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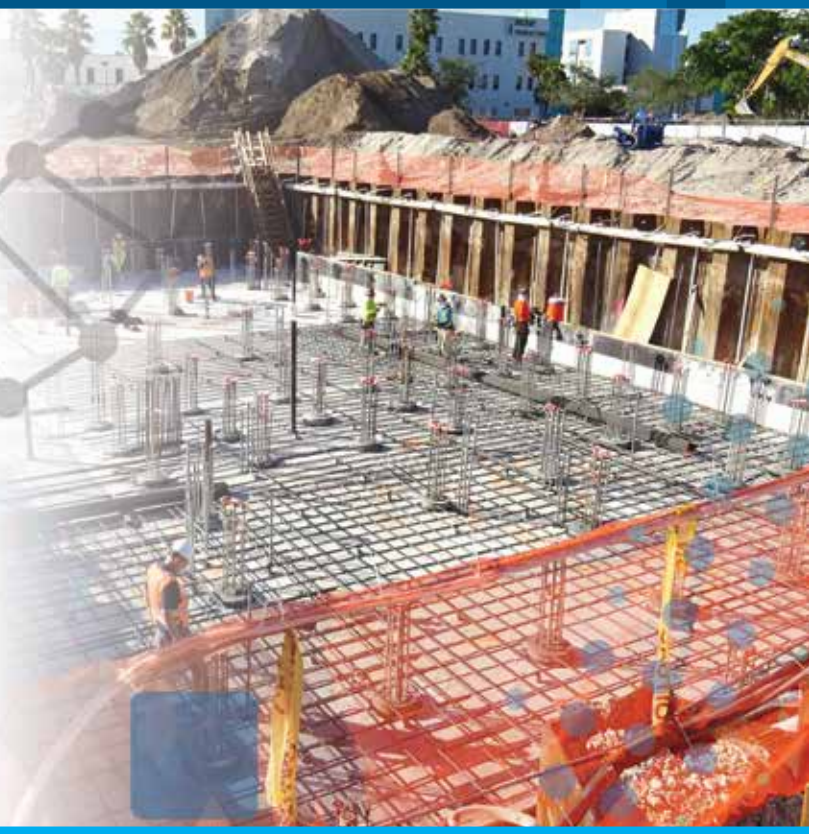
HEALTHCARE

CARING FOR OUR COMMUNITIES



CONSTRUCTING SPECIALIZED HEALTHCARE FACILITIES

Proton therapy is a fast-growing healthcare technology that requires a specialized construction approach. An advanced form of radiation therapy, proton therapy is highly effective and typically causes fewer side effects in patients than other cancer treatments. This technology is gaining popularity due to its ability to target cancer cells without harming healthy cells, and many new centers are being proposed worldwide. Construction of these specialized cancer treatment facilities is multi-faceted with complex requirements that require coordination by an experienced team.

Terracon focuses on geotechnical engineering, environmental consulting, building enclosure consulting, and materials testing, including special inspections, for projects housing various types of radiation therapies used by hospitals, including proton therapy. Each healthcare facility offering proton therapy has unique requirements, so every project plan must be tailored accordingly.

The foundation for a proton therapy device is heavily reinforced and waterproofed before concrete placement.

CREATING STABLE ENVIRONMENTS FOR LIFE-SAVING EQUIPMENT

Whether being installed in a new or existing facility, proton therapy equipment is very sensitive to vibration and requires unusually thick foundation walls, sometimes up

Continued on page 2

The cover for a proton therapy chamber is lowered into the building through the roof.

to 10 feet thick. Additionally, the precision treatment delivered via proton therapy equipment must have an ultra-stable platform, so vibration control should be used during construction in both existing and new facilities. Proton therapy equipment manufacturer's published vibration tolerances are very small, so an understanding of these requirements is critical in designing and conducting foundation installations, especially in or adjacent to existing facilities. Variances can result in the need for very costly recalibration of the proton therapy equipment and result in significant delays for critically needed treatment for patients.

