CERTIFICATION REPORT

For

GEOTECH, INC.
<u>Cold Top Ex-Situ Vitrification System</u>

July 22, 2002

New Jersey Department of Environmental Protection
Division of Science, Research and Technology
Office of Innovative Technology & Market Development
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SECTION I

INTRODUCTION

In accordance with the Energy and Environmental Technology Verification (EETV) Program at N.J.S.A. 13:1D-134, the New Jersey Department of Environmental Protection (NJDEP) is required to identify, evaluate, verify, and expedite the commercial use of new environmental technologies that provide significant environmental benefits to the State of New Jersey. In addition, the EETV Program establishes the framework for developing a process for providing technical guidance, coordination of the required approvals and reviews, and revision of the regulatory framework affecting the development and commercial use of these technologies.

An IET receiving a certification from the NJDEP results in the following:

1) The programs that issue permits can rely on the evaluation and verification process to establish contract provisions, protocols, policies, principles and/or technical guidance to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the IET;
2) The development and implementation of a series of outreach and education seminars to assist in the deployment and expedited commercial use of the IET; and
3) Working closely with the State Treasurer to be included in State bid specifications, as deemed appropriate by the State Treasurer.

The New Jersey Institute of Technology (NJIT) and the United States Environmental Protection Agency (USEPA), conducted a pilot study to demonstrate the use of the Cold Top Vitrification Process by Geotech, Inc. to treat chromium-contaminated soil from sites in Hudson County in New Jersey. This pilot study was funded by the New Jersey Department of Environmental Protection. Furthermore, the Cold Top Ex-Situ Vitrification System was chosen of as a pilot project by the USEPA Superfund Innovative Technology Evaluation (SITE) program, which has been established to identify and promote the use of innovative environmental treatment and monitoring technologies.

The Cold Top Ex-Situ Vitrification System was used primarily to reduce the concentration of hexavalent chromium in chromium-contaminated soils, and convert the contaminated soil into a usable product. Information regarding the technology's verification was published in the EPA's "Innovative Technology Evaluated Report", dated December 1999, and NJIT's report, dated August 1999. Geotech, Inc., in accordance with the EETV Program, is hereby seeking a certification from the NJDEP so that its Cold Top Ex-Situ Vitrification System can be established as an IET and gain acceptance through any site remediation permitting process involving the use of the vitrification process for chromium-contaminated soil from sites in New Jersey.

SECTION II

SUMMARY OF VERIFICATION REPORTS FROM NJIT AND USEPA

Technology Description

The Cold Top Ex-Situ Vitrification System uses a high-voltage electric furnace to convert contaminated soil particles into a monolithic, vitrified mass. According to Geotech, vitrification transforms the physical state of contaminated soil from assorted crystalline matrices into a glassy, amorphous solid, which is comprised of interlaced polymeric chains of alternating oxygen and silicon atoms.

The main unit of the Cold Top Ex-Situ Vitrification System is a 1,350 kilovolt-amp (kVA) electric resistance furnace that is capable of attaining temperatures of up to 5,200 °F (2,900 °C). The furnace is initially charged with a mixture of sand and alumina-silica clay, which is electrically heated. This heated material forms a molten pool, to which the chromium-contaminated soil is added via a screw conveyor, thus enabling the chromium to substitute for the silicon in interlaced polymeric chains. When the desired soil-melting temperature is reached, the final molten product is transferred into insulated molds to allow slow cooling.

Material not collected in the molds for physical or chemical testing was discharged to a water sluice for immediate cooling and collection before off-site disposal. Other configurations of the full-scale system allow outflow to be converted to pellets and fibers. The furnace is equipped with an off-gas treatment system, which includes a baghouse, cyclone, and wet scrubbers, to control emissions.

Technology's Claims - Goals and Objectives

According to the EPA's "Innovation Technology Evaluation Report" and NJIT's report, the claims made by Geotech for the Cold Top Ex-Situ Vitrification System are as follows:

Claim1 - In chromium contaminated soil, the chromium can readily substitute for silicon in the interlaced polymeric chains, thus rendering the chromium immobile to leaching by aqueous solvents and, therefore, non-hazardous. Furthermore, the vitrified product satisfies the RCRA TCLP standards for total and hexavalent chromium.

