

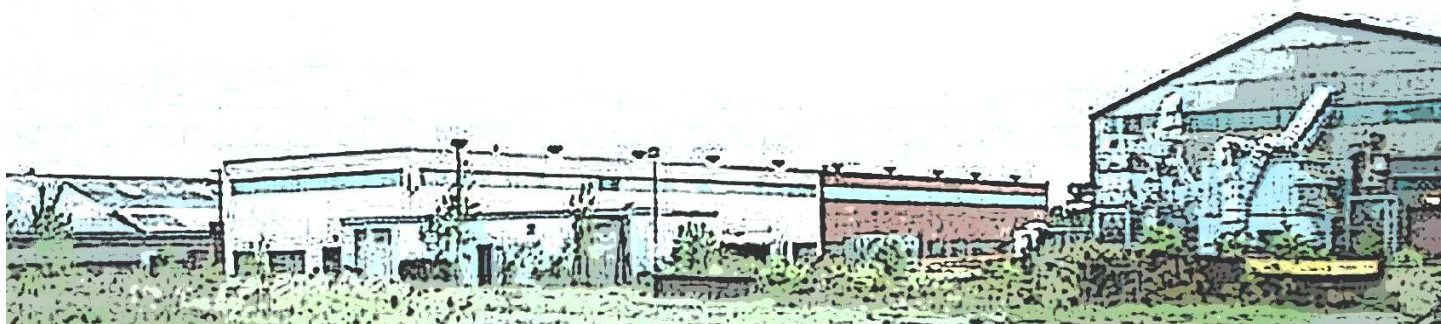
FINAL

Gamma Walkover Survey Plan

Former Guterl Specialty Steel Corporation FUSRAP Site

Lockport, New York

June 2006



Prepared for:

**US Army Corps of Engineers
Buffalo District**
1776 Niagara Street
Buffalo, New York 14207-3199



Prepared by:

Earth Tech, Inc.
300 Broadacres Drive
Bloomfield, New Jersey 07003



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Contract W912P4-05-D-0001

Delivery Order 0001



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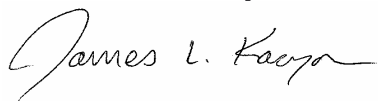
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- ORISE, 1999, Table 13 Radionuclide Concentrations in Surface Soil, Exterior Systematic Locations
- ORISE, 1999, Table 14 Radionuclide Concentrations in Soil, Exterior Locations of Elevated Activity
- ORISE, 1999, Table 15 Radionuclide Concentrations in Soil, Exterior Borehole Locations

Attachment 2 – Referenced Figures from Prior Investigations

- ORISE, 1999, Figure 33 Guterl Specialty Steel Corporation – Class 1 and 2 Areas Measurement and Sampling Locations
- ORISE, 1999, Figure 34 Guterl Specialty Steel Corporation – Landfill Area – Measurement and Sampling Locations
- ORISE, 1999, Figure 35 Guterl Specialty Steel Corporation – Exterior Class 3 Area - Sampling Locations
- ORISE, 1999, Figure 36 Guterl Specialty Steel Corporation – Impacted Areas
- NYSDEC, 1999, Figure 1, Area Between Allegheny Ludlum Fence and Park Avenue – 1999 Survey Areas
- USACE, 2005b, Figure 2 Guterl Steel Site Entities

Attachment 3 –Performance of a GPS-based Gamma Walkover Survey

Attachment 4 – Standard Operating Procedures

- SOP 1, Portable Detection Equipment
- SOP 6, General Radiological Equipment Checklist

Attachment 5 – Gamma Walkover Survey Equipment

Acronyms

AEC	Atomic Energy Commission
BGO	Bismuth Germinate
COPCs	Constituents of Potential Concern
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (aka Superfund)
DCGL _W	Derived Concentration Guideline Limit “Wilcoxon rank sum”
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FSP	Field Sampling Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HP	Health Physicist
IA	Investigative Area
<i>MARSSIM</i>	<i>Multi-Agency Radiation Survey and Site Investigation Manual</i>
MED	Manhattan Engineer District
NaI	Sodium Iodide
NRC	U.S. Nuclear Regulatory Commission
NYSDEC	New York State Department of Environmental Conservation
PM	Project Manager
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation & Recovery Act of 1976
RI/FS	Remedial Investigation/Feasibility Study
RIE	Remedial Investigation Engineer

RPP	Radiation Protection Plan
RPT	Radiation Protection Technicians
RSO	Radiation Safety Officer
SOW	Scope of Work
SSHM	Site Safety and Health Manager
SSHP	Earth Tech Site Safety and Health Plan
TPP	Technical Project Planning
USACE	U.S. Army Corp of Engineers

1 Introduction

In accordance with United States Army Corps of Engineers (USACE), Buffalo District contract number W912P4-05-D-0001, delivery order number 0001, Earth Tech has prepared this *Final Gamma Walkover Survey Plan* for the former Guterl Specialty Steel Corporation site (Guterl Steel site), as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), in accordance with Task 5 of the March 2005 delivery order Scope of Work (SOW) (USACE, 2005a).

The strategy for the Guterl Steel site, as directed by Congress and specified by USACE, is to address all Manhattan Engineer District (MED) and Atomic Energy Commission (AEC)-related waste at the Guterl Steel site (and adjacent properties, if necessary). The strategy will follow the process defined in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). The criteria in CERCLA (United States Environmental Protection Agency (USEPA), 1988) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (USEPA, 1990) will be used for site evaluation and remedy.

This document describes the activities planned to conduct a Gamma Walkover Survey (GWS) to locate and map areas of elevated gamma radiation in the outdoor areas of interest that are within and around the Guterl Steel site.

The location of the Guterl Steel site is shown in **Figure 1-1**, Site Location Plan.

1.1 Historical Background

During the period from 1948 through 1956, rolling and forming operations on uranium and thorium metals were performed at the Guterl Steel site. This work was performed under a contract between a previous owner (Simonds Specialty Saw and Steel) and the AEC.

A number of radiation surveys conducted since that time have identified uranium and thorium contamination on the structures and equipment in a number of the buildings at the Guterl Steel site that were associated with the conduct of this work, in surface and subsurface media within and around these buildings, and in the surface and subsurface soils at several other areas within and around the Guterl Steel site.

The areas known to include residual MED/AEC materials include the buildings and the exterior areas within the Excised Area, the Landfill Area, the Niagara County Industrial Development (NCIDA) Property, and the Railroad Right-of-Way. The boundaries of these areas are shown as overlays on an aerial photograph of the Guterl Steel site in **Figure 1.1-1**, Detailed Site Plan.

As discussed in Section 2.3 of the *Data Gap Analysis Report* (DGAR) summarizing the August 2005 Technical Project Planning (TPP) Meeting, the concept of developing Investigative Areas (IAs) to better manage the assessment of existing data and future data needs was introduced (USACE, 2006a). The IAs are:

- IA01 Excised Area – Building Surfaces and Interiors (including Building 24)
- IA02 Excised Area – Building Exterior Areas

IA03	Landfill Area
IA04	Niagara County Industrial Development Agency (NCIDA) Property (Allegheny operations area, not including Excised Area, Landfill Area, or Building 24)
IA05	Railroad Right-of-Way North of Site Proper
IA06	Off-site Northeast Properties
IA07	Groundwater
IA08	Site Utilities (Sewers and drains)

IA02 through IA05 have been designated to have a GWS conducted prior to the conduct of additional field sampling in order to aid in the location of candidate areas for additional characterization activities. The bases of the GWS activities in each of these are described in **Sections 2.4.1 through 2.4.5**. **Figure 1.1-2** shows the boundaries of these IAs overlaid onto an aerial photograph of the Guterl Steel site.

The Excised Area, containing IA01 and IA02, is so named because it was excised from a prior purchase by Allegheny Ludlum Corporation due to the known presence of residual MED/AEC materials. The buildings in the Excised Area are designated by numbers 1 through 6, 8, 9, 24 and 35. The GWS survey within the boundaries of the Excised Area is limited to the exterior land areas surrounding these buildings (IA02).

IA03, the Landfill Area, is located west of the northwest corner of the NCIDA property and extends north beyond the apparent landfill area to the southern edge of the parking area at a commercial overhead door company. Allegheny Ludlum presently owns and operates the steel mill facilities on the balance of the property shown as IA04, NCIDA Property. IA05, the Railroad Right-of-Way, includes an abandoned railroad spur that was used to service the Guterl Steel site during the period of MED/AEC operations. IA06, Off-site Northeast Properties, has been eliminated as a potential area of concern by the Data Gap Analysis process.

1.2 Project Organization and Responsibilities

The project organization chart is shown in **Figure 1.2-1**.

The USACE will coordinate Earth Tech's GWS efforts with property owners and stakeholders and will obtain consent from the site owner before any GWS work is conducted. Appropriate local, State, and Federal officials as well as the site owner and other affected parties will be notified of the survey schedule.

Earth Tech's Project Manager (PM) will coordinate Earth Tech's GWS activities with the USACE and will serve as the primary Earth Tech point-of-contact for all communications with the USACE, the property owners with areas to be surveyed, and other interested parties or agencies. The PM is responsible for overall project planning, managerial oversight of the conduct of all operations, and general management of the resources required for safe and efficient conduct of the GWS.

The Site Safety and Health Manager (SSHM) is responsible for the implementation of the Earth Tech Site Safety and Health Plan (SSHP; USACE, 2006b) for the Guterl Steel site. This includes the conduct of training, instruction, and routine and special inspections of the GWS tasks to insure compliance with the requirements of the SSHP.

The Health Physicist (HP) is responsible for the development and implementation of SSHP Attachment C, Radiation Protection Plan (RPP; USACE, 2006b) for the Guterl Steel site. The HP will provide professional health physics support for the conduct of the GWS, as required, and will oversee the conduct of the RPP.

The Site Radiation Safety Officer (RSO) is responsible for the routine conduct of the RPP as required to support of the GWS tasks. The RSO will supervise the Radiation Protection Technicians (RPTs) for the conduct of the RPP.

The Remedial Investigation Engineer (RIE) is responsible for planning, directing and coordinating the conduct of the GWS. The RIE is responsible for the quality assurance/quality control (QA/QC) of the survey data, the processing of the survey data for imaging, and the preparation of daily GWS reports for delivery to the USACE.

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2 Description of Work

The March 2005 USACE SOW, paragraph 3.6.1 (describing Task 6 - Acquisition of Field Data) states:

“In order to aid the selection of soil sampling locations, a gamma walkover survey shall be performed at Guterl Specialty Steel Corporation prior to the commencement of other fieldwork and sampling. The contractor shall propose the amount of survey coverage, in the separate gamma walkover survey plans, as described in Task 5. Where possible, gamma activity data will be collected concurrently with global positioning data. Daily gamma survey results and/or a daily map of the gamma survey progress shall be made available to the USACE by the close of business one working day following any gamma survey activity.”

The March 2005 SOW, paragraph 3.5, (describing Task 5 – Project Work Plans) states that for the “gamma walkover survey, a separate set of plans shall be produced. The gamma walkover survey plans shall contain all applicable sections of the project work plans related (only) to the execution of the survey.”

Taking these two paragraphs into consideration, Earth Tech recommends that the GWS be conducted in exterior areas within and around the Guterl Steel site in order to locate and map areas that are found to have gamma radiation levels that are in excess of background conditions. The intent of the GWS is to provide accurate location of these elevated findings and to define their aerial extent. The GWS results will be used to direct subsequent investigations that may be needed to define the nature and vertical extent of these locations.

A secondary aspect of the GWS is to locate and map the site features that allow the survey data to be related to the buildings, structures, and boundaries at the Guterl Steel site. This will involve the combination of civil survey locations with point, line, and area features defined by global positioning systems (GPS), or other positioning methods, to create accurate maps of the site features upon which the GWS data can be imaged. This will aid in data visualization, data interpretation, and planning of subsequent characterization survey activities.

The conduct of the GWS requires a number of preparatory tasks that include:

- Site-specific training
- Setting up the site infrastructure
- Clearing vegetation for survey access
- Establishing civil survey benchmarks and survey grids for the GWS

Site-specific training will be completed prior to the conduct of any on-site work in support of the GWS. Setting up the site infrastructure includes establishing the essential facilities and utilities that are needed to support the project staff, conducting site-specific training and implementing the SSHP and RPP that are required to support the GWS.

In addition, some areas may have vegetation that needs to be cleared to provide access for the civil surveys and for the survey coverage requirements of the GWS. Civil surveys are required to establish sufficient benchmarks throughout the site that can be used to reference the GWS data to the appropriate New York State Plane Coordinate System.

These preparatory tasks are described in more depth beginning in **Section 2.1**. Once these preparatory tasks are completed, the actual conduct of the GWS will begin.

The first step of the GWS will be conducted at a background reference area in order to document the findings of the GWS methods in a non-impacted local area that is thought to be representative of the Guterl Steel site. After completion, review, and approval of the GWS data at the background reference area, the GWS will be conducted at the Guterl Steel site.

Subsequent to execution of the GWS, additional characterization surveys, including isotopic analysis of soil samples, will be conducted at the background reference area as part of the *Sampling and Analysis Plan, Volume 1 – Field Sampling Plan* (FSP; USACE, 2006c). This additional data will be used to verify that the background reference area is non-impacted and qualified to serve as representative of the background reference area for the Guterl Steel site.

The March 2005 SOW requires that the GWS record the location of each measurement and that the results be reported the next day by the close of business. An efficient way to accomplish this is to interface the gamma detector directly to a GPS unit with a data logger that automatically records the location and the gamma reading on a prescribed frequency. The GWS preferred data logging rate is once per second while the surveyor walks at 0.5 meters per second.

The general GWS process involves slowly scanning the soil surface with an appropriate gamma sensitive radiation detector while walking slowly down adjacent lanes to accomplish the specified survey coverage. At the end of each day, the GWS survey results will be delivered to the RI Engineer for QA/QC, imaging and reporting. The results will be imaged as overlays on aerial photographs and/or contour plots for delivery to the USACE.

Under ideal conditions where GPS can provide sufficient location accuracy, each of the instrument survey readings are automatically collected in a data logger with (x, y) coordinates that are referenced to the New York State Plane Coordinate System. If the site terrain is relatively flat the gamma detector can be mounted on a push cart to carry the equipment weight, to maintain the specified detector height above grade, and to fix the detector (x, y) position relative to the location of the GPS antenna.

Due to the various site conditions, several different methods of positioning, survey scanning, and data recording may be required. The possible methods of positioning include, in order of desired utilization: GPS, laser range finder, ultrasonic range finder, or measuring tapes. An alternative method of conducting the gamma survey includes manually scanning the detector probe above the ground surface at the desired height above grade. These alternative methods are discussed in more detail in **Section 8.3**.

Survey coverage will generally fall into three categories consistent with classifications in *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (U.S. Nuclear Regulatory Commission (NRC), 2000) as follows.

Areas that have no reasonable potential for residual contamination are classified as *non-impacted areas*. These areas have no radiological impact from site operations, are typically identified early in the process, and require no further evidence to demonstrate compliance with the release criteria.

Areas with reasonable potential for residual contamination are classified as *impacted areas*. Impacted areas are further divided into one of three classifications:

- *Class 1 Areas:* Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) or known contamination (based on previous radiation surveys) above the derived concentration guideline limit (Wilcoxon rank sum) or DCGL_w.^{*} Examples of Class 1 areas include:
 1. Site areas previously subjected to remedial actions
 2. Locations where leaks or spills are known to have occurred
 3. Former burial or disposal sites
 4. Waste storage sites
 5. Areas with contaminants in discrete solid pieces of material and high specific activity.
- *Class 2 Areas:* Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the DCGL_w. To justify changing the classification from Class 1 to Class 2, measurement data should exist that provides a high degree of confidence that no individual measurement would exceed the DCGL_w. Other justifications for reclassifying an area as Class 2 may be appropriate based on site-specific considerations. Examples of Class 2 areas include:
 1. Locations where radioactive materials were present in an unsealed form
 2. Potentially contaminated transport routes
 3. Areas downwind from stack release points
 4. Upper walls and ceilings of buildings or rooms subjected to airborne radioactivity
 5. Areas handling low concentrations of radioactive materials
 6. Areas on the perimeter of former contamination control areas.
- *Class 3 Areas:* Any impacted areas that are not expected to contain any residual radioactivity or are expected to contain levels of residual radioactivity at a small fraction of the DCGL_w, based on site operating history and previous radiation surveys. Examples of Class 3 areas include:
 1. Buffer zones around Class 2 areas
 2. Areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification

For consistency with the scanning survey concepts used in the FSP, the baseline GWS coverage is 100% for Class 1, 25% for Class 2, and between 5 and 10% for Class 3 areas. The survey areas designated as Class 1 and 2 at this pre-GWS stage are shown in **Figure 2-1** for each of the IAs. There are no Class 3 areas designated at this stage; however, it is expected that some of the areas will be reclassified based on the GWS findings.

MARSSIM specifies 100% scanning surveys for Class 1 areas and allows some flexibility in the selection of the survey coverage for Class 2 and Class 3 areas. The 25% scanning survey coverage

^{*} The DCGL_w is the DCGL for average concentrations over a wide area, used with statistical tests (that is, the Wilcoxon rank sum test) in accordance with *MARSSIM* guidance.

for Class 2 areas is planned because it is sufficient to identify anomalies of elevated gamma levels with areas in excess of 2 m². The value between 5 and 10% for the Class 3 area is planned to assure sufficient data over a 400 m² area to support a decision that an area is either potentially impacted or not impacted based on the mean of survey data, with a confidence level of at least 95%. It is also generally consistent with the scanning survey protocol in the FSP for Class 3 areas, which is specified at 6.3%.

This GWS plan has been developed to accommodate a modification of either increased or decreased coverage pending daily data review and USACE guidance. Any decision to increase or decrease the survey coverage will be determined in consultation with USACE.

Although the baseline GWS protocol is consistent with the scanning survey concepts in the FSP (USACE, 2006c), there may be a benefit for performing a 100% survey throughout the site at the characterization stage. A comparative level-of-effort discussion for both the baseline GWS and a comprehensive GWS is presented in Section 9.

2.1 Site Infrastructure Setup

2.1.1 Site Specific Training and Site Safety

The SSHP and the RPP detail the site safety organization, responsibilities, and requirements for the non-radiological and the radiological safety related issues that are specified for use at the Guterl Steel site. Earth Tech will conduct the required site-specific training, establish the required project organizational support, and implement the required elements of the SSHP and the RPP for the conduct of the GWS prior to conducting the GWS field activities.

2.1.2 Access and Security

The GWS will require access to the background reference area, and to all of the IAs, including the Excised Area and the surrounding areas belonging to Allegheny Ludlum. The GWS may also require access to some of the adjacent properties north of the Allegheny Ludlum property, including those properties adjacent to the IA04 Railroad Right-of-Way corridor.

Earth Tech will coordinate all of its GWS related efforts through the USACE. The USACE will be responsible for obtaining rights-of-entry into all of the properties to be surveyed.

Some of these areas may be secured from direct access by fences, locked gates, or postings and other barriers. Earth Tech will coordinate with USACE to maintain security during the conduct of GWS operations in these areas.

2.1.3 Facilities and Utilities

Earth Tech will coordinate its efforts to setup its site infrastructure with the USACE. Earth Tech anticipates bringing temporary office and field support trailers on site to house its field support personnel and equipment. Earth Tech will work with the USACE for coordinating with Allegheny Ludlum for initial site access and for the supply of utilities. Earth Tech will also work with the USACE for coordinating with Allegheny Ludlum for routine control and access to these facilities during the conduct of the GWS activities. Earth Tech will be responsible for maintaining security for its on-site facilities and equipment.

2.1.4 Site Preparation

Site preparation involves obtaining consent for performing the survey, establishing property boundaries, evaluating physical characteristics of the Site, accessing surfaces and land areas of interest, and establishing a reference coordinate system. Site preparation may also include removing equipment or materials that restrict access.

2.2 Site Clearing

Based on a review of aerial photographs and site visits, some areas are believed to have vegetation or other obstructions that may interfere with the access required to conduct the GWS in accordance with the specified survey protocol. Earth Tech will coordinate with the USACE for right-of-entry and permission prior to performing any clearing or requests to move obstructions within these areas.

2.2.1 Vegetation

Clearing vegetation will be required in those areas where it may interfere with the conduct of the GWS survey and the survey coverage objectives. Thick and high groundcover may prevent using the specified detector height above grade and interfere with the ability to conduct a consistent gamma scan of the ground. Heavy brush and trees may interfere with surveyor access. The overhead canopy from trees in the area of the survey may interfere with and even preclude acceptable GPS positioning accuracy.

Section 4.8.4.2 of *MARSSIM* discusses site clearing techniques for land areas that will be used during this survey as necessary to produce adequate results. Site clearing is also addressed in the SSHP.

2.2.2 Obstructions

Other obstructions at the site may interfere with the conduct of the GWS survey and the survey coverage objectives. Any such obstructions will be identified during the initial on-site GWS planning phase.

The use of GPS near some obstructions, such as buildings or chain-link fences, can produce errors in the GPS positioning accuracy that exceeds acceptable limits. In these cases, alternative positioning methods will be used to collect the GWS data.

Alternative methods will also be evaluated in cases where an obstruction interferes with surveyor access or the ability conduct a sufficiently close gamma scan of the ground. Earth Tech will coordinate with USACE for prior approval for any removal or relocation of an obstruction from these areas.

2.3 Site Civil Survey

Earth Tech and its subcontractor will establish survey grade benchmarks tied to the New York State Plane Coordinate System at locations around the site for use in the conduct of the GWS and subsequent characterization surveys. These benchmarks may include property boundary locations and other locations that are convenient for access during the conduct of the GWS throughout the areas of interest.

2.3.1 Property Boundaries and Reference Coordinate Benchmarks

Property boundaries and survey benchmarks will be determined using available public information, and will be established by a NYS licensed surveyor as part of site mobilization activities. Civil surveys will be performed to provide benchmarks across the site.

The survey grade benchmarks will be located to provide a reference for the GWS data to local grid systems that may be established during the characterization surveys. The benchmarks will be tied to New York State Plane Coordinate System (West Zone). Earth Tech will use these survey grade benchmark locations to establish local grid coordinates at mapping grade (sub-meter) using a GPS unit.

2.3.2 Survey Units and Survey Grids

Dividing the Guterl Steel site into survey units is critical only for the final status survey. According to *MARSSIM*, characterization surveys may be performed without dividing the site into survey units. Hence, this will not be done for the present survey.

However, a local grid system will be established at the site prior to and during the GWS to:

- Aid in establishing and maintaining the specified survey coverage based on local grid coordinates.
- Provide a mechanism for referencing a measurement back to a specific location so that the same survey point can be readily relocated.
- Support direct comparison to data collected in prior surveys.
- Facilitate subsequent systematic selection of subsequent measuring/sampling locations.
- Provide a convenient means for determining average activity levels by area.

Each grid will consist of a system of intersecting lines, referenced to a fixed site location or bench mark. The grid lines will be arranged in a perpendicular pattern, dividing the survey location into squares or blocks of equal area.

The site-wide outdoor reference coordinate system will be tied to the New York State Plane Coordinate System (West Zone). It will initially be established as 20-meter grid squares oriented to grid north with the origin at the southwest corner.

Scale drawings of the survey areas will be developed that indicate facility features and superimposes the grid reference systems.

2.3.3 Site Features

The physical characteristics of the Guterl Steel site can have a significant impact on the complexity, schedule, and cost of the GWS survey. These characteristics include the total area to be surveyed, the number and size of structures to work around, the condition of the buildings that impact access and safety, access and security requirements, topography, near surface geology, the type of surface (soil type, road bed materials, asphalt, concrete, etc.), ground cover, and other vegetation. Some of these variables can directly impact the collection and interpretation of the GWS data. Section 4.8.3 of *MARSSIM* discusses the many considerations about land areas that can impact the ability to perform a characterization survey. The Guterl Steel site land areas are generally easily accessible,

but, because some parts are covered or paved with different types of media, the variance in background can interfere with the ability to identify contamination under these surfaces.

Earth Tech will map the accessible corners and/or boundaries of the major facilities, structures, and site features to aid in relating the GWS data and findings to the facilities and structures that are presently at the site. These site features may include buildings, utilities, drain lines, ditches, gates, mounds, and monitoring wells. GPS, along with alternative positioning systems where necessary, will be used to produce these site feature maps.

2.4 Gamma Walkover Surveys

This section addresses the conduct of the baseline GWS. Baseline survey coverage is 100%, 25%, and between 5 to 10% coverage for Class 1, 2 and 3 areas, respectively. Under a comprehensive GWS, all gamma walkover surveys would be conducted at 100% coverage regardless of the area classification.

2.4.1 Reference Background Area

The first GWS will be conducted at a background reference area in order to document the GWS data collection at an area that is not impacted. The GWS background survey data will be reviewed to evaluate the statistical variation of the data at a non-impacted area for subsequent comparison to and evaluation of the GWS data. The survey of the background reference area is addressed in **Section 7** in more detail.

2.4.2 IA02 Excised Area – Building Exterior Areas

2.4.2.1 Assumption Basis for IA02

Oak Ridge Institute for Science and Education (ORISE) detected radiological contamination in soils at various locations within the Excised Area (ORISE, 1999). Areas identified as contaminated by ORISE included areas directly west of Building 24 and Building 6/8, the area between Building 2 and Building 3, a portion of the small courtyard east of Building 5, and areas west of Building 2 and north of Building 1 in the general area below the former railroad tracks.

The exterior portion of the Excised Area was surveyed using a site-specific grid, but the grid used was not tied to the New York State Plane Coordinate System. The extent of radiological contamination (horizontal and vertical) was roughly established, although the sample density may not be sufficient for full delineation of impacted (contaminated) areas. Some contamination found was associated with firebrick and pieces of radioactive metal.

2.4.2.2 Gamma Walkover Survey for IA02

The GWS for IA02 will be conducted to achieve survey coverage of 100%. The close proximity to the buildings in the Excised Area, the chain link fence surrounding the exterior areas, and the relatively narrow alleys between several of the buildings will require alternative positioning methods to be used. In addition, some limits to access due to vegetation and slope issues may require the use of the man-carried survey mode.

For schedule estimating purposes it is assumed that 80 percent of the area can be surveyed using the push cart mounted detector with GPS location and automated data recording. It is assumed that the

balance of the area will be surveyed with the man-carried survey mode, half of which can use GPS and half of which must use alternative methods due to overhead obstructions or cultural influences (fence).

2.4.2.3 Class 1 Areas in IA02

At the Pre-GWS stage, the entire ground and paved area in IA02 will be designated as Class 1. The total Class 1 area in IA02 is approximately 16,000 m², not including ground covered by buildings.

Subsequent to the GWS effort, some of these Class 1 areas within the Excised Area may be reclassified as Class 2 areas.

2.4.2.4 Class 2 Areas in IA02

IA02 has no Class 2 areas at the Pre-GWS planning stage. However, the GWS may identify areas that can be reclassified as Class 2 areas.

2.4.2.5 Class 3 Areas in IA02

IA02 has no Class 3 areas at the Pre-GWS planning stage. However, the GWS survey may identify areas that may be reclassified as Class 3.

2.4.3 IA03 – Landfill Area

The total area of the Landfill Area is approximately 36,500 m² (approximately 9 acres).

2.4.3.1 Assumption Basis for IA03

Based on surveys conducted by or for the New York State Department of Environmental Conservation (NYSDEC), the presence of significant concentrations of radiological contamination in soils in IA03 has not been confirmed, with the exception of a limited area at the northeast corner of the Landfill Area (NYSDEC, 1994).

