

2022 Outstanding International Project

South East Asia Jungle Track | Auckland Zoo, New Zealand

By Darin A. Brenner and Monica Lake



Fig. 1

Aqua-Environs Construction was subcontracted to provide shotcrete installations as a part of our broader scope of work: construction services to create a naturalistically themed terrestrial and aquatic habitats for Auckland Zoo's new South East Asia Jungle Track (SEAJT), the Zoo's most ambitious project in its 99-year history. Our company utilized shotcrete to help create natural, realistic animal habitat areas as well as public spaces to achieve engaging natural environments for animals and fish in the zoo's care and for the zoo's visitors. Due to unique structural and theming capabilities, we chose to use wet-mix shotcrete in many key areas as both a finished surface as

well as the structural form to help us create these remarkable habitats; this will ensure their long-term durability and function as Auckland Zoo's South East Asia Jungle Track. The habitats created include Lowlands (Sumatran tigers), Lowlands (Asian small-clawed otters), and Swamp Forest (Sunda gharial/crocodile).

LOWLANDS (SUMATRAN TIGERS)/ZONE 3

The Lowlands habitat consists of a series of interconnected tiger areas; each area is linked by an arched steel bridge that enables the tigers to pass over the visitor pathways. The experience is an up-close (and safe) encounter with tigers

looking down on visitors. The stunning Lowlands habitat features the use of shotcrete to create realistic dens, earth embankments, waterfalls and pools, and rock outcroppings where tigers occupy high rock plateaus while visitors sit on themed rock escarpments and walk alongside gravel and mud embankments. Sumatran tigers are endangered, and the hope of this facility is to provide additional support to genetic stock being preserved by conservation-minded ethical zoos around the world (such as the Auckland Zoo) whilst providing enriching habitats and quality welfare and care to the tigers as well as the hope for future cubs.

Our team performed all shotcrete theming work within the tiger habitat areas. We used various underlying forms over a steel reinforcement support system that was established for shotcrete placement. The purpose was to create artificial environments sculpted and textured for often hyper-realistic artificial earthen embankments. Additionally, we focused on crafting life-like rock features, including waterfalls, pools, and rock outcroppings. The Lowlands Sumatran tiger exhibit includes a large, covered public viewing shelter where several significant artificial rock forms were fabricated to provide visitors and tigers a shared safe experience on the same rock. These shelters are safely divided by large glass viewing windows that are seamlessly integrated throughout the rock outcroppings; this provides comfort and access for all for up close encounters and views. Great visitor experiences are enhanced by the shelter's rock elements which allow visitors to sit, climb, and stand adjacent to a tiger. The appearance of the shotcrete rock was designed to look like the basalt prevalent in Auckland, New Zealand. In addition, local basalt rock, scree, and boulders were utilized to hem in the shotcrete rock formations to more organically integrate with other sculpted shotcrete formations before finishing with scenic staining, coloring, and aging; all of this was done before the addition of soil and plantings to soften up these hard elements.

LOWLANDS (ASIAN SMALL-CLAWED OTTERS)/ZONE 3

Located adjacent to the Lowlands habitat for tigers is the Lowlands habitat for small-clawed otters. The shotcrete used in this area consists of two forks of a gurgling stream, sandy pebbly riverside beaches, massive hollowed out logs, and a waterfall spillway through a rock crevice creating a series of clear, sandy pools and shaded, mossy banks. Most of the habitat's forms, features, and surfaces were reliant on elaborate shotcrete artistry. In some cases, we incorporated bits of real rock, pebble and sand substrates which were carefully and strategically embedded directly into the outer surfaces of the shotcrete matrix. This technique was used to re-create natural streambeds or landscape embankments typical of a small stream where alluvial rock and sedimentary layering is present in differing amounts. In this habitat, our team's ultimate challenge was to provide an endless variety of enrichment opportunities throughout the habitat for the inquisitive and energetic small-clawed otters, including two artificial logs/tree snags. One of the trees



Fig. 2

was fabricated to form a natural den that was large enough to accommodate a family of otters. This fully structurally-formed shotcrete den, was hollowed out by adopting other products and techniques to create many entrances carefully hand carved by our artisan team prior to final scenic painting, staining, and aging with lichens and moss.

