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Civil Engineering

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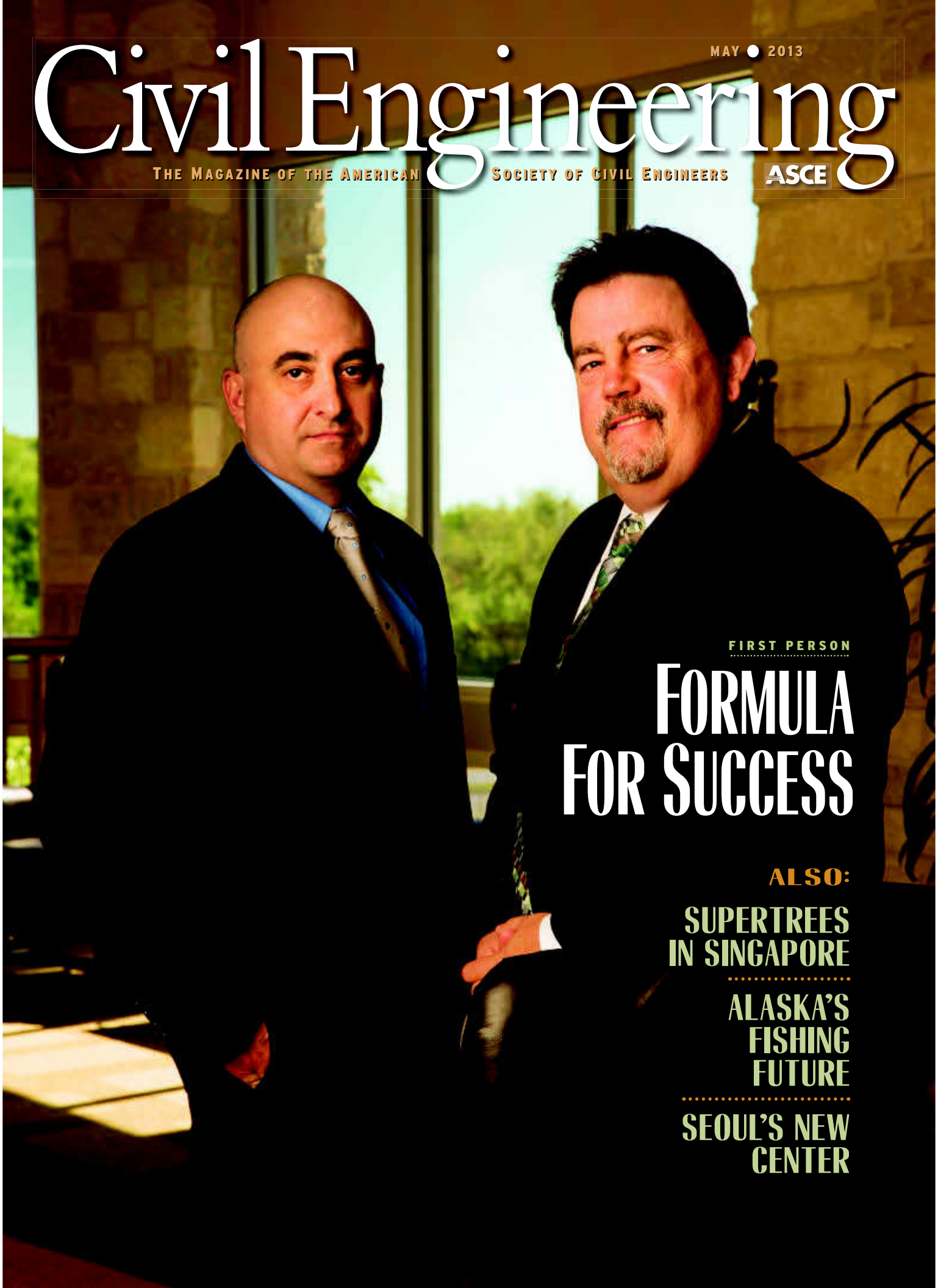


FIRST PERSON

FORMULA FOR SUCCESS

ALSO:

SUPERTREES IN SINGAPORE

ALASKA'S FISHING FUTURE

SEOUL'S NEW CENTER

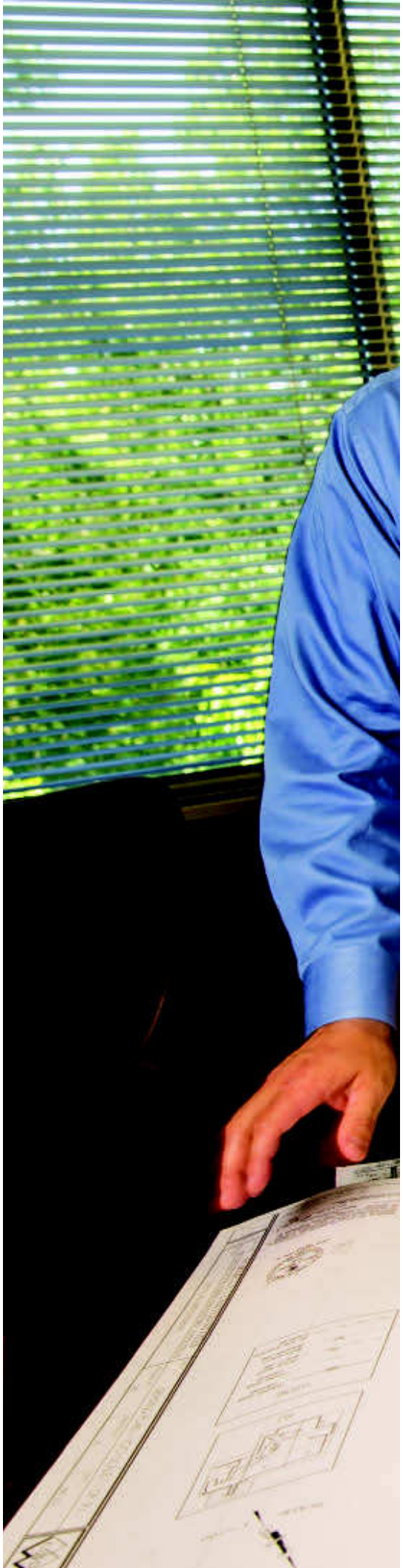
FIRST PERSON

RACING TO THE FINISH

When in 2010 the city of Austin, Texas, was awarded the United States Grand Prix for 10 years, plans to construct the Formula 1 racecourse there, the Circuit of the Americas, quickly got under way, and an unlikely midsize civil engineering and surveying firm—Carlson, Brigance & Doering, Inc.—was awarded the civil engineering design contract.

