

**RADIOLOGICAL WORK PLAN FOR
3821 RIVER ROAD
TOWN OF TONAWANDA, NEW YORK
NYSDEC SITE #C915003**

Prepared for:



**Inventum Engineering, PC
441 Carlisle Drive, Suite C
Herndon, Virginia 20170**

Prepared by:



MJW CORPORATION
Radiation Consulting Professionals

**15 Hazelwood Drive, Suite 112
Amherst, New York 14228**

January 28, 2025

MJW Job No. 24.1022.1

Acronyms:

ALARA – as low as reasonably achievable
ASTs – aboveground storage tanks
BCP – Brownfield Cleanup Program
CAMP – Community Air Monitoring Program
COC – chain of custody
CPM – counts per minute
DPM – disintegrations per minute
ECDIA – Erie County Industrial Development Agency
HASP – Health and Safety Plan
HAZWOPER – Hazardous Waste Operations and Emergency Response
IRM(s) – Interim Remedial Measures
NORM – Normally Occurring Radioactive material
NRC – Nuclear Regulatory Commission
NYS – New York state
NYSDEC – New York State Department of Environmental Conservation
NYSDOH – New York State Department of Health
ORNL – Oak Ridge National Laboratory
OSC – On-site coordinator
pCi/g – picocuries per gram
PPE – Personal Protective Equipment
RAWP – Remedial Action Work Plan
RCS – Radiological Control Supervisory personnel
RCT – Radiation Protection Technicians/radiological control technicians
RIR – Remedial Investigation Report
RITC – Riverview Innovation and Technology Campus
RIWP – Remedial Investigation Work Plan
RSO – Radiation Safety Officer
RWP – Radiological Work Plan
TCC – Tonawanda Coke Corporation
TENORM – Technologically Enhanced Naturally Occurring Radioactive Material

1.0 Introduction

1.1 General

This Radiological Work Plan (RWP) has been prepared to address the radiological monitoring and safety activities required during the ongoing site investigation activities to determine the presence of potential Technically Enhanced Naturally Occurring Radioactive Material (TENORM). Slag was encountered during the Remedial Investigation of the 3821 River Road Brownfield Cleanup Program (BCP) Site located at 3821 River Road in the Town of Tonawanda, New York. TENORM was detected during the Remedial Investigation and subsequent radiologic surveys at the adjoining Riverview Innovation & Technology Campus (RITC) BCP Site located at 3875 River Road, Town of Tonawanda, New York.

In accordance with the approved RITC Remedial Investigation Work Plan (RIWP) for the adjacent RITC site, the slag was screened by MJW and submitted for radiological analysis. The results of the analyses conducted by MJW were included in the RITC draft Remedial Investigation Report (RIR) and comments from the New York State Department of Environmental Conservation (NYSDEC) triggered the need for additional testing to define the procedure required for the development of the Remedial Action Work Plan (RAWP). Remediation of TENORM is not a requirement of the BCP, a component of the alternatives analysis process, or a criterion for selection of the remedial actions at the BCP Site. The management of TENORM is a criteria of the RAWP and a Site Management Plan.

The 3821 River Road BCP Site (#C915003), owned by 3821 River Road, Inc., is the parcel adjacent to the south of RITC BCP Site (#C915353), and commonly referred to as the “Plastics” site. Attachment 1 shows the location of the 3821 River Road BCP Site with respect to River Road and the RITC site. Industrial properties and the Niagara River are located further west of River Road. In addition to the work described herein, MJW has conducted work for other properties around the 3821 River Road BCP Site. For clarity, the following site names are used by MJW:

- 3821 River Road BCP Site – The 3821 River Road property or “Plastics” which is entered into the BCP. The site number is #C915003 and the Site owner is 3821 River Road, Inc.
- Site 108 – 3800 River Road, a portion of the former Tonawanda Coke Corporation (TCC) State Superfund Site, NYSDEC #915055, OU3. Site 108 is owned by RITC.
- 4111 River Road Site – Property previously owned by the Erie County Industrial Development Agency (ECIDA), now owned by the Town of Tonawanda. The 4111 River Road Site is north of the BCP Site, separated by a railroad right-of-way. Work on this Site was conducted for the ECIDA.
- 3875 River Road BCP Site (#C915353) – The adjacent former Tonawanda Coke Facility which is now the Riverview Innovation & Technology Campus (RITC) and is under investigation and remediation through the BCP. An approved Radiological Work Plan is in place for the RITC BCP Site and the TENORM investigation is being conducted by MJW and a draft TENORM Investigation Summary Report was submitted to NYSDEC in September 2024. Comments were received on the draft TENORM Investigation Summary Report in December 2024 and a revised draft TENORM Investigation Summary Report was resubmitted in January 2025.

This Work Plan provides specific work details, the areal and vertical extent of the 3821 River Road BCP Site that is being investigated to determine if TENORM is present on the Site and provides all existing

data available from the project area for development of radiological work precautions. The RIWP¹ is available on the NYSDEC Infocator: (<https://extapps.dec.ny.gov/data/DecDocs/C915003/>).

This investigation work plan, as with the work plan submitted for the RITC site, includes the components of the new policy document DMM-5 issued by NYSDEC regarding management of TENORM (Reference 1). Guidance is provided for how to appropriately handle TENORM encountered during construction or earthwork projects, such as clearing, grading, excavation, filling, demolition, or stockpiling.

The MJW Corporation has been performing radiological work in Western New York, New York State and several other sites in the US since 1991. MJW has been involved in the characterization and remediation of sites with potential radiological issues across a wide spectrum of nuclides and quantities. Consequently, MJW has developed procedures to perform all of the tasks necessary to characterize the potential for TENORM on the 3821 River Road BCP Site and also to provide the expert radiological management and trained technicians to ensure work done on the 3821 River Road BCP Site is done safely when TENORM or radioactive source management is required.

1.2 Previous Site Investigative Work

The 3821 River Road BCP Site has been the subject of detailed remedial investigation activities since the fourth quarter of 1981.

The BCP Site was originally developed by Allied in the early 1950s and was operated as a manufacturing facility through 1982. The area was serviced by numerous rail lines to deliver coal and transport coke, tar and other by products of the TCC coking process. The 3821 River Road BCP Site was used by the TCC for administrative facilities and warehousing. The RITC site was utilized for active industry with the tracks, including those of a central coal stacker reclaimer, were constructed over ballast composed primarily of various types of slag. The samples listed in Table 1 in Section 1.2.1 represent the different slag materials encountered during the RI at the neighboring RITC site (3875 River Road). Although the origin of the slag is unknown, it would have likely been purchased starting in 1917, there was a fully integrated steel mill adjacent to the TCC Site that was known to have produced both blast furnace and open-hearth furnace slags. The steelmaking process may have slightly increased the Naturally Occurring Radioactive Material (NORM) in their raw materials but as previously mentioned the slag tested during the Remedial Investigation were tested and the Ra-226 concentrations averaged about 3 picocuries per gram (pCi/g) as did the U-238 (alpha spec) concentrations. These results are a classic example of NORM as the primordial isotopes are in secular equilibrium and thus have similar and/or identical concentrations. Given 3821 River Road is adjacent to the RITC site it is likely that the soils for that site may also contain NORM as well.

Following the identification of possible TENORM slag on adjacent properties, MJW conducted a GPS-enhanced overland gamma survey at the 3821 River Road BCP site to provide for additional environmental characterization and the development of the 3821 River Road BCP Site Radiological Work Plan. This initial walkover, conducted in October 2023, revealed a limited number of relatively small locations of elevated measurements between 1.5 to 2 times background. Refer to Section 1.4 for additional details regarding the results of this survey.

¹ https://extapps.dec.ny.gov/data/DecDocs/C915003/Report.BCP.C915003.2017-10-31.Investigation_Summary.pdf

1.2.1 Previous Investigations of Adjacent Sites

At the time the RIWP was prepared, the potential for slag materials was not addressed as there was no direct evidence of the presence of materials until they were encountered during the field investigations for the adjacent RITC site and several rail lines from that site crossed the 3821 River Road Site boundary. During the RITC BCP Remedial Investigation, Inventum Engineering, P.C. (Inventum) and the NYSDEC observed possible TENORM slag and samples were collected for screening and subsequently submitted for radiological analysis. MJW performed a GPS-enhanced overland gamma survey in response to comments on the Draft RIR and to provide data for the preparation of the RITC site work plan. MJW has completed soil sampling on the RITC site, Site 108 and the 4111 Site beginning in late 2020.

Samples collected on the adjacent site RITC site are included in the report *Analytical Data Quality Assurance Review for Six Soil Samples Collected During a Site Investigation of The Tonawanda Coke River Road Facility in Tonawanda, NY* dated February 10, 2021 (Attachment 2) and the draft summary report for the 2024 survey and sampling efforts. The samples described in the 2021 report were collected between October 30, 2020, and November 18, 2020. The samples were submitted to Eurofins TestAmerica in St. Louis, MO with gamma spectroscopy and alpha spectroscopy analyses performed for U-238 and Th-232. A summary of the radiological analytical results is shown in Table 1 below.

Table 1. RITC site (3875 River Road) Test Pit Soil Analysis (Samples Collected 10/30 to 11/18/2020)

	901.1, Gamma Spec	901.1, Gamma Spec	Alpha Spec	901.1, Gamma Spec	Alpha Spec
<i>Method→</i>					
Sample Number	[Ra-226], pCi/g	[U-238], pCi/g	[U-238], pCi/g	[Th-232], pCi/g	[Th-232], pCi/g
TP-BCP-34-A	4.46	5.04	3.12	0.858	1.36
TP-BCP-34-B	3.7	2.73	4.06	0.561	0.737
TP-BCP-32-W45	0.515	0.851	0.474	0.735	1.58
TP-BCP-44A	2.99	2.42	2.31	1.07	0.322
TP-BCP-44B	3.26	3.5	4.35	1.22	0.783
TP-BCP-47	3.79	1.59	3.29	2.58	1.95
Averages:	3.12	2.67	2.93	1.17	1.12

The gamma spectroscopy analyses for Ra-226 and gamma and alpha spectroscopy analysis for U-238 show that all samples analyzed are in equilibrium, and thus were classified as NORM. Th-232 results show an average of about 1.12 pCi/g which is very near normal Th-232 background concentrations of 1 pCi/g. The sample locations are shown in Attachment 2.

Although policy DMM-5 does not address NORM specifically, it should be pointed out that the Table 1 reported low level concentrations of NORM have no radiological consequences, especially for an industrial/commercial site. This is due to the fact that there are no possible pathways for exposure, i.e., no drinking water wells, no crops being grown in the soil, no potential for inhalation exposures and no possibility for direct radiation exposures above background. Even the most rudimentary risk assessment would demonstrate this to be true.

The development of the 3821 River Road BCP Site by Allied in the 1950's may have included slag obtained from the same 1917 source as found on the adjacent RITC site.

