ENGINEERING / REMEDIATION / CLOSURE

Case 1: Persulfate ISCO Remediation of PFAS in Groundwater

EXCALIBUR provided expert third-party assessment of activated persulfate chemical oxidation (ISCO) for remediating PFAS in groundwater at a politically sensitive site abroad. PFAS plume control was already underway via a massive groundwater extraction and treatment system employing granular activated carbon (GAC) and **EXCALIBUR**'s client was interested in augmenting the remedial program by persulfate ISCO. Impacted drinking water sources, community involvement and worldwide press coverage, and governmental threats of criminal and civil penalties made the site and PFAS cleanup activities highly visible. On behalf of its longtime multi-national client, **EXCALIBUR** evaluated the proposition of persulfate ISCO treatment of the PFAS-impacted aquifer beginning with a field-scale pilot study. As an emerging technology for PFAS remediation, **EXCALIBUR** gave the persulfate ISCO proposal applied to the site specifics a thorough assessment.

In its final analysis, **EXCALIBUR** guided its client away from any immediate field testing of persulfate ISCO treatment of the PFAS plume. **EXCALIBUR** found there was insufficient knowledge / characterization of the thousands of PFAS compounds potentially present at the site and which compounds were treatment priorities, key information since persulfate ISCO is thought to be potentially effective on some subclasses of PFAS but not others (e.g., PFOS and sulfonic acid compounds). Additionally, **EXCALIBUR** was concerned that since persulfate ISCO has been shown in laboratory testing to be effective on certain PFAS only if the temperature of the treatment area was raised considerably, which appeared impractical for the highly productive site aquifer. Lastly, **EXCALIBUR** noted that while the persulfate ISCO treatment offered the prospect of breaking larger PFAS molecules into smaller ones, there is uncertainty about the toxicity and mobility of the smaller breakdown PFAS

molecules and whether the existing GAC treatment system would be effective in removing the smaller molecules.

EXCALIBUR advised that any in-field persulfate ISCO testing of PFAs treatment should only follow a well-designed and implemented and successful bench-scale pilot study that addresses the myriad of concerns. PFAS have unique chemical properties that require innovative combinations of existing and/ or entirely new technologies. **EXCALIBUR'**s guidance touched on application of known PFAS cleanup technologies such as GAC; sorption and anion exchange resins; organoclays and biomaterials stabilization; thermal destruction; coagulation–flocculation used in wastewater treatment; membrane filtration and reverse osmosis; and nanofiltration. In this case, **EXCALIBUR** could NOT recommend the immediate in-field pilot testing or use of persulfate ISCO for treatment of the large plumes of PFAS compounds given the site geological, geochemical and geopolitical complexities. Instead **EXCALIBUR** offered a logical, prudent, cost-effective, and defensible phased approach to meet the client's legal, regulatory, environmental and business objectives, an approach. In brief, **EXCALIBUR** drew upon its experience evaluating conventional and emerging remedial technologies / pilot testing protocols and facts about PFAS to guide its client away from immediate pilot testing of persulfate ISCO to help avoid a potentially costly mistake.

Case 2: Innovative Soil/Groundwater Remediation System, Industrial Coatings Plant, MD.

For over 14 years, EXCALIBUR has been serving a multi-national Fortune 500 coatings manufacturer by characterizing and cleaning up multiple areas of its largest and most productive paint manufacturing facility. The site has been impacted by spills from operating over 70 USTs, dozens of ASTs, pipelines, wastewater treatment equipment and other systems since the late 1940s. Products spilled over the years include:

gasoline, diesel, fuel oil, mineral spirits, trichlorethane (TCA), toluene, ethylbenzene, xylenes, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene and other hazardous materials

The site investigations, cleanup, monitoring and risk assessments completed by EXCALIBUR have been under the oversight of both the state hazardous waste regulators and the USEPA, Region 3 under the RCRA program. The site investigations, cleanup, monitoring and risk assessments completed by **EXCALIBUR** have been under the oversight of both the state hazardous waste regulators and the USEPA, Region 3 under the RCRA program. **EXCALIBUR**'s knowledge of site characterization techniques is exhibited by the variety of techniques used over the years to investigate the complicated site including: Geoprobing, drill rig and hand augering, soil gas surveys, Shelby tube sampling, conductivity / resistivity profiling and others. Multiple remedial technologies have been employed in different areas of concern to address contamination including: air sparging, SVE, high vacuum multi-phase extraction, enhanced aerobic bioremediation, source removal (excavation), trench groundwater extraction / treatment, monitored reductive dechlorination, and monitored / documented natural attenuation. Site challenges and complexities **EXCALIBUR** has successfully overcome during characterizations and remediation include: (i) addressing contamination beneath 24-hour/ day busy, congested plant operations / buildings focused on production; (ii) both overburden and bedrock groundwater impacts; (iii) both petroleum and chlorinated solvents; (iv) heterogeneous, lower permeability overburden; (v) impacts adjacent to the property line; (vi) remediating with subsistence of a 100+ year buildings; and (vii) poor existing documentation of buried features and utilities. **EXCALIBUR** met these challenges successfully delineating the site impacts, designing and installing remediation systems, operating and maintaining (O&M) the remediation equipment complex, monitoring / documenting remedial performance, assessing current and future risks of the residual impacts, and gaining state regulatory approval to terminate remedial operations and close several site areas. In March 2013, **EXCALIBUR** prepared and submitted to USEPA, Region 3 a RCRA Facility