By Brett R. Pasquarella, P.E., M.ASCE, and Charles R. Brigance, Jr., P.E., M.ASCE

PORTRAIT BY DARREN CARROLL



BRETT PASQUARELLA RECALLS THE STARTING POINT: "In January 2010, Charles Brigance, the president and a principal of Carlson, Brigance & Doering, Inc., walked into my office and said, 'Brett, you won't believe this, but you know that Wandering Creek subdivision—we've been working on the off-site utilities for it?' I replied, 'Yeah.' He continued, 'They want to build a Formula 1 racetrack out there!'"

It's really no surprise that when Formula 1, also known as F1, awarded the United States Grand Prix for 10 consecutive years beginning in 2012, the license was given to a group in Texas. After all, Texans are well known for their love of sports, their big venues, and their wealth. If Texas were a nation, its economy would rank 14th in the world by gross domestic product, and six of the country's largest cities are here in Texas: Houston (4th), San Antonio (7th), Dallas (9th), Austin (14th), Fort Worth (16th), and El Paso (20th).

But why Austin? Austin is accustomed to handling the large crowds associated with such well-established events as the Austin City Limits Music Festival; the South by Southwest film, music, and interactive festivals; the University of Texas football games; and the Republic of Texas Biker Rally, which together bring more than 17 million visitors to the city and its environs annually. Additionally, the Round Rock–Austin–San Marcos corridor had recently

The authors—Brett R. Pasquarella, P.E., M.ASCE, and Charles R. Brigance, Jr., P.E., M.ASCE—had been working on the utilities for a residential subdivision in Austin, Texas, that instead became the site of the United States Grand Prix, and to their surprise their firm, Carlson, Brigance & Doering, Inc., was selected to perform the civil engineering design for the event's new racetrack, the Circuit of the Americas.

been ranked as 1 of the nation's 10 fastest growing metropolitan areas while maintaining national recognition as one of the best, "greenest," and safest metro areas in the United States.

As a significant plus, Austin had converted Bergstrom Air Force Base into Austin-Bergstrom International Airport more than a decade earlier, which also played an important role in Formula 1's decision to come to central Texas. The base had served as a United States Air Force Strategic Air Command base during the cold war years—a home to B-52 bombers, the largest and heaviest aircraft in the American arsenal at the time. To become airborne when fully loaded, these planes require a 15,000 ft runway, which influenced the decision making for Formula 1, as every race team flies on large transport planes that require lengthy runways. Most other Texas airports would have required upgrades to their runways, but Austin's was already ideal. Austin is also geographically located to easily welcome domestic and international visitors thanks to its perfect location between such hubs as Houston, San Antonio, and the Dallas and Fort Worth area, which combined boast more than 130 daily departing international flights.

The racetrack, known as Circuit of the Americas (COTA), is situated on a 1,100-acre site, the circuit taking up approximately 330 acres. It is the only track in the United States built for the sole purpose of hosting a Formula 1 race and is 1 of 27 purpose-built tracks in the world to have earned the highest ranking (grade 1) from the Federation internationale de l'automobile.

Formula 1 racing is very different from most auto racing. The engineering that goes into setting up the cars for the race is incredibly challenging. The cars are very dependent upon electronics, and are capable of lateral forces of 5*g*. Several engineers monitor a multitude of streaming data from the race cars, and a considerable amount of technology developed in the Formula 1 racing community eventually finds its way into the cars we drive every day. There are specific rules governing Formula 1 races—for example, how to pass another car, when to use the Drag Reduction System to achieve greater speed, and how many types of tires are required. Furthermore, once the race starts, no refueling is permitted.

A TEAM OF INVESTORS set out to ensure that the project would be complete in time for the inaugural race, which was originally scheduled for June 2012 but was later changed to November of that year—less than three years away! Much like every other aspect of this enormous endeavor, the design of the track was a tremendous undertaking, the various buildings and outdoor spaces designed by a team of international architects, engineers, and consultants working together.

To backtrack for just a moment, when Carlson, Brigance & Doering (CBD) learned that the proposed Wandering Creek subdivision would in fact become a Formula 1 racetrack, it didn't cross any of our minds that our firm would secure the civil engineering design contract for the project. CBD is a midsize civil engineering and surveying firm located in southwest Austin. There were just nine people working in the engineering department, and we were still in the midst of the Great Recession.

The racetrack, known as Circuit of the Americas, is situated on a 1,100-acre site, and the track takes up approximately 330 acres. It is the only racetrack in the United States built for the sole purpose of hosting a Formula 1 race. At one point, more than 1,000 workers were on-site.

CIRCUIT OF THE AMERICAS

The world-renowned German track design firm Tilke Engineers & Architects was responsible for the facility master plan, the track design, and the track electrical system. Tilke's design took advantage of the track's natural topography and took inspiration from tracks around the world. The site lent itself to a very high elevation at turn 1, and the total elevation change of 133 ft affords fans exceptional visibility of the track. German-based Hart Consult International GmbH, led by Dr. rer. nat. Rainer Hart, who developed a special quality assurance system for racetracks and test tracks that is used all over the world, served as the paving consultant. The Austin office of Terracon was contracted to conduct soil borings and offer subgrade recommendations for the pavements from the racetrack to the parking lots and drives, as well as foundation design for the site buildings. Horizon Environmental Services, Inc., of Austin, was contracted to provide a geological assessment of the tract and handle the U.S. Army Corps of Engineers' permitting application.

It didn't take long for the project to gain momentum,

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and by April 2010 CBD was meeting with Tilke representatives, who came to Austin to educate themselves about local codes and regulations. Pasquarella gave them a short presentation on how we design for a 100-year storm event, and he could see the wheels turning as they mentally converted cubic feet per second to liters per second. When they realized how much runoff there was, they were very surprised that we had to account for that kind of intense rainfall event. Germany doesn't have that type of rainfall, and thus their storm systems are somewhat smaller. After the initial meeting and site visit, Brigance was summoned to Germany for meetings at Tilke's office to further discuss the site and local regulations. As CBD provided answers to their questions, our relationship grew into one of mutual respect for each other and our roles on the project.

