

Transforming a century-old site from a settling basin to a substation.

The 230 kV Entergy Substation is being constructed for the Sewerage and Water Board of New Orleans (SWBNO) on top of former drinking water settling basins from the 1890s.



The substation is just one critical piece in SWBNO's developing Power Complex—a grand plan to enhance stormwater management and delivery of clean drinking water in a city on the front lines of climate risk.

Read on to learn how the execution team dealt with:

- settling soil at the foundation site
- high heat and humidity during construction
- supply chain disruptions
- working inside an existing facility with another active construction site
- flood mitigation needs of a substation in a city below sea level



Site groundbreaking with New Orleans City Councilmember Eugene J. Green-Deanna Rodriguez, President and CEO of Entergy New Orleans-New Orleans Mayor, LaToya Cantrell; SWBNO Executive Director, Ghassan Korban; New Orleans City Councilmembers Joseph I. Giarrusso III and Freddie King III

Modernizing a Century-Old Site

The Sewerage and Water Board of New Orleans (SWBNO) has produced its own power for generations, using turbine generators that had been operational since the 1920s (in addition to overseeing the city’s drinking water, wastewater, and stormwater). It’s modernizing its plant with the development of a new [Power Complex](#), which will continue on-site generation AND enable the use of local utility Entergy’s grid power, increasing resiliency for its customers. Entergy Power Complex plans include building the new Entergy Substation, as well as replacing turbine generators and installing new static frequency changers to create the power needed for SWBNO’s 25-hz pumps.

“We pump every drop of water that falls on the city. And with that, we rely very, very significantly on power,” said Ghassan Korban, SWBNO Executive Director.

Entergy partnered with Black & Veatch to design and construct the SWBNO Substation to withstand the elements, ensuring the city can connect to the power it needs to drain storm water and provide fresh drinking water to the community throughout critical events.

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A Project Driven by Partnership

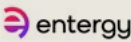
This project is not only a case study of technical ingenuity, but also of the importance of collaboration.

“It’s happening because of the partnership that we were able to create with the city, with the state, with the federal government, as well as the local power company, Entergy,” said Korban, SWBNO Executive Director.

“Bringing Black & Veatch in early on as we were scoping the project really helped. That collaboration was essential,” said Mario Ceravolo, Entergy Project Manager.



Entergy power customer and true one water utility



Local electric utility provider



EPC service provider



Construction Contractor



Transmission Subcontractor



In-process foundations on top of piles for bus supports (left) and transformer foundations (right)

Civil and Geotechnical Considerations

In situations where this volume of fill is installed on a site, short-term settlement and long-term settlement of the soil needs to be considered while designing foundations.

- Using information from both the Geotechnical Reports provided by Entergy and SWBNO and supplemental Geotechnical Reports put together by the BV team, BV’s group used Plaxis 3D to model the estimated settlement at the substation location both short term and long term (30 years).
- The model helped the Geotechnical team determine that the estimated vertical soil settlement due to the weight of the fill and the underlying soils, over 30 years, would be approximately 8 inches. This led to the conclusion that typical pier and slab on grade designs would not be adequate to mitigate the effects of the settlement and the down drag forces.

Estimated Settlement Required Deep Foundations

Due to the estimated 8” of settlement that would be seen in the center of the checkerboard (those soils compressing more than the ones on top of the existing struts), a lot of special design considerations were required.

Foundation Design Considerations

Because of the estimated settlement and down drag forces, a deep foundation design was needed to ensure that equipment in the substation wouldn’t be affected by this long-term differential settlement.

Black & Veatch’s Geotechnical group ran calculations to determine the most effective deep foundation system for the power substation given the settlement effects. The chosen solution was a pile and pile cap and pedestal foundation system to support all the structures, equipment, the control enclosure, and the metal clad switchgear at the substation. The solution included:

- 14-inch square precast concrete piles, 40 feet to 45 feet in length to mitigate long term settlement to less than one inch for all major equipment and enclosure locations. Rather than typical practice where the down drag determines the foundation design criteria, we determined the down drag criteria to limit settlement to one inch. Helical piles, 2-7/8 inches x 30 feet long, were used to support stair stoop foundation locations.