Claim2 - The vitrified chromium contaminated soil can be added to hot mix asphalt concrete for reuse.

Bench Scale Study

Prior to the pilot full-scale demonstration by Geotech, a bench-scale study involving chromium-contaminated soil from ten (10) chromium contaminated sites was conducted. These sites were considered representative of a range of physical and chemical characteristics of Hudson County contaminated sites. The contaminated soil samples were vitrified at the same temperature Geotech's pilot scale demonstration. The chromium-contaminated soil samples from these sites were subjected to the Toxic Characteristics and Leachability Procedure (TCLP) test, before and after the vitrification process.

Pilot Full Scale Demonstration

To perform the pilot full scale demonstration, the chromium-contaminated soil samples were excavated from Liberty State Park, and Site 130 (Colony Diner). The material from both sites was taken to a facility in Camden, New Jersey, where it was dried, crushed, sieved, and blended with several additives. The prepared soil was then dried to decrease the moisture content, and the dust from the drying process was captured in the bag house. During the drying process, the contaminated soil was mixed with sand, carbon and dust from the bag house. The sand increased the silica content to facilitate vitrification, and the carbon increased electrical conductivity. The resulting mixture was dried, well blended, and placed in polypropylene bags before being transported to the Geotech, Inc. site at Niagara Falls, New York.

During the processing phase, the gases from the vitrification oven and the dust from the baghouse were collected. The products and waste streams of the vitrification process were sampled and analyzed. The vitrified product was sent to NJIT where it was crushed and grounded to smaller sizes. The crushed and ground vitrified samples were sent to EPA, Envirotech Research, Inc., and Stevens Institute of Technology for analysis.

Data Analysis and Results

The data analysis and results of the bench scale study and the pilot scale demonstration are as follows:

<u>Bench Scale Study</u>

During the bench scale study, the TCLP test was performed on the soil samples from the selected sites before and after the vitrification process. According to the analysis by Stevens Institute of Technology, as included in the USEPA's report, the TCLP test results for total chromium in the contaminated soil from Site 130 and Liberty State Park, before vitrification, were 48.6 mg/L and 32.4 mg/L respectively. The TCLP test results of the vitrified products from both locations were less than 1.0 mg/L. In addition, the concentration of hexavalent chromium from the untreated samples from Site 130 and Liberty State Park were reduced from concentrations 4,800 mg/kg and 1,240 mg/kg respectively to less than 5.2 mg/kg in the vitrified products.

Pilot Full Scale Demonstration

During the pilot full scale demonstration, the soil samples from Liberty State Park and Site 130 were vitrified at the Geotech's facility at Niagara Falls, NY. EPA's and NJIT's reports on the vitrified products showed considerable reductions in the hexavalent chromium concentrations. The hexavalent chromium at the Liberty State Park and Site 130 locations were reduced from approximately 2,000 mg/kg and 900 mg/kg to concentrations averaging 9.5 mg/kg and 4.8 mg/kg respectively. The TCLP test for the total chromium at both Liberty State Park and Site 130 were 1.0 mg/L and 0.31 mg/L respectively.

Quality Control (QC) and Quality Assurance (QA)

Quality control checks and procedures were an integral part of the Geotech's SITE demonstration to ensure that the quality assurance objectives were satisfied. These QC checks focused upon the representative samples, including sample collection and shipping, and analysis of data. All data were analyzed statistically to determine the overall accuracy, precision, and completeness. The results of the statistical analyses were as follows:

Compound	Matrix	Analytical Method	Accuracy % Recovery	Precision (RPD)	Completeness Percentage
Chromium	Solid	SW-846; 3052 & 6010A	75 to 125	<25	90
Cr^{+6}	Solid	SW-846; 3060A & 7196A	70 to 130	<30	90
Chromium (TCLP)	Solid	SW-846; 1311 3010A, & 7196A	70 to 125	<25	90
Chromium	Vitrified Product	SW-846; 3052 & 6010A	75 to 125	<25	90
Cr^{+6}	Vitrified Product	NJIT/XPS	-	-	90
Chromium (TCLP)	Vitrified Product	SW-846; 1311, 3010A & 6010A	75 to 125	<25	90

XPS - (X-ray photoelectron spectroscopy performed by NJIT)
RPD - Relative percent difference