This area is an NYSDEC inactive hazardous waste site (NYSDEC, 2003), and as such NYSDEC has conducted several studies of this area. Surface radiological data are inadequate for RI/FS purposes.

The Landfill Area is shown in **Figure 1.1-2**. Refer to ORISE Tables 13 through 15 and Figures 34 and 36 included in Attachments 1 and 2, respectively, for presentation of the sampling locations, the ranges of summary measurements, and the approximate extent of the contamination in the Landfill Area (ORISE, 1999).

2.4.3.2 Gamma Walkover Survey Basis for IA03

The GWS for IA03 will be conducted to achieve survey coverage of 25%. Particular attention will be paid to locations that the ORISE survey indicated had significant contamination. The Class 2 gamma walkover survey will define areas of elevated contamination and may result in a reclassification of these areas to Class 1. If this happens, these areas will be resurveyed as Class 1 (data obtained during the Class 2 survey will be used to complement the added survey so that the Class 1 survey criteria are met efficiently).

Similarly, the Class 2 gamma walkover survey may demonstrate that some areas may be reclassified as Class 3, with a commensurate reduction in survey activity in those areas.

There are some areas where access may be restricted by vegetation including trees and thick brush. Marshy areas are noted along the western and southern boundaries. Wet soil conditions in these areas will preclude the usefulness of the GWS. Wetland delineation may be needed if radiological material is found in the western or southern part of the Landfill Area. For schedule estimating purposes at this time, the entire area is planned for surveying as a Class 2 area.

For schedule estimating purposes it is assumed that 80 percent of the area can be surveyed using the push cart mounted detector with GPS location and automated data recording. It is assumed that the balance of the area will be surveyed with the man-carried survey mode, half of which can use GPS and half of which must use alternative methods due to vegetation and cultural issues (fence, overhead power)..

2.4.3.3 Class 1 Areas in IA03

Previous surveys of the Landfill Area indicate contamination that may be potentially greater than the DCGLs in the northeast corner, so that a portion of the northeast corner may be a Class 1 area. However, the survey did not adequately define the extent of this contamination. It is likely that some large portions of IA04 should be classified as Class 1, but this is uncertain.

Subject to verification of these indications by the GWS, the entire landfill will be considered to be a Class 2 area. Initially, the total Class 1 area will be 0. This will be subject to change, depending on whether the survey of IA03 as a Class 2 area causes portions of it to be reclassified as Class 1.

2.4.3.4 Class 2 Areas in IA03

The entire Landfill Area will be considered as Class 2 for the initial GWS. If the GWS results warrant, some portion of the initial Class 2 area may be reclassified as Class 1 or Class 3.

If the Class 2 GWS demonstrates that some portions of IA03 may be reclassified as Class 3, there will be a commensurate reduction in survey activity in those portions.

For the initial GWS, the total Class 2 area is approximately 36,500 m². This will be subject to change, depending on whether the gamma walkover survey of IA03 as a Class 2 area causes portions of it to be reclassified as Class 1 or Class 3.

2.4.3.5 Class 3 Areas in IA03

None of IA03 will be initially surveyed as Class 3 area. However, this may change as a result of the gamma walkover survey.

2.4.4 IA04 – NCIDA Property (Excluding Excised Area, Landfill Area, and Building 24)

The total area of IA04 is approximately 211,000 m² (52 acres), including areas occupied by buildings. The building-occupied area is approximately 12,000 m² (3 acres), so the total outdoor area is approximately 199,000 m².

2.4.4.1 Assumption Basis for IA04

Figure 1.1-2 shows the NCIDA boundaries. Refer to ORISE Tables 13 and 14 and Figures 33, 35 and 36 included in Attachments 1 and 2, respectively, for presentation of the sampling locations, the

ranges of summary measurements, and the approximate extent of the contamination in those NCIDA areas covered by the ORISE survey (ORISE, 1999).

2.4.4.2 Gamma Walkover Survey Basis for IA04

The GWS for IA04 will be conducted to achieve survey coverage of 25%. The close proximity to the buildings in the NCIDA Area, the chain link fence surrounding the exterior areas, and the relatively narrow alleys between several of the buildings may require alternative positioning methods to be used. Some limits to access may require the use of the man-carried survey mode.

Particular attention will be paid to locations that the ORISE survey indicated had significant contamination. The Class 2 gamma walkover survey will define areas of elevated contamination and may result in a reclassification of these areas to Class 1. If this happens, these areas will be resurveyed as Class 1 (data obtained during the Class 2 survey will be used to complement the added survey so that the Class 1 survey criteria are met efficiently).

Similarly, the Class 2 gamma walkover survey may demonstrate that some areas may be reclassified as Class 3, with a commensurate reduction in survey activity in those areas.

There are some areas where access may be restricted by terrain and vegetation. Although much of this area is open and flat, some of the area north of the Excised Area is characterized by what appears to be piles of materials that were indiscriminately dumped.

For schedule estimating purposes it is assumed that 90 percent of the area can be surveyed using the push cart mounted detector with GPS location and automated data recording. It is assumed that the balance of the area will be surveyed with the man-carried survey mode, half of which can use GPS and half of which must use alternative methods due to vegetation and cultural issues (fence, building shadows).

2.4.4.3 Class 1 Areas in IA04

The ORISE survey detected several locations with radiological contamination greater than the screening levels. However, the survey did not adequately define the extent of this contamination. It is likely that some large portions of IA04 should be classified as Class 1, but this is uncertain.

Initially, the total Class 1 area will be 0. This will be subject to change, depending on whether the GWS of IA04 as a Class 2 area causes portions of it to be reclassified as Class 1.

2.4.4.4 Class 2 Areas in IA04

All outside areas of IA04 will be classified initially as Class 2.

Particular attention will be paid to locations that the ORISE survey indicated had significant contamination. The Class 2 gamma walkover survey will define areas of elevated contamination and may result in a reclassification of these areas to Class 1. If this happens, these areas will be resurveyed as Class 1 (data obtained during the Class 2 survey will be used to complement the added survey so that the Class 1 survey criteria are met efficiently).

Similarly, the Class 2 GWS may demonstrate that some areas, such as the extreme southeastern and southwestern areas, may be reclassified as Class 3, with a commensurate reduction in survey activity in those areas.

Initially, the total Class 2 area is approximately 199,000 m². This will be subject to change, depending on whether the survey of IA04 as a Class 2 area causes portions of it to be reclassified as Class 1 or Class 3.

2.4.4.5 Class 3 Areas in IA04

None of IA04 will be surveyed as Class 3. However, this may change as a result of the gamma walkover survey.

2.4.5 IA05 – Railroad Right-of-Way North of Site Proper

The total area of IA04 is approximately 24,300 m² (6 acres).

2.4.5.1 Assumption Basis for IA05

The NYSDEC (NYSDEC, 1999) reported that “elevated uranium and thorium concentrations [were] found along the former rail spur at several locations up to about 600 feet north of the Allegheny Ludlum fence.” Specifically:

- Above background readings were found at the southern-most part of “manual survey #1,” (see Figure 1 in **Attachment 2**, extracted from NYSDEC, 1999) on the back side of a mound of soil that was placed there during the leveling/filling work done behind the Lombardi property.
- Above background readings up to about 30,000 cpm at small spots located near what would have been the spur bed during “manual survey #2” (see Figure 1 in **Attachment 2**).
- Two areas with maximum count rates greater than 100,000 cpm were observed, at about 185 feet and at about 475 feet north of the intersection of two fences along the north boundary of the Allegheny Ludlum property. These areas are consistent with the disposal of radioactive waste along the rail spurs that served the steel mill. Some of the elevated areas have recognizable fire brick at or near the surface which will contribute to the measured radiation, but most of the above background readings were believed to result from uranium and thorium disposal.
- Elevated readings were on both sides of the former spur line (indicated by still-remaining railroad ties and northward extensions from those indications) over much of its length extending north to West Avenue.
- Radioactive material found consisted of small pieces of thorium metal, soil-like matrix containing mixtures of uranium and thorium, one location of identifiable small flakes containing uranium and thorium, slag, and fire brick.

The railroad right-of-way is shown on **Figure 1.1-2**.

2.4.5.2 Gamma Walkover Survey Basis for IA05

The GWS for IA05 will be conducted to achieve survey coverage of 25%. There are some areas adjacent to the railroad spur where access may be restricted by terrain, slope, vegetation, and stored materials and equipment. For schedule estimating purposes it is assumed that 80 percent of the area can be surveyed using the push cart mounted detector with GPS location and automated data

recording. It is assumed that the balance of the area will be surveyed with the man-carried survey mode, half of which can use GPS and half of which must use alternative methods.

The NYSDEC survey will be used to help guide the survey of IA05. The GWS will be used to verify and validate the NYSDEC survey. Particular attention will be paid to locations that the NYSDEC survey indicated had significant contamination. The Class 2 gamma walkover survey will define areas of elevated contamination and may result in a reclassification of these areas to Class 1. If this happens, these areas will be resurveyed as Class 1 (data obtained during the Class 2 survey will be used to complement the added survey so that the Class 1 survey criteria are met efficiently).

Similarly, the Class 2 gamma walkover survey may demonstrate that some areas may be reclassified as Class 3, with a commensurate reduction in survey activity in those areas. The GWS may locate discrete sources of radioactive material based on the anecdotal evidence in NYSDEC survey. In such cases, as an ALARA measure, the sources will be recovered and handled as radioactive waste.

2.4.5.3 Class 1 Areas in IA05

IA05 has no Class 1 areas.

2.4.5.4 Class 2 Areas in IA05

IA05 will be surveyed as a Class 2 area.

The total Class 2 area is approximately 24,300 m².

2.4.5.5 Class 3 Areas in IA05

IA05 has no Class 3 areas.

2.4.6 IA06 – Off-site Northeast Properties

The data gap analysis determined that IA06 includes only non-impacted areas. Based on this determination, no further characterization of this area is planned.

3 Mapping Requirements

The general survey design will be such that the GWS data can map:

- The gamma count rate collected in a 1 second interval while scanning near the ground surface.
- Clusters of elevated gamma indications at user specified intervals.
- Contour plots showing isopleths that illustrate the interpolation of the gamma readings over the survey area.
- Three-dimensional images of the gamma readings over the survey area where the height indicates the intensity of gamma reading.

The survey data density associated with the Class 1 and Class 2 survey coverage is demonstrated in **Section 9**.

3.1 Site Grid Systems

A primary site coordinate system will be established based on the New York State Plane coordinates. Civil survey grade benchmarks established around the site will provide ready access to the primary coordinate system. This system will be used to establish the alignment of Grid North and Grid East to be used throughout the site.

A secondary system of local site grids will be established for routine use during the characterization surveys and for potential alignment and correlation with survey grids from prior site surveys. The origin and axis of these local grids will be referenced to the primary coordinate system. The origin of these local grids will be established such that the origin is located at the southwest corner of the grid. The vertical axis of the grid will be aligned with Grid North and the horizontal axis will be aligned with Grid East.

Subordinate grid units within the secondary local grid system will be delineated by row and column where the first column beginning at the origin proceeding toward Grid East is designated by number 1, the next column then by number 2, then 3, etc., and beginning with the first row above the origin proceeding toward Grid North designated by the letter A, the next row then by B, then C, etc.

3.2 Survey Data

The SOW requires that GWS data use New York State Plane coordinates. While this can be automated for GPS based surveys, other positioning systems may be used that produce the initial survey data in local grid coordinates. In such cases, the initial survey data will be maintained for recordkeeping purposes and a secondary data record will be produced where the local grid coordinate positions are translated to the New York State Plane coordinates.

3.2.1 Position Data

The field survey data will be verified for relative location and proper orientation by plotting a track map that shows the location of each data reading that was collected during a survey. The individual locations can be color coded to indicate the gamma level intensity at that location and the assembled map can serve to show trends in the data and to indicate clusters that may constitute areas of interest and their approximate boundaries. As the GWS proceeds, the track maps will be assembled over the

site aerial photograph to demonstrate that the survey coverage is consistent with the specified area classification.

The track maps will also be reviewed to identify and demarcate any areas where the survey data was not collected. If these omitted areas are not justified, perhaps due to obstructions, they will be documented for further evaluation.

3.2.2 Gamma Data

Each survey gamma data set will be checked for quality. These checks will include:

- General correlation of the data to the daily background or a beginning and an ending static count over a known point (such as the origin of the local subordinate grid).
- Review of the data for reasonable transition from low to high readings that are consistent with standard gamma instrument performance.
- Identification of data spikes that could indicate an electronic problem within the gamma instrument or the interface to the data logger, or mechanical shock to the detector (such as hitting a rock).
- Identification of any dropped data that could indicate a cable connection problem, a problem within the gamma detector, the ratemeter, the interface, or the data logger.

3.3 Data Imaging

The GWS gamma data will be imaged using color contour plots and/or three-dimensional color plots of the data. These images will be correlated with site feature maps and/or overlaid onto aerial photographs to aid in interpretation.

Both will show the data relative to the background reference area and the local area derived background by plotting isopleths and/or color transitions to indicate the areas of interest by selecting transition points that illustrate the findings. The bases of these transitions may be:

- A multiple of the background (such as 2 times the mean of the background at the reference area, or mean of the background plus 1 standard deviation, plus 2 standard deviations, etc.).
- A multiple of a statistic of the local area data (such as mean value of the survey data plus 1 sigma, plus 2 sigma, plus 3 sigma, etc.).
- A division of the range of the data into an equal number of parts.

A Geographic Information System (GIS) will be used to manage the GWS data and to produce consolidated images of the individual surveys into a comprehensive GWS data map for the site.

4 Instrumentation

4.1 Soil and Pavement Surface Scanning

Instrumentation will be selected based on detection sensitivity to provide technically defensible results that meet the objectives of the survey. Consideration for instrument selection will include the detector field of view, gamma detection sensitivity, the potential for damaging the detector, and the ability to interface the instrument for automatic recording of data and position.

Table 4.1-1 is extracted from NUREG-1507, which presents the Scan Minimum Detectable Concentrations (MDCs) for some common radionuclides when using sodium iodide (NaI) detectors. This table provides a general indication of the detection capability of these instruments, which are one of the standard GWS instruments of choice. One or more of each of these instruments (or equivalent) will be used during the survey. **Section 8.2** and **Section 8.3** presents the preferred and alternative detectors, respectively, and **Attachment 5** shows examples of the equipment that will be used in this survey.

4.2 Selection of Instruments

Detector selection will depend on the survey to be performed, terrain, surface contour and survey area size. The preferred gamma scanning instrument has a wide detector FOV and it can be interfaced directly to a data logger for automatic recording of position with the corresponding gamma reading. **Attachment 3** includes the procedure for Performance of a GPS-based Gamma Walkover Survey.

The following SOPs, included in **Attachment 4**, provide supporting procedures for gamma scanning activities:

- SOP 1, Portable Detection Equipment
- SOP 6, General Radiological Equipment Checklist

4.3 Instrument Calibration

All standard instruments shall be calibrated by a qualified calibration/repair facility at least annually in accordance with manufacturers' instructions. Sources used in calibration will be National Institute of Standards and Technology-traceable. The large area detectors require special calibration and will be calibrated by the Health Physicist. A calibration certificate or report will be maintained on-site for each instrument and included in the project final report. See SOP 1, Portable Detection Equipment in **Attachment 4**.

Each instrument shall be checked at the beginning, middle, and end of each shift with check sources to verify that its response is within ± 20 percent of the value established by the calibration laboratory for that instrument/check source/geometry combination. If the instrument fails the post-survey source check, all data collected during that time period with the instrument must be reviewed and adjusted or discarded as appropriate. The affected data shall be flagged and later studied by the HP or equivalent to determine if they are useable.

Each item of survey equipment shall meet function response requirements before and during its use. Control charts shall be maintained to monitor the performance of field instruments for the duration

of the project in accordance with SOP 1 in **Attachment 4**. If survey equipment requires repair during a workday, it shall be repaired and its proper function verified before it is returned to use.

5 Minimum Detectable Concentrations

The following sections describe how the Minimum Detectable Concentrations (MDCs) will be determined for field equipment. These determinations can be made to support quantitative evaluation of the results given a number of restrictive assumptions on the nature and extent of the radioisotopes within the surface soils. However, since the use of gross counting gamma detectors precludes isotopic identification and the concentration of the MED/AEC materials is known to be highly variable at different locations across the Guterl Steel site, the practical use of the GWS data is typically limited to qualitative analysis by comparison of the gross counting results to that from the surrounding local area data and/or the reference background area.

5.1 Scan Minimum Detectable Concentrations

The minimum detectable concentration of a scan survey (scan MDC) depends on the intrinsic characteristics of the detector (such as efficiency and physical probe area), the nature (type, abundance, and energy) of emissions, the relative distribution of the potential contamination (point versus distributed source and depth of contamination), scan rate, and personal characteristics of the surveyor. *MARSSIM* Section 6.7.2.1 discusses the basis for estimating scanning MDCs and arrives at the following equation for scan MDC:

$$\text{Scan MDC} = \frac{\text{MDCR}}{\sqrt{p A \varepsilon_i \varepsilon_s}} \times \frac{100 \text{ cm}^2}{100 \text{ cm}^2}$$

MDCR is the minimum detectable count rate (interpolated from *MARSSIM* Table 6.6), and p is surveyor efficiency (assumed to be 0.5), A is the effective area of the probe, ε_i is the instrument or detector efficiency, and $\varepsilon_s = 0.5$ is the efficiency of the contamination source. The final factor, which equals 1, helps put the units of scan MDC into dpm/100 cm².

An overview of the approach used to determine scan MDCs for land areas that is taken from this section in *MARSSIM* follows.

“The NaI(Tl) scintillation detector background level and scan rate (observation interval) are postulated, and the MDCR for the ideal observer, for a given level of performance, is obtained. After a surveyor efficiency is selected, the relationship between the surveyor MDCR (MDCR_{surveyor}) and the radionuclide concentration in soil (in Bq/kg or pCi/g) is determined. This correlation requires two steps — first, the relationship between the detector’s net count rate to net exposure rate (cpm per μR/h) is established, and second, the relationship between the radionuclide contamination and exposure rate is determined.

For a particular gamma energy, the relationship of NaI(Tl) scintillation detector count rate and exposure rate may be determined analytically (in cpm per μR/h). The approach used to determine the gamma fluence rate necessary to yield a fixed exposure rate (1 μR/h) — as a function of gamma energy — is provided in NUREG-1507 (NRC, 1997b). The NaI(Tl) scintillation detector response (cpm) is related to the fluence rate at specific energies, considering the detector’s efficiency (probability of interaction) at each energy. From this, the NaI(Tl) scintillation detector versus exposure rates for varying gamma energies is determined. Once the relationship between the NaI(Tl) scintillation detector response (cpm) and the exposure rate is established, the MDCR_{surveyor} (in cpm) of the NaI(Tl) scintillation detector can be related to the minimum detectable net exposure rate. The

minimum detectable exposure rate is used to determine the minimum detectable radionuclide concentration (i.e., the scan MDC) by modeling a specified small area of elevated activity.

Modeling (using MicroshieldTM) of the small area of elevated activity (soil concentration) is used to determine the net exposure rate produced by a radionuclide concentration at a distance 10 cm above the source. This position is selected because it relates to the average height of the NaI(Tl) scintillation detector above the ground during scanning.

The factors considered in the modeling include:

- radionuclide of interest (considering all gamma emitters for decay chains)
- expected concentration of the radionuclide of interest
- areal dimensions of the area of elevated activity
- depth of the area of elevated activity
- location of dose point (NaI(Tl) scintillation detector height above the surface)
- density of soil

Modeling analyses are conducted by selecting a radionuclide (or radioactive material decay series) and then varying the concentration of the contamination. The other factors are held constant—the areal dimension of a cylindrical area of elevated activity is 0.25 m² (radius of 28cm), the depth of the area of elevated activity is 15 cm, the dose point is 10 cm above the surface, and the density of soil is 1.6 g/cm³. The objective is to determine the radionuclide concentration that is correlated to the minimum detectable net exposure rate.” (MARSSIM, 2000)

Given the wide variation in COPC mixtures and concentrations across the areas of interest and the uncertainty in the source term conditions, it is not possible to calculate a Scan MDC that will have universal application for the Guterl Steel site. The Scan MDC is subject to understanding or assuming the source term parameters noted above.

5.2 Static Minimum Detectable Concentrations

Static counts will be made during the daily response checks. Additional static counts may also be taken in order to correlate scanning data to static data on areas of interest. According to *MARSSIM*, the critical level (L_C) is the level, in counts, at which there is a 5 percent statistical probability of incorrectly identifying a measurement system background value as greater than background. Any response above this level is considered to be greater than background. The detection limit (L_D) is an *a priori* estimate of the detection capability of a measurement system and is also reported in units of counts. The MDC is the detection limit (counts) multiplied by an appropriate conversion factor to give units consistent with a site guideline, such as pCi/g or dpm/100 cm². In other words, the MDC is the *a priori* net activity level above the critical level that an instrument can be expected to detect 95 percent of the time.

6 Scan Investigation Levels

The data gap analysis process found that the radioactive constituents of potential concern (COPCs) at the Guterl Steel site are uranium (^{238}U , ^{235}U , and ^{234}U) and thorium (^{232}Th). **Table 6-1** presents acceptable surface contamination levels for these COPCs. The DGAR indicates that uranium concentrations vary widely across the areas of interest and are generally much greater than thorium concentrations at the Guterl Steel site, but not always.

Provisional radiological screening values for use during the preliminary stages of the characterization survey were also established during the data gap analysis. They are discussed in detail in Section 2.6 of the DGAR. These values, which are thought to be conservative, will be used to identify potentially impacted areas during the characterization survey and to guide the characterization field sampling activities. **Table 6-2** presents the provisional soil screening values (above local natural background) for the COPCs.

The gross gamma counting field instruments that are proposed for conduct of the GWS are routinely used to conduct gamma scanning surveys in order to identify the presence of near surface concentrations of radioactive materials and are generally considered as industry standards. The identification of elevated locations is typically performed by comparing the gamma scanning count rate from an area of interest to the mean count rate from a representative non-impacted background reference area. Once representative source term parameters are determined from the characterization field sampling data, the scan MDCs for the GWS will be determined for evaluation of possible correlations between the elevated indications and near-surface COPC concentrations.

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7 Reference Area Background Determination

A GWS will be conducted at a background reference area in order to document the GWS data collection at an area that is not impacted. This data will be reviewed to evaluate the statistical variation of the data at a non-impacted area for subsequent comparison to and evaluation of the GWS data.

For the purposes of a final status survey, *MARSSIM* defines the background reference area as a geographical area in which representative reference measurements are performed for comparison with measurements performed in specific survey units. The background reference area will have similar physical, chemical, radiological, and biological characteristics as the areas being investigated but has not been contaminated by site activities (that is, it is non-impacted).

MARSSIM allows the land area of a Class 1 survey unit for a final status survey to be up to 2,000 m². The corresponding background reference area should have about the same area as the survey unit. However, for the Guterl Steel site GWS, the background reference will be set to at least 900 m² for the following reasons:

- The present survey is not a final status survey.
- This area, comprising the equivalent of two and one-half 20 meter x 20 meter grids, should be sufficient to demonstrate the mean and variance in the background data for the each of the planned survey protocols.
- The GWS methods use gross counting instruments that measure all gamma photon energies. Due to the potential for different mixtures of radioisotopes and the associated variance in gamma energies, the GWS data is intended for qualitative, rather than quantitative, evaluation. The GWS data from the Guterl Steel site will initially be evaluated qualitatively to identify areas of elevated gamma activity for further investigation based primarily on comparison of each survey measurement to the adjacent measurements made in the immediate surrounding areas. At this stage of the characterization survey, the reference to the background reference area is an important but secondary issue that will be used to compare the GWS data to that collected in a known non-impacted area.

Therefore, the background reference area for background soil samples and background radiation measurements will have an area of at least 900 m² and will be surveyed as if it were a Class 1, Class 2, and Class 3 area in order to obtain data that demonstrates the variance in the background gamma radiation levels for each of the planned survey protocols. This information will be used for comparison with the GWS data from the Guterl Steel site.

The proposed background reference area is shown in **Figure 7-1**.

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8 Survey Methods

8.1 Gamma Walkover Survey Protocol

The GWS protocol for the Guterl Steel site includes:

- A surveyor walking rate at no more than 0.5 m/s.
- Using either a push cart mounted gamma detector assembly that is fixed at a height near the ground surface with a FOV that is at least 1 m wide or a man-carried gamma detector that is slowly scanned near the ground surface back and forth across the path of the surveyor to create a 1 m wide scanning pattern.
- Recording the surveyor position and detector data recording at 1 hertz, thereby producing 2 data records for each meter of surveyor path.

The baseline GWS protocol is intended to be consistent with the basic concepts that are specified for the conduct of scanning surveys in the FSP, which is based on the scanning survey coverage recommended in *MARSSIM*. Accordingly, the baseline GWS specifies the following survey coverage based on the recommendations shown in *MARSSIM* Table 2 and as presented in more detail in **Section 8.4**:

- Class 3 areas at 7% coverage with locations selected based on professional judgment and the survey objectives
- Class 2 areas at 25% coverage on a parallel pattern of survey lanes at 4 meter centers
- Class 1 areas at 100% coverage on a parallel pattern of survey lanes at 1 meter centers
- Flexible application of the area classification with intent to upgrade or downgrade these classifications as necessary, based on the observational findings, in order to achieve the desired survey quality using the most cost-effective methods

The value of 7% for the Class 3 area is planned to assure the collection of sufficient data over a 400 m² area to allow a comparison to the scanning survey data from a non-impacted area and support a decision that an area is either potentially impacted or not impacted based on the mean of survey data, with a confidence interval for the scanning survey data of at least 95%. It is also generally consistent with the scanning survey protocol in the FSP for Class 3 areas, which is specified at 6.3%. The 7% scanning survey coverage is illustrated and discussed in **Section 8.4.1**.

MARSSIM allows some flexibility in the selection of the survey coverage for Class 2 and Class 3 areas based on professional judgment and survey objectives. *MARSSIM* Table 2 recommends systematic and judgmental scanning survey coverage for Class 2 land areas at between 10 and 100%. The specified 25% scanning survey coverage for Class 2 areas is specified here because it is thought to be sufficient to identify contiguous areas of elevated gamma levels having dimensions in the direction perpendicular to the surveyor path that are in excess of 3 meters. This protocol should be sufficient to identify the findings shown in Figure 36 of the ORISE 1999 survey and should provide more accurate information on the spatial extent of the findings (ORISE, 1999). The basis for the 25% coverage is detailed further in **Section 8.4.2**.

MARSSIM specifies 100% scanning surveys for all Class 1 areas. The basis for the specified coverage and survey protocol is detailed in **Section 8.4.3**.

This GWS plan has been developed to accommodate a modification of either increased or decreased coverage pending daily data review and USACE guidance. Any decision to increase or decrease the survey coverage will be determined in consultation with USACE.

Although the baseline GWS protocol is consistent with the scanning survey concepts in the FSP (USACE, 2006c), there may be a benefit for performing a 100% survey throughout the site at the characterization stage. A comparative level-of-effort discussion for both the baseline GWS and a comprehensive GWS is presented in Section 9.

8.2 Preferred Method

The preferred survey method is to use GPS positioning with a 0.71 meter wide, cart-mounted Bismuth Germinate (BGO) plastic scintillation detector with the detector output directly interfaced to the GPS data logger for automatic recording at 1 hertz. This GWS system offers the best productivity and can achieve true 100% survey coverage.

This detector will provide a field of view that is approximately 1 meter wide in the direction of the survey path. For consistency with the use of the *MARSSIM* guidance, the percent of survey coverage is determined by the actual area scanned by the instrument, which is directly dependent on the detector's field of view and the surveyor scanning protocol. Accordingly, a detector with a field of view of less than 1 meter will require a proportionately greater time to provide the same scanning survey coverage for a given detector scan speed.