1.3 Discussion of Tonawanda Regional Radiological Background in Soils

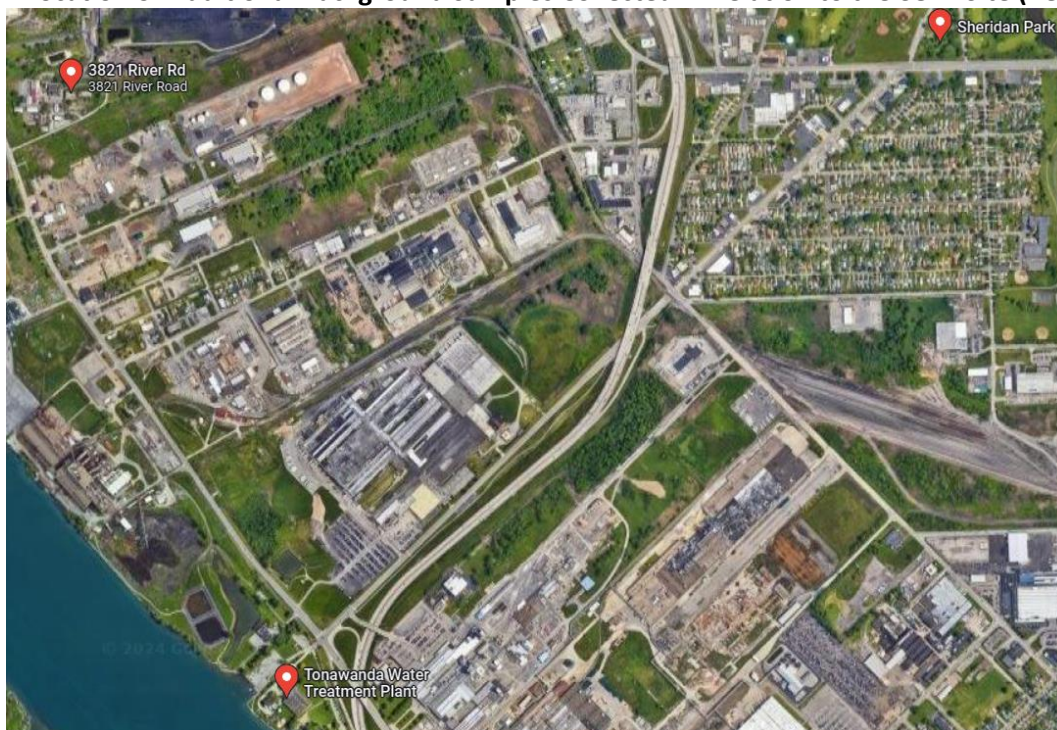
The initial background sample for the 3821 River Road BCP Site was collected from the 4111 River Road site adjacent to, and just north of, the RITC site. It should be noted that this property lies between a railroad right of way, and has former rail lines, and the adjacent large fly ash landfill (the NRG landfill for the former Huntley station is immediately north of 4111 River Road). Unfortunately, the 4111 River Road background sample analysis did not produce a usable U-238 value as alpha spectroscopy analysis was not requested, only gamma spectroscopy. The Ra-226, Ra-228 and Th-232 values for the 4111 River Road Site sample were usable and indicated background-comparable levels of Radium (Ra-226) of 2.06 Ci/g, Ra-228 of 1.38 pCi/g and Th-232 of 1.38 pCi/g, respectively. Due to this unusable result for U-238, MJW decided to collect two additional area background samples for analysis. One from the Tonawanda Treatment Plant property near Aqua Lane (GPS coordinates 42°57'54.6"N 78°55'22.3"W) and one in Sheridan Park just north of Sheridan Drive (GPS coordinates 42°58'54.2"N 78°54'04.0"W). These additional sample data are shown in Table 2 below and sample locations in relation to the RITC are shown on Figure 1 below.

Table 2. Results of Additional Background Sampling for the 3821 Site (Samples Collected 12/24/2023)

<i>Method→</i>	901.1, Gamma Spec	901.1, Gamma Spec	901.1, Gamma Spec
Sample Number	[Ra-226], pCi/g	[U-238], pCi/g	[Ra-228], pCi/g
01122024-TWT1	0.822	1.02	0.986
01122024-SB1	0.734	1.48	0
01122024-TWT1(DUP)	0.673	0	1.25
Average (Non-Zero Results)	0.74	1.25	1.12

The sample collected at the Tonawanda Water Treatment Plant (TWT1) is located 1.11 miles south of the 3821 River Road BCP Site. The Sheridan Park sample (SB1) is located 1.48 miles east of the 3821 River Road BCP Site. The average concentration results are slightly below the other background sample results discussed above. This lower background is utilized as the location history of the TWT1 and SB1 background samples have a low potential for historic radiological impacts. The location of these additional samples in relation to the 3821 River Road BCP Site are shown in Figure 1 below.

Figure 1. Location of Additional Background Samples Collected in Relation to the 3821 Site (Red Dots)



It should be noted that in Oak Ridge National Laboratory (ORNL) report number ORNL/TM-7343 (11/1981) titled "State Background Radiation Levels: Results of Measurements Taken During 1975-1979", six surface soil samples were collected in New York State, three collected in the Tonawanda area as follows:

- *NY-1 City of Tonawanda at the city limit on River Rd. across from Consolidated Freightways Terminal (about 1.5 miles north of the 3821 River Road BCP Site). Measured soil nuclide concentrations were: Ra-226, 0.97 ± 0.08 pCi/g; Th-232, 0.65 ± 0.06 pCi/g, and U-238, 0.99 pCi/g.*
- *NY-3 West side of River Rd. across from the Allied Chemical Corp. (5 miles north of the 3821 River Road BCP site). Measured soil nuclide concentrations were: Ra-226, 1.2 ± 0.04 pCi/g; Th-232, 0.88 ± 0.06 pCi/g, and U-238, 1.2 pCi/g.*
- *NY-4 Intersection of Tonawanda Creek Rd. and Niagara Falls Blvd. in North Tonawanda (5.8 mi northeast of the 3821 River Road BCP Site). Measured soil nuclide concentrations were: Ra-226, 0.69 ± 0.04 pCi/g; Th-232, 0.40 ± 0.12 pCi/g, and U-238, 0.76 pCi/g.*

The three other New York sites that were sampled were all in Lockport, NY (approximately 18 miles directly northeast of the BCP Site) and reported similar background values to those above. The three U-238 values were: NY-2, 0.97; NY-5, 0.85, and NY-6, 0.96 pCi/g. The average of all reported U-238 soil samples analyzed is 0.96 pCi/g, for Ra-226 the average is 0.85 pCi/g and for Th-232 the average is 0.71 pCi/g. All reported counting errors were 2 Sigma.

1.4 GPS-Enhanced Gamma Walkover Survey of the BCP Site

A review of the information in Table 1 in Section 1.2.1 shows that for the adjacent RITC BCP Site, six slag samples were taken in February of 2021 during the remedial investigation. As a result of the preliminary remedial investigation sample results and comments from the NYSDEC for the RITC site, a gamma walkover survey was then conducted at the 3821 River Road BCP Site and the RITC site to provide information to prepare the respective site work plans. Attachment 3 is titled *Gamma Walkover Survey Report for the Riverview Innovation & Technology Campus, Inc. 3875 River Road, Tonawanda, New York 14150. BCP SITE No. C915353.*

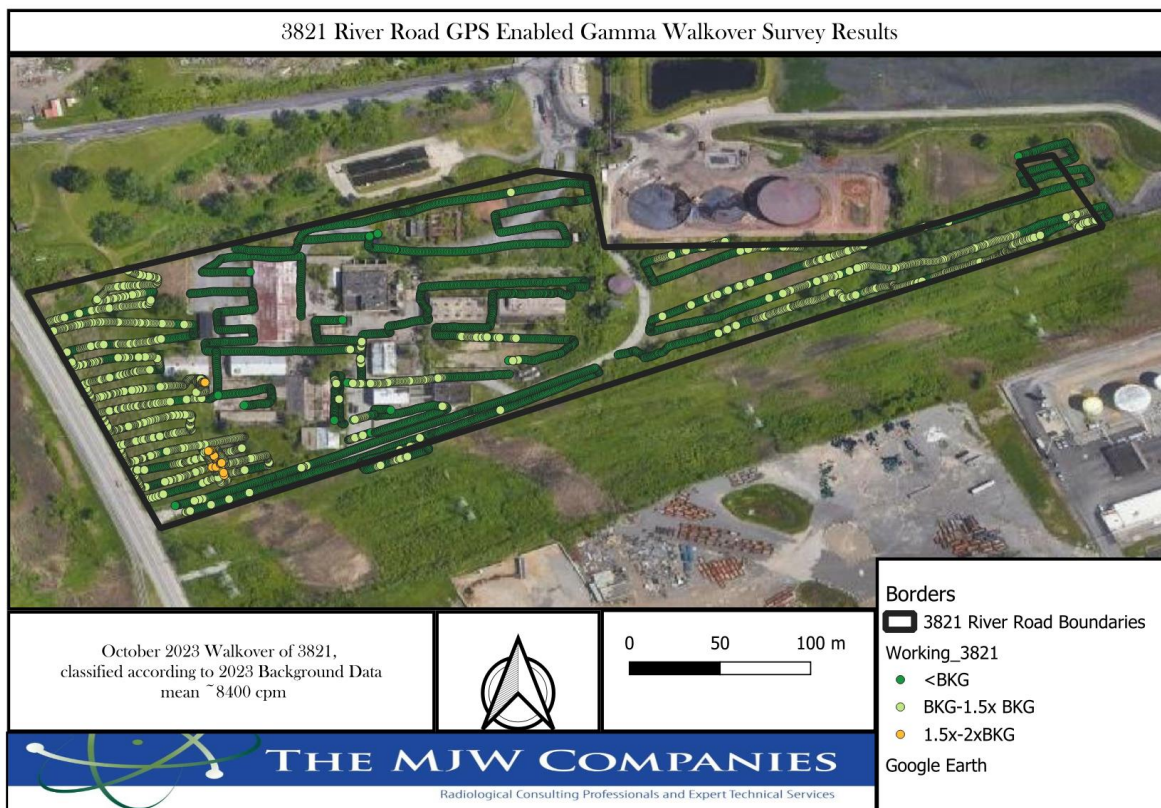
The procedural details of the overland gamma walkover survey of the area are described in MJWRCP-40 - GPS Gamma Survey Procedure (See Attachment 5). Briefly, a Ludlum model 43-10 2" x 2" NaI detector is coupled to a Ludlum 2241-2 ratemeter (or equivalent) and further coupled with a Trimble datalogger and GPS unit mounted in either a wheeled cart or backpack. The following data activities are included: (1) properly collect and record GPS enhanced gamma radiation survey data followed by, (2) properly downloading survey data from the Trimble datalogger, or equivalent, (3) evaluate and correct the survey data, and (4) export the data into an ArcView shapefile format for use in geographical mapping software (i.e., ESRI ArcGIS, VSP, etc.) or equivalently capable geographical positioning software.

The results of the gamma walkover survey performed in October of 2023 on the 3821 River Road BCP Site (Figure 2) show a lack of elevated areas of gamma activity. No data points were evaluated as being twice the background level, with only 32 of more than 7000 above the 1.5 times background cutoff. Statistical analysis did indicate gamma rate clustering. Comparison of the 10 nearest-neighbors gamma activity to each data point provided an R^2 value of .921. The ability of each measurement to coincide and predict the surrounding measurements creates a basis for establishing the bounds of potential elevated activity.

The focus of this work plan is to expand upon this preliminary GPS overland gamma information by:

1. Performing additional gamma walkover survey(s) beginning in line with the potential elevated activity areas and scan the property in a north/south direction with a crosshatch pattern applied where elevated activity may be suspected. The additional walkover survey will also improve 3821 River Road BCP Site coverage, as the preliminary survey had several inaccessible areas (due to ongoing work, weather conditions, etc.).
2. Following this additional walkover survey, MJW technical staff will collect eight (8) biased soil samples and four (4) unbiased surface and subsurface samples in and around areas of elevated activity. Two (2) unbiased soil samples will be collected unassociated with elevated activity.

Figure 2.



