PROJECT RESUME
Marco D. Boscardin, Ph.D., D.GE, F. ASCE
Registered Professional Engineer as listed below

Boscardin Consulting Engineers, Inc. / Marco Boscardin – Consulting Engineer
53 Rolling Ridge Road
Amherst, MA 01002-1420

October 2021
413-549-3804 Office
413-237-4852 Mobile

EDUCATION

Ph.D., Geotechnical Engineering, University of Illinois at Urbana - 1975-1980
M.S., Geotechnical Engineering, University of Illinois at Urbana - 1974-1975
B.S., Civil Engineering, Massachusetts Institute of Technology - 1969-1973

PROFESSIONAL REGISTRATION

Registered Professional Engineer, State of Illinois (062-039449) – 1981 to date
Registered Professional Engineer, Commonwealth of Massachusetts (34186-C) – 1988 to date
Also, a PE in New York, New Jersey, Connecticut, Pennsylvania, New Hampshire, Vermont, and Virginia

PROFESSIONAL SOCIETIES

Academy of GeoProfessionals – Diplomate, Geotechnical Engineer
American Society of Civil Engineers – Fellow
American Concrete Institute
American Society for Testing and Materials
ASFE – The Geoprofessional Business Association
Association of Engineering Geologists - Affiliate Member
Deep Foundations Institute
Disputes Review Board Foundation – Professional Member
Geo-Institute
International Society of Soil Mechanics and Foundation Engineering
International Tunneling and Underground Space Association
North American Trenchless Technology Society
The International Association of Foundation Drilling - Technical Affiliate
The Underground Construction Association of SME
The Moles

CONTINUING EDUCATION

Disputes Review Board Administration and Practice Workshop, May 2002
Disputes Review Board Chairing Workshop, May 2002
DRBF Administration & Practice/Chairing Workshop, April/July 2020
DRBF Caltrans DRB/DRA Candidate Workshop 19-21 October 2021

GENERAL BACKGROUND

Dr. Boscardin has over 40 years of experience which includes geotechnical and geo-structural engineering industry ad academic experience with emphasis on underground construction, excavation support, instrumentation and building response to construction, shallow and deep foundations, and contaminant site evaluation, management and remediation. His background includes soil and rock tunneling, trenchless construction, excavation support, foundations, building and utility response to nearby construction, soil and rock laboratory testing, slope stability, dams, blasting, dewatering, grouting and other ground improvement, contaminated site assessment and remediation, geotechnical/structural instrumentation, structural design, and forensic and claims-related services.

RECENT PROFESSIONAL EXPERIENCE

12/02 to Date Principal, Boscardin Consulting Engineers, Inc., 53 Rolling Ridge Road, Amherst, MA 01002-1420. Boscardin Consulting Engineers, Inc. focused on geotechnical and structural engineering design and consultation for underground construction projects.

5/89 to 12/02 - GEI Consultants, Inc., Winchester, MA rose from project manager to MA and NH Branch Manager and member

of the Board of Directors. Project work included construction phase design of head walls and thrust pits for tunnel jacking through frozen ground for the Big Dig, geotechnical design for rock tunnels and rock slopes, litigation projects, construction support services for the MBTA Transitway Project (Boston), and excavation support design for Capitol Visitor's Center, Washington, D.C.

9/84 to 5/89 - Asst. Professor, Dept. of Civil Engineering, Univ. of Massachusetts at Amherst. Taught geotechnical courses with research activities on rock engineering, tunneling, foundations, excavations, and railroad ballast performance.

6/82 to 9/84 - Visiting Faculty, Dept. of Civil Engineering, Univ. of Illinois at Urbana. Co-Investigator of subsidence above abandoned coal mines and associated effects on structures and utilities, also taught introductory geotechnical courses.

6/80 to 5/89 - Consulting Civil/Geotechnical Engineer. Activities included: Design, analysis, evaluation, and remediation of problems associated with foundations for structures, open cuts, braced excavations, slopes, and walls in soil and rock; Tunnels in soil and rock; mines; Prebid studies and designs for contractors; Forensic engineering and litigation support.

1/75 to 6/80 - Teaching and Research Assistant, Dept. of Civil Engineering, Univ. of Illinois at Urbana. Investigated excavation-induced ground movements and associated effects on nearby structures.

3/76 to 6/80 - Various consulting geotechnical engineering jobs for Drs. Cording and Davisson, Univ. of Illinois at Urbana,

3/74 to 8/74 - Field Engineer, GEI Consultants, Inc., Winchester. MA. Performed construction over sight, instrumentation, and monitoring during installation of large diameter fiberglass outfall pipes (9-ft) on land and in a marine environment.

6/73 to 3/74 - Structural Designer, Charles T. Main, Inc., Boston, MA. Duties included structural design of steel and concrete structures for industrial structures and electric power generating facilities.

6/68 to 6/73 - Construction Laborer and Crew Leader, Marco Boscardin and Sons, Inc. Dover Plains, NY. Worked on concrete and masonry construction for residential, commercial, industrial, farm, and educational structures.

REPRESENTATIVE EXPERIENCE

Bridge Related Experience

- **Long Island Viaduct Boston, MA** - Performed feasibility evaluation of foundation reuse alternative and new foundation alternative for bridge reconstruction. Bridge is composed of 16 spans with up to 250-foot spans for a total length of 3450 feet. The spans are supported on 15 concrete piers and two abutment structures. The piers are founded on rock in some cases, crushed stone fill on rock in other cases, and timber piles into glacial till for a third set of cases. Also developed field subsurface investigation and geophysical investigation programs for evaluating existing and new bridge pier foundation conditions.

- **Goodwin Dam Spillway Channel and Channel Bridge, Riverton, CT** - Technical support and review for rock channel slope stability evaluation and bridge abutment foundation evaluation. Channel is approximately 175 feet wide and 70 feet deep and was constructed using blasting methods to remove the gneiss and schist rock leaving nearly vertical slopes. Bridge is a concrete arch structure built circa 1959, with an approximately 175-foot-span and carries secondary road traffic. Project included field mapping rock discontinuities by hand and via 3-D laser scanning, performing stability analyses, and developing remedial recommendations for the slope and bridge foundations.

- **University Avenue Bridge Over the Merrimack River, Lowell, MA** – Technical reviewer of geotechnical report for replacement of a three-span, 492-foot-long bridge. Existing bridge is a three-span structure supported by two abutments and two piers founded on a quartzite sandstone/siltstone. Review focused on rock mass properties interpreted from field

observations and laboratory testing. Properties of interest included bearing pressures, compressibility, permeability and excavatability (rippability).

- **Design-Build Culvert Replacement, Ryegate, VT –** Geotechnical and Instrumentation Engineer for D/B Team for cut-and-cover, cast-in-place concrete, stream culvert replacements under US Route 5 and the WACR railroad embankments. The new culvert openings are approximately 26 feet high and 32 feet wide with an aggregate length of 430 feet. The excavations range up to 70 feet deep and utilize sheet pile walls with hollow bar tiebacks and soil nails for temporary excavation support. Traffic was maintained on both highway and the railroad using temporary bridges, installed over a long weekend, supported on pile foundations. Designed instrumentation program and evaluated instrumentation data to monitor movements and performance of SOE and Bridges during Construction.

- **Temporary Railroad Bridge and Culvert Replacement, New Haven, VT** – The purpose of the project is to replace the existing pair of 4-foot by 5-foot stone culverts that convey a creek through the Vermont Rail railroad embankment with a 16-foot-wide by 7-foot-high by 110.5-foot-long precast concrete culvert. Developed a subsurface investigation plan and performed geotechnical investigations for a cut-and-cover, pre-cast concrete, stream culvert replacement and temporary railroad bridge foundations.

- **Pearl Harbor Memorial Bridge (Q Bridge), New Haven, CT** – Technical reviewer and consultant for cofferdams and base mats to support vibratory caisson construction equipment for large bridge (over Quinnipiac River with over 500-foot span) foundation element installations in organic silts over sand. Considerations included dynamic and static deformation moduli of the soft/weak silts, potential settlements and bearing pressures. Project also included foundation considerations for crane support mats on fills over the silts for existing bridge demolition. Key consideration was deflection of base mats during construction.

- **SOE for Fuel Oil Clean Up, Fitchburg, MA** – Feasibility study, then design for SOE for excavation of fuel oil soils. Issues addressed include river and related stone arch bridge adjacent to excavation area, support and protection of 8-inch-diameter natural gas main immediately adjacent to SOE, residual contamination between SOE wall and bridge abutment, use of part of SOE as a permanent cut-off wall, and installation in coarse alluvial and glacial till soils. Prepared SOE, excavation and backfilling design and specifications for sheet pile and secant pile (to protect the gas line) SOE, as well as sealed interlocks for permanent sheet piles, and later barrier grouting of bridge abutment wall and soil behind wall using polyurethane grouts

- **Settlement of Railroad Bridge Pier, Haverhill, MA –** Provided independent evaluation of potential DSC during construction of scour protection measures for support piers for a bridge over the Merrimack River with a length of 1900 feet and spans up to 180 feet. Protection measures include driven sheet piles and permeation grouting. Issues include potential for vibration induced settlements and groutability of soils.

- **Bridge Building, Vassar College, Poughkeepsie, NY** – Independent reviewer for geotechnical and design and construction. Provided monitoring and recommendations for completion of construction of the abutment portions of building in and varved clays that had been experiencing SOE movements during construction. The Bridge building was a two-story integrated science center that spans over the Fonteyn Kill (a water body). The building is composed of 3 spans, with a total length of nearly 400 feet, and a maximum span of 100 feet.

- **Bridge over River, Farmington, NH -** Provided engineering services and litigation support for an excavation support, bridge sheet pile cofferdam driving construction claim. Single span, approximately 50 feet.

- **Long Branch, NJ -** Evaluation and claims support related to sheet pile cofferdam flooding and by-pass pumping for bridge over a waterway. The temporary cofferdam was constructed to permit construction of bridge piers and abutments for a bridge reconstruction across a narrow lake. Served as expert witness for an arbitration hearing. Length 250 feet, 36-foot spans.

- **Bass River Crossing, Yarmouth, MA –** Provided engineering support and technical review to the prime consultant regarding feasibility of using HDD methods to install a 270 psi, 20-inch-diameter, 900-foot-long section of steel pipe gas line along Highbank Road and under the Bass River. The alternative is to support the gas line on the currently existing bridge which was built 1953 to replace a prior bridge located about 40 feet to the north of the existing bridge. The existing

bridge is approximately 200 feet long, 30 feet wide and comprised of 9 spans supported on driven, treated timber piles. Tasks included developing a subsurface investigation program, evaluating potential entrance and exit points, alternative HDD alignments, north and south of the existing bridge and potential obstructions posed by existing and prior bridge piling. Due to the elevations, slopes and curvatures of the road on either of the bridge as well as the potential for obstructions and impacts on residents along the road, it was determined that supporting the pipe on the bridge was a preferred alternative, even after considering reducing the pipe diameter to 12 inches to permit tighter installation curvatures.

- **Washington Street Bridge, Dover, NH**- Peer reviewer for geotechnical/foundation recommendations for a new, single, approximately 150-foot-span, vehicular bridge over a the Cocheco River.

- **Longfellow Bridge, Boston, MA** – Provided input on glacial till properties for existing foundation evaluation by others of highway and light rail transit bridge over the Charles River Basin. Bridge is approximately 1750 feet long with a maximum span of approximately 188 feet.

- **I-95 Extension and I-395 Viaduct, Baltimore, MD -** Instrumented, performed and analyzed pile load tests to develop value engineering design recommendations for I-95 and I-395 interchange structures. Instrumentation included electronic load cells, hydraulic pressure gages on rams, dial indicators, wire-mirror systems, telltales and optical surveying to monitor the load and movement of the test piles and reaction systems during compression and tension pile load testing. Pile types were H, pipe, Monotube, and mandrel-driven shell filled with concrete.

- **Wharf Improvements, Portsmouth, NH -** Managed foundation design and construction recommendations for waterfront facilities improvements to accommodate larger vessels. Improvements include modification/replacement of the bowline mooring structure, construction of bow and breast line guide structures, replacement of the stern line mooring structure, construction of a cellular cofferdam dolphin, and dredging to enlarge and deepen the berthing area.

Grouting, Ground Improvement, Ground Modification Experience

- **Contaminated Soil Effects on Jet Grout Strength, Medford, MA** – Provided consultation to the Contractor regarding the effects of diesel fuel soil contamination on the strength of jet grout columns in those soils, including assessment of contract documents information on soil contamination.
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- **Surcharge Loading and Settlement, N. Bergen, NJ –** Evaluated preloading an area augmented with wick drains to expedite drainage and consolidation of silt and clay deposit.

- **Settlement of Railroad Bridge Pier, Haverhill, MA –** Provided independent evaluation for D/B Contractor of construction of scour protection measures at pier. Protection measures include driven sheet piles and permeation grouting. Issues include potential for vibration induced settlements and groutability of soils.

- **Settlement of a Pair of Six-Story, Mixed-Use Buildings, West New York, NJ –** Provided expert geotechnical review services related to settlement of two buildings located on the west shoreline of the Hudson River. Soils consisted of miscellaneous fill, over a thick deposit of soft to very soft silts and clays. Foundation system for the buildings was spread and strip footings after ground treatment using deep dynamic compaction, wick drains and surcharge loading. Portions of buildings experienced greater than estimated settlements.

- **Design-Build Culvert Replacement, Ryegate, VT –** Geotechnical and Instrumentation Engineer for D/B Team for cut-and-cover, cast-in-place concrete, stream culvert replacements under US Route 5 and the WACR railroad embankments. Work includes filling abandoned concrete and granite block culverts with flow fill and grout to seal and prevent further ground loss, and treating sinkhole and loose embankment soils with permeation and compaction grouting.

- **UMass Boston, Integrated Sciences Complex, Boston, MA** – Design engineer of record for contractor installing controlled modulus column (CMC) elements approximately 25 to 30 feet deep to improve ground support for utilities and surface landforms for the complex. The site is reclaimed land and includes granular fill over miscellaneous land fill, cohesive fill over soft organic soils over deep marine sands and clays. Bearing strata for buildings is on the order of 100+ feet below the existing ground surface. The building is supported by deep foundation elements designed by others. Tasks

included reviewing/checking/approving CMC design computations and drawings; assisting in planning, instrumenting, performing and evaluating a CMC load test; performing periodic site visits to observe CMC and load transmitting platform (LTP) construction; meeting with site construction personnel, project designs and construction manager personnel to address changes and issues that arose during construction.