This preferred GPS-based GWS procedure is detailed in **Attachment 3**.

8.3 Alternative Methods

There are many conditions at the Guterl Steel site where the preferred method will not be useable due to interference with the GPS accuracy, limitations to access, and the potential for injury to personnel or damage to the instrumentation. The alternative methods for consideration, in order of preference, include:

1. Modes of operation
 - a. Man-carried
2. Positioning systems
 - a. Total station
 - b. Laser range finder
 - c. Ultrasonic range finder
 - d. Measuring Tapes
3. Gamma scanning detectors
 - a. 15 cm diameter BGO
 - b. 2 inch x 2 inch (5 cm by 5 cm) NaI
 - c. FIDLER
4. Data recording methods
 - a. Hand-held PC interfaced to the gamma instrument for automated recording

- b. Hand-held PC interfaced to the gamma instrument for on-demand recording
- c. Survey forms for manual recording

These alternative methods can be combined as desired to overcome a given issue that prevents use of the preferred method and still achieve the desired survey objective. For example, the laser range finder can be substituted for the GPS system where the GPS location accuracy is not acceptable. Or the 15 cm diameter BGO detector can be substituted for the 0.7 meter wide BGO when the push-cart cannot be used due to terrain or vegetation. The hand-held PC can be substituted for the GPS data logger when GPS is not able to be used.

For the worst case conditions, the ultimate flexibility provided by manual methods may be required. In some cases, the manual approach is the most expedient solution, considering the tradeoff between the benefit and the cost of alternatives.

For whichever alternative is selected to accomplish the survey objective, when automated data logging can be used, refer to **Attachment 3** for the general instructions on conducting the procedure.

8.4 Survey Coverage

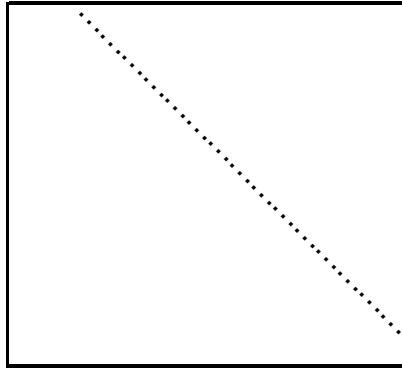
The specified survey area coverage has a corresponding impact on the data density, which in turn has a corresponding level of uncertainty for detection of a given size area of elevated gamma radiation. It also directly affects the level of effort (LOE). The area survey protocol and coverage for the GWS shown in **Section 8.1** is specified to meet the survey objectives for identification of areas with gamma radiation levels in excess of background levels. It is also intended to allow flexible application of the survey classification at this stage in order to use field observation and the review of survey data imaging to increase the data density where additional definition of boundary conditions is desired and to possibly decrease the data density where it is apparent that the initial data density is not warranted.

To demonstrate the data density associated with the proposed survey coverage and to consider the impacts, the following GWS survey coverage rates are discussed below:

- 100% for Class 1 (10 lanes east-west or north-south, on 1 meter centers)
- 25% for Class 2 (5 lanes east-west or north-south, on 4 meter centers)
- 7% for Class 3 (one diagonal pass across opposite corners of a 20 meter by 20 meter grid)

The discussion and three illustrations that follow illustrate the different data densities in a 20 m x 20 m grid that result from using the above survey protocol to achieve 7%, 25%, and 100% survey coverage.

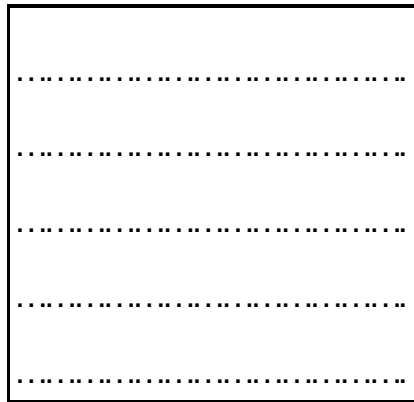
8.4.1 Survey Coverage at 7%



Survey data density for a 7% coverage survey
(1 diagonal pass through a 20 m x 20 m grid)

This illustration shows the data density in a 20 m x 20 m grid that is produced from a 7% coverage survey (a diagonal pass through the grid approximately crossing opposite corners). This is the proposed data density for the Guterl Steel site GWS at Class 3 areas. An image of a diagonal pass from one corner to the opposite corner will have approximately 56 dots, representing the 2 data locations per meter over the 28.3 m long path. The 1 m wide scanning survey width produces a 28 m² wide survey pattern per 400 m² grid, or 7% survey coverage. The average data density with this survey protocol (7% coverage) is 1 diagonal path x 56 data points per path in 400 m², or approximately 1 data point per each 7 m² (or approximately 0.14 data point/m²).

8.4.2 Survey Coverage at 25%



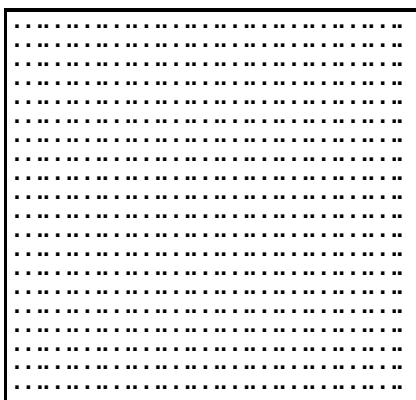
Survey data density from a 25% coverage survey
(5 lanes east-west or north-south, on 4 meter centers)

This illustration shows the data density in a 20 m x 20 m grid that is produced from a 25% coverage survey (5 lanes east-west or north-south, on 4 meter centers). This is the proposed data density for the Guterl Steel site GWS at Class 2 areas. Each of the lanes shows 40 dots, representing the 2 data locations per meter over the 20 m long lane. The 1 m wide scanning survey width produces a 20 m² per lane times 5 lanes per 400 m² grid, or 25% survey coverage. The average data density with this

survey protocol (25% coverage) is 5 lanes x 40 data points per lane in 400 m², or 1 data point per each 2 m² (0.5 data point/m²).

Since the 1 m wide survey scan extends 0.5 m into each adjacent lane, this survey coverage should be able to detect a 3 m wide area centered between the lanes. However, it is possible that a 2 m wide area that is centered between adjacent lanes might not be detected. It is even conceivable, although unlikely, that such an area lying parallel to the lanes could extend across the entire area without limit. At the Guterl Steel site, the cause of most of the elevated gamma readings in exterior areas appears to be due to unintentional dispersals or casual disposals. These are thought to result from tracking contamination, spilling material during handling and transport, and disposing of waste that was contaminated with MED/AEC materials. Prior surveys indicate that the exterior areas with MED/AEC materials are generally found at the site either as very small localized pieces or fairly large volumetric distributions of unconsolidated materials. Neither of these was found to be confined to uniform linear shapes.

8.4.3 Survey Coverage at 100%



Survey data density from a 100% coverage survey
(20 lanes east-west or north-south, on 1 meter centers)

This illustrates the data density for a 100% coverage survey. The planned 100% survey coverage with a cart-mounted detector that has a 1 m wide FOV will result in an actual area surveyed that is 100% of the area. If a man-carried detector is used that has a 0.3 m diameter FOV, the side to side scanning to achieve a 1 meter survey scan width should locate elevated gamma readings from any areas that are equal to or greater than 0.25 m².

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9 Period of Performance and Schedule

9.1 Level of Effort

9.1.1 Baseline GWS

The actual field survey area for the conduct of the baseline GWS, as shown in Figure 2-1, is estimated at a total of 85,677 m² without contingency. The basis for the estimated level of effort is shown in **Table 9.1.1-1**.

9.1.2 Comprehensive GWS

The actual field survey area for the conduct of the comprehensive GWS, assuming a change to the baseline GWS to include 100% coverage for the entire site, is estimated at a total of 280,552 m² without contingency. The basis for the estimated level of effort is shown in **Table 9.1.2-1**.

9.2 Schedule Elements

The major schedule elements to be considered include, in general order of sequence:

Activity:	Estimated Duration:
Site-specific Training	3 days
Setup Site Infrastructure	5 days
Site Clearing	4 days
Civil Survey Activities	7 days
Gamma Walkover Survey (baseline)	8 days
Gamma Walkover Survey (comprehensive) (Optional)	24 days
Final Reporting	20 days

The durations presented are estimates, and do not include contingency for unforeseen items, survey coverage adjustments (up or down), crew number and size, weather delays, etc. Field mobilization would be coordinated to occur simultaneously with the FSP mobilization to take advantage of site infrastructure arrangements for that program. Civil surveys established for the GWS program would be designed to be useful for the FSP program, as well.

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10 References

- New York State Department of Environmental Conservation (NYSDEC), 1994. Engineering Investigations at Inactive Hazardous Waste Sites – Preliminary Site Assessment, Task 3 – Evaluation of Initial Data. Volumes I and II. Guterl Specialty Steel, City of Lockport, Niagara County. Prepared for NYSDEC by ABB Environmental Services, Portland, ME. April.
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- US Nuclear Regulatory Commission (NRC), 1998. Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. NUREG 1507. June.

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TABLES

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Table 4.1-1

Final Gamma Walkover Survey Plan
Former Guterl Specialty Steel FUSRAP Site

2"x 2" NaI Scintillation Detector Scan MDC for Uranium and Thorium

Radionuclide/Radioactive Material	Scan MDC (pCi/g)	Weighted cpm/μR/h
Th-232 decay series (sum of all radionuclides in thorium decay series, in equilibrium)	18.3	830
Processed Natural Uranium (U-238, U- 235, and U-234)	80.0	3,990

Notes:

1. The background for the 2x2 NaI detector is assumed to be 10,000 cpm. The observation interval was 1 second and the level of performance was selected to yield d' of 1.38.
2. Referenced from NUREG-1507 Table 6.4.

Table 6-1

Final Gamma Walkover Survey Plan
Former Guterl Specialty Steel FUSRAP Site

Acceptable Surface Contamination Levels

<i>Nuclide^a</i>	<i>Average (dpm/100 cm²)^{b c}</i>	<i>Maximum (dpm/100 cm²)^{b d}</i>	<i>Removable (dpm/100 cm²)^{b e}</i>
Natural U, ²³⁵ U, ²³⁸ U and associated decay products	5,000	15,000	1,000
Natural Th, ²³² Th	1,000	3,000	200

^a Where surface contamination by both alpha- and beta/gamma-emitting nuclides exists, the limits established for alpha- and beta/gamma-emitting nuclides should apply independently.

^b As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive materials as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency and geometric factors associated with the instrumentation.

^c Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each object.

^d The maximum contamination level applies to an area of not more than 100 cm².

^e The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Table 6-2

Final Gamma Walkover Survey Plan
Former Guterl Specialty Steel FUSRAP Site

Soil Screening Levels (above local natural background) for the COPCs

<i>Nuclide</i>	<i>Soil Concentration (pCi/g)</i>
²³⁸ U	14
²³⁵ U	8
²³⁴ U	13
²³² Th	1.1

Table 9.1.1-1

Final Gamma Walkover Survey Plan
Former Guterl Specialty Steel FUSRAP Site

**Estimated Level of Effort for the Conduct of the Baseline GWS
at the Guterl Steel Site (survey coverage consistent with the scanning survey
concepts in the FSP)**

Survey Area Classification Survey Coverage		Class 1 100 %	Class 2 25 %	Class 3 6.3 %	Total
Investigative Area (IA)					
Number	Name				
IA 01	Excised Area - Buildings (including Bldg 24)	NA	NA	NA	0
IA 02	Excised Area - Exterior Areas (Soils)	16000	0	0	16000
IA 03	Landfill Area	0	36500	0	36500
IA 04	NCIDA Area	0	199000	0	199000
IA 05	Railroad ROW North	0	24300	0	24300
IA 06	Off-Site NE Tracts	NA	NA	NA	0
IA 07	Groundwater (site- wide)	NA	NA	NA	0
IA 08	Site Utilities (Sewers, drains)	NA	NA	NA	0
Other	Background Reference Area ⁽¹⁾	3600	3600	3600	10800
Summary					
Total Estimated Site Area (m ²)		19600	263400	3600	286600
Above Total x % Coverage = Actual Survey Area (m ²)		19600	65850	227	85677

Notes:

1. The background reference area is assumed to be 30 m x 30 m = 900 m². The background reference area will be surveyed by each of the possible gamma scanning instruments (1 preferred and 3 alternates) in accordance with the specified survey protocol and for each specified survey coverage. This makes the effective total background reference area equal to 3600 m².

Table 9.1.2-1

Final Gamma Walkover Survey Plan
Former Guterl Specialty Steel FUSRAP Site

**Estimated Level of Effort for the Conduct of the Comprehensive GWS
at the Guterl Steel Site (100% coverage for all Class 1, 2 and 3 areas)**

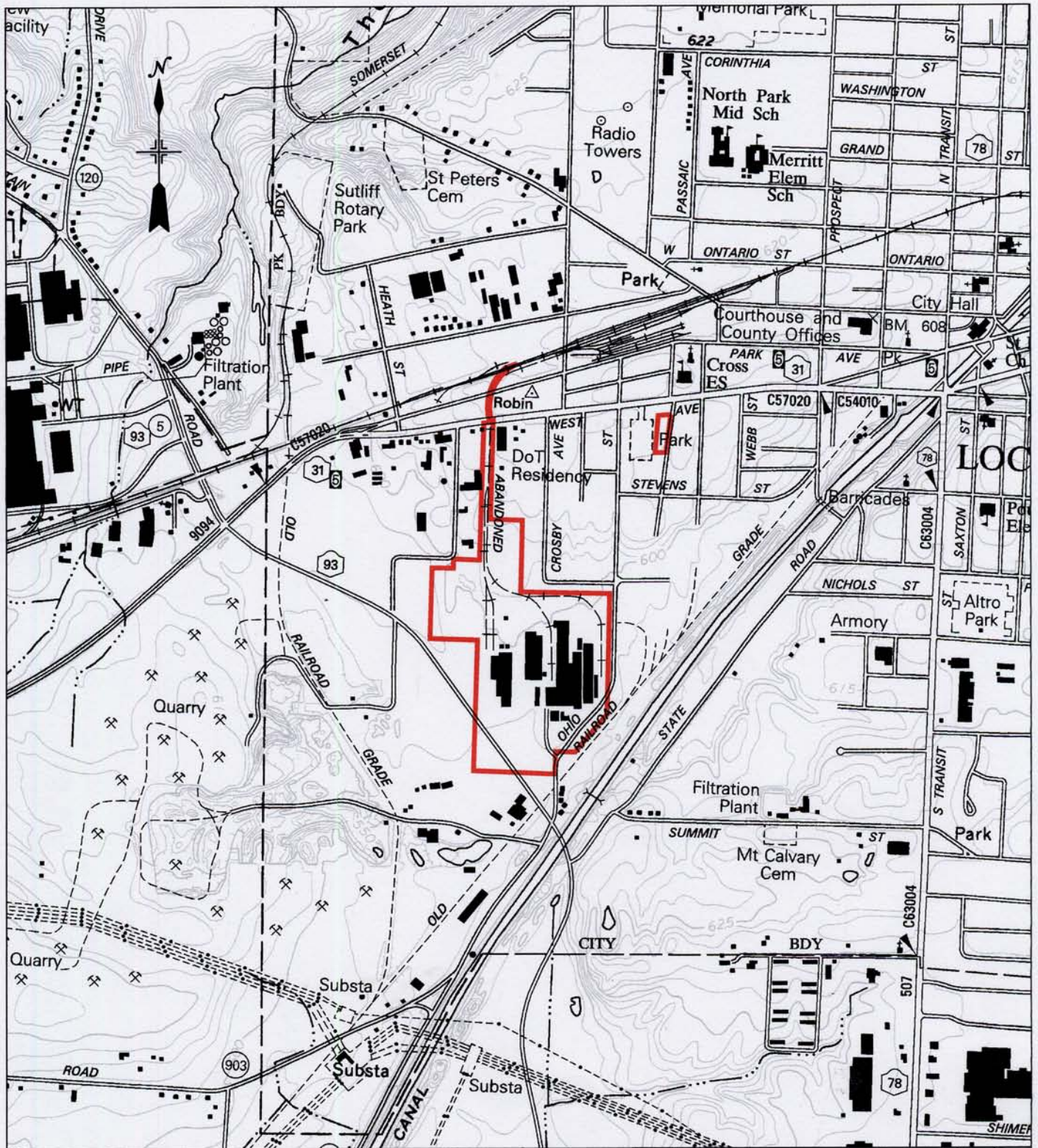
Survey Area Classification		Class 1	Class 2	Class 3	Total
Survey Coverage		100%	100%	100%	
Investigative Area (IA)					
Number	Name				
IA 01	Excised Area - Buildings (including Bldg 24)	NA	NA	NA	0
IA 02	Excised Area - Exterior Areas (Soils)	16000	0	0	16000
IA 03	Landfill Area	0	36500	0	36500
IA 04	NCIDA Area	0	199000	0	199000
IA 05	Railroad ROW North	0	24300	0	24300
IA 06	Off-Site NE Tracts	NA	NA	NA	0
IA 07	Groundwater (site-wide)	NA	NA	NA	0
IA 08	Site Utilities (Sewers, drains)	NA	NA	NA	0
Other	Background Reference Area	3600	900	252	4752
Summary					
Total Estimated Site Area (m ²)		19600	260700	252	280552
Above Total x % Coverage = Actual Survey Area (m ²)		19600	260700	252	280552

Notes:

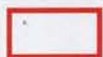
- The background reference area is assumed to be 30 m x 30 m = 900 m². The background reference area will be surveyed by each of the possible gamma scanning instruments (1 preferred and 3 alternates) in accordance with the specified survey protocol and for each specified survey coverage. This makes the effective total background reference area equal to 3600 m² for the Class 1 area, 900 m² for the Class 2 area, and 252 m² for the Class 3 area.

FIGURES

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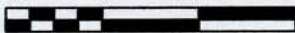


LEGEND



SITE LOCATION

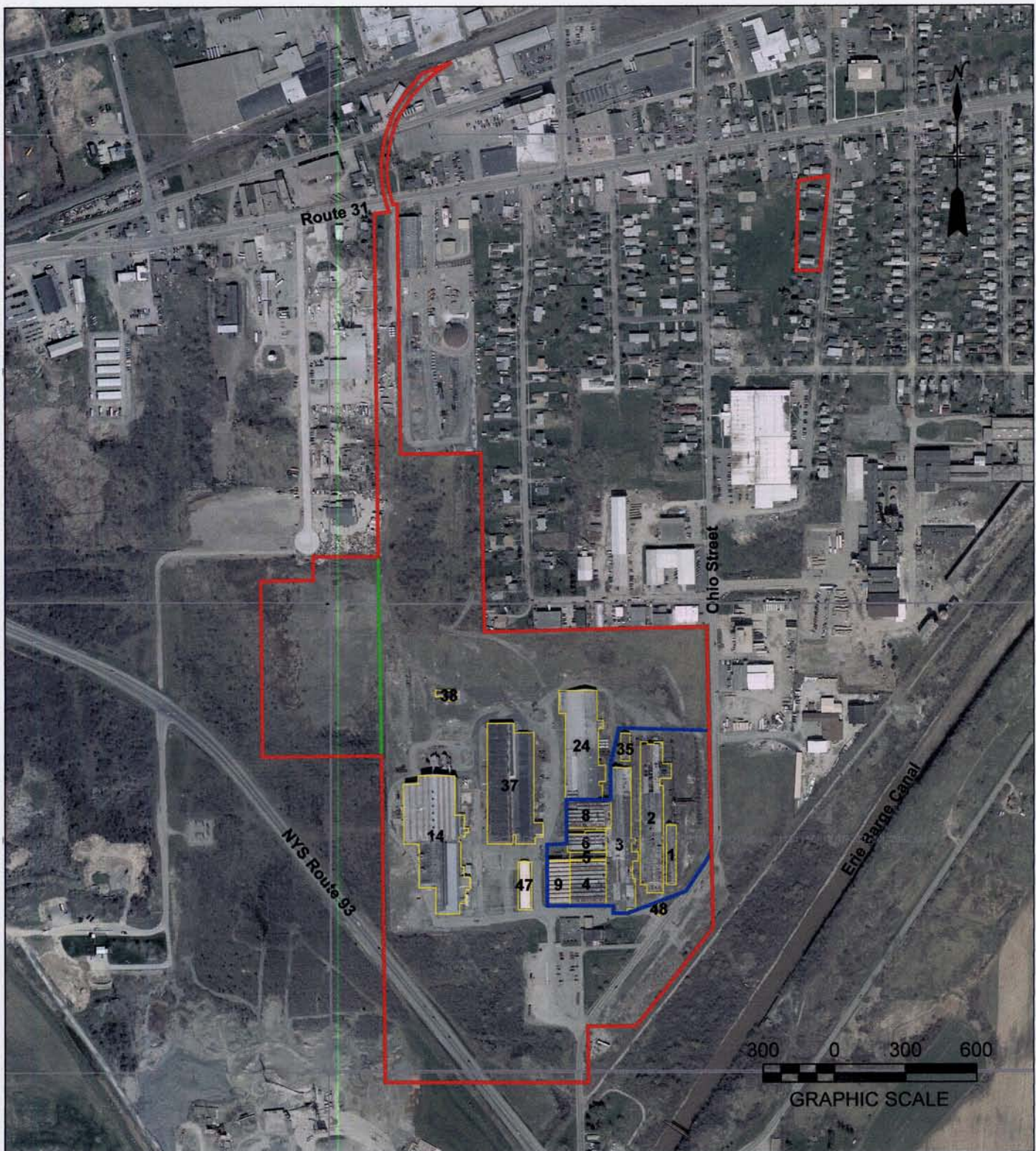
750 0 750 1500



GRAPHIC SCALE



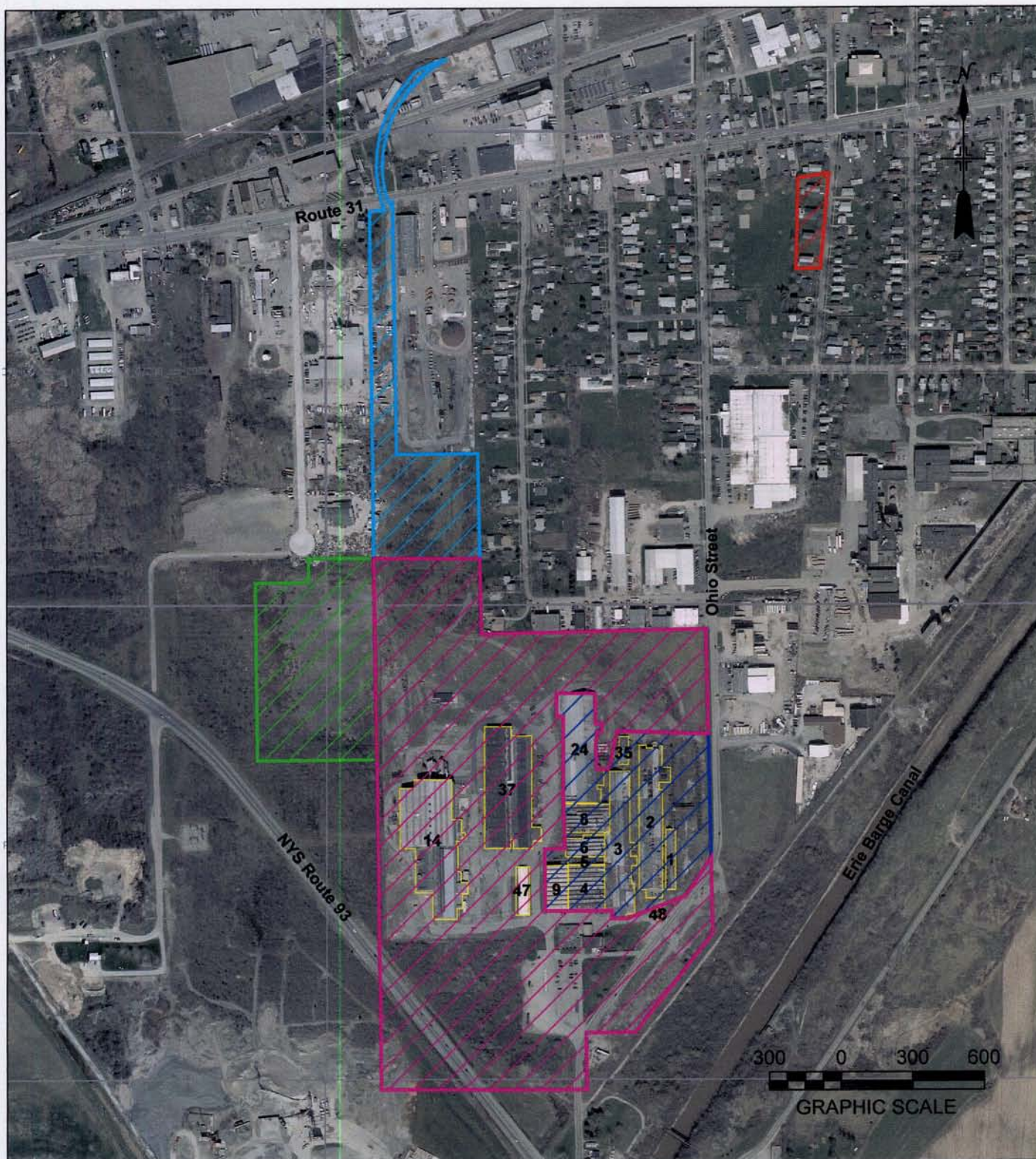
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		REVISIONS					
Prepared by :				Prepared for :			
DESIGNED BY :		DB		GUTERL SPECIALTY STEEL CORPORATION		LOCKPORT, N.Y.	
DRAWN BY :		DB		SITE LOCATION PLAN			
CHECKED BY :		JK					
SUBMITTED BY :		JK		DATE :		SCALE :	
				JUNE 8, 2006		AS SHOWN	
				DRAWING NO. :		FIGURE 1-1	



LEGEND

- Guterl Site Boundary
- Guterl Excised Boundary
- Guterl Landfill Boundary
- 24 Guterl Buildings

SYMBOL		DESCRIPTIONS		DATE		APPROVED	
		REVISIONS					
Prepared by: <small>A Tyco International Ltd. Company</small>		Prepared for: United States Army Corps of Engineers Buffalo District					
DESIGNED BY:		GUTERL SPECIALTY STEEL CORPORATION LOCKPORT, N.Y. DETAILED SITE PLAN					
DRAWN BY:							
CHECKED BY:							
SUBMITTED BY:		DATE:		SCALE:		DRAWING NO.:	
JK		JUNE 8, 2006		AS SHOWN		FIGURE 1.1-1	