SWAMP FOREST (SUNDA GHARIAL/CROCODILE)/ZONE 2

The Swamp Forest habitat is an immersive, hot house indoor dome structure. It encompasses a series of independent and interconnected pools, each with varying depths, that enables visitors to follow along a clear, tropical river filled with hundreds of fish including the rare Arawana species. The larger river pool within the habitat is home to the Sunda gharials, also known as Tomistoma crocodiles, which can grow up to 4m (13 ft) long or more. All the subcontractors called this area the "Tomidome" throughout the construction phases. This unique and unusual habitat was created within a large, circular pre-cast concrete building capped by a 30m (98 ft) high transparent ethylene tetrafluoroethylene (ETFE) dome structure. The greenhouse environment is a light filled,

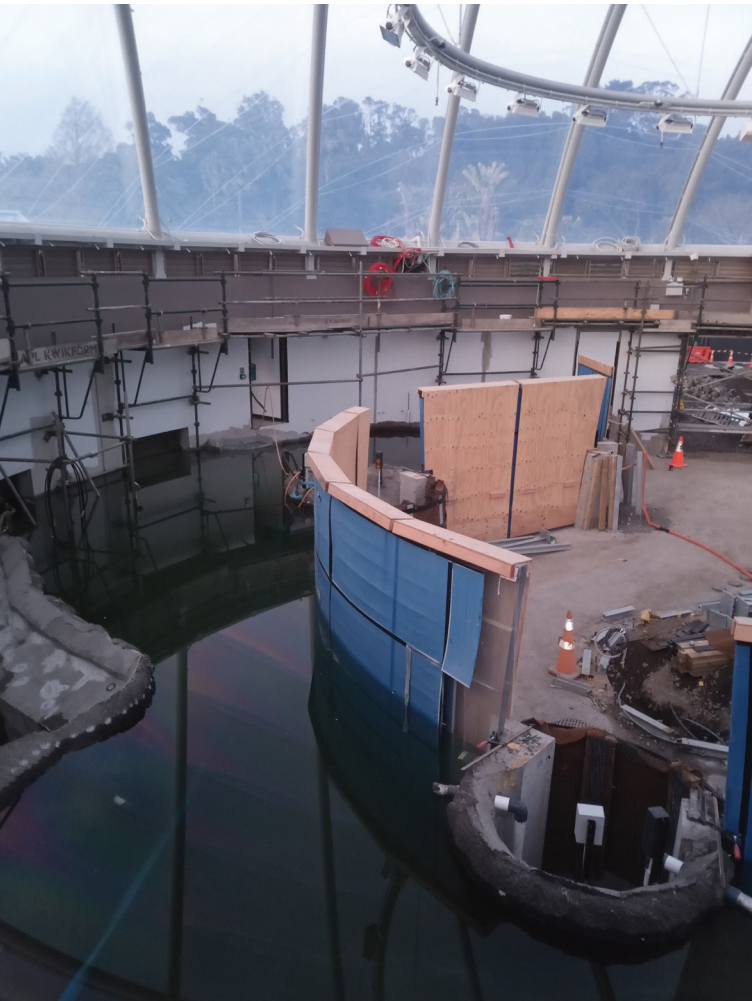


Fig. 3

temperature-controlled space with high humidity to simulate a swamp forest in South East Asia with a halogen “light clock” keeping tropical/equatorial time periods during winter months. A high degree of realism for the riverbanks and beds was achieved by utilizing the application of shotcrete, which was initially used as the reliant form for the structure and the prevalent shapes as well as to accommodate the complex, free-form design layout of high-density 12 mm (0.5 in.) diameter steel reinforcement at 200 mm (8 in.) on center. The steel reinforcements were shaped in natural, obtuse formations making the tasks of engineering, installation, waterproofing, and final shotcrete application challenging to achieve reliable structural integrity whilst authenticating the perceived environmental eco-type. Very specific animal husbandry items were crucial to the life science team and needed to be achieved by allowing these large crocodylians the opportunity to rest comfortably beneath undercut, dark shadowed ledges. It also needed to allow them to bask in the sun’s UV rays while laying on water ledges and beaches and not injuring their bodies and feet while allowing them unabated movement in the habitat, mimicking their natural behaviors in these environments in the wild.

These forms and shotcrete applications had to also meet the stringent, functional water containment and

waterproofing purposes as they are essentially large aquariums. These aquariums incorporated numerous large acrylic viewing panels up to 80 mm (3 in.) thick and 7 m (23 ft) placed along the visitor pathway and pools. The entirety of this habitat is quite similar to a large-scale terrarium or palladium but one that visitors can actually walk in and through. The entire immersive habitat is indoors and was completed with diverse and unusual tropical plant flora for a truly unique and rare botanical landscape. The transparent (ETFE) domed-ceiling habitat also boasts a durable greenhouse, and contains land-based, in-water, and shore-based soft-scaping plants as well as large, towering trees. A rain curtain set above and throughout the dome structure provides an authentic overhead rain effect for visitors, plants, and wildlife. A Bornean swamp forest environs soundtrack playing through a speaker system completes the experience by immersing visitors in forest and river sounds as they experience the habitat. Visitors are encouraged to bring their umbrellas and be prepared to listen to the rain and fauna!

