VICINITY PROPERTY DATA ASSESSMENT, SAMPLING, AND REMEDIATION AT THE WAYNE INTERIM STORAGE SITE

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ABSTRACT

The United States Army Corps of Engineers (USACE) has effectively pursued the Congressional mandate to administer and execute the Formerly Utilized Sites Remedial Action Program (FUSRAP) at the Wayne Interim Storage Site (WISS). The WISS is a 6.5-acre site located in a highly developed area of northern New Jersey in the township of Wayne. Environmental Chemical Corporation (ECC) has assisted the USACE at WISS by providing engineering design and administrative services in conducting remediation of WISS as defined in the Record of Decision (ROD) of 2000. The remediation focuses on the removal of tailings and associated materials contaminated with residual quantities of natural uranium, radium-226 (Ra-226), thorium-232 (Th-232), and heavy metals. The WISS is currently under consideration for site deletion according to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) closure process. As part of the closure process, the current status of the surrounding vicinity properties (VPs) must be evaluated in comparison to the ROD criteria. The WISS FUSRAP Team conducted an extensive historical record search of the Administrative Record. Each property identified as potentially impacted by site operations was placed into a spreadsheet and sample results from that property inputted. Each property was then evaluated against the cleanup criteria presented in the ROD. Review of the individual property data indicated four properties which require further investigation. The WISS FUSRAP Team decided to perform additional sampling to increase the sample population, fill data gaps, and provide additional analytical information. The four properties were previously remediated and backfilled. The sampling of the four properties was performed with direct push technology. Each property was divided into survey units and sample points designated using a random start point and a triangular grid. Sample cores were then taken at each location. Each sample core was pushed to a minimum of one foot past the native soil/backfill interface. Gamma logs were then taken from each borehole in six inch intervals. Soil samples were taken from the soil core corresponding to the highest reading from the borehole. Soil sampling results were compiled and statistical analysis performed. Results indicated that two of the properties required additional remediation. The remediation of the two properties commenced in 07/23/03. The remediation resulted in 2000 cubic yards of material excavated, packaged, and disposed. Final status surveys in accordance with the Multi Agency Radiation Site Survey and Investigation Manual (MARSSIM) were performed on the two properties. Backfill of the two properties commenced on 08/18/03. The results of the VP investigation process used at WISS produced a streamlined process to eliminate unnecessary field operations and reduced overall project costs.

INTRODUCTION

The length of time involved in addressing a site such as the Wayne Interim Storage Site (WISS) results in issues that may impact site deletion from the National Priority List (NPL). These issues include how to evaluate interim response actions, Vicinity Property (VP) concerns, technology advancement, and regulatory changes.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site close out process for The Wayne Interim Storage Site (WISS) began in 1980. Over the past 24 years significant changes in radiation protection guidance and practices have occurred. These changes have forced modifications to the actions taken at the WISS site.

The path for the for closure for the WISS moved through the typical phases of this process as shown below

- Site Discovery
- Preliminary Assessment/Site Investigation
- National Priority List
- Remedial Investigation / Interim Remedial Action(s)
- Preliminary Close Out Report
- Feasibility Study
- Record of Decision
- Remedial Action
- Final Remedial Action Report
- NPL Site Completion/Final Close Out Report
- NPL Site Deletion
- Long-Term Monitoring (LTM)

Throughout the process, protection of the public health and safety was the project's primary focus. Initial actions were conducted to insure public safety and then ultimately to reduce impacts to the future public health.

Preliminary Assessment/Site Investigation

In 1980, the New Jersey Department of Environmental Protection (NJDEP) requested that an aerial survey be conducted over the former W.R. Grace facility to determine the radiological conditions. This survey was conducted in 1981. The NRC Division of Fuel Cycle and Material Safety requested walkover surveys of the former W.R. Grace facility and the property immediately to the south. The Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU) performed this survey in 1982. A similar survey was performed by NJDEP in 1982. Both the NJDEP and ORAU surveys indicated surface radionuclide concentrations in excess of those acceptable under the United States Department of Energy (DOE) remedial action guidelines presented as Table I.