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At this point CBD had not been awarded the civil engineering design project. We had done a lot of research and answered a lot of questions, and we had been checking for possible "land mines" in the permitting process. In June we were granted a formal interview, which Brigance attended. From that meeting emerged a request for a formal proposal to provide the necessary civil engineering design. It was about a month later when staff met in CBD's conference room and Brigance announced, "Well, we asked for it and we got it." We immediately

organized how we would handle design, and we set a date for submittal to the City of Austin and Travis County. Pasquarella would design the detention and water quality controls for the site and would have the task of coordinating permitting with the jurisdictional entities of the City of Austin, Travis County, the Travis County Fire Marshal's Office, the Federal Aviation Administration, the Corps of Engineers, the Federal Emergency Management Agency (FEMA), and the Lower Colorado River Authority. Pasquarella remembers saying at that time, "I want to design this one for all the small firms who never got a chance to be here." Brigance would be the main liaison between CBD and the owners. Steven P. Cates, P.E., a project manager for CBD, would lead the rest of our staff on the design of the infrastructure. But make no mistake: we all had a hand in the design of one aspect or another. It was a team effort of epic proportions.

We began the design of the racetrack in August 2010, and at that time the inaugural race was to be held in June 2012. Obviously, this was an extremely tight schedule for designing and building a facility of this size—just 21 months. The permits required from the various entities had to be obtained prior to any construction, and because there is no permitting process in the City of Austin or Travis County for a design/build project, a full set of site plan drawings would have to be submitted to these agencies for review. The plan was in such a state of flux that it was constantly evolving, and the design would change overnight. Literally while we slept our German counterparts were altering the layout of the site.

We met with the City of Austin's project review team and the city manager. Pasquarella remembers walking off the elevator, heading to the meeting, and encountering one of the department heads—someone he had known for almost 20 years. The person smiled and said, "So, you're the one?" Pasquarella replied, "Yep," and was met with, "I thought it would be someone bigger." The message we got from the City of Austin was that they would not be the reason the project would not be completed on time. They were on board to help make it happen, and their cooperation during the process—along with that of Travis County and its Fire Marshal's Office—would be vital to meeting the deadline.

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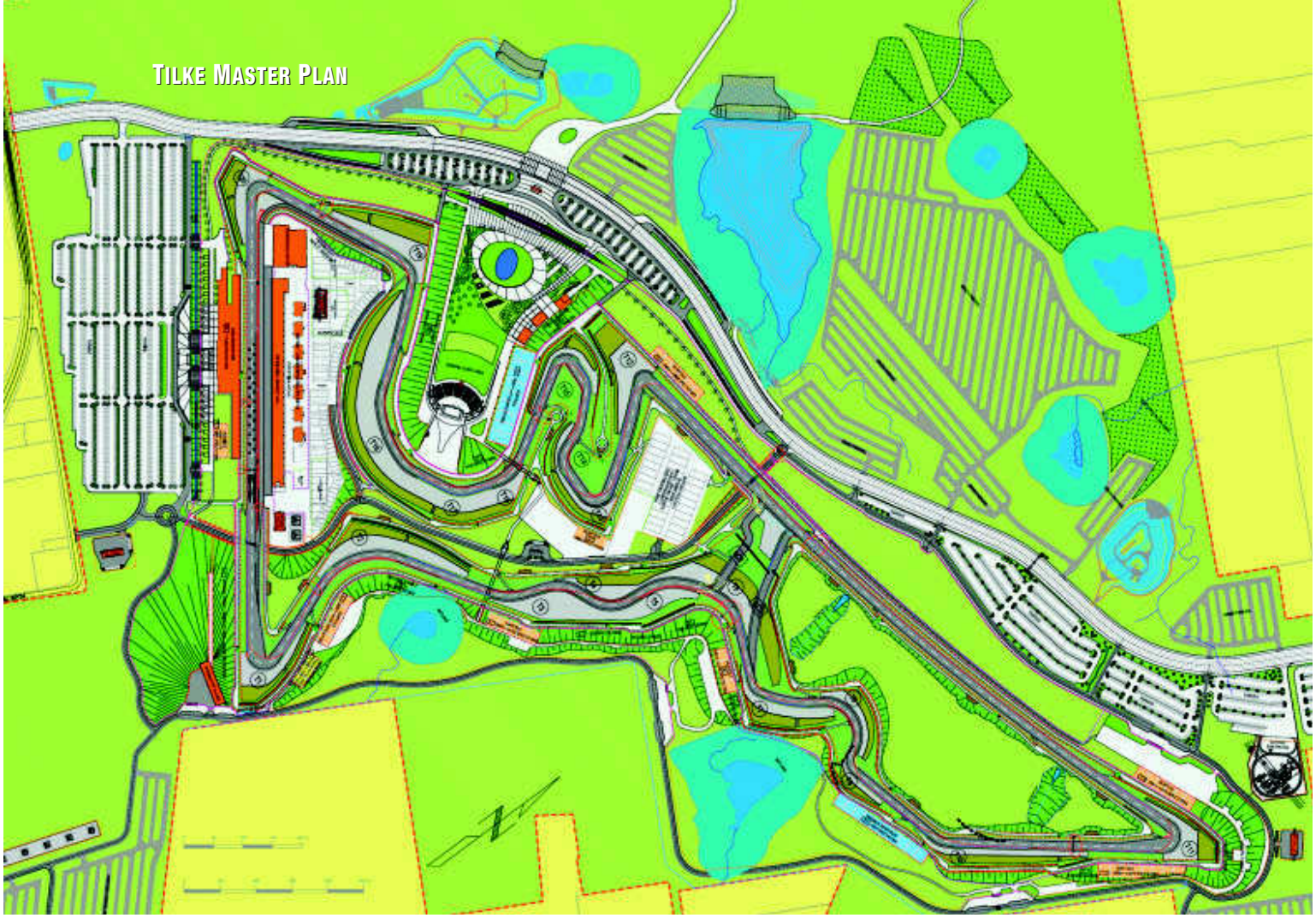
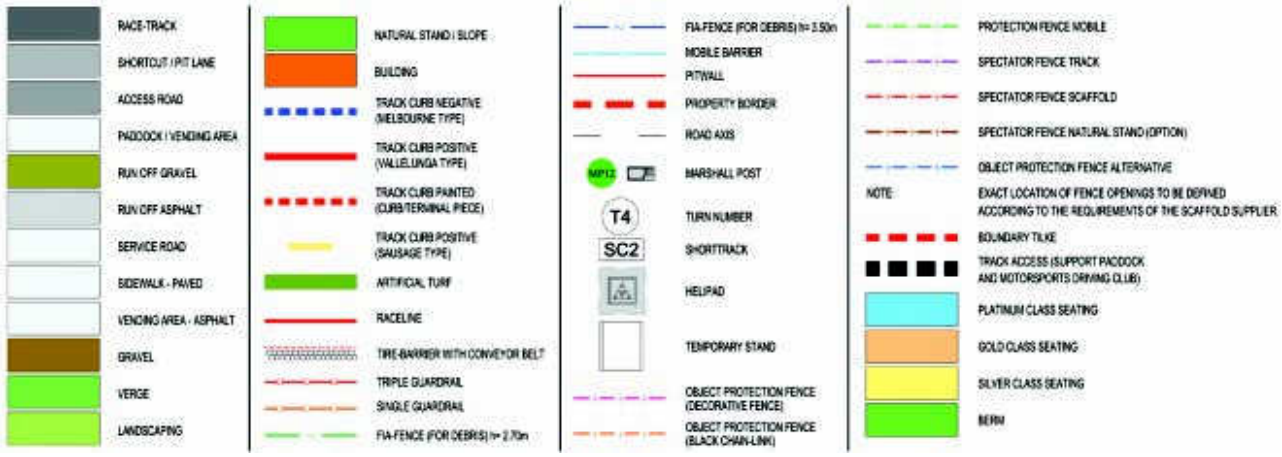
A developers' agreement would have to be entered into by the owners of COTA and Travis County. The county was extremely concerned with traffic congestion before and after any Formula 1 race. County officials wanted an estimate of how long it would take to get visitors into and out of the venue. The traffic impact study, performed by the Austin office of Kimley-Horn and Associates, Inc., would establish the projected traffic patterns during a Formula 1 event. Kimley-Horn personnel went as far as to visit the Formula 1 Silverstone Circuit, in Towcester, United Kingdom, and were able to survey traffic patterns from a helicopter and determine how local officials there handled the traffic. They observed that traffic management was effected for the most part by reversing flow, depending on whether visitors were entering or leaving the venue. The road network surrounding the Austin site would have to be upgraded in the future, but there was not enough time to do it before the first race. The amount of upgrading needed would be assessed and included in the developers' agreement. The county outlined how the review process for the site would be handled. The assessment of what improvements would have to be built continued through the review process, and we at CBD—our calculators in hand—began the mother of all design projects. It was now August 2010.