Shotcrete enabled our team to utilize their artistry and technical skills to create the South East Asia Jungle Track, a world-class, highly immersive experience that brings people together to build a future for wildlife. Our client, The Auckland Zoo, located on the North Island of Aotearoa, New Zealand, enlisted the expertise of both local and renowned international zoo design and construction experts. Ignite Architects, a local firm, worked in partnership with SHR/ Studio Hanson Roberts from Bainbridge Island, WA, USA, and various zoo staff on this project. Their collective goal was to plan, design, and construct a revitalized series of habitats for the South East Asian animals and fish in the Zoo’s care, encompassing approximately one-fifth of the total acreage of the zoo. Particular zoo staff focus and coordination was led and conducted by Auckland Zoo’s Capital Infrastructure Zoo Director, Monica Lake. Assisting here were team leads including Lauren Booth from the carnivore team; Richard Gibson, Head of Animal Care and Conservation; and Don McFarland, lead of the Ectotherm team. Aqua-Environs was invited to invent and create new concepts and methods for many themed construction elements both prior and in-situ thanks to the zoo staff, architect teams, and an open-minded prime contractor and project manager working together, making all these unique outcomes possible.

The project was completed and open to the public in October 2022, and the new track is a must-see destination for New Zealanders and visiting international tourists as they join the Zoo in celebrating its upcoming centenary. As a result of their familiarity with our work, Aqua-Environs Construction was selected to lead this immersive habitat creation by the prime contractor, NZ Strong of Auckland, New Zealand and Auckland Zoo staff. In particular, NZ Strong Project Manager, Garyth Jones, was instrumental in helping select Aqua-Environs due to his long history and experience with zoo construction projects; this allowed for a great deal of collaboration and ease of progress on new ideas and solved a myriad of construction buildability problems within the entirety of the SEAJT.

While visitors will be amazed and delighted by the natural feel of the South East Asia Jungle Track, few will realize that over 100 m³ (130 yd³) of shotcrete was applied throughout all habitats/zones. Much of it consisted of outer-detailed artificial rock or other environment simulations whilst many significant areas served structural only or a combination of purposes as well. On time, properly mixed concrete deliveries by Atlas Concrete of Auckland proved critical to our success. Close to 70 m³ (90 yd³) of shotcrete was designed and applied with a special mixture for the Swamp Forest pools. The special mixture met not only the engineers' and architects' standards, but our own higher standards as well. We had wished to have a shotcrete mix which would inhibit the transfer of concrete minerals and chemicals into the Swamp Forest aquariums and pool water both immediately and over time. This was especially important as the Swamp Forest habitat portrays and behaves both aesthetically and chemically similar to the water conditions of South East Asia lowland peat bog rivers which typically have a pH range that is slightly acidic and are soft waters. We decided to utilize a product known to have gelling, swelling, and sealing attributes within the concrete matrix. Aquron, distributed by a New Zealand vendor, Markham NZ Ltd., mitigated the possibility of too much mineral transfer once in contact with the aquarium pool water. Supplemental complete "system" surface waterproofing coatings and layers were then applied by a certified team from Markham NZ Ltd. once shotcrete placement was completed and in the curing phase, prior to any water filling. A specialized, low-swelling synthetic water-bar joint tape compound, provided by Markham NZ Ltd., was part of the waterproofing system and sealed the many construction joints required by the design engineers to eliminate potential cold-joint concrete leakage. The shotcrete mixture design consisted of a 30 MPa (4500 psi) low-slump mix, utilizing synthetic short poly fibers fly ash to help hold and aid the creation of the unusual shapes and overhangs found throughout the pools whilst providing a good matrix for the desired waterproofing compatibility. The use of other products made of crystallizing waterproofing products or silica fume would likely have proven disadvantageous in this instance due to the unique and sensitive nature and qualities of the environments attempting to be replicated and the ultimate water conditions sought by the zoo's ectotherm team. To minimize shrinkage in the pool shotcrete, we incorporated a shrinkage-reducing admixture and conducted regular laboratory tests for compressive strength and shrinkage. We also installed remote temperature monitors within the shotcrete matrix to track and record curing temperature changes. This meticulous approach ensured optimal strength, durability, and quality for the pools' shotcrete, meeting required standards for long-lasting durability.

In the Lowlands/Zone 3, throughout the rock and earthen environments where artistic shotcrete was placed, we often elected to incorporate various pigments directly into the concrete mixes in varying amounts. We incorporated these pigments at the batch plant. The pigment was comprised of select oxides from our two, quality New Zealand suppliers:

Permacolour and Peter Fell, both of which aided and directed us with selection and use.