Table I DOE remedial action guidelines for land areas

SOIL (land) GUIDELINES	
Radionuclide	**Soil Concentration (pCi/g) above background**[abc]
Radium-226	5pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15 cm thick layer soil layer below the surface layer.
Radium-228	
Thorium-230	
Thorium-232	

[a] These guidelines take into account in-growth of radium-226 from thorium-230 and of radim-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentration of individual radionuclides shall be reduced so the dose for the mixtures will not exceed the basic dose limit [100mRem/yr].

[b] These guidelines represent the allowable residual concentrations above background averaged across any 15 cm thick layer to any depth and over any contiguous 100-m^2 surface area.

[c] Localized concentrations in excess of these limits are allowable provided that the average over a 100-m^2 area is not exceeded.

The Environmental Protection Agency (EPA) amended the NPL on September 21, 1984, to include the Wayne Interim Storage Site (49 FR 37070). The revision to the NPL listed WISS as *W.R. Grace & Co (Wayne Plant)*, with a hazard ranking system score of 200 (49 FR 37070, 37083).

Remedial Investigation / Interim Remedial Action(s) / Preliminary Close Out Report

Under the Energy and Water Appropriations Act of fiscal year 1984, Congress directed the DOE to initiate a research and development decontamination project for the former W.R. Grace Facility and vicinity properties in the Townships of Wayne and Pequannock. The results of the DOE review identified thirty-nine properties that required further investigation and or remediation.

These properties were assigned by the USDOE to Formerly Utilized Sites Remedial Action Program (FUSRAP), and in 1984, the USDOE acquired the property from W.R. Grace and Company. FUSRAP is an effort to identify, decontaminate, or otherwise control sites where low-level radioactive contamination remains from either the early days of nation's atomic energy program or commercial operations causing conditions that Congress mandated the USDOE to remedy.

From 1985 to 1987, the USDOE, acting under its authority through the 1984 Energy and Water Appropriations Act, investigated and removed contaminated soils from the school bus maintenance facility, Township Park, and the banks of the Sheffield Brook. This material was stockpiled at the former W.R. Grace facility, which then became known as the Wayne Interim Storage Site.

The USDOE and the EPA signed a Federal Facility Agreement that established the cleanup responsibilities for each agency under the National Contingency Plan in 1991. The USDOE cleanup activities were completed in 1993 at a railroad spur where monazite sands ore was offloaded prior to processing. These interim activities were conducted under an Engineering

Evaluation/Cost Assessment (EE/CA) that under went public comment and revision. The intent of this action was to protect the public from radiation exposure by removing radioactive contamination from uncontrolled public and private properties. The DOE utilized criteria based on federal regulations (40 CFR 192) and DOE orders (presented in Table I) as the criteria to demonstrate meeting this intent. The DOE issued a certification docket for the projects following successful remediation of these vicinity properties to the established guidelines.

Feasibility Study / Record of Decision

In the years subsequent to the interim remediation performed by the DOE a feasibility study and proposed plan evaluating cleanup alternatives were released to the public in June 1999. The Record of Decision (ROD) identifying "Excavation to Residential Use and Disposal" was signed on May 15, 2000.

The ROD for WISS lists soil cleanup criteria that are based on federal regulations and meet acceptable dose equivalent limits. The soil cleanup criteria is an average combined concentration of Ra-226 and Th-232 above naturally occurring background, and an average concentration of total uranium above naturally occurring background. The ROD criteria for radionuclides are presented in Table II .

Table II . Wayne Interim Storage Site Record of Decision, Radiological Criteria for Remediation

Radionuclides	Selected Criteria Residential Soil Cleanup (pCi/g)
Th-232 + Ra-226, Combined	5[a,b]
Total Uranium	100

[a] Th-232 is substituted for Ra-228 based on assumed equilibrium.
[b] Cleanup level based on site specific risk assessment. Ra-226 + Th-232 = an average concentration of 5 pCi/g above background concentrations for unrestricted residential land use.

Remedial Action / Final Remedial Action Report

The remedial action for the WISS proper was completed in April of 2002. As part of the Final Remedial Action Report process so that the property may be considered for site deletion according to the CERCLA site closure process, the current status of the surrounding vicinity properties (VPs) (with consideration given to interim removal actions) must be evaluated in comparison to the ROD criteria.