One of the most challenging aspects of the design was the drainage system. Three large drainage basins—referred to as respectively basins A, B, and C—drained through the site and under the racetrack. Basin A covered 185 acres; basin B, 288 acres; and basin C, 147 acres. These basins would have to be routed under the track in a closed storm sewer system to the adjacent main tributary of Dry Creek. In the event of a high-intensity storm, storm water had to be kept off of the racetrack to prevent damage. The grading plan and the drainage system quickly became the focal point of the design and would dictate how the site utilities would be laid out. Three water quality and detention ponds would have to be placed at the end of each of these drainage basins. These are required by city and county regulations. Basin B was the largest of the three drainage areas, and an existing large agricultural lake was





TILKE ENGINEERS & ARCHITECTS ANC CARLSON, BRIGANCE & DOERING, INC.

located at the end of it. Constructed more than 50 years ago for a cattle operation, the lake had approximately 4 acres of surface area and featured well-established plant and animal life, so we felt that incorporating it into the design would be a benefit to both the site and the environment.

We discussed our intentions with the City of Austin and together arrived at a plan to turn the lake into a hybrid wet pond without making it intrusive. First a concrete spillway and inverted outlet pipe would have to be installed to control outflow during the 2-, 10-, 25-, and 100-year storm events and to establish a permanent pool elevation for the pond. A large gabion mattress and large boulders would be placed on the downstream side of the spillway to help with erosion during heavy rainfall events. The spillway was sized to pass the probable maximum flood event for the 24-hour storm, which equates to 44.2 in. of rainfall. The edges of the pond, about 20 ft back from the permanent pool elevation or edge of the water, would feature several different types of trees planted to provide shade and promote aquatic life. We utilized a gabion wall at the upstream end where the inflow from the two main storm sewer systems came to the surface. A gabion mattress was placed just downstream of each inflow headwall to capture trash and sediment. Finally, a fountain was placed in the pond to help with aeration during Austin's hot, stagnant summer months.

Ponds A and B are more traditionally engineered wet ponds. They were constructed within the specific parameters contained in the City of Austin's *Drainage Criteria Manual* and *Environmental Criteria Manual.* The water quality portion of the pond was designed with a forebay to capture sediment, as well as a main pool. The permanent pool elevation was established by the inverted outflow pipe. The detention volume was stacked on top. Again, these ponds were designed to control the 2-, 10-, 25-, and 100-year storm events. The ponds were hydraulically modeled using the Corps of Engineers Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS). The runoff from this development had to be equal to the predeveloped conditions.

