



EDi No. 307



21. Heritage Minerals Radiological Characterization and Technical Support Services

<b>22. Year Completed Professional Service:</b>	<b>Year Completed Construction:</b> <small>(if applicable)</small>	<b>Manchester Township, New Jersey</b>
2010	n/a	<b>Contract Role:</b> <input type="checkbox"/> Prime Contractor <input checked="" type="checkbox"/> Subcontractor
<b>CAGE Code:</b> ID1U3		<b>DUNS Number:</b> 61.680.5073

<b>23 a. Project Owner/Customer:</b>	<b>23 b. Point of Contact Name:</b>	<b>23 c. POC Contact Info.:</b>
AMEC Earth & Environmental, Inc. 285 Davidson Avenue, Suite 405 Somerset, New Jersey 08873	David Mackie, P.G. Senior Project Manager	732.302.9500 (p) 732.302.9504 (f) david.mackie@amec.com (e)

Key Personnel:			
Stan Waligora, Sr., CHP	Albuquerque Corporate Office	Swaligora@edi-nm.com	505.341.3578
Michael C. Marable, Project Mgr.	Tennessee Regional Office	Mmarable@edi-nm.com	865.482.7789

24. (Include scope, size, and cost) Brief Description of Project and Relevance to this Contract:	
<b>warded Price:</b> \$87,524.40	<b>Final/Projected Cost:</b> \$93,407.00
<b>Award Date:</b> 06.03.2010	<b>Contract No.:</b> 767660000-02
<b>Period of Performance:</b> 06.03.2010 –06.30.2010	<b>Final or Projected Schedule:</b> 06.30.2010
<b>Contract Type:</b> <input type="checkbox"/> Firm Fixed Price <input type="checkbox"/> Cost Reimbursement <input checked="" type="checkbox"/> Time and Materials <input type="checkbox"/> Cost Plus Fixed Fee <input type="checkbox"/> Cost Plus Award Fee <input type="checkbox"/> Performance Based	
<b>Type of Work Performed:</b> 562910, Remediation Services	
<b>% of Work Self Performed:</b> 100%	<b>% of Work as Subcontractor:</b> 100%

<b>Contracting Officer</b> <small>(if applicable):</small>	<b>Contracting Agency &amp; Address:</b>	<b>Contracting Officer Contact Info.:</b>
Stephen Posten Vice President	AMEC Earth & Environmental, Inc. 285 Davidson Avenue, Suite #405 Somerset, New Jersey 08873	732.302.9500 (p) 732.302.9504 (f) david.mackie@amec.com (e)

**Background**

Environmental Dimensions, inc. (EDi) was retained by AMEC Earth & Environmental (AMEC) to perform a Global Positioning System (GPS) linked gamma ray survey of the Heritage Minerals, Inc. (HMI) site located in Manchester Township, New Jersey. A portion of the HMI property was previously used for mineral production. Processed ores contained naturally occurring radioactive gamma emitting radionuclides. By-product wastes constituted technologically enhanced naturally occurring radioactive material (TENORM). This GPS gamma ray survey is a component of the Remedial Investigation Work Plan developed by AMEC for HMI to allow development of remedial action alternatives for the TENORM. The AMEC Remedial Investigation Work Plan was reviewed and approved by the New Jersey Department of Environmental Protection.



Heritage Minerals Site Aerial View

## Process History

In 1960, American Smelting and Refining Co. (ASARCO) purchased 7,000 acres in Manchester Township for recovery and production of titanium minerals. Mining began in 1973 and ended in 1982. Overburden was removed down to the Cohansey aquifer and the heavy mineral sands were dredged. Minerals in the sands included titanium minerals, zircon, quartz, kyanite, silliminite, and monazite. The sands were hydraulically dredged and pumped to the processing facilities. The sands contained naturally occurring radioactive materials including radionuclides from the thorium-232 decay series, the uranium-238 decay series and potassium-40. During the milling processes, the products were concentrated in thorium and uranium to the extent that a Nuclear Regulatory Commission (NRC) Source Material License was required.

The mineral sands were screened for dewatering and excess water and coarse materials were returned to the borrow pits. The ore bearing sand slurry was conveyed to a wet mill, which consisted of vertical spirals for physical separation of dense from less dense fractions. The dense fraction (approximately four percent) had enhanced concentrations of titanium minerals, zircon, quartz, kyanite, silliminite, and monazite. The less dense slurry (about 96 percent) was returned to the borrow pits. The dense fraction stockpiled on the ground east of the dry mill for further dewatering and has been designated as the "Gray Area." Front-end loaders carried the concentrated sands to the dry mill.

The dry mill utilized electrostatic separators designed to separate conducting from non-conducting materials; then electromagnetic separators were used to separate magnetic from non-magnetic materials. Electrically conductive titanium dioxide bearing materials were further separated by high-tension separators and then further processed magnetically to produce the final product. During periods of equipment malfunction monazite-enriched concentrates were stockpiled on the ground south of the dry mill.