VICINITY PROPERTY EVALUATION

The WISS FUSRAP Team conducted an extensive historical record search of the Administrative Record. Each property identified as potentially impacted by former site (WISS) operations was placed into a database. The post remedial soil sample results from those properties were also input into the database. The post remedial soil sample database results were then compared to the criteria of the Record of Decision (ROD) of 2000. The protocol presented in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) was applied to demonstrate compliance with the criteria established in the ROD.

Each property was then evaluated against the cleanup criteria presented in the ROD. The data was considered as though the surveys were performed under the WISS ROD. The number, quality and collection methods of the data points were evaluated with respect to the MARSSIM protocols.

All but four of the vicinity properties evaluated demonstrated compliance with the WISS ROD criteria. These four properties did not meet the WISS ROD criteria either owing to insufficient subsurface data, or potential areas of contamination in excess of the ROD criteria existed that required further investigation. It was likely that the four properties would meet appropriate dose limits, however, additional data may have been required to complete the assessment. The WISS FUSRAP team therefore had two alternatives to demonstrate compliance with WISS ROD criteria;

1) Perform a formal dose assessment of the properties utilizing existing data
2) Perform additional investigation of the four properties and take actions as appropriate

The WISS FUSRAP team chose the investigation option as due consideration was given to the potentiality there could be a requirement for institutional controls, additionally the potential existed that five year review on properties might indicate that the ROD criteria would be exceeded, although they may have met acceptable risk levels in their current state. Simply stated, the possibility existed that the property use might be limited. Further, a concern existed that there may be insufficient data to support risk modeling. Therefore the WISS FUSRAP team chose to perform additional investigation of the properties:

- Wayne Township, lot 37
- Wayne Township, lot 31
- Wayne Township, lot 4a
- Wayne Township, Wayne Township Park

Figure 1 displays the locations of the four properties relative to the WISS.

Fig. 1 Locations of the vicinity properties that were subject to further investigation

CHARACTERIZATION METHODOLOGY

Since the properties in question had been subject to interim removal actions, existing data represented the residual contaminant levels under the backfill material utilized to return the property to its original grade. This posed a challenge to the design of the additional investigations. Additionally, the project team wanted as a much as possible, to adhere to the MARSSIM protocols for surveys. MARSSIM identifies a multi-layered approach to surveys (e.g. Scoping, Characterization, and Final Status Surveys). MARSSIM also indicates that in some cases, scoping and characterization surveys may be used for determining final status. In the case of the Vicinity Properties, consideration was given to the possibility, that if the characterization sampling indicated a property did not require additional efforts these data could be applied as final status data.

Overcoming the subsurface residual contamination issue is discussed below. To address concerns over additional surveys the characterizations were done to meet the data quality objectives of a final status survey in accordance with MARSSIM.

The location reference grid established in the *Post-Remedial Action Report for the Remedial Action DOE, 1984, 1986, 1993,* at the Vicinity Properties (VPs), was reconstructed and overlaid onto the New Jersey 1927 North American Datum (NJ27NAD) state plane grid coordinates. This resulted in the construction of a 10-meter by 10-meter grid system and subsequently each property was divided into series of survey units. The survey units were delineated in a manner consist with the Multi Agency Radiation Site Survey and Investigation Manual (MARSSIM) utilizing the reconstructed grid system and the historical data from the Radiological Surveys and the Post-Remedial Action Reports conducted for the DOE, 1984, 1986, 1993.

Due to the variability in contaminant distribution, evident by differing excavation depth across the areas of investigation, the investigation of the four VPs consisted of both surface and subsurface surveys. A walkover scan, surface survey, was performed utilizing a 2 in. by 2 in. Sodium Iodide (NaI) detector connected to Data Logger, which recorded the exposure rate in micro-Roentgens per hour (uR/h). An exposure rate to insitu activity correlation developed for the WISS was used to assist in identifying gamma anomalies. A Differential Global Positioning System[i](DGPS) was used to physically locate the integrated readings within the established survey units and grid system.