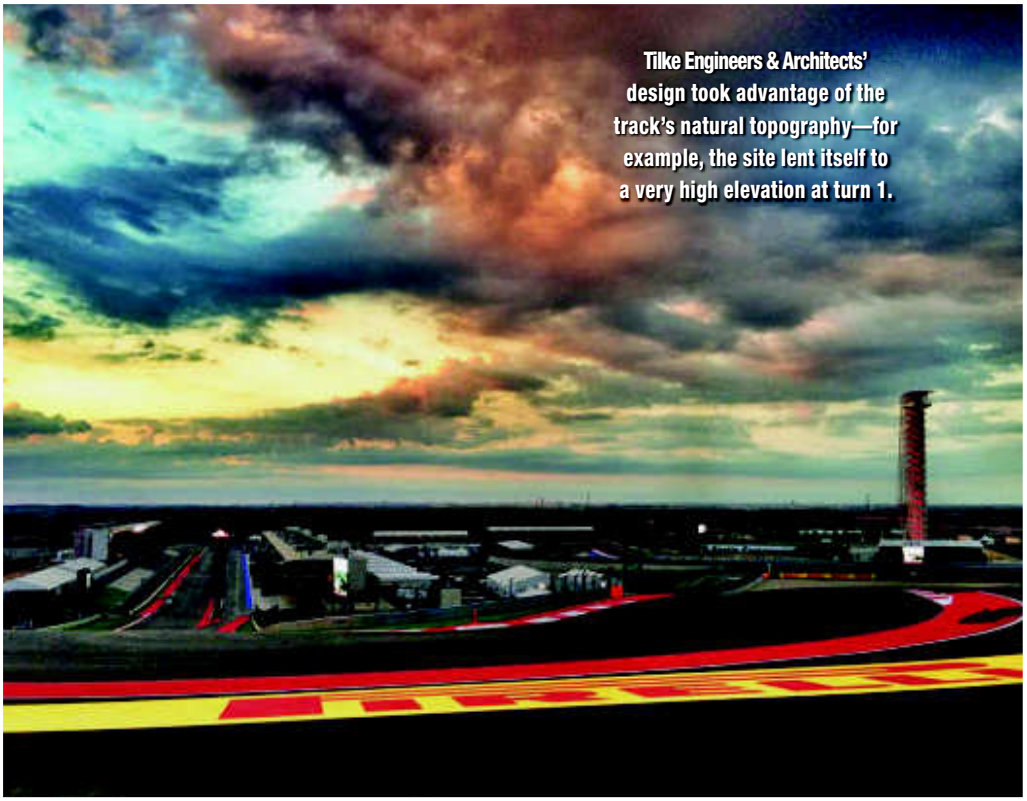
The main storm sewer systems for this project were large underground concrete box culverts. The system that conveyed the drainage to pond B is divided into three systems: a 10 by 5 ft box culvert, a 10 by 3 ft box culvert, and a 42 in. reinforced-concrete pipe. Some of these systems ran for more than 2,000 linear ft. The expense of the drainage systems was becoming an issue. Drainage basin A also was a large box culvert in the initial design, but through value engineering we were able to convert a good portion to a trapezoidal channel that would run in front of the entrance to the main grandstand. This eliminated almost 2,000 linear ft of box culvert and considerable construction cost. Systems B and C were running under main sections of the racetrack and would remain enclosed conduit.

There were portions of the main tributaries that ran up into the site and were classified by the U.S. Environmental Protection Agency as "waters of the United States," which meant that they fell under the jurisdiction of the Corps of Engineers. On the basis of the site layout, portions of the small tributaries required mitigation in that they would require relocation or removal. New tributaries were established running across the infield grass area and also through the site beyond the tip of the circuit at turn 11. There were two smaller stock tank ponds located on the east—or uphill—side of the track that were classified as wetlands by the City of Austin and the Corps of Engineers. These two ponds were protected and incorporated into the site layout. The ponds would undergo a restoration of sorts that would help to establish new vegetation within a mandatory 150 ft setback. Invasive species would be removed, and a new mix of seed would be planted to establish Texas blackland prairie grasses. These grasses would be reflective of the type of vegetation present before the property was overgrazed by cattle. The plantings were specified by TBG Partners, an Austin landscape architecture firm.

Another main concern was how to handle erosion control during construction. A large earthmoving project was necessary to create the shape of the track. We had cut and fill in our grading plan in excess of 20 ft. The amount of material that ended up being moved on the entire project was almost 4.1 million cu yd. The main concern was having a large stripped area (about 375 acres) during an intense rainfall that could potentially send sediment into the adjacent Dry Creek tributary and farther downstream. This would be environmentally deleterious as well as a violation of City of Austin and Travis County regulations.

We developed a three-level erosion control plan. The main entrance to the site was a large, 75 ft wide curb and gutter roadway named Circuit of the Americas Boulevard. The road snaked through the site like a main circuit cable. The first level of protecting the natural waterway was to install a standard silt fence and rock berms on the downstream side of the roadway embankment. The storm-water ponds would also be rough cut in the first stage of construction so that they would act as sediment traps. The second level of defense was to construct the roadway in such a way that it could act as a protective dike. Runoff would have to build up enough head to overtop the roadway. Generating enough fill for the embankment was an issue but would not turn out to be a big problem once we learned of the pavement design section for the racing surface. The third and final portion of the design was to incorporate smaller sediment traps throughout the site to head off sediment before it reached the Circuit of the Americas Boulevard. These smaller sediment traps were outfitted with a floating skimmer that would allow the traps a long drawdown time and ensure that the sediment did not leave the traps.

The three levels of erosion control actually ended up



Tilke Engineers & Architects' design took advantage of the track's natural topography—for example, the site lent itself to a very high elevation at turn 1.

CARLSON, BRIGANCE & DOERING, INC., *OPPOSITE;* CIRCUIT OF THE AMERICAS, *ABOVE*

A main concern was the ability of the grass parking pad to support a helicopter during inclement weather. To address this concern, a product called GRASSPROTECTA was used as reinforcement for grass areas.

serving a dual purpose. The sediment traps contained most of the rainfall events that occurred during construction. Almost all of that water was reused to process the fill material that was placed at the site. The erosion controls were tested on January 23, 2012, when the site received a total of almost 9 in. of rain, 7 in. of it falling in a roughly three-hour period. The series of controls held their ground—literally and figuratively—the runoff leaving the site during and after the event being clear and clean of silt. However, the vertical components were able to continue during that time.

As the site design continued, so did the necessary water main extension and wastewater interceptor designs. CBD was retained to design these and to obtain permits for them when the project originally was to consist of 2,400 residences. When the land use changed, the City of Austin reassessed the sizing and reduced the wastewater from a 36 in. line to a 30 in. line. The water utilities provided to the site were via a 24 in. water line of ductile iron that needed to be extended over 2 mi to the project and then through it by way of Circuit of the Americas Boulevard, the main roadway accessing the site. This would be a City of Austin water line once it was constructed and accepted. Wastewater sewers would be constructed and brought to the site by building almost 3 mi of 30 in. fiberglass gravity pipe manufactured by HOBAS Pipe USA, of Houston, to the tract and a new, 1,100 gpm lift station. This project included an 800 ft bore 42 in. in diameter under the centerline of Dry Creek. The proposed water and wastewater lines are oversized to accommodate future development within the area. The utility projects contained elements that made them challenging in their own right. The lift station had a 12 ft diameter wet well and a 48 in. horizontal storage pipe

> "I WANT TO DESIGN THIS ONE FOR ALL THE SMALL FIRMS WHO NEVER GOT A CHANCE TO BE HERE."

