WHITE PAPER / **ENHANCED MGP SITE REMEDIATION**

A MORE EFFICIENT, TARGETED APPROACH TO MANUFACTURED GAS PLANT SITE CLEANUP

BY Ben Clement

Remediating former manufactured gas plant (MGP) sites traditionally has been a time-consuming, highly disruptive process. By combining multiple targeted technologies, owners can now close sites more effectively, with a higher degree of certainty, while minimizing implementation costs, remobilization efforts and disruption to the community.

Prior to the widespread construction of natural gas lines in the U.S. in the 1950s, the gas needed for streetlights, manufacturing and residences was produced from coal at more than 50,000 manufactured gas plants (MGPs) across the country. Though the plants are now abandoned or demolished, some former MGP sites continue to pose environmental and public health concerns. Volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons, creosote and coal tar are among the hazardous substances that can be found in surrounding soil, surface water and groundwater.

To identify and pinpoint the location of this contamination, environmental investigators traditionally employed test pits and conventional soil and groundwater sampling techniques. Efforts focused first on the areas most likely impacted and then radiated outward until the site-specific remedial objectives were met.

When hazardous chemicals were found in soil, remediation commonly involved excavating the contaminated soil and then transporting it off-site for disposal. This highly disruptive process often resulted in significant truck traffic and odor-control concerns in the smaller towns where MGPs are frequently located. In an effort to meet regulatory requirements, significant quantities of unimpacted material are often removed unnecessarily to access the impacted materials. Because multiple contaminants are usually involved, groundwater and surface water remediation often require both liquid phase- and vapor phase-activated carbon adsorption and purification solutions.

Advances in investigative techniques have resulted in the development of high-resolution site characterization (HRSC) strategies that facilitate more targeted remedies to deliver higher degrees of certainty. In addition to being more sustainable, less disruptive and more cost-effective over the life of the project than conventional methods, HRSC strategies have proven to accurately characterize the extent and volume of impact. How? By allowing the practitioner to increase the amount and type of data that can be collected and considered and ultimately identify the primary transport and fate mechanisms.

Site-specific objectives should be defined prior to implementing a comprehensive site characterization plan. Once those objectives are in place, a few specific HRSC investigative techniques and tools can be applied to achieve precise, predictable results.

ENVIRONMENTAL SEQUENCE STRATIGRAPHY (ESS) EVALUATION

A high-resolution site investigation for a complex MGP site today begins with an environmental sequence stratigraphy (ESS) evaluation. Increasingly considered a best practice by the U.S. Environmental Protection Agency that improves confidence in subsurface investigation findings, ESS allows a stratigrapher to place high-resolution and other environmental subsurface data in a geologic and hydrogeologic context. This step may be taken prior to collecting any subsurface data or by utilizing existing historical boring logs. A conceptual site model — the centralized hub of site-specific information that's updated and analyzed to inform eachstep of the remediation process — can be enhanced by knowledge of the regional depositional environment and recognition of patterns based on vertical grain-size sequences. By developing a well-defined stratigraphic hypothesis that targets key locations requiring model development, refinement and remedial design, the stratigraphic hypothesis streamlines the field investigation process.

An ESS evaluation might not be necessary for all sites, but it can provide significant value for sites with large footprints, a dynamic depositional history and complex hydrogeology, or where access to collect subsurface information in the field is complicated by infrastructure or time constraints. This information can be used to identify and predict source material distribution and contaminant migration pathways, direct additional sampling efforts, determine locations for monitoring and remediation wells, and improve overall remediation and monitoring efficiency.

DIRECT-SENSING EQUIPMENT

Sensor-embedded equipment and vehicles are making remote data collection more effective and mobile. While the direct-push tools developed over the last 20-plus years are becoming more powerful, direct-sensing equipment collects a greater variety of data from the subsurface in less time than conventional drilling techniques and produces less waste in the process.

On a recent MGP project where commingled contaminants were present, Burns & McDonnell collected data on a significant number of metrics, including formation electrical conductance and hydraulic conductivity, as well as detection of organic compounds, VOCs and chlorinated compounds. All metrics were displayed in depth-discrete tabular and image files. Using direct-sensing tools, data was collected at an average production rate of more than 200 feet per day, compared to 100 feet per day that might be typical for conventional boring and sampling. Applying such an effective approach allowed the field team to target monitoring well locations and analytical sampling based on real-time results. The direct-sensing equipment also generated zero investigative derived waste soil, compared to 50-200 gallons of soil that could be produced during a day of conventional drilling and sampling.

The data collected could then be exported in a tabular format for processing and integration with other data presentation platforms. Since the quality and extent of the environmental impacts can be determined in the field, fewer mobilizations are needed to delineate and confirm the results.

Depending on the needs of the site, a project might employ multiple specialty direct-sensing tools. Existing sensing technologies include alternatives for the identification of dense nonaqueous-phase liquids common at MGP sites and light nonaqueous-phase liquids (LNAPLs) as well as dissolved-phase organic, volatile organic and chlorinated organic compounds. Electrical conductivity and hydraulic profiling tool probes can be implemented together to collect a significant amount of physical subsurface data and are typically available for use either individually or with contaminant-sensing equipment.