The sampling of the four properties was performed with direct push technology. Each property was divided into survey units and sample points designated using a random start point and a triangular grid. The sample point locations were logged with the DGPS system. Sample cores were then taken at each location. Each sample core was pushed to a minimum of one foot past the native soil/backfill interface. Gamma logs were then taken from each borehole in six inch intervals. Soil samples were taken from the soil core corresponding to the highest reading from the borehole or the top six inches of native material (below the backfill material). Soil sampling results were compiled and statistical analysis performed.

Exposure Rate to Insitu Activity Correlation

In order to efficiently implement the investigational effort a correlation between exposure rate in micro-Roentgens per hour (uR/hr) and activity concentration in pCi/g established for the Wayne Interim Storage Site (WISS) was applied. The contaminated soils at WISS have relatively stable ratios of contaminates. This is particularly true of soils at activities at or near the ROD cleanup criteria. The activity ratio of Th-232 to Ra-226 is typically 3 to 1. A varying ratio of activities would result in differing exposure rates for the same activities of soil since Th-232 and Ra-226 produce different exposure rates per pCi. The relatively constant ratio present at WISS allowed for the use of a correlation throughout the entire site.

The initial correlation-sampling event occurred in early 2001. The initial correlation event consisted of thirty-five sample locations were selected placing an emphasis in areas where subsurface contamination was thought not to be present. The locations also emphasized areas of the site where activity concentrations were thought to range from 2 to 5 pCi/g combined Ra-226 and Th-232.

At each sampling location, contact and one-meter exposure rates were collected. Soil samples were collected to a depth of 15 cm after the exposure rate measurements. The soil samples were then analyzed for Ra-226 and Th-232 via gamma spectroscopy. Sample results and exposure rates from each sampling location were then compiled and an analysis performed. The regression analysis indicated that soils with a uniform activity of 5 pCi/g of Ra-226 and Th-232 above background combined would yield a consistent exposure rate (see Figure 2). The correlation was adjusted periodically throughout the course of the remediation response in the influence from gamma fields of source material adjacent to measurement location (shine). This was accomplished the application of a secondary correction factor. The secondary correction factor was acquired by a applying a three dimensional regression analysis to the data. The accuracy of the correlation became increasingly unstable as levels lateral gamma influence rose to a factor two times the level of the direct measurement.

The measurements taken below the established critical level of lateral gamma influence proved to be effective in the remediation of WISS. The correlation along with the scanning methodology also proved effective in guiding the excavation and continuing production rates.

The scanning correlation methodology was demonstrated to be effective during the completion of Final Status Surveys (FSS). A total of 349 FSS samples were taken with an average of 1.98 pCi/g, radium and thorium combined, and a standard deviation of 1.48 pCi/g during FSS at the WISS property.

As the contamination on the vicinity properties was from of the same source as that at the WISS the WISS team chose to use the existing correlation as a guide for the identification of potential anomalies on the VPs and should the soil samples collected from the vicinity properties collected above the established ROD criteria contain differing ratios the gamma data would be re – evaluated. The ratios of the radium and thorium for those samples that were above the ROD criteria were found to be consistent with the ratios established at the WISS. The data presented in the *Post Remedial Action Report, DOE 1984, 1986, and 1993.*