SUMMARY CONCLUSION:

What typifies this project for our entire team is our ability to find ways to work through the often sudden and extreme challenges that occurred throughout nearly this entire project due to COVID and because of the New Zealand government's very strict regulatory system. The government successfully implemented measures to keep COVID out of the country, and to stamp out domestic outbreaks, which they achieved for most of the project's duration. All around the world, all nations and people were impacted to one degree or another by COVID. However, in New Zealand, to keep COVID out of the country, and to stamp out domestic outbreaks, the lockdown meant that for certain periods, individuals were unable to go to work at all. Thus, we had several long and short delays with some full stops for up to six weeks on two separate occasions. These interruptions greatly affected our progress and ability to stay ahead and earn a living, creating a mystery of when we would be able to resume work.



Fig. 4



Fig. 5

Additionally, the New Zealand government had created a series of strict COVID levels which most people followed throughout the duration of the main COVID period and were obediently followed by the prime contractor and all sub-contractors on this project. Initially, I had personal concerns on this project because I was working far from home and my family was living in California, USA. COVID came up just two months into the project in early 2020, which made for a “Twilight Zone” feel when New Zealand’s country-wide lockdown began in late March 2020. Thankfully, I had the opportunity to make it home to see my family in the U.S. twice during the entire SEAJT project despite the challenges posed by restrictive border regulations, which were open only to citizens and permanent residents. This involved special air ticket bookings, mandatory quarantine in New Zealand’s government-run hotels upon return, and multiple mandatory COVID tests at these facilities, as well as pre-departure flight requirements and COVID tests. New Zealand was one of the first nations to initiate these requirements in early-to-mid 2020, and they continued to a lesser extent until June 2022.

We began Aqua-Environs Construction in late 2006 to early 2007 when our family lived in New Zealand. However, our very first two projects were done in Le Clede, Idaho, in early-mid 2006 for friends with a keen passion for the streams and waterfalls of the mountains.

In 2017, we decidedly moved to California to be near extended family and provide better schools and universities for our children. We will continue returning to New Zealand/Oceania for these sorts of special and exciting projects if they suit our family and the personal and business relationships we have built over the years within New Zealand.

The Auckland Zoo will always be a special place for us for many reasons. The staff treated us like family which made the experience much more bearable and comfortable given its unusual 100-year ironic circumstances on two fronts - a centennial and a pandemic! We hope the Auckland Zoo’s South East Asian Jungle Track is enriching for the wildlife and truly a centerpiece for the community and the country of New Zealand for years to come. This project also created a special memory to earmark the Zoo’s first Centennial celebration.

We are grateful to also be able to share it with the ASA, Shotcrete magazine, and its readership.

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Darin A. Brenner is a Co-Director, with Ora B. Brenner, of Aqua-Environs, a family-owned, specialized landscape, aquatic, and theming construction business of over 15 years. Darin is passionate about exploring new ideas as a landscape artist and as a builder of natural features and elements.

Both Darin and Ora have run the operation from Auckland, New Zealand since its founding and will continue to do so as the “roots” of the business foundation. They recently moved and now base themselves out of Sacramento, California as Aqua-Environs Construction LLC and will be looking to a future in North America assisting zoos, aquariums, civil infrastructure, commercial, and a variety of unique, private client projects.



Monica Lake, Capital Infrastructure Director, Auckland Zoo, New Zealand, has more than 30 years of experience in the management of design and construction for public projects and good, modern zoos. She is Head of Zoo Environment, Design & Construction at Auckland Zoo. She has recently completed the South East Asia

Jungle Track, the largest project in the Auckland Zoo's hundred year history, and the winner of numerous design and construction awards. Before taking up her role at Auckland Zoo, she was Director of Projects at Woodland Park Zoo in Seattle, Washington, USA where her work included a Humboldt Penguin habitat which received AZA's 2010 Exhibit Award top honors. Before her work in zoos, she managed a wide range of projects for the City of Seattle, including Seattle's New City Hall and plaza. Monica grew up in Pasadena, California, USA, and from an early age, was inspired by plants and landscapes. She earned a B.A. in Economics at the University of California, Santa Cruz and attended a Master of Architecture program at the University of Washington.

2022 OUTSTANDING INTERNATIONAL PROJECT

Project

**South East Asia Jungle Track
Auckland Zoo, New Zealand**

Shotcrete Contractor
Aqua-Environs Construction

Architect-Engineer
Studio Hanson Roberts

Material Supplier/Manufacturer
Atlas Concrete

Equipment Manufacturer
**Concrete Pumping Equipment NZ Ltd.
& Putzmeister Products**

General Contractor
NZ STRONG

Project Owner
Auckland Zoo – Tātaki Auckland Unlimite