- Pile caps designed between 2 – 2.5 feet thickness of varying sizes, grouping equipment locations as needed to support constructability. During design of the pile caps, the higher water table as well as flood elevation impacts were considered.
- The pile cap and pile locations were optimized, while also avoiding the existing concrete struts that previously supported the old concrete basin.
 - Pile locations and installations needed to miss the struts, which meant that during engineering design, unique pile cap sizes were used to ensure that the piles were located properly.
- Foundation pedestals supporting the Substation Control Enclosure and the Metal Clad Switchgear Building were raised to higher top of concrete elevations to lift the enclosures above any 500 year flood elevations.
 - Design considerations included rebar design for a cantilevered pedestal supporting the high wind enclosure loads.
 - A system of platforms and stairs were installed to provide access to the enclosures.

Electrical Design considerations

From an electrical perspective, there were also settlement concerns with below grade material installation. BV had to plan support for anything running a distance (grounding, conduit, trench, etc.)

that would eventually travel the checkerboard of spots with up to estimated 8” of settlement. To mitigate the risks this stress could cause to the ground grid conductors, each ground grid conductor run was installed with additional slack at key locations to reduce stress on cadweld connection points. To reduce settlement stress on conductors in conduits, each below grade conduit was pile-supported or encased with rebar reinforced concrete.

Installation

Black & Veatch subcontracted with Patriot Construction, a local piling procurement and installation construction company, for the power substation installations of the piles, pile caps and pedestals.

Prior to pile driving activities, a test pile was driven, and pile testing was conducted to verify that the test data matched the expected data from the geotechnical calculations and models. Once the pile design was verified, piling installation activities moved forward. Black & Veatch provided QA/QC oversight of these construction activities.

The engineered design will ensure that long term settlement effects will be mitigated, while also ensuring that equipment and enclosures will be protected from future flood events at the power substation.



Left: concrete pile driving. Center: installed concrete piles, prior to foundation caps and foundation installation. Right: preparation for installing grouped foundation on top of piles with mud mat and pumps to dewater.

Designed for Resiliency and Reliability

The project's location and critical nature meant that resiliency and reliability remained top of mind. Increased grid power capacity was necessary to get more power to this area to power this new site using nearby existing transmission lines, while continuing to power the other loads in the area. Using a special type of conductor that had more power carrying capacity while not needing more structure and foundation support allowed BV to re-use the existing structures. This decision got more power out of existing structures and foundations, and helped to upgrade the grid faster, with fewer impacts and disruptions to existing customers and infrastructure.



The substation's location in New Orleans (a city below flood level) and near open water (a draw to birds and other wild life) meant that flood and animal mitigation measures were increasingly important to the project's resiliency and reliability. Raising critical electrical components above the 500-year flood elevation ensures the substation can continue to operate even if flooded. When electrical equipment is closer together because it is medium voltage, we added covers over air insulated bus and fittings to limit ability for animal caused outages or operational interferences as well as enclosing the medium voltage power distribution system in switchgear, also reducing opportunities for animal driven outages.

Using New C7 Conductor Technology

The project team was tasked with increasing the capacity of the line while re-using existing structures and clearances. To meet this criteria, they used [Southwire C7 conductor](#), a Zirconium Aluminum Conductor with carbon fiber composite core (ZTACCR). This conductor had near double the ampacity as similar sized ACSR (aluminum conductor steel reinforced) conductors.

The C7 conductor is relatively new technology and had been implemented in a handful of Entergy projects before, but the specific size and capacity used on this substation was new to the industry. Because it was so new, there were a couple of unique challenges:

- No hardware existed for it. The hardware provider ([AFL](#)) needed a sample to be able to test and confirm that hardware would perform as needed.
- [Southwire](#) still needed to manufacture and test the new sized conductor. Thus, the sample needed by the hardware provider couldn't be provided until after this was done.
- The contractor had not previously worked with C7, which required specific installation considerations.

Black & Veatch acted as a liaison to coordinate testing between AFL and Southwire to ensure it was done on time and material could be delivered to the Job site to support the re-conductor work being done during the outages. They coordinated a series of meetings between Bird Electric, Southwire, AFL and Entergy to ensure handling and installation methods were understood. In addition, there was a Southwire representative on site for the first installation to ensure everything went smoothly.

The conductor's materials also merited special attention. Because the core was carbon fiber, it was strong in tension, but weaker than other options under bending and compression. Extra care had to be taken during installation, and Black & Veatch worked with Southwire to ensure set up for pulling activities would not cause a hazardous bend on the conductor. During the installation of compression dead-ends, extra steps were required to ensure the core was not crushed or damaged. Southwire representatives were also on site during the first installation of the dead-ends, to walk through this process with the craft workers.