Radiological monitoring and related actions are required for all activities that may be impacted by TENORM materials at the 3821 River Road BCP Site to protect public and worker health and safety and to control potential release of materials off-site (i.e., fugitive dust emissions, runoff, etc.) to levels as low as reasonably achievable (ALARA). Attachment 4 is MJWRCP-03, Field Investigation Survey Procedure, dated September 15, 2015. The 3821 River Road BCP Site has an ongoing NYSDEC and New York State Department of Health (NYSDOH) approved Community Air Monitoring Program (CAMP) that will be implemented throughout all sampling activities.

SITE DESCRIPTION

2.0 Site History

The 3821 River Road BCP Site was originally developed by Allied in the early 1950s and was operated as a manufacturing facility through 1982. Site operations included the polymerization of ethylene into low molecular weight polyethylene (trademark: A-C Polyethylene and Co-polymers), which was finished into powder, pelleted and solid forms.

Allied sold the property to Rouse Breihan, Inc. in 1985. After the change in ownership, several of the Site buildings were used for office and laboratory space, vehicle maintenance, and warehousing by the TCC up until the shutdown of TCC operations in October 2018. TCC was the previous property owner and site operator of the adjoining property to the north and east of the Site. The former TCC property is now owned by the RITC. A trucking firm previously leased space at the Site from Rouse-Breihan for offices,

truck maintenance and repair. The purchase of the subject property by 3821 River Road, Inc. was completed August 2022. The Site had been vacant since 2019 until the purchase by 3821 River Road, Inc.

Approximately 27 buildings were recently present on the 3821 River Road Site and along with 12 aboveground storage tanks (ASTs) with aboveground and below grade piping located in the center portion of the Site. The ASTs are actively being removed, the above ground piping has been removed, and only three of the 27 remain. The slab-on-grade concrete buildings pads are still present for the previously demolished buildings

The 3821 River Road BCP site is a volunteer under the terms of the BCP Agreement signed on January 24, 2023 (NYSDEC, 2020a). The volunteer status is a recognition that the 3821 River Road, Inc. never operated any of the plant's equipment that had possibly caused releases to the environment, never disposed any waste on or from the 3821 River Road BCP Site and have never conducted any commercial or industrial operations on the 3821 River Road BCP Site and has exercised all appropriate care since acquisition. Additionally, in recognition of the focus of this Radiological Work Plan, 3821 River Road, Inc. did not import any slag materials to the 3821 River Road BCP Site. Based on the results of Remedial Investigations at adjacent sites, any slag was used for construction of property's permanent structures, presumably starting in or about 1950.

Since the acquisition, 3821 River Road, Inc. implemented a series of NYSDEC and NYSDOH approved Interim Remedial Measures (IRMs) and associated activities to improve the safety, eliminate potential sources of releases, and improve control of the remaining infrastructure, both within and outside the requirements of the BCP Program. The implemented and ongoing IRMs are eliminating potential exposures and safety hazards on the 3821 River Road BCP Site. Descriptions of the Remedial Investigation, alternatives analysis, and IRM scope of work completed under the BCP are provided in the work plans and reports posted on the NYSDEC InfoLocator. Work completed prior to and during the Remedial Investigation that has dramatically improved conditions on the 3821 River Road BCP Site include, but are not limited to:

- Site Security – Changed gate access codes and installed security cameras. Cameras are monitored 24/7;
- Secured drums and containers that were stored incorrectly, unstable or unsafe;
- Disposal of laboratory chemicals
- Disposal of waste oils;
- Asbestos abatement;
- Aboveground piping removal;
- AST decommissioning;
- Hazardous Material Management and Waste Management for proper disposal;
- Vegetation Management to allow walkover surveys;
- Building demolition of condemned structures; and
- Conducting daily perimeter fence and security inspections.

3.0 Work Plan Roles and Responsibilities

The project team for the implementation of this radiological work plan include:

Project Manager – The project manager overseeing this work plan is the president of MJW, David A. Dooley, Ph.D., CHP. Dr. Dooley brings 40 years of experience to this work.

Radiation Safety Officer – Alex Bartels is MJW’s Radiation Safety Officer (RSO) for our NYSDOH radioactive materials license and he oversees all of the radiation protection technicians we employ.

Radiation Protection Technicians – MJW’s radiation protection technicians are trained according to MJW’s Radiological Control Manual and all of the associated implementing procedures. They are also required to have current Hazardous Waste Operations and Emergency Response (HAZWOPER) training.

MJW is not managing the ongoing IRMs on the property and will comply with the On-site Coordinator’s (OSC) Health and Safety Plan (HASP) and the 3821 River Road BCP Site Community Air Monitoring Program (CAMP). MJW will coordinate all onsite activities with OSC.

4.0 Overland GPS Gamma Survey Protocols

As described, MJW will perform additional gamma walkover survey(s) beginning just east of the potential elevated activity areas (Western Edge of permanent structures) and scan the property in a north/south direction and work the survey crosshatch to provide as much information as possible about the extent of potential elevated activity areas. The instrumentation to be used is described above in Section 1.4. All overland gamma GPS assisted property surveys shall be performed in accordance with MJW Radiological Control Procedure No. 40., Performing a GPS Enhanced Radiation Survey and Data Assessment, Rev.4, dated October 29, 2021. MJWRCP 40 is attached to this work plan as Attachment 5.

5.0 Soil Sample Collection and Analysis

Following the additional walkover survey, MJW technical staff will collect 8 biased surface and subsurface soil samples and 4 unbiased surface and subsurface samples in and around the areas of elevated activity areas. 2 unbiased samples will be collected with no regard for walkover data. The sample locations will be marked in the field with pin flags noting the associated sample numbers. OSC will document the location and elevation using the onsite GPS equipment.

All soil sample collection will be performed in accordance with MJWRCP-66 Soil Sampling Protocols Rev. 0 dated December 4, 2020. This procedure is shown in Attachment 6. Attachment 7 is the Soil Sample Data Sheet which catalogs all of the field data used for the selection of the location including sample type, radiation readings at various distances, analyses requested, etc.

6.0 Laboratory Analysis of Samples

Collected samples will be placed in appropriate containers and shipped to an accredited laboratory for radiological analysis. MJW routinely uses GEL Labs located in Charleston, SC and that is the laboratory proposed for the sampling of this work plan.

For more information about GEL's radiochemistry services see the following link:

<https://www.gel.com/laboratories/services/radiochemistry-analysis> GEL's chain of custody (COC) form is shown in Attachment 8.

7.0 Disposition of On-Site Background-Comparable Material

During the investigation, MJW would seek to return the material from the test pits to the excavation area. In accordance with DMM-5 policy Section B: "TENORM (Background-comparable) (below 5 pCi/g of radium-226) – the Department may either grant a variance to allow the excavated TENORM (Background-comparable) to be returned to the excavation/AOC, or the assigned ERS determines, and approves, that the proposed use and handling in the AOC is acceptable. The Department will also require that appropriate and approved institutional control(s) be put in place (e.g., deed restriction, environmental easement) for each AOC." For purposes of this investigation phase, we initially assume the site soils are "background comparable" if gamma activity data is the same as or lower than that of similar associated sites; of which all samples analyzed have been below the DMM-5 policy value of 5 pCi/g. The range of sample data concentrations collected to date will not significantly increase radiological risk to anyone working on or near the site if it is re-interred. The long-term plan for the site is industrial/commercial allowing any remaining materials to be interred under a building slab or a parking lot as was the case for the 310 Ship Canal site per Part C "Management Plan Requirements for TENORM Fill". The work plan will be revised to change "background level" to "background-comparable". In MJW's experience with this material, Ra-226 concentrations for overland gamma surveys have to typically be at least 2-3 times background levels to be considered statistically significant. Lastly, DMM-5 policy (Reference 1), Sections 3 and 4 discuss survey levels at 1.5 times background as a level above background that should be investigated. MJW has 2 Ph.D. statisticians on staff and their characterization on this issue is that 1.5 times background is extremely difficult to confirm that it is statistically significantly above soil background levels. In the attached Excel file, please find an example of this very issue on a site in the western US. The point of the graph shown is that the average Ra-226 concentration is 1.14 ± 0.25 pCi/g while the average gamma count per minute (CPM) is $12,023 \pm 1,339.4$. The graph trendline shows a Coefficient of Correlation or R^2 value of 0.22 which means there is little correlation between these two values. The problem is natural soils have more energetic gamma signals from K-40 and Th-232 daughters than from Ra-226.

8.0 Radiological Controls and Workplace Safety

Radiation Protection Technicians/radiological control technicians (RCT) and radiological control supervisory personnel (RCS) will provide radiological coverage to ensure the radiological safety of MJW, OSC and Inventum Engineering workers during work activities required for any surface and subsurface survey and sampling work.

8.1 Radiological Monitoring Documentation

The RCT and/or RCS will complete daily field notes to identify work activities performed, site conditions, notable events, and radiological findings. The notes will include a site work area map and samples collected. MJW Corporation "Survey Data Form" (Attachment 9) will be completed for all walk-over or investigative surveys performed in response to significantly elevated instrument readings or off-normal events (i.e., instrument count rates > 2 times background or personnel contamination. A COC form (Attachment 8) will be initiated in the field for all samples collected.

9.0 Personal Protective Equipment (PPE) and Radiological Hygiene

Workers will follow all requirements for PPE and hygiene actions based on radiological, chemical, and physical hazards as established by MJW safety manuals and procedures and the OSC Health and Safety Plan for the 3821 River Road BCP Site. The minimum requirements based upon anticipated radiological and physical conditions will include:

9.1 Required PPE

The required PPE will be worn at all times on the site outside the parking lot or office building.

- Safety glasses or shield,
- Hard hat,
- Ear plugs,
- Hard-toe work boots,
- Work gloves, and
- Safety (high visibility) vest or similar.

More stringent controls may be required if higher levels of radioactivity are encountered.

9.2 Hygiene and Contamination Monitoring

The following precautions shall be observed to promote work-place safety and in accordance with the 3821 River Road BCP Site HASP (Appendix B of the RIWP):

- No eating, drinking, smoking, or chewing within any active work area,
- Hand washing required upon exit from any active work area,
- Hand and foot radiological survey meter "frisk" when exiting areas where elevated radioactivity has been detected. Personnel frisks will be performed using the Ludlum 44-9 GM probe and/or the Ludlum 44-89, alpha/beta probe or equivalent instrument combinations.
- Excavator buckets and tires/tracks to be frisked before release to non-restricted use.

When release surveys using field instruments exceed 2 times the instrument background count rate, the RCT and RCS will take measures to confirm results using longer count times or by moving more slowly over the area. If an elevated count rate is confirmed, the RCT may wipe or wash the area, remove debris or soil material and resurvey the area until readings indicate ALARA. Materials or personnel exceeding 3 times instrument backgrounds should not be released without further decontamination efforts and count rates indicate ALARA. This information will be documented on forms such as those similar to Attachment 9 MJWRCP-04. Rad Contamination Survey Map and Data Sheet.

Materials and equipment released for unrestricted use will not exceed New York State (NYS) and Nuclear Regulatory Commission (NRC) limits as stated in NYSDOH Radiation Guide 10.10, Table 1 (Attachment 10), see Reference 2. It is the responsibility of the RCS to evaluate field instrument counts per minute (CPM) against Table 1 release limits in disintegrations per minute (DPM) using instrument calibration factors for the radionuclides of interest.