Each of these tools can provide the increased data density many regulatory agencies require, helping prove that the potential areas of impact have been adequately characterized. They also can minimize the number of conventional soil borings required for sample collection and laboratory analysis by allowing practitioners to select locations to confirm direct-sensor readings. Conventional boring techniques are still required to collect samples for laboratory analysis and for field representatives to verify the results of direct-sensing tools. However, by decreasing costs associated with conventional drilling — while increasing data density and thus decreasing uncertainty — additional funding previously reserved for a feasibility study might be available for data collection or the predesign investigation stage of a project. For example, in scenarios where a monitored natural attenuation approach might be considered, targeted microbial analysis can be used to quantify bacterial populations and assess the functionality of microbial species potentially capable of degrading site-specific contaminants.

THREE-DIMENSIONAL VISUALIZATION (3DV) TOOLS

3DV is a communication tool for presenting data that is valued by a variety of internal and external stakeholders. Continuous vertical data profiles provided by direct-sensing tools are recorded in easily converted database files that can be used to produce 3DV models that supplement field observations and analytical laboratory data. In addition to presenting findings in user-friendly formats, many of the tools can perform calculations on subsurface material volumes, containment masses within stratigraphic units, and other values that might be useful for remedial design. Information that can be depicted using 3DV tools include stratigraphic/lithologic data, containment concentrations and boring/monitoring well locations, above- and below-grade infrastructure, analytical sampling intervals and photoionization detector responses.

GEOPHYSICAL TOOLS

The energy exploration industry has long used geophysical tools with downhole dataloggers to collect physical characteristics of materials they are passing through. Many of the same techniques used to identify porous, oil-containing geologic units also can be used to identify units either limiting or encouraging contaminant transport. Additionally, in bedrock environments, advances in downhole acoustic and televiewers can provide a high-resolution image of borehole walls and the presence, size and orientation of fractures that can guide the placement of monitoring well screens.

Some geophysical tools can be used at the surface without any subsurface intrusion, helping to minimize disruption to property owners or tenants. Multichannel analysis of surface waves (MASW), for example, can be used to locate subsurface structures without surface excavation, advance drill tooling or pavement removal. At a commercial residential property owned by a third party, Burns & McDonnell used MASW to identify the presence and footprint of a former gas holder tank that was believed to extend beneath an existing building. In less than two days — including mobilization, data collection without subsurface disturbance, and demobilization — the site was restored to its original conditions, and the generated data revealed the holder tank was present but did not extend beneath the existing building.

This noninvasive alternative to the conventional method of test pit advancement did not require the cutting or removal of pavement in front of an existing apartment building, deep excavation that presents significant safety concerns, backfilling or surface restoration. Furthermore, the resulting data was easily geo-referenced and imported into a 3DV model to enhance the presentation of site conditions to stakeholders and provide quantitative estimates of contaminants targeted for remediation.

GEOCHEMICAL TOOLS

Different stratigraphic units or aquifer matrices might have unique geochemical properties that can provide valuable information on groundwater flow as well as identify the way certain units could respond to the addition of chemical amendments under different remedial alternative scenarios. One example of the analysis and visualization of groundwater geochemical parameters includes the use of trilinear diagrams, or Piper plots, to present major cations and anions, including calcium, magnesium, sodium, potassium, sulfate, chloride and alkalinity. These plots can provide insight into the reliability and quality of groundwater data and the water types present in each formation. Also, they can be used in conjunction with physical hydrogeologic measurements to validate groundwater flow regime assumptions. Many of these parameters typically are recommended for preliminary evaluation of monitored natural attenuation, so their collection and analyses can be multipurposed.

Piper plots provide visual and graphical evidence to support the correlation of wells monitoring similar or distinct hydrogeologic units. By conducting a charge balance, major cations and anions also can be used to evaluate the consistency and defensibility of groundwater data. The laboratory analyses required to complete the evaluation are economical and require little, if any, additional sample volume. While these techniques are not new, more software platforms are available to make the management and presentation of the data more efficient and easier to use in conjunction with other site data.

LESSONS LEARNED

The multiple HRSC tools now available can minimize life cycle project costs, limit intrusiveness, leverage the value of all data collected and optimize remedial design. Not all tools may be appropriate or required for all scenarios. In most cases, however, increased data collection efforts during the site characterization will provide greater cost certainty during the remediation phase of a project.

BIOGRAPHY

BEN CLEMENT is a senior geologist at Burns & McDonnell, has extensive experience in site characterization activities (soil/groundwater/vapor intrusion) with an emphasis in hydrogeologic interpretations. While familiar with a wide range of conventional drilling and sampling approaches, he also has experience collecting and analyzing data using high-resolution site characterization technologies for enhancing conceptual site models. Additionally, Ben specializes in planning and implementing remediation strategies, including soil excavation, hydraulic containment, LNAPL recovery, air sparging/soil vapor extraction, and in situ remedies utilizing both chemical oxidation and enhanced aerobic bioremediation.

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