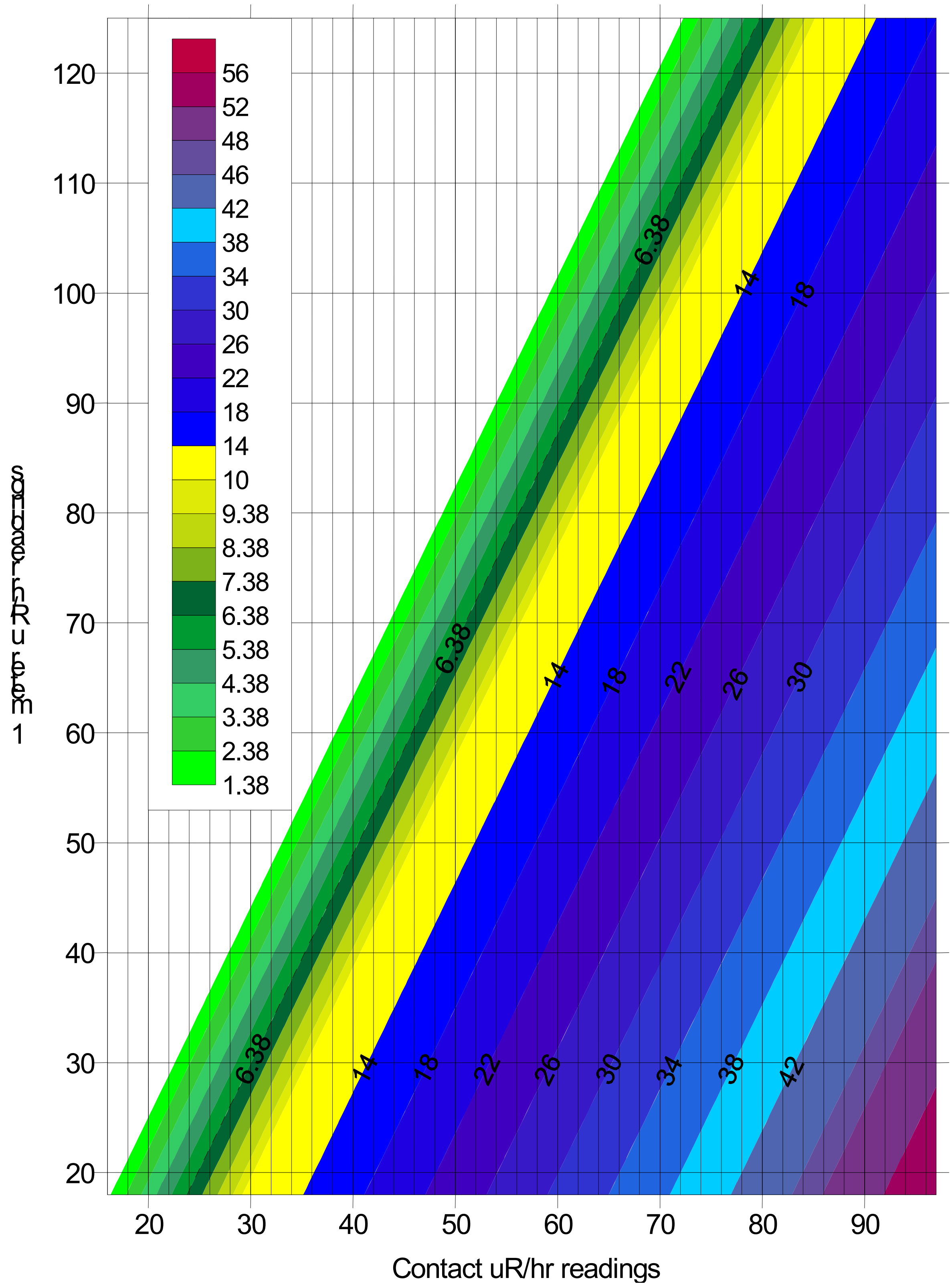

Fig. 2 Wayne interim storage site insitu radium & thorium combined to micro-roentgens per hour

Surface and Subsurface Soils Analysis

Each property was divided into survey units and sample points designated using a random start point and a triangular grid the sample point locations were logged with the DGPS system. The WISS Team collected surface and subsurface soil samples at sample point locations. Continuous soil cores were collected until the native in-situ soil is encountered. Continuous soil core direct push technology (DPT) was utilized to collect subsurface soil samples. The DPT is typically performed using a 2-inch outer diameter sleeve. The WISS FUSRAP team opted to use a 3-inch outer diameter tube for a number of reasons; the ability to capture larger sample volumes, and the ability to utilize a 2-inch by 2-inch NaI detector for down-hole logging. The 2-inch by 2-inch NaI detector provides an increased sensitivity in locating the gamma emissions from the contaminants of concern compared to instruments that employ either a 1-inch by 1-inch NaI detector or a 1-inch by ½ -inch NaI detector. The largest disadvantage of employing the larger diameter sleeve is that it seems to be more prone to bore-hole refusal and may result in an increased number of borings to achieve the required depths. The Figure 3 provides an example of the direct push equipment.

The down-hole gamma logging was performed using a Ludlum Data Logger Ratemeter/Scaler, coupled to a Ludlum NaI gamma detector. Readings were obtained and recorded every 0.5-ft interval below ground surface.