From 1982 through present, Humphrey's Gold conducted tailings reprocessing. This company leased the land from Heritage Minerals, Inc. (a subsidiary of Hovson's, Inc.—formed in 1986 to specifically purchase the land from ASARCO.) HMI processed tailings for zircon recovery from 1987 to 1990. Further processing to recover leucoxene, rutile, and zircon occurred for six months during 1990.

Zircon and monazite had the highest concentrations of naturally occurring radioactive material (NORM). Zirconium silicate may contain up to three weight percent uranium and up to 13 weight percent thorium. Monazite (rare earth phosphate) may contain as much as 12 weight percent thorianite (ThO<sub>2</sub>) and one weight percent triuranium octaoxide (U<sub>3</sub>O<sub>8</sub>).

All milling and separation processes were physical and would not alter uranium and thorium daughter radionuclide equilibriums. However, radium-226 and radium-228 may have been selectively dissolved *in-situ* during residence in the initial aquifer deposit and in subsequent wet and slurry operations.

The Wet Mill and the Dry Mill contained licensable quantities of uranium and thorium. From May 2003 through January 2005, both buildings were decommissioned and demolished. The NRC License was terminated after decontamination and off-site disposal of 3,385 tons of monazite. There is sufficient residual technologically TENORM to require further remediation prior to release of the site for uncontrolled use. The investigation is proceeding with the oversight of the New Jersey Department of Environmental Protection. This investigation will provide sufficient characterization of the site radiological conditions to allow selection of remedial action alternatives.

## Scope of Work

### Task 1 - GMS Gamma Survey

As part of the remedial investigation (RI), a surface Global Positioning Systems (GPS) gamma radiation survey was performed of the Blue and Gray Area tailings and the Plant Area (including the former Nuclear Regulatory Commission [NRC] License Area). The main objectives of the GPS gamma survey were to define the horizontal extent of TENORM at the site and identify radiological anomalies for further subsurface investigation. The total area covered by the survey was approximately 220 acres. Establishment of the natural background conditions were important for the assessment and interpretation of the survey results. Therefore, GPS gamma survey measurements were made within non-impacted areas.



GPS Gamma Ray Survey Unit mounted on ATV.



EDI provided all field personnel and equipment required to carry out the work. AMEC provided EDI with electronic base maps, georeferenced aerial photographs, and other geographical information as needed to support the GPS gamma survey. An AMEC Field Manager was present to assist EDI during the survey.

**Deliverables for this task included:**

1. A narrative report containing an analysis of the radiation intensity distribution within the survey area along with the background radiation intensity distribution, and the corresponding mean and standard deviation.
2. A contour plot of radiation intensity isopleths (“iso-intensity contours”) within the survey area, and showing the approximately limits of TENORM (as defined in relation to the characteristic background distribution).
3. Raw gamma survey readings in electronic format (e.g., comma delimited, MS Excel or Access database format), including horizontal coordinates in New Jersey State Plane Feet (NAD83).

**Task 2 – Instrument Rental and Field Instruction**

AMEC carried out three subsurface soil investigations, which entailed the collection and radiological screening of continuous soil cores over depth intervals of 5- to 80-feet below the ground surface. Per EDI’s previous recommendation, AMEC performed the radiological screening of the soil cores using Ludlum Model 2221 scaler/ratemeter coupled to a Ludlum Model 44-10 2 x 2-inch NaI(Tl) gamma scintillation detector. EDI provided field instruction of AMEC personnel in its proper use and calibration (instruction took place concurrently with the GPS gamma survey).

**Task 3 – Peer Review and Technical Support**

EDI provided technical peer review and general technical support services. The types of work products AMEC requested as peer review or technical support from EDI included:

- Draft Remedial Investigation Report submittal to the NJDEP
- Calculations in support of site-specific Derived Concentration Guideline Levels (DCGLs) for the Site
- Calculations required under Section 5.5.2.2 of the MARSSIM (for example, Wilcoxon Rank Sum test) to assess the relative variability between the survey results and background contaminant levels within the reference area

**Conclusion**

Instruments were set up and quality checked at the beginning and end of each survey day. At the end of the day, the Trimble data loggers were downloaded and files sent for data reduction and visual presentation. These were always completed by the beginning of the following workday. EDI and AMEC personnel were able to see the isopleth contours from the previous day’s survey. A cumulative map was provided to summarize the current survey with all prior survey results. Survey of the originally defined 178-acre area was completed on July 15<sup>th</sup>. However, there was not a complete bounding of the impacted survey area. Borders remained to be higher than the natural background. The survey continued on through July 26<sup>th</sup> identifying those boundaries. Walking hand-held survey measurements were taken in areas where tree canopies may have affected reception of the GPS signals. Ultimately, the survey area grew to approximately 220 acres.

The overall average of 6,004 measurements is  $4,671 \pm 977$  cpm (68% confidence). Three areas had between 1,000 and 2,000 measurements and demonstrated the degree of variability of the gamma radiation background.