- **Building Compensation Grouting, Spadina Subway Extension, Toronto, Canada** - Technical review of compensation grouting design to limit building movements and report and risk evaluation for protection of a 3-story university building where twin, 20-ft-diameter subway tunnels are to be constructed about 28 feet directly below the building foundations and a 65-foot-deep braced excavation is to be constructed 15 feet from the building. The ground conditions consist of fill over medium dense to very dense glacial till and glaciolacustrine sands, silts and clays.

- **TBM Break-in Break-out blocks Eglinton Subway Line, Toronto, Canada** – Prepared and revised jet grouting specifications and test program for tunnel shaft entrance and exit eye ground stabilization for 7 shaft locations on the Eglinton-Scarborough Crosstown Twin Tunnels project. The goal was to prevent ground loss during TBM exiting launch shafts and entering reception shafts. Key issues included strength, stability, continuity, and permeability of the head walls, as well as, controlling jet grout related heave during installation, determining percent of ground that needed to be treated, identification of methods of to verify that treated ground met specification requirements.

- **MBTA Light Rail Accessibility Program at Copley Station, Boston, MA –** Provided geotechnical and building response consulting services for construction of a new elevator access shaft to an underground subway line in close proximity to a historic church. We were brought in mid-project to develop building, ground movement and excavation support movement and deformation criteria after construction jet grouting activities were observed to be impacting the church in order to safely expedite completion of construction. Tasks included reviewing past and current construction activities and building response data, setting criteria for ground and building response to permit completion of the work while protecting and managing risk to the historic fabric of the structure, inspecting the structures foundations and façade via test pits and boom lifts, reviewing results of pile load tests on existing timber piles supporting the church, reviewing SOE and dewatering construction submittals to complete the work, reviewing and developing recommendations for building, ground and excavation instrumentation which included automated data acquisition, and reviewing instrumentation data. Instrumentation included automated total station surveying of the façade of the church, in place inclinometers between the excavation and church, convergence gages in and crack gages on the church, seismographs, piezometers and observations wells accessible remotely via a web-based system.

- **South Ferry Terminal, New York, NY -** Pre-bid evaluation of a composite jet grout, micropile excavation support system option, to limit ground movements and ground water inflow while protecting overlying existing subway tunnel relative to excavation induce ground movements.

- **ADA Access Elevators and Pedestrian Tunnel, MBTA Boston, MA –** Technical Support and Risk Review for Design of elevator shafts, underpinnings and 15-foot-diameter, 150-foot-long pedestrian tunnel in a highly congested urban setting. Project involved threading the structures around and under existing structures undergoing renovation for high-scale use as well as two subway station structures and two levels of subway tunnel. Project to employ jet grouting, underpinning, micropile and ground freezing construction techniques.

- **SR99 Bored Tunnel Alternative, Seattle, WA –** Served as reviewer of planned tunnel settlement and building and utility response mitigation measure reports for the design-build team that was selected to construct an approximately 57-foot-diameter, 1.7-mile-long highway tunnel in soil up to 250 feet deep under downtown Seattle. Also, serving on the expert review panel for the design-build team during final design and construction. Key aspects include evaluating risk, controlling face pressures to balance high water pressures and control tunnel face ground loss, and protection of structures affected by the highway tunnel construction including modern and historic buildings, a viaduct structure and the BNSF Railroad tunnel. Tunnel construction and building protection measures considered included secant piles, compensation grouting, jet grouting, micropiles, underpinning, and building strengthening.

- **North Shore Connector LRT Project, Pittsburgh, PA** - Developed building protection and underpinning design and construction recommendations for approximately 6,700 feet of mined twin tube light rail transit soil and rock tunnels with stations passing under the Allegheny River and in downtown Pittsburgh. Potentially affected structures include historic buildings and ramps, aerial highway structures and utility lines adjacent to TBM mined tunnels, and slurry wall, deep soil

mix wall, cutter soil mixing wall, sheet pile wall and soldier pile wall excavation support systems. Project design included jet grout, compaction grouting, permeation grouting ground improvement to limit ground movements and related building movements during tunneling and open cut excavation, and preparation of a geotechnical baseline report (GBR). Provided construction phase services related to instrumentation, jet grouting, and tunneling which included responding to RFIs reviewing submittals, mix designs and field data, meetings with the owner and contractors, participating in test sections, reviewing DSC submissions and assisting in disputes review board (DRB) presentation preparation.

- **MBTA Silver Line Phase III, Boston, MA** - Developing geotechnical design and construction, and risk mitigation recommendations, building and transit station protection/underpinning design and construction recommendations, and excavated materials management specifications for an approximately 4,000-foot-long, twin tube, mined and open cut underground bus rapid transit tunnel through marine deposits, glacial till and rock in a dense urban setting. Construction methods considered include TBM mining, NATM mining, open cut excavation with slurry walls, jet grouting ground improvement, secant pile walls, and underpinning.

- **MBTA South Boston Piers Transitway, Boston, MA -** Developed geotechnical design and construction recommendations and provided construction support services for a 1,600-foot-long underground bus tunnel located in a dense urban environment. Tunnel sections include cut-and-cover tunnels, an immersed tube tunnel, a NATM mined tunnel using ground freezing to control groundwater and support two existing 7-story historic buildings during tunneling directly under the buildings, and installation of slurry walls for future adjacent construction. The tunnel structure included a sealed membrane liner. Important aspects of the project include design and construction monitoring of foundation and excavation systems and underpinning to minimize impacts on adjacent structures, utilities, and future construction, design of instrumentation systems to provide data to monitor progress and impacts of the construction and provide a basis for adjusting the foundations of the buildings to control damage, pile foundations for reconstructed wharfs, and evaluation and monitoring of existing historic seawalls adjacent to and above open cut and tunnel construction, and design of a permanent groundwater pressure relief system for an existing station affected by the new construction. Design included soil mix subgrade struts to stabilize an open cut with a soft bottom. The soil mix was replaced with jet grout based on acceptance of the Contractor's value engineering proposal. Services during construction included submittal and instrumentation data review and evaluation, planning periodic adjustments of the buildings' underpinning, monitoring jet grouting, ground freezing, compensation grouting, mini pile installation and other geotechnical construction at the site.

- **Central Artery/Tunnel Project, Tunnel Jacking, Contract C09A4, Boston, MA -** Provided geotechnical and temporary works, and tunnel jacking design services to contractor for installation, via tunnel jacking, of four tunnels under multiple commuter and Amtrak railroad tracks. Tunnels range in size up to 80 feet wide by 40 feet high by 350 feet long. Issues being investigated include controlling ground movements affecting the railroad facilities during and after construction excavation, ground stabilization by ground freezing, jet grout base slab support, slurry wall headwall design and developing jacking reaction.

- **Metro System, Washington, D.C.** – Collected tunnel-induced ground deformation data and building performance data during construction of stations and tunnels for the G-1 and F-2 lines of the Metro construction and used the data to develop building response estimation and damage criteria. Later worked on several station and tunnel construction projects (E1-d, Shaw Station, Navy Yard Station) as consultant to the contractor developing building impact and risk of damage estimates due to construction of stations by open cut methods, and 21-ft –diameter tunnels using EPB (with compressed air back up) methods, developing and implementing building monitoring systems, mining and lining back grouting sequencing, dewatering, and compensation/compaction grouting ground improvement and mitigation plans.

- **Granby 2/5 Microtunneling – MDC - CWP, Hartford, CT - Performed** design phase reviews, and a geotechnical baseline report (GBR) review for 48 and 60-inch sewer installations. Also provided construction phase services including: review and recommendations related to launching and receiving shaft performance and settlement issues in soft varved silt and clay soils; and alignment tolerance and alignment control during microtunneling. Modifications to access shafts included jet grout stabilized entry and exit eye blocks.

- **Garden Street Microtunneling – MDC - CWP, Hartford, CT -** Performed design phase reviews, and a GBR review for 60-inch sewer installation. Also provided construction phase services including review and recommendations related to: launching and receiving shaft performance and settlement issues in soft varved silt and clay soils; ground improvement at shaft eyes; and alignment tolerance and alignment control during microtunneling.

Tunneling Related Experience

- **Toronto OLS Subway line, Toronto, Canada, -** Provided geotechnical consultation and support to a Design-Build Joint Venture team during the bidding/pre-award phase. Services included: review of the GBR and GD;, assist in selecting JV design parameters for the temporary (SOE) and final underground structures; development of earth and rock pressure loading diagrams for temporary and permanent structures; support and protection of potentially affected structures and utilities; ground water inflow during construction estimates; potential pressures due to creeping/squeezing ground; potential seismic related pressures on temporary and permanent structures; and , instrumentation and monitoring of potentially affected structures and utilities.

- **60-to-72-inch-Diamter Pipe Ramming and Microtunneling for Culvert Installations Through Railroad Embankment, New Haven and Ferrisburg, VT –** Provided consultation and contractor design review services regarding steel casing design and installation loads for two, 50-foot-long pipe ramming installations and one, 100-foot-long microtunnel installation through railroad embankment composed of medium stiff to stiff clays.

- **Ground Loss and Settlements during Tunneling, Sacramento County, CA –** Provided expert review and claims support services regarding ground losses and settlements during construction of a 120-inch-diameter, 19,400-foot-long tunnel using an earth pressure balance (EPB) tunnel boring machine (TBM). Ground control measures included jet grouting at manhole and "safe haven" locations. Ground losses reportedly resulted in settlements, subsidence, and sinkholes above and near tunnel alignment.

- **Design of SOE for Cut-and-Cover Installation of Utility Steam Tunnel, Andover, MA –** Prepared Contractor SOE and Instrumentation design for a shallow, 220-foot-long, 8.5-foot by 8-foot, pre-cast concrete steam tunnel installed using cut-and-cover methods. Unique features of project include: close proximity of historic structures at each end of tunnel alignment, presence of duct bank crossing alignment requiring support, and limited construction periods defined by owner, requiring scheduling the work over two construction seasons.

- **ADA Access Elevators and Pedestrian Tunnel, MBTA Boston, MA –** Technical Support and Risk Review for Design of elevator shafts, underpinnings and 15-foot-diameter, 150-foot-long pedestrian tunnel in a highly congested urban setting. Project involved threading the structures around and under existing structures undergoing renovation for high-scale use as well as two subway station structures and two levels of subway tunnel. Project to employ jet grouting, underpinning, micropile and ground freezing construction techniques. Developed instrumentation program.

- **South Fork Intake, WCSA Abingdon, VA –** Provided technical and field oversight support for design and construction of a 160-foot-long, 5-foot-diameter intake tunnel in limestone with karst features. Final construction was performed using drill and blast methods and a steel casing pipe jacked in place concurrently. The final configuration included two, 20-inch-diameter HDPE carrier pipes and several 4-to-8-diameter HDPE conduits for utility support lines slipped into the casing and supported with spacers. Reviewed blasting vibration data.

- **SHCT Clean Water Project, MDC Hartford, CT -** Provided geotechnical, underground construction, instrumentation and GDR/GBR reviews related to design of a deep rock storage tunnel, related shafts, and microtunnels for consolidation conduits as well as associated structures for the MDC's CWP. Project included construction in varved clay and glacial till soils, and in sandstone and shale with basalt dike. Construction included slurry supported TBM launching and receiving shafts as well as drop shaft. Part of technical and risk review team for the 20+ foot diameter, 3-mile-long deep rock storage tunnel, and participated in developing criteria for composition and use of a DRB on the project.

- **Transbay Transit Center Project, San Francisco, CA -** Performed a Peer Review and Value Engineering services at the preliminary design level for approximately 1.3 miles of cut-and-cover and mined railroad and transit tunnels and related stations. Issues addressed included construction methods, risk, monitoring and mitigation of construction impacts on

adjacent structures and utilities, tunnel and station waterproofing, soil-structure interaction, construction dewatering, types of excavation support, and project risks.

- **SR99 Bored Tunnel Alternative, Seattle, WA –** Served as reviewer of planned tunnel settlement and building and utility response mitigation measure reports for the design-build team that was selected to construct an approximately 57-foot-diameter, 1.7-mile-long highway tunnel in soil up to 250 feet deep under downtown Seattle. Also, serving on the expert review panel for the design-build team during final design and construction. Key aspects include evaluating risk, controlling face pressures to balance high water pressures and control tunnel face ground loss, and protection of structures affected by the highway tunnel construction including modern and historic buildings, a viaduct structure and the BNSF Railroad tunnel. Tunnel construction and building protection measures considered included secant piles, compensation grouting, jet grouting, micropiles, underpinning, and building strengthening.

- **Eglinton Subway Line, Toronto, Canada** – Prepared and revised jet grouting and instrumentation design and specifications and test program for tunnel shaft entrance and exit eye ground stabilization for 7 shaft locations on the Eglinton-Scarborough Crosstown Twin Tunnels project. Key issues included strength, stability, continuity, and permeability of the head walls.

- **North Shore Connector LRT Project, Pittsburgh, PA** - Developed building protection and underpinning design and construction recommendations for approximately 6,700 feet of mined twin tube light rail transit soil and rock tunnels with stations passing under the Allegheny River and in downtown Pittsburgh. Potentially affected structures include historic buildings and ramps, aerial highway structures and utility lines adjacent to TBM mined tunnels, and slurry wall, deep soil mix wall, sheet pile wall and soldier pile wall excavation support systems. Project design included jet grout, compaction grouting, permeation grouting ground improvement to limit ground movements and related building movements during tunneling and open cut excavation, and preparation of a geotechnical baseline report (GBR). Provided construction phase services related to instrumentation, jet grouting, and tunneling which included responding to RFIs reviewing submittals, mix designs and field data, meetings with the owner and contractors, participating in test sections, reviewing DSC submissions and participating in disputes review board (DRB) preparation and presentation.

- **Abandoned Mine Evaluation, CA** – Part of team evaluation operational risks associated with acid mine drainage from an abandoned mine that produce iron, silver, gold, copper, zinc and pyrite from the 1860s to the 1960s. Evaluation included a brief inspection of the accessible portions of existing mine workings including viewing the condition of 5 to 10-year-old repairs to mine supports as it pertains to continued operation of acid mine drainage abatement systems. In addition, soil and rock slope stability in the vicinity of mine portals and along pipelines conveying mine drainage and dams and impoundments on the site were evaluated relative to risks to operation of acid mine drainage abatement measures.