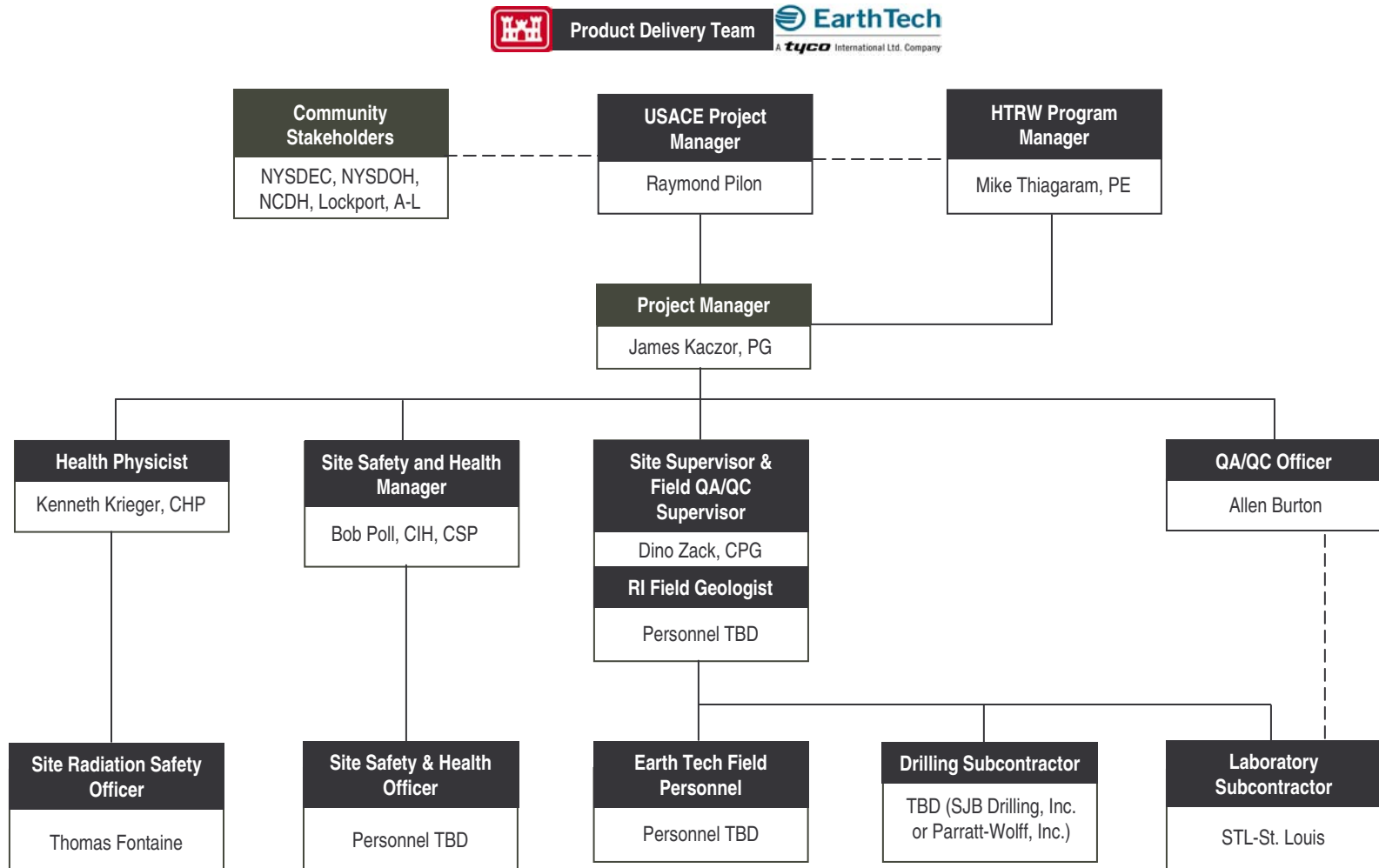


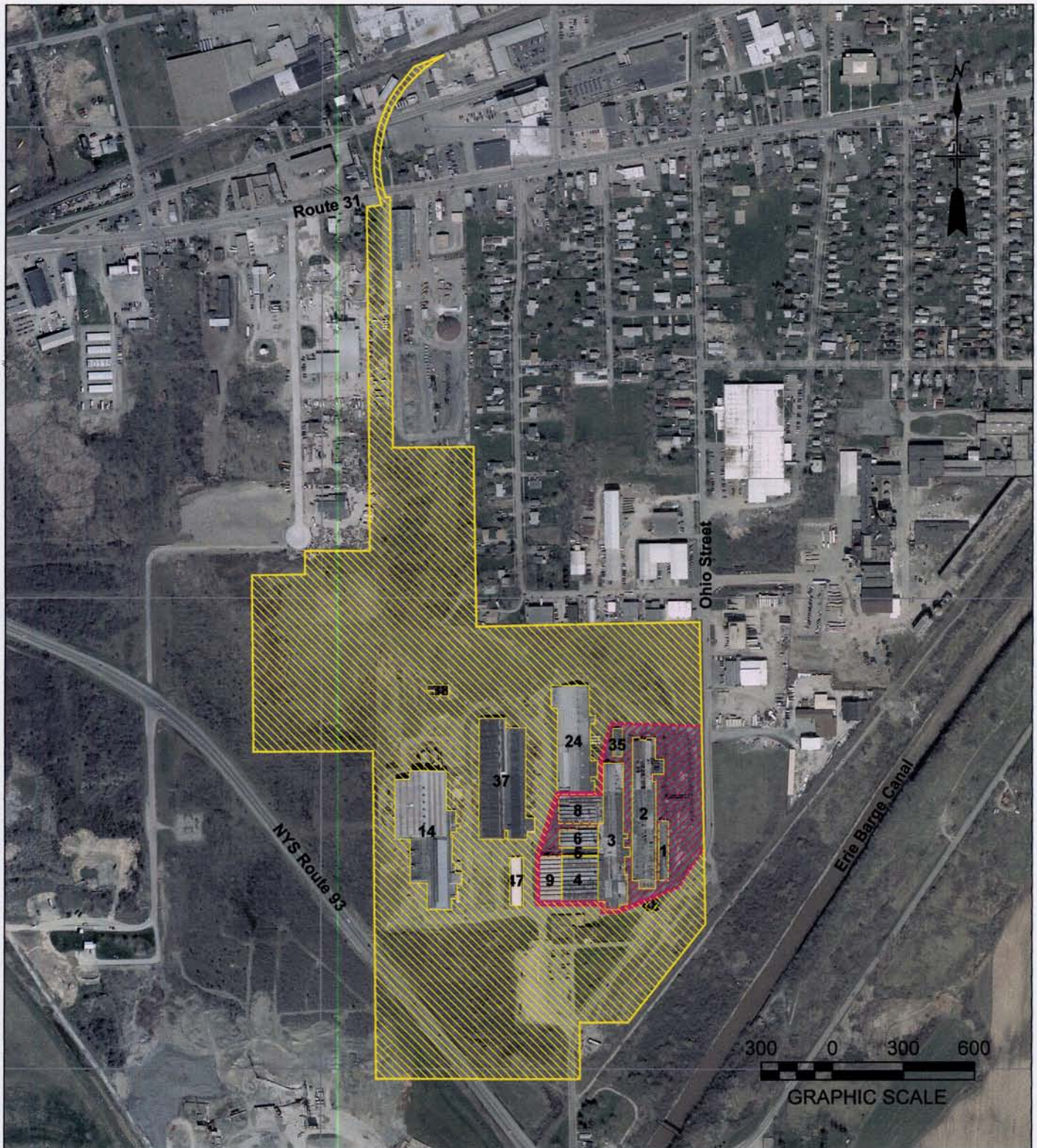
LEGEND

- 24** Gutert Buildings
- IA01 Excised Area - Building Surfaces and Interiors & IA02 Excised Area - Building Exteriors
- IA03 Landfill Area
- IA04 NCIDA Property
- IA05 Railroad Right-of-Way
- IA06 Off-site Northeast Properties
- IA07 Groundwater & IA08 Site Utilities includes all hatched areas.

SYMBOL		DESCRIPTIONS	DATE	APPROVED
		REVISIONS		
Prepared by:		Prepared for:		
EarthTech A Tyco International Ltd. Company		United States Army Corps of Engineers Buffalo District		
DESIGNED BY:	GUTERL SPECIALTY STEEL CORPORATION LOCKPORT, N.Y. INVESTIGATIVE AREAS			
DRAWN BY:				
CHECKED BY:				
SUBMITTED BY:	DATE:	SCALE:	DRAWING NO.:	
JK	JUNE 8, 2006	AS SHOWN	FIGURE 1.1-2	

Figure 1.2-1
Organization Chart
Former Guterl Specialty Steel Corporation FUSRAP Site
Lockport, New York





LEGEND

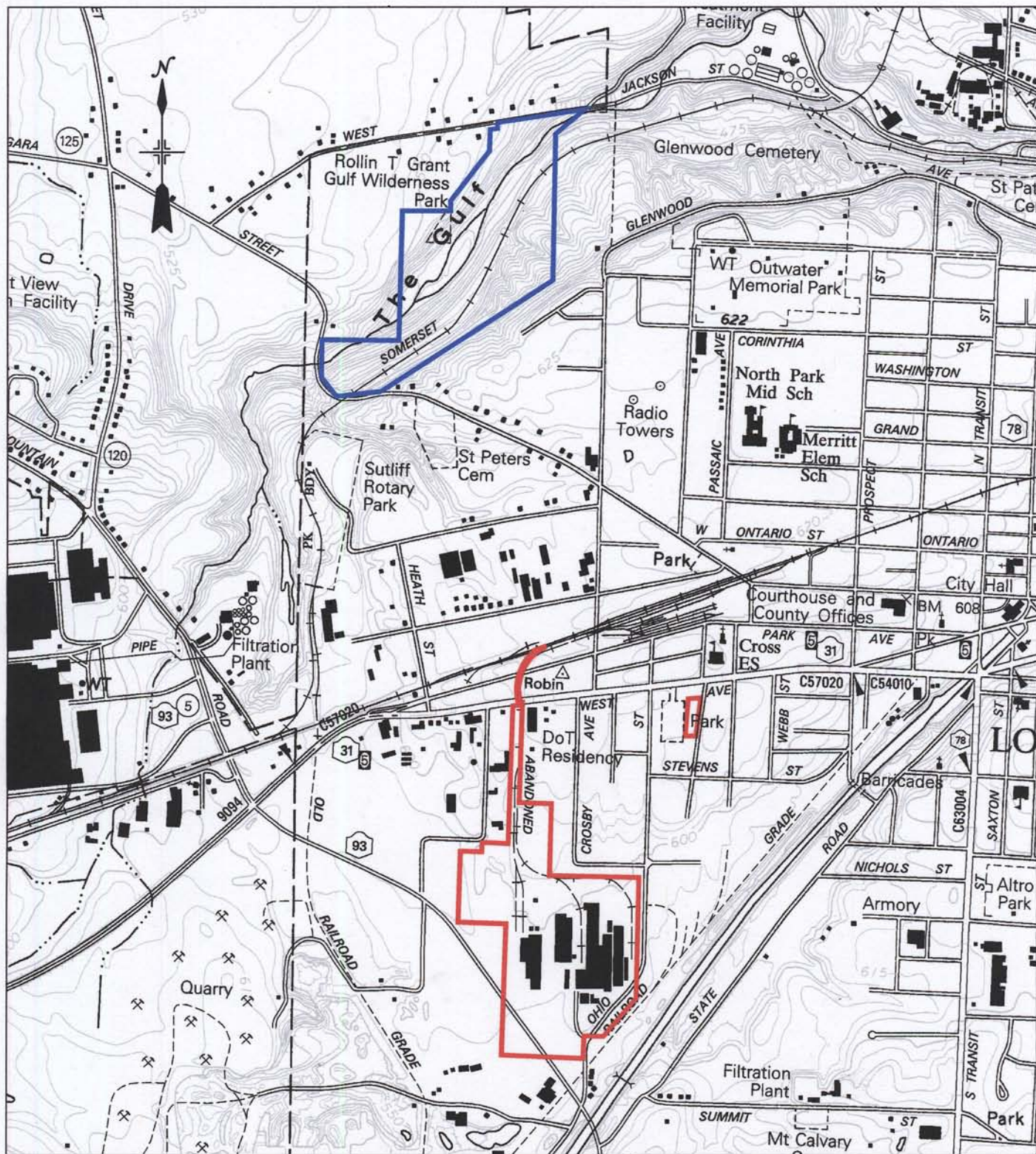


Class 1 Areas

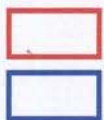


Class 2 Areas

SYMBOL		DESCRIPTIONS	DATE	APPROVED
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DESIGNED BY :		GUTERL SPECIALTY STEEL CORPORATION LOCKPORT, N.Y. Pre-GWS Area Classifications		
DRAWN BY :				
CHECKED BY :				
SUBMITTED BY :		DATE :	SCALE :	DRAWING NO. :
JK		JUNE 8, 2006	AS SHOWN	FIGURE 2-1



LEGEND



SITE LOCATION
BACKGROUND
SOIL SAMPLE
SITE LOCATION

750 0 750 1500

GRAPHIC SCALE



SYMBOL		DESCRIPTIONS		DATE		APPROVED	
		REVISIONS					
Prepared by:		EarthTech		Prepared for:		United States Army Corps of Engineers Buffalo District	
DESIGNED BY:		DB		GUTERL SPECIALTY STEEL CORPORATION LOCKPORT, N.Y.			
DRAWN BY:		DB					
CHECKED BY:		JK					
SUBMITTED BY:		JK		DATE:		SCALE:	
				JUNE 8, 2006		AS SHOWN	
						DRAWING NO.: FIGURE 7-1	

ATTACHMENTS

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ATTACHMENT 1

Referenced Data Tables from Prior Investigations

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TABLE 13

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
0N, 0E	987	< 0.2	0.5 ± 0.2 ^b	< 0.3	< 8.3 (4.3 ± 1.1) ^c
5N, 125E	921	0.2 ± 0.1	< 0.5	< 0.3	< 7.1 (1.6 ± 0.9)
5N, 145E	900	0.2 ± 0.1	< 0.2	< 0.2	< 4.8 (0.4 ± 0.6)
15N, 155E	907	< 0.3	< 0.4	< 0.4	< 8.0 (1.6 ± 1.0)
15N, 165E	825	0.8 ± 0.2	1.0 ± 0.3	< 0.4	< 6.0 (2.1 ± 1.3)
20N, 122E	728	< 0.1	< 0.3	< 0.2	< 4.6 (0.5 ± 0.7)
25N, 175E	759	0.8 ± 0.2	0.7 ± 0.3	< 0.3	< 7.7 (1.4 ± 1.2)
35N, 155E	850	0.3 ± 0.1	0.3 ± 0.1	< 0.2	< 6.0 (2.8 ± 0.8)
35N, 175E	1164	0.1 ± 0.1	< 0.2	< 0.1	< 2.4 (< 0.5)
35N, 185E	867	< 0.2	< 0.3	< 0.2	< 6.2 (0.6 ± 0.7)
40N, 0E	939	< 0.1	< 0.1	< 0.1	< 2.4 (< 0.5)
40N, 122E	1141	< 0.1	< 0.3	0.2 ± 0.2	< 5.5 (1.3 ± 0.5)
45N, 185E	775	0.6 ± 0.1	< 0.4	< 0.2	< 8.6 (3.1 ± 1.1)
45N, 195E	939	0.4 ± 0.1	< 0.4	< 0.3	< 7.8 (1.3 ± 1.0)
55N, 155E	790	0.6 ± 0.1	1.2 ± 0.3	0.6 ± 0.3	< 9.2 (6.4 ± 1.6)
55N, 175E	880	0.5 ± 0.1	< 0.3	0.2 ± 0.2	< 5.0 (2.2 ± 0.8)
55N, 185E	936	0.6 ± 0.1	0.6 ± 0.2	< 0.2	< 4.4 (2.0 ± 0.7)
55N, 195E	792	0.7 ± 0.1	0.9 ± 0.2	< 0.2	< 5.9 (1.8 ± 1.0)
60N, 124E	877	0.4 ± 0.1	< 0.4	0.5 ± 0.4	6.5 ± 4.0
65N, 5E	1214	< 0.1	0.2 ± 0.1	< 0.2	< 5.8 (1.2 ± 0.7)
65N, 25E	856	0.2 ± 0.1	0.4 ± 0.1	0.2 ± 0.2	6.4 ± 2.6
65N, 185E	796	0.7 ± 0.2	0.8 ± 0.2	< 0.3	< 9.3 (3.4 ± 1.2)
65N, 195E	1077	0.4 ± 0.1	0.5 ± 0.2	< 0.2	4.3 ± 3.1
70N, 45E	789	0.5 ± 0.2	1.3 ± 0.3	1.1 ± 0.4	24.8 ± 9.6
75N, 15E	1230	0.2 ± 0.1	0.4 ± 0.1	0.4 ± 0.2	9.2 ± 3.8
75N, 155E	831	< 0.3	1.0 ± 0.3	0.7 ± 0.4	9.2 ± 6.9
75N, 175E	1086	0.6 ± 0.1	< 0.3	< 0.2	< 4.5 (1.8 ± 0.5)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
75N, 185E	843	1.3 ± 0.3	1.4 ± 0.3	< 0.6	< 13 (2.5 ± 1.0)
75N, 195E	850	0.9 ± 0.2	0.9 ± 0.2	< 0.3	< 6.5 (2.8 ± 1.0)
75N, 205E	667	0.8 ± 0.2	1.2 ± 0.3	< 0.4	17.4 ± 9.4
80N, 0E	736	0.6 ± 0.2	0.8 ± 0.3	< 0.5	< 15 (2.0 ± 0.8)
85N, 5E	1253	0.3 ± 0.1	0.5 ± 0.1	< 0.2	< 4.8 (1.7 ± 0.6)
85N, 185E	737	0.5 ± 0.1	0.9 ± 0.2	< 0.2	6.4 ± 3.4
85N, 195E	1147	0.5 ± 0.1	0.6 ± 0.2	< 0.3	< 7.9 (1.6 ± 0.9)
85N, 205E	684	0.5 ± 0.2	0.5 ± 0.2	< 0.4	< 9.6 (1.9 ± 0.9)
95N, 15E	1552	< 0.1	< 0.1	0.2 ± 0.1	10.2 ± 3.0
95N, 155E	744	0.5 ± 0.2	0.9 ± 0.3	< 0.5	< 15 (2.6 ± 1.1)
95N, 175E	544	1.0 ± 0.2	< 0.6	< 0.3	5.2 ± 5.1
95N, 185E	679	1.1 ± 0.2	1.4 ± 0.3	0.3 ± 0.3	12.0 ± 6.1
95N, 195E	901	0.2 ± 0.1	< 0.3	< 0.2	< 4.2 (0.5 ± 0.8)
95N, 205E	967	0.6 ± 0.1	0.9 ± 0.2	0.4 ± 0.2	6.7 ± 4.2
105N, 165E	544	0.9 ± 0.2	< 0.7	< 0.5	< 11 (7.2 ± 1.8)
105N, 195E	835	< 0.1	< 0.2	< 0.1	< 2.9 (< 0.7)
105N, 205E	958	0.5 ± 0.1	0.7 ± 0.2	< 0.3	< 7.4 (2.0 ± 0.8)
115N, 15E	936	< 0.2	< 0.4	< 0.3	< 9.9 (< 1.5)
115N, 155E	878	0.5 ± 0.1	0.4 ± 0.2	< 0.4	< 12 (< 1.5)
115N, 175E	1162	0.4 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	2.8 ± 2.3
115N, 185E	946	0.4 ± 0.1	0.6 ± 0.2	0.5 ± 0.2	14.0 ± 4.7
115N, 195E	702	1.0 ± 0.2	0.6 ± 0.3	0.9 ± 0.3	19.8 ± 7.0
115N, 205E	873	< 0.2	0.5 ± 0.2	< 0.3	< 8.6 (1.6 ± 1.0)
120N, 0E	580	< 0.1	0.2 ± 0.1	< 0.2	< 4.8 (0.9 ± 0.7)
125N, 25E	259	< 0.3	< 0.6	0.9 ± 0.6	28 ± 13
125N, 165E	866	0.5 ± 0.2	< 0.7	< 0.5	< 11 (1.8 ± 1.1)
125N, 185E	548	0.9 ± 0.2	0.7 ± 0.3	< 0.4	< 9.9 (2.4 ± 1.4)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
125N, 195E	611	3.0 ± 0.7	1.2 ± 0.4	0.6 ± 0.5	< 18 (7.2 ± 1.9)
125N, 205E	893	0.4 ± 0.1	0.5 ± 0.2	< 0.4	< 7.6 (1.9 ± 0.9)
128N, 115E	837	0.4 ± 0.1	0.6 ± 0.2	0.2 ± 0.2	8.0 ± 4.7
135N, 155E	730	1.1 ± 0.2	1.2 ± 0.3	< 0.3	< 11 (1.9 ± 1.2)
135N, 175E	1153	0.3 ± 0.1	< 0.5	0.9 ± 0.3	21.1 ± 6.3
135N, 185E	524	< 0.3	< 0.4	< 0.3	< 8.7 (0.4 ± 1.0)
135N, 195E	643	< 0.3	0.8 ± 0.3	< 0.3	< 7.0 (1.5 ± 1.2)
135N, 205E	919	0.6 ± 0.1	< 0.3	0.3 ± 0.2	4.4 ± 2.6
140N, 20E	568	< 0.1	< 0.2	< 0.1	< 3.0 (0.6 ± 0.5)
145N, 165E	596	0.7 ± 0.1	1.1 ± 0.3	0.7 ± 0.3	< 9.7 (7.1 ± 1.4)
145N, 185E	639	1.0 ± 0.2	0.9 ± 0.3	< 0.3	< 6.9 (< 1.2)
145N, 195E	712	0.6 ± 0.1	< 0.3	< 0.3	< 6.8 (1.4 ± 1.0)
145N, 205E	522	2.1 ± 0.3	1.5 ± 0.4	< 0.5	< 11 (3.7 ± 1.7)
150N, 112E	891	< 0.2	0.4 ± 0.2	1.2 ± 0.4	34.6 ± 7.7
155N, 155E	808	0.4 ± 0.1	0.5 ± 0.2	< 0.2	< 5.4 (1.7 ± 0.6)
155N, 175E	1164	0.2 ± 0.1	< 0.4	< 0.3	5.5 ± 3.9
155N, 185E	985	< 0.1	< 0.2	< 0.2	< 4.6 (0.1 ± 0.4)
155N, 195E	659	< 0.2	0.9 ± 0.2	< 0.3	< 7.9 (2.3 ± 1.0)
155N, 205E	638	1.1 ± 0.2	1.0 ± 0.3	< 0.3	< 8.8 (1.8 ± 1.3)
160N, 0E	508	0.3 ± 0.1	0.6 ± 0.2	< 0.2	< 4.6 (1.4 ± 0.8)
160N, 82E	814	0.5 ± 0.1	1.3 ± 0.3	0.8 ± 0.3	14.6 ± 6.3
165N, 165E	521	0.5 ± 0.2	< 0.5	0.8 ± 0.4	20.7 ± 9.1
165N, 185E	851	0.2 ± 0.1	< 0.3	< 0.2	< 4.0 (1.2 ± 0.8)
165N, 195E	697	0.7 ± 0.2	< 0.7	0.3 ± 0.4	< 15 (8.7 ± 1.8)
165N, 205E	857	0.7 ± 0.2	1.1 ± 0.3	< 0.3	< 8.4 (2.5 ± 1.3)
170N, 118E	1059	0.2 ± 0.1	0.5 ± 0.1	< 0.2	< 5.4 (2.8 ± 0.7)
175N, 175E	1535	< 0.1	< 0.2	< 0.2	< 4.4 (0.4 ± 0.3)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
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Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
175N, 185E	697	0.3 ± 0.2	0.7 ± 0.2	< 0.4	< 9.8 (1.0 ± 0.9)
175N, 195E	907	0.6 ± 0.2	0.8 ± 0.2	0.7 ± 0.5	18.5 ± 7.8
175N, 205E	1051	0.6 ± 0.1	0.6 ± 0.2	0.2 ± 0.2	< 6.9 (1.2 ± 0.9)
178N, 95E	959	0.4 ± 0.1	0.5 ± 0.2	< 0.2	0.7 ± 0.6
180N, 20E	1071	0.2 ± 0.1	< 0.3	< 0.2	< 6.1 (0.8 ± 0.7)
180N, 80E	754	0.5 ± 0.2	< 0.7	0.5 ± 0.3	3.6 ± 1.1
185N, 165E	501	< 0.3	0.8 ± 0.3	0.7 ± 0.4	13 ± 11
185N, 185E	1204	0.3 ± 0.1	0.5 ± 0.1	< 0.2	3.6 ± 2.6
185N, 195E	891	0.6 ± 0.1	< 0.7	< 0.4	< 12 (2.3 ± 1.4)
185N, 205E	702	1.0 ± 0.3	1.2 ± 0.3	< 0.5	< 15 (2.8 ± 1.9)
190N, 122E	819	0.4 ± 0.1	0.8 ± 0.2	0.4 ± 0.3	15.3 ± 7.5
195N, 75E	663	0.3 ± 0.1	0.5 ± 0.2	< 0.2	2.4 ± 1.0
195N, 95E	1023	0.4 ± 0.1	0.6 ± 0.2	< 0.2	3.1 ± 1.0
195N, 175E	1356	0.2 ± 0.1	0.4 ± 0.1	< 0.2	< 5.5 (1.3 ± 0.5)
195N, 185E	1349	0.2 ± 0.1	< 0.3	< 0.2	< 5.1 (0.9 ± 0.5)
195N, 195E	926	0.4 ± 0.1	< 0.2	< 0.2	< 4.1 (0.7 ± 0.6)
195N, 205E	1164	0.3 ± 0.1	0.4 ± 0.1	< 0.2	< 3.9 (0.9 ± 0.5)
200N, 0E	816	0.6 ± 0.1	0.8 ± 0.3	< 0.3	< 9.3 (2.8 ± 1.2)
205N, 165E	558	0.5 ± 0.2	0.7 ± 0.3	< 0.5	< 13 (2.0 ± 0.9)
205N, 185E	1435	0.2 ± 0.1	< 0.2	< 0.1	< 2.9 (< 0.4)
205N, 195E	710	0.4 ± 0.1	0.5 ± 0.2	< 0.3	< 8.5 (2.1 ± 1.3)
205N, 205E	1497	< 0.1	0.2 ± 0.1	< 0.1	< 4.2 (0.4 ± 0.4)
210N, 118E	929	< 0.2	0.4 ± 0.2	< 0.3	1.3 ± 0.6
215N, 75E	702	0.5 ± 0.1	0.7 ± 0.2	< 0.3	1.4 ± 0.9
215N, 95E	730	< 0.2	0.4 ± 0.2	< 0.2	1.2 ± 0.9
215N, 135E	897	0.2 ± 0.1	0.4 ± 0.2	< 0.2	1.5 ± 0.8
215N, 155E	787	0.6 ± 0.1	0.8 ± 0.2	< 0.2	< 6.2 (1.2 ± 0.7)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
215N, 175E	1414	0.2 ± 0.1	0.4 ± 0.1	< 0.1	< 3.5 (0.6 ± 0.3)
215N, 185E	1509	< 0.1	0.2 ± 0.1	< 0.1	< 2.8 (0.4 ± 0.3)
215N, 195E	1035	< 0.1	< 0.2	< 0.2	< 5.7 (0.8 ± 0.6)
215N, 205E	401	0.7 ± 0.2	< 0.7	< 0.5	< 11 (2.7 ± 1.2)
220N, 20E	770	0.7 ± 0.2	0.8 ± 0.3	< 0.5	< 9.9 (1.4 ± 1.2)
240N, 80E	750	0.6 ± 0.2	0.7 ± 0.2	< 0.4	< 12 (< 1.9)
240N, 160E	627	< 0.2	< 0.4	< 0.2	< 6.2 (< 1.0)
240N, 200E	832	0.7 ± 0.2	0.7 ± 0.2	< 0.3	< 7.1 (1.2 ± 0.9)
241N, 0E	954	0.4 ± 0.1	0.4 ± 0.1	< 0.2	< 6.3 (< 0.9)
260N, 20E	681	0.6 ± 0.2	0.9 ± 0.2	< 0.3	< 5.8 (0.7 ± 0.9)
260N, 140E	1222	0.4 ± 0.1	1.0 ± 0.2	0.4 ± 0.2	5.4 ± 3.0
260N, 180E	940	0.4 ± 0.1	0.5 ± 0.2	< 0.4	< 7.8 (2.2 ± 0.8)
280N, 80E	1187	0.5 ± 0.1	0.5 ± 0.2	0.2 ± 0.2	< 7.0 (2.0 ± 0.7)
280N, 120E	1090	0.6 ± 0.1	0.6 ± 0.2	0.2 ± 0.2	< 6.9 (2.4 ± 0.8)
280N, 160E	1115	0.2 ± 0.1	< 0.2	< 0.2	< 5.6 (0.8 ± 0.7)
280N, 200E	785	0.6 ± 0.1	< 0.4	< 0.2	< 5.4 (< 0.9)
300N, 20E	778	< 0.2	0.7 ± 0.2	< 0.3	< 7.4 (1.9 ± 1.1)
300N, 60E	964	0.4 ± 0.1	< 0.5	< 0.4	< 5.3 (1.5 ± 0.8)
300N, 100E	834	0.7 ± 0.1	1.1 ± 0.3	2.6 ± 0.5	51 ± 11
300N, 140E	1108	0.3 ± 0.1	0.8 ± 0.2	0.5 ± 0.3	13.2 ± 4.6
300N, 180E	610	0.8 ± 0.2	1.0 ± 0.4	< 0.4	< 7.6 (2.4 ± 1.6)
320N, 40E	732	0.6 ± 0.1	0.6 ± 0.2	0.3 ± 0.2	11.5 ± 4.2
320N, 80E	1174	0.5 ± 0.1	0.6 ± 0.2	0.3 ± 0.2	4.6 ± 3.9
320N, 120E	1003	< 0.2	0.4 ± 0.1	0.2 ± 0.2	7.8 ± 4.6
320N, 160E	792	0.7 ± 0.1	< 0.4	< 0.3	< 6.4 (2.4 ± 1.1)
320N, 200E	732	0.6 ± 0.2	< 0.7	< 0.5	< 11 (2.2 ± 1.3)
340N, 20E	517	< 0.3	1.0 ± 0.3	< 0.4	< 12 (5.1 ± 1.7)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
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Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
340N, 60E	988	< 0.2	0.5 ± 0.2	< 0.3	< 7.8 (1.4 ± 0.7)
340N, 100E	686	0.5 ± 0.2	< 0.8	1.4 ± 0.5	36.2 ± 9.6
340N, 140E	766	0.5 ± 0.1	0.9 ± 0.2	0.3 ± 0.2	< 7.7 (3.4 ± 1.1)
340N, 180E	821	< 0.2	< 0.3	< 0.2	< 4.2 (0.9 ± 0.7)
359N, 0E	686	0.5 ± 0.1	0.8 ± 0.3	< 0.3	< 9.6 (0.8 ± 1.0)
359N, 40E	852	< 0.3	< 0.5	< 0.3	< 12 (1.8 ± 0.8)
359N, 80E	755	0.4 ± 0.1	0.7 ± 0.2	< 0.3	< 8.0 (1.2 ± 0.9)
359N, 120E	728	0.6 ± 0.1	0.9 ± 0.2	< 0.3	< 6.6 (1.2 ± 0.9)
359N, 160E	785	1.4 ± 0.4	1.4 ± 0.4	< 0.6	< 14 (2.1 ± 1.3)
359N, 200E	839	0.6 ± 0.1	0.9 ± 0.2	< 0.3	< 8.2 (2.0 ± 1.3)
240N, 280W	649	0.5 ± 0.1	0.5 ± 0.1	0.1 ± 0.1	5.2 ± 1.8
260N, 20W	1040	0.4 ± 0.1	0.7 ± 0.2	< 0.2	< 4.4 (1.2 ± 0.6)
260N, 100W	775	0.5 ± 0.2	0.7 ± 0.2	< 0.3	< 10 (1.1 ± 1.2)
260N, 140W	911	0.5 ± 0.1	< 0.4	< 0.3	< 11 (0.8 ± 0.8)
260N, 180W	1027	< 0.1	0.2 ± 0.1	< 0.2	< 3.9 (1.6 ± 0.7)
260N, 260W	750	0.6 ± 0.1	0.5 ± 0.1	0.9 ± 0.2	18.2 ± 2.9
260N, 300W	658	0.8 ± 0.2	0.5 ± 0.1	0.2 ± 0.2	< 4.9
262N, 60W	925	0.4 ± 0.1	0.6 ± 0.2	< 0.2	< 6.6 (< 1.1)
280N, 0W	939	0.6 ± 0.2	0.9 ± 0.3	0.3 ± 0.3	< 13 (3.3 ± 1.2)
280N, 40W	742	0.5 ± 0.1	0.7 ± 0.3	< 0.3	< 9.3 (2.5 ± 1.2)
280N, 80W	795	0.9 ± 0.2	1.2 ± 0.3	0.5 ± 0.3	< 9.0 (5.9 ± 1.5)
280N, 160W	776	< 0.2	< 0.5	< 0.3	< 7.3 (0.9 ± 1.0)
280N, 200W	800	< 0.1	< 0.3	< 0.2	< 5.8 (< 0.9)
280N, 240W	613	0.5 ± 0.1	0.8 ± 0.1	0.3 ± 0.1	5.0 ± 2.1
280N, 280W	723	0.4 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	< 4.9
280N, 338W	490	0.6 ± 0.1	0.7 ± 0.2	0.2 ± 0.2	5.1 ± 2.4
283N, 120W	992	0.2 ± 0.1	< 0.2	< 0.2	< 4.9 (2.1 ± 0.7)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
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Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
300N, 20W	738	0.7 ± 0.2	< 0.8	< 0.5	< 13 (2.8 ± 1.2)
300N, 60W	648	0.4 ± 0.1	0.5 ± 0.2	< 0.2	< 5.6 (1.5 ± 0.8)
300N, 100W	891	0.4 ± 0.1	< 0.4	0.5 ± 0.3	8.6 ± 3.8
300N, 140W	1058	0.6 ± 0.1	0.9 ± 0.3	1.3 ± 0.4	32.3 ± 7.6
300N, 180W	1003	< 0.1	< 0.2	< 0.2	< 5.8 (< 0.7)
300N, 220W	877	0.3 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	4.5 ± 2.4
300N, 260W	767	0.4 ± 0.1	0.5 ± 0.1	0.2 ± 0.1	4.9 ± 2.0
300N, 300W	618	0.3 ± 0.1	0.6 ± 0.1	0.1 ± 0.1	< 5.1 (1.6 ± 0.5)
320N, 0W	796	0.4 ± 0.1	0.5 ± 0.2	< 0.2	< 6.0 (1.8 ± 1.1)
320N, 40W	633	0.5 ± 0.1	< 0.4	< 0.3	< 7.7 (2.3 ± 0.9)
320N, 80W	814	0.6 ± 0.2	< 0.7	< 0.4	< 10 (2.2 ± 1.0)
320N, 120W	815	0.3 ± 0.1	< 0.2	0.3 ± 0.2	< 4.0 (1.3 ± 0.7)
320N, 160W	999	0.5 ± 0.1	0.7 ± 0.2	0.3 ± 0.2	< 12 (3.3 ± 1.2)
320N, 200W	767	0.5 ± 0.1	0.6 ± 0.2	< 0.3	< 8.6 (2.6 ± 1.2)
320N, 240W	700	0.5 ± 0.1	0.5 ± 0.1	0.2 ± 0.2	6.9 ± 2.9
320N, 280W	723	0.6 ± 0.1	0.8 ± 0.1	0.3 ± 0.1	6.5 ± 2.3
320N, 320W	644	0.6 ± 0.1	0.5 ± 0.1	< 0.2	2.0 ± 2.7
340N, 20W	758	0.5 ± 0.1	< 0.5	< 0.3	< 11 (5.0 ± 1.4)
340N, 60W	697	0.6 ± 0.1	0.8 ± 0.2	< 0.4	< 11 (4.4 ± 1.3)
340N, 100W	929	0.4 ± 0.1	0.5 ± 0.3	0.3 ± 0.2	7.4 ± 4.5
340N, 140W	964	0.8 ± 0.2	< 0.5	< 0.4	< 12 (< 1.6)
340N, 180W	981	0.4 ± 0.1	0.3 ± 0.1	< 0.2	< 5.7 (2.6 ± 0.8)
340N, 220W	567	0.4 ± 0.1	0.6 ± 0.1	0.6 ± 0.2	13.5 ± 3.2
340N, 260W	742	0.5 ± 0.1	0.5 ± 0.1	0.4 ± 0.1	10.2 ± 2.8
340N, 300W	698	0.7 ± 0.2	0.8 ± 0.2	0.3 ± 0.2	5.2 ± 2.9
357N, 120W	781	1.5 ± 0.4	< 0.7	< 0.5	< 11 (1.9 ± 1.1)
359N, 40W	632	0.7 ± 0.2	0.8 ± 0.3	0.3 ± 0.2	< 9.7 (4.8 ± 1.5)