9.3 Community Air Monitoring Program (CAMP)

MJW supported by Ontario Specialty Contractor (OSC), the 3821 River Road General Contractor, will take reasonable steps to suppress potentially contaminated fugitive dusts such as misting with water or curtailing intrusive activities. Dust monitoring shall be conducted in accordance with the 3821 River Road BCP Site CAMP (Appendix C of the RIWP) by Inventum. In addition to the perimeter monitoring conducted for the CAMP, a potable air monitoring station will be located no more than 50-feet downwind of the subsurface sample locations that involve the use of heavy construction equipment.

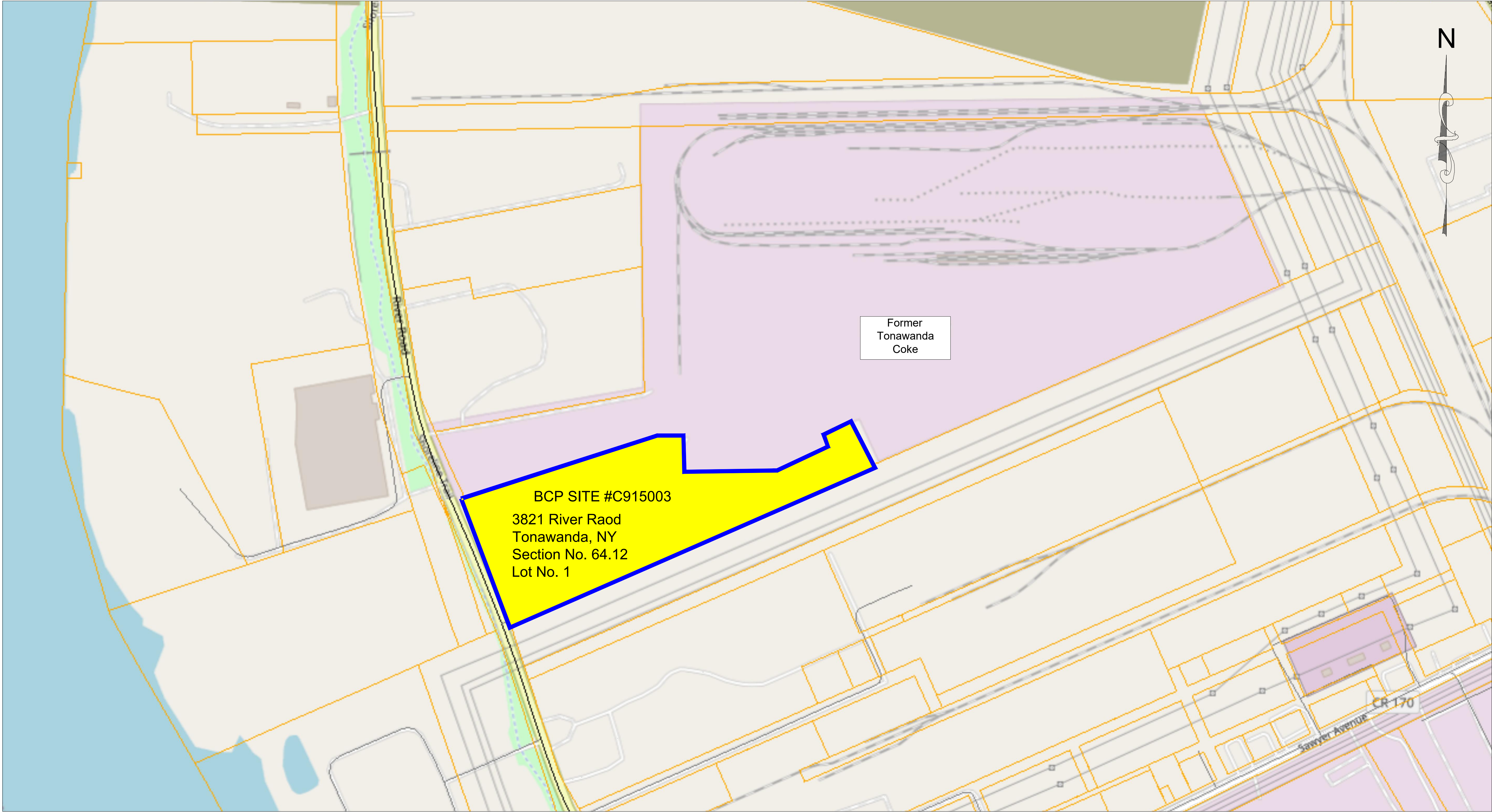
10.0 Reports

MJW will prepare a report detailing the activities and the results of the additional GPS overland gamma survey performed and the activities and analytical results for all surface and subsurface soils collected. The report and data will be in a form that will allow Inventum Engineering to incorporate the requirements into the RAWP and the Site Management plans for the 3821 River Road BCP Site.

11.0 References

1. NYSDEC, Radioactive Materials Management Section, 2023, DMM-5, Management of Soils Contaminated with Technologically Enhanced Naturally Occurring Radioactive Material (TENORM), October.
2. NYSDOH Radiation Guide 10.10, 1986, Guide for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Radioactive Materials.
3. Inventum, October 20, 2023, Remedial Investigation Work Plan, Riverview Innovation & Technology Campus, Brownfield Cleanup Program, Site No. C915353, 3875 River Road, Tonawanda, NY 14150.
4. Inventum, August 18, 2023, Draft, Remedial Investigation Report, Riverview Innovation & Technology Campus, Brownfield Cleanup Program, Site No. C915353, 3875 River Road, Tonawanda, NY 14150.

Attachment 1. Associated Figures



Erie County, New York, Interactive Mapping Viewer, www2.erie.gov/gis

D

DRAWING BY

CHECKED

APPROVED

RB

PROPERTY OF INVENTUM ENGINEERING

IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND AS SUCH IS SUBJECT TO RECALL AT ANY TIME WITHOUT NOTICE. IT IS NOT TO BE REPRODUCED OR COPIED IN ANY FORM FOR THE BENEFIT OF PARTIES OTHER THAN NECESSARY PARTNERS, FINANCIAL INSTITUTIONS, OR EMPLOYEES OF INVENTUM ENGINEERING. ANY REPRODUCTION OR COPIING WITHOUT THE WRITTEN CONSENT OF INVENTUM ENGINEERING IS PROHIBITED.

NOTICE: THIS DRAWING HAS BEEN PREPARED UNDER THE PROFESSIONAL SEAL AND SIGNATURE OF AN ENGINEER. ANY REPRODUCTION OR COPIING WITHOUT THE WRITTEN CONSENT OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS DOCUMENT IN ANY WAY.