Investigation and Corrective Measures Study (RFI/CMS) covering the entire 23-acre complex. The RFI/CMS includes a comprehensive risk assessment and post-remedial care plan that is expected to complete the remedial solution for the site to obtain state and USEPA regulatory close-out of further investigation and remedial activities for the plant.

Case 3: Design, Construction, O&M of Superfund Cleanup, Montross, VA

EXCALIBUR designed, installed, operated & maintained and attained regulatory closure for chlorinated solvent contaminated soil in two areas on its client's USEPA Region III Superfund site. As part of this work, EXCALIBUR professional staff evaluated detailed soil, surface water, sediment, and groundwater monitoring data collected over several years to profile the extent and remedy for solvent contamination in soil beneath the Superfund site. EXCALIBUR coordinated closely with its hydrogeologist and risk assessment and field investigation experts to ascertain the sources and dynamics of on-site contamination relative to USEPA directives and remedial goals. **EXCALIBUR** subsequently prepared detailed remedial design work plan for EPA review and addressed series of follow-up regulatory comments prior to engineering phase of project. **EXCALIBUR**'s plan accounted for bench and pilot-scale testing leading to implementation of long-term remedies. **EXCALIBUR**'s focus was toward design, installation, and operation of test facilities to verify optimal system(s) and specifications for formal downstream engineering design consistent with in-field pump test criteria and site conditions. **EXCALIBUR** completed the 30%, 95% and final remedial design / specifications to meet USEPA requirements and enable construction of soil vapor extraction (SVE) system. **EXCALIBUR** subsequently constructed and operated the remedial system to address two separate areas within design specifications in order to meet the regulatory cleanup requirements within 2 years.

Case 4: Lagoon Closure/Sludge Remediation, Raleigh, North Carolina

EXCALIBUR provided project management, investigative/field support, and senior technical advisory services in support of the successful closure of two former industrial lagoons at a pharmaceutical manufacturing facility in Raleigh, North Carolina. This turn-key characterization/remediation project was awarded through a competitive bid process and approved by the North Carolina Department of Environment and Natural Resources (DENR).

Since the volume and chemical nature of the waste sludge were unknown, a detailed assessment of the lagoons was initially performed to develop an integrated waste management and closure plan. Services also included development and successful negotiation of: the closure plan with DENR, a separate sediment and erosion control plan, and a separate agreement with the City of Raleigh Industrial Pretreatment Division for discharge of the lagoon wastewater. A key element of the winning approach was the development of a cost-effective treatment process for the hazardous sludge, which was needed to efficiently dispose of nearly 30,000 tons of the waste material in a Subtitle D landfill under all applicable regulations. Due to the moisture content, the sludge was bulked by adding a combination of native soils and sawdust to facilitate on-site handling, loading, and off-site disposal. The final step involved developing and implementing a detailed remedial confirmation plan, verified by a series of in-field screening and laboratory analyses of soil samples collected from various depths and distances from the lagoon bottoms and perimeters. Hand-in-hand with the closure of one lagoon, a design and cost estimate was provided for conversion of the lagoon to a spill containment area. A lined retention basin was designed to maximize the storage capacity of the containment area.

Overall, the success of this project enabled the industrial client to remove two historic waste management units serving as contaminant source areas while simultaneously providing the client with the option to convert one into additional containment capacity in the event of a spill.

Case 5: Ship Yard Wastewater Collection and Treatment System Design, Alaska

Alaska Ship & Drydock, Inc. (ASD) hired EXCALIBUR to provide engineering design services for its dry dock expansion plans at ASD's Ketchikan, Alaska ship yard. ASD was adding a second floating dry dock and an upland berth pad to service ships and other vessels up to 450 feet long and 100 feet wide. As part of this expansion to the existing 10,000-ton floating dry dock operations, ASD needed to design and build a wastewater collection and treatment system to capture and treat metals and petroleum contaminated wastewater run-off from the dry dock decking and berthing surfaces contaminated with ship hull wash water prior to discharge.