Flood and Animal Mitigation

Enclosed switchgear and protective covers

Entergy has a common practice of adding protective covers on substation Medium voltage equipment terminals and bus to prevent animal intrusion and minimize animal driven outages. Medium voltage phase spacing is typically 2-3', which is small enough that if an animal bridges across the two live bus phases it would cause a phase to phase fault and trip out the equipment to protect it from damage. This site took an additional step and changed design to enclosed switchgear, which provides even more protection, as part of Entergy's desire to create reliability for its customers.

The design team converted a majority of open-air bus and equipment to insulated switchgear and bus duct. However, due to station service limitations, a hybrid approach was taken by maintaining open-air electrical connections for the low-side distribution transformer and bus duct interface. The remaining open-air bus and connecting equipment was then insulated with an aftermarket solution to mitigate outages on this section of bus.

- All open air, non-insulated conductors were wrapped in silicone rubber insulation tubing and wrapped in silicone rubber fusing tape to secure.
- Silicone rubber covers are installed on all exposed medium-voltage bushings and arresters. Polycarbonate flex barriers are installed on all medium-voltage insulators to prevent any contact with live parts.
- Silicone rubber fusing tape is applied to all exposed electrical connections or conductors after tubing and covers are applied to completely insulate all exposed live parts.

Raised equipment

The control enclosure and switchgear buildings were elevated to ensure future flood levels were met. Equipment cabinets, outdoor supply panels and junction boxes were installed or confirmed to be at an appropriate height to ensure 500 year flood levels would not affect electrical operation of the equipment.

Vendor coordination was crucial in communicating the elevation adjustment for the buildings.

- All physical interface points were reviewed to determine what adjustments were needed to affected equipment (i.e. stairs & landings, external cable tray extensions, above grade conduit interfaces, bus duct building entrance)
- The medium-voltage bus duct to switchgear building interface was one of the one most crucial coordination points with the vendor. Transitioning the bus duct support from a client standard structure to vendor-provided steel structures required an elevation change in order for the bus duct to match up seamlessly with the building entrance.

Construction coordination was also very important to determine constructability and establish means and methods for install.

- Due to the large conduits and floor cutout constraints, concrete encased feeder conduits would need to be installed within 1 inch of design to ensure proper alignment with the switchgear. Prior to setting of the switchgear building, the field created templates and forms to begin laying out conduit required for the medium-voltage feeder duct banks.





On the right of picture, 230kV HV breakers, which required collaborating with the client to allocate breakers for other projects to ensure were delivered on time. The equipment took a year to deliver after purchasing - now lead times over 2 years.

Overcoming Construction & Procurement Challenges

Supply chain dilemmas can be damaging to an EPC project and its all-important schedule. “It’s a one BV perspective, no one works in a silo,” said Amala Okolo, Procurement Operations Manager. Procurement was engaged at the initial proposal stage of the project and the same team followed it through from the proposal stage through the execution phase. They worked hand in hand with engineers on a daily and weekly basis to ensure that the project moved smoothly. They leveraged the larger team, and collaborated with the client, supplier and engineers to find timely solutions for supply issues for all equipment, with special attention needed to:

- Transformers
- SSVTs
- Breakers
- Small pieces and parts

As the substation was being constructed inside a working facility and co-located with another construction site, collaboration and communication was required to keep everyone safe and on schedule. Additionally, the humidity of the region combined with record-breaking summer temperatures necessitated implementing a heat safety plan and an alternate work schedule to keep craft safe and the project on schedule. Bold leadership, frequent collaboration, and an EPC mindset were critical to project success.



The team moved quickly to purchase the 230/24 kV 67MVA transformers in 2022; they were delivered a year after purchasing. The transformers feed the 24kV enclosed bus duct connecting to the 24kV Switchgear on raised foundations for flood mitigation. Transformer lead times are now significantly longer than what was seen in this project.

Procurement

Equipment Delays and Collaborative Exchanges

SSVTs, while not the large transformer pictured above, were one piece of equipment that required particular attention for this project. Lead times are 50-100+ weeks and need to be secured well ahead of time.