Conclusions of Verification Reports for Cold Top Vitrification Process

The conclusions of the vitrification process of the chromium-contaminated soil as indicated in the NJIT's report is as follows:

1. From the bench scale study, vitrification of the chromium-contaminated soil can significantly decrease the availability of hexavalent chromium. In nearly all vitrified samples analyzed, the TCLP results were less than 1.0 mg/L for chromium.
2. From the pilot full scale demonstration, the hexavalent chromium in the vitrified product ranged from 3.6 mg/kg - 6.5 mg/kg for Site 130, and 7.3 mg/kg - 12.1 mg/kg for Liberty State Park. Overall, the average concentration of hexavalent chromium in the vitrified product from Site 130 and Liberty State Park were 4.8 mg/kg and 9.5 mg/kg respectively.
3. Concentration of hexavalent chromium of the vitrified product was below NJDEP non-residential cleanup standard.
4. A comparison of the vitrified product with the New Jersey Department of Transportation (NJDOT) specifications suggests that the vitrified product can be mixed with concrete asphalt and made suitable for use. However, the vitrified product must account for less than 50 % of the overall mixture.
5. Emissions of dioxins, particulate, oxides of nitrogen, sulfur dioxide, carbon monoxide, and hydrogen chloride were minimal, and in no instance exceeded New York State requirements.

Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) nine evaluation criteria are used to conduct detailed analysis of remedial alternatives in feasibility studies. The USEPA used these nine criteria to assess Geotech's technology and the results are shown in Figure 1. The table that is contained in Figure 1 is a replica of that contained in the USEPA's verification report.

Table 1. Feasibility Study Evaluation Criteria for the Geotech Technology

	CRITERION	GEOTECH TECHNOLOGY PERFORMANCE
1	Overall Protection of Human Health and the Environment	The Geotech technology fuses hazardous inorganic constituents into a noncrystalline, glass-like product. Air emissions are reduced by using an air pollution control system (APCS).
2	Compliance with Federal ARARs	Compliance with chemical-specific applicable or relevant and appropriate requirements (ARARs) depends on the treatment efficiency of the vitrification system and the chemical constituents of the waste. Compliance with chemical-, location-, and action-specific ARAR must be determined on a site-specific basis. For most sites, the following environmental regulations will be applicable to Cold Top operations: Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); Resource Conservation and Recovery Act (RCRA); the Clean Air Act; the Clean Water Act; and the Occupational Safety and Health Act.
3	Long-Term Effectiveness and Permanence	As the vitrified products met RCRA Toxicity Characteristic Leaching Procedure requirements, these fused wastes were considered to be permanently treated. Treatment residuals from the APCS can be recycled through the system, and the vitrified product and ferrofurnace bottoms may be recycled or may require proper off-site disposal.
4	Reduction of Toxicity, Mobility, or Volume Through Treatment	Vitrification reduces the mobility of the waste feed by fusing hazardous inorganic constituents into a high-density, noncrystalline, glass-like product. Toxicity is also reduced by the chemical reduction of hexavalent chromium to less toxic species, such as trivalent chromium.
5	Short-Term Effectiveness	Short-term risks to workers, the community, and the environment are present during waste-handling activities and from potential exposure to process air emissions. Adverse impacts from both activities can be mitigated with proper personnel safety and waste-handling procedures and air pollution system control.
6	Implementability	The Cold Top system vitrifies a wide variety of materials. Geotech plans to establish a full-scale fixed facility in the northern New Jersey area. Currently, Geotech does not operate a transportable system, so only transportation of the waste feed needs to be evaluated for this criterion.
7	Cost	Costs for treatment by the Cold Top technology depend on waste- and location-specific factors such as the volume of material to be treated, physical properties of the material to b treated, transportation costs, electricity costs, and economic value or cost to dispose of the vitrified product and ferrofurnace bottoms. For the treatment scenarios evaluated in the economic analysis contained in this Innovative Technology Evaluation Report, costs ranged from $83 to $213 per ton.
8	State Acceptance	State acceptance to the full-scale, fixed Cold Top facility is likely to be favorable.
9	Community Acceptance	The minimal short-term risks presented to the community along with the permanent fusing of hazardous waste constituents in the waste, producing a usable product, should increase the likelihood of community acceptance of this technology. Additionally, as treatment by this technology takes place off site, acceptance by the community from where the waste is removed should be favorable.