ASD enlisted **EXCALIBUR** and its engineering expertise to listen carefully to ASDs objectives, help ASD refine its goals and design solution that fully accounted for facility operations, budget constraints and **limited** space. **EXCALIBUR** was then able to develop a facility operations compatible, innovative and cost effective wastewater collection and treatment system design. Unique challenges of the design included potential 25-foot tidal swings, low ambient temperatures, facility congestion / limited space, elevated and variable wastewater concentrations of copper, zinc, lead and oil & grease, widely ranging wastewater flows and strict ocean discharge permit constraints. **EXCALIBUR** met these challenges by designing the ~14,000 gpd treatment system to be situated on a floating barge to limit space requirements on the facility grounds. The

floating treatment system barge was designed with large integral holding tanks to provide operational flexibility. **EXCALIBUR**'s treatment system design incorporating fully automated operation, cost effectively removing up to 96 mg/l copper, 87 mg/L zinc and 10 mg/L TOG using electro-coagulation for primary wastewater treatment prior to ocean discharge. **EXCALIBUR** assisted ASD with implementation of the dry dock facilities expansion.

Case 6: Chlorinated Solvent Groundwater Extraction / Treatment System Rebuild, Eastern Shore, MD

EXCALIBUR was hired to trouble-shoot and renovate a failing groundwater remediation system at a ~14-acre USEPA, RCRA regulated site located in a remote area on Maryland's eastern shore. The site had been used to manufacture electronic heating elements and shallow overburden groundwater became contaminated with chlorinated solvents including PCE, 1,1,1-TCA and degradation compounds. The failing 200-gpm capacity remediation system consisted of a network of 30 groundwater extraction wells with a 3-foot diameter, 30-foot tall air stripping tower for groundwater treatment. A relatively unusual system of venturi educators submerged in each of the 30 remediation system wells powered by a 30-horsepower pump in the remediation compound were used to withdraw groundwater from the subsurface for treatment and discharge.

Due to design flaws and wear and tear, the fledgling system became impossible to maintain in operable condition and regulatory citations were a concern. **EXCALIBUR** remedial system design and operation experts were brought on board to identify the source of the operation and maintenance problems and to design and implement cost effective solutions. An initial engineering inspection and electronics controls testing by **EXCALIBUR** led to repairs of some key components before more comprehensive trouble-shooting of the system. When the testing was complete, **EXCALIBUR** identified and implemented a number of cost effective modifications to facilitate maintenance of

system components and enable trouble-free operations with maximized up-time efficiency. Changes to the system led to more than a 10-fold increase in groundwater extraction rates and continuous operations verified by newly installed telemetry. **EXCALIBUR**'s upgrade services included: (a) replacing the down-well piping, fittings and venturi educators so they could be easily removed for maintenance; (b) replacing failed pressure, level and other switches in the treatment compound; (c) installing remote monitoring / control telemetry; (d) winterizing exposed piping; (e) designing / installing a guy wire / deadman guy wire support system for the stripping tower; (f) completing an engineering integrity inspection of the corroded ASTs used by the treatment system; and (g) installing a new flow totalizer with electronic outputs feeding readings to the new telemetry unit for remote monitoring of flow rate and total processed flow. The success of the upgrades **EXCALIBUR** designed and implemented advanced the site to closure when in 2014 the USEPA released the Statement of Basis document for the RCRA site.

Case 7: Engineering Design for Parking Garage Dewatering / Treatment System, Silver Spring, MD

EXCALIBUR's engineers designed a cost effective, fully automated groundwater treatment system for a $22M parking garage with 1,789 parking spaces on 7 decks at a redevelopment site in Silver Spring, Maryland. This parking garage development project was eventually awarded "Overall Excellence in Smart Growth" by the USEPA. EXCALIBUR was enlisted to help on the project because of its remedial design expertise and reputation which were well suited to accommodate the parking garage intersecting groundwater contaminated with volatile organic compounds (VOCs) from historical industrial activities in the area. The parking garage foundation sump / dewatering system, designed to keep water from accumulating in the lower deck area required treatment prior to discharge. In particular, EXCALIBUR's engineers were tasked with developing a low cost, low maintenance system design that would

accommodate variable input flow rates while adequately treating groundwater to remove high levels of MTBE (36,000 ppb), benzene (160 ppb) and perchloroethylene (PCE) (1,650 ppb) in order to meet the strict surface water discharge requirements.

Another design criterion for **EXCALIBUR**'s engineers was that the treatment system had to be designed to be used during the construction phase of the project (Phase I) to treat groundwater generated by excavation dewatering. To accommodate the requirements, **EXCALIBUR** developed a mobile treatment system design which would allow the treatment system to first be used above-grade during construction / dewatering (Phase I) but then moved to a designated location in the lower deck of the newly constructed parking garage to automatically treat accumulated sump groundwater during the normal course of garage operations (Phase II). To minimize the potential for operational issues during construction and subsequent automated operations in the garage, **EXCALIBUR**'s designers kept the system equipment and controls as least complicated as possible while ensuring safe and effective operations. The design incorporated low profile air stripping to remove the VOCs sufficiently to meet discharge requirements while minimizing treatment costs with minimal inorganic precipitation expected in the treatment components. Appropriate instrumentation, controls and telemetry were incorporated into the design. **EXCALIBUR**'s design drawings were used for permitting and for procuring constructor bids. The project was successfully completed in 2004.