INVENTUM ENGINEERING

441 CARLISLE DRIVE

SUITE C

HERNDON, VIRGINIA 20170

(703) 722-6049

www.InventumEng.com

FIGURE 1

DRAWING NUMBER

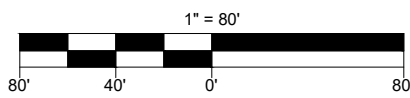
RI WORKPLAN

SITE LOCATION MAP

3821 RIVER ROAD

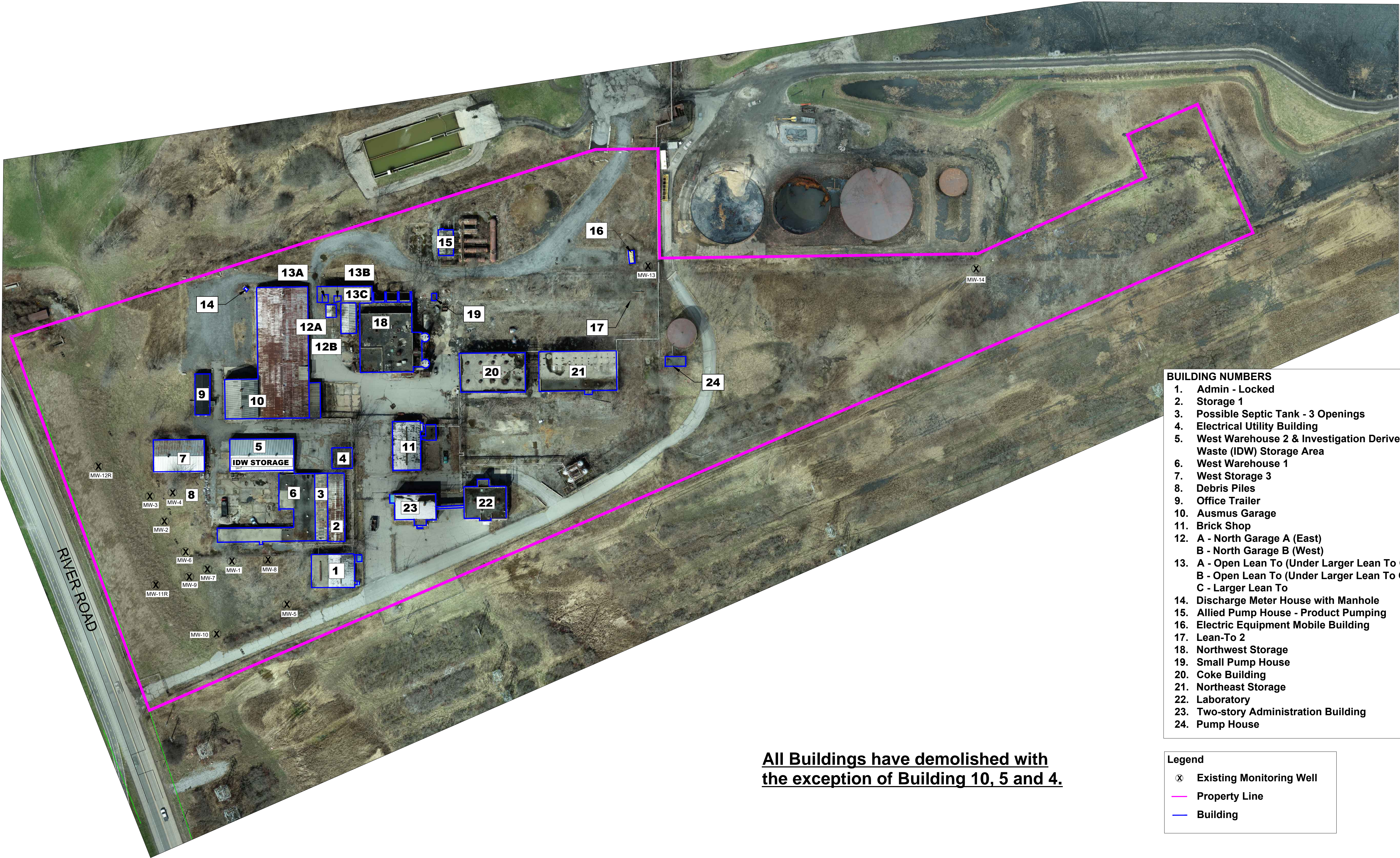
TONAWANDA NEW YORK, 14150

NYSDEC BCP SITE #C915003



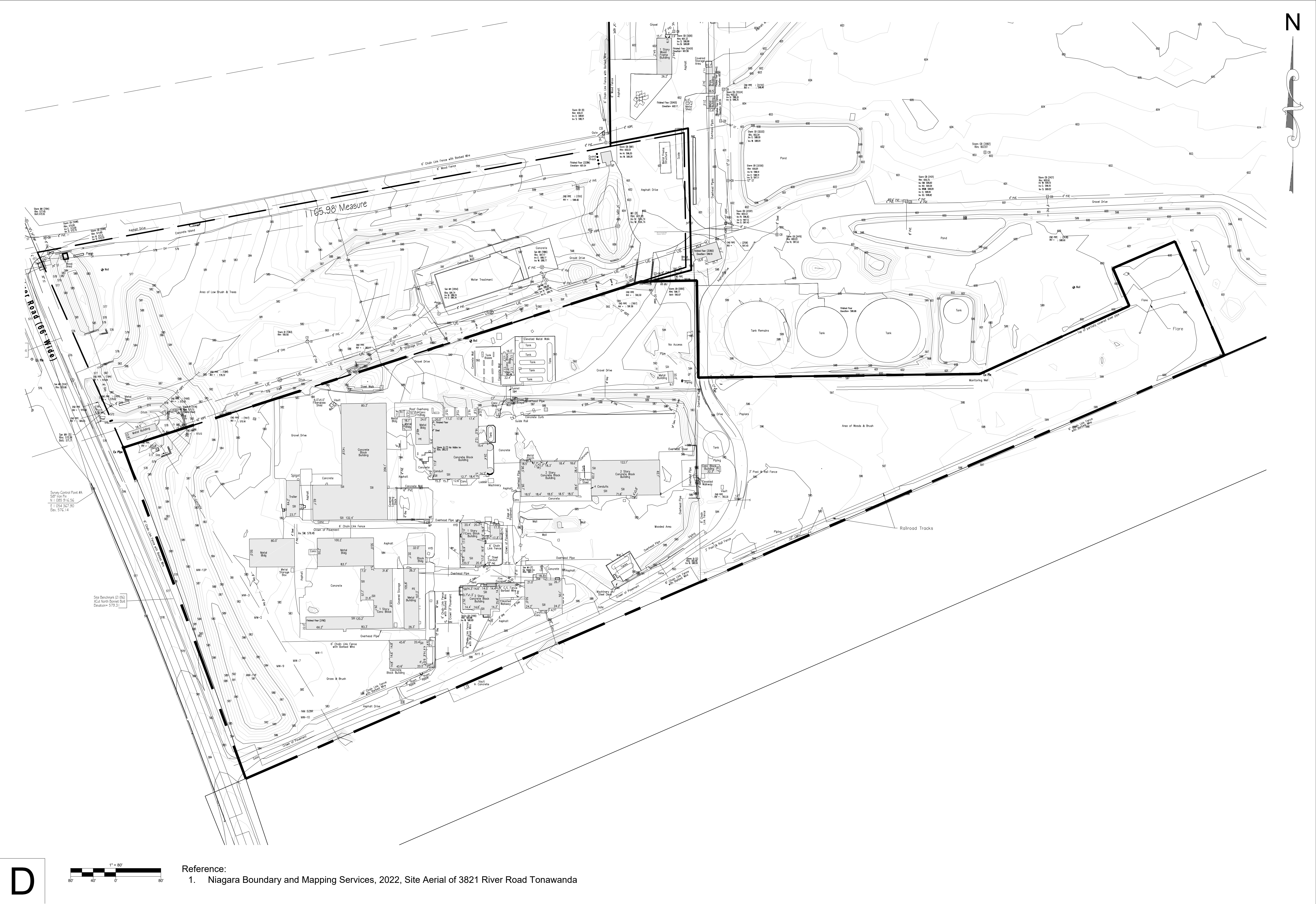
- References:
1. Parsons, 2021, Tonawanda Plastics Site NYSDEC ID 915003 Draft Site Investigation Summary Report
 2. Niagara Boundary and Mapping Services, 2022, Site Aerial of 3821 River Road Tonawanda
 3. Building names provided by previous seller, not documented.

All Buildings have demolished with the exception of Building 10, 5 and 4.



- BUILDING NUMBERS**
1. Admin - Locked
 2. Storage 1
 3. Possible Septic Tank - 3 Openings
 4. Electrical Utility Building
 5. West Warehouse 2 & Investigation Derived Waste (IDW) Storage Area
 6. West Warehouse 1
 7. West Storage 3
 8. Debris Piles
 9. Office Trailer
 10. Ausmus Garage
 11. Brick Shop
 12. A - North Garage A (East)
B - North Garage B (West)
 13. A - Open Lean To (Under Larger Lean To C)
B - Open Lean To (Under Larger Lean To C)
C - Larger Lean To
 14. Discharge Meter House with Manhole
 15. Allied Pump House - Product Pumping
 16. Electric Equipment Mobile Building
 17. Lean-To 2
 18. Northwest Storage
 19. Small Pump House
 20. Coke Building
 21. Northeast Storage
 22. Laboratory
 23. Two-story Administration Building
 24. Pump House

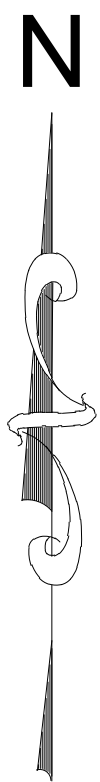
- Legend**
- X Existing Monitoring Well
 - Property Line
 - Building



D

1" = 60'
80' 40' 0' 80'

Reference:
1. Niagara Boundary and Mapping Services, 2022, Site Aerial of 3821 River Road Tonawanda



INVENTUM ENGINEERING
441 CARLISLE DRIVE
SUITE C
HERNDON, VIRGINIA 20170
(703) 722-6049
www.InventumEng.com

SITE TOPOGRAPHIC MAP, APRIL 2022
3821 RIVER ROAD
TONAWANDA, NY 14150
NYSDEC BCP SITE #C915003

DRAWING BY	RB
CHECKED	
APPROVED	
PROPERTY OF INVENTUM ENGINEERING IMPORTANT: THIS DRAWING PRINT IS LOANED FOR MUTUAL ASSISTANCE AND IS SUBJECT TO RECALL AT ANY TIME. ANY REUSE, REPRODUCTION, OR MODIFICATION OF THIS DRAWING WITHOUT THE WRITTEN CONSENT OF INVENTUM ENGINEERING IS PROHIBITED. ANY REUSE OF THIS DRAWING WITHOUT THE WRITTEN CONSENT OF INVENTUM ENGINEERING IS PROHIBITED. NOTICE: THIS DRAWING HAS BEEN PREPARED UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER. IT IS A PROFESSIONAL DOCUMENT AND IS NOT TO BE REPRODUCED OR USED IN ANY MANNER WITHOUT THE WRITTEN CONSENT OF INVENTUM ENGINEERING.	

FIGURE 5
DRAWING NUMBER
RI WORKPLAN

Attachment 2. Analytical Data Quality Assurance Review for Six Soil Samples Collected During a Site Investigation of The Tonawanda Coke River Road Facility in Tonawanda, NY



Memorandum

February 10, 2021

To: Mr. James Edwards
Inventum Engineering, PC
481 Carlisle Dr. Suite 202
Herndon, Virginia 20170

From: Martin Willett
Director of Health Physics and Remediation Services
MJW Corporation

Subject: Analytical Data Quality Assurance Review for Six Soil Samples Collected During a Site Investigation of The Tonawanda Coke River Road Facility in Tonawanda, NY

Introduction

A quality assurance and quality control (QA/QC) review of the Laboratory Analytical Data received from Eurofins TestAmerica, St. Louis, Laboratory Job ID: 160-40621-1 and released on 1/11/2021 was performed for Inventum Engineering LLC by MJW Corporation. The laboratory data report contained results for six (6) soil samples collected during a Tonawanda Coke facility investigation conducted between October and November 2020.

Summary of Laboratory Sample Receipt Condition:

- Standard analytical laboratory protocols were followed during the analysis of the samples and no problems were encountered or anomalies observed, laboratory quality control samples were within established control limits.
- Analytical methods and test results met NELAP requirements for parameters for which accreditation is required or available.
- Samples were received on 11/30/2020 in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 9.4 C.

Laboratory Notes Related to Analytical Methods and Results:

Radium-226 By Gamma Spec (21 Day Ingrowth)

- Samples were analyzed for Radium-226 by gamma spec after a 21-day ingrowth period in accordance with EPA method 901.1. The samples were dried on 12/04/2020, prepared on 12/10/2020 and analyzed on 12/31/2020. As a result, samples met the 21day ingrowth requirement prior to analysis for Ra-226.
- Samples results for *Pb-210 by gamma spec (method 901.1)* were estimated.
- *Insufficient sample was provided for a sample to fill the geometry calibrated for Ra-226 analysis by gamma spectroscopy.* The samples contained large pieces of rock.
- Results for several requested isotopes have no or low abundance gamma peaks. *Quantification of the analyte was inferred under the assumption of equilibrium with decay chain progeny or parent isotopes. This assumption was added by the laboratory and was not based on process knowledge.*

Gross Alpha and Gross Beta Radioactivity

- Sample analysis was performed on 12/23/2020 following method SW-846 Method 9310. No analytical or quality issues were noted.

Isotopic Thorium and Uranium (Alpha Spectrometry)

- Sample analysis was performed on 01/04/2021 and 01/07/21 following method DOE A01R_Th and U. For Thorium analysis, *a correction to data results to account for interference observed in the blank sample was applied.*
- Quality issues were not observed for U isotopic analysis.

Sample Analytical Results

Samples Analyzed

Lab ID	Client Sample ID	Collected Date / Time	Received
160-40621-1	TP-BCP-34-A	10/30/20 11:15	11/30/20 13:47
160-40621-2	TP-BCP-34-B	10/30/20 11:15	11/30/20 13:47
160-40621-3	TP-BCP-32-W45	11/09/20 01:00	11/30/20 13:47
160-40621-4	TP-BCP-44-A	11/13/20 11:50	11/30/20 13:47
160-40621-5	TP-BCP-44-B	11/13/20 11:50	11/30/20 13:47
160-40621-6	TP-BCP-47	11/18/20 09:20	11/30/20 13:47

Table 1: Laboratory Sample Results

Lab ID	Analyte	Method	Result (pCi/g)	Lab Qualifier ¹	Error (pCi/g)	MDA (pCi/g)
160-40621-3	TH-232	Alpha Spec A-01-R	1.58		0.270	0.0487
160-40621-3	U-238	Alpha Spec A-01-R	0.474		0.131	0.0598
160-40621-3	AC- 228	Gamma 901.1	0.735		0.237	0.258
160-40621-3	BI-214	Gamma 901.1	0.515		0.178	0.168
160-40621-3	RA-226	Gamma 901.1	0.515		0.178	0.168
160-40621-3	TH -232	Gamma 901.1	0.735		0.237	0.258
160-40621-3	U-238	Gamma 901.1	0.851		0.591	0.810
160-40621-1	TH-232	Alpha Spec A-01-R	1.36		0.253	0.0521
160-40621-1	U-238	Alpha Spec A-01-R	3.12		0.419	0.0527
160-40621-1	AC- 228	Gamma 901.1	0.858	U	1.07	1.51
160-40621-1	BI-214	Gamma 901.1	4.46		0.785	0.415
160-40621-1	RA-226	Gamma 901.1	4.46		0.785	0.415
160-40621-1	TH -232	Gamma 901.1	0.858	U	1.07	1.51
160-40621-1	U-238	Gamma 901.1	5.04		2.24	2.92
160-40621-2	TH-232	Alpha Spec A-01-R	0.737		0.182	0.0554
160-40621-2	U-238	Alpha Spec A-01-R	4.06		0.499	0.0612
160-40621-2	AC- 228	Gamma 901.1	0.561	U	0.957	1.10
160-40621-2	BI-214	Gamma 901.1	3.70		0.841	0.597
160-40621-2	RA-226	Gamma 901.1	3.70		0.841	0.597
160-40621-2	TH -232	Gamma 901.1	0.561	U	0.957	1.10
160-40621-2	U-238	Gamma 901.1	2.73		1.38	2.53
160-40621-4	TH-232	Alpha Spec A-01-R	0.322		0.107	0.0402
160-40621-4	U-238	Alpha Spec A-01-R	2.31		0.344	0.0490
160-40621-4	AC- 228	Gamma 901.1	1.07		0.355	0.312
160-40621-4	BI-214	Gamma 901.1	2.99		0.467	0.205
160-40621-4	RA-226	Gamma 901.1	2.99		0.467	0.205