Flight operations constituted a significant component of the engineering in that two helipads were required: one for emergency medical transport and another to accommodate those commuting to events via helicopter.

connected to a second 12 ft diameter manhole and wet well. These projects were cost participation projects that would have to be put out for bids; the projects were advertised and the contract was awarded. Construction began and utility projects were being built concurrently with the site work. CBD was now tasked with the construction administration for these utility projects. It should be noted that these utility projects would have been challenging enough on their own without the time constraints that we were requested to meet.

The site's internal utilities were part of our design and included the water and wastewater needed for the facility buildings. Another part of our responsibility was to profile the main duct banks that would supply power to the track via the new electric substation that the utility company Austin Energy built at the north end of the site.

Once the gas lines were relocated, the drainage, water, and wastewater lines were routed through the site, and we were mindful that we would have to keep as few track crossings as possible. The lines were designed using the typical fixture counts from the International Association of Plumbing and Mechanical Officials' *Uniform Plumbing Code,* and 3-D modeling really came into play with the various necessary utilities. We had typical drainage, water, wastewater, and electric utilities, but there was a special electronics package for the racing circuit drainage lines for Tilke's slotted trackside drains, streetlights, gantries, and way-finding posts. The modeling of these items in 3-D helped identify conflicts before they became a problem. Alignments and grades were changed before the contractor started the work. There were so many designers for the nontypical utilities needed for this project that the weekly review of the 3-D model was crucial in keeping the design and project on schedule.

We completed our initial design and submitted it for review by the City of Austin and Travis County on August 31, 2010. The 149-sheet submittal was set up as a "rough-cut" permit for the site. It allowed us to begin grading as well as to perform some drainage, erosion control, and utility work. The permit allowed two structures: the two tunnels needed for access to the paddock during a race. The tunnels were items having a long lead time. They would be cast-in-place concrete and would have to be complete in order to finish grading the track. The set of plans would have to be approved by the City of Austin, Travis County, the Corps of Engineers, and the Travis County Fire Marshal's Office. Prior to approval, variances for cut and fill limits and construction on steep slopes were needed from both the City of Austin and Travis County.

The City of Austin required two variances from its land development code. The first was for cut and fill exceeding 8 ft; the second for construction on slopes in excess of 15 percent. These variances were granted by the City of Austin's Environmental Board and its Zoning and Platting Commission. Conditions placed on the project by members of the Environmental Board were to be incorporated into the project plan set. They included a blackland prairie restoration project within the site, a 5-acre community garden with water service, a riparian corridor restoration along Dry Creek, planting of shade trees throughout the asphalt parking lots, and storm-water sampling cleanouts on the drainage system for monitoring runoff.

The Travis County variance was a result of the schedule. County regulations require that a project that amends the FEMA floodplain must have approved conditional letters of map revisions prior to approval of the site plan. The paddock area in which the pit building, the media building, the medical building, and the team buildings were to be built was in a floodplain defined by FEMA as zone A. The tributary classified as a floodplain was a result of backwater from the main channel of Dry Creek. The tributary would be filled in and made level to accommodate the 1,100 ft long pit building and its accompanying structures.

ANYONE WHO HAS BEEN THROUGH THE FEMA REVIEW PROCESS UNDERSTANDS THAT IT TAKES AT LEAST SIX MONTHS, EVEN IF EVERYTHING PROCEEDS PERFECTLY. WE JUST DIDN'T HAVE THAT KIND OF TIME.

Anyone who has been through the FEMA review process understands that it takes at least six months, even if everything proceeds perfectly. We just didn't have that kind of time. Representatives of the Corps of Engineers met us on-site to inspect what were classified as "waters of the United States." Pasquarella remembers greeting them at the gate, accompanied by Brigance, with a .45 caliber 1911 handgun strapped to his leg. The representatives got out of their car, and one of them took one look at Pasquarella and asked, "Wild pigs?" Pasquarella responded, "Better to have it and not need it than to need it and not have it."

The site consisted of a very dense mix of brush and mesquite. There were dirt ranch roads, but once we got off the road, the vegetation did not allow us to see more than 20 ft. When we reached one of the tributaries, we would dismount to travel up and downstream on foot. We saw signs of feral pigs but didn't encounter any. Most of the tributaries originally classified as waters of the United States did not have all the vegetation required to meet the Corps of Engineers' guidelines. Most of them therefore lost their classification as waters of the United States after the daylong site investigation. A couple of them did remain classified as such, however, and required protection, and some required the implementation of mitigation measures. New tributaries were carved out of the grading and established as new channels.

CBD received the site development permit on January 28,

2011. A project manager—MBC Consultants, Inc., headquartered in Terrell, Texas—was brought in, and the general contractor selected for the project was Austin Commercial, which is headquartered in Dallas and is a subsidiary of Dallas-based Austin Industries. Once these firms were mobilized along with their earthwork contractor—RANGER Excavating, LP, headquartered in Austin—they began work on the project. The erosion controls were installed, and the immense earthmoving operation was begun.

The permitting process continued with the next site plan application. This application contained all of the internal utilities, drainage, track details, pavement design, structural details, lanes for emergency vehicles, and landscaping plans and details. The resulting site plan was reviewed, and a permit was granted on June 28, 2011. This put us 18 months away from the inaugural race, November 18, 2012. (This new race date was officially announced in December 2011.) This set of plans went through a rigorous review at the Travis County Fire Marshal's Office. The review was extensive, as there were buildings associated with the approval of the initial permit. The emphasis was on emergency access to the site and placement of fire hydrants. The ability of the police and fire departments to quickly gain access to every area of the site was of paramount importance, and the Travis County Fire Marshal's Office had the final say in approving the site to host the event. Other aspects of the site came into play as well, among them pedestrian routes and mass communication. They would all contribute to the ability of emergency personnel to act quickly. We satisfied the requirements of the review and received approval but agreed that the fire lane markings and signage would be completed in the field once the site construction had reached a certain point.

The plans were granted a permit, but the design was certainly a long way from being completed. As the construction progress continued, the owners started to focus on what kind of temporary seating would be utilized and where it would be located. The landscape design and pedestrian access to the site continued to evolve, affecting the grading and utilities. New items were added to the site plan weekly. One such example is a 78-space parking area for recreational vehicles between turns 11 and 12, which required numerous utility hookups and other grading revisions. The tight schedule for the project drove what had quickly become a design/build project, as we were well into the construction stage while major design changes were being implemented. The reviewing entities had to be kept up to speed as the changes were made, as did the contractor.