Case 8: Cleanup of Catastrophic Spill Impacting Municipal Water Supply, PA

For over 15 years, EXCALIBUR has been providing necessary consulting, engineering, remediation and regulatory support services needed for an east coast regional oil and gasoline distributor to remediate and attain clean-closure by meeting the state

residential drinking water standards. The site had a catastrophic 4,200-gallon spill of unleaded gasoline product from an underground storage tank (UST) directly into groundwater. Nearby residences noticed gasoline odors in their homes, gasoline product was observed in the storm sewer and a creek about ¼mile from the spill site, and ultimately, the town water supply wells were found to be impacted with MTBE.

After emergency response actions and site characterization, **EXCALIBUR** designed and managed the construction of a multi-phase groundwater and free product recovery system that included five on-site and off-site recovery wells aligned along the axis of the contaminant plume. Under the PADEP-approved RAP, **EXCALIBUR** completed operation, maintenance and monitoring (OM&M) of the remediation system over approximately 7years until the free product recovery efforts were completed and dissolved levels indicated the remedial objectives had been achieved. Components of **EXCALIBUR**'s remedial design implemented at the site under PADEP oversight include source removal via exaction; on-site bio-pile construction and bioremediation; multi-phase extraction, gravimetric oil / water separation, air stripping, granular activated carbon adsorption; and discharge to a remote storm sewer on the opposite side of a hill top under an NPDES permit. **EXCALIBUR** also provided litigation support services to its client who was being sued by the town water supply company due to the contamination in their water supply wells. In this capacity, **EXCALIBUR** prepared and presented hydroglogic flow and contaminant fate and transport analyses, served as a fact witness and offered deposition testimony. The multiple site challenges and complexities that **EXCALIBUR** successfully navigated for this cleanup include: (i) large volume of spilled gasoline; (ii) contamination beneath busy road and off-site commercial and residential properties (iii) both overburden and bedrock groundwater impacts; (iv) lower permeability overburden; and (v) impacted town water supply wells and associated litigation. **EXCALIBUR** has successfully helped its client demonstrate attainment of the PADEP statewide health standards (SHS) for all by one remaining well. Once the last point of compliance well has met the attainment demonstration

requirements, **EXCALIBUR** will be assisting its client with the soil attainment demonstration and the Remedial Action Completion Report (RACR) so the site may be clean closed upon regulatory approval.

Case 9: Third-Party Engineering Reviews and Cost Verifications for UST Trust Fund, PA.

For more than 15 years, EXCALIBUR has been serving as the third-party technical reviewer for a state UST Indemnification Trust Fund. In this capacity EXCALIBUR has saved the insurance fund nearly $10M in unjustified or unsubstantiated environmental costs. EXCALIBUR serves as a technical expert on site characterization, environmental engineering, and remediation to evaluate and comment on the more complicated insurance claims.

Have routinely evaluated cases involving soil and groundwater contamination to determine if site characterization was correctly performed and interpreted, and whether remediation approach employed was the most appropriate and cost effective for the specific site. To meet these project goals, have reviewed extensive files and back-up data provided by applicant, interviewed applicants and his/her consultants to verify information and fill data gaps, and have conducted independent research on key engineering, regulatory, and risk-based closure issues. Have frequently conducted site-specific remedial alternatives analyses and developed cost estimates for comparison against the costs already incurred. Prepared detailed technical opinion letters describing the basis of our opinion, the appropriateness, completeness, or deficiencies in the work performed by the applicant, and our recommendations for reimbursement, additional data collection, or other measures.

EXCALIBUR's services include (a) claim eligibility reviews involving forensic evaluation to established the likely timing and source(s) of claimed release (b) technical assessment of the cost effectiveness and efficiencies of site characterizations and remediation planned and underway (c) performance-based fixed price contracting via negotiation or competitive bidding claim site cleanups; and (d) expert litigation support work.

Case 10: Auto Dealer Decommissioning / Cleanup for Redevelopment, VA

Planned and managed all environmental, engineering, and remediation services in support of construction company client's renovation and rebuild of largest automotive sales and service facility in Eastern U.S. Contracted / managed 9 different specialty support firms for analytical laboratory, drilling, Geoprobe, underground integrity tank testing, earthwork, trenching, demolition, and various excavation and excavation-related services. Completed environmental due diligence, asbestos, and lead paint assessments to determine estimated cost to address environmental liabilities. Emptied, decommissioned, and removed the leaking UST and impacted soil, followed by confirmation sampling and analysis. Developed and oversaw removal of 27 hydraulic lifts, the surrounding oily soils, and several thousands of gallons of hydraulic oil and oily water and groundwater which seeped into some of the excavations.