- **MBTA Silver Line Phase III, Boston, MA** - Developing geotechnical design and construction, and risk mitigation recommendations, building and transit station protection/underpinning design and construction recommendations, and excavated materials management specifications for an approximately 4,000-foot-long, twin tube, mined and open cut underground bus rapid transit tunnel through marine deposits, glacial till and rock in a dense urban setting. Construction methods considered include TBM mining, NATM mining, open cut excavation with slurry walls, jet grouting ground improvement, secant pile walls, and underpinning.

- **Miramar Water Treatment Plant Upgrade and Expansion, San Diego, CA** – Participated in developing design recommendations and later reviewed contractor tunnel construction, support, instrumentation and grouting submittals for the design team/owner for open cuts and tunnels constructed under existing sedimentation basins. Twelve-foot-diameter horseshoe-shaped tunnels to house 120-inch-diameter pipes were constructed in the Stadium Conglomerate directly beneath two sedimentation basins. The tunnels were mined using roadheaders and hand mining methods with spiling and shotcrete with steel ribs support. The key issue was to perform the construction with little impact to the serviceability of the sedimentation basins so that they could continue function following the construction.

- **West Roxbury Sewer Tunnel Rehabilitation, West Roxbury, MA -** Performed geotechnical and contaminated materials evaluation and management for conceptual design of alternatives for repair, rehabilitation and replacement of 12,500 ft of 7-ft-diameter, rock tunnel and 1000 ft of soil tunnel. Evaluated new rock tunnel construction, slip lining of existing tunnel and spray on lining. Performed geotechnical and contaminated soils management services for final design and construction of the slip lining of the 1000-ft soil tunnel.

- **MBTA South Boston Piers Transitway, Boston, MA -** Developed geotechnical design, construction, instrumentation monitoring recommendations and provided construction support services for a 1,600-foot-long underground bus tunnel located in a dense urban environment. Tunnel sections include cut-and-cover tunnels, an immersed tube tunnel, a NATM mined tunnel using ground freezing to control groundwater and support two existing 7-story historic buildings during tunneling directly under the buildings, and installation of slurry walls for future adjacent construction. The tunnel structure included a sealed membrane liner. Important aspects of the project include design and construction monitoring of foundation and excavation systems and underpinning to minimize impacts on adjacent structures, utilities, and future construction, design of instrumentation systems to provide data to monitor progress and impacts of the construction and provide a basis for adjusting the foundations of the buildings to control damage, pile foundations for reconstructed wharfs, and evaluation and monitoring of existing historic seawalls adjacent to and above open cut and tunnel construction, and design of a permanent groundwater pressure relief system for an existing station affected by the new construction. Design included soil mix subgrade struts to stabilize an open cut with a soft bottom. The soil mix was replaced with jet grout based on acceptance of the Contractor's value engineering proposal. Services during construction included submittal and instrumentation data review and evaluation, planning periodic adjustments of the buildings' underpinning, monitoring jet grouting, compensation grouting, mini pile installation and other geotechnical construction at the site.

- **Four Mile Fork Drainage Basin Tunnel, WV -** Developed design and specification recommendations for excavation and support of an unreinforced concrete-lined dam diversion tunnel in sandstone and shale.

- **Burlington Tunnel, Burlington, VT –** Provided rehabilitation/report design and construction recommendations for a 340-foot-long brick masonry-lined railroad tunnel originally built in 1860/1861. The tunnel was taken out of service for repairs to the deteriorated surface of the brick lining and to allow lowering of the invert of the tunnel to improve clearances. The tunnel lining is an elliptical-shape horseshoe configuration supported limestone footing blocks. Based on historic reports, the 1860's tunneling encountered what appear to be running sand conditions that made the stabilization and control of the ground during the original mined construction difficult. Rehabilitation construction design addressed, removal of invert of tunnel and impacts on tunnel lining stability and movements before and during construction. Rehabilitation construction included removal, lowering, and re-installing the tunnel invert, application of shotcrete to deteriorated sections of tunnel lining, and grouting of lining to repair existing cracks in the masonry, and monitoring deformations during construction.

- **Central Artery/Tunnel Project, Tunnel Jacking, Contract C09A4, Boston, MA -** Provided geotechnical and temporary works, and tunnel jacking design services to contractor for installation, via tunnel jacking, of four tunnels under multiple commuter and Amtrak railroad tracks. Tunnels range in size up to 80 feet wide by 40 feet high by 350 feet long. Issues being investigated include controlling ground movements affecting the railroad facilities during and after construction excavation, ground stabilization by ground freezing, jet grout base slab support, slurry wall headwall design and developing jacking reaction.

- **Staple Bend Tunnel, PA -** Technical consultant for design of rehabilitation measures for a 900-ft-long, horseshoe-shaped soil and rock tunnel 19 ft wide by 20 ft high. This is a historic tunnel, circa 1833, reportedly the first RR tunnel and the third tunnel overall constructed in the US. Ends are in soil with masonry and concrete lining (150 ft) and the central 600 ft is unlined rock tunnel. Tunnel is being rehabilitated for public access while retaining historic elements, e.g. portal facades, masonry lining and interior rock exposures. Investigation program included detailed mapping of tunnel condition, borings in portal areas and limited test pitting of the tunnel floor. Designed repairs include rebuilding facade retaining structures, installing spot rock bolts, repointing masonry lining and installing shoring post in overhang areas.

- **The New-Gate Prison and Copper Mine, CT -** Inspected the condition of the mine, evaluated the safety of the mine for public access, and developed recommendations regarding support maintenance, support replacement, loose rock removal, and new support installation needs for continued safe public access. The mine is a historic site that is open to the public, including underground tours of the mine. The copper mine was reportedly first put into service circa 1705. The mine was later used as a prison from 1773 to 1827. Also performed follow up inspection and recommendations 7 years later.

- **Greenup Lock Extension, Culvert Bypass Alternatives Analysis, KY** - Technical lead for the alternatives analysis that investigated 15 different options for installing a culvert around the existing 600-ft lock to provide filling capacity for the 600-ft lock extension on the Ohio River. Open cut, braced sheet piles, braced slurry walls, and various tunneling options were considered. Each alternative was examined with respect to cost, constructability, and risks associated with construction and expected costs. The most economic and viable options resulting from the analysis were the combination of an open cut with a braced slurry wall or braced sheet pile wall.

- **Central Artery, DO14C and D017A Design Sections, Boston, MA** - Task manager for subsurface investigation, laboratory testing, data analyses, and data and engineering report preparation. Subsurface investigations included standard penetration test borings, thin-walled tube sampling, rock coring, cross-hole seismic tests, water level and pressure monitoring, borehole permeability testing (packer, constant head, and variable head methods) and site hydrogeology. Also directed *in situ* testing including pressuremeter, dilatometer, and field vane tests for the Central Area. Laboratory testing included sample radiography, standard index tests, triaxial strength testing (compression, extension, and K_o), direct simple shear tests, consolidation tests, and dynamic triaxial tests. Data analyses were performed to develop subsurface profiles, to estimate soil properties, and to provide soil and rock parameters and geotechnical design and construction recommendations for use by the Section Design Consultants. Geotechnical design issues included soil and rock excavation, slurry walls for excavation support, pipe jacking and tunneling for utility line relocations, water control during construction, seismic loads, and effects of construction on adjacent structures, utilities, and tunnels.

- **Stillwater Tunnel, Utah** Monitored rock tunnel instrumentation. Instrumentation included vibrating wire strain gages on steel ribs, inclinometers (oriented horizontally for tunnel crown observations), a curvometer (for change in curvature of steel ribs), and a deflectometer (tunnel springline movements) for a water transmission tunnel.

- **Plateau Creek Pipeline, CO -** Performed geotechnical analyses and evaluations in connection with the preliminary geotechnical investigation and final design for replacement of the water pipeline. Evaluated alternatives for replacement of a 2,500-foot-long tunnel section that was in a deteriorated, unlined tunnel, in sandstone and shale. Also evaluated feasibility of using pipe jacking and microtunneling in-lieu of open cut techniques to install several shorter, 48-inch-diameter pipeline segments in soil and rock at road and stream crossings. Final design activities included design, specification and, geotechnical baseline report review and revision for a 3,400-foot-long drill and blast tunnel (SEM/NATM) and a 10,000-foot-long, 20-foot-diameter TBM rock tunnel to house the 48-inch diameter water line. Served as technical reviewer of final design for tunnel and portal rock excavation and support.

- **Metro System, Washington, D.C.** – Collected tunnel-induced ground deformation data and building performance data during construction of stations and tunnels for the G-1 and F-2 lines of the Metro construction and used the data to develop building response estimation and damage criteria. Later worked on several station and tunnel construction projects (E1-d, Shaw Station, Navy Yard Station) as consultant to the contractor developing building impact and risk of damage estimates due to construction of stations by open cut methods, and 21-ft –diameter tunnels using EPB (with compressed air back up) methods, developing and implementing building monitoring systems, mining and lining back grouting sequencing, dewatering, and compaction grouting ground improvement and mitigation plans.

- Also provided design and evaluation services for projects at contaminated sites where ground improvement methods, mostly in situ stabilization, was evaluated and used to isolate and encapsulate contaminated soils in place.

Excavation and Building Response, Instrumentation Experience

- **SOE Recommendations and Design for MGP Soil Excavation and Removal, Lynn, MA –** Evaluated ground conditions and prepared preliminary sheet piled, tied back, and sloped SOE designs for contaminated soil removal. SOE was to protect a roadway and utilities adjacent to the excavation in sandy soils.

- **Design-Build Culvert Replacement, Ryegate, VT –** Geotechnical and Instrumentation Engineer for D/B Team for cut-and-cover, cast-in-place concrete, stream culvert replacements under US Route 5 and the WACR railroad embankments. The new culvert openings are approximately 26 feet high and 32 feet wide with an aggregate length of 430 feet. The excavations range up to 70 feet deep and utilize sheet pile walls with hollow bar tiebacks and soil nails for temporary excavation support. Traffic was maintained on both highway and the railroad using temporary bridges, installed over a long weekend, supported on pile foundations. Designed instrumentation program and evaluated

instrumentation data to monitor movements and performance of SOE and Bridges during Construction.

- **Temporary Railroad Bridge and Culvert Replacement, New Haven, VT** – The purpose of the project is to replace the existing pair of 4-foot by 5-foot stone culverts that convey a creek through the Vermont Rail railroad embankment with a 16-foot-wide by 7-foot-high by 110.5-foot-long precast concrete culvert. Developed a subsurface investigation plan and performed geotechnical investigations for a cut-and-cover, pre-cast concrete, stream culvert replacement and temporary railroad bridge foundations.

- **Monitoring Culvert through Railroad Embankment, Middlesex, VT** – Resumed monitoring of prior existing inclinometer in a railroad embankment near a culvert that had experienced damage due to instability of the embankment slope. Original inclinometer readings were by VTrans (March 2014 to June 2015), converted data files and set up to run with a different inclinometer setup, yet maintain continuity of reading history from March 2014. Processing readings and evaluating data approximately quarterly.

- **SOE for Fuel Oil Clean Up, Fitchburg, MA** – Feasibility study, then design for SOE for excavation of fuel oil soils. Issues addressed include river and related stone arch bridge adjacent to excavation area, support and protection of 8-inch-diameter natural gas main immediately adjacent to SOE, residual contamination between SOE wall and bridge abutment, use of part of SOE as a permanent cut-off wall, and installation in coarse alluvial and glacial till soils. Prepared SOE, excavation and backfilling design and specifications for sheet pile and secant pile (to protect the gas line) SOE, as well as sealed interlocks for permanent sheet piles, and later barrier grouting of bridge abutment wall and soil behind wall using polyurethane grouts

- **UMass Boston, Integrated Sciences Complex, Boston, MA** – Design engineer of record for contractor installing controlled modulus column (CMC) elements approximately 25 to 30 feet deep to support utilities and surface landforms for the complex. The site is reclaimed land and includes granular fill over miscellaneous land fill, cohesive fill over soft organic soils over deep marine sands and clays. Bearing strata for buildings is on the order of 100+ feet below the existing ground surface. The building is supported by deep foundation elements designed by others. Tasks included reviewing/checking/approving CMC design computations and drawings; assisting in planning, instrumenting, performing and evaluating a CMC load test; performing periodic site visits to observe CMC and load transmitting platform (LTP) construction; meeting with site construction personnel, project designs and construction manager personnel to address changes and issues that arose during construction.

- **Pearl Harbor Memorial Bridge, New Haven, CT** – Technical reviewer and consultant for cofferdams and base mats to support vibratory caisson construction equipment for large bridge foundation element installations in organic silts over sand. Considerations included dynamic and static deformation moduli of the soft/weak silts, potential settlements and bearing pressures. Project also included foundation considerations for crane support mats on fills over the silts for existing bridge demolition. Key consideration was deflection of base mats during construction.

- **Upper Saucon, PA –** Conceptual phase consultation and evaluation regarding potential for mine subsidence and related impacts on the design and performance of a large, secure data facility composed of two, 400-ft by 600-ft main buildings and a number of smaller support structures sited over the footprint of an abandoned mine. Risk issues considered included potential for and likely magnitude of subsidence associated with abandoned zinc mine complex 700 to 1200 feet below the ground surface and the deformation and performance issues likely for the various structures to be located above and near the mine. The host rock for the mine is limestone and karst features were also a consideration in the site development and conceptual foundation design.

- **Lopatcong, NJ** - Consultation and review regarding foundation design for a large secure facility in an area with karst (solution limestone) ground conditions. Foundation systems considered included 4 to 6 ft diameter drilled shaft and large spread footings as well as a mixed system. Key issues included detection of solution activity zones at specific foundation element locations, verification methods to employ during construction, bearing capacity and settlement.

- **Albany Hospital, Albany, NY** - Consultation related to evaluating ground movements and related risks associated with braced excavations, 20 to 30 feet deep, in a deep deposit of soft to very soft varved clay including potential movements and impacts to adjacent buildings and utilities. Considerations included global stability of the excavations, large surcharge

loadings due to nearby buildings, applicable support of excavation (SOE) types and stiffnesses and ground improvement options.