Lab ID	Analyte	Method	Result (pCi/g)	Lab Qualifier ¹	Error (pCi/g)	MDA (pCi/g)
160-40621-4	TH-232	Gamma 901.1	1.07		0.355	0.312
160-40621-4	U-238	Gamma 901.1	2.42		0.947	1.45
160-40621-5	TH-232	Alpha Spec A-01-R	0.783		0.177	0.0258
160-40621-5	U-238	Alpha Spec A-01-R	4.35		0.534	0.0583
160-40621-5	AC- 228	Gamma 901.1	1.22		0.536	0.681
160-40621-5	BI-214	Gamma 901.1	3.26		0.575	0.380
160-40621-5	RA-226	Gamma 901.1	3.26		0.575	0.380
160-40621-5	TH -232	Gamma 901.1	1.22		0.536	0.681
160-40621-5	U-238	Gamma 901.1	3.50		1.16	1.59
160-40621-6	TH-232	Alpha Spec A-01-R	1.95		0.319	0.0464
160-40621-6	U-238	Alpha Spec A-01-R	3.29		0.451	0.0539
160-40621-6	AC- 228	Gamma 901.1	2.58		0.440	0.294
160-40621-6	BI-214	Gamma 901.1	3.79		0.495	0.214
160-40621-6	RA-226	Gamma 901.1	3.79		0.495	0.214
160-40621-6	TH -232	Gamma 901.1	2.58		0.440	0.294
160-40621-6	U-238	Gamma 901.1	1.59		0.915	1.43

1. U Result is less than the sample detection limit.

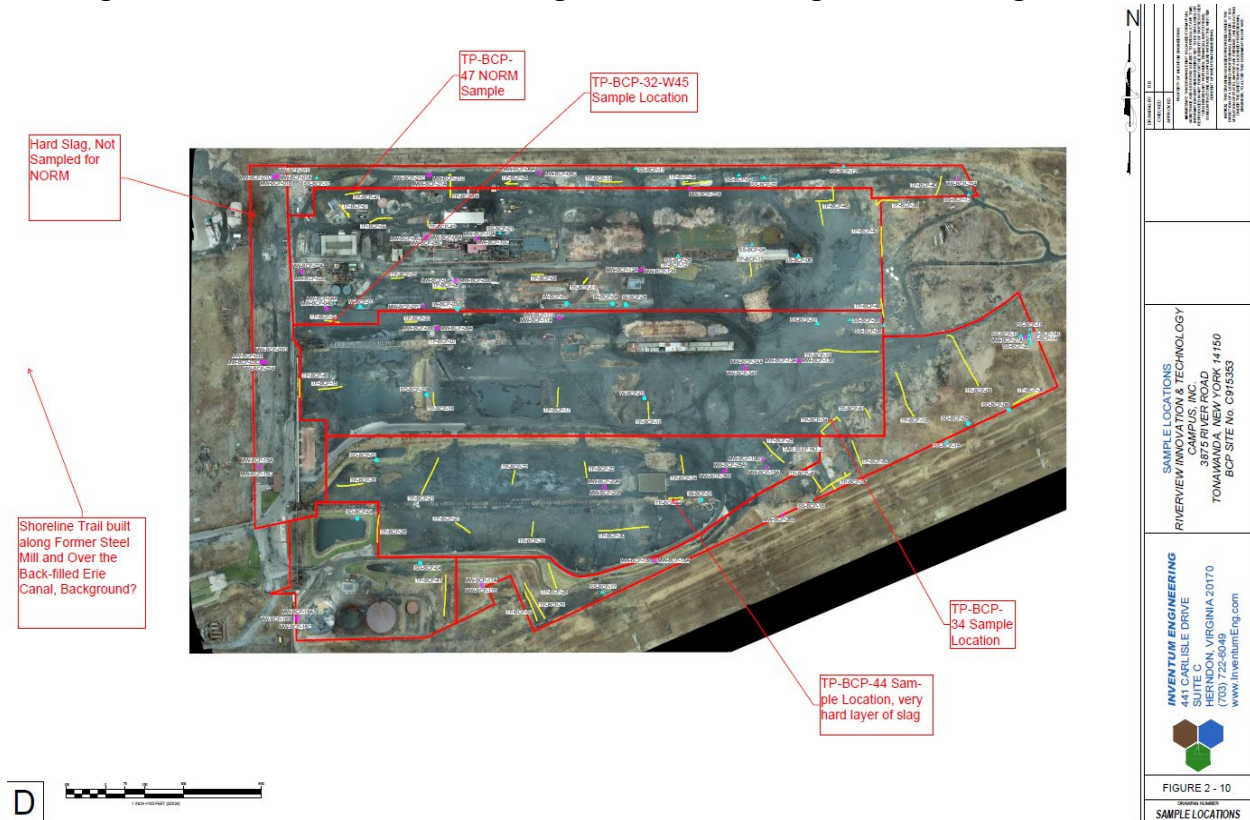
QA/QC Summary:

There were no laboratory quality assurance sample result exceptions noted. Results for LCS, Blanks and Duplicate samples were within acceptance criteria and all duplicate Relative Error Ration (RER) results were in RER limit of 1. Based on QC sample results, the data are determined usable and no upward or down bias in sample results is evidenced.

The laboratory narrative identified a deficiency in sample volume for one sample however, the sample was not identified and analytical results for all samples were reported without exceptions noted.

In general, the sample results for U-238 and Th-232 are slightly above the range of concentrations that are inferred for average background soils (.5 to 1.5 pCi/g) but not outside the range of concentrations that can be encountered. Based on the gamma spectroscopy result for U-238, Ra-226 and Th-232 progeny nuclides appear to be in equilibrium with parents and alpha spectroscopy results generally confirm the gamma spec results. The samples do not appear to indicate any enhancement of one isotope or the other and concentration ranges are likely due to soil types from the area.

Figure 1. November 2020 Test Pitting Locations Radiological Monitoring at RITC Site



Attachment 3. RITC GPS Report for Inventum Engineering

Gamma Walkover Survey Report

For

RIVERVIEW INNOVATION & TECHNOLOGY CAMPUS, INC.
3875 RIVER ROAD
TONAWANDA, NEW YORK 14150
BCP SITE No. C915353

Prepared for:



By:



15 Hazelwood Dr., Suite 112
Amherst, NY, 14228

1.0 Introduction

During June of 2023, MJW was requested by Inventum Engineering to perform a GPS enabled gamma walkover survey (GWS) of the 86.5-acre Riverview Innovation and Technology Campus, located at 3875 River Road, Tonawanda, New York 14150 (Site). The Site was previously used as a Coke plant storage location and railroad junction for the former Tonawanda Coke Company during the majority of the twentieth century. The Site location is shown in Figure 1.

The Site is becoming largely vegetated and soils appear to consist of various types of fill materials originating from plant and railroad operations. The observable fill in soils at the Site contained coke, coal, brick, concrete, slag, wood and other materials, with little to no native soil identifiable in the upper two (2) feet of the surface. The composition of the fill materials, including the slag material, was not uniform based on visual observations in-field.

The GWS was requested to identify surface gamma radiation levels resulting from surface and near-surface soils and fill materials. During the GWS, surface gamma radiation readings in counts-per-minute (cpm), were logged together with GPS coordinates, at 1-second intervals. The data were then used in determining the location and potential for Technically Enhanced Natural Occurring Radioactive Materials (TENORM) at the Site. MJW performed these activities over a three-day period beginning on June 30th, and including July 3rd, and July 5th.

Previous Site characterization activities involving soil sampling and test pits excavation were completed in October and November of 2020.

2.0 Methodology

Instrumentation utilized for the survey consisted of a GPS enabled Ludlum 2221 ratemeter coupled with a Ludlum 44-10 2"x2" NaI detector. MJW mounted the equipment to a specially modified cart to enable consistent detector geometry at ten (10) centimeters above the ground surface. The integrated GPS unit logged gamma and location data at 1-sec intervals during the GWS.

A transect plan was created to provide guidance in-field for optimal survey coverage. Transects were spaced twelve (12) meters apart to provide a high probability of discovering locations exhibiting elevated gamma readings or trends in near surface soils. The Site covers approximately 86.5 acres and there are active remediation and demolition activities taking place. Preplanned survey transects were followed to the extent possible with deviations required to avoid locations where activities were on-going and topography or site conditions such as pits, overgrown vegetation, fencing, and flooding prevented access. Transects were walked wherever possible but in-field adjustments were made to avoid obstructions and to delineate elevated gamma reading locations when observed.

Background gamma count rate data were collected at the nearby Erie County Water Authority property located at 3750 River Road in Tonawanda, NY. The background scan location is west of the Site adjacent to the Niagara River and has similar soils and geology with no known radiological impacts. Data was collected over impervious (paved) and pervious soil surfaces. The soil/vegetation surface cover average from count rate data collected in the background area was used to evaluate site GWS due to the similarity in surface cover over the majority of the Site survey area. Site Locations with hard cover such as concrete will be evaluated separately using the appropriate background average count rate. Figure 1 displays the location of both the background study area and the Site.

3.0 Data Analysis

The Site and background GWS data were statistically analyzed using Visual Sample Plan (VSP). The data collected were evaluated using indicators such as outliers tests, data distribution, and sample population statistical values to determine usability. Based on the 614 data points collected in the background location over soil covered areas, a mean gamma count rate for near surface soils was determined to be 8392.9 ± 400.08 counts per minute (cpm) with a near normal distribution. The background location and data are shown in Figure 2.

The Site GWS resulted in 28,884 data points over the three days the survey was conducted. Based on a statistical evaluation of the data, the data mean, and standard deviation were determined to be 7900.8 ± 3065.9 cpm indicating that much of the survey area is at or near background gamma levels. A histogram of Site GWS data showing the data distribution is provided in Figure 3. The histogram shows that count rate data above the study area mean (to the right of the red vertical line in Figure 3) were observed in approximately one third of the data with the more elevated data results falling outside what might be expected if the data were normally distributed near tail and right of the curved red line in Figure 3). The locations associated with this data have a greater potential for the presence of TENORM. Figure 4 shows the GWS data located on the Site.

4.0 Results

Site GWS data binned using the Jenks Natural Breaks algorithm along the gamma readings is shown in Figure 4. Although the potential for radiological impacts below the upper 1-ft of soil or hardcover material cannot be dismissed with GWS results alone, the potential for near-surface and deeper impacts is much greater in areas with GWS data above 1.5x background or in locations indicating an increasing trend in the near surface gamma readings. As observed in Figure 4, the majority of the northern half of the Site is characterized by increasing count rate data exceeding 1.5x the average background reading with several locations exceeding twice the background mean count rate. To a lesser extent, the southwestern area of the Site also showed increasing trends in readings at or above 1.5x the background mean. Based on these results, the presence of TENORM in the northern half and southern perimeter areas of the site are most likely. Because the elevated reading locations do not appear to be consistent over the Site, other than the most elevated locations which are located in the central area of the Site, it is probable that fill materials containing elevated levels of Naturally Occurring Radioactive Materials (NORM) or TENORM were used as fill during periodic filling or railroad operations when the facility was operating. To determine the nature and extent of the NORM or TENORM impacts for use in evaluating potential management or disposal options and costs during future Site development or management activities, additional investigations including sampling and analysis would be required.