Subsequently conducted additional environmental assessments and asbestos and lead paint surveys at a neighboring maintenance complex with over 25 in-ground hydraulic (oil) lifts which was also being gutted and completely upgraded. The following environmental issues were identified: friable and non-friable asbestos containing materials, surfaces coated with leaded painted, and an uncharacterized former UST and numerous potentially leaking hydraulic lifts. Field sampling confirmed that the soils and groundwater had been impacted with elevated levels of petroleum product. Developed

and oversaw removal of 27 hydraulic lifts, the surrounding oily soils, and several thousands of gallons of hydraulic oil and oily water and groundwater which seeped into some of the excavations. Provided structural engineering evaluations, before and during demolition and removal of concrete slabs near key foundation supports, and prepared site for follow-on electrical work for new electrical lift stations. Monitored and adjusted work space atmosphere during demolition activities, conducted confirmation soil and waste sampling and analysis, coordinated waste manifesting, transportation, and disposal, and all subsurface geophysical mapping, and cleaned out and grouted in-place all old underground piping, man-ways, and defunct utilities.

Completed a facility/client specific remedial alternatives analysis to identify most cost effective and practical *ex-situ* and *in-situ* remedies. This information was also used to negotiate site purchase terms and conditions, and enable site developer and his architect let bids for third-party asbestos removal, structural demolition, and facility redevelopment in and around the contaminated areas. Based on strategy developed as part of project, led all negotiations with VDEQ on remediation compatible with customer's site redevelopment plans. Successfully negotiated limited soil removal *only* in those locations already targeted for site redevelopment, and for natural attenuation, *without any need for remediation* of the groundwater.

Based on the ability to develop practical, business-friendly solutions during the first phase of the project, retained again to manage and implement the removal of two additional5,000-gal USTs, six more hydraulic lifts and reservoir tanks, and three in-ground, oil/water separators. Closely coordinated with prime construction contractor to ensure each task was completed within the context of the overall fast-track site demolition/restoration master schedule for the sales and service complex. Efficiently managed all excavation, trenching, UST removal, confirmation sampling, site restoration, and regulatory negotiations to complete all work ahead of schedule and under budget.

Case 11: Broad-based Engineering/Remediation Program throughout New York

Over a 6-year period, managed all field investigation, engineering, remediation, construction management and regulatory negotiations associated with several contaminated telecommunication facilities located in separately regulated regions throughout New York in support of $1 billion property transaction. Successfully negotiated with New York State Department of Environmental Conservation (NYSDEC) to manage the entire effort as a single program with one regulatory point of contact representing multiple regulated regions to ensure consistent, streamlined regulatory reviews and reduced costs.

Successfully negotiated technology-based soil and groundwater clean-up standards for select sites to reduce the amount of time and money needed to obtain certified site closures.

Conducted detailed remedial alternatives analyses to identify best site- and client-specific technologies and approaches. For each alternative, schedules, capital and O&M costs, potential to cause operational disruptions, and other major advantages and disadvantages were quantified and compared. Based on these evaluations the following technologies were selected and used to clean up the subsurface contamination at the facilities:

- Soil Vapor Extraction (SVE);
- Combined in-situ groundwater sparging/SVE;
- Recirculating extraction, treatment, and re-infiltration of nutrient-amended

groundwater;
- Bioremediation;
- Excavation and on-site thermal oxidation of contaminated soils;
- Groundwater extraction and treatment using phase separation and granulated activated carbon;
- In-situ chemical oxidation; and
- Excavation/offsite disposal of contaminated soil.

Highlights on the innovative solutions used to remediate select telecommunication facilities are presented below.

Site 1, NYSDEC Region 7- Negotiated to use temporary remedial pilot-scale system to remove petroleum contamination from both

Site 2, Region 7- Excavated more than 2,000 tons of heavily contaminated soil and a 3,000-gal. UST, and treated over 1,000 tons of the soil in an on-site thermal oxidation unit within a short 18-day project window. Soils too saturated for treatment were transported offsite and recycled; the concrete from with UST was screened for contamination and returned to the excavation to reduce backfilling costs. The tank was crushed and transported offsite and recycled. Over 80,000 gallons of contaminated groundwater were collected and treated in a system constructed at the facility during the field project prior to being directly discharged in accordance with a Stipulation Agreement negotiated with the NYSDEC. Completely restored the UST area using treated soil from the thermal oxidizer, imported fill material, and gravel followed by paving atop of an engineered geofabric and sub-base gravel.

After removal of the source area, designed and installed a recirculating groundwater extraction, treatment, nutrient enhancement, and re-infiltration system to remove elevated levels of petroleum constituents. Successfully negotiated technology-based clean-up goals followed by risk assessment with the NYSDEC to avoid prolonged

operation and maintenance of the treatment system other wise needed to meet the initially more stringent NYSDEC standard cleanup values. Prepared bid specifications, held on-site bid conferences with prospective subcontractors, and hired equipment vendors and excavation contractors to help install the system. After two years of operation achieved technology-based standards, demonstrated that system had reached its technological limit in cleaning up the subsurface and obtained closure from the NYSDEC

Site 3, NYSDEC Region 4- After completing a focused field investigation and remedial alternatives analysis, settled on SVE as the most appropriate clean-up technology for the site. Conducted on-site pilot study to confirm technology selection followed by design and installation of SVE system equipped with air emission control system and remote O&M telemetry/system performance capabilities. Successfully operated system for two years until site monitoring data demonstrated system had achieved remedial closure goals. Applied for formal closure that was readily granted by NYSDEC.