- **Capitol Visitors Center, Washington, D.C. -**Technical review and oversight of slurry wall and tieback excavation support system temporary works design for the Contractor of a 55-foot deep, approximately 300 feet by 500 feet excavation for an underground visitors' center for the United States Capitol Building in Washington, DC. The excavation is to within 2 feet of the Capitol Building which is supported on shallow foundations. Tasks included evaluation of impacts of construction on the building, design of slurry wall and tiebacks for the temporary construction loads and to limit displacements of SOE and the adjacent Capitol Building.

- **Ramona Street Extension, San Diego County, CA** – Rock removal evaluation for street and related utility extension. Examined rock removal alternatives including: drill and blasting; ripping; closely spaced drilling with mechanical breaking; and closely spaced drilling with expansive grouts. Key concerns included noise and vibration during excavation. Developed preliminary rock removal designs for each methodology and estimates of feasibility and probable cost ranges for each methodology.

- **Caton Place, Brooklyn, NY -** Pre-bid evaluation of soldier pile and lagging and secant pile excavation support system options, as well as, raker, cross-lot and tieback bracing support options and expected adjacent building movements, protection/underpinning.

- **South Ferry Terminal, New York, NY -** Pre-bid evaluation of a composite jet grout, micropile excavation support system option, to limit ground movements and ground water inflow while protecting overlying existing subway tunnel relative to excavation induce ground movements.

- **Barclay Street, New York, NY -** Pre-bid evaluation of a tied back secant pile wall excavation support system alternative, and related adjacent building displacement, performance and protection.

- **Citizen's Gas Works/Carroll Gardens, Brooklyn, NY –** Preliminary design recommendations for excavation support system to permit excavation during MGP contamination remediation. Key issues included limiting deflections and damage to roads, utilities and a nearby building and dewatering concerns. SOE alternatives considered included driven steel sheet piling and solder pile and lagging systems.

- **Building Compensation Grouting, Spadina Subway Extension, Toronto, Canada -** Technical review of compensation grouting design to limit building movements and report and risk evaluation for protection of a 3-story university building where twin, 20-ft-diameter subway tunnels are to be constructed about 28 feet directly below the building foundations and a 65-foot-deep braced excavation is to be constructed 15 feet from the building. The ground conditions consist of fill over medium dense to very dense glacial till and glaciolacustrine sands, silts and clays.

- **MBTA Light Rail Accessibility Program at Copley Station, Boston, MA –** Provided geotechnical and building response consulting services for construction of a new elevator access shaft to an underground subway line in close proximity to a historic church. We were brought in mid-project to develop building, ground movement and excavation support movement and deformation criteria after construction jet grouting activities were observed to be impacting the church in order to safely expedite completion of construction. Tasks included reviewing past and current construction activities and building response data, setting criteria for ground and building response to permit completion of the work while protecting and managing risk to the historic fabric of the structure, inspecting the structures foundations and façade via test pits and boom lifts, reviewing results of pile load tests on existing timber piles supporting the church, reviewing SOE and dewatering construction submittals to complete the work, reviewing and developing recommendations for building, ground and excavation instrumentation which included automated data acquisition, and reviewing instrumentation data. Instrumentation included automated total station surveying of the façade of the church, in place inclinometers between the excavation and church, convergence gages in and crack gages on the church, seismographs, piezometers and observations wells accessible remotely via a web-based system. Dewatering included recharge wells to maintain water levels and limit related impacts on the church on other nearby structures and utilities. Geotechnical related construction activities included jet grouting, secant pile installation for SOE and shaft bottom stability, and demolition of an existing MBTA access stairway.

- **Castalia Pump Station, Castalia, OH -** Analyzed base heave mechanisms of pump station excavation that had already experience base heave and prepared remedial construction and excavation bracing design recommendations to permit completion of excavation and construction.

- **Shands Hospital, Gainesville, FL** - Design of a soldier pile and lagging excavation support system in the Miami limestone for an addition for the University of Florida Shands Hospital.

- **10 St. James Avenue Development, Boston, MA -** Provided earth support system for installation of slurry walls used as permanent walls for a 4-story underground parking garage below a 21-story building. Designed walls for temporary loads during construction, and bracing to facilitate up-up construction techniques requiring coordination between bracing installation and removal and construction of building framing. The excavation was adjacent to two existing buildings and is founded below the existing foundations for both buildings. Design included evaluation of bracing system movements, groundwater control and impacts on adjacent structures as well as value engineering redesign of wall layout to improve schedule and reduce dewatering.

- **Harvard Medical School Research Building, Boston, MA -**Technical consultant for design of slurry wall earth support system in deep marine clay and sand deposits. Slurry wall support system to be used as permanent walls for multi-story building with two stories of underground parking. The excavation support system was designed for an excavation of up to 50 feet below existing ground surface adjacent to several buildings. Design included evaluation of bracing system movements and impacts on adjacent structures as well as value engineering redesign of wall layout to improve schedule and reduce dewatering.

- **Former Manufactured Gas Plant, Beardstown, IL -** Provided preliminary design of a braced steel, sheet pile wall to support an excavation between an existing building and the toe of an existing levee. Developed recommendations and specifications for final design including special equipment to minimize settlement of building footings founded in loose soils.

- **Jones Island Shaft, Milwaukee, WI -** Evaluation of settlements due to dewatering of soft estuarine clays during construction for a 12-foot-diameter, 200-foot-deep shaft associated with a deep storm water detention system.

- **Central Artery/Tunnel Project, Immersed Tube Tunnel, Contract C05A1, Boston, Massachusetts** Project manager in charge of installing instrumentation and monitoring performance of tangent pile walls and slurry walls for East Boston (a secant pile wall) and South Boston area (a 250-ft-diameter, 85-ft-deep circular diaphragm wall) cofferdams during construction of the tunnel. Instrumentation included slope inclinometers, piezometers, surface settlement points, building settlement points, and deformation monitoring points. Purpose of instrumentation was to provide data on the performance of the slurry and tangent pile walls relative to excavation support and ground water control as well as performance of excavation slopes during construction of the ITT.

Forensic and Claims Related Experience

- **Interstate Highway Embankment Surcharging and Wick Drain Performance Review, Norfolk, VA –** Performed a review and opinions regarding the performance of highway embankment construction over a thick layer of soft organic clay utilizing wick drains and staged surcharge loading for the Contractor arm of a design-build team. Examined wick drain and surcharging design petameters, predicted embankment stability and settlement vs. field performance, and timing of removal of surcharge, as well as, immediate, primary consolidation, and long-term (secondary) settlements.

- **Heave Monitoring, Evaluation, Remediation Options Review of Ore Thickener Tanks, S, A. –** Reviewed data and remediation of heaving proposals for 45-meter-diameter thickener tanks at a metals mine site. Recommended supplemental site investigations, recommended data collection modifications, process displacement and distortion vs time data. Periodically process, review, and evaluate additional data as they are submitted.

- **Eroding Ocean-Front Slope Review and Evaluation, S.A.** – Reviewed undermining and stability of a 70-m-high, benched mine tailings deposit slope being undercut by ocean (Pacific) waves. Commented on proposed remediation alternatives proposed including geo-mattresses, and various slope angle and location modifications. Recommended a site exploration program and a slope monitoring (total station, inclinometers, and piezometers) program.

- **Jet Grouting Effects and Stability of Foundations of an Adjacent Building, New York, NY –** Investigated the heaving and response of a 6-story reinforced concrete warehouse structure due to jet grouting for soil support and groundwater control during modifications to an adjacent subway fan building. Reviewed during and post-grouting building displacement data and observed conditions in both the fan building and the warehouse structure and developed and analysis of the level of damage to the warehouse buildings foundations. Prepared a report summarizing my findings regarding the safety of the building's foundations and recommendations for repairs to base slab cracks and clogged floor drains.

- **Adjacent Construction Impacts, New York, NY -** Provided forensic evaluation and litigation support services related to two claims regarding old/historic buildings settling and allegedly damaged due to adjacent construction of 9-to-19-story buildings. Construction activates of concern included instrumentation and monitoring, demolition, excavation, underpinning, SOE sheeting installation, pile driving, bored pile installation and permeation grouting.

- **Adjacent Construction Impacts, Albany, NY -** Provided forensic evaluation and litigation support services related to a claim regarding an old building settling and allegedly damaged due to adjacent building construction/development. Construction activates of concern included instrumentation and monitoring, demolition, excavation, underpinning, SOE sheeting installation, pile driving, and auger-cast pile installation.

- **Surcharge Loading and Settlement, N. Bergen, NJ –** Provided litigation support services related to a claim regarding preloading an area augmented with wick drains to expedite drainage and consolidation of silt and clay deposit.

- **Settlement of Railroad Bridge Pier, Haverhill, MA –** Provided independent evaluation of potential DSC during construction of scour protection measures at pier. Protection measures include driven sheet piles and permeation grouting. Issues include potential for vibration induced settlements and groutability of soils.

- **Settlement of a Pair of Six-Story, Mixed-Use Buildings, West New York, NJ –** Provided expert geotechnical review and witness services related to settlement of two buildings located on the west shoreline of the Hudson River. Soils consisted of miscellaneous fill, over a thick deposit of soft to very soft silts and clays. Foundation system for the buildings was spread and strip footings after ground treatment using deep dynamic compaction, wick drains and surcharge loading. Portions of buildings experienced greater than estimated settlements.

- **HDD Sewer Alignment Mediation, Brattleboro, VT –** Provided mediation support to the general contractor regarding a DSC claim related to alignment control and hard drilling during a HDD installation of a 660-foot-long, 24-inch-diameter steel (later changed to HDPE) casing pipe with an 8-inch-diameter fused PVC carrier pipe to serve as a gravity sewer. The crossing passed under I-91, a rural road, a stream, and a cemetery. The key issues were difficulty in vertical alignment control leading to a dip in the sewer and harder drilling than indicated by the boring data and geologic report. Services included reviewing contract documents, claim petition, reviewing readily available geologic literature for the project area, and developing a professional opinion on behalf of the general contractor regarding the geologic conditions pertinent to the claim.

- **Hard Rock Encountered during HDD, N. Bergen, NJ –** Provided litigation support related to a claim regarding rock hardness and rate of HDD excavation for installation of a 230KV and 345KV electrical transmission line bundle under a creek, in an urban area. The HDD bore was approximately 1280 feet in length and 36 inches in diameter with a bundle consisting of three, 12-inch-diameter and two, four-inch-diameter HDPE casing pipes pulled into to the bore. Services included reviewing contract documents, claim petition, construction records, performing addition test borings, testing rock core strength and hardness, reviewing readily available geologic literature for the project area, and developing a professional opinion on behalf of the general contractor regarding a DSC claim.

- **Surcharge Loading and Settlement, N. Bergen, NJ –** Provided litigation support services related to a claim regarding preloading an area augmented with wick drains to expedite drainage and consolidation of silt and clay deposit.

- **TVA Ash Pond Dike Evaluation, Kingston, TN –** Retained by the Insurer to perform a preliminary forensic review of records leading up to and following the December 2008 failure of fly ash pond containment dikes at the Kingston Fossil Plant.

- **Elementary School, Hatfield, MA –** Provided engineering services related to a claim regarding frost heaving of sidewalks that went to Arbitration.

- **Telecommunications Lines, Newark and Edison, NJ –** Provided engineering services related to investigation of two claims associated with horizontal directional drilling and conduit installation and collapse during grouting.

- **North Shore Connector, Pittsburgh, PA –** Provided engineering services and presented to a Disputes Review Board regarding a tunneling differing site condition related to excavation and behavior characteristics of claystone and amount of fines generated during mining.

- **Planet Hollywood, Boston, MA -** Provided engineering services and litigation support related a claim regarding building damage, excavation support, and sheet pile driving vibrations and related settlement.

- **Antelope Island Borrow, Salt Lake City, UT -** Exploration and evaluation of a large, 10 million cubic yards borrow source on Antelope Island. Borrow used to construct fills associated with I-90 construction. Included litigation support services.

- **Farmington Bridge, Farmington, NH -** Provided engineering services and litigation support for an excavation support, bridge sheet pile cofferdam driving construction claim.

- **Long Branch, NJ -** Evaluation and claims support related to sheet pile cofferdam flooding and by-pass pumping. The temporary cofferdam was constructed to permit construction of bridge piers and abutments for a bridge reconstruction across a narrow lake. Served as expert witness for an arbitration hearing.

- **Colonie, NY -** Provided litigation support services regarding wetlands construction impacts on the stability of a soil slope in overconsolidated clays and associated damage and repairs to existing pipelines and structures.

- **Boston, MA -** Provided litigation support services related to bentonite slurry composition and performance, and its role in slurry wall construction.

- **Boston, MA –** Provided DRB presentation and support services related to tunnel leakage performance and slurry wall construction methods and details for the Central Artery Project.

- **Boston, MA –** Provided claims support services related to ground freezing impacts on performance of underground structures.

- **Perry's Victory National Park, OH** - Evaluated alternative design submittals related to claim for a seawall foundation in rock. Included concrete key and caisson alternatives to resist horizontal loadings.

- **Route 101, Candia-Raymond, NH -** Provided engineering services and litigation support for a highway rock excavation construction claim.

- **Napa, California.** Provided litigation support services regarding a sheet pile wall microtunneling cofferdam design and performance.

- **Soil Nail Wall – South Hadley, MA** – Performed a forensic evaluation for a claim regarding the performance of a soil nail wall used as excavation support during construction of a college dormitory. The soil nail wall was constructed in glacial lake deposits and subjected to heavy rain events that affected its performance.

- **Structural Evaluation of Damage to Existing Buildings Former MGP Site, Suffern, NY -** Technical Consultant for evaluation of damage to existing structures related to settlement of foundations. Existing buildings were constructed above former MGP site facility structures. Project included evaluation of structural condition of building due to damage to date and recommendations for additional supports/repairs to existing walls.

- **Perimeter Road, Manassas, VA -** Investigation of pavement condition and development of recommendations for reconstruction in areas of pavement failure at IBM Building No. 250.

Pipeline and Other Trenchless Experience

- **Feasibility Study for HDD to upgrade electrical service. Amherst, MA –** Provide analysis and evaluation regarding the feasibility and costs for installation of conduits for upgrading the electric service by the proposed extension of a 13.8 kV power line from the Central Heating Plant (CHP) to the North Village Apartment Complex, which is owned and operated by the University of Massachusetts at Amherst. Evaluated several options for installing a 6-conduit, 3200-long HDPE bundle under wetlands to the complex.
- **ConED Bronx Street Microtunnel, White Plains NY –** Provided design consultation for the installation of a 30-inch-diameter steel casing approximately 150 feet long to house a 24-inch-diameter, 867 psig steel natural gas trans mission line. The crossing is under a road and under a 5-ft -y-10-foot concrete culvert. The ground conditions are loose sands under the ground water table. Services included preliminary casing design calculations for both overburden and jacking related stresses, corrosion mitigation measures, and evaluation of settlements, vibration, and other construction impacts on nearby water, electrical and gas utility lines.