Figures

Figure 1:

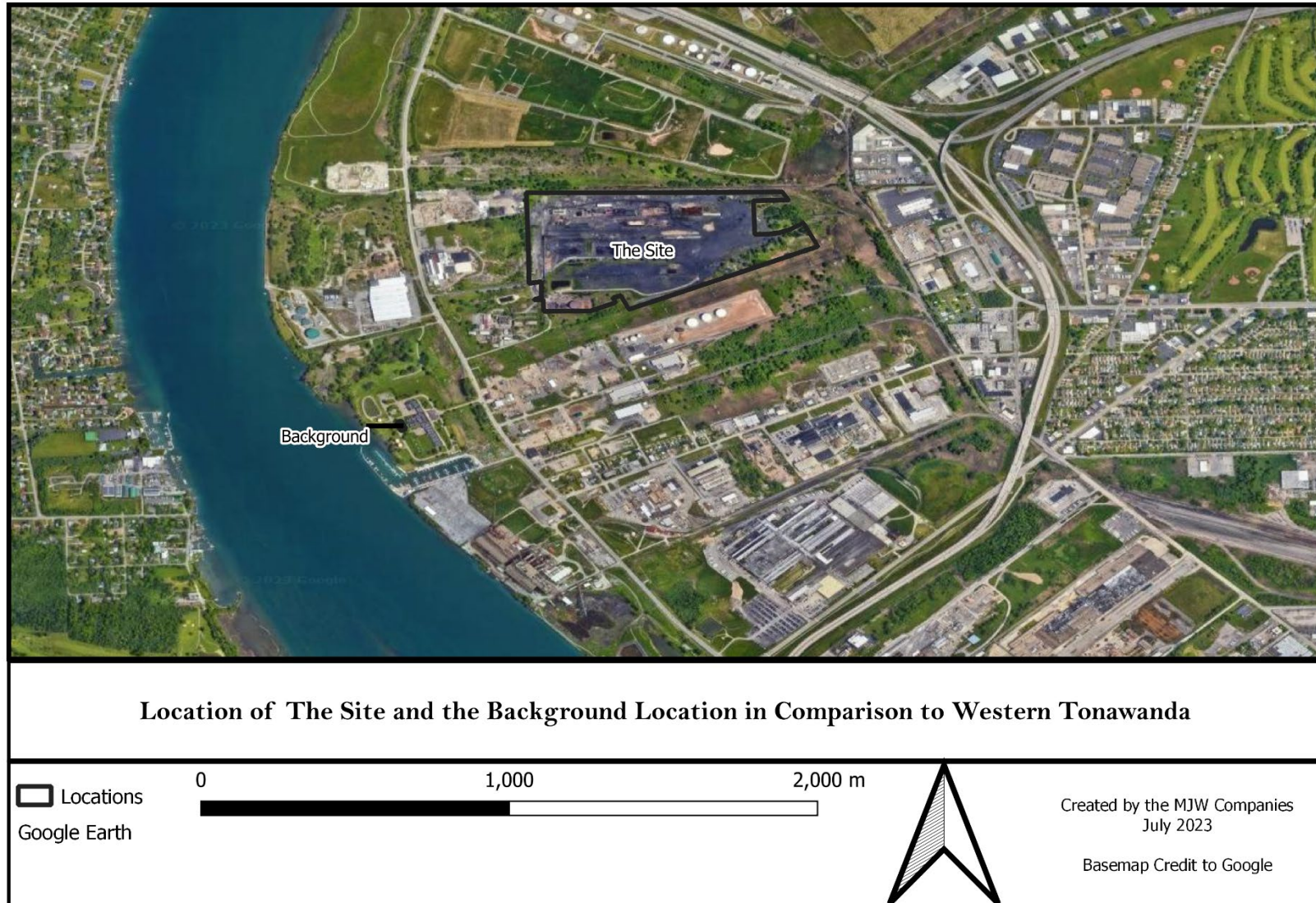


Figure 2:
Background Gamma Walkover Survey Data Collected at
Erie County Water Authority Property Adjacent to Riverview Site

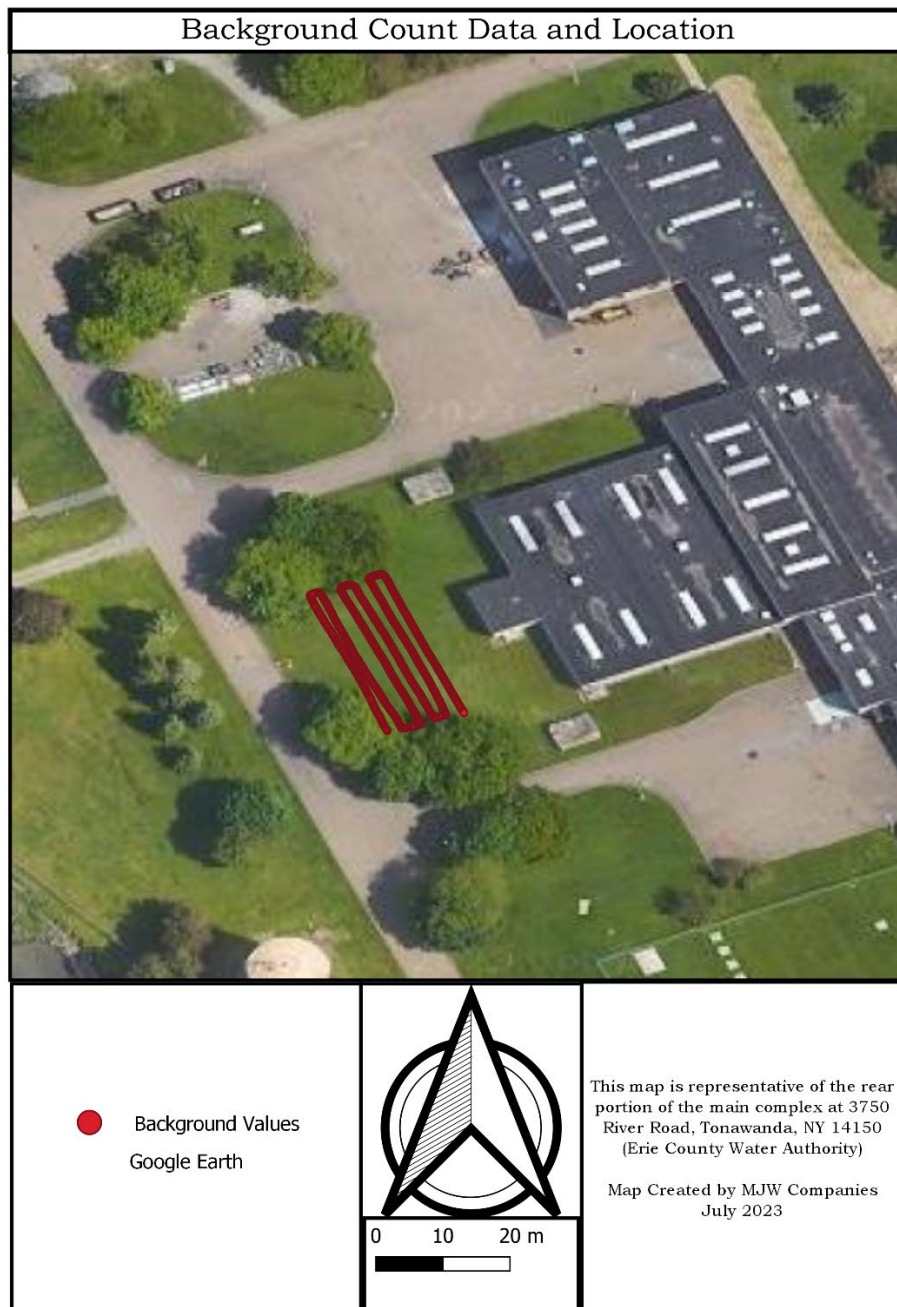


Figure 3: Histogram of Riverview Technology Center Gamma Walkover Data Distribution

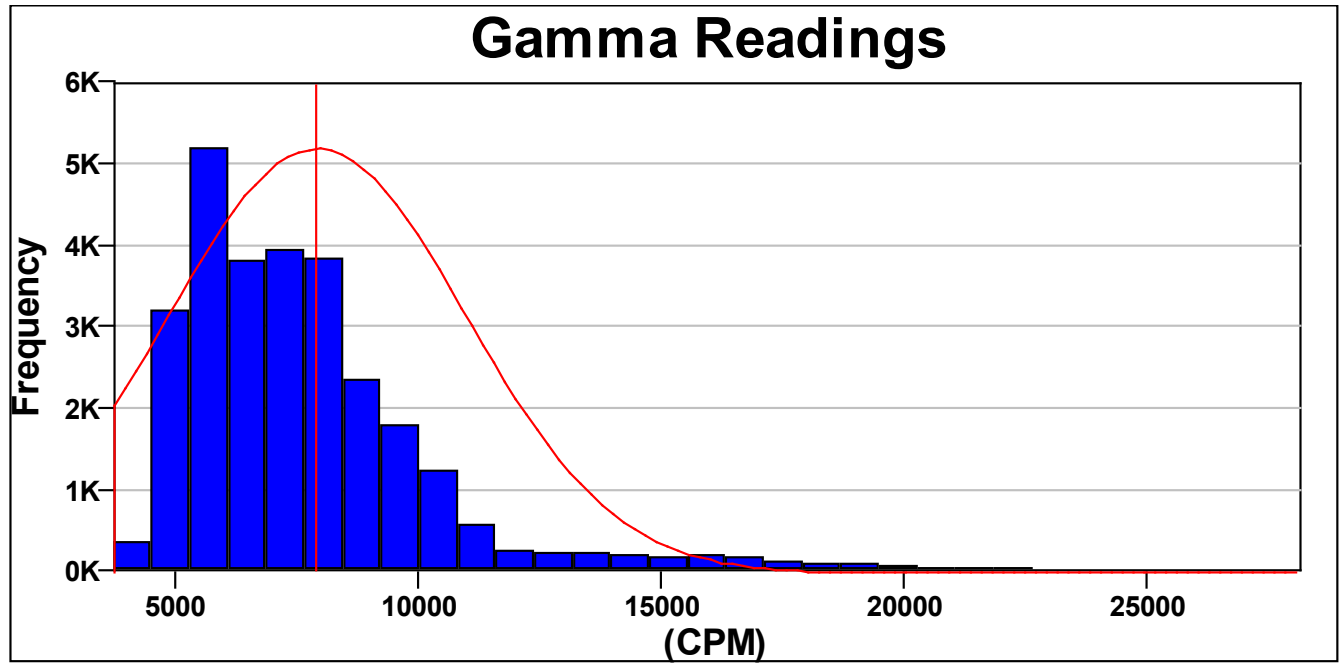
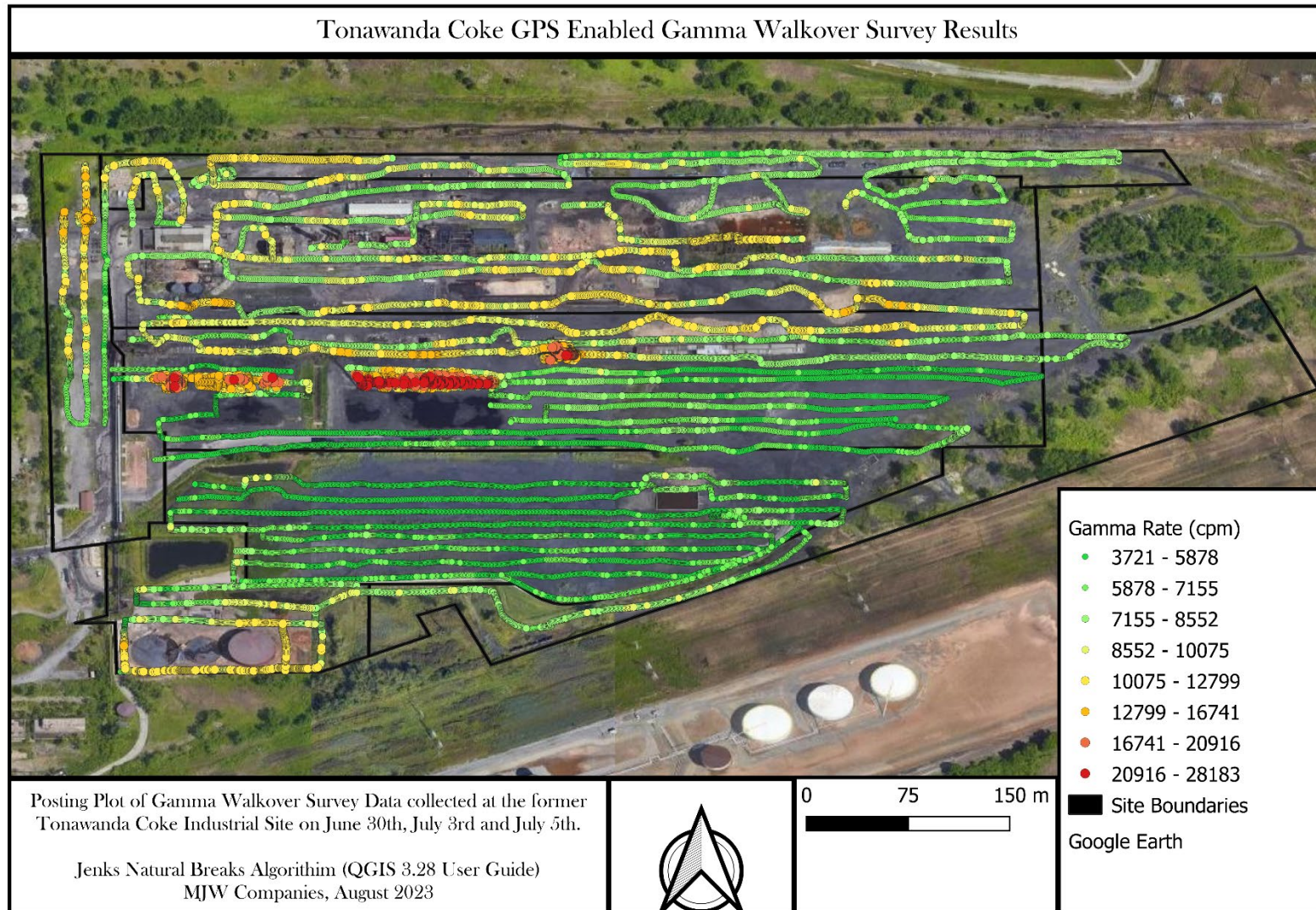