Site 4, Region 7- Completed detailed remedial pilot study to confirm feasibility of restoring contaminated soil and groundwater using combined groundwater sparge and SVE technologies. The engineering design for the combined system was readily approved by the NYSDEC and client. Subsequently, completed 30 and 95 percent design packages, developed bid packages let to pre-qualified subcontractors, constructed the SVE trenching network, and installed sparge wells and SVE system and equipment compound. Operated system for two years and obtained clean closure from State.

Site 5, NYSDEC Region 9- Excavated over 1,000 tons of contaminated soil, removed the UST, and constructed temporary groundwater collection, extraction, and treatment system. Arranged for soil to be transported to offsite batch asphalt recycling facility. Subsequent groundwater monitoring confirmed effectiveness of approach that was presented in a closure petition approved by the State.

Case 12: Successful RCRA Closure, Pharmaceutical Manufacturing Facility, VA

Fully executed the RCRA closure plan for three separate hazardous waste storage areas at active manufacturing plant. Work included decontamination of storage racks and pads, drilling and sampling soil borings for confirmation monitoring, statistical analyses risk assessment evaluations, extensive regulatory interface and engineering inspections and certifications necessary to achieve RCRA closures for the three hazardous waste storage units.

Careful planning and coordination with facility production staff and management and with drilling, laboratory, and decontamination subcontractors resulted in no disruptions of on-going manufacturing operations.

Elevated levels of inorganic constituents beneath two of the former hazardous waste storage pads spurred additional background sampling from undisturbed areas to determine if the origin of the elevated inorganic constituents was the former storage operation (in which remediation would be required) or from a natural source. Naturally occurring inorganics were detected at similar elevated levels, however, despite extensive statistical analyses (student t-test, 95% tolerance interval comparisons, 95% UCL point estimate comparisons, and non-parametric Wilcoxon Rank-sum test), an exclusive natural source could not be proven to the RCRA regulators. Nevertheless, through persistent negotiation and assistance solicited from the US EPA Region III, the VADEQ was eventually persuaded to accept the elevated levels beneath the pad were naturally occurring. The major arguments that won over the State included: 1) no other constituents were found above risk-based concentrations; 2) no clear pattern of hazardous waste releases were evident; 3) elevated inorganics in background and sub-pad areas were very similar; 4) only very small quantities of inorganics were ever used on site; and 5) the toxicity criteria for the elevated inorganics were very conservative.

Based on these diligent efforts, the facility was granted clean closure for all three hazardous waste units, without having to take any deed restrictions or incur any plant disruptions and the project came in well under budget and on schedule.

Case 13: RCRA Closure of Hazardous Waste Storage Area, Metal Finishing Plant, VA

Managed the successful closure of a RCRA hazardous waste storage facility at an operating electroplating plant and provided the associated professional engineering certification. The plant, specializing in high-technology electroplating services for governmental science and defense agencies, stored its hazardous wastes indoors and adjacent to its wastewater treatment plant prior to being shipped off-site for proper disposal. With recent operational changes, the facility began storing its hazardous wastes on-site for less than 90 days. As such, the RCRA interim-status facility elected to forgo becoming a permitted hazardous waste treatment, storage and/or disposal facility (TSDF) by closing its storage facility under the formal RCRA process.

Valuable direction was given to the client during the preparation of a final closure plan for the RCRA unit by identifying multiple options for completing the closure work more cost effectively and in a shorter period of time. Some of these insightful cost saving options inserted into the plan included: risk assessment in lieu of background sampling and subsequent statistical analyses; scarification of concrete in lieu of concrete removal; subdivision of the hazardous waste unit into quadrants for decontamination and confirmation sampling; and use of Virginia-specific background lead concentrations in soil rather than default values in the US Environmental Protection Agency's (USEPA's) IEUBK lead uptake model and others. Subsequent to the preparation of the plan with these cost-saving options, negotiations were held with the Virginia Department

of Environmental Quality (VDEQ) to present and discuss these options to obtain the agency's consent on the approach. Following the engineer's structural inspection of the concrete slab, the decontamination of the hazardous waste storage unit was completed using steam cleaners, pressure washers and liquid vacuum recovery equipment. The unit was decontaminated and confirmation sampling was performed over a week-end in order to avoid any disruption to facility operations. A risk analysis was subsequently performed using the decontamination rinsate sample analytical results. Based on the results of these analyses, follow-up concrete coring and soil and concrete sampling were completed. Using the analytical results from the concrete and soil sampling, the risk analysis was completed and the RCRA clean closure report was prepared, certified and submitted to the VDEQ for final approval. VDEQ approval of the clean closure of the RCRA unit is expected in 1999.