- **Champlain Hudson Power Express, Dresden, NY to NYC, NY -** Providing geotechnical and HDD design consultation for a pair of DC cable underground installation to bring1250 MM of clean power from Canada to NYC. BCE's focus will be the on the approximately 28 crossings that range from 1000 to 5000 feet long to install two 12-inch-diameter HDPE casings at each crossing. Services include bore locations, preliminary model simulation for pullback force and pipe stress estimates and inadvertent release evaluations, work area requirements, avoiding obstructions, and inadvertent release prevention and mitigation plans, We will also assist in the development of geotechnical information and consultation for the approximately 90 HDD crossings being designed by other members of the team.

- **NGrid, Electric Cable Ducts, Quincy, MA -** Provided technical support to the prime design consultant during feasibility and final design of electric cable ducts under streets, utilities, wetlands, and railroad alignments. This was a congested area with limited work areas. Four alignments were examined during the preliminary/feasibility design and included both microtunnel/jack & bore and HDD installation methods. The preferred alignment is currently in final design and consists of a 1400-foot-long, HDD slick bore of a 7-conduit HDPE bundle. The HDD alignment included both vertical and horizontal curves to pass under pipe supported sewer and storm sewer conduits and is routed under a tidal wetland. Key issues included securing sufficient work areas for drill rig and supporting equipment, and pipe bundle fusing and assembly for the pullback. Services include assisting with geotechnical field investigation and laboratory testing program design, selecting the bore route, modeling the bore construction to estimate casing installation stresses and inadvertent release (fract-out) potential.

- **Ocean Outfall Diversion Design-Build Project, Bay Park, Long Island, NY –** During bidding provided a DB Contractor bidding team with an independent evaluation of geotechnical design and construction options issues associated with 30-to-40-foot-diameter, 30-to-70-foot-deep access shafts for approximately 3.6 miles of 78-inch-diameter microtunneling (MT) in 13 segments ranging from approximately 1200 to 1950 feet and approximately 7 miles of 6-foot-diameter re-lining of an existing sewer. Examined sheet pile, slurry wall, secant pile and jet grout support of excavation alternatives. Steel vs. GFR pipe, direct install vs. casing with carrier pipe, and the need for and spacing of intermediate caking stations (IJSs). Later I performed independent checks of DB designer's jacking loads and IJS requirements for the clay, sand and clay, sands encountered along the MT alignments.

- **NGrid, Electric Conduit HDD Installation Under I-90, Newstead, NY -** Provided technical support to the prime design consultant during design for HDD installation of a 20-inch-diameter HDPE casing, approximately 830 feet long through limestone rock for conduits for two electric cables. Services include assisting with geotechnical field investigation and laboratory testing program design, selecting the bore route, modeling the bore construction to estimate casing installation stresses and inadvertent release (fract-out) potential.

- **Avangard, Electric Conduit Wetlands and I90 and I390 Trenchless Crossings, west Henrietta, NY -** Provided technical support to the prime design consultant during alternatives evaluation of jack & bore/microtunnel and HDD installation options for 250 to 800 crossing HDPE or Hobas casings in glaciolacustrine silts, sands and clays for 2 to 5

electrical conduits. Services include assisting with geotechnical field investigation and laboratory testing program design, selecting the bore route, modeling the bore construction to estimate casing installation stresses and inadvertent release (fract-out) potential.

- **Vineyard Wind Landfall, Yarmouth, MA –** Provided an independent technical review for the attorneys for the Town of Yarmouth during the Energy Facilities Siting Board hearings. The review focused on a proposed horizontal directional drilling and jet plowing landfall alternative for 3, approximately 2000-foot-long, 18-inch-diamtert, HDPE casings for the power cables for the wind power project at the transition from an undersea jet plow installation to a land-based trenched cable duct system.

- **Waterline Crossing of River, Front Royal, VA –** Provided technical support to the prime design consultant during **a** feasibility review of trenchless crossing options of the Shenandoah River for a 12-inch-diameter HDPE water line. Four river crossing locations were studied and HDD and microtunneling options were considered. The project was complicated by the presence of limestone, saprolite, and karst and solution features being prevalent in the area. I assisted the design team during paper studies of the geologic conditions and risks, development of a geophysical and subsurface exploration and testing program, identification of a preferred crossing location, and the recommendation that microtunneling be used. Later provided technical support during final design, plans and specifications for the 600-foot-long, 48-inch-diameter microtunnel option in a zone of competent limestone found at the site.

- **O&R, 3 HDD L-47 Powerline Crossings, Norwood, NJ -** Provided technical support to the prime design consultant during change in design from Jack and Bore/Microtunneling to HDD to install 42-inch and 36-inch-diameter, 400 to 700 feet long, HDPE casings for 7 to 8 electric power cable conduits under small (narrow and shallow) streams at three locations. Ground conditions ranged from silts to sands to clays to weathered rock and the horizontal design alignment required slight horizontal curves during the installation.

- **ConEd Gas Distribution Main Crossing, City Island, MY –** Provided geotechnical design support services for a HDD crossing of an 8-inch-diamter, 1300-foot-long high-pressure gas, steel pipe under the channel connecting East Chester Bay and Pelham Bay in the Bronx. Geologic conditions included bottom silts, sands and rock (gneiss). Services include feasibility studies, subsurface investigation and geotechnical testing planning, final design alignment selection and modeling, specifications, submittal reviews, and construction phase support.

- **SEMCO Gas Transmission Pipeline, Marquette County, MI –** Provided engineering support and technical review to the prime consultant regarding feasibility and final design of HDD installation for six river crossings as part of the Marquette Connector Pipeline Project (MCPP), a new, 1000 psi pressure, gas transmission pipeline. The portion of the gas transmission pipeline to be constructed by HDD methods includes both 20-inch and 10.75-inch outside-diameter steel natural gas pipeline segments with corrosion coating, ranging from 900 to 1300 feet long, through soil and rock. Also provide design support related to ancillary pipe jacked, auger bored, and SBU mined crossings.

- **EverSource Electric Cable Crossing, Norwalk, CT** – Provided engineering support and technical review for a pair of 900-foot-long, 36-inch-diameter HDPE casings in very soft sediments under the Norwalk river. Review focused on permitting plans for mitigating inadvertent releases and adjustment to design alignment and installation details, drilling fluids and pressures to reduce the potential for releases.

- **Lake Champlain, NY/VT –** Provided engineering support and technical review to the prime consultant regarding feasibility of using HDD methods to install eight, 12-inch-diameter, 500-to -1000-foot-long, HDPE casings in rock (limestone) and sandy lake sediments for high voltage cable crossing of Lake Champlain. Services include feasibility studies, final design alignment selection and modeling, specifications, submittal reviews, and construction phase support.

- **Taunton River Crossing, Fall River, MA –** Provided engineering support and technical review to the prime consultant regarding feasibility of using HDD methods to install a 12-inch-diameter, 1900-foot-long, steel casing in rock (sandstone/shale) and coarse alluvial sediments for a gas crossing of the river. Services include feasibility studies, final design alignment selection and modeling, specifications, submittal reviews, and construction phase support.

- **Bass River Crossing, Yarmouth, MA –** Provided engineering support and technical review to the prime consultant regarding feasibility of using HDD methods to install a 270 psi, 20-inch-diameter, 900-foot-long section of steel pipe gas

line along Highbank Road and under the Bass River. The alternative is to support the gas line on the currently existing bridge which was built 1953 to replace a prior bridge located about 40 feet to the north of the existing bridge. The existing bridge is approximately 200 feet long, 30 feet wide and comprised of 9 spans supported on driven, treated timber piles. Tasks included developing a subsurface investigation program, evaluating potential entrance and exit points, alternative HDD alignments, north and south of the existing bridge and potential obstructions posed by existing and prior bridge piling. Due to the elevations, slopes and curvatures of the road on either of the bridge as well as the potential for obstructions and impacts on residents along the road, it was determined that supporting the pipe on the bridge was a preferred alternative, even after considering reducing the pipe diameter to 12 inches to permit tighter installation curvatures.

- **Telecommunications Lines Installed via HDD, Newark and Edison, NJ –** Provided engineering services related to investigation of two claims associated with horizontal directional drilling and bundled conduit installation and collapse during grouting. Two casings were 24-inch- diameter HDPE, and two were 22-inch diameter HDPE. The crossings ranged from 350 to 500 feet long. One pair of crossings was under a river and the other pair under a railroad line. The river crossing was in alluvial sand and silt soils and the railroad crossing was mostly in weather shale ground conditions.

- **Miscellaneous Gas Pipeline Projects – NY, VT and MA** – Performed feasibility and permitting phase evaluations of approximately a dozen crossings. Prepared layout design recommendations for 6 to 10-inch-diameter steel and HDPE gas pipeline crossings of highways, wetlands, other environmentally sensitive areas using HDD, microtunneling, pipe jacking and horizontal auger boring methods. Crossings ranged from 80 to 1000 feet in clay, sand and glacial till soil conditions.

- **Massport Telecommunications Cable, Boston, MA** - Prepared feasibility study regarding the applicability of and risks associated with trenchless construction methods for installation of a pair of fiber-optics cables along several alternative alignments under the and around the Reserve Channel in South Boston. Alternative alignments range from about 800 feet to 3500 long and horizontal directional drilling (HDD) (16-inch-diameter casing) and microtunneling (48-inch-diameter casing) methods of installation of casing pipe in soil and rock were evaluated. Key issues included presence of a high voltage cable crossing the alignments, future dredging of the waterfront area, miscellaneous fill materials and remnants of old waterfront structures, related structures and their foundations. Prime factors in the evaluation included technical feasibility, relative risk, site access, and cost.

- **HDD Utility Installation, St. Mark's School, Southborough, MA -** Performed geotechnical studies and prepared HDD design recommendations for installation of a 4-inch-diameter HDPE casing for a sewerage force main passing under a pond and wetlands area. The HDD installation was 600 feet long and passed through glacial soils and bedrock. Geotechnical studies included borings, rock testing, and GPR survey of top of rock. Design included developing drill path and specification criteria. Also provided construction phase services.

- **HDD Crossing, Rensselaer, NY** - Provided geotechnical and HDD design recommendations for installation of a 3000-foot-long, 28-inch-diameter HDPE gray water pipe through soils under the Hudson River to bring water to a power facility. Tasks included reviewing geology and geotechnical as well as site access information to identify potential HDD alignments, preliminary evaluation of a drill path and pipe installation stresses, and HDD specifications.

- **HDD River Crossing, Plymouth, NH -** Developed design recommendations and specifications for replacement utility lines under the Pemigewasset River by horizontal directional drilling (HDD) methods. The HDD crossings are approximately 705 feet long each, and pass through glacio-fluvial and glacio-lacustrine deposits and a zone of soil reportedly contaminated with gasoline related products. The utilities include a 12-inch-diameter HDPE casing for a water line; a 12-inch-diameter HDPE casing for two telecommunications lines and a Fire Alarm line; a 6-inch-diameter HDPE for an electrical conduit; and a 10-inch-diameter HDPE casing for a sewer force main. Key issues included limited work areas, management of contaminated soils, impact of contaminated soils on the water line, and assessment of the risk associated with higher blow-count soils present along part of the alignment and evaluation of the potential for obstructions.

- **Cape Cod Canal HDD Crossing, MA -** Evaluation of geologic and geotechnical factors affecting the feasibility and risks associated with construction, using horizontal directional drilling, of an 18-inch-diameter natural gas pipeline under the Cape Cod Canal. Six crossing alignments ranging from 1,400 to 3,000 feet long were evaluated. Ground conditions included shallow bedrock, glacial till, end moraine, glacial outwash, and glacio-lacustrine and miscellaneous fill deposits. A key issue was the evaluation of the risk of encountering obstructions (cobbles and boulders) at each crossing alignment. The pipeline was constructed along one the crossing alignments identified and evaluated as having low risks relative to construction.

- **Providence Harbor HDD Crossing, RI -** Performed a post-construction review and evaluation of the design and construction of a 3,300-foot-long segment of an 18-inch-diameter natural gas pipeline crossing installed under the Providence Harbor using horizontal directional drilling methods that passed through fill, organic silt, glacial outwash and till, and shale and sandstone bedrock. Review and evaluation considered pre-construction information and decisions, contract specifications and conditions, compatibility of construction methods and equipment with ground conditions, construction control, and risk factors.

- **MassPike, Blandford, MA** - Peer reviewer for design of a replacement for a collapsed steel culvert crossing under I-90. The new culvert is an approximately 300-foot-long, 9-foot-inside-diameter reinforced concrete pipe, jacked into place near the base of the embankment. The review focused on the geotechnical and structural aspects of the reinforced concrete pipe culvert design, culvert headwall design, and the trenchless construction process to be used to install the pipe. Key issues included: potential obstructions related to boulders in glacial till soils and highway embankment fills; ground water levels, dewatering, and ground loss related to water control; and ground loss and settlement of the interstate highway above the installation. The pipe was successfully installed via pipe jacking methods. The existing culvert was filled and abandoned in-place in order to mitigate the possibility of further ground loss and settlement or other deleterious impacts on the highway above.

- **South Fork Raw Water Intake, Abingdon,** VA – Provided forensic evaluation services, redesign services, redesign construction phase services, and original design claims support services related to a HDD installation for a water system's river intake lines. Original design was for two, 20-inch-diameter HDPE lines and one 8-inch-diameter HDPE line, each approximately 190 feet long installed by HDD methods in a limestone formation with solution activity and karst features. Original HDD method selected by the contractor used pressurized air as a drilling fluid and the reaming of the pilot bores could not be completed. Redesign included an HDD option and a 54-inch-diameter jack and bore option. The project completion contractor elected to finish the project using a 60-inch-diameter steel casing, jack and bore option with a bundle of two 20-inch, one 8-inch, one 4-inch, and six 3-inch HDPE carrier pipes inserted into the casing. Both SBU and drill and blast methods were tried on the completion contract most of the work performed using drill and blast tunneling methods.