TABLE 13 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL
EXTERIOR SYSTEMATIC LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
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Grid Coordinates ^a	Sample Quantity (g)	Radionuclide Concentrations (pCi/g)			
		Ra-226	Th-232	U-235	U-238
359N, 80W	702	0.6 ± 0.1	0.8 ± 0.2	< 0.3	< 6.3 (2.5 ± 1.1)
359N, 160W	750	0.8 ± 0.2	0.7 ± 0.3	< 0.3	< 8.3 (< 1.5)
359N, 200W	737	0.7 ± 0.2	0.8 ± 0.2	< 0.3	< 8.5 (2.6 ± 1.3)
360N, 240W	967	0.6 ± 0.1	0.6 ± 0.2	0.8 ± 0.3	12.4 ± 8.0
360N, 280W	827	0.6 ± 0.2	0.4 ± 0.3	< 0.4	< 11 (2.4 ± 1.0)
360N, 320W	736	0.6 ± 0.1	0.5 ± 0.1	0.2 ± 0.1	1.9 ± 1.4
380N, 140W	683	0.6 ± 0.2	0.8 ± 0.4	< 0.3	< 8.9 (1.0 ± 1.1)
380N, 180W	714	0.6 ± 0.1	0.9 ± 0.3	< 0.3	< 8.2 (1.8 ± 1.3)
380N, 220W	842	0.4 ± 0.1	0.7 ± 0.2	1.0 ± 0.3	22.6 ± 6.9
380N, 260W	784	0.6 ± 0.1	0.7 ± 0.2	< 0.2	< 6.0 (3.1 ± 0.9)
380N, 300W	800	0.5 ± 0.1	0.6 ± 0.1	0.2 ± 0.1	3.6 ± 1.9
400N, 120W	579	0.7 ± 0.1	0.8 ± 0.3	< 0.3	< 8.3 (1.0 ± 0.9)
400N, 160W	755	< 0.3	0.7 ± 0.2	< 0.3	< 8.2 (1.2 ± 1.0)
400N, 200W	1014	0.4 ± 0.1	< 0.4	0.3 ± 0.2	7.3 ± 3.3
400N, 240W	861	0.7 ± 0.1	< 0.6	0.3 ± 0.3	< 9.9 (3.2 ± 1.2)
400N, 280W	775	0.5 ± 0.2	< 0.5	< 0.4	< 10 (2.3 ± 1.3)
400N, 320W	723	0.5 ± 0.1	0.6 ± 0.1	< 0.1	< 3.9
420N, 140W	596	0.8 ± 0.3	0.9 ± 0.3	< 0.5	< 12 (< 2.3)
420N, 180W	583	0.5 ± 0.2	< 0.6	< 0.4	< 13 (2.8 ± 1.7)
420N, 220W	864	0.4 ± 0.1	0.5 ± 0.2	0.2 ± 0.2	9.1 ± 6.7
420N, 260W	879	0.5 ± 0.1	0.6 ± 0.2	0.4 ± 0.2	15.5 ± 4.9
420N, 300W	707	0.6 ± 0.1	0.5 ± 0.1	0.1 ± 0.1	2.8 ± 2.4
420N, 340W	536	0.9 ± 0.2	0.6 ± 0.2	0.2 ± 0.2	< 5.5 (1.1 ± 0.6)
440N, 320W	653	0.5 ± 0.1	0.5 ± 0.1	0.2 ± 0.1	< 3.5

^a Refer to Figures 33 and 34.

^b Uncertainties are total propagated uncertainties at the 95% confidence level.

^c Pa-234m (1001 keV) peak was used to determine activity except where values were less than the MDC in which case the Th-234 (63 keV) result was included in parenthesis.

TABLE 14

**RADIONUCLIDE CONCENTRATIONS IN SOIL
EXTERIOR LOCATIONS OF ELEVATED ACTIVITY
GUTERL STEEL SPECIALTY CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinate ^a	Depth (cm)	Radionuclide Concentrations (pCi/g)				
		Sample Quantity (g)	Ra-226	Th-232	U-235	U-238
62N, 58E	0-15	688	< 0.4	< 0.9	5.9 ± 0.9 ^b	108.5 ± 5.8
70N, 124E	0-15	1040	< 0.3	< 0.4	33.3 ± 2.5	912 ± 51
70N, 124E	15-30	928	< 0.9	< 1.2	137.1 ± 9.4	3,640 ± 190
79N, 26E	0-15	682	0.7 ± 0.2	3.8 ± 0.7	2.0 ± 0.7	48 ± 19
82N, 26E	0-15	663	1.0 ± 0.3	39.5 ± 3.8	6.8 ± 1.3	238 ± 30
83N, 26E	15-30	461	< 2.8	307 ± 30	6.6 ± 6.1	320 ± 150
85N, 124E	0-15	1082	< 0.5	95.1 ± 8.9	2.4 ± 1.2	185 ± 25
85N, 124E	15-30	924	< 0.3	17.9 ± 1.8	3.3 ± 0.7	138 ± 18
89N, 10E	0-15	834	< 0.2	7.8 ± 1.0	0.6 ± 0.4	23.4 ± 9.2
90N, 24E	0-15	843	< 0.3	6.1 ± 0.8	3.5 ± 0.7	86 ± 15
90N, 24E	15-30	651	0.5 ± 0.2	1.3 ± 0.4	1.5 ± 0.6	45 ± 10
94N, 26E	0-15	795	< 0.3	19.6 ± 2.1	3.0 ± 0.9	91 ± 17
94N, 26E	15-30	699	0.7 ± 0.1	< 0.6	< 0.3	< 9.1 (1.6 ± 1.5) ^c
101N, 188E	0-15	934	4.3 ± 0.6	2.3 ± 0.7	< 0.9	17 ± 16
105N, 116E	0-15	911	< 0.5	4.3 ± 0.8	35.3 ± 3.0	2,660 ± 140
105N, 116E	15-30	774	< 0.5	1.4 ± 0.4	11.1 ± 1.4	736 ± 57
105N, 186E	0-15	941	1.3 ± 0.2	0.8 ± 0.3	< 0.5	< 10 (2.2 ± 1.2)
106N, 184E	0-15	875	0.3 ± 0.1	< 0.3	0.8 ± 0.3	16.8 ± 6.2
106N, 184E	15-30	876	0.9 ± 0.3	39.1 ± 3.8	1.9 ± 0.8	59 ± 19
106N, 185E	0-15	412	< 6.9	< 8.7	341 ± 32	44,400 ± 2,200
111N, 199E	0-15	608	< 1.1	< 1.5	433 ± 29	13,020 ± 600
116N, 18E	0-15	1152	< 0.2	1.7 ± 0.4	11.0 ± 1.3	266 ± 25
134N, 80E	0-15	846	< 0.3	< 0.6	13.2 ± 1.4	329 ± 30
135N, 75E	0-15	683	< 1.7	< 2.1	299 ± 20	8,770 ± 430
135N, 75E	15-30	563	< 0.6	< 0.9	109.5 ± 7.6	2,750 ± 140
168N, 26E	0-15	161	< 5.3	< 5.4	1,079 ± 76	54,800 ± 2,700
201N, 185E	0-15	1159	0.4 ± 0.2	11.6 ± 1.2	10.9 ± 1.1	279 ± 21
272N, 108E	0-15	887	< 3.7	< 4.3	293 ± 23	23,500 ± 1,100
276N, 119E	0-15	809	< 0.3	33.5 ± 3.3	11.4 ± 1.5	343 ± 29
276N, 119E	15-30	825	0.4 ± 0.2	8.3 ± 1.0	8.1 ± 0.9	218 ± 19
278N, 145W	0-15	737	0.7 ± 0.2	1.9 ± 0.3	3.1 ± 0.5	84 ± 11
285N, 115E	0-15	870	0.5 ± 0.1	1.2 ± 0.3	1.8 ± 0.4	35.3 ± 7.9
289N, 144W	15-30	720	< 0.6	< 0.9	118.0 ± 8.1	3,050 ± 160

TABLE 14 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SOIL
EXTERIOR LOCATIONS OF ELEVATED ACTIVITY
GUTERL STEEL SPECIALTY CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinate ^a	Depth (cm)	Radionuclide Concentrations (pCi/g)				
		Sample Quantity (g)	Ra-226	Th-232	U-235	U-238
289N, 144W	0-15	1032	< 1.5	< 2.0	246 ± 18	6,970 ± 370
296N, 88E	0-15	1006	< 0.7	13.0 ± 2.2	48.1 ± 4.7	1,196 ± 98
296N, 88E	15-30	736	< 0.4	8.6 ± 1.1	17.6 ± 1.8	397 ± 38
297N, 126W	0-15	1237	< 0.1	0.4 ± 0.1	1.0 ± 0.3	23.1 ± 5.8
297N, 126W	15-30	1175	< 0.7	< 1.0	61.7 ± 5.4	1,860 ± 120
306N, 139W	0-15	936	< 0.4	1.1 ± 0.5	16.9 ± 1.8	615 ± 43
306N, 139W	15-30	858	1.1 ± 0.2	1.1 ± 0.3	9.3 ± 1.0	241 ± 21
306N, 94E	0-15	654	0.6 ± 0.3	4.9 ± 0.9	15.5 ± 1.7	397 ± 38
306N, 94E	15-30	707	< 0.4	5.4 ± 0.8	19.8 ± 1.8	465 ± 40
326N, 205W	0-15	614	0.4 ± 0.2	5.5 ± 0.9	0.9 ± 0.5	17.8 ± 9.5
345N, 208W	0-15	883	0.4 ± 0.1	< 0.3	8.2 ± 0.7	182 ± 13
379N, 199W	0-15	779	1.1 ± 0.3	8.7 ± 0.9	0.5 ± 0.3	6.5 ± 4.9
379N, 199W	15-30	685	1.5 ± 0.2	21.8 ± 2.1	0.3 ± 0.4	12.8 ± 6.1
395N, 204W	0-15	781	1.4 ± 0.2	11.0 ± 1.1	0.7 ± 0.2	17.0 ± 4.0
405N, 215W	0-15	817	21.0 ± 1.8	1.2 ± 0.3	0.3 ± 0.3	< 8.6 (5.2 ± 1.5)

^a Refer to Figure 33.

^b Uncertainties are total propagated uncertainties at the 95% confidence level.

^c Pa-234m (1001 keV) peak was used to determine activity except where values were less than the MDC in which case the Th-234 (63 keV) result was included in parenthesis.

TABLE 15

**RADIONUCLIDE CONCENTRATIONS IN SOIL
EXTERIOR BOREHOLE LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Depth (cm)	Radionuclide Concentrations (pCi/g)				
		Sample Quantity (g)	Ra-226	Th-232	U-235	U-238
107N, 184E	0-15	904	< 0.2	< 0.3	0.2 ± 0.2 ^b	3.8 ± 4.7
107N, 184E	15-60	438	0.6 ± 0.1	1.0 ± 0.3	1.6 ± 0.4	35.9 ± 8.5
107N, 184E	60-120	309	1.2 ± 0.3	< 0.9	< 0.7	10.4 ± 8.4
168N, 24E	0-15	931	< 0.1	< 0.3	< 0.2	< 6.9 (0.9 ± 0.6) ^c
168N, 24E	15-60	166	0.5 ± 0.1	< 0.4	< 0.3	< 7.4 (1.5 ± 0.8)
168N, 24E	60-120	646	0.6 ± 0.2	0.8 ± 0.3	< 0.4	< 9.0 (3.2 ± 0.7)
200N, 184E	0-15	967	0.3 ± 0.2	11.5 ± 1.2	10.4 ± 1.1	225 ± 21
200N, 184E	15-60	681	0.9 ± 0.3	2.9 ± 0.6	2.4 ± 0.6	30 ± 12
200N, 184E	60-120	382	1.0 ± 0.2	1.2 ± 0.4	0.3 ± 0.3	< 11 (5.7 ± 0.8)
224N, 160E	0-15	1076	1.0 ± 0.1	1.3 ± 0.2	< 0.2	< 5.8 (2.0 ± 0.5)
224N, 160E	15-60	193	2.1 ± 0.3	2.6 ± 0.4	< 0.4	< 9.2 (3.3 ± 0.5)
224N, 160E	60-120	817	1.2 ± 0.2	1.2 ± 0.3	< 0.3	< 9.4 (1.5 ± 0.7)
224N, 160E	120-180	169	1.0 ± 0.2	< 0.6	< 0.3	< 9.5 (1.7 ± 0.6)
275N, 146E	0-15	816	0.8 ± 0.3	1.9 ± 0.4	1.4 ± 0.6	83 ± 15
275N, 146E	15-60	418	1.1 ± 0.2	1.4 ± 0.4	0.8 ± 0.3	33 ± 12
275N, 146E	60-120	148	0.6 ± 0.2	1.0 ± 0.3	0.3 ± 0.4	9.0 ± 8.7
277N, 84E	0-15	1328	< 0.1	0.3 ± 0.1	0.2 ± 0.1	< 5.1 (0.7 ± 0.4)
277N, 84E	15-60	932	0.4 ± 0.1	0.5 ± 0.1	< 0.2	< 5.9 (1.5 ± 0.5)
277N, 84E	60-120	536	0.4 ± 0.1	0.5 ± 0.2	< 0.2	< 5.3 (2.1 ± 0.4)
289N, 87E	0-15	717	< 0.7	23.0 ± 2.6	34.7 ± 3.1	828 ± 62
289N, 87E	15-60	440	< 0.3	6.0 ± 0.8	10.3 ± 1.2	268 ± 26
290N, 76E	0-15	783	0.8 ± 0.1	0.8 ± 0.2	0.2 ± 0.3	8.5 ± 4.7
290N, 76E	15-60	403	0.7 ± 0.1	< 0.4	< 0.3	< 8.1 (3.7 ± 0.6)
290N, 76E	60-120	194	0.2 ± 0.1	< 0.3	< 0.3	< 7.4 (1.1 ± 0.5)
290N, 98E	0-15	924	0.5 ± 0.1	0.6 ± 0.3	1.1 ± 0.4	32 ± 11
290N, 98E	15-60	419	< 0.3	1.2 ± 0.3	1.7 ± 0.5	24 ± 12
290N, 98E	60-120	142	0.7 ± 0.2	1.2 ± 0.3	1.1 ± 0.3	25 ± 12
291N, 120E	0-15	1039	< 0.2	< 0.4	< 0.4	< 11 (4.3 ± 0.7)
291N, 120E	15-60	160	0.5 ± 0.2	< 0.6	0.6 ± 0.3	12 ± 10
291N, 120E	60-120	449	0.7 ± 0.2	< 0.6	< 0.4	< 11 (2.4 ± 0.6)
291N, 154E	0-15	490	0.4 ± 0.1	3.4 ± 0.5	0.3 ± 0.3	9.1 ± 6.3
291N, 154E	15-60	361	1.0 ± 0.2	7.2 ± 0.9	< 0.5	< 11 (8.7 ± 1.1)

TABLE 15 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SOIL
EXTERIOR BOREHOLE LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Depth (cm)	Radionuclide Concentrations (pCi/g)				
		Sample Quantity (g)	Ra-226	Th-232	U-235	U-238
291N, 154E	60-120	452	0.7 ± 0.1	1.2 ± 0.3	< 0.3	$< 9.4 (1.4 \pm 0.6)$
291N, 154E	120-180	201	0.2 ± 0.1	< 0.5	< 0.4	$< 9.4 (0.7 \pm 0.5)$
303N, 112E	0-15	762	0.8 ± 0.1	1.2 ± 0.3	0.8 ± 0.3	18.9 ± 6.0
303N, 112E	15-60	381	1.0 ± 0.2	1.7 ± 0.4	1.1 ± 0.4	12.5 ± 8.5
303N, 112E	60-120	177	0.9 ± 0.2	1.3 ± 0.4	< 0.4	$< 14 (6.0 \pm 0.8)$
304N, 118E	0-15	873	< 0.7	< 1.1	105.7 ± 7.6	$3,110 \pm 160$
304N, 126E	0-15	804	< 0.2	1.3 ± 0.3	3.6 ± 0.6	79 ± 13
304N, 126E	15-60	376	0.6 ± 0.2	1.9 ± 0.4	2.6 ± 0.4	79 ± 13
304N, 126E	60-120	132	< 0.4	< 0.8	0.8 ± 0.5	22 ± 12
310N, 84E	0-15	819	0.6 ± 0.2	1.0 ± 0.3	0.9 ± 0.4	14.6 ± 8.7
310N, 84E	15-60	694	0.7 ± 0.2	0.7 ± 0.3	< 0.3	$< 11 (5.4 \pm 1.0)$
310N, 84E	60-120	799	0.6 ± 0.2	< 0.6	< 0.4	$< 11 (1.9 \pm 0.9)$
310N, 118E	0-15	936	< 0.2	1.0 ± 0.3	1.0 ± 0.4	30.2 ± 8.4
310N, 118E	15-60	849	0.8 ± 0.1	1.1 ± 0.3	0.4 ± 0.4	14.8 ± 5.3
310N, 118E	60-120	423	0.6 ± 0.1	0.6 ± 0.2	0.5 ± 0.3	11.2 ± 6.4
311N, 13E	0-15	713	0.9 ± 0.2	2.7 ± 0.4	0.3 ± 0.4	$< 9.3 (5.8 \pm 1.9)$
311N, 13E	15-60	363	0.8 ± 0.2	0.5 ± 0.3	0.2 ± 0.3	$< 9.4 (3.8 \pm 1.3)$
311N, 13E	60-120	778	0.4 ± 0.1	0.7 ± 0.2	< 0.3	$< 7.4 (0.5 \pm 0.7)$
312N, 65E	0-15	896	0.5 ± 0.1	4.7 ± 0.2	11.2 ± 0.4	288.4 ± 9.7
312N, 65E	15-60	579	0.5 ± 0.1	1.2 ± 0.3	1.5 ± 0.3	37.2 ± 8.5
312N, 65E	60-120	928	0.3 ± 0	0.4 ± 0.1	< 0.2	$< 4.7 (1.4 \pm 0.3)$
313N, 64E	0-15	955	0.4 ± 0.3	6.7 ± 0.7	16.4 ± 1.2	397 ± 29
313N, 64E	15-60	525	0.5 ± 0.2	2.0 ± 0.3	3.3 ± 0.4	89 ± 15
313N, 64E	60-120	178	< 0.2	2.3 ± 0.5	5.6 ± 0.6	159 ± 18
272N, 79W	0-15	888	< 0.3	< 0.5	14.6 ± 1.3	428 ± 29
272N, 79W	15-60	668	< 0.3	0.8 ± 0.3	18.0 ± 1.6	471 ± 34
272N, 79W	60-120	454	0.4 ± 0.1	< 0.3	3.4 ± 0.5	85 ± 10
272N, 79W	120-180	805	< 0.3	< 0.5	1.3 ± 0.4	23 ± 10
282N, 87W	0-15	1194	< 0.2	< 0.4	12.2 ± 1.2	343 ± 26
282N, 87W	15-60	678	1.0 ± 0.2	0.8 ± 0.3	4.6 ± 0.7	118 ± 14
282N, 87W	60-120	452	0.6 ± 0.2	< 0.6	1.2 ± 0.3	34.7 ± 8.2
282N, 87W	120-180	511	0.5 ± 0.1	< 0.4	0.3 ± 0.2	11.9 ± 5.4
282N, 165W	0-15	817	0.3 ± 0.1	0.4 ± 0.1	< 0.2	$< 4.4 (1.5 \pm 0.8)$