Case 14: Closure of Hazardous Waste Disposal Units, Confidential State Agency Client, VA

Managed the closure of three RCRA-regulated Hazardous Waste Management Units (HWMUs) for the State of Virginia. The three HWMUs were located at an active regional headquarters facility employing hundreds of people that includes administrative offices, machine shops, and maintenance and manufacturing facilities. Project team provided environmental consulting, permitting support, regulatory negotiation, risk assessment, engineering, and construction management services. More specifically, the project included: 1) developing and negotiating site-specific risk-based closure standards; 2) conducting remedial engineering alternatives analyses to identify cost-effective and practical soil and groundwater clean-up solutions; and 3) coordinated and oversaw engineering and construction management to excavate, transport and dispose of hazardous soils associated with the hazardous waste management units.

Oversaw and directed construction team to excavate and temporarily stage on-site scores of roll-off boxes containing over 1,500 tons of hazardous wastes without disrupting any of the busy normal onsite operations.

Completed bid packages, competed subcontractor work, and selected most qualified subcontractor to implement waste removal and management at one unit where waste solvents were disposed of into the subsurface through an in-ground drain field. Package included specifications and engineering drawings for construction of contingency groundwater remediation piping network in the open excavation slated for use as part of a future groundwater treatment system. Oversaw and directed construction team to excavate and temporarily stage on-site scores of roll-off boxes containing over 1,500 tons of hazardous wastes without disrupting any of the busy normal onsite operations. Subsequently, obtained closure for the most contaminated unit. Construction activities associated with the closure of the other two hazardous waste management units were completed shortly thereafter.

Case 15: Coal Tar Product Recovery System Rebuild and O&M, Eastern OH

When cleanup problems emerged / progress had stalled, EXCALIBUR was hired by the PRP for a ~4-acre coal tar Superfund site in eastern Ohio to trouble-shoot, perform remedial system upgrades and then perform optimized, cost-effective operation and maintenance, monitoring and reporting. The site had been used for nearly 25 years as a coal tar refinery during which time spills occurred to impact groundwater with free-phase and dissolved coal tar. Initial response actions under the ROD included excavation and off-site thermal treatment of surface soil, and river sediments and construction of a

RCRA Subtitle D cap over on-site disposed materials. Collection of perched groundwater and maintenance of hydraulic control were part of the permanent remedy.

The groundwater collection / hydraulic containment system consisted of a coal tar interceptor trench with two sumps where groundwater and extremely viscous coal tar were extracted separately using a combination of double-diaphragm and Blackhawk low-flow reciprocating piston pumps. **EXCALIBUR'**s assessment of the remediation system identified multiple issues with the system / design causing operational and maintenance difficulties and poor performance. Clogged pump discharge piping and stuck Blackhawk footing valves were found by **EXCALIBUR** diagnostic engineers. **EXCALIBUR** surmised that the identified maintenance issues had led to continuous operation and ultimate failure of the remediation system air compressor powering the pumps. Based on its observations, **EXCALIBUR** developed a cost effective system renovation & maintenance plan designed not only to restore & improve coal tar recovery rates but also to optimize system efficiencies / limit future downtime. To restore system operations while minimizing capital and re-design expenditures, **EXCALIBUR** replaced the failed system air compressor, cleaned out the remedial system oil/water separator, exchanged the liquid GAC water treatment units, pulled, disassembled and used parts cleaner on the Blackhawk product pumps, removed the old and ran new piping from the well heads to the recovery compound, adjusted the pump activation timing on the PLC. To increase system operational efficiency moving ahead, **EXCALIBUR** developed an updated O&M plan which included frequent routine pulling, disassembly and cleaning of the Blackhawk coal tar pumps. As a result of **EXCALIBUR**'s efforts, coal tar recovery when from negligible to more than 5 gallons coal tar in a 24-hour period with the new O&M protocols resulting in a notable increase in system up-time. USEPA, Region 5 specifically reports on the notable increase (since 2012) in their on-line summary of this site.

Case 16: Streamlined Closure, Stubborn Legacy Industrial Site Impacted With PCBs, Linden NJ

After more than 14 years of incremental remedial actions, mounting cleanup costs and uncertainty posed by series of contractors, the PRP enlisted EXCALIBUR to develop and implement a definitive, more cost effective, efficient plan to accelerate cleanup and regulatory closure of a highly contaminated 3-acre industrial site in Linden, NJ. EXCALIBUR successfully completed the closure within the next few years while saving the PRP over $500,000, exceeding client expectations on all fronts.

The site was impacted with widespread PCB-contaminated soil and benzene in groundwater from years of past polyester resin manufacturing. PCBs in hydraulic oil used in the production operations had been spilled and tracked with equipment and spread over much of the site and neighboring lots by storm water runoff, including an adjacent Conrail property and Amtrak's East Coast high speed rail line tract.