- **HDD Electric Lines under Wetlands, Milton, MA** - Designed a shallow HDD crossing of four, 8-inch-diameter, 600 feet long, steel cased, pipe cables under a sensitive wetlands area. Soil conditions consisted of glacio-fluvial sands, gravels, cobbles and boulders. Key issues were avoiding natural obstructions and inadvertent drilling fluid returns to the ground surface due to the shallow alignment and the coarse nature of the ground. Ground penetrating radar (GPR) was used to identify alignments through the ground with lower probabilities of encountering cobble and boulder obstructions. The installation of the pipe cables was completed using HDD, but electrical testing indicated that field applied protective coatings at field welded joints were damaged by pulling through the coarse ground and susceptible to corrosion and the client elected to change to a trenched installation.

- **Merrimack River Crossing, Haverhill, MA** – Performed feasibility evaluation and alternatives analyses for a 35 kV electric power line replacement crossing of the Merrimack River which is approximately 1200 feet wide at this area. Three installation alternatives were evaluated: a) cut-and-cover; b) jet plow; and c) horizontal directional drilling (HDD). The ground conditions are fluvial-glacial soils, predominately sands and gravels with cobbles and boulders, glacial outwash, glacial till and shallow rock (phyllite). Key issues are: placing the new crossing so that it is deep enough to resist the scouring of the river; dealing with the steep banks of the river and its impact on the overall length of an HDD crossing; and the effects of an HDPE casing on the thermal characteristics of the installation. The likely casing size for an HDD installation is between 12 inches and 42 inches depending on the thermal modeling.

- **HDD Lake Crossing, VT & NY** – Preliminary and permitting design for four submarine cables crossing a deep lake. A combination of HDD and plowing installation is anticipated. The case of four complete HDD crossings with 12-inch-

diameter casings, each 8,000 feet each long was examined, but did not emerge as the preferred alternative due to risks associated with the depth and length of the crossing as well as with site access and work area issues. However, a composite HDD- plow system was investigated further, with four, 1000-foot-long HDD installations from each shoreline through limestone rock to cofferdams in the lake where plowing was used to complete the installation. Services included preliminary HDD layouts including shoreline work areas, geotechnical evaluations. Work included planning geotechnical investigation and testing, work area layouts, evaluation of guidance systems near existing high voltage lines and preliminary cost estimates for various alternative including cut and cover installations.

- **Okemo Street River HDD Crossing, Elkhart, Indiana** – Peer review, design recommendations, and bid review for installation of a 30-inch-diameter, 500-foot-long HDPE water line under a river. Ground conditions were primarily medium dense to very dense fine to coarse sands with silt. Key issues included minimum radius of curvature and sufficient size of work/access areas.

- **East Boston Relief Sewer Rehabilitation, Boston, MA -** Performed subsurface investigations, prepared geotechnical and contaminated soil management design, a geotechnical baseline report (GBR), and construction recommendations and specifications for approximately 15,000 feet of sewer tunnel rehabilitation and replacement. Also provided construction phase services during initial lining and later microtunnel, in-line microtunnel and pipe-bursting construction. The project design included consideration of microtunneling, horizontal directional drilling, pipe bursting, pipe lining and cut-and-cover construction methods, ground modification in the form of jet grouting and permeation grouting, and related construction risks.

- **Chambers Reservoir Project, Douglas County, CO** - Preliminary design phase geotechnical investigation consultation for an intake shaft (approximately 20 ft by 29 ft) and inlet pipelines (approximately 4 feet diameter and 100 and 250 feet long). The upper portion of the dam embankment consists of sand and clay soils over claystone and conglomerate bedrock. The intake shaft penetrates about 40 feet into the claystone and the lower inlet pipeline is to be installed using trenchless construction methods (pipe jacking, microtunneling or horizontal auger boring). Key issues include swell potential of the clays and claystone, strength of the claystone and stickiness and clogging potential of the clay and claystone relative to shaft construction and trenchless construction methods selected.

- **San Vicente Bypass Pipeline Project, San Diego County, CA** – Tunnel design consultant for new 4 -ft-diameter by pass water pipeline. Proposed bypass alignments range from approximately 1500 ft long to 2700 ft long with about 900 ft in a recently placed engineering fill and 600 to 1800 ft in rock (conglomerate and granite). Construction methods considered include microtunneling/pipe jacking and a mined, horseshoe-shaped tunnel constructed using drill-and-blast and/or road header excavation techniques. Key issues are risks to and protection of new marina structures in the fill portion of the project during construction and widely varying ground, strength and abrasivity conditions in the rock affecting tunnel constructability decisions. Provided bidding and construction phase services.

- **MDC Clean Water Program, Phase I, Hartford, CT –** Project manager and technical lead for the team provided project-wide geotechnical services to The Metropolitan District Commission and their program management unit. The overall program includes approximately 60 miles of new sanitary sewers; 20 miles of tunnels and conduits; and related head works and pumping stations with an estimated Phase I construction cost of $800,000,000. Tasks included developing program-wide: an updateable program database of available geotechnical information for use during design of various project segments; a soils management plan and excavate analysis; a geotechnical QA/QC plan and procedures; and a contaminated soils management plan. Additional Task Order Services included: preliminary design subsurface investigations of geotechnical and contaminated ground conditions and related recommendations; value engineering and constructability reviews of the geotechnical and contaminated materials aspects (including instrumentation, building protection, and geotechnical baseline reports) of final designs and risks for trenched, trenchless (e.g. pipe jacking and microtunneling) and deep storage tunnel construction prepared by others; and construction phase support including contaminated material management and disposal, differing site conditions evaluations, and geotechnical instrumentation evaluations.

- **Homestead Avenue Interceptor Extension – MDC - CWP, Hartford, CT - Performed** design phase value engineering reviews, constructability reviews, and geotechnical baseline report (GBR) reviews. Also provided construction phase services including review and recommendations related to automated instrumentation, pilot tube microtunneling, and the first curved microtunnel installation in the US. The project originally consisted of approximately 3600 ft of 72-inch-diameter microtunneling in the soft, glacial-age, varved clays of the Connecticut River Valley and about 1000 ft of open cut

installation in miscellaneous fill soils. Key issues included microtunneling near the rock-soil interface and under active railroad tracks; mitigation of building, railroad, and adjacent utility settlement impacts and monitoring their performance; and construction in a crowded urban environment. Construction phase contractor proposed alternates implemented included about 600 ft of 15-inch-diameter pilot tube microtunneling, 600 ft of 72-inch-diameter microtunneling with an 1800 ft radius curve, and 200 ft of 72-inch-diameter pipe jacking all in lieu of portions of the original open cut areas.

- **Chestnut Street Drainage Project, Marblehead, MA - Technical consultant/reviewer** for an investigation to evaluate hard rock microtunneling vs. open trench options for an approximately 800-foot-long, 54-inch-diameter storm sewer outfall to be constructed through a bedrock knob adjacent to Marblehead Harbor. Provided a report summarizing our evaluation and construction recommendations, as well as, specifications for microtunneling and portal construction.

- **Newtown Sewer Crossing, Newtown, CT** Reviewed and developed recommendations for completion of construction of a sewer under an operating railroad by pipe jacking methods. Installation of the 42-inch-diameter steel casing had been stopped because blasting to remove rock at the jacking face had heaved the rail bed above. Tasks included reviewing the construction records for the railroad company to evaluate the potential causes of the heave; recommending measures to complete the construction while protecting the rail bed and maintaining rail traffic; and recommending measures to stabilize the rail bed in the heave zone and minimize the potential for a chronic maintenance problem at that location.

- **Lake Burnt Mills Dam, Suffolk, VA -** Provided geotechnical consultation and recommendations for replacement/rehabilitation of low-level outlet buried pipelines, inlet/outlet structures, and valve and equipment buildings associated with a 45-ft-high, 1900-ft-long earth embankment dam impounding a 10,000-acre feet reservoir. Pipeline construction included underwater construction, conventional construction within cofferdams, and microtunneling through the dam while maintaining operation of the reservoir.

- **Power Plant Diffuser System, Wiscasset, ME** - Performed geotechnical construction monitoring and testing associated with open cut installation of a twin 9-foot diameter fiberglass cooling water pipeline on land and in the soft sediments of an estuary. Installed instrumentation to monitor pipe behavior during backfilling. Instrumentation included pneumatic total pressure cells and electrical resistance strain gages. Work included rock excavation, dike and embankment construction, subaqueous construction, and pipe bedding and backfilling.

- **New Neponset Valley Sewer, MA -** Developed geotechnical design and construction recommendations and prepared specifications for small diameter (micro) slurry face tunneling and conventional pipe jacking for installation of a sewer force main under roads and railroad tracks and through an area of potentially contaminated soils. Considerations included evaluation of trenched and trenchless technologies, including ground freezing, jet grouting, permeation grouting and slurry walls, compatible with soil conditions and the environmental and space constraints of the site. Also performed review of contractor submittals, blast monitoring, and review of procedures and ground response data during tunneling under an active gas main during construction. Project included the construction of 8.4 miles of gravity and force main relief sewer up to 48 inches in diameter and construction of a pump station.

- **Innerbelt, Road Rail Line Crossing, Somerville, MA -** Technical consultant for two pipe jacked crossings of MBTA and B&M rail lines to install a 48-inch-diameter steel casing pipe for ducts of electric and telecommunication lines. Supervised geotechnical investigation, preparation of contract documents, and application to rail lines for permission to install the crossing. This fast-track effort minimized engineering time to help minimize the impacts of long review time associated with rail line approval. Prepared a list of qualified contractors, assisted in evaluating bids, and observed construction of jacking pits and installation of the piping.

- **Chelsea Creek Crossing, Chelsea, MA –** Technical Consultant for feasibility study of trenchless and direct burial crossings of the Chelsea Creek River to replace electric lines damaged by dredging of the river.

- **Hultman Aqueduct Risk Analysis and Repair Design, Weston to Southborough, MA –**. Technical reviewer and consultant during evaluation of the condition of the Aqueduct and related leaking. The Hultman Aqueduct is the principal water conduit for the Metropolitan Boston Area. Tasks included evaluation of the soil bedding supporting the Aqueduct to assess the risk to pipeline and leakage performance. The work included test pits excavated to expose the aqueduct near leak locations. Two test pits were extended to excavate beneath the active aqueduct.

Foundation Experience

- **Hospital Addition Underpinning, Brattleboro, VT** – Came in after original underpinning system was considered unbuildable due to cohesionless, dunning sands, and developed with a contractor an alternative system. Initially, investigated the use of permeation grouting with OPC and microfine cement to stabilize the soils so that the original pit underpinning could be performed. However, available equipment and timing did not provide encouraging results in a grouting test section. Then designed and implemented a micropile and soil nail wall underpinning that successfully underpinning the wall of a 2-story masonry structure with a basement and expedited the schedule for the completing the underpinning.

- **Environmental Remediation Excavation Impacts on an Adjacent Structure, Manchester, NH –** Joined the project after a 23-foot-deep braced excavation cell (approx. 40 ft by 100 ft) was observed to cause settlement of a 4-story brick masonry structure about 5 feet from the edge of the excavation. I observed the conditions at the site and reviewed the instrumentation data, and worked with the contractor to develop a plan to complete the backfilling, remove sheet piling and close out of the first cell, as well as plan for installation of sheet piles, bracing, and excavation and backfilling sequence for a second cell adjacent to the first cell while managing additional movements of the building to tolerable levels. The plan was approved and the work completed while safely supporting and controlling the movements of the building.

- **Column Underpinning and Support During Contaminated Soil Removal, Fall River, MA –** Prepared demolition building support and underpinning designs and submittals for removal of contaminated soils from the under slabs and footings from the interior of a large warehouse building.

- **CTDOT, GBR for Parking Garage, Stamford, CT -** Provided technical support to the owner's design team during preparation of a geotechnical baseline report (GBR) for drill shaft, micropile, and spread footings on rock for a design-build project.

- **Foundations for Propane Facility, White River Junction, VT –** Performed subsurface investigations for a proposed propane terminal facility to be located adjacent to a railroad line and provided preliminary foundation and site preparation recommendations for support in fill, fluvial and glacial till soils present at the site. Key issues included: the site was located adjacent to the Connecticut River and presented slopes that required substantial site work; upper, loose soils that either required densification or deep foundations. Examined the alternatives of: deep (pile) foundations; over excavation and replacement using compacted granular soils at the site and use spread foundations; or preload the site and use spread footings. Preloading the site appeared to be the more economical alternative.

- **Foundations South Windsor, CT –** Technical consultant for an industrial building expansion founded on silts and clays in the Connecticut River Valley. Key issues included bearing pressure evaluation and settlement estimates. Investigation and recommendations considered stress history of the soil profile based on geotechnical laboratory testing and prior construction/observations at the site. Given the amount filling needed to raise the grade at the site, monitored preloading of the site was included as a recommendation.

- **Foundations in Karst, Lopatcong, NJ –** Provide review and consultation regarding design and construction of foundations for a large building with heavy column loads in an area where solution activity in the limestone bedrock had created karst conditions. The foundation system included a blend of large diameter drilled shafts and shallow spread footing.

- **Tanker Offloading Facility, Fall River, MA** - Provided feasibility/permitting phase consultation regarding the geotechnical aspects of waterfront structures and dredging for a port facility. Evaluations include large (270-foot-diamter) tank foundation alternatives, ground improvement, river bank and related dike slope stability, consideration of trenched and trenchless options for installing pipeline to and offshore loading facility and dredged material stabilization and on-site reuse. Performed site investigations including in situ testing to develop soil compressibility, strength and liquefaction parameters.

- **Central Artery, Tiedown Test Element Program, Boston, MA** - Task manager for designing rock and soil tiedown element test program, developing contract documents, evaluating bids for tiedown element installation and testing, monitoring instrumentation and field testing by the contractor, evaluation of test data, and preparation of a report describing

the tests, the results and design recommendation. Instrumentation includes vibrating wire strain gages, electronic load cells, optical surveying, hydraulic pressure gages, and data acquisition.

- **Peer Review, Pile Load Test Waiver, Boston, MA** - Two new elevators are being installed in the existing building and are to be supported by micropiles. Provided an independent evaluation in support of a request for a waiver of the requirement to perform a pile load test. The existing building is an 8-story brick structure, with a concrete slab foundation supported on caissons bearing in clay.