TABLE 15 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SOIL
EXTERIOR BOREHOLE LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Depth (cm)	Radionuclide Concentrations (pCi/g)				
		Sample Quantity (g)	Ra-226	Th-232	U-235	U-238
282N, 165W	15-60	343	0.6 ± 0.1	0.9 ± 0.3	0.9 ± 0.3	21.0 ± 8.8
282N, 165W	60-120	156	1.2 ± 0.2	1.2 ± 0.4	0.9 ± 0.3	22 ± 10
284N, 147W	0-15	837	< 0.2	0.7 ± 0.2	0.9 ± 0.3	15.6 ± 6.9
284N, 147W	15-60	391	< 0.2	0.7 ± 0.3	0.4 ± 0.3	7.7 ± 5.6
284N, 147W	60-120	725	0.6 ± 0.1	0.7 ± 0.2	< 0.2	5.0 ± 4.4
284N, 147W	120-180	173	< 0.2	0.4 ± 0.2	0.5 ± 0.2	10.7 ± 7.6
290N, 126W	0-15	977	0.5 ± 0.1	0.5 ± 0.2	0.6 ± 0.3	20.3 ± 6.7
290N, 126W	15-60	176	0.5 ± 0.2	< 0.5	2.6 ± 0.5	73 ± 12
290N, 126W	60-120	390	1.4 ± 0.2	1.5 ± 0.3	0.4 ± 0.3	15.1 ± 7.2
290N, 126W	120-180	166	0.7 ± 0.2	0.9 ± 0.3	0.6 ± 0.3	< 14 (12.8 ± 1.6)
299N, 43W	0-15	1136	0.5 ± 0.1	0.7 ± 0.2	1.9 ± 0.4	28.0 ± 1.8
299N, 43W	15-60	566	< 0.5	< 0.7	93.1 ± 6.6	2,830 ± 140
299N, 43W	60-120	641	< 0.1	0.8 ± 0.2	2.2 ± 0.3	50.2 ± 8.1
299N, 43W	120-180	836	0.5 ± 0.1	< 0.4	2.7 ± 0.4	64 ± 12
299N, 43W	180-210	298	< 0.3	0.6 ± 0.4	17.7 ± 1.6	415 ± 33
304N, 80W	0-15	750	0.7 ± 0.4	19.5 ± 2.1	< 1.0	< 13 (< 3.6)
304N, 80W	15-60	319	0.6 ± 0.2	2.5 ± 0.6	< 0.4	< 11 (3.0 ± 1.4)
304N, 80W	60-120	338	1.5 ± 0.3	1.5 ± 0.4	0.4 ± 0.4	12.8 ± 8.6
304N, 80W	120-180	467	0.8 ± 0.2	1.0 ± 0.3	0.5 ± 0.3	9.0 ± 7.5
304N, 158W	0-15	841	< 0.3	< 0.5	17.1 ± 1.6	425 ± 35
304N, 158W	15-60	572	< 1.0	< 1.3	525 ± 35	17,780 ± 810
304N, 158W	60-120	478	< 0.8	< 1.1	262 ± 18	6,970 ± 330
304N, 158W	120-180	535	< 0.3	< 0.4	4.6 ± 0.7	121 ± 17
319N, 145W	0-15	758	0.5 ± 0.2	0.8 ± 0.3	< 0.4	< 15 (2.4 ± 1.3)
319N, 145W	15-60	813	< 0.3	0.8 ± 0.2	8.2 ± 1.0	223 ± 23
319N, 145W	60-120	191	1.2 ± 0.3	< 0.8	31.3 ± 2.6	819 ± 56
319N, 145W	120-180	390	< 0.3	1.0 ± 0.3	0.5 ± 0.2	11.3 ± 7.4
325N, 177W	0-15	1272	< 0.4	< 0.5	63.8 ± 2.0	1,843 ± 49
325N, 177W	15-60	249	0.2 ± 0.1	0.7 ± 0.3	1.1 ± 0.4	31.7 ± 8.9
325N, 177W	60-120	198	0.4 ± 0.1	0.7 ± 0.1	1.1 ± 0.2	35.1 ± 4.1
342N, 121W	0-15	587	1.3 ± 0.2	1.7 ± 0.4	< 0.4	< 14 (3.6 ± 1.8)
342N, 121W	15-60	137	< 0.5	< 1.0	< 0.7	< 21 (5.3 ± 1.7)
342N, 121W	60-120	794	0.7 ± 0.2	1.1 ± 0.3	< 0.5	< 14 (1.2 ± 1.1)

TABLE 15 (Continued)

**RADIONUCLIDE CONCENTRATIONS IN SOIL
EXTERIOR BOREHOLE LOCATIONS
GUTERL SPECIALTY STEEL CORPORATION
LOCKPORT, NEW YORK**

Grid Coordinates ^a	Depth (cm)	Radionuclide Concentrations (pCi/g)				
		Sample Quantity (g)	Ra-226	Th-232	U-235	U-238
358N, 19W	0-15	732	< 0.4	< 0.5	6.0 ± 0.9	142 ± 24
358N, 19W	15-60	459	0.6 ± 0.1	0.9 ± 0.1	5.2 ± 0.3	136.3 ± 6.5
358N, 19W	60-120	768	0.6 ± 0.1	0.8 ± 0.3	2.3 ± 0.5	48 ± 13
358N, 19W	120-180	277	0.5 ± 0.2	0.6 ± 0.3	1.0 ± 0.4	31 ± 13
362N, 197W	0-15	960	0.7 ± 0.2	2.0 ± 0.3	0.6 ± 0.4	8.0 ± 7.4
362N, 197W	15-60	174	1.1 ± 0.2	3.2 ± 0.5	1.3 ± 0.4	19 ± 16
362N, 197W	60-120	79 ^d	< 0.5	3.2 ± 1.2	< 0.8	< 35 (5.7 ± 2.5)
362N, 197W	120-180	192	1.0 ± 0.2	5.5 ± 0.8	0.9 ± 0.5	27 ± 12
402N, 186W	0-15	833	0.7 ± 0.3	17.1 ± 1.8	< 0.9	18 ± 10
402N, 186W	15-60	175	< 0.4	15.8 ± 1.8	< 0.8	< 17 (15.2 ± 1.8)
402N, 186W	60-120	523	0.8 ± 0.2	3.1 ± 0.5	0.3 ± 0.3	< 11 (6.2 ± 0.9)
402N, 186W	120-180	159	1.2 ± 0.3	6.8 ± 0.9	< 0.6	9.8 ± 7.6
410N, 189W	0-15	435	< 2.0	371 ± 35	< 5.4	< 75 (20 ± 10)
410N, 189W	15-60	423	0.7 ± 0.3	13.1 ± 1.5	< 0.7	< 14 (5.5 ± 2.7)
410N, 189W	60-120	488	0.8 ± 0.3	17.4 ± 1.9	< 1.2	< 19 (1.7 ± 2.8)
410N, 189W	120-180	876	0.9 ± 0.2	3.9 ± 0.6	< 0.5	< 8.6 (2.5 ± 1.7)
412N, 191W	0-15	667	0.9 ± 0.2	2.9 ± 0.4	< 0.4	< 8.4 (6.5 ± 1.9)
412N, 191W	15-60	467	1.8 ± 0.2	5.1 ± 0.6	0.5 ± 0.3	10.7 ± 4.9
412N, 191W	60-120	475	1.2 ± 0.2	1.9 ± 0.4	< 0.5	< 12 (3.1 ± 1.4)
412N, 191W	120-180	510	0.9 ± 0.1	1.3 ± 0.3	< 0.3	< 7.5 (0.9 ± 0.9)

^a Refer to Figures 33 and 34.

^b Uncertainties are total propagated uncertainties at the 95% confidence level.

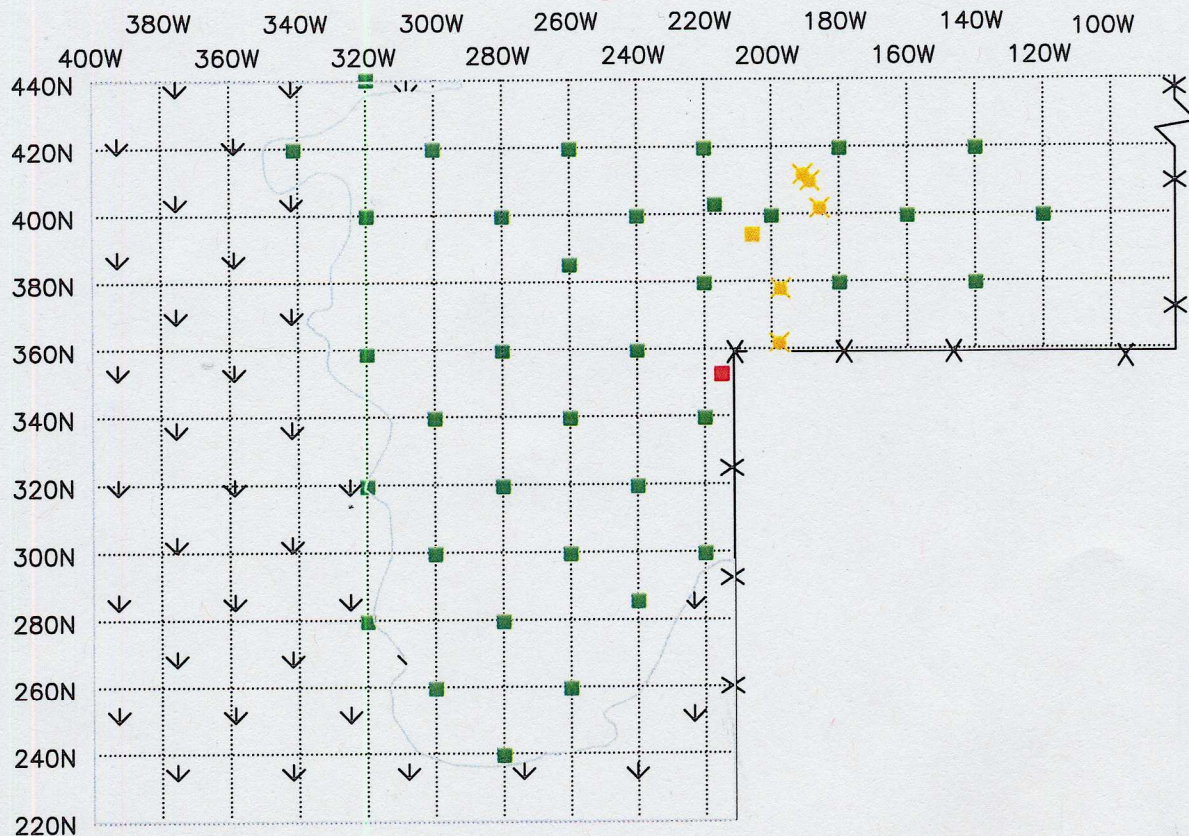
^c Pa-234m (1001 keV) peak was used to determine activity except where values were less than the MDC in which case the Th-234 (63 keV) result was included in parenthesis.

^d Sample had insufficient volume for an appropriate geometry. Values are semi-quantitative.

ATTACHMENT 2

Referenced Figures from Prior Investigations

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MEASUREMENT/SAMPLING LOCATIONS SOIL

(>15 cm) (0-15 cm)



≤35 pCi/g, U-238



>100 pCi/g, U-238



>5 pCi/g, Th-232



FENCE



Marsh Inaccessible

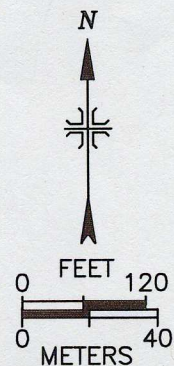


FIGURE 34: Landfill Area – Measurement and Sampling Locations

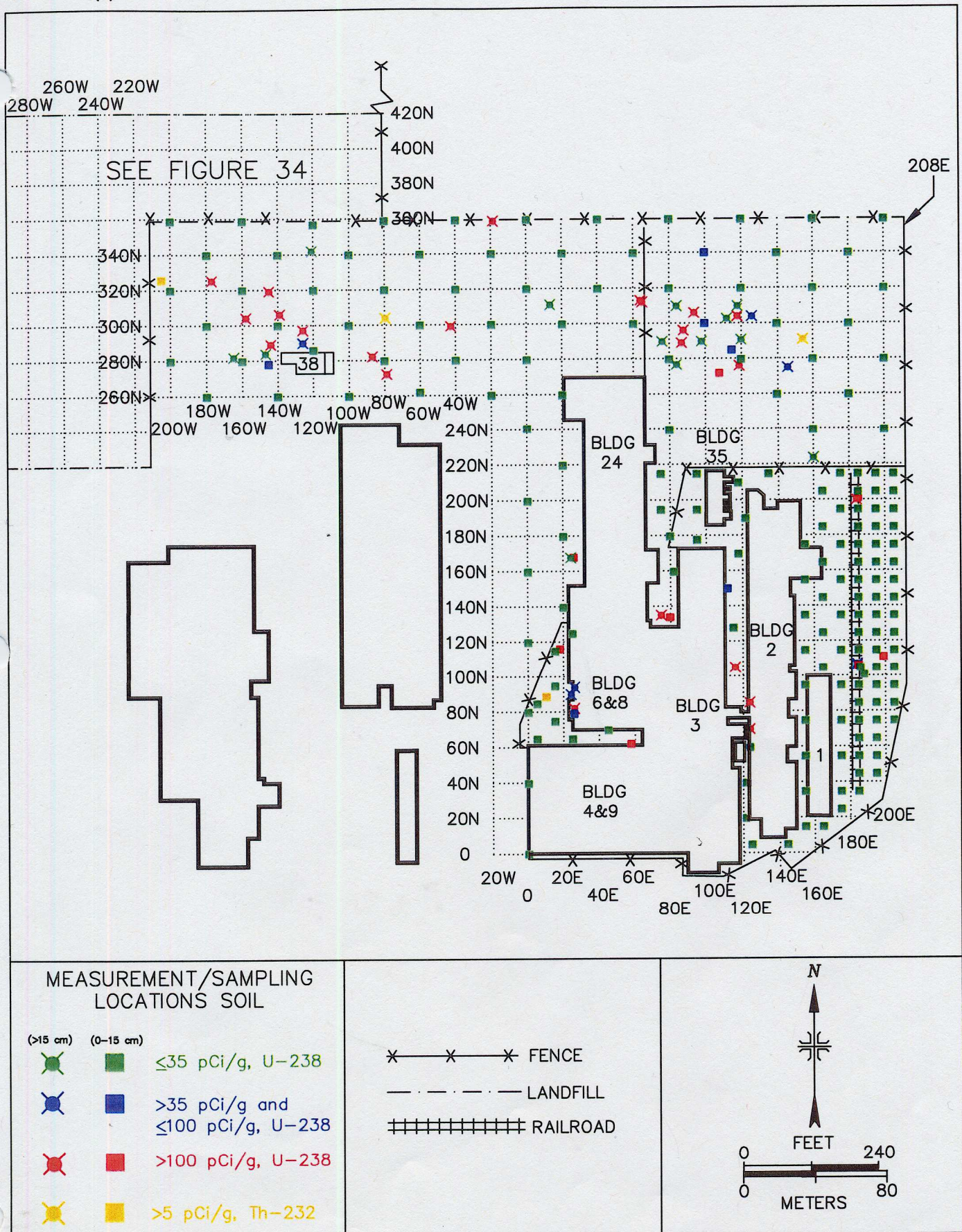


FIGURE 33: Guterl Specialty Steel Corporation — Class 1 and 2 Areas Measurement and Sampling Locations

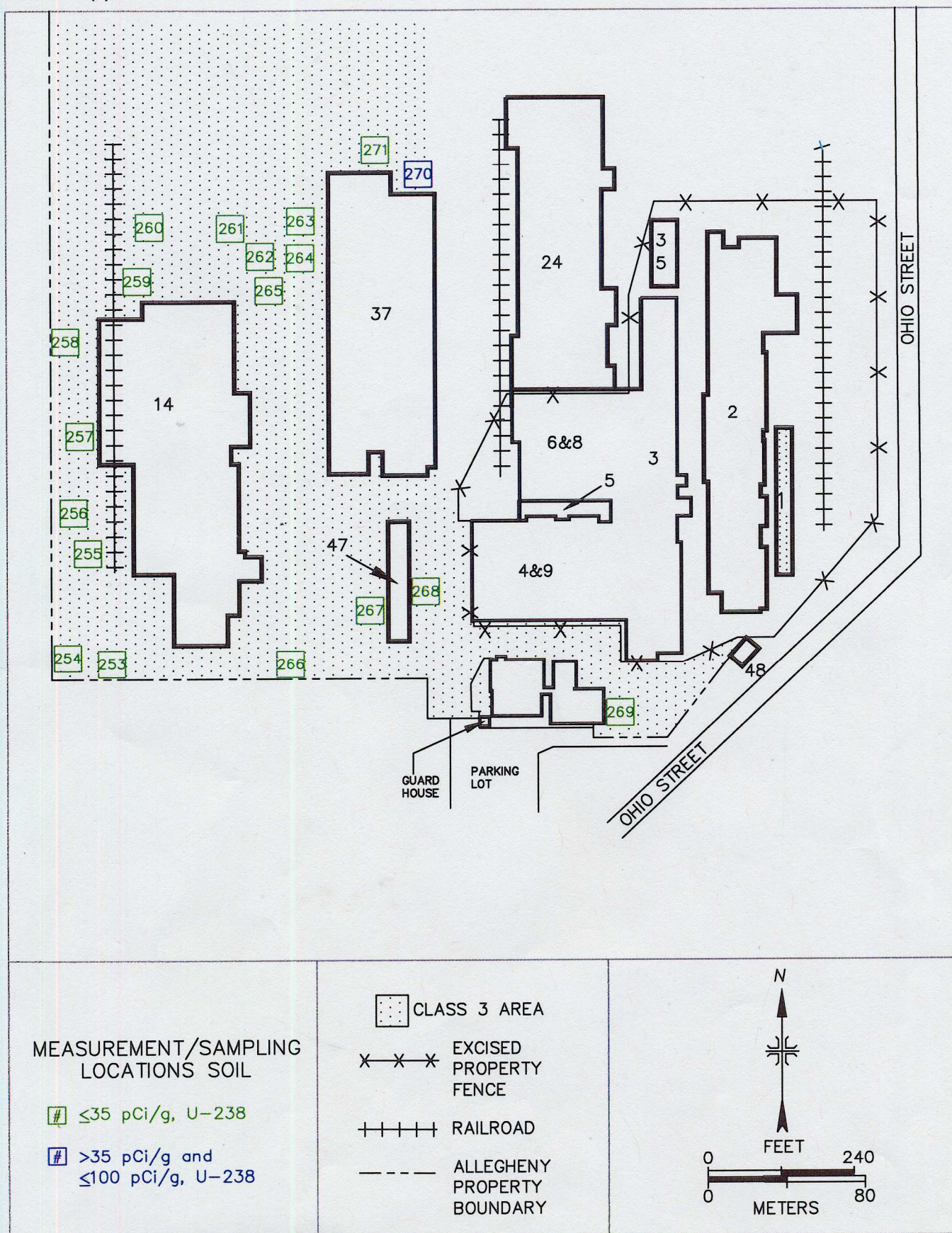


FIGURE 35: Exterior Class 3 Area – Sampling Locations

ATTACHMENT 3

Performance of a GPS Based Gamma Walkover Survey

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Performance of a GPS-based Gamma Walkover Survey

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1 Purpose

This guide establishes the bases for performing a gamma walkover survey using a Global Positioning System (GPS) interfaced to a gamma scintillator for the purpose of conducting a gamma walkover survey (GWS).

Candidate gamma scintillators include the following:

- Ludlum Model 44-151 Bismuth Germinate (BGO) Gamma Scintillator (71 cm wide” x 10 cm deep x 3.8 cm thick, or 28” wide BGO);
- Ludlum Model 44-132 BGO, (14.6 cm diameter x 2.54 cm height, or 6” BGO);
- Ludlum Model 44-10 Sodium Iodide (NaI) (5.08 cm diameter x 5.08 cm height, or 2”x2” NaI);
- Field Instrument for Detection of Low Energy Radiation (FIDLER); or
- any equivalent detector.

The preferred detector for scanning is the Ludlum 44-151 because of its wide field-of-view (FOV) of approximately 1 m. It is typically mounted on a push-cart with its width centered over the surveyor path such that the wide FOV is perpendicular to the surveyor path. The cart carries the equipment weight and also serves to maintain a fixed relative position between the GPS antenna and the detector, which yields accurate horizontal positioning, and a fixed detector height above grade, which assures accurate vertical positioning of the detector relative to the surface being scanned.

The other smaller gamma scintillators are typically used in a man-portable mode where they are carried by the surveyor and slowly scanned from one side of the surveyor path to the other as the surveyor proceeds along the survey path. For a given survey walking rate, this requirement to scan back and forth across the surveyor path reduces the time over an area, and thus the detection sensitivity. This, along with the smaller FOV that is generally associated with these smaller detectors, means that actual area surveyed will not be as great as that with a detector of wider FOV for a given surveyor walking rate.

While these smaller detectors can be mounted in an array, either on a push-cart or vehicle, to comprise a wider FOV, the level of difficulty in maintaining multiple instruments for consistent correlated response is not negligible.

For either case, the detector is interfaced through a Ludlum Model 2221 ratemeter (or equivalent) that has been modified with an RS-232 port (or equivalent) for direct communication of the detector data to a GPS data logger. The data logger automatically records the GPS position and the detector data at user specified rates, typically once per second.

The same equipment may also be used to record the data for static gamma measurements with the above detectors or to record the output from exposure rate instruments, such as a Ludlum model 19A MicroR Meter (or equivalent). It can also be used to collect region-of-interest (ROI) of energy corrected dose rate data from a gamma scintillator with a multi-channel analyzer

instrument (MCA), such as the Berkeley Nucleonics Model 935 Portable Surveillance and Measurement System (SAMS) (or equivalent) . For these cases, the detector data is collected at the user specified frequency with the detector maintained in a stationary position for a specified time, after which the counts are integrated to yield total counts for the period. This approach is useful for performing and recording the data for static background and response checks.

This guide describes the use of a Trimble GPS Pathfinder Power field kit coupled with Trimble TerraSync™ software to form a GPS mapping system(or equivalent).

2 Scope

This work instruction applies to Earth Tech or subcontract personnel performing a GPS gamma walkover survey.

3 References

- ANSI N323-1978 *American National Standards Radiation Protection Instrumentation Test and Calibration*
- SOP 001 *Portable Detection Equipment, SARSG SOP 001, August 2001, Earth Tech San Antonio Radiation Safety Group.*
- Trimble 2004 *GPS Pathfinder® Systems User Guide, Version 2.00, Revision A, Part Number 40889-10-ENG, April 2004, Trimble Navigation Limited.*
- Trimble 2005a *TerraSync™ Software: Getting Started Guide, Version 2.50, Revision A, April 2005.*
- Trimble 2005b *TerraSync™ Software: Reference Manual, Version 2.50, Revision A, April 2005.*

4 Definitions

Coordinate	Any set of numbers used in specifying the location of a point on a line, on a surface, or in space.
Differential Correction	Processing GPS rover data in order to remove errors.
Global Positioning System	A satellite-based navigation system that provides precise position and time information. A typical GPS receiver (equipment) consists of an antenna, signal processing electronics, and processor. The primary function of the receiver is to acquire signals, recover orbital data, make range and Doppler measurements, and process this information to obtain the user position.

Weight	0.625 kg (1.38lbs)
Power	3.1 W, 9 to 32 V
Temperature	–30 °C to 60 °C (–22 °F to 140 °F) operating –40 °C to 80 °C (–40 °F to 176 °F) storage
Humidity	100% fully sealed
Casing	Fully sealed, dustproof, waterproof, shock resistant

6 Work Instructions

6.1 Daily Instrument Checks

Personnel using a radiological meter shall that ensure pre-operational checks are performed in accordance with SOP 001 daily before and after use. The automated collection of integrated detector data obtained by use of GPS/GWS static counting methods discussed in Section 1 may be substituted for the manual data recording methods in SOP 001.

Survey meter background will be verified daily with a one minute integrated count compared against acceptance criteria. Acceptance criteria will be set at ± 3 standard deviations of ten one-minute background counts.

Prior to the survey, the mean background values of each survey instrument will be compared. The instrument with the highest (mean) background count rate will be compared to the instrument with the lowest (mean) background count rate. Only instruments with a (mean) background count rate within 10% of all other instrument (mean) background count rates (at the same location) will be used for the survey.

BGO and NaI detectors (including the FIDLER) are sensitive to temperature effects and the background can be seen to drift upwards with increasing temperature. This effect is gradual but may warrant some monitoring for significance depending on the temperature change since performing the initial background and response check. The typical intended use of GWS scanning data is to evaluate the data over a contiguous area qualitatively for identification of areas of elevated gamma emission, rather than quantitatively. The effect does not generally warrant correction of the gamma scanning data for qualitative uses.

Personnel using GPS equipment will perform a daily operational check against a known survey benchmark or secondary station to verify that position accuracy is acceptable (sub-meter) prior to use.

6.2 Connecting Trimble Pathfinder Hardware

6.2.1 GPS Pathfinder Power Cabling

Figure 6-1 shows the GPS Pathfinder Power receiver mounted in its weatherproof housing.

The GPS Pathfinder Power receiver has one physical port, as shown in Figure 6-2. This port combines two RS-232 serial communications ports (Port A and Port B), one 1 PPS port, and power input.



Figure 6-1. GPS Pathfinder Power housing



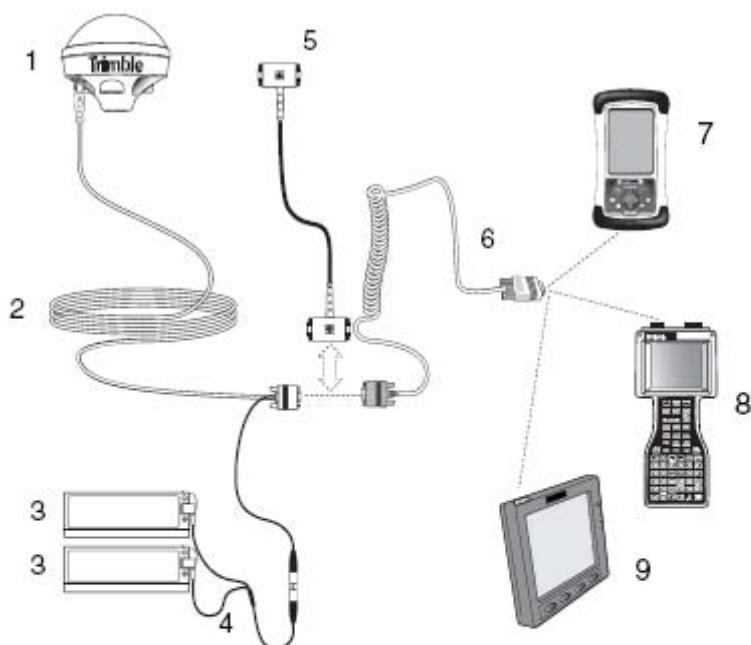
Figure 6-2. GPS Pathfinder Power port

The port is a 12-pin male bulkhead connector:

- Port A is set by default to output NMEA-0183 messages and receive RTCM SC-104 correction data. The port can also be setup to communicate Trimble's format TSIP (Trimble Standard Interface Protocol).
- Port B is set by default to input and output TSIP messages.