A geologist performed geologic logging of all continuous cores. The geologist was responsible for determining the location of the interface of backfill and native in-situ soil. One sample was obtained at each subsurface sampling location. The singular sample was collected at the depth below the location of the interface of backfill and native in-situ soil and where the maximum gross gamma measurement was observed. The samples were then transferred to the laboratory for gamma spectroscopy analysis.

Offsite sample analysis was conducted by gamma spectrometry utilizing the methods equivalent to those referenced by EPA 903.1 or the method that United States Environmental Protection Agency, Environmental Measurements Laboratory (EML) has defined in *The Procedures Manual of The Environmental Measurements Laboratory Volume I, 28th Edition, February, 1997* (HASL 300) as method Ga-01-R, Gamma Radioassay. This procedure is used for the nondestructive measurement of gamma-ray emitting radionuclides from a variety of environmental matrices by high resolution germanium (Ge) detector. The procedure is used for qualitative, quantitative, or relative determinations of radionuclide concentrations.

The WISS on-site laboratory developed an in-growth factor for on-site analysis of Ra-226 in soils. The site specific in-growth factors projected the total radium activity in soil sample at any day within the nominal 21-day equilibrium period. This factor was applied to the samples results analyzed during the characterization phase of the operation. Using gamma spectroscopy and the radon in-growth factor(s) generated a significant savings in analytical costs and reduced the time required to produce the analytical sample results. By way of example, the cost savings can be seen when comparing the costs for alpha spectroscopy ($325/sample) for the contaminants of concern compared to the costs of gamma spectroscopy ($75/sample).

Fig. 3 Example of direct push equipment

Data Reduction and Presentation

Data reduction of field measurements was accomplished by merging the data outputs of the DGPS, the scaler, laboratory analyses, and CAD drawings produced by civil surveyors to produce maps which present exposure rates, elevations, survey unit boundaries, direct measurement locations, and sampling locations on a single map.

The data reduction process involved the decoding and filtering the data from; the scaler, the DGPS, and the laboratory results in a series of database tables to be processed by the geostatistical program employed by the WISS project team. The data were processed using the geostatistical methodology know as kriging. Kriging is a statistical tool developed by Matheron (1963) and named in honor of D.G. Krige. Although originally developed specifically for ore reserve estimation, kriging has been used for other spatial estimation applications, such as analyzing and modeling air quality data (Grivet, 1980; Faith and Sheshenski, 1979) or as in the case of the WISS VPs for estimating the relative size of an area of contamination. At its simplest, kriging can be thought of as a way to interpolate spatial data much as an automatic contouring program would. In a more precise manner, kriging can be defined as a best linear unbiased estimator of a spatial variable at a particular site or geographic area. Kriging assigns low weights to distant samples and vice versa, but also takes into account the relative position of the samples to each other and the site or area being estimated (Lefohn, 1987).

The data reduction process involved the generation of multiple kriged maps utilizing a unified coordinate system. The resulting maps produced were then combined with scaled CADD maps of the site. In this case, three of the five survey units contained contamination above the DCGL established in the WISS ROD. Two of the survey units were located on one property, the Wayne Township Park, and the third survey unit was located on lot 4a, Wayne Township. The application of this method of data reduction proved to be an effective way to identify the areal extent of contamination. An example of these maps and comparison to the extent of remedial action presented as Figure 4.

CHARACTERIZATION DATA EVALUATION

The supplemental characterization data collected from four properties was reviewed by the WISS FUSRAP team. The results investigational surveys indicated that two of the four properties: Wayne Township, lot 37 and Wayne Township, lot 31 did not require any further action to meet the WISS ROD criteria. Since the characterization surveys were conducted to meet the data quality objectives of a final status survey in accordance with MARSSIM no further information was required to demonstrate compliance with the ROD criteria.

However, the two other properties: Wayne Township, lot 4a, and Wayne Township Park warranted further remedial action to meet the WISS ROD criteria. The data from the investigational process formed the basis for establishing the locations and initial areal extent of the remedial efforts. The remedial efforts began on July 23, 2003.