A unique aspect of our design was the pedestrian access from McAngus Road, which would require crossing Dry Creek. We considered several options but settled on a railcar "bridge." This solution was cost effective, and from a sustainability perspective we felt that the reuse of an old railcar was a good choice. The structure is essentially an old railcar converted into a bridge by removing the axles. The plan utilized two railcars side by side that would provide a 20 ft wide bridge with a pedestrian rail. The manufacturer—Lone Star Bridges, LLC, of La Grange, Texas—fabricated the bridge to the specified dimensions. We poured two concrete bridge abutments for support. The bridge was delivered to the site but had to be anchored, and so the two halves were welded together in the field, along with the pedestrian rail. The bridge sat in the middle of the 100-year floodplain, and the trail system and the bridge provided a very picturesque pedestrian approach to the facility.

A new function we dealt with on this site was that of flight operations. Two helicopter landing areas were located on-site. The first helipad, located at the medical building in the paddock, was for emergency medical transport and included two helicopter landing pads. The problem was the amount of activity that this area would see during a Formula 1 race. A number of temporary tents would be set up in the paddock to serve the race teams and support personnel. The paddock would also be crammed with pallets of provisions and equipment, making our task of meeting the safety specifications for the helipads more difficult. The helipad striping and fencing went through several design iterations as representatives from the Federal Aviation Administration met with us on-site. Eventually we reached a consensus, and the representatives were satisfied that this area could conduct safe flight operations. The second helipad site was set up to handle the people commuting via helicopter to an event. This portion of the site also went through a vigorous review, and as a result the original orientation was changed. There would be two concrete landing pads and six grass parking pads onto which passengers would disembark.

One of the main concerns was the ability of the grass parking pad to support a helicopter during inclement weather. To address this concern, we used a product called GRASS-PROTECTA, manufactured by *(Continued on Page 82)*

FACILITY HIGHLIGHTS

The final design of the entire facility includes:

- 20-turn, 3.4 mi track
- Track seating capacity for 120,000 fans total: 14,000 permanent seats and temporary seating for the remainder
- Three-story, 300,000 sq ft main grandstand that will seat approximately 8,000
- Three-level, 210,000 sq ft pit, or paddock, building with 36 garages. The upper floors of the paddock will seat 5,000.
- 152,720 sq ft grand plaza
- 5,000-seat amphitheater with a total capacity of 14,000
- Permanent concession areas and restrooms
- 251 ft high observation tower
- 40,000 sq ft state-of-the-art conference and media center with kitchen facilities
- A 8,485 sq ft team building
- A 5,500 sq ft medical center offering paramedic services
- Maintenance building
- Fuel distribution building
- Six helipads

Racing to the Finish

(Continued from Page 73) Boddingtons, part of the U.K. firm Fiberweb Geosynthetics Ltd. GeoSolutions, Inc., of Austin, introduced us to the product when we were looking for a way to reinforce the vehicular grass parking areas. GRASSPROTECTA functions in much the same way as the metal airfield gratings used in World War II. It's a polymer-based product that comes in 8 ft rolls. The idea is to seed an area, roll the product out over the seeded area, and let grass grow up through it. The grass will eventually cover the product, and mowing then becomes possible. As the event grew closer, we knew we would not have sufficient time to revegetate the helicopter grass parking pads, so we sodded a 60 by 60 ft square, rolled the GRASSPROTECTA over the sod, and staked it down with the necessary ground staples. We added a layer of TriAx TX5 Geogrid—manufactured by Tensar International Corporation, of Atlanta—under the GRASSPROTECTA as inexpensive insurance to help support the loads in inclement weather. We doubled the required number of stakes to hold it in place. The pads were watered daily until the event. The landing pads worked successfully without incident for more than 2,300 flights during the event weekend, and the Federal Aviation Administration was very pleased with the product's performance.

THE PROJECT REALLY started to come together in September 2012. Austin Bridge & Road, headquartered in Irving, Texas, and a subsidiary of Dallas-based Austin Industries, completed the final paving of the 3.4 mi circuit. The design parameters that went into the racetrack pavement section constituted the most critical element of the project. The speeds of Formula 1 cars can exceed 200 mph. Given the speed of the cars and the wear and tear on the track, the specifications for the paving material and the way in which it is placed are extremely stringent. The track itself must be incredibly even and level because the slightest bump or joint in the track surface can spell disaster during a race.

The big question was, how do you build a Formula 1 track on clay material having a high plasticity index? The team of consultants originally considered moisture conditioning but decided that such an approach would be insufficient for the level of quality needed. Instead, the team decided to undercut and remove the expansive clays and then backfill with select fill to ensure that the track would be isolated and move as a unit.

RANGER Excavating removed more than 4 million cu yd of expansive soil beneath the track area. Once the desired excavation grade was reached (approximately 10 ft below grade), a 30 mil (0.030 in.) polyethylene waterproof membrane was laid beneath a 6 ft 6 in. plug of sandy loam soil, followed by a 1 ft 6 in. layer of pit run material, 6 in. of crushed concrete, and a chip seal. A total of 940,000 cu yd of select fill material was imported, used as backfill, and compacted, bringing the elevation back to grade level. This fill was then tested before the paving operation began to ensure that no settlement had occurred.

AS THE RACE DATE APPROACHED WE WERE STARTING TO SEE A LIGHT AT THE END OF THE TUNNEL, BUT IT TURNED OUT TO BE A TRAIN COMING AT US.

The asphalt was specifically designed for this track. The mix is crucial because the coarse texture of the track surface must not become polished smooth by the sliding tires of the race cars.

The local aggregates came from quarries in Marble Falls, Texas. The aggregate was then shipped by rail to a drum mix plant in Menard, Texas, where it was mixed into the hot-mix asphalt concrete. At that plant, aggregate of different sizes was weighed and fed into the drum via a conveyor belt. After the aggregate and bitumen were fired to 340ºF, asphalt oil was added, and the "hot mix" was put into a silo that fed the trucks for hauling. The material had to be delivered to the site and installed before the mix dropped below 300ºF. This specification was crucial to the entire paving process.