The antenna and receiver are built into and connected within the same housing, so an antenna cable is unnecessary.

To use a GPS Pathfinder Power receiver with a field device with standard serial port, the system will be connected as shown in Figure 6-3.



- | | | |
|---|--------------|--|
| 1 | P/N 29653-00 | Integrated GPS/beacon antenna |
| 2 | P/N 22628 | Antenna cable |
| 3 | P/N 17466 | Camcorder batteries |
| 4 | P/N 24333 | Dual battery cable |
| 5 | P/N 40887-00 | RTCM/NMEA cable |
| 6 | P/N 45052 | GPS Pathfinder field device cable |
| 7 | P/N 49675-50 | Trimble Recon handheld |
| 8 | P/N 45268-50 | TSCe field device |
| 9 | | Field device with standard serial port |

Figure 6-3. GPS Pathfinder Power receiver/field device connection diagram

6.2.2 Loading GPS Pathfinder Power Equipment into the Backpack

Figure 6-4 illustrates the features inside the backpack.

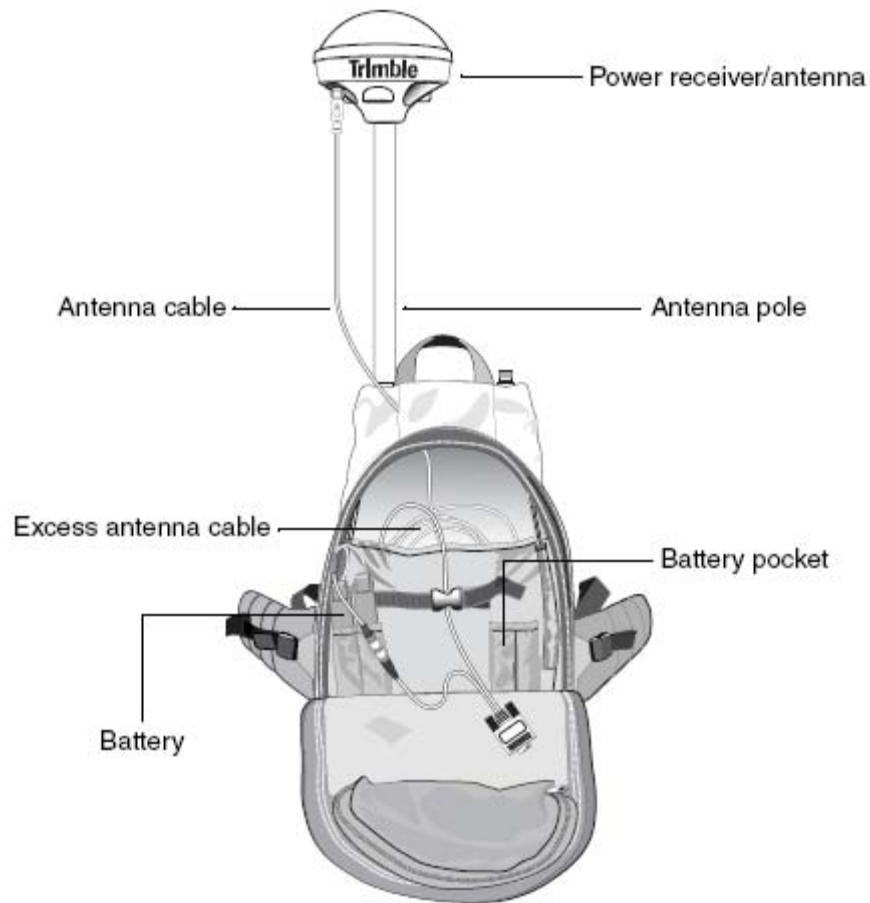


Figure 6-4. GPS Pathfinder Power receiver in the backpack

To load the GPS equipment into the backpack, the backpack will be opened and these steps followed:

1. Place two fully charged batteries in the backpack. One battery goes in each of the battery pockets, with the connector clips facing up, towards the front.
2. Connect the battery cable (P/N 24333) to the two batteries in the battery pockets.
3. Screw the antenna pole(s) onto one of the antenna mounts. The poles need to be high enough for the GPS Pathfinder Power receiver to be above your head.
4. Install the GPS Pathfinder Power receiver on top of the antenna pole.
5. From the outside of the backpack, insert the DE9 connector of the field device data cable through the data cable outlet.
6. Pull the cable through the data cable strain relief retainer and pull it tight.
7. Place the receiver data/power cable (P/N 40492-00) in the sleeve pocket.
8. Pull its bulkhead cable connector out of the backpack through one of the antenna cable outlets.
9. Connect the bulkhead connector to the GPS Pathfinder Power receiver on top of the pole.

10. Connect the TA3 connector on the receiver data/power cable to battery cable (P/N 24333). Place the excess cable in the sleeve pocket.
11. Connect the DE9 connector on the receiver data/power cable (P/N 40492-00) to the DE9 connector on the field device data cable.
12. Pull the data cable through the cable retainer loops on the side of the backpack.
13. Connect the field device cable to the field device.
14. Close all compartments.

6.2.3 Fitting the backpack

Figure 6-5 illustrates the front and back views of the backpack.



Figure 6-5. Backpack adjustment front and back views

It is important that the Trimble backpack fits properly for maximum comfort and efficiency. To optimize the fit of the backpack:

1. Load the GPS equipment into the backpack.
2. Loosen the hip belt, the stabilizer straps, and the shoulder straps.
3. Position the hip belt so that the top of the belt is at the same height as the top of the hip bone.
4. Tighten the hip belt until it is firmly around the hip.
5. Tighten the shoulder pads by pulling down on the shoulder pad adjustment straps. The straps should be firm but not cutting in the arm.

6. Adjust the height of the chest strap to be positioned just below the collarbones. The chest strap helps to keep the backpack in the right place on the body and is also used to fine-tune the shoulder straps to the most comfortable position.

Note – The harness is designed to follow body movements rather than resist them. However, it may be desirable to minimize the backpack movement when balance is critical (for example, when climbing in rocky areas). To do this, tighten the side stabilizer straps.

6.2.4 Caring for the backpack

To maintain the durability of the Trimble backpack and protect its waterproofing:

- Clean it regularly with a soft brush and warm water to remove dirt and other foreign material.
- Dry the backpack thoroughly before storing it to avoid the risk of mildew.
- Store it in a well-ventilated, dry area away from direct sunlight or heat.

6.3 TerraSync Software

The TerraSync software is designed for collecting and updating geographical data (GIS and spatial data) on a field computer.

The GPS Pathfinder Power receiver will be connected to a field computer that has the TerraSync software installed. The TerraSync software acts as the controlling software to track GPS status, log data and update existing data, and navigate in the field.

As the GPS acquires satellite data it will show the number of usable satellites. The PDOP value represents the configuration of satellites in the sky with respect to the rover's position. A minimum of 4 satellites ($SV = 4$) and $PDOP < 4$ is needed to acquire the most accurate data. As you increase the SV value and decrease the PDOP value, the accuracy of your data improves. (This is dependent upon configuration of TSCI unit, *i.e.*, manual 2D, manual 3D, over determined 3D, auto 2D/3D).

Steps

- Select “DATA COLLECTION” is highlighted and press ENTER. Select “CREATE NEW FILE” and press ENTER.
- To reopen an a file select REOPEN FILE
- Press F2 (New) to start logging again.
- The Pro XR will automatically assign a file name with starts with “R” for rover file followed by two digits representing the month; two digits representing the day; and two digits representing the current hour based on a 24-hour clock, followed by a consecutive letter starting with “A” indicating the first file collected. Rename the files using Site filename conventions.
- The next screen to appear is “ANTENNA OPTIONS”; verify the correct antenna type (normally, integrated GPS\beacon\satellite), then press ENTER.

- Next, the start feature menu will appear. Select the type of feature to be surveyed, line generic for walkover, point generic to locate a specific point, by highlighting and pressing ENTER.
- Press ENTER to confirm the height of antenna dome versus the ground surface (height above ellipsoid-RAE).
- The Pro XR will begin collecting GPS data. Verify by observing that the positioning information in the lower right corner is moving.
- Press F5, Press F1 (EXT-external sensor), Press F3 (status), verify detector readings are being collected by observing a new number every second, or two as applicable.

6.4 Constraints

The rate of the walkover survey should not exceed 0.5 m s^{-1} , unless requested by the client. The distance from the ground surface should be maintained at approximately 10 cm (4 inches).

A walkover survey should not be performed if the ground is covered with equal to or greater than 10 cm (4 inches) of snow.

A walkover survey should not be performed if the ambient temperature is outside of the range provided by the manufacturer. A Ludlum 44-10 detector acceptable range is -15° C to 50° C (5° F to 122° F), unless otherwise certified by the manufacturer.

In order to ensure 100 percent coverage of *MARSSIM* Class 1 walkover areas, survey paths are normally in straight lines at approximately 1-m transects. Survey paths may be modified as needed to conform to walkover area configurations or decrease coverage. Class 2 area survey coverage will be approximately 25 percent at approximately 4-m transects. Class 3 area survey coverage and transect lengths will be determined by the Project Manager or Health Physicist.

6.5 Pausing

To pause the survey; press ESC to exit the EXT status screen, Press ESC to exit the EXT screen, Press F5 (The arrow), and Press F1 (Pause). To resume the survey, Press F1.

The survey should be paused when one of the following conditions is encountered:

- The survey is finished, before leaving the survey area for a break, or when standing still for more than a minute.
- A persistent error message is encountered, such as; TOO FEW SVs, PDOP TOO HIGH, or MEMORY NEARLY FULL.
- One of the numbers in the lower right corner of the screen stops changing during the survey.

If, during the survey, either number in the lower right corner of the screen stops changing for more than a few seconds, stand still, pause the survey, and do the following:

If the position data information on the bottom stops:

- Check for an error message.

- Check the cable connecting the handset and the Pro XR.

If the sensor data number on the top stops:

- Check cables connecting the handset and detector ratemeter.
- Ensure the detector ratemeter is ON.
- Ensure the detector ratemeter is set to Digital Rate

6.6 Finalizing

When finished surveying the feature, press ESCAPE three times. The screen will display please confirm ABANDON FEATURE LINE GENERIC. Press F1, Press ESCAPE, Press F1 to confirm exit of data collection.

Press ESCAPE from the new data collection screen. This will return you to the Start feature menu, and you may select another feature to survey. Press the green button to power down.

6.7 Transferring Data From GPS Receiver to Pathfinder Office

The following equipment is necessary to download data;

- Trimble TSC-1 GPS datalogger
- Personal computer (PC) with the Pathfinder office software
- GPS unit-to-PC download cable (DE9 connector to 9-pin)
- Office Support Module (OSM-PF) with 12-pin Hirose connector optional
- the Trimble Pathfinder office donigal key

Connect cable to bottom of GPS receiver (other end should be connected to computer via the serial port.)

Turn GPS receiver on.

When the handset is turned on it will try to connect to GPS. Press ENTER twice and wait a few seconds and this message will disappear.

Select File Manager and then press ENTER.

Select File Transfer and press ENTER.

The Data logger is ready to transfer data (should be displaying a message: “Connect cable to PC”).

7 Setting up Pathfinder Office Software to Transfer Data

Double click on the Pathfinder Office icon; a “Select Project Window” should appear. If the Window does not appear, click on File and highlight Projects. A “Select Project” Dialog Box will appear.

To Choose a Project in Pathfinder Office, select the button with an inverted triangle to get the project drop-down list. In the drop-down list, scroll to your project; and select it. Click OK in the Select Project Dialog Box.

For a new project, select Project window and click the NEW button. In the box next to Project Name, type the name of your Project (for example, VP22). Do not use special characters, spaces, or underbars when defining a project name. When creating a Project with single digit numbers, add a leading zero (0) [for example, VP01L].

In the box next to Project Folder, check to see what directory it is going to set the Project up in. At the end type the string, \Project name (\VP22 or \VP01L). The next three boxes should stay the same on all Project names: backup, export, and base respectively. Click the OK button to return to the original select Project dialog box. Click the OK button again to complete the Project setup for this session.

7.1.1 Data Transfer to the PC

In the Pathfinder Office program window, click on UTILITIES and highlight Data Transfer.

Once the Dialog Box is open, double-check the “DESTINATION DIRECTORY”. Make sure that the file will be transferred to the Project of the site/property you are working on.

Look in the Available Files area of the Dialog Box. Choose the file(s) that haven't been transferred yet in the box, and press the Add button. Should you accidentally choose the wrong file(s), you can remove the file by highlighting the file in the Selected Files area of the Dialog Box and press the remove button.

After choosing the file(s) to transfer, click on the Transfer button. The transfer process may take a while to complete (depending on file size, computer speed, and so on). A window showing the progress of the data transfer will appear.

When the file transfer is complete, press the Disconnect button. Then click the Close button to close the Data Transfer dialog box. Failure to follow this step will reset the TSCI data logger (GPS Unit) to the factory default settings, and you will have to reconfigure the data logger.

Following the data transfer, Escape back to the main menu of the TSCI Data Logger, turn off the data logger, disconnect the cable from the data logger.

7.2 Viewing Files

In the Pathfinder Office program, select the VIEW menu and select MAP (If a map window was already present this step must be repeated).

An “Open” file dialog box will appear. When this dialog box opens, the file(s) that you just transferred (downloaded) should already be highlighted. If additional file(s) are needed, then highlight the file(s) that you need to view, then click OPEN. To open multiple files at once, press the ctrl button as you click on each file. It may take a while to open the file (depending on the size of files, computer speed, etc.). A progress window will appear showing the progress of the operation. (If the computer is a slower model, the window may appear distorted but this will fix itself after a while.) After the file(s) open, a map will appear.

8 Performing Differential Correction

Following data download, use a Differential Correction Utility (DCU) to remove errors in GPS data. The DCU improves the accuracy of GPS positions. Instructions for using the DCU are contained in Attachment 2, “Performing Differential Correction”.

After Differential Correction is completed, collected data may be viewed in Pathfinder Office by; selecting FILE, selecting the files of interest (*.COR), and selecting OPEN. After the files open, select the map icon in the tool bar. If all of the data is acceptable, then export the data from Pathfinder Office to a holding directory on the PC. At this point, the files of interest will be manipulated using ArcView .

Open ArcView. Start a new view. Click on the add theme icon.

Open the holding directory. Add all of the “sensor.shp” files. Select the first theme to be edited. Go to the “theme” menu and select “start editing”.

8.1 Convert a Data String to Numeric

Open the theme table. Select the EDIT menu, then ADD FIELD.

The field definition dialog box opens. The field NAME should be defined as CPM (Counts Per Minute), the TYPE should be NUMBER, and WIDTH set to 16 and 0 (zero) DECIMAL PLACES. Click the OK button. The field is created at the end and is highlighted.

Select the CALCULATE icon. The field calculator dialog box appears. In the FIELDS area double-click the TEXT option. [TEXT] should appear in the box at the bottom of the dialog. In the REQUESTS area double-click the ASNUMBER option. The area at the bottom of the Field Calculator Dialog Box should now contain the text “[Text].AsNumber”. Click the OK button. Arc View converts the “TEXT” field containing a “string” to the “CPM” field which is defined as a “numeric” field.

Select the TEXT field. Click on the EDIT menu and select the “Delete Field” option. Click the “Yes” button to confirm the deletion of the text field. Minimize the table.

In the VIEW window click on the THEME menu and select “Stop Editing”. Click on the “Yes” button to save the changes made.

Rename the files that are to be used by Arc view in Windows Explorer . Highlight the first file (NOTE, LINE, OF SENSOR). Select the HOME key. The cursor should now be located at the front of the word that was highlighted. Type in a file name that will identify the data that was collected. Press ENTER. Having changed the file name, the other files in this directory may be copied, and pasted, as desired.

8.2 Displaying a Walkover Survey in Arcview

Open Arc view software. Open the current project. A base map of the area of interest will appear. Select the “+” icon (on the tool bar that is in the upper left corner). A theme may now be added to this project. The directory will request a file. Locate the (manipulated/renamed) ArcView files. The theme will then be added to the base map. Add the appropriate scale to this theme according to the determined background. Walkover data may then be reviewed.

Verify any questionable radiological activity data by returning to the coordinates, and re-surveying the immediate area.

Any data with a PDOP of 6 or greater will not be used. Walkover surveys will be discontinued if a PDOP value greater than 5.9 is encountered. The PDOP value will also be verified as less than 6 during the export process routine.

8.3 Creating a Waypoint File

In order to locate a point from a walkover survey, the point needs to be converted to a waypoint file, and downloaded to the TSC 1. In Microsoft Access ,select FILE, GET EXTERNAL, IMPORT, FILE TYPE (.xls). Select FILE, SAVE AS, EXPORT.

In Pathfinder Office , select FILE, WAYPOINTS, ASCII IMPORT, ALL FILES, FILES TO WAYPOINTS.

8.4 Locating a Waypoint File With the TSC1

Select NAVIGATION on the main menu, and press ENTER. Press F4 (Target). Select the location that is to be found.

Start walking in the direction the location is expected to be. An arrow will appear, change heading until the arrow is pointing straight up.

When the target location is close, the screen will revert to a map, with a circle indicating the target location, and an “X” indicating the receiver location. The receiver is at the target location when the “X” is within the circle.

To select a new target press F4.

9 Records

Documentation of factory calibration dates and services performed will be included with project files for long term retention.

ATTACHMENT 1 Configuring the GPS Handset

Each handset will have to be initially configured before each project and may need to be reconfigured in the case of power loss. This table provides a list of settings.

Rover Options:

L02t::dng- options:

Logging intervals:

Point feature Is

Line/Area Is

Not in feature Is

Velocity None

Confirm end feature No

Minimum positions 3

Carrier Phase:

Carrier Mode Off

Minimum Time 10 mins

Position filters:

Position Mode * 1 (See Below)

Elevation Mask 100

SNR Mask 6.0

PDOP Mask 10.0

PDOP Switch 6.0

Apply real-time Auto

RTK Mode Off

Antenna Options:

Height 21.325ft

Measure Vertical

Confirm Per feature

Type Integrated GPS/Beacon/Sat ...

Part No. 33580-50

Communication Options:

Real Time Input Options:

Radio Type Custom

Baud Rate 9600

Data Bits 8

Stop Bits 1

Parity None

RTCM options:

Station Any

Age 20s

Coordinate System: *2 (See below)

Altitude Unit Feet

Coordinate Unit Feet

Altitude reference MSL

Geoid Model DMA 10 x 10 (Global)

Units and Display:

Distance (2D) Feet

Area Feet squared

Velocity MPH

Angles Degrees

Angle format DDMMSSss

Order North/East

North Reference True

Magnetic Declinations Auto

Null String ?

Language English

Time and Date:

24 hour clock No

Time (Current)

Date Format MM/DD/YY

Date (Current)

External Sensors: *3 (See Below)

Auto Connect Yes

Name BGO 28, BGO 6, NaI 2x2 or FIDLER (as appropriate)

Channel 0

Connect ?

Disconnect ?

Data Request ?

Intervals:

Point Features LOs

Line/area LOs

Not in feature LOs

Attribute None

Data received:

Prefix R

Suffix \OD\OA (use zeroes not the letter O)

Max Byte ?

Time Out 0.100s

Audible click Yes

Status Line Yes

Hardware (TSC1):

LCD contrast 45%

Back light Off

Low voltage charging Off

Auto shut off 60

Beep volume High

Free space (Dependant on situation)

PC Card free space N/A

Battery source Dependant on situation)

Internal Battery (Dependant on situation)

External Battery (Dependant on situation)

Software Version (Dependant on situation)

* 1 - Configuration: Position Filters: Position Mode:

Should be set for Over Determined 3D if there are ample satellites, (4 satellites available) but can be set on Auto 2D/3D if 3 dimensional surveys are not required by the client.

*2 - Configuration: Coordinate System:

Should be set to the area the survey location. Likely default - US State Plane 1983, followed by the part of the state in which the survey is located (i.e. US State Plane 1983:

Zone Missouri East 2401)

*3 - Configuration: External Sensor:

Under the “Select Sensor” menu the first choice should be either the detector name or “Sensor I” select it and press Fl. Set name to either “BGO 28”, “BGO 6”, “NaI 2x2” or “FIDLER”, if it reads “Sensor 1”

.

ATTACHMENT 2 Performing Differential Corrections

Earth Tech will normally use the OmniStar differential correction service for real-time correction of the surveyor GPS coordinates to obtain sub-meter accuracy in location at a 1 hertz update rate. If the OmniStar service is not available, differential corrections can be applied to the GWS GPS data via post processing with GPS base station data obtained for the date and time of the survey by use of the following procedure.


1. GPS base station may be downloaded via several GPS Community Base Stations via the Internet. The sites can be found by performing a net search for “GPS Base Station.”
2. All base fields must be in the same format. The Trimble SSF and DA T formats and RINEX format are supported.
3. To achieve maximum accuracy, the base station must be within 500 kilometers (300 miles) of the survey site and relatively at the same elevation. It is also important to choose a base station that has a similar logging interval as the rover. Trimble recommends a logging interval that does not exceed 30 seconds.
4. Post processing on rover files are then performed with a Differential Correction Engine (DCE) using base station files from a Continually Operating Reference Station (CaRS) maintained by the Nation Geodetic Survey. The DCE will verify the list of base station providers is current. Once the desired base station has been selected, the DCE will transfer the necessary base station file(s) to the base directory. Complete coverage of rover files will then be verified with smart code and carrier phase processing.
5. Using the Differential Correction Utility, enter the Pathfinder Office program.
6. Select Utilities/Differential Correction from the pop-up menu. The main menu Differential Correction window will appear.
7. By default, the last used set of files is selected as rover files. They appear in the Select Files list box. To change the list of select input files, press Browse in the rover files area. The Select Rover File dialog appears. Replace or modify the list of input files and press OK. To select base files, press Browse in the Base Files area. The selected Base Files dialog appears.
8. Select the appropriate base files and press OK.
9. To automatically select base files, press Auto Select. The Auto Select Base File dialog appears. Select Full Search to search all base files in a given directory, or select Quick Search to search base files for a specified range of base file names.
10. When the search is complete, the Confirm Select Base Files dialog appears. The Rover files box lists the rover file(s) that were selected. The Selected Base files box lists the base file(s) that were found having matching time stamps.
11. The Coverage column (under Rover Files) displays Full, Partial, or None. This indicates how much of each rover file is covered by the select base file(s). If Partial or None appears, you should reselect the base station file(s) or you may have to
12. Reevaluate the time intervals of the rover file(s) and acquire the needed base coverage.

13. Once you are satisfied with base station coverage, press OK in the Selected Base Files dialog. Next, the Reference position dialog box appears.
14. Confirm that the reference position is correct for the base station used and press OK. This will start Differential Correction.
15. The time required for correcting the file varies depending on the size of the rover files, the number of base files is used, and the speed of your computer. If differential correction is successful, the Differential Correction Completed dialog box will appear and provide a log on the positions corrected.

ATTACHMENT 4

Standard Operating Procedures

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Earth Tech Standard Operating Procedure	PROCEDURE NO. <u>SARSG, SOP 001</u> DATE: <u>August 20, 2001</u>  APPROVED: _____ SARSG Leader
Portable Detection Equipment	

The San Antonio Radiological Services Group (SARSG) is responsible for the issuance, revision, and maintenance of this policy. Any deviations from the procedures set forth in this policy require approval of the SARSG Leader. This SOP supersedes SARSG SOP 001, February 9, 2001.

1.0 PURPOSE

The purpose of this procedure is to provide instruction for operating portable radiation detection instrumentation. For aspects of instrumentation operation not covered in this procedure, refer to the instrument technical manual.

2.0 SCOPE

This procedure provides guidance for the response and source checks of portable instrumentation and area radiation monitors. Response and source checks are the periodic checks to verify that the instrument is properly functioning within the manufacturer's specifications. Guidance is also provided for removing from service, shipping and receipt of instruments returned from repair and calibration.

3.0 EQUIPMENT

- 3.1** Portable instrument.
- 3.2** Appropriate sources for each instrument.
- 3.3** Source holder.

4.0 PRECAUTIONS

- 4.1** When operating a battery powered instrument, the batteries shall be checked each time the instrument is used and batteries changed when required.
- 4.2** Handle instruments with care. Do not drop or allow them to bang against hard surfaces. Use only instruments possessing a current calibration.

- 4.3 Care should be taken when using thin window detectors (pancake and scintillation detectors) near sharp objects so that the window and detector shall not be damaged.
- 4.4 Slowly enter areas of unknown radiation with instruments on the high scale to avoid off-scale readings and subsequent prolonged recovery time.
- 4.5 Although incidental contact with the surveyed surface will not generally contaminate the detector, minimize contact with the surface.
- 4.6 Occasionally verify instrument is responding properly if background appears low.
- 4.7 When checking instruments, place the source in its holder or center it on the probe as required.
- 4.8 Carefully pack for shipment any instrument being sent to a facility to be calibrated or repaired to avoid damage in transit.
- 4.9 Radiation survey instruments and count rate instruments shall be calibrated at least every twelve months, after the instrument is repaired.

5.0 PROCEDURE

5.1 Steps prior to using instruments

5.1.1 Calibration Verification

- 5.1.1.1 All portable radiological instruments shall have a current calibration label.
- 5.1.1.2 All field instruments will be verified to be under current source check prior to use.

5.1.2 Physical Check

- 5.1.2.1 Inspect the general physical condition of the instrument and detector prior to each use.
- 5.1.2.2 Inspect for loose, damaged knobs, buttons, cables, connectors, broken/damaged meter movements/ displays, dented or corroded instrument cases, punctured/deformed probe/probe window(s), cables, etc., and any other physical impairments that may affect the proper operation of the instrument or detector.
- 5.1.2.3 Any instrument or detector having a questionable physical condition shall not be used until corrected.

5.1.3 Battery Check

- 5.1.3.1 Check that there is sufficient voltage being supplied to the detector and instrument circuitry for proper operation.

5.1.3.2 Perform this check in accordance with the instrument's technical manual; although, it is generally performed as follows:

- 5.1.3.2.1 Position the appropriate selector switch to the "Batt" position or depress the "Batt Check" button with the instrument on.
- 5.1.3.2.2 Observe the indication for the current battery condition. Typically, the current battery condition will be indicated by a meter deflection into the "Batt OK" region or "Batt OK" on the display, etc.
- 5.1.3.2.3 If unsatisfactory results are obtained, refer to the technical manual for replacement of the batteries and repeat the check. The instrument shall display a satisfactory battery check prior to use.

5.1.4 High Voltage (HV) Check

- 5.1.4.1 HV is adjusted appropriately during instrument calibration and does not require adjustment for normal operation.
- 5.1.4.2 A HV check is required prior to each use as applicable in accordance with the instrument technical manual.
- 5.1.4.3 An instrument with suspected HV problems shall be reported to the Project Manager and RSO.

5.1.5 Instrument Source Check

This check is performed daily to verify that the instrument will respond accurately to a known source of radiation. Locate the source for the instrument/detector being used and perform the response source check as described in the following.

- 5.1.5.1 Determine the background radiation level. It must be low enough to allow a measurable response to the check source being used. Careful monitoring of changing background levels is necessary to obtain accurate instrument readings.
- 5.1.5.2 Check the battery condition. If batteries are not in the allowed range, replace the batteries or clean contacts as necessary. If battery check is not satisfactory after corrective actions, then place instrument out of service and send to an authorized calibration facility for repair and calibration.
- 5.1.5.3 Perform source checks with appropriate sources. For on-contact readings, verify that the source to probe geometry is reproducible, in direct contact, and facing the probe.
- 5.1.5.4 Record the source check results on the Radiological Instrument Daily Calibration Record, Attachment 1.