This equipment was critical for operation and was also one of the last pieces of equipment to be delivered. The SSVTs were secured well ahead of time and the order was tracked for almost a year prior to its need. However, this did not ensure smooth sailing:

- While it was noted as “on track” for the distributor, the BV team was notified the month it was to be delivered that it would be delayed 6 months.
- The issue was discovered to be a mix of the manufacturer’s schedule and sequencing of plant production, material availability and a miscommunication between supplier parties of the need by date.
- Our relationship with our supplier led them to go the extra mile for us to push the issue with the manufacturer – we were able to get a much more acceptable delivery time.
- However, it was still a week behind what was needed for our critical schedule, so Black & Veatch temporarily utilized an Entergy SSVT to stick to the scheduled outage.

Failure to adjust this delivery date or to install on time would have had cascading and significant effects on the project schedule, costs and that of other projects for our clients. This case demonstrated the importance of the procurement team establishing relationships proactively. They knew the key players to go to when an issue arose and were immediately able to engage with the right people to get to a more acceptable solution.

The Manpower to Expedite

Because of supply chain constraints and longer lead times across the board, Black & Veatch engaged expeditors to ensure timely delivery. Across the industry, we're seeing a lot more effort is needed to expedite and coordinate materials, to ensure correct and timely delivery and receipt. Expeditors make sure materials and deliverables are shipped and received correctly to meet project schedule. Black & Veatch was able to pull in a qualified and trained expeditor from their other industries/solutions, when procurement became more cumbersome and more issues arose on the this particular substation project than typical. This helped to alleviate the project team from the time to coordinate, allowing them to keep their focus on design and construction activities while keeping dedicated proactive collaboration going with our suppliers. The expeditor provided quicker feedback to suppliers when their delays impacted our schedule and started negotiations sooner for improvements or mitigation plans. This made the difference to prevent project impacts from early notifications of concerns on several materials including the new T-line hardware, T-line conductor, SSVT, Switchgear, cable and several others. This is an example of something that has not been a significant issue in the past becoming increasingly important and time-consuming that BV has the staff to solve.

Construction Coordination

A Shared Workspace

The site's footprint was small and shared space included an access road and parking with another construction site within the facility. Mutual respect, coordination, and open, clear communication were key to maintaining safety as well as protecting the schedule. Tactics included:

- Weekly (sometimes daily) coordination between OCI site management and the neighboring SWBNO contractor, discussing: upcoming heavy hauls, large deliveries, and work schedules.
- Multiple scopes (for the substation site and upgrades at other Entergy locations to support this project) were worked in parallel. This was a delicate balance that created efficiencies but required special care to forecast.
- Clear delineation of each worksite.
- Explicit upfront signage with entry instructions for delivery drivers
- Proactive coordination with SWBNO site security on changes to work schedules and anticipated traffic
- Frequent conversations and collaboration with SWBNO on safety plans, construction plans and deliveries



Heat Safety

B&V, OSHA and Entergy all require a heat mitigation plan for the workplace. For the first few months of construction at the substation site in fall and spring (peaking at 50 craft and subcontractors on site), the weather didn't significantly impact the work schedule or productivity.

However, when the project hit the summer months, a record-breaking heat wave in New Orleans forced the plan to be implemented. In addition to utilizing the helpful [OSHA Heat Safety APP](#), the plan included work/rest and hydration schedules, as well as the steps below:

- All of the staff took the B&V Heat Illness Prevention training.
- Each day had a heat stress monitor. This person was also responsible for ensuring that everyone was drinking the required amount of water during the day.
- Shade for stationary work areas.
- Frozen popsicles.
- Water breaks when needed.
- Offices and vehicles were made available for cooling areas.

Once July hit, the heat index was regularly above 112, requiring craft to stay out of the heat half or more of the daytime to stay safe. This impacted productivity and financials that was putting us behind schedule. To keep the project on track, the Black & Veatch team temporarily worked at night. This created new and additional challenges, including:

- Determining the optimal start time.
- Adding sufficient illumination to safely work in the dark.
- Performing Lighting calculations to determine what lighting is sufficient.
- Rescheduling the craft, lunch breaks, and deliveries.
- Arranging nighttime security guards
- Planning time during the day for communication between field construction management and home-office team members and the client.

