

SALVAGING PETROLEUM-CONTAMINATED SOILS FOR HIGHWAY CONSTRUCTION



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Between 800,000 and 1.2 million underground storage tanks in the United States are leaking gasoline and fuel oil. Each leak contaminates soil and has the potential to contaminate groundwater. In 1984 the U.S. Congress added Subtitle I to the Resource Conservation and Recovery Act to regulate leaking underground storage tanks. Almost all 50 states now require removal and proper disposal of petroleum-contaminated soil (PCS) to prevent further contamination of groundwater. The quantity of this soil, which is not classified as hazardous waste but as solid waste, is projected to increase substantially during the next few years, and the availability of solid-waste disposal facilities for this material is limited.

Excavated PCS from leaking underground storage tanks can either be disposed of in landfills or decontaminated—by bioremediation and low-temperature desorption—and used in the highway industry as construction materials. In New Jersey an extensive laboratory and field study, sponsored by the New Jersey Department of Environmental Protection, was conducted to

evaluate the feasibility of using PCS in the production of hot-mix asphalt.

Petroleum-contaminated soil consists of mixtures of coarse aggregates, natural sands, silts, clays, and petroleum products. Light petroleum product, mixed into asphalt cement in small amounts, changes the cement's specification or characterization only slightly. The use of petroleum-contaminated soil in asphalt concrete production has three environmental benefits: incineration, dilution, and solidification. Part of the petroleum is burned as fuel for the process, reducing the level of soil contamination and the cost of fuel. The remaining petroleum, diluted as contaminated soil, is mixed with virgin aggregates. Asphalt cement acts as a binder, solidifying and stabilizing petroleum-contaminated soil in the end product, asphalt concrete.

The first phase of study used soil contaminated by heating oil, and established that it was possible to include up to 35 percent petroleum-contaminated soil in hot-mix asphalt, based on the total weight of the aggregates. The test results showed that this asphalt produced a much better



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paving material than standard hot-mix asphalt, with higher stability (strength) values and acceptable voids and flow values. The durability of the test asphalt against freezing and thawing and against wet and dry conditions was the same as that of the control mix.

The test asphalt also passed leachability and air-emission tests. The leachability tests for hydrocarbons showed that maximum release was less than 25 parts per billion after subjecting the specimens to four days of vigorous shaking while immersed in analytical water. The results of a long-term leachability test did not show significant increase in contamination concentrations over time for any of the compounds tested. Field study of the applicability of the process was extensive. An air sampling and analysis system for monitoring volatile organic compounds (VOC) emitted by asphalt plants showed that the concentrations of the target chemicals were less than one part per million, and the concentrations of VOC were lower than the New Jersey Department of Environmental Protection specification for normal asphalt plants.

During the second phase of the study, a base course of a two-lane highway with heavy vehicu-

lar traffic was constructed with 15 454 metric tons (17,000 tons) of hot-mix asphalt concrete made with remediated petroleum-contaminated soil. The paved stretch was 4.8 kilometers (3 miles) long with a lane and shoulder in each direction. The thickness of the base course varied from 100 millimeters (4 inches) at the center to 75 millimeters (3 inches) at the toe; it was covered with a layer of surface course 50 millimeters (2 inches) thick, made with regular asphalt concrete.

Before the full-scale field demonstration, a laboratory mix design was performed with the aggregates and remediated PCS supplied by the asphalt plant. The gradation of this mix was similar to that proposed by the plant and accepted by the New Jersey Department of Transportation. The performance of the mix was evaluated by testing its Marshall stability, durability, and permeability. The values for the mix using these measurements were similar to those obtained during the first phase of the study. The laboratory tests showed that the field-produced asphalt concrete containing remediated PCS conformed to the job specifications. Samples of this asphalt showed durability and permeability results similar to those obtained during the mix-design stage. The performance of

Petroleum-contaminated soil (opposite page) in asphalt production (above) helps to dilute and stabilize pollutants that otherwise would be discarded in landfills.

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Test section of New Jersey State Route 72 incorporates petroleum-contaminated soil.

the pavement was evaluated immediately after construction and one year later using a heavy-weight deflectometer, which showed that the performance of the asphalt is comparable to that of standard hot-mix asphalt.

The field and laboratory tests proved that remediated petroleum-contaminated soil can be used to produce hot-mix asphalt concrete suitable for highway pavement, and enabled the NJDOT recycling task force to conclude that up to 20 percent of the soil may be added to bituminous-stabilized base course or used as a soil aggregate, as long as the soil complies with the aggregate quality and gradation requirements of the NJDOT 1989 standard specification for hot-mix asphalt.

Production of asphalt concrete with soil that is contaminated by petroleum requires the purchase of monitoring equipment and items such as new storage bins and a system for conveying set quantities of the material to the rotary dryer. Modification of production plants and additional monitoring of product mixes are also necessary.

Plant operators must make sure that PCS does not adversely affect the quality of plant air emission and the final product. The soil must be stored properly until its use, to prevent the leaching of contaminants, a problem that can be easily solved by using sloped concrete pads lined with emulsion sealer and collecting the leachate from the lowest end of the pad.

The inclusion of petroleum-contaminated soil in hot-mix asphalt is now widely accepted. Several hot-mix asphalt plants, including two in New Jersey that operate with permits from the New Jersey Department of Environmental Protection, produce hot-mix asphalt with remediated PCS for highway construction. In addition to its proven safety, this material is economical. Adding 5 percent of the soil to a mix can save the producer \$0.45 per metric ton of hot-mix asphalt by replacing virgin aggregate, which costs approximately \$9 per metric ton. If a solid-waste disposal cost of \$100 per metric ton is factored in, an additional \$5 is saved per ton of asphalt produced.