Avoiding moisture intrusion is also a consideration for installation of proton therapy equipment, even more so when this sensitive equipment is installed in below-grade areas of a facility. Terracon provides pre-construction consulting to evaluate the proposed building enclosure (roofs, walls, and below-grade waterproofing) designs and systems, and provides recommendations to protect this very sensitive equipment. During construction, submittal review and site observations document that installation quality meets the intended design. Specialty testing (air and water penetration) is also conducted to verify the building enclosure systems will perform as intended. In addition, Terracon's team of industrial hygienists are available for specialized indoor air quality consulting.

PROTECTING PATIENT CARE DURING EXPANSION

Protecting patient health and safety during construction is important when proton therapy treatment equipment is planned for hospital expansions, as the rest of the facility must keep running during construction.

Foundations in particular require special attention. The equipment chamber is typically constructed first, the equipment is installed, and then walls are built surrounding the equipment. Even expansions comprised of only one or two stories need to be treated as multi-story due to the loads on the foundation. For one recent project, Terracon's team evaluated the existing pile foundation and recommended improvements due to very loose soil conditions at a depth of 30 feet.

The proton therapy facility at AdventHealth Altamonte Springs (formerly Florida Hospital Altamonte) provides an example of this kind of project. The Terracon team provided standard materials testing and special inspections of the facility addition, including the reinforcing steel in the large concrete box encapsulating the equipment.

Thickness of the walls and roof were inspected to verify that no cracks would form in the concrete due to temperature differentials or shrinkage in the concrete. Cracks must be avoided because they can fail to contain protons during equipment use.

Terracon's work at the Altamonte Springs facility was performed while the hospital was in operation, requiring the relocation of an existing ambulance loop outside the building. The team's experience with the complexities of this type of project, the relationships with the client and contractors, and our ability to be responsive were factors in the successful completion of the project.

WHAT IS PROTON THERAPY?

Proton therapy is an advanced form of radiation therapy that is non-invasive and uses a single beam of high-energy protons to treat various forms of cancer.

Experts predict the number of patients treated per year with proton therapy will increase from 16,200 in 2015 to 300,000 in 2030.

Benefits:

- Kills cancer and spares healthy tissue
- Limits negative side effects patients experience
- At maximum energy, a proton beam travels 125,000 miles per second—equivalent to two-thirds the speed of light

FOR MORE INFORMATION ABOUT TERRACON'S HEALTHCARE CAPABILITIES, CONTACT:

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COMPLETING THE PICTURE WITH GEOPHYSICAL INVESTIGATIONS

Advancements in geophysical technology provide a great supplement to traditional soil boring. Using nonintrusive, geophysical techniques, Terracon can help you understand much more about the subsurface of your project site, particularly the variations that occur between soil borings. These methods are minimally disruptive, fast, and relatively inexpensive.

The explosion of technology and data processing capability have allowed dramatic increases in the resolution of geophysical instrumentation. However, the adequate utilization of these revolutionary tools is restricted by three things:

1. Understanding of the benefits and limitations,
2. Selection of the proper geophysical tools from an ever-increasing toolbox, and
3. Ability to interpret the data to yield meaningful results and integrate those results with information gained using intrusive methods.

THE COMPLETE PICTURE

Geotechnical engineers and geologists have developed a myriad of methods to explore the subsurface with tools that collect samples and allow us to visually see, feel, and test the samples. These methods have stood the test of time, and the profession has great confidence in them. A geophysicist's expertise is a great complement to the traditional sampling methods. Tools to remotely measure variations in natural subsurface conditions, when administered by trained geophysicists, can complete the picture started with traditional sampling methods.

OPENING THE GEOPHYSICAL TOOLBOX

Just like any toolbox, the geophysical toolbox offers various ways to perform the tasks. Geophysical tools help us measure physical properties of the earth such as electrical resistivity, vibrations, variations in sound wave velocity, magnetism, and gravitational fields. All of these properties, and especially the variation of these properties, can provide understanding of the subsurface soil, groundwater, and rock conditions.

The complexity and diversity of geophysical methods often creates a challenge in determining which method is right for investigating the subsurface conditions of each unique site. Factors to be considered include site surface conditions, desired depth of investigation, ambient conditions in the area, and local geology. Terracon has developed a table which we refer to as our Geophysical Matrix, which is intended to be a guide for the proper use and application of geophysical methods.