FIGURE 1. Replica of Table 1 from USEPA Verification Report

SECTION III

NJDEP EVALUATION OF GEOTECH'S COLD TOP VITRIFICATION PROCESS

Satisfaction of Regulatory Criteria

The evaluation of Geotech's Cold Top Vitrification Process was performed to determine the effectiveness of the technology to convert chromium-contaminated soil into a vitrified product that satisfies the RCRA standards. The guidelines, as presented in the NJDEP's "Guidance Document for the Remediation of Contaminated Soils", January 1998, were used to assess the technology's performance claims and analytical data to validate the "Demonstrated Effectiveness" of the technology. Within the guidance document, "Demonstrated Effectiveness" is defined as the "successful treatability test at some scale completed". Therefore, the successful completion of the pilot full-scale demonstration, whereby the chromium-contaminated soil is reduced to a form that is considered non-hazardous, validates the "Demonstrated Effectiveness" of the technology. The Cold Top Vitrification Process of Geotech, Inc. was shown to transform the chromium-contaminated soil into a product that satisfies the RCRA TCLP standards, and provide a permanent solution to hexavalent chromium.

Limitations

Although certain regulatory criteria were satisfied, certain limitations are associated with Geotech's Cold Top Vitrification Process. According to the report titled "SITE Technology Capsule", from the USEPA, vitrification requires a significant amount of energy. Also, the contaminated soils must be relatively dry and have little organic content to reduce the generation of large amounts of steam and organic vapors. Furthermore, depending on the characteristics of the contaminated soil, certain air pollution control systems should be in place to reduce or prevent the emission of dioxin, particulate, oxides of nitrogen, sulfur dioxide, carbon dioxide, carbon monoxide, etc.

Certification of Cold Top Vitrification Process

According to the NJIT's report, the vitrification process is considered to be a viable alternative to the many ex-situ and in-situ physical, chemical, and biological treatment technologies to inhibit the reversion of the vitrified product back to its hexavalent form. As indicated in the USEPA's verification report, there was an increase in the total chromium concentration of the vitrified product. However, the overall concentration of the hexavalent chromium, a known carcinogen, was reduced. This would indicate that the hexavalent chromium was converted to trivalent chromium, which is a less hazardous material. Also, as indicated in the verification reports, the TCLP test of the total chromium in the vitrified product was much lower than the RCRA standard of 5.0 mg/L, and the hexavalent chromium was practically non-existent.

Although the concentration of the total chromium in the vitrified product remains high, the low leachability potential makes it a much better alternative than leaving the contaminated soil untreated. This will greatly reduce the potential for water contamination, and air pollution since any ambient temperatures would be so small, when compared to the temperature required for vitrification, to cause any volatilization of air contaminants. Overall, the TCLP test of the vitrified product produced values that were well within the acceptable RCRA TCLP standards. Furthermore, the stabilization of the vitrified product makes it a viable additive to other materials, such as concrete, to be beneficially used. The vitrified product was determined to be a viable additive to asphalt concrete matrix to satisfy the New Jersey Department of Transportation (NJDOT) standards.

In spite of the limitations that exist, the NJDEP views the Cold Top Vitrification Process as providing an overall net environmental benefit, in that the vitrified product can reduce the chances of contamination to the waters, land, and air of the State. In addition, the risk to human health is also reduced. Therefore, having satisfied the performance claims of the technology, the NJDEP hereby **certifies** the Cold Top Vitrification Process as an innovative environmental technology for transforming chromium-contaminated soil into a vitrified product to achieve the following:

1. Extremely low concentration of hexavalent chromium;
2. Reduce the leaching of total and hexavalent chromium; and
3. Beneficially used when combined with an asphalt concrete matrix.

In order to satisfy the limitations noted above, the NJDEP requires that the regulatory requirements relating to air, water, and site remediation must be addressed before commencing any full-scale operation of the Cold Top Vitrification Process. This can be accomplished by contacting all applicable programs within the NJDEP to ascertain the necessary procedures and permits that are required to enable the successful operation of the Cold Top Ex-Situ Vitrification System.