- **I-95 Extension and I-395 Viaduct, Baltimore, MD** - Instrumented, performed and analyzed pile load tests to develop value engineering design recommendations for I-95 and I-395 interchange structures. Instrumentation included electronic load cells, hydraulic pressure gages on rams, dial indicators, wire-mirror systems, telltales and optical surveying to monitor the load and movement of the test piles and reaction systems during compression and tension pile load testing. Pile types were H, pipe, Monotube, and mandrel-driven shell filled with concrete.

- **Allied Hospital, Wilkes Barre, PA** - Geotechnical investigation and design for a four-story rehabilitation facility sited on strip mine spoil over four levels of abandoned coal mines. A test embankment was constructed and monitored to investigate potential deep-seated settlements and the potential for additional mine collapse and associated ground response were evaluated. Foundation was designed as structural mat to span potential subsidence.

- **Baystate Medical Center, Phase 3, Springfield, MA –** Provided geotechnical consultation and report, specification and drawing review to the project's geotechnical consultants for the Phase three addition with a footprint of approximately 85,000 sf immediately adjacent to existing hospital facilities include facilities with sensitive equipment such as MRI units, pathology laboratories and operating theaters. Key issues addressed include construction ground movements and vibration impacts associated with excavation and related temporary support walls for mat foundations on glacial till up to 40 feet below the ground surface and within 5 to 10 feet of existing facilities, instrumentation to monitor performance of the SOE and response of key facilities, slab under drainage and waterproofing. SOE included soldier piles and lagging, secant pile walls and tiebacks. Assisted with alternatives review of methods to perform work within the strict noise, vibration and work area/access site constraints.

- **Wharf Improvements, Portsmouth, NH** - Managed foundation design and construction recommendations for waterfront facilities improvements to accommodate larger vessels. Improvements include modification/replacement of the bowline mooring structure, construction of bow and breast line guide structures, replacement of the stern line mooring structure, construction of a cellular cofferdam dolphin, and dredging to enlarge and deepen the berthing area.

- **Eliot Hospital, Manchester, NH** - Project Manager in charge of geotechnical investigations and foundation design for six- and eight-story additions to an existing hospital.

- **Steeplegate Mall, Concord, NH** - Project Manager in charge of construction observations during site earth work, pavement construction, utility trench construction, wetlands outfall head wall, and site facilities installation for a 400,000-square-foot mall. Work also included geotechnical design recommendations to accommodate conditions encountered during construction.

- **Northeast Corridor Electrification Foundations, MA, CT, RI** - Technical consultant for earth support system for installation of support foundations for electrification catenary support poles. Support systems installed within six feet of main passenger and freight rail lines in a variety of locations with varied sub-surface conditions.

- **Underpinning, Building 150, Kittery, ME** - Project Manager in charge of contractor submittal review and construction observations during mini-pile installation to underpin a 3-story building at Portsmouth Naval Shipyard.

- **Animal Care Facility, Amherst, MA** - Project Manager for subsurface investigations and foundation design recommendations for a three-story animal care facility for the University of Massachusetts. The new facility is adjacent to an existing building and impacts on the existing building were evaluated during design.

- **Mill Valley Estates, Amherst, MA** - Geotechnical investigations, laboratory testing, and foundation design recommendations for a 35-acre development consisting of 3-story structures on a deep deposit of soft, varved clay.

- **Agawam Alzheimer Facility, Agawam, MA -** Performed foundation investigations for a one-story wood frame facility with a footprint area of about 30,000 square feet on a 6-acre site. Investigations were preformed to provide data on the underlying varved clay, as well as, on the overlying sand and rubble fill materials. Foundation design and construction recommendations were developed for the building and associated parking areas, roadways, and cut and fill slopes.

- **Elementary School, Shutesbury, MA -** Project manager in charge of subsurface investigations and foundation design recommendations for 100-foot by 200-foot elementary school addition.

- **Temple Israel, Greenfield, MA -** Evaluated the condition of the super structure and the foundation of the building and developed recommendations for remedial measures to minimize future settlements, distortions and cracking.

- **Hadley, MA -** Developed preliminary design recommendations for foundations for an equine center situated in an area of deep, Connecticut River Valley, varved clays.

- **Deerfield, MA -** Developed preliminary design recommendations for foundations for a storage facility for Historic Deerfield. The site is underlain by terrace deposits of the Deerfield River.

- **Amherst, MA -** Project manager in charge of field investigations, laboratory testing, and foundation recommendations for a nursing home facility at a varved clay site.

- **Hope Creek Generating Station, Salem, NJ -** Evaluation of lateral and axial capacities of nuclear plant cooling tower foundation piles driven through marine clays.

- **Hadley, MA -** Report regarding geotechnical investigation and foundation and pavement geotechnical design recommendations for a new automobile tire retail outlet.

- **Village School, Royalston, MA –** Performed site investigations and prepared foundation design, slab-on-grade waterproofing and pavement subgrade recommendations for an approximately 14,000 sf new campus classroom facility for a private school. Foundations are to be constructed on glacial till using frost protected shallow foundation methods.

- **Parking Garage, Storrs, CT** - Project Manager for subsurface investigations and foundation recommendations for a 4-story university parking garage in glacial till soils.

- **Parking Garage, York, PA** - Designed H-Pile foundation alternative, including pile caps, for a 4-story parking facility in a karst area.

- **DEC Educational Facility, Merrimack, NH** - Project Manager in charge of subsurface investigations and foundation design recommendations for 65,000-square-foot auditorium building and 60,000-square-foot classroom building for Digital Equipment Corporation's Educational Facility.

Soil and Rock Slope, Dam, Dike Experience

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- **Draped Mesh Support, Franklin, MA -** Design of draped mesh to control rock fall for a 15-to-35-foot-high, near vertical rock slope.

- **Dam Inspections, Hopewell, NJ –** Routine inspections of two, small low hazard earth embankment dams and spillway structures and recommendations for maintenance and repairs. One dam is 12.5 feet high and 200 feet long with a discharge pipe spillway structure, the other dam is 14 feet high and 870 feet long with a concrete spillway structure, a long concrete lined spillway channel with energy dissipaters, and a low-level outlet pipe. Prepared inspection reports for submittal to town and state. Recommendations included vegetation and erosion control, and clearing debris from downstream channels.

- **Haverstraw Quarry, New City, NY –** Performed an evaluation of current rock slope stability for a diabase, aggregate quarry and developed monitoring program for slope movement. The goal of the project was to protect work safety as the quarry expanded.

- **Long Island Viaduct Boston, MA** - Performed feasibility evaluation of foundation reuse alternative and new foundation alternative for bridge reconstruction. Bridge is composed of 16 spans with up to 250-foot spans for a total length of 3450 feet. The spans are supported on 15 concrete piers and two abutment structures. The piers are founded on rock in some cases, crushed stone fill on rock in other cases, and timber piles into glacial till for a third set of cases. Also developed preliminary plans field subsurface investigations and geophysical investigations for evaluating existing and new bridge pier foundation conditions.

- **Goodwin Dam Spillway Channel and Channel Bridge, Riverton, CT** - Technical support and review for rock channel slope stability evaluation and bridge abutment foundation evaluation. Channel is approximately 175 feet wide and 70 feet deep and was constructed using blasting methods to remove the gneiss and schist rock leaving nearly vertical slopes. Bridge is a concrete arch structure built circa 1959, with an approximately 175-foot-span and carries secondary road traffic. Project included field mapping rock discontinuities by hand and via 3-D laser scanning, performing stability analyses, and developing remedial recommendations for the slope and bridge foundations.

- **University Avenue Bridge Over the Merrimack River, Lowell, MA** – Technical reviewer of geotechnical report for replacement of a three-span, 492-foot-long bridge. Existing bridge is a three-span structure supported by two abutments and two piers founded on a quartzite sandstone/siltstone. Review focused on rock mass properties interpreted from field observations and laboratory testing. Properties of interest included bearing pressures, compressibility, permeability and excavatability (rippability).

- **Deerfield No.5 Hydroelectric Project, Monroe, MA -** Project Manager in for evaluation and design of remedial measures for hydroelectric plant canal dikes and conduit/tunnel along the Deerfield River. Issues included slope stability evaluation and upgrade, and seepage evaluation and control. Developed designs for dike improvements including slope and toe drainage, revised slope angles and heights, and a 250-foot-long, 12-foot diameter fiberglass pipe extension for the Conduit No. 2.

- **San Vicente Dam Raise Project, San Diego County, CA –** Independent review of 90% Design Drawings, Specifications and Geotechnical Report for Package 2 – Foundation Excavation, Access Roads, Dam Penetration, Tunnel and Piping, including soil and rock slopes and penetration of existing dam and dam foundation with a 9-ft-diameter tunnel for a low-level outlet. The proposed dam raise is from about a 200-ft-high concrete dam to 300 ft high using roller compacted concrete (RCC).

- **Rock Slope, Waltham, MA** – Performed stability analyses, and prepared design recommendations for slope stabilization and rockfall protection for 65-foot-high, 65° to 80° slope in diorite rock. The site had been occupied by an old wood structure and is being redeveloped with a new commercial structure that is near the toe of the slope.

- **Cerrillos Dam, Puerto Rico -** Evaluated construction implications of rock excavation and support conditions for river diversion structures and dam foundation preparation. Evaluations included grouting to control seepage and excavation and support requirements for diversion tunnel and abutment excavations.

- **Rock Wall, Clifton, NJ -** Performed stability analyses and provided design recommendations for an up to 120-foot-high rock slope with a slope angle of 70° and glacial till soil zones. Slope was part of an exhausted traprock quarry that is now being developed with buildings. The slope materials include glacial till and basalt overlying sandstone, siltstone and claystone. Key issues included investigation of and dealing very low strength seams in the claystone, controlling exposure and deterioration of the claystone using shotcrete and soil nails/rock dowels to prevent long-term undermining of the basalt above, and water control and drainage, including in near vertical fault related features. Project also included a 40-foot-high soil nail wall to support a glacial till slope above the rock.

- **Rock Slope, Waltham, MA -** Performed stability analyses, rockfall analyses and prepared design recommendations rockfall protection and slope scaling and maintenance for 65-foot-high, 65° to 80° slope in diorite rock. The site had been

occupied by an old wood structure and is being redeveloped with a new commercial structure that is near the toe of the slope. Later post construction worked with owner to evaluate risks associated with construction blasting on adjacent property relative to rock slope stability and performance.

- **Larson Quarry, Dekalb, Illinois.** Design recommendations for underground expansion of Larson Rock Quarry. Included design of open cut slopes and room and pillar mine in limestone and shale to be developed using drill and blast methods.

- **Rocky Hill Quarry, Eliot, ME -** Project manager in charge of geotechnical investigations and design recommendations for a proposed 300-acre quarry. Scope of work included subsurface explorations, field reconnaissance, materials evaluations, investigation of rock slope stability conditions, hydrogeologic investigations and blasting program, and evaluation of impact of blast-induced vibrations on adjacent structures. Work included instrumentation and data monitoring for a seven-day pump test. Instrumentation included flow meters, pressure transducers, water level indicators, and automatic data acquisition systems.

- **Llanarch Quarry, West Chester, Pennsylvania.** Stability evaluation and recommendations for instrumentation and remediation of rock quarry walls. Included subsurface investigation and rock bolting recommendations.

- **Metallic Mineral Mine Stability, Confidential Client -** Consulted on slope stability issues for several large open pit mines including underground conveyor tunnels processing chambers, some in excess of 200m deep. Examined stability parameter investigation and selection, controlling and managing ground water inflows, groundwater affects on stability, instrumentation and monitoring, and safety factors and reliability in analyses,

- **Lake Ilo Dam Modifications. Dunn County, ND -** Task manager for the rock anchor testing program and development of rock anchor recommendations for concrete spillway stability improvements. The test program included testing four prototype anchors with 20- to 50-foot-long bond zones to evaluate capacity and creep characteristics for anchorages located in interbedded soft claystone and coal strata. Due to heterogeneity of the strata, anchors exhibited a "slip then stick" behavior during loading increase.

- **Thornes Dam, Amenia, NY.** Technical consultant and reviewer for the evaluation and design of repairs to this approximately 38-foot-high concrete gravity dam. The dam is considered a Class C “high hazard” dam. The project included subsurface explorations to determine foundation and seepage conditions, stability analyses, dam failure analyses to determine areas that would be inundated in the event of failure, and the evaluation of alternatives to increase the stability of the dam to acceptable levels. On the basis of the evaluation, rock anchors were designed to stabilize the dam.

- **Lake Abeniki Dam, Dixville Notch, NH.** Technical consultant and reviewer for the investigation and design of the reconstruction of this approximately 30-foot-high embankment dam. This Class C dam (high hazard) is located above a resort community and supplies water for fire protection, power generation, and manufacturing processes. The existing timber crib spillway had deteriorated and showed signs of bulging and instability. Also, uncontrolled seepage was observed along the toe of the embankment. GEI was engaged for the design of the reconstruction of the dam. The design includes new primary and auxiliary spillways, raising the dam by about 6 feet, and installation of toe drains to control seepage. A temporary cofferdam also was designed to stabilize the existing spillway pending reconstruction and to maintain the pond during removal of the existing spillway.

- **Arthur's Pond Dam and Upper Reservoir Dam, Cornwall-on-the-Hudson, NY.** Technical reviewer the evaluation of Arthur's Pond Dam and Upper Reservoir Dam. Arthur's Pond Dam is a 27-foot-high earth embankment and masonry dam. Upper Reservoir Dam is a 33-foot-high earthen embankment dam. The initial evaluation involved the performance of stability analyses and the development of preliminary recommendations for the design of repairs to the dams. A preliminary evaluation of earthquake-induced liquefaction potential of the foundation soils beneath both dams was also conducted. Additional subsurface explorations and final design of the repairs are currently in progress.

- **Harris Pond Dam, Nashua, NH.** Project manager responsible for supervision of subsurface explorations, performance of stability and seepage analyses, and development of remedial design of repairs of a 35-foot-high masonry core wall embankment dam. Remedial repairs included construction of a new retaining wall, installation of permanent drains to control embankment seepage and to relieve hydrostatic pressures behind existing retaining walls, and strengthening existing retaining walls.

- **Cobble Mountain Dam, MA** Planned and performed cross-hole shear wave velocity tests to provide data for evaluation of seismic performance of a 263 ft high, 730 ft long; hydraulic fill dam completed 1932.

- **Pogue Pond Dam, VT -** Project Manager in charge of subsurface investigations and engineering evaluation and recommendations to remediate seepage conditions in the slope of an embankment dam.