Taking all these things into consideration, the team made the decision to begin a construction schedule of 3:00 a.m. – 11:30 a.m. until the heat subsided. This timeframe had the least amount of traffic, both coming and going, allowing time during the day for collaboration before the heat was significantly disruptive. Eight light plants were used at night to address the illumination issues. This created an additional issue of shadows cast over the work area making it harder to work, so individual head lamps were used to mitigate this challenge. With the schedule change, the team began to bring in their lunch, as there were no establishments open at this late hour. We flexed schedules of some team members to allow them to work the extra hours needed for meetings and deliveries that couldn't be adjusted.

The results of these actions were clear: an almost 70% reduction in needed rest minutes.

- From 4/30 – 7/15 over 1,100 man-hours were lost to rest time due to the heat mitigation plan.
- From 7/15 – 10/15 only 650 hours were lost.

Heat Index	Work / Rest Min	Hydration Schedule
<90 F	Normal work - Unlimited	Basic heat safety and planning
91 - 103	Light Work – 55/5 Normal Work 50/10	Light Work – 1 cup/hr. Normal Work – 2 cups/hr.
104 to 111	Light Work – 50/10	Basic heat safety and planning
Normal Work – 40/20	Light Work – 2 cup/hr. Normal Work – 3 cups/hr.	Light Work – 1 cup/hr. Normal Work – 2 cups/hr.
112 to 121	Light Work – 40/20 Normal Work 30/30	Light Work – 2 cup/hr. Normal Work – 3 cups/hr
122 to 129	Light Work – 30/30 Normal Work 20/40	Light Work – 3 cup/hr. Normal Work – 1 quart/hr
> 130	Light Work See *** Normal Work***	New Mitigation Plan



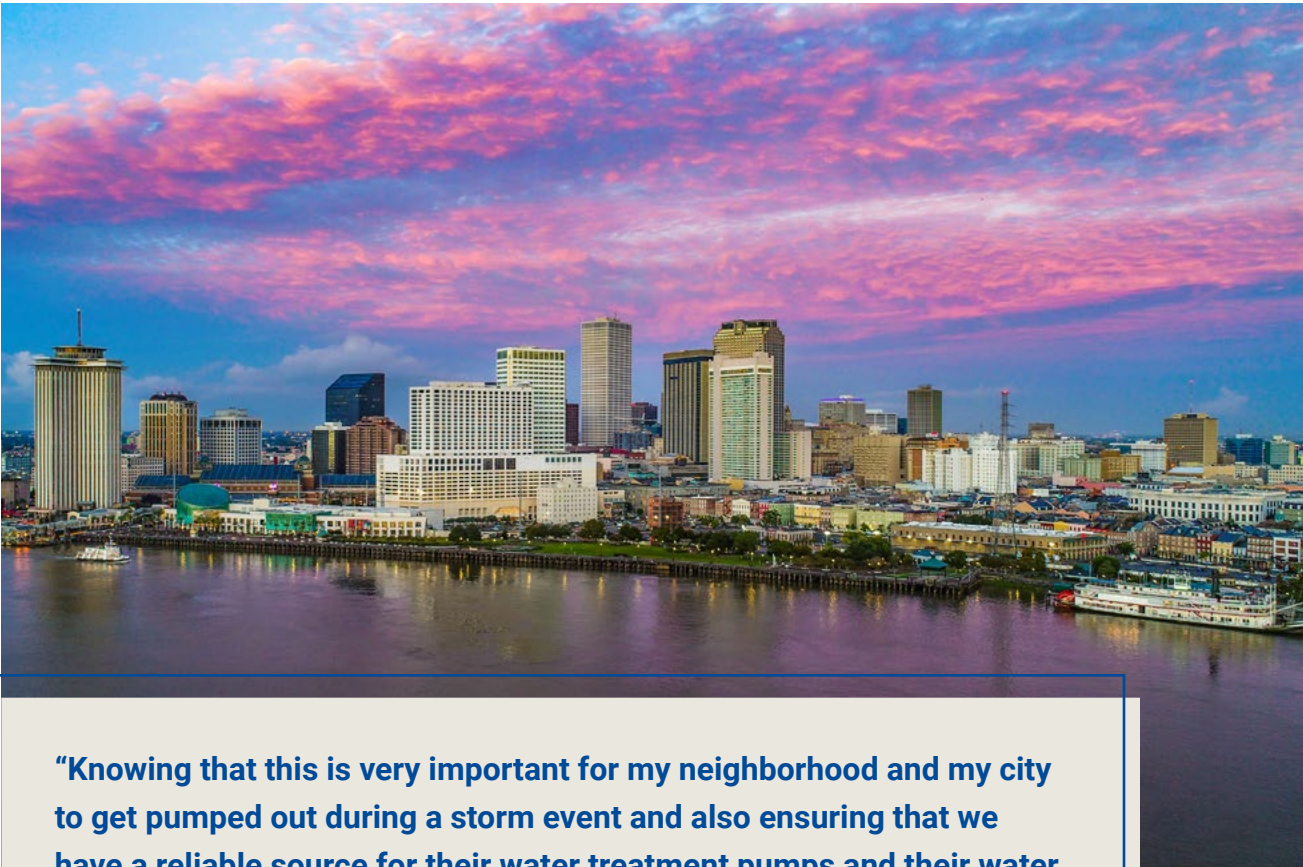
Top, Chart of work and rest and hydration schedules required by heat index, bottom, night work at the site.