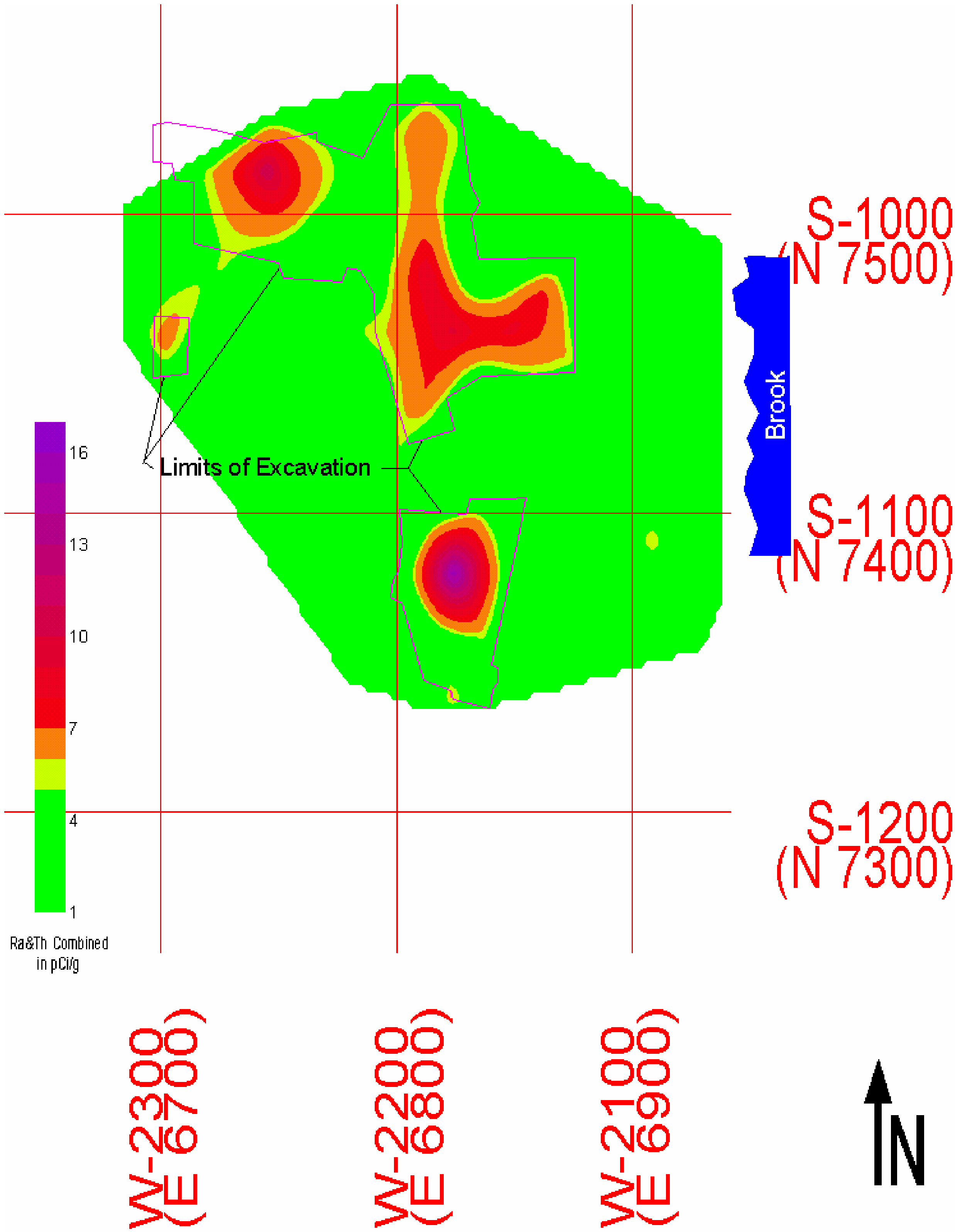

Fig. 4 Example of vicinity property investigation using kriged data to identify the subsurface extent of contamination

REMEDIATION PROCESS

The excavation process was controlled in a fashion similar to the WISS site itself. An in-process soil sampling program for remedial activities consisted of Cell Characterization Surveys (CCS), Remedial Action Support Surveys (RASS), and Final Status Surveys (FSS). The purpose of the CCS is to determine residual radiological concentrations present in soil that is to be either excavated or made available for the RASS.

