Lower COSTS, Fewer DELAYS

A highway expansion project applies XRF technology to obtain cost-effective remediation.

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X-ray fluorescence (XRF) spectrometry is a non-destructive, analytical method used primarily to detect the metal composition in soil/solids samples. Portable XRF instruments can provide rapid, accurate analysis of heavy metal levels in soil on new construction or redevelopment sites. In response to the growing need for field analysis of metals, many of these units have been adapted for use in the environmental field. They provide field data that can be used to identify and characterize contaminated sites and guide remedial work, among other applications.

Soils remediation challenge

A general contractor was awarded the construction contract for a highway expansion project in which a consulting firm that had been contracted by the highway department identified the presence of metals-contaminated soils on the project site. The project included the installation of overpasses at the intersection of two major highways, and the contaminated soils were located in the expansion rights-of-way. The highway department requested that the general contractor retain a different environmental consulting firm to manage the contaminated soils during the planned construction/remediation activities. Additionally, the department requested a plan to minimize the costs of the construction/remediation project.

Because it was about a two-hour drive from the expansion project to the nearest metropolitan area with a highway department-approved laboratory,

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a traditional approach to sample collection and laboratory analytical procedures for the soils was not practical. Further complicating matters at the site , the remediation and construction projects were being conducted concurrently; the project schedule did not allow for the time needed to analyze samples at a laboratory without paying for a rush analysis of the soil samples.

Management plan

The general contractor contacted an environmental consulting firm and presented the highway department's request for an overall construction/remediation management plan. The construction plans already included excavation of soils along areas of the two highways scheduled for widening, and placement of imported soils to build new on-ramps and exit ramps. Several deep structural piers were being installed in the contaminated soils areas.

Initial evaluation of the existing soil data for the project area indicated that the majority of the soils from the site were acceptable for reuse. However, the areas where metals exceeded the applicable reuse criteria were scattered across the project area, and the limits of the soils exceeding the reuse criteria were poorly defined. As a result, soils testing during excavation would be required to determine suitability for reuse based on the metals concentrations.

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Immediate cost savings for the project could be realized by reducing the overall volume of soils requiring disposal and reusing acceptable soils on the site to build the on- and exit-ramps. Approximately 75,000 cu. yards of soil were scheduled for excavation across the project area. If the soils were to be properly characterized and disposed, the cost of the remediation project would have been over $2.3 million. In order to comply with state regulations, sampling of the soils on a 50 cu. yard basis would be required to determine their suitability for reuse on the construction project. That meant that 1,500 samples would have to be collected and analyzed.

Selection of metals testing technology

Due to the sampling requirements and project time constraints, several field testing technologies for metals were evaluated. For comparison's sake, the estimated cost for collection and analysis of traditional laboratory samples was approximately $75,000 and included a normal turnaround time of five to seven business days, or $150,000 for a 24-hour rush analysis.

Immunoassay/test kits were evaluated first. This method of analysis typically required purchasing a test kit, including the reagents and powders necessary to extract the metals from the soil and provide qualitative concentration results. Since the contractor believed the immunoassay could not provide reliable quantitative results, this technology was not selected.

The second technology evaluated was a portable spectrophotometer. The initial cost was relatively low but required purchase of various test kits/reagents for digestion and analysis of soil samples. The total digestion and test time for each individual metal would have been 45 minutes or more to allow time for proper digestion as various reagents were added. The total time required to perform analyses for the spectrophotometer was not feasible with the scheduled collection of 1,500 samples across the site.

Solution

The last technology evaluated was the portable XRF instrument. The contractor was impressed that the instruments could analyze multiple metals at the same time, resulting in shorter turnaround times. The state agency approved the technique for evaluation of soils.

To test a sample with an XRF instrument, a small quantity of soil is placed into a disposable plastic container that holds the correct volume of soil. The analyzer is positioned over the container and held in place. The analytical time depends on the matrix but is typically completed in less than a minute.

The initial cost of an XRF instrument was fairly high (approximately $35,000 to $45,000), and rental rates for such an instrument ranged from about $500 to $600 per day. However, the quick turnaround times

It required 1,500 soil samples to determine what soils could be recycled. The XRF equipment efficiently allowed the contaminated soil to be identified and stockpiled for proper disposal.

Soil tests at the construction site found that some of the soil was contaminated with metals and could not be used. Excavated soils had to be stockpiled until a determination allowed the soil to be properly disposed or reused on the project.

and the reproducibility of the quantitative results led to the technology's selection.

An additional concern with the instrument was its use of a radioactive x-ray source. Using a radioactive source required specific licensing, maintenance and transportation requirements. Research indicated XRF instruments utilizing x-ray tubes (similar to cathode ray tubes utilized in televisions) did not require these licensing and transportation restrictions. In order to meet the project objectives, the environmental consultant purchased an XRF instrument equipped with an x-ray tube and the associated soil testing software, and negotiated a rental rate of $350 per day for use of the instrument.

The expansion project

The initial remediation/construction phase of the project was scheduled to be completed in 90 days. The first phase of the project consisted of a total of 64 working days. As construction began, the excavated soils were stockpiled for analysis; samples were collected and analyzed utilizing the XRF instrument, an average of approximately 24 samples per working day. Based on the results, the soils were segregated for reuse on the on-ramp/exit ramp construction or for future waste disposal. The project was completed within the 90-day schedule. The soils stockpiled for disposal were properly characterized for waste disposal using conventional laboratory methods in order to meet the disposal facility's requirements.

Project results

The objectives of the highway department were to reduce overall direct project costs and avoid delays due to traditional remediation projects. Because the XRF instrument was utilized based on a nominal daily rental rate, the cost difference between traditional analysis of the 1,500 samples on a normal turnaround time basis and use of the XRF resulted in a cost savings of over $50,000. Additionally, the project was completed on schedule, resulting in cost savings from avoiding project delays and payment for rental of idle construction equipment. For the approximately 10,000 cu. yards of soil requiring disposal, costs were approximately $300,000, resulting in a savings of approximately $2 million when compared to disposing all of the excavated soils from the site. ***PE***

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