Protecting the Local Community from Hazards and Outages

A project impacting such critical services required careful consideration to protect the community from hazards and outages. The team kept the local community top of mind in all they did. SWBNO led the communication effort to proactively inform residents of the anticipated construction activity, including the work for this part of the project. The team provided clarity on the project’s purpose, goals and plans. The transmission line being rebuilt was along a residential

road, which required BV to develop a traffic plan and construction plan that allowed residents to maintain access to their houses. The line we rebuilt is part of Entergy’s Grid network that feeds many nearby critical customers, including a local hospital. Black & Veatch worked with Entergy to create a complex and detailed outage schedule to minimize outages and ensure that the local hospital could maintain continuous power.

Entergy was also aware of the significance of the project to the local community. In particular, Mario Ceravolo (Entergy Project Manager), who lives just a few miles from the project and is both an Entergy and SWBNO customer.



“Knowing that this is very important for my neighborhood and my city to get pumped out during a storm event and also ensuring that we have a reliable source for their water treatment pumps and their water treatment system makes me feel a lot better that I’m doing something good for the city,” Ceravalo said.



A Complicated Cut-In Sequence

The in-service date for the project would have conventionally required a schedule where most transmission line work was completed in the summer. Summer outages would be difficult for any line because of the high load demand, but it was not even an option here because an outage would impact one of Entergy’s critical substations. To work around this, the work was divided into reconductoring and cut-in scope.

Reconductoring Scope

The reconductoring scope needed to be completed before the summer of 2023, to avoid the peak summer loads. It included reconductor of approximately 3/4 of a mile of existing structures. The engineering team designed the two new dead-end poles so the line could be reconnected in its original configuration, bypassing the power substation. The design also ensured that communication fiber could be installed before the summer. All structures were installed during this scope, including the ones required for the cut-in scope. This cut down the time and cost associated with mobilizing heavy equipment.

Cut-in Scope

The cut-in scope was then constructed in the fall of 2023. Because most of the work was already completed, this was a relatively small and simple piece of work, which reduced the outage duration and risk of delays. The team installed two spans of new conductor and removed the previously installed bypass. This approach minimized the potential for risk for the project by having already completed the more complicated new foundation and structure installation leaving less room for delays and less work that needed to be coordinated to complete at the same time as the Substation energization.

Constant Communication

Black & Veatch’s construction arm, Overland Contracting, was coordinating with subcontractor-turned-subsiary Bird Electric for the project. [Bird Electric](#) started out as the reconductoring/cut-in subcontractor, but was [acquired](#) by Black & Veatch in May 2023.

The two groups remained connected during the project duration with consistent communication via email, calls and Microsoft Teams chat. They focused on the early potential pitfalls and risk, including:

- Identification of new hardware that was required
- Additional training to handle/install C7 conductor
- Coordination and review of work plans
- Implementing good traffic control plans



Provided by a Full-Service Black & Veatch Offering

In addition to serving as Owner’s Engineer for the SWBNO Substation site three years prior, Black & Veatch provided full engineering, procurement, and construction (EPC) services for the project. Black & Veatch self-performed the **testing and commissioning** services at the SWBNO substation and remote facilities, as well as performed the majority of substation construction by Black & Veatch company [Overland Contracting Inc.](#) and T-line re-conductor and station cut-in with recently acquired [Bird Electric](#).

“This project is really a culmination of a number of years working on open book EPC projects with Entergy, and it was a great candidate for us to develop the scope together to really make sure we considered all of the different risks to the project to keep it operating for years to come,” said Katie Muer, Black & Veatch’s project manager for the substation.