Remediation of on-site PCBs had been mostly addressed by source removal (excavation), capping and institutional controls (deed restrictions) but the boundaries and severity of the offsite PCBs had still not been addressed across the Conrail and Amtrak properties, and benzene remained above NJDEP's standards in site groundwater.

Despite these challenges, **EXCALIBUR** succeeded in more cost effectively closing the site ahead of schedule under NJDEP ISRA and USEPA TSCA regulatory oversight. This required overcoming many complex and in some cases related obstacles that had stymied all prior attempts, including accounting for: (a) negotiating/ securing off-site access issues with two separate impacted parties; (b) limited to no accessibility to major high-speed Amtrak rail line (which also contained buried critical fiber optic and rail communications lines); (c) an incomplete delineation of offsite PCBs; (d) coordinating all engineering/ remedial activities without disrupting on-site property warehousing

operations of an overly demanding owner who purchased his from the PRP client; (e) troubleshooting and addressing a highly deficient storm water drainage system on- and off-site; (f) background levels of PCBs not originating from the client site discovered in shallow soils along the former Conrail tracks; (g) coping with evolving NJDEP ISRA / permitting regulations / requirements; (h) high concentrations of PCBs in soil that exceeded TSCA thresholds (50 ppm); (i) devising an engineering remedy for stubborn, recalcitrant benzene in the low permeability shallow aquifer; and (j) responding to the client's desire to avoid potential downstream liabilities associated with PCB waste disposal. Investigating and remediating the Amtrak high speed rail parcel was infeasible so EXCALIBUR recommended to its client in consultation with NJDEP to assume / accept that the parcel was PCB-impacted and address this assumed contamination by instituting a deed restriction on the Amtrak property which after considerable effort was negotiated with the railroad, including funding the costs of its associated biennial inspections and NJDEP reporting obligations. In parallel, **EXCALIBUR** facilitated access to and delineation of PCBs exceeding USEPA TSCA residential and non-residential standards. Conrail balked at cleaning up the PCBs to any standards less strict than NJDEP's residential standards (0.49 ppm) unless **EXCALIBUR**'s client paid a hefty fee in addition to covering the costs for biennial inspections and reporting to NJDEP into perpetuity. The problem **EXCALIBUR** flagged with attempting a cleanup to NJDEP's residential standards was the pre-existing background levels of PCBs not originating from the client site along the former Conrail lines. To get around this problem, **EXCALIBUR**'s engineers used drainage patterns on the Conrail property to convince NJDEP that PCBs could not have migrated in runoff uphill beyond certain boundaries. This enabled the **EXCALIBUR**'s team to proceed with the PCB cleanup to NJDEP's residential standards while limiting the area of remediation. Separate remedial action work plans were developed: one for the USEPA for the TSCA-regulated PCB excavation area; and the other for the non-TSCA-regulated PCB excavation area. A key component of both remedial action plans, accepted

without condition by both regulatory agencies, was that the PCB delineation work would not only define the volumes to be remediated but the existing data would also serve as the attainment soil sampling. Once the defined areas were excavated, therefore, there would be no question that the remediation work had attained the NJDEP residential standard. **EXCALIBUR** competitively bid the PCB removal work on the Conrail property to minimize costs and maximize work quality resulting in digging out and disposing of 680 tons of TSCA-regulated PCB-impacted soil and over 900 tons of non-TSCA-regulated PCB-impacted soil. In meeting the residential cleanup standards, **EXCALIBUR** achieved the client's and Conrail's goal of no need for future monitoring or reporting requirements. **EXCALIBUR** also provided critical information on various waste disposal options to the client which upon their decisions resulted in reduced liabilities and over $100,000 in waste disposal savings.

EXCALIBUR cost effectively addressed the final remedial challenge of benzene-impacted groundwater beneath the former polyester resin manufacturing plant by conducting an engineering remedial alternatives analysis leading to combined spot excavations of low permeability saturated soil, and multiple targeted *in-situ* chemical oxidation events in and around the excavation, and vigilant monitoring and NJDEP interfacing. Initial oxidation events used sodium persulfate and hydrogen peroxide, whereas subsequent engineering progress evaluations specified chemical oxidation events used calcium peroxide. Subsequent groundwater monitoring demonstrated the source removal and treatment events had reduced dissolved benzene concentrations sufficiently to attain the very stringent 1 ppb residential standard, meaning the Classification Exemption Area permit and associated environmental monitoring / reporting obligations would no longer be needed.

EXCALIBUR's dedicated site characterization, engineering, regulatory and neighboring negotiation, permitting, detailed reporting, and PCB soil and benzene groundwater remediation efforts resulted in the approved closure of this impaired industrial site that

others had unsuccessfully labored for decades to close. **EXCALIBUR** was strongly commended by its corporate client for accomplishing its environmental liability management goals by expeditiously removing this facility from its portfolio of costly legacy facilities at a cost far less than forecast by others.

land use without sustaining damage with a minimum of 2 feet of material installed in the areas designated for the isolation barrier.