift forces that can occur when a tunnel cross section has an arc exceeding 180 degrees and is surrounded by water exerting pressure in multiple directions.

TEAM APPROACH TO WATER QUALITY

When discussing aquarium construction, the force of millions of gallons of water easily becomes the focus, but containment pools are only part of the equation. Installing the pipes that carry the water relies on a carefully orchestrated team effort. The tanks must be refreshed continually with clear water filtered to remove contaminants that would harm the animals. While similar to the large conveyance requirements of water treatment facilities, the life support systems (LSS) for aquariums are additionally challenged by needing to coordinate with the large viewing panels, skimmers, and pool foundations. In other words, the pipes must be positioned not only to integrate seamlessly with the structure’s watertight reinforced concrete walls and foundation, but also with the visitor experience.

Structural engineers can be instrumental in helping assign priorities to these competing factors. The large diameter pipes are expensive, so their configuration — balanced with the flow of guests and location of the LSS pumps, basins and degas towers — is critical to the budget. Working closely with the other disciplines, engineers look for innovative ways to increase the proximity of the pipes to the containment pools and filtration room. Combining everyone’s knowledge and experience leads to the best-informed choices and cost-effective solutions.

CONSTRUCTION SEQUENCING

Routing the LSS pipes also involves pressure testing for leaks — an essential project component built into the schedule with a focus on conserving time and protecting the budget. The underground piping beneath the main exhibit tank goes in first, with pipe corridors carefully located to reduce the effects that the LSS pipe construction and related earthwork have on the project’s critical construction path. Adhering to a well-planned sequence of events and anticipating scheduling issues reduces the construction timeline, which also results in overall cost savings.

LOOKING FORWARD

Water containment technology has long been in existence for water treatment facilities and reservoirs, but developing its use

for aquariums has introduced innovations to better serve the wellbeing of aquatic animals. Understanding that these projects are not just business-as-usual opens new possibilities for engineers to improve the performance of environments specialized to support animal welfare and public awareness of underwater worlds. Every new project is a chance to build on prior experience and keep improving outcomes for clients, visitors and inhabitants. The following examples offer insights into recent aquariums benefiting from ongoing research and development.

SeaWorld Abu Dhabi exemplifies the integration of concrete aquarium pools into the framework of a complex building configuration. Containing 25 million liters of water, it is the world’s largest and most expansive marine-life aquarium, housing more than 68,000 animals, including sharks, schools of fish, manta rays and sea turtles.

The focal point for visitors is the “Endless Vista,” a 20-meter-tall vertical window across multiple levels that reveals stunning aquatic scenes. As part of a global effort, the strategic structural design involved careful analysis and coordination with the LSS team. The solution accommodates the facility’s vast scale by employing the multi-level aquarium’s reinforced concrete walls both as the primary liquid containing structural system and the lateral force resisting system. Additionally, as part of the lateral system, the pool walls are designed to remain water-tight

under all but the most severe seismic motion estimated at the site.

The New York Aquarium’s Ocean Wonders: Sharks! exhibit is a three-story cast-in-place concrete structure designed to reflect the Eastern Seaboard’s natural environment. Eleven salt-water tanks reveal the mysteries of sea life right next to New York City with a variety of experiences, including a coral reef tunnel and expansive shark tank with overhead viewing through a shipwreck. Framing consists of mild steel reinforced concrete slabs and beams, concrete shear walls and a mat foundation. The lowest building level is partially submerged.

Unique design challenges included buoyancy design for high groundwater as well as 100-year flooding; hurricane level wind forces; heavy saltwater tank and life support system loads; and potential for liquefaction of the native, sandy soils. Using the exhibit pool walls to support the back-of-house mezzanine level keeps the guest area free of columns and allows for expansive, dramatic and uninterrupted views into the main shark exhibit.

Michael Leonard is the principal and owner of MLA Engineering, with more than 40 years of experience providing engineering for regional, national and international projects.

Trailhead

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Richlite, a sustainable material locally made from recycled FSC-certified (Forest Stewardship Council) paper composite, helping the building recede into the forested landscape. Circular skylights create dappled light over the interior plaza reminiscent of sunlight filtering through leaves.

The building is constructed from mass plywood, a veneer-based mass timber product supplied by local Oregon company Freres Wood. Made from trees sustainably sourced from regional forests, this innovative wood

product generates minimal production waste. With the mass plywood structure visible inside, the building showcases the warmth and beauty of wood alongside sustainable forest management practices. Targeting LEED Gold, the building also includes a photovoltaic roof array and manages water via an onsite stormwater management system.

As Woodland Park Zoo marks its historic 125th anniversary in 2024, Forest Trailhead initiates the next chapter of the zoo’s story with interactive and accessible experiences putting con-

servation awareness at the forefront. Ultimately, Forest Trailhead invites visitors to embark on a journey of discovery and stewardship in the world’s forests, starting in their own Pacific Northwest backyard.