The table below provides a summary of the variety of applications on which Terracon has utilized geophysical techniques.

What are you facing on your site?

GEOPHYSICAL INVESTIGATION APPLICATIONS

- Abandoned wells
- Bedrock depth/configuration
- Bedrock rippability
- Borehole clearance
- Buried drums/underground storage tanks
- Buried pipelines
- Buried stream channels
- Concrete slab thickness
- Contamination zones
- Embankment seepage
- Fault studies
- Forensic studies
- Foundation studies
- Gravel exploration
- Ground response
- Grounding/corrosion potential
- Groundwater barriers
- Groundwater depth
- Groundwater flow patterns
- Historic structure protection
- Landfill delineation
- Landslide delineation
- Pavement thickness
- Permeable zones
- Pile depth determination
- Pile driving monitoring
- Rebar depth/configuration
- Tunnel inspection
- Underground utilities
- Unexploded ordinance
- Void detection/karst

Visit terracon.com/geophysical for more information.

INTERPRETING THE RESULTS

Over the last 20 years, the ability to gather and process data in the field using digital techniques has grown exponentially. Now, we can store and interpret the massive amount of data that can be collected from various geophysical tools in seconds.

Understanding what this data means for a particular project's needs is a critical responsibility that should be entrusted only to trained geophysicists who have experience in the geologic setting and with a clear understanding of the needs of the project. For foundation and similar studies, the geophysicist must partner with geologists and geotechnical engineers to see the picture more clearly.

Terracon can assist you with complex subsurface investigations using the advanced geophysical techniques. With more than 45 team members dedicated to geophysical work in 27 offices, we have the resources to meet your needs. Our knowledge, experience, and expertise allow us to provide clients with a unique perspective on which geophysical methods are available and which are most suitable for their specific sites.

JACOB SPINSBY, P.G., MSC

Jacob is national manager of Geophysical Services located in Terracon's Denver office. He has more than 15 years of geophysical and management expertise, including subsurface utility engineering, geophysical exploration, and infrastructure non-destructive evaluation.

MINIMIZE LEGIONELLA RISKS WITH WATER MANAGEMENT PLANS

In recent years, the number of cases of Legionnaires' disease reported to the Centers for Disease Control and Prevention has risen at an alarming rate. Building water systems can favor the growth of *Legionella* bacteria. A concern for building owners and occupants alike, these bacteria are common and thrive in wet environments with moderately elevated temperatures such as hot tubs, building hot water systems, and heating, ventilating, and air-conditioning system cooling tower units in large facilities. This potentially deadly disease is caused by breathing in mist from water that contains the *Legionella* bacteria. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 188-2018, *Legionellosis: Risk Management for Building Water Systems*, establishes requirements for water systems and building owners to help prevent possible Legionnaires' disease outbreaks.

COMPLIANCE RELIES ON TEAMWORK

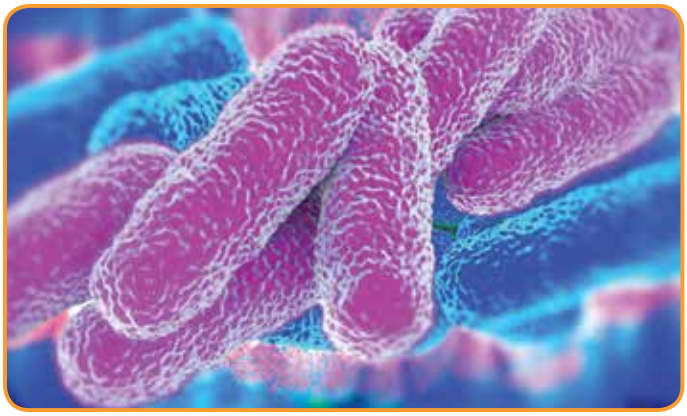
To properly comply with the ASHRAE standard, building owners should form a multidisciplinary program team that may include the building owner, maintenance or engineering staff, water treatment specialists, infection control prevention specialists, microbiologists, and certified industrial hygienists. This team of professionals is critical to the development and implementation of a water management plan (WMP).