Once the mix arrived on-site, Austin Bridge & Road began the paving process. The first course consisted of 17.72 in. of a hydraulically bound crushed limestone road base, followed by a 3.1 in. asphalt base course. Next was a 2 in. asphalt binder course and a 1.6 in. asphalt wearing course specially designed with high bitumen content for racing circuits to create a stronger, more skid-resistant surface.

It is important to note that typical pavers in the United States lay asphalt at approximately 30 ft per minute for a 2 in. mat. This rate was too high for the COTA track for two reasons. First, in order to pave a 3.4 mi track without any longitudinal seams, three pavers must run simultaneously, laying 13 ft 1.48 in. (4 m) wide lanes without stopping, as that might cause unevenness, bumps, or seams in the track. Second, as mentioned earlier, the mix had to be placed before the temperature dropped below 300ºF. So with the mix plant working furiously to produce the necessary amount of asphalt to meet the stringent specifications for these layers and deliver it to the site at a rate that would permit a continuous installation process, the pavers would have to lay the asphalt at a rate of less than 30 ft per minute. But if a typical paver is run at a lower rate, the vibratory screed will cause "chatter," or ripples. For that reason, Austin Bridge & Road used pavers specially designed by the German firm JOSEPH VÖGELE AG. By using a tamper bar and pressure bars that compact the asphalt as it is placed, these machines can lay the asphalt at a rate of less than 10 ft per minute without causing bumps. Their precompacting high-density screeds ensure smoothness and evenness.

And just to make sure the custom pavers were performing correctly, special electronic leveling systems were

used to test each paving layer. While ultrasonic sensors checked the surface for any irregularities, the track was also checked lengthwise and crosswise to ensure a levelness that did not exceed a variance of more than 3 mm (0.11811 in.) in 13 ft, 1.48 in. (4 m). Throughout the paving process, the asphalt quality and density were also checked using nuclear and nonnuclear density gauges.

In September 2012, four VÖGELE pavers placed the final wearing course. After the track was in place, it was monitored over the next couple of months for movement. The results revealed that the track was performing as the design intended. Finally, the track was certified by the Federation internationale de l'automobile in October 2012 and was ready to host the United States Grand Prix.

As the race date approached we were starting to see a light at the end of the tunnel, but it turned out to be a train coming at us. The final challenge for CBD was handed down at the end of April 2012. Travis County and COTA had reached an agreement about upgrading the road network surrounding the racetrack. The first improvement was to extend and upgrade a single-lane asphalt county road known as Kellum Lane. Upon completion Kellum Lane was about 3 mi long and three lanes wide. It provided another vital access point and helped relieve traffic congestion. This was accomplished by allowing exiting vehicular traffic out onto Pearce Lane and ultimately Highway 71. It was now May, and the race was to be held in November. We were asked to design this road, obtain a permit for it, put the project out for bids, and oversee its construction by race day. We thought, "This thing will get out of control. It will get out of control and we will be lucky to live through it." But in the end we agreed it could be done. Why not? Lee Whited, P.E., M.ASCE, a project manager for CBD, was the lead designer.

The roadway design consisted of a 70 ft right-of-way and 39.5 ft of pavement. The road would be designed so that it would be possible for the county to expand it in the future. Water quality and detention structures were provided. There were five water quality ponds located along the route for this purpose. The design began in May 2012 and was submitted to Travis County on June 15. The design continued through July as the county reviewed the application. Travis County granted a permit for the site plan on July 31. There was a slight snag because of an existing water line in the Kellum Lane that was owned and operated by Austin Water Utility. The line was lowered because of the shallow cover over the pipe. Again, with time as the critical feature, a majority of the line was replaced. There were several residences along Kellum Lane that took service off the water line, and service was continued until we could energize the tested new line. The project was advertised, and a contract was awarded. RANGER Excavating received the contract and was given 90 days in which to complete the work. Construction began in mid-August and continued up to November 13. A walk-through with representatives of Travis County was held on November 14, and the road was opened to traffic the following day. November 16 was the first day of the event and featured practice sessions for the race teams. The qualifying rounds were held on November 17. We made it!

THE BIG QUESTION WAS, HOW DO YOU BUILD A FORMULA 1 TRACK ON CLAY MATERIAL HAVING A HIGH PLASTICITY INDEX?

On November 18, 2012, the Formula 1 United States Grand Prix was held. The race was greeted by 117,429 exuberant, screaming fans who packed the 1,100-acre facility watching Vodafone McLaren Mercedes' Lewis Hamilton claim his fourth Grand Prix victory of the season. Infiniti Red Bull Racing's Sebastian Vettel finished second, and Scuderia Ferrari's Fernando Alonso came third. McLaren received the trophy in the World Constructors' Championship during Austin's inaugural event. The $400-million sports and entertainment venue, completed just days before its first major event, received rave reviews from the tens of thousands of fans who traveled to Austin from around the world to see Formula 1's return to the United States. Total attendance for the three-day event was 265,499, Friday's practice sessions and Saturday's qualifying rounds drawing respectively 65,360 and 82,710 fans.

A Grand-Am Road Racing event was held at COTA in March of this year, and a MotoGP event will take place there in late April. A V8 Supercars event is scheduled for mid-May, and the second running of the United States Grand Prix will be in November. COTA's Austin360 Amphitheater opened in early April and will be a frequent venue for concerts. **CE**

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PROJECT CREDITS **Owner:** Circuit of the Americas LLC, Austin, Texas **Geotechnical consultant:** Terracon, Austin, Texas **Civil engineer:** Carlson, Brigance & Doering, Inc., Austin, Texas **Environmental engineer:** Horizon Environmental Services, Inc., Austin, Texas **Construction firm and manager:** Austin Commercial, Dallas **Landscape architect:** TBG Partners, Austin, Texas **Architects:** Miró Rivera Architects, Austin, Texas; STG Design, Austin, Texas; Tilke Engineers & Architects, Aachen, Germany; and HKS Architects, Dallas **Earthwork contractor:** RANGER Excavating, LP, Austin, Texas **Track paving:** Austin Bridge & Road, Irving, Texas **Project manager:** MBC Consultants, Inc., Terrell, Texas **Structural engineer:** Walter P Moore, Austin, Texas **Mechanical, electrical, and plumbing engineer:** Michael E. James & Associates, Austin, Texas **Americans with Disabilities Act consultant:** Altura Solutions, L.P., Austin, Texas **Lighting:** Archillume Lighting Design, Inc., Austin, Texas