The design of the CCS is based on the specific data quality requirements for transportation and disposal of the excavated material and the exigent demands of the RASS and FSS. The CCS provides information on variations in the contaminant distribution in an area. If the data acquired from the CCS indicates the radioactive activity is above the radiological criteria [also known as the Derived Concentration Guideline Level (DCGLs), the soil was removed from the grids to the predetermined depth identified by the characterization survey, and stockpiled for shipment. If the data acquired during the CCS indicated that the residual radioactive contamination present within a grid(s) is at or below the radiological DCGLs, the grids become eligible for a RASS.

Remedial Action Support Surveys are performed when analytical results from the CCS indicate that residual radiological concentrations in grids are at or below the radiological DCGLs. The RASS was performed to investigate whether the $DCGL_W$ was exceeded, and if so, the surface area and concentration of the exceedance. The entire survey unit is surveyed with a two inch by two inch sodium iodide (NaI) detector coupled to a ratemeter/scaler. Results of these surveys will be used to determine if further excavation is required or if the grids are eligible for a FSS.

Additional remediations were performed in the areas if residual radioactive material is detected above the $DCGL_W$. A comprehensive appraisal of the impact of the area of elevated contamination is completed during the FSS phase.

The RASS and FSS surveys are both performed using a two by two-inch NaI detector and a Digital Global Positioning System (DGPS) unit. The data obtained from the DGPS is used to correlate exposure rate, radiological, and chemical sampling data to a physical location at WISS. The use of the DGPS allows for documented readings within 3 feet of the true coordinates. Survey teams typically consist of two technicians. One technician operates the DGPS, and the other scans the surface soils. The scan is performed approximately 5 cm from the ground surface. The use of the DGPS system allows the team to collect gamma measurements in multiple forms such as counts per second, uR/hr, or an integrated dose.

A Final Status Survey (FSS) is performed only after the RASS indicates that an area is available for verification sampling to demonstrate compliance to the cleanup criteria. A surface scan is performed that effectively detects residual contamination at levels at least 50% of the radiological DCGL. The scanning also permits the surveyor to identify elevated areas of contamination that may be present in a survey unit. The Health Physicist evaluates areas of elevated contamination according to the Elevated Measurement Comparison (EMC) procedures in MARSSIM. Soil sampling is performed once the scanning survey has been completed and documented.

The CCS, RASS, and FSS surveys performed in accordance with the MARSSIM protocols, employing the processes and field techniques developed at the WISS, were performed on the two properties. The remediation resulted in 2000 cubic yards of material excavated, packaged, and disposed. Backfill of the two properties commenced on August 18, 2003.

Post Remedial Action Reports (PRAR) were prepared for the 2 remediated VPs. The reports document the final status of these properties and when combined with the VP evaluation and the WISS property PRAR provide EPA with information to facilitate deletion of the site from the NPL.

CONCLUSIONS

Issues related to the evaluation of interim response actions, VP concerns, technology advancement, and regulatory changes are to be expected at the time of consideration for site deletion from the NPL. These issues can be addressed efficiently and with limited costs as demonstrated by the WISS project.

Employing the discussed methods and techniques produced a streamlined process to eliminate unnecessary field operations and therefore reduced overall project costs. This process utilized significant elements from MARSSIM, combined with the techniques and processes developed and deployed at the WISS:

- Existing data evaluation
- Integration of FSS data quality objectives in the Characterization
- Exposure Rate to Insitu Activity Correlation
- Radon In-Growth Factor for on-site analysis of Ra-226 in soils
- Geostatistical data reduction techniques
- Remedial approaches
  - Cell Characterization Surveys
  - Remedial Action Support Surveys
- Final Status Surveys

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FOOTNOTES

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[i] *The DGPS has the ability to locate and relocate and aid in navigating to a location within a variance of 0.1 meters - 0.4 meters. However, it should be noted there are a number of factors which can affect DGPS performance. Close proximity to an Electro-Magnetic field whether generated by heavy equipment motor, or by the one generated by the actual metal itself will cause the variance to increase. Adverse weather conditions whether ionospheric (solar flares) or tropospheric (rain, heavy snow, or very dense and highly charged cloud cover) will also affect the variance.*