SYSTEM DESCRIPTION AND ANALYSIS ESSENTIAL

As part of the WMP development, the program team should create a description and analysis of the building's water systems. Typical building systems that should be included in this plan are open and closed-circuit cooling towers, evaporative condensers, whirlpools or spas, ornamental fountains, misters, atomizers, and air washers or humidifiers. Some common building factors related to Legionellosis that will determine if potable water systems should be included in the plan are multiple housing units with centralized water heater systems; buildings more than 10 stories high; healthcare facilities in which patients stay more than 24 hours; housing or treatment areas for burn, chemotherapy, or transplant patients, or immunocompromised occupants; and housing for occupants who are more than 65 years old.

Once system components are identified, they are described in a written narrative, and a process flow diagram is prepared that helps identify exposure hazards and control measures.

Identification of locations with hazardous conditions helps to determine what control measures may be applied. A control measure can include water treatment methods and procedures, or actions to maintain physical (temperature or pH) or chemical (disinfectants) conditions in the system. Once a control measure is identified, control limits (maximum, minimum, or range of values to be maintained), monitoring methods and frequency, and corrective actions when control measures are outside of control limits can be determined.



Use of a water management plan can help building owners avoid the health risks associated with Legionella bacteria.

PROGRAM CONFIRMATION

Program confirmation is a critical step in the WMP process and includes program verification and validation. Verification involves making sure that initial and ongoing procedures are being implemented as designed and that control measures are in place and effective. Validation involves confirming that the WMP controls hazardous conditions in the system by verifying that control measures are documented and show that the system is in control. *Legionella* sampling is not required for system validation, however if control limits are not being maintained, if the program is for a healthcare facility with immunocompromised patients, or if the building has a history of Legionnaires' disease cases, periodic sampling may be prudent.

The program team should work together to develop documentation and communications plans that include notifications to building occupants and employees, training for those involved, and communication as a tool to improve the program itself. The WMP must be reviewed and updated annually.

The Terracon nationwide network of industrial hygienists and engineers can help building owners to identify *Legionella* risk and develop WMPs to help ensure a safe and healthy environment and minimize business operational impacts.

MIKE CRANDALL, CIH

Mike is a senior industrial hygienist in the Terracon Phoenix office. He has more than 40 years of experience in industrial hygiene and building investigations, working with commercial and institutional clients.

ADDRESSING CORROSION EXTENDS CONCRETE SERVICE LIFE

Concrete is generally thought to be a resilient material. Yet, those responsible for maintaining today's concrete structures are finding their buildings and bridges may not last as long as they'd like, partly due to the destructive effects of corrosion.

IT'S NOT TOO LATE TO ADDRESS FACILITY CORROSION

Rest assured, corrosion issues can be successfully addressed. Long-term durability in modern concrete structures is frequently impacted by corrosion of the embedded steel used to reinforce and limit cracking. Steel, when exposed to oxygen, has a thin protective layer on the surface that helps to prevent the steel from corroding. Concrete can help maintain this protective layer by maintaining a high pH level. If this pH drops, the protective layer can diminish and allow the steel corrosion process to begin. As steel corrodes, it begins to expand and is capable of expanding up to six to 10 times in volume. Long before reaching this level of corrosion, the steel will cause the concrete covering the steel to crack and potentially spall.

One of the more common causes of corrosion, and eventual spalling of concrete, comes from the use of de-icing salts and a chemical process known as carbonation. De-icing salts generally consist of chlorides, electrolytes that react with other components in the concrete to form an acid, which can cause areas of severe corrosion. Carbonation of concrete develops when carbon dioxide in the atmosphere reacts with components in cement—the bonding agent of concrete—to form a molecule with a lower pH. This reaction affects the concrete from the concrete surface to the interior, or through cracks in the concrete cover. It may take years for these chemical reactions to reach the steel, and several more years to see the effects of the corrosion. However, if not treated early, the reaction may cause severe and dangerous conditions

HOW INTERVENTION EXTENDS BUILDING LIFE

Terracon recently helped a client address deterioration of concrete used in a 60-year-old residence hall at a university. It was suspected that salts containing chlorides were used within the concrete mixture to help accelerate the concrete curing time when it was placed during the winter months. A combination of chlorides, moisture, and carbonation eventually caused the steel reinforcement to corrode the concrete on the underside of the facility's roof decks.