- **Ambrosia Lake Facility, NM** – Evaluated Seepage and effectiveness of a partially penetrating slurry cutoff wall in a uranium tailings dam. The investigation included evaluation of the impact of the seepage and seepage control measures on the stability of the dam embankment.

- **Deer Lake Dam, Fishkill, NY** - Project manager in charge of engineering evaluations to investigate and recommendations to remediate deteriorating seepage conditions in the slope of an embankment dam. Tasks included field explorations including piezometers, seepage analyses, and remedial design and monitoring recommendations.

- **Route 106/Loudon Road Improvements, Concord, NH -** Project manager in charge of geotechnical construction observation services and geotechnical design recommendations for widening highways feeding into a regional mall. Construction included compaction control of embankment fills, subgrade and pavement structure compaction control, soil and rock slope improvements.

- **Amherst, Massachusetts** Evaluated design proposals for remediation of an unstable highway slope above a river.

- **Conway, Massachusetts** Investigated an unstable slope in till above a river and provided recommendations for protection of a structure located at the crest of the slope.

Cutoff Walls Experience

- **Herbert Hoover Dike Rehabilitation Project, Reach 1, Seepage Cut-Off Wall Martin and Palm Beach Counties, FL –** Reviewed and evaluated, for the Contractor, construction records, field permeability tests, laboratory permeability and strength tests, core logs, core photographs, and televiewer logs from a 500-foot-long, 80-foot-deep (50 feet in soil and 30 feet in limestone, 2-foot-thick continuous slurry wall installed using a hydromill and self-hardening cement-bentonite slurry for conformance with project performance criteria. Key issues included in-place permeability, wall continuity and features observed in the borehole/televiewer photographs. Developed supplemental and modified procedures to verify wall conformance. Our evaluation supported the Contractor's successful construction of the wall. The 500-foot demonstration wall was a precursor to construction of a 3-mile-long segment of slurry wall by the same methods.

- **Feather River Levee Slurry Wall, Marysville, CA -** Technical consultant for design and construction cement bentonite and soil bentonite slurry walls to improve levee stability during flood events. Approximately, 13,000 feet of slurry wall construction, up to 65 feet deep is planned, with the first phase of about 5000 feet currently under construction. Reviewed plans and specifications, assisted with submittal reviews and participated in startup slurry wall construction and training of field inspection staff.

- **Containment Slurry Wall, Canadys, SC -** Technical consultant for forensic investigating of an existing soil-bentonite slurry containment wall in the dikes surrounding a coal ash pond. The ash pond was approximately 95 acres with about 8,300 feet of slurry wall. Later, developed and supervised laboratory mix design, compatibility testing, and permeability testing programs for a Portland cement, slag cement and bentonite slurry containment wall, then performed calculations and prepared drawings and specifications for containment wall design and construction including slurry wall mix performance, instrumentation and testing protocols, jet grout closure details at locations of penetrations through the slurry wall/dike.

- **Containment Slurry Wall, Confidential Client, MA -** Provided technical support during the design and construction observation for a soil-bentonite slurry wall constructed to contain low pH brine. The wall was approximately 1 meter thick, 510 long and 5 to 11 meters deep. A key issue was the compatibility of the slurry wall components with the brine. Design included compatibility testing of the proposed material with brine from the site and long-term hydraulic conductivity testing of the proposed and as-build slurry mix.

- **Spectacle Island, Boston Harbor, MA -** Provided technical assistance during the preparation of design and construction recommendations for a soil-bentonite slurry wall constructed to control landfill leachate migration. The wall is approximately 3 feet thick, 1,300 feet long, and up to 35 feet deep. Design issues investigated include mix design to achieve the desired hydraulic conductivity and compatibility of soil, bentonite, and leachate.

Contaminated Site Experience

- **Containment Wall Stability Evaluation and Repair Design, Berlin, NH –** Performed stability and condition assessment of 100+ year old concrete containment/retaining walls at a contaminated site near a river. Included geophysical surveys, wall mapping and inspection, developing and implementing an instrumentation and monitoring program, and design of concrete demolition and high-strength shotcrete repairs to address erosion of portions of wall.

- **Granite Block Wall Stability Evaluation, Lowell, MA** – Performed stability and condition assessment of nearly 200-year-old granite block walls retaining mercury and wood treatment chemical contaminated soils. Also evaluated proposed in-situ soil treatment impacts on wall stability.

- **Soil Permeability Relative to No. 2 Fuel Oil, Leominster, MA –** Developed testing program and performed computations to estimate site soil permeability relative to No. 2 Fuel Oil and amount of oil contained in the soil at the site of a fuel oil release.

- **Abandoned Mine Evaluation, CA** – Part of team evaluation operational risks associated with acid mine drainage from an abandoned mine that produce iron, silver, gold, copper, zinc and pyrite from the 1860s to the 1960s. Evaluation included a brief inspection of the accessible portions of existing mine workings including viewing the condition of 5 to 10-year-old repairs to mine supports as it pertains to continued operation of acid mine drainage abatement systems. In addition, soil and rock slope stability in the vicinity of mine portals and along pipelines conveying mine drainage and dams and impoundments on the site were evaluated relative to risks to operation of acid mine drainage abatement measures.

- **Tidal Flats Vegetation Restoration, Everett, MA -** Managed restoration/enhancement of salt marsh vegetation in an intertidal area composed of historic fill. Tasks included field and laboratory testing to evaluate limiting factors for plant growth; greenhouse study to investigate compatibility of various plant rootstock with site soils; and planting and monitoring performance of 85,000 spartina alterniflora seedlings, 25,000 of a root-stressed variety and 60,000 of saltwater nursery-raised seedlings, in the tidal flats area.

- **Burlington, VT -** Technical consultant for a feasibility study regarding MGP-contaminated sediment removal and capping options. Developed sampling and geotechnical testing program to provide base parameters for evaluating feasibility of various dredging and capping options.

- **MGP SOE, Haverstraw, NY –** Consultation regarding support of excavation and dewatering design for excavation to remove MGP contamination. Reviewed alternatives for excavation within 5 feet of adjacent structures, related instrumentation to monitor excavation and building performance. Issues included ground movement and vibration effects on buildings and utilities and working beneath a temporary enclosed to control odors and off-gassing during excavation.

- **Dredged Material Management Plan, Massachusetts Coastal Zone Management** - Managed preliminary geotechnical investigations and a sediment decontamination technology assessment for the Dredged Material Management Plan (DMMP) in support of major navigational dredging operations at four ports in the Commonwealth of Massachusetts. Preliminary geotechnical investigations included the review, analysis, and compilation of existing geotechnical data on the harbors of Fall River, Gloucester, New Bedford, and Salem. Sediment decontamination technology screening was conducted to evaluate alternative remedial technologies that potentially apply to the treatment of sediments that are not suitable for conventional aquatic or upland disposal due to elevated contaminant concentrations. As part of this technology assessment, we conducted a survey of over 100 vendors of treatment technologies. Based on the results of this survey, we developed a sediment treatment technology database containing current information for each technology in several major comparative categories including: ability to treat various contaminant types, effects of sediment characteristics on the treatment process, potential role of the vendor in a sediment decontamination project, capabilities and logistical requirements of the process equipment, and information on current and projected costs.

- **MTA Maintenance Facility, Chicopee, MA -** Project manager for investigation and evaluation of releases associated with fuel USTs and development of remedial action measures. Work at the site included passive soil gas screening, drilling and monitoring well installation, soil and ground water sampling and analysis, and coordination with facility personnel to maintain traffic flows during field work.

- **Former MGP Site, Spencer, MA -** Technical specialist to support MCP Phase III and Phase IV activities at the site. Remedial actions at the site included grading the site, removing excess materials from the site, and construction a pavement on the site to serve as a barrier restricting access and infiltration to underlying soils containing coal tar related contaminates including PAHs. The paved area was designed to serve as a municipal parking facility. Contaminated soils removed from the site were screened and sent to a licensed utility boiler for disposal/recycling.

- **MCP Immediate Response Action (IRA), Former Manufactured Gas Plant (MGP) Site, Salem, MA** - Managed feasibility study (FS) and design of an IRA to address a condition of Substantial Release Migration (releases of sheens, low pH groundwater, and DNAPL) to a surface water body. The IRA included a FS to identify and screen potential response alternatives to address site conditions. The selected alternative designed includes a horizontal drain for a DNAPL recovery system and a funnel and gate system to treat groundwater leaving the site. Funnel options considered included slurry walls, drive HDPE sheet piles, and trenched insertion of a rolled HDPE sheet. The trenched insertion of the rolled HDPE sheet toed into a clay-confining layer at a depth of approximately 23 feet was selected for design. The treatment includes a limestone gate/permeable wall to raise groundwater pH followed by a powdered activated carbon (PAC)/sand gate to address dissolved VOCs. In another portion of the site, a DNAPL recovery system consisting of recovery wells has been designed. Air sparging to create a biofence to address dissolved VOCs is planned downgradient of the recovery wells.

- **Former MGP Site, Providence, RI** - Managed monthly and annual post closure monitoring. Tasks at the site included monthly monitoring of groundwater wells for the presence of immiscible phase product and annual monitoring of groundwater quality per state requirements. Also investigated groundwater conditions as related to pipeline corrosion and monitored subsurface conditions revealed during aboveground fuel oil storage tanks at site.

- **Former MGP Site, Salem, NJ** - Provided technical support for the proposed excavation of contaminated soils adjacent to a tidal creek in Salem, New Jersey. The project includes excavation to various depths below the water table, relocation of a railroad line to allow excavation within the right-of-way, and treatment of contaminated groundwater from dewatering. Engineering analyses include excavation support design, and groundwater modeling to estimate dewatering quantities and resulting treatment costs. The predicted dewatering quantities were used in cost comparisons of construction alternatives. Considered various options for water control including slurry walls and jet grout base slabs.

- **Former MGP Site, Egg Harbor, NJ** - Performed excavation support system design peer review. Excavation support system was part of a former MGP site remediation program that included excavation of contaminated soils which were then treated thermally. After treatment, soils were re-used to refill the excavation. The excavation support system included cantilevered and tied-back steel sheet piling. Issues considered included water control, depth of excavation, base stability, wall stability, wall movement, constructability of the system as designed, and risks associated with the proposed system.

- **Stormwater Culvert Rehabilitation, Everett, MA -** Project Manager for inspection and evaluation of the condition of a 1600-foot-long, 5.5-foot-wide by 10-foot-high pipe arch culvert, and for analysis, design, and construction of repairs including a 100-foot-long, long-span, aluminum drainage culvert replacement section in contaminated soils performed as a URAM and miscellaneous spot repairs in other sections of the culvert. The work included research of corrosion and constructability issues, presenting design options to client, design of repairs and preparation of construction specifications, evaluation and routing of storm water flows, investigation of soil and sediment contamination and selection of disposal options for 3000 tons of contaminated soil surrounding the damaged culvert section and 160 tons of sediment from within the culvert, and provided construction oversight and management services

- **Warehouse Redevelopment, Hatfield, MA** - Technical specialist during remedial activities during redevelopment of a warehouse facility. Former facility at site used inks and pigments, and contamination associated with MEK and MIBK was encountered during redevelopment construction activities and removed from the site. Investigated the extent and feasibility of removal of contaminated soils under building foundations, performed indoor air quality monitoring, and worked on expediting contamination removal activities while complying with regulations during the transition from old to new MCP.

Miscellaneous

- **Steam Chambers, Kern County, CA -** Laboratory testing and geotechnical design for oil sand stream extraction caverns. The extraction system included horizontal drilling to install pipes for injection of steam and extraction of oils.

- **Underground Storage Caverns, Fort Saskatchewan, Canada** Finite element analyses and design recommendations for deep caverns in salt rock formation for storage of natural gas. Caverns were approximately 250 feet in diameter and 6,000 feet deep. Included consideration of creep behavior.

- **Coal Mine Subsidence, Illinois** Evaluated causes and impacts and developed recommendations for remedial measures in regions of coal mine subsidence for the Abandoned Mined Lands Reclamation Council. Remedial measures included backfilling and grouting to fill mined voids and to arrest ground movements. Project work included borehole photography, design, installation, and monitoring of instrumentations to provide data on settlement and horizontal movement of the ground and affected structures.

- **Granite Curbing Investigation, NH, MA, and NC -** Principal investigator in charge of evaluating the properties and performance characteristics of granite curbing from various sources. Testing included density, compressive and tensile strength, durability, and freeze-thaw resistance.

- **Ballast Test Section, Broken Bow, NE -** Principal investigator in charge of installation of test section and monitoring performance of five types of rock ballast on a mainline for Burlington-Northern Railroad and Meridian Aggregates.

- **Concrete Tie Center Binding Investigation, Bill, WY -** Project manager for field investigation and evaluation of railroad track bed soil conditions affecting life and performance of concrete ties.

- **Shoulder Ballast Cleaning Study, Bushnell, IL -** Project manager for field investigation to study effectiveness of shoulder ballast cleaning on ballast life and track bed performance.

- **Crash Wall Evaluation, AAR Test Facility, Pueblo, CO -** Performed geotechnical and structural analyses of a retaining structure that serves as a crash wall to test railroad vehicles. The existing wall was to be subjected to a higher test crash load, 3,000,000 pounds, than in the past during and up coming tank car test. Analyses included soil berm resistance, sliding resistance of the structure, overturning/rocking resistance of the structure, as well as, ability of the concrete and steel components of the structure to resist the higher loading. Recommendations included placement of accelerometer instrumentation to document the response and movement of the crash wall structure during the test.

- **Prebid, Value Engineering, and Other Evaluations** Performed analyses and developed construction and value engineering alternatives for contractors during the bidding phases of projects involving tunnel and open-cut excavations in soil and rock. Included evaluation of compatibility of proposed construction methods and equipment with the expected ground conditions, effect of excavation-induced ground movements on adjacent structures and utilities, and recommendation of measures to minimize potential adverse response. Techniques evaluated include, slurry walls, sheet pile walls, soldier pile and king pile walls, soil nail walls, MSE walls, deep dynamic compaction, deep soil mixing, jet grouting, permeation grouting, compaction grouting, compensation grouting, secant pile walls, in situ densification by vibration, stone columns, wick drains and other geotechnical construction methods. Included projects in Canada, Puerto Rico, Washington, D.C., Milwaukee, Chicago, Phoenix, Washington and Florida.

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