Scott Crawford is a partner at LMN Architects with a focus on computational design tools and a passion for civic projects. Jennifer DuHamel is a principal at LMN Architects with 16 years of experience across a range of project types.

Designing

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conservation.

Embracing the urban site, we located the new Ocean Pavilion across the promenade where it would be anchored to the fabric of the waterfront revitalization. This single move yielded opportunities to create visual connections that highlight the urban/natural interface, showing how humans have impacted all aspects of the environment. From a civic perspective, the building becomes a focal point — the jewel sitting at the nexus of the waterfront promenade. It offers many opportunities for generosity to the public — spectacular views from the accessible roof deck, a graceful pedestrian descent from Pike Place Market down to the waterfront, and interpretive opportunities outside the paywall. We’re excited

to see that many of these ideas have survived in the design as executed by LMN Architects, and look forward to visiting when it opens this fall.

SOBELA OCEAN AQUARIUM

Our most recent aquarium was a very different animal than the Pacific Northwest projects. The Sobela Ocean Aquarium, located on the campus of the Kansas City Zoo, is a 72,000-square-foot, ground-up facility that features 650,000 gallons of water and a broad survey of marine life from sand tigers to nudibranchs. Our charge here was to deliver “wow” — to create an indoor, all-season experience that would draw visitors to the zoo campus all year long.

Deep in the heart of the Mid-

west, we quickly realized that visitors here come from a different starting point. Many will never visit the ocean, and few will be tuned into the critical role it plays in our climate. This facility was a unique chance to build in them a passion for and connection to the ocean.

To do so, we orchestrated the visitor path to evoke the experience of the ocean, leveraging sensory cues such as light quality, temperature, spatial volume, and sound to foster the emotional bonds built when having the experience in real life. It’s an experience that unfolds to meet you at a human scale, and surprises you with a dynamic, pulsing wave tank, the moment you enter. Overlaid as an interpretive framework: the storyline of ocean currents as the superhigh-

way that interconnects all ecosys-

tems. This storyline ties together a disparate animal collection and is a backbone to showcase the ocean as the key player in the health of our environment.

Every project has its challenges. For the Sobela Ocean Aquarium, it was the COVID-19 pandemic. Our client group had given us the freedom to make the project as sustainable as possible, so long as the measures fit within the budget. As admitted climate warriors, we took this charge, seeking every opportunity to stretch the project performance past our LEED Silver baseline.

Then the wild inflation of 2021 hit. Wood prices were up. Electrical switch gear was up. PVC piping doubled in cost over a month. To keep within arm’s reach of our \$61 million construction bud-

get, we had to make some hard decisions. Among these was the return to gas boilers — a hard pill to swallow. In the year since this project opened, I’ve made my peace with it. Our team worked hard to make all-electrical systems cost competitive, and by stretching toward this goal, we delivered a project that really tightened up its energy usage.

The truth is, the electrical grid in Kansas City is still fully reliant on fossil fuels; I take solace in the idea that, as it improves, the project we’ve delivered will easily adapt to an all-electric future.

EHDD has been designing aquariums for 40 years. Our journey, starting with Monterey Bay Aquarium, has been characterized by a willingness to challenge the status quo, a tendency to embrace unique cultural and

with no abrupt edges. This new, integrated design better mirrors an open ocean experience and increases the comfort factor for both sharks and humans.

Another exhibit featuring live coral is set to open Spring 2025. The aquarium has been raising live coral for several years but hasn’t had a place to display them for guests. A significant renovation, cutting through a 10-inch concrete wall and expanding the aquarium by enclosing an outer deck area, will provide space for this purpose. This new exhibit will include a wall with three new tanks and interactive monitors.

“Restoring this well-loved aquarium also provides an opportunity to connect the stories of these aquatic animals and their wild homes with our community for years to come,” Varsik said.

Point Defiance Zoo & Aquarium is the Northwest’s only combined zoo and aquarium. In addition to the Tropical Reef Aquarium, there is a Pacific Seas Aquari-

um with hammerhead sharks, green sea turtles, eagle rays and the popular Tidal Touch Zone. The zoo is a leader in marine-focused conservation work, with staff and volunteers participating in various projects to protect marine species. From monitoring local kelp forests and rockfish populations in Puget Sound, to participating in research that benefits hammerhead sharks in the coral reefs of Hawaii, staff are working to care for aquatic habitats.

The 29-acre Point Defiance Zoo & Aquarium is also home to more than 400 marine and land species, many of which are threatened and endangered, including walruses, polar bears, sea otters, Sumatran tigers, Malayan tapirs and clouded leopards.

Geoff E. Anderson is a principal at Schemata Workshop and was project manager on the PDZA’s Tropical Reef Aquarium renovation project.

Lynne Riesselman is a principal at EHDD, whose design of aquarium, cultural and university projects is shaped by a drive to leverage the interconnection of nature and the built environment. Recent work includes the Presidio Tunnel Tops Youth Campus and the Sobela Ocean Aquarium.

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