Our team provided the owner with a survey and testing of the concrete to map the distress and determine the cause of the deterioration. Based on our findings, we developed repair options and an engineer's estimate for completing the repairs. Due to the age of the building, the budget, and the long-term plan for the building, only a portion of the decks was selected for repair. Areas selected for repairs utilized sacrificial anodes, tabs of zinc connected to the steel meant to corrode before

Left: Concrete spall before work began.

Right: Sacrificial anodes installed after the concrete has been removed and the rebar cleaned and prepped.

the steel corrodes, allowing for extended service life of the steel. Observations were performed to check the connection between the sacrificial anodes and the steel, the cleaning and coating of the steel reinforcement, and the installation of the mortar to confirm the repair mortar was well bonded to the substrate.

The repairs performed are expected to provide an additional 10 years of service life to allow the structure to be used while the building is slowly decommissioned.

JEFF POE, JR., P.E., MSCE, RRO

Jeff is an engineer in the Charlotte, N.C., office. He has six years experience in building enclosure design and testing, structural material diagnostics and repairs, and contract administration.

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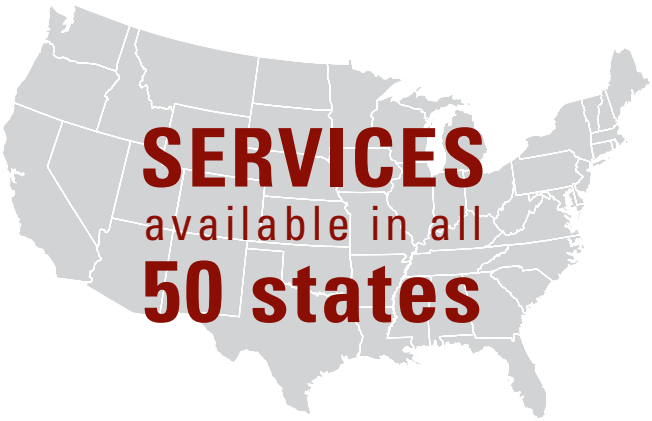

More Than 150 Offices Nationwide

TERRACON ACQUISITIONS ENHANCE ENVIRONMENTAL AND GEOTECHNICAL RESOURCES IN THE SOUTHEAST

Terracon is pleased to announce its acquisition of two organizations enhancing our geographic presence and depth in Georgia and the Southeast.

ENVIRONMENTAL SERVICES, INC.
A Terracon COMPANY

Environmental Services, Inc. (ESI) is a full-service environmental consulting firm providing environmental, and natural and cultural resources solutions. Founded in 1986, ESI serves public- and private-sector clients nationally from its headquarters in Jacksonville, Fla., and offices in Raleigh, N.C., and Savannah, Ga.

GEC
GEOTECHNICAL & ENVIRONMENTAL CONSULTANTS, INC
A Terracon COMPANY

Geotechnical & Environmental Consultants, Inc. (GEC) is an environmental, geotechnical, and construction materials consulting firm based in Georgia, with headquarters in Macon and offices in Columbus and LaGrange. The firm serves public- and private-sector clients throughout Georgia and the Southeast in the education, commercial, industrial, and government markets.

"Both companies have a strong presence in the Southeast and are deeply committed to the clients and communities they serve," said Gayle Packer, Terracon president and CEO. "Their expertise and services complement our existing environmental, geotechnical, and materials capabilities and will allow us to support our clients throughout the Southeast even more nimbly."

For more information, visit terracon.com/media

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TERRACON COMPANIES

- Argus Pacific, Inc.
- Building Exterior Solutions, Inc.
- Dente Group
- Earth Exploration Inc.
- Engineered Concepts
- Environmental Services, Inc.
- GeoCapitol Engineering, LLC
- GeoConcepts Engineering, Inc.
- Geotechnical & Environmental Consultants, Inc.
- Mayes Testing Engineers, Inc.
- NORCAL Geophysical Consultants, Inc.
- St. John-Mittelhauser & Associates

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