5.1.5.5 Instruments with source check responses that vary by more than 20% under identical conditions shall be removed from service and the Project Manager notified.

5.1.6 Daily Response Checks

This instrument check is performed to see if the instrument responds to a source of radiation. This is a qualitative check only.

5.1.6.1 Intermittent response checks of the count rate survey and radiation survey instruments shall be performed everyday if instrument is in use. Documentation of these response checks is not required.

5.1.6.2 Begin with the instrument on the highest range/scale and enable the audible device, if applicable.

5.1.6.3 Slowly move the detector towards the check source and observe for an increase in audible and/or visual response.

5.1.6.4 Change the range/scale of the instrument as appropriate to obtain a readable indication and to check each of the meter ranges/scales possible. If an appreciable response can not be obtained, even in the lowest range, evaluate instrument performance by comparison to previous source check data for the instrument.

5.1.7 Should the response check be unsatisfactory, the instrument shall be removed from service. Record this on the instrument check form, Attachment 1. Send the instrument to an authorized calibration facility for repair and calibration.

5.1.8 When an instrument has reached its calibration due date, the instrument shall be sent to an authorized calibration facility.

5.2 Using Exposure Rate Instruments (survey instruments that read in R/hr, mR/hr, or μ R/hr)

5.2.1 General Area Surveys

Hold the detector at waist level with the most sensitive areas of the detector facing the item or areas being surveyed. Unless the radiation level on the item being surveyed is known, start on the high scale and work down scale until the instrument reading is between 1/4 and 3/4 (mid scale) scale, if possible.

5.2.2 Direct Surveys

Hold the detector at about one inch from the surface of the item being surveyed.

5.3 Using Beta-Gamma Friskers

5.3.1 Counting Smears and Air Sample Filters

Hold the detector no further than 1/2 inch from the smear or filter. Count the smear for a minimum of five seconds, or if positive indication is noted, count for at least 15 seconds or until the meter indication stabilizes.

5.3.2 Frisking

Hold the detector within 1/2 inch of the surface being frisked. Move the detector no faster than two inches per second. Stop when positive indication is noted from audio response, allow meter indication to stabilize and record that value. The background for release of materials/equipment should be 100 cpm or less.

5.4 Using Alpha Survey Meters

Hold the detector within 1/4 inch of the surface being surveyed. Move the detector no faster than two inches per second. Stop when positive indication is noted and allow meter indication to stabilize; record that value.

5.5 Instruments requiring calibration or repair at an off-site facility, as determined in Section 5.1, are treated as follows.

5.5.1 Remove the instrument from service and record information on instrument check form. In addition, fill out the appropriate information in the Out of Service Tracking Log, Attachment 2.

5.5.2 Instruments with delicate probe windows should have a probe cover secured to prevent damage. Any special instructions should be included with the instrument.

5.5.3 Carefully package the instrument and ship to the calibration facility.

5.6 Receipt of Repaired/Calibrated Instrument

5.6.1 Perform a reference source check of the instrument using the appropriate source.

5.6.1.1 Record the reference source check on Attachment 1.

5.6.1.2 Verify instrument has the correct calibration due date on the calibration sticker.

5.6.1.3 A new set of baseline dose rate/count rate numbers will be established for the instrument.

5.6.2 Place the date the instrument was returned to service in the Out of Service Tracking Log, Attachment 2.

5.7 Calibration

Instruments used for monitoring and contamination control shall be:

- Periodically maintained and calibrated on an established frequency of at least once per year;
- Appropriate for the type(s), levels, and energies of the radiation(s) encountered;
- Appropriate for existing environmental conditions; and
- Routinely tested for operability.

- 5.7.1 Radiological instruments shall be used only to measure the radiation for which their calibrations are valid.
- 5.7.2 The ANSI N323 method for radiological instrumentation calibration will be adhered to.
- 5.7.3 Calibrations shall use National Institute of Standards and Technology (NIST) traceable sources.
- 5.7.4 Calibration procedures shall be developed for each radiological instrument type and should include frequency of calibration, precalibration requirements, and primary calibration requirements, periodic performance test requirements, calibration record requirements and maintenance requirements.
- 5.7.5 Pocket and electronic dosimeters and area radiation monitors should be calibrated at least annually.
- 5.7.6 The effects of environmental conditions, including interfering radiation has on an instrument shall be known prior to use.
- 5.7.7 Functional tests should be used to assess the instrumentation's features.
- 5.7.8 In unusual and limited situations it may be necessary to use an instrument in an application other than that envisioned by the manufacturer.
- 5.7.9 Special calibrations should be performed for use of instrumentation outside manufacturer's specifications.
- 5.7.10 The instrument should be adjusted, calibrated and labeled to identify the special conditions and used only under the special conditions for which it was calibrated.
- 5.7.11 Instruments should bear a label or tag with the date of calibration and date calibration expires.
- 5.7.12 A properly authorized company such as Ludlum or Suntrac Services will calibrate instruments, at least once per year or in accordance with manufacturer recommendations.

6.0 ACTION LEVELS

- 6.1 Readings that deviate more than $\pm 20\%$ from reference source check readings obtained at the time the instrument was first calibrated require instrument re-calibration.
- 6.2 Unsatisfactory response battery check.
- 6.3 Unsatisfactory operation of instrument.

7.0 RECORDS

- 7.1 Radiological Instrument Daily Calibration Record, Attachment 1.
- 7.2 Out of Service Tracking Log, Attachment 2.

8.0 REFERENCES

- 8.1 Instrument Technical Manuals
- 8.2 Knoll, Glenn F., *Radiation Detection and Measurement*, 2nd Edition. John Wiley and Sons, Inc., 1979.
- 8.3 *Multi-Agency Radiation and Site Investigation Manual (MARSSIM)*, NUREG-1575, Revision 1, Aug 2000.

ATTACHMENT 1**Radiological Instrument Daily Calibration Data****INSTRUMENT:** _____**SERIAL NO.:** _____**CALIBRATION DUE DATE:** _____**DETECTOR:** _____**SERIAL NO.:** _____**SOURCE CHECK MATERIAL:** _____**SERIAL NO.:** _____**COUNT TIME:** _____**VOLTAGE SETTING:** _____**BATTERY CHECK:** _____

Pre-Calibration				
cpm	Average cpm	± 20% (avg. μR/hr)	Date	Initials
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Post-Calibration				
cpm	Average cpm	± 20% (avg. μR/hr)	Date	Initials
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

Reviewed By: _____


ATTACHMENT 2

OUT OF SERVICE TRACKING LOG

Instrument ¹	Serial # ²	Calibration Due Date ³	Out of Service Date ⁴	Remarks ⁵	Returned to Service Date ⁶

- 1. Instrument type
- 2. Instrument serial number
- 3. Calibration due date
- 4. Date removed from service
- 5. Reason instrument removed from service
- 6. Date instrument returned from service

Reviewed By: _____

<p style="text-align: center;">Earth Tech Standard Operating Procedure</p>	<p>PROCEDURE NO. <u>SARSG, SOP 006</u></p> <p>DATE: <u>September 17, 2001</u></p>
<p style="text-align: center;">General Radiological Equipment Checklist</p>	<p>APPROVED:  SARSG Leader</p>

The San Antonio Radiological Services Group is responsible for the issuance, revision, and maintenance of this policy. Any deviations from the procedures set forth in this policy require approval of the SARSG Leader.

1 PURPOSE

This procedure establishes a ready-reference for collecting and transporting the equipment and supplies needed during the performance of radiological surveys.

2 EQUIPMENT

The following items should be available and loaded before departing for the survey site:

- | | |
|-------------------------------|--------------------------------------|
| a. Whatman Filter Paper ____ | p. Steel Toed Boots ____ |
| b. Swipe Envelopes ____ | q. Rain Gear ____ |
| c. TLD badges ____ | r. Sample Log or Numbers ____ |
| d. Leather/Rubber Gloves ____ | s. Health & Safety Plan ____ |
| e. Chalk ____ | t. Ventilation Equipment ____ |
| f. Grease Pencil ____ | u. Batteries (extra for meters) ____ |
| g. Small Tool Box ____ | v. Mantels (marked with an 'X') ____ |
| h. Thermometer ____ | w. Booties ____ |
| i. Check Sources ____ | x. Camera ____ |
| j. Labels ____ | y. Crime Tape & Radiation Signs ____ |
| k. Duct Tape ____ | z. Nylon String ____ |
| l. Radiation Waste Bags ____ | aa. Plastic Sheeting ____ |
| m. Pipe Wrench ____ | bb. Tyvek Suits ____ |
| n. Soil Kit ____ | cc. Bung Wrench * ____ |
| o. Chalk Line Kit ____ | dd. Radiation Detection Meters ____ |

ee. Administrative supplies: Pens, paper, clipboard, grease pencils, white drum markers, permanent makers _____

ff. Step-off Pads _____

gg. Communication Devices _____

hh. P-10 Gas (extra) _____

ii. Coolers _____

jj. Flashlight _____

kk. Sample Containers _____

ll. Sampling Equipment (shovels, picks, etc.) _____

mm. Coveralls _____

nn. Decon Equipment/Supplies _____

oo. Training Folders _____

pp. Field Notebook _____

qq. References (MARSSIM, etc.) _____

rr. Emergency Telephone Numbers _____

ss. Personal Protective Equipment _____

tt. QAPP _____

uu. Work Plan _____

vv. Cell Phones _____

3 Before departing for the job site verify the following tasks have been accomplished:

a. Instruments have been source checked: _____

b. Swipe paper has been marked: _____

c. Detection meters have been packed so as to avoid damage while in transport:

* **NOTE:** Use caution when opening waste drums. If drums or containers are leaking or bulging, notify the Site Manager/RSO.

ATTACHMENT 5

Gamma Walkover Survey Equipment

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Attachment 5. GWS Walkover Survey Equipment

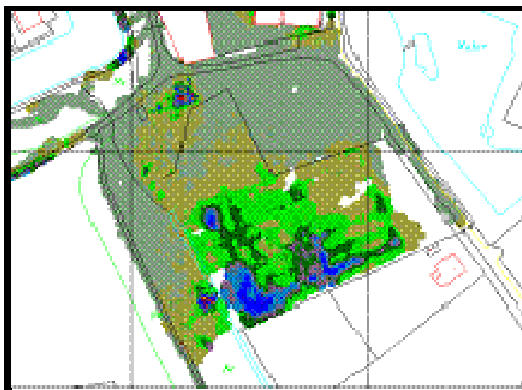
GPS Gamma Scanning Survey System



Man-carried and Cart-mounted GPS-RAD Gamma Scanning Equipment

The Trimble GPS system is used for performing man-carried and cart-mounted walkover and static surveys. For gamma walkover surveys (GWS), the GPS system is interfaced to one (or more) gamma detector(s) of interest for automatic recording of the survey instrument data with the corresponding GPS location coordinates. Gamma detectors such as a NaI(Tl) detector, a BGO plastic scintillator, or the FIDLER are typically used with ratemeters that are configured with RS-232 ports for communication with the GPS. These, or alternative combinations, can be used in a man-carried or a cart-mounted mode.

When interfaced to the SAMS (or other similar instruments), which contains a 2-inch × 2-inch NaI(Tl) detector with built-in high voltage supply, preamplifier, amplifier, analog-to-digital converter, pulse analyzer, and computer-controlled hardware and software, it can be used to perform on-site dose-rate measurements, and radioisotope identification and quantification.



The Trimble GPS logs gamma measurement data from a scintillation detector is typically carried approximately six inches above the ground surface and GPS position information from a portable backpack system. The results are presented in tabular and graphical formats. The position information is accurate to 0.5 meter. The scintillation detector can be setup with a specific energy window or a broad gamma window to detect the gamma

photons from specific radioisotope photons or to measure all gamma energies. The Trimble software can collect data as frequently as one measurement per second. The spatial density depends on the walking speed.

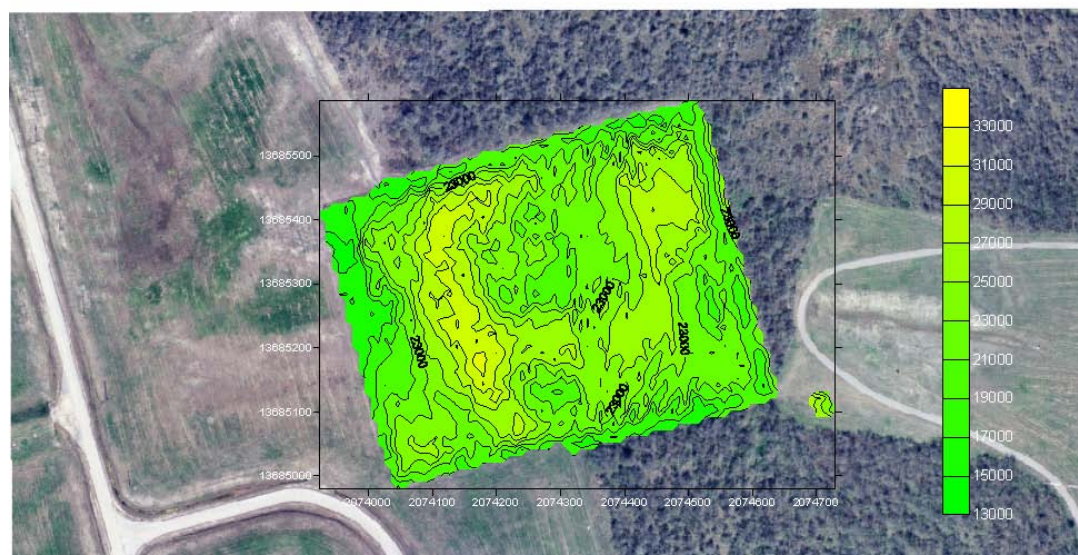
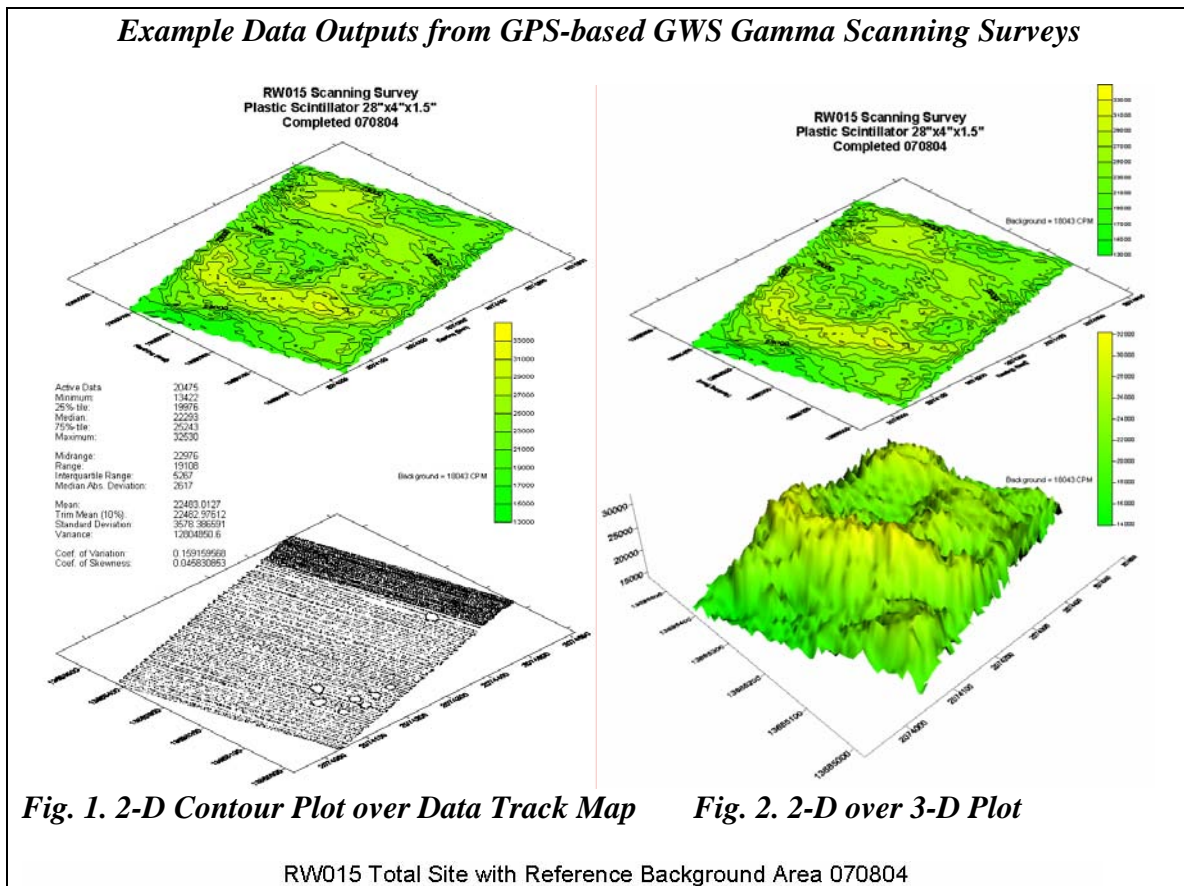


Figure 3. Color Contour Plot over Aerial Photograph (note Background Reference Area at eastern boundary)

Ludlum Model 193-6 Meter with 6" BGO Detector

- ***4 Ranges***
- ***Automatically
Adjusting Alarm
Setting***
- ***Micro-processor
based***
- ***6" X 1" Plastic
Gamma Scintillator***
- ***Total Counting
Range from 0 - 5,000
 $\mu\text{R/hr}$***



INDICATED USE: General purpose survey with alarm capabilities

DETECTOR: 6"(15.2cm) diameter X 1"(2.5cm) thick plastic scintillation detector

SENSITIVITY: Typically 2000 cpm/mR/hr (137Cs gamma)

METER DIAL: 0 - 1 $\mu\text{R/hr}$, BAT TEST (others available)

MULTIPLIERS: X1, X10, X100, X1000

LINEARITY: Reading within $\pm 10\%$ of true value

ALARM: The Model 193 has a dual action alarm.

1. A fixed alarm point can be set at any point from 10% of full scale to full scale, and is indicated by a constant audible tone, and the lamp turning on.
2. A quick deviation alarm that is based on background radiation levels. When the instrument is turned on, it takes an 8 second measurement of background radiation levels and determines a deviation alarm setting. If the radiation level exceeds this setting, the alarm audio will beep every 1/8 second, and the lamp will flash.

AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)

CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)

RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading

RESET: Pushbutton to zero the meter, and also re-accumulate background data and recalculate the alarm point.

POWER: 2 each "D" cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 600 hours with alkaline batteries (battery condition can be checked on meter)

METER: 2.5" (6.4cm) arc, 1 mA analog type

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -20°F(-29°C) to 140°F(60°C)

OVERALL LENGTH: 51"(129.5 cm)

WEIGHT: 8.5 lbs(3.9 kg) including batteries

Ludlum Model 44-10 Gamma Scintillator



INDICATED USE: High energy gamma detection

SCINTILLATOR: 2-inch (5.1-cm) diameter \times 2-inch (5.1-cm) thick NaI(Tl) scintillator

SENSITIVITY: Typically 900 cpm ($\mu\text{R h}^{-1}$)⁻¹ (¹³⁷Cs)

ENERGY RESPONSE: Energy dependent

COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers

TUBE: 2-inch (5.1cm) diameter magnetically shielded photomultiplier

OPERATING VOLTAGE: Typically 500 – 1200 volts

DYNODE STRING RESISTANCE: 60 megohms

CONNECTOR: Series C (others available)

CONSTRUCTION: Aluminum housing with beige polyurethane enamel paint

TEMPERATURE RANGE: -4° F (-20° C) to 122° F (50° C)

SIZE: 2.6 inches (6.6 cm) diameter \times 11 inches (27.9 cm)length

WEIGHT: 2.3 pounds (1.1kg)

FIDLER

Large thin NaI scintillator for the detection of low energy photons. (F)ield (I)nstrument for (D)etecting (L)ow (E)nergy (R)adiation.



Sodium iodide gamma scintillator: Model 489-55, Victoreen Instrument Co.; Model SPA-3, Eberline Instrument Corporation; or equivalent (Thin crystal, Model PG-2, Eberline Instrument Corporation, Model G5 "FIDLER", Bicron Corporation, or equivalent may be used when low energy photons are the radiation of concern).

Portable ratemeter or ratemeter-scaler: Model PRM-6; Eberline Instrument Corporation; Model 2221, Ludlum Instrument Corporation; or equivalent, equipped with audible speaker.

Ludlum Model 2221, Scaler/Ratemeter Single Channel Analyzer



INDICATED USE: Field analysis

COMPATIBLE DETECTORS: G-M, proportional, scintillation

CONNECTOR: Series "C" (others available)

AUDIO: Built in unimorph speaker with volume control (greater than 60 dB at 2 feet, full volume)

AUDIO DIVIDE: Thumb switch for 1, 10, or 100 events-per-click

AUDIO JACK: For optional headset

METER DIAL: 0 - 500 cpm; 50 - 500k cpm logarithmic scale (others available)

MULTIPLIERS: $\times 1$, $\times 10$, $\times 100$, $\times 1k$, and LOG for logarithmic scale

LINEARITY: Reading within $\pm 10\%$ of true value with detector connected

DIGITAL DISPLAY: 6-digit LCD display with 0.5" (1.3 cm) digits

LCD BACKLIGHT: Activated by LAMP switch

DIGITAL RATEMETER: Provides a digital display of count rate when selector switch is in Dig. Rate position

SCALER: Used in conjunction with timer to allow for gross counting with range from 0 - 999999 counts when

selector switch is in Scaler position (controlled by COUNT and HOLD buttons)

TIMER: Switch selectable divisions of 0.1, 0.5, 1, 2, 5, 10 minutes or CONT (continuous) for manual timing

CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)

HIGH VOLTAGE: Adjustable from 200 - 2400 volts (can be checked on display)

THRESHOLD: Adjustable from 100 - 1000 (can be checked on display)

WINDOW: Adjustable from 0 - 1000 above threshold setting (can be turned on or off)

GAIN: Adjustable from 1.5 - 100 mV at threshold setting of 100

OVERLOAD: Senses detector saturation. Indicated by "-----" on LCD display and meter going to full scale (adjustable depending on detector selected)

RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading

RESET: Push-button to zero meter

POWER: 4 each "D" cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 250 hours with alkaline batteries (battery condition can be checked on digital display)

METER: 2.5" (6.4 cm) arc, 1 mA analog type

CONSTRUCTION: Milled and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4°F (-20°C) to 122°F (50°C)

May be certified for operation from -40°F (-40°C) to 150°F (65°C)

SIZE: 9" (22.9 cm) height \times 4.3" (10.9 cm) width \times 10" (25cm) length including handle

WEIGHT: 5.5 lbs (2.5kg) including batteries

Ludlum Model 12 Ratemeter



COMPATIBLE DETECTORS: G-M, proportional, scintillation

METER DIAL: 0 - 500 cpm, 0 - 2.5 kV, BAT TEST (*others available*)

MULTIPLIERS: $\times 1$, $\times 10$, $\times 100$, $\times 1000$

LINEARITY: Reading within plus or minus 10 percent of true value with detector connected

CONNECTOR: Series "C" (*others available*)

AUDIO: Built in unimorph speaker with ON/OFF switch (*greater than 60 dB at 2 feet*)

CALIBRATION CONTROLS: Accessible from front of instrument (*protective cover provided*)

HIGH VOLTAGE: Adjustable from 200 – 2500 volts (*can be read on meter*)

DISCRIMINATOR: Adjustable from 2 – 60 mV

RESPONSE: Toggle switch for FAST (4 s) or SLOW (22 s) from 10 percent to 90 percent of final reading

RESET: Push-button to zero meter

POWER: 2 each D cell batteries (*housed in sealed compartment that is externally accessible*)

BATTERY LIFE: Typically 600 hours with alkaline batteries (*battery condition can be checked on meter*)

METER: 2.5" (6.4 cm) arc, 1 mA analog type

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4°F (-20°C) to 122°F (50°C)

SIZE: 6.5 inches (16.5 cm) height \times 3.5 inches (8.9 cm) width \times 8.5 inches (21.6 cm) length

WEIGHT: 3.5 lbs (1.6 kg) including batteries

Ludlum Model 2241 Digital Survey Meter



INDICATED USE: General purpose survey, gross counting

COMPATIBLE DETECTORS: G-M, proportional, scintillation

CONNECTOR: Series C (others available on request)

AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)

ALERT/ALARM: Indicated by enunciator on display and audible tone

DISPLAY: 4 digit LCD display with 0.5-inch (1.3-cm) high digits, separate enunciators for display units, alert, alarm, low battery, detector overload, counting overflow, and scaler counting

BACKLIGHT: Push-button to activate

RATEMETER: Can display in R/hr, Sv/hr, cpm, or cps when control switch is in RATEMETER position

DISPLAY RANGE: Auto ranging from $0.0 \mu\text{R h}^{-1}$ – 9999 R h^{-1} ; $0.000 \mu\text{Sv h}^{-1}$ – 9999 Sv t^{-1} ; 0 cpm – 999k cpm;

or 0 cps – 100 kcps

LINEARITY: Reading within ± 10 percent of true value with detector connected

SCALER: Activated by push-button in handle (count time adjustable from 1 to 9999 s in 1-s intervals)

CALIBRATION CONTROLS: Accessible from front of instrument (protective cover provided)

HIGH VOLTAGE: Adjustable from 200 volts – 2500 volts

DISCRIMINATOR: Adjustable from 2 mV – 100 mV

OVERLOAD: Indicated by OVERLOAD on display (adjustable depending on detector selected)

RESET: Push-button to zero display, acknowledge and/or reset alarm

POWER: 2 each D cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 200 h with alkaline batteries (low battery indicated on display)

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4°F (-20°C) to 122°F (50°C)

SIZE: 6.5 inches (16.5cm) height \times 3.5 inches (8.9cm) width \times 8.5 inches (21.6cm) length

WEIGHT: 3.5 lbs (1.6kg) including batteries

Ludlum Model 19A MicroR Meter



WORKING ENVIRONMENT: Splash proof shields for outdoor use

INDICATED USE: Low level gamma survey

DETECTOR: 1-inch \times 1-inch sodium iodide NaI(Tl) scintillator

SENSITIVITY: Typically $175 \text{ cpm } (\mu\text{R h}^{-1})^{-1}$ (^{137}Cs gamma)

ENERGY RESPONSE: Energy dependent

METER DIAL: 0 – 500 $\mu\text{R h}^{-1}$ dual colored logarithmic scale, BAT TEST

ALARM: Indicated by red lamp and audible tone (Alarm audio overrides the audio ON/OFF switch)

LIGHT: Push-button to activate

LINEARITY: Reading within ± 10 percent of true value

AUDIO: Built in unimorph speaker with ON/OFF switch (greater than 60 dB at 2 feet)

CALIBRATION CONTROLS: All calibration controls are internal

RESPONSE: Dependent on number of counts present (typically not greater than 7 seconds from 10 percent to 90 percent of final reading)

RESET: Push-button to zero meter

POWER: 2 each “D” cell batteries (housed in sealed compartment that is externally accessible)

BATTERY LIFE: Typically 600 h with alkaline batteries (battery condition can be checked on meter)

METER: 2.5 inches (6.4 cm) arc, 1 mA analog type

CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint

TEMPERATURE RANGE: -4°F (-20°C) to 122°F (50°C)

SIZE: 7.8 inches (19.8 cm) height \times 3.5 inches (8.9 cm) width \times 8.5 inches (21.6 cm) length

WEIGHT: 4.5 pounds (2.1 kg) including batteries