Figure 4:



Attachment 4. MJWRCP-03 Field Investigation Survey Procedure_09_15_2015



General Radiological Survey Procedure for Radiological Site Investigations

1.0 PURPOSE

The objective of this procedure is to detail the required methods and actions to be taken for collecting radiological survey data of sufficient quality and quantity to meet regulatory guidance outlined in MARSSIM and other relevant or referenced documentation.

This procedure will outline standardized techniques to ensure comparability and reproducibility of the survey data.

2.0 RESPONSIBILITIES

2.1 Radiological Control Supervisor (RSC)

The radiological control supervisor (RCS) is responsible for review of the survey plan and all supporting documentation to ensure that the survey Data Quality Objectives (DQOs) are understood and can be related to field staff conducting the survey. The RCS will ensure that complete documentation is collected for survey points and samples, that field audits are performed during data collection, and that audit findings and data are reviewed and properly logged and narrated in the project file.

2.2 Radiological Control Technician (RCT)

The RCT is responsible for reading, understanding, and executing the protocol and techniques described in this procedure including the operation of instrumentation and completing the required documentation described or referenced in this procedure.

3.0 PREREQUISITES/REQUIREMENTS

The RSC and RCTs must be trained and competent in the techniques and instrumentation described, understand work site hazards and safe work protocol required to perform the work described in this procedure.

4.0 PROCEDURE

Survey details and techniques, including calculations and instrument requirements, will be fully described and specified in specific project or task documentation. The following sections outline the general requirements necessary for performing surveys of the type identified:

4.1 Fixed Survey/Sample Point Location

Every fixed sample location must be spatially located within a Survey Unit. Survey Units (SU) can be comprised of small or large surface areas, a single room or several rooms in a building, grouped together according to their contamination potential (i.e., Class 1, 2 or 3, etc.). Prior to entering the field to conduct a survey:

- SUs with their respective origin points must be identified on a site map
- The number of samples required for each SU should be calculated or approximated and located on the survey map
- The location of each sample location should be identified with local x and y coordinates, measured from the SU referenced origin point.

Sample locations will be identified through a diagram on survey data sheets to ensure proper location identification during the survey in each unit. Survey points can be moved for various reasons as long as the new location is accurately identified with local coordinate's measured from the identified SU origin point.

4.2 Gamma Survey Grid Layout

When areas are required to be surveyed with a specified coverage percentage, survey grids are typically established over the area and a scan survey is conducted. The scan survey follows a predetermined grid laid out over the SU in a density pattern sufficient to measure radiation levels at specified intervals to meet the coverage requirement. Survey grid markers are often used and set up as reference points to assist the surveyor in tracking survey locations and grid lines over large areas.

To establish a survey grid in a building space such as a room, hallway etc., or in outdoor areas, the grid spacing must first be established. Grid spacing will be determined and documented in the Survey Work Plan during survey planning. Grid layout and spacing is based upon the required coverage obtained by factoring in survey meter window area, the instrument type being used, measurement interval, rate of distance traveled between measurements, and the instrument height above the ground surface.

The percent coverage of the survey must be known prior to the field investigation and is a critical DQO for setting up and planning any gamma or instrument scan during a site investigation. Once the survey DQOs are identified and an appropriate Investigation Work Plan has been prepared to identify the variables necessary to determine grid size and spacing, the following steps will be performed:

Laying out the Grid:

- Inspect the area to be delineated and when possible, remove unnecessary objects or vegetation to provide as clear and unobstructed view as possible.
- Identify the area/room origin or reference point
- Using paint, tape, stakes, flags or other appropriate marking devise, measure the required X axis grid distance from the origin point and mark the surface at the required spacing interval. Always include a North arrow and scale on the site drawing and include dominate features to be sure that the grid can be recreated after the survey is completed.
- Repeat the same process along the Y axis from the origin.

- When wall surveys are required, mark a Z axis from the origin up the wall. Z coordinate locations will have the X and Y coordinates respective to their position along the floor/surface grid.
- Draw the area indicating the location of the origin; X and Y axis, and any dominate features (doorways, tables, landscape features, etc.)

4.3 Instrument Surveys

4.3.1 Identifying and Preparing Instruments for Use

An appropriate and calibrated ratemeter/scaler match (i.e., Ludlum 43-68 probe/and 43-60 ratemeter, Model 239-1F floor monitor, Ludlum 43-10 and 2241-2, or equivalent), must be tested for sensitivity and the detection of the investigation contaminants of concern (COC). The instrument sensitivity must be below the COC investigation action level (AL), preferably under 50% of the AL. Once the instrument has been determined to be sensitive enough to use, it can be deployed to perform direct alpha/beta counts to verify the presence of contamination at investigation levels.

When using gas proportional counters (Ludlum 43-68 probe or the Model 239-1F floor monitor), instrument purging using P-10 gas is required prior to operational use. The RCT must be familiar with instrument operation and care prior to field use. Always refer to the operational procedure or the manufacturers' manual for complete instructions if there is uncertainty concerning the use of a particular instrument.

4.3.1.1 Instrument Operational Checks

Prior to performing any measurements, the following Operational Checks must be performed:

- Select the "Battery Check" indicator to verify batteries are fully charged. Replace batteries if necessary. Record reading on field work sheet.
- Select High Voltage (HV) setting and compare reading to the required setting used during calibration for detection of general or specific isotopes as necessary to perform the survey. Record reading on field work sheet.
- Set ratemeter detection setting, if present, to the appropriate setting required by the survey work plan for detection of contaminants of interest (e.g. alpha/beta, alpha, beta, etc.). Record setting on field work sheet.
- Set ratemeter time setting, if present to "one minute" unless otherwise stated in survey work plan.
- If gas proportional counters are being used, purge the instruments with P-10 gas and set the gas flow to the required flow rate prior to use.
- Perform a minimum of 5 background readings in a non-impacted location and record readings. Calculate the average background count rate and check that it is within normal expected range for the area background.
- Perform a minimum of 5 source checks in a non-impacted location and record readings. Calculate the average source count rate. Check to be sure that the average source reading is within 20% of the calibration reading for the source(s) being used.

Use the Field Data Survey Sheet specifically designed for the survey being performed or when appropriate, a more generic survey data sheet can be used to record the operational data collected.

Note: Survey data cannot be collected without instrument operational data recorded and reviewed prior to field measurements.

4.3.1.2 Survey Data Collection

Scaler or Fixed Position Readings:

Scaler readings are the total integrated counts observed at a particular location by the survey probe for the time interval selected on the meter.

- Using a properly calibrated and field checked instrument, hold or place the instrument probe over the area of interest at the specified height for the duration of the time setting (e.g., one minute, .5 minute, etc.) as indicated by the ratemeter/scaler window freezing or an indicator displayed in the window.
- With the instrument probe in-place over the location to be investigated, set the instrument to the “scaler” setting and activate the scaler count using the appropriate switch or toggle on the ratemeter.
- Record the activity observed, instrument used, time constant, and surveyor on the field data sheet. If a fraction of one minute (i.e., 0.5, etc) is selected, record the meter reading on the data sheet with the time constant used.

Scanning/Ratemeter Surveys:

In ratemeter mode, the ratemeter continuously evaluates data from the survey probe. The ratemeter display is updated every 2 seconds and the surveyor must continuously observe the meter readout and the survey progresses. The following steps are used to perform a survey in ratemeter mode:

- Using a properly calibrated and field checked instrument set the ratemeter/scaler on the appropriate scale for the survey area. Use the lowest scale available. If the meter goes off scale, step back and reset the scale to the next higher setting.
- To better monitor the relative intensity of the contamination present, activate the audio on the ratemeter.
- Slowly (approx. 2ft/sec) move the probe over the area being surveyed and observe or listen to the count rate.
- Record survey data for a given distance or transect line as the estimated average count rate over the distance. Note an associated range (high and low readings) as the area is covered.
- Hot Spot Investigation: If an elevated count rate is indicated (generally 3x the area background readings or at the survey AL), stop and resurvey the area by holding the probe over the location long enough to determine the actual count rate as indicated by a steady reading or performing a scaler reading. Record the reading and note the location based on grid location and/or location features on the survey data sheet and survey plan layout drawing.
- If elevated counts are identified, continue to survey the area until the “hot spot” perimeter is delineated and the activity levels are determined by one or more one

minute scaler readings. Delineate the area using measuring tape, perimeter GPS coordinates or by marking the area and documenting the findings on the site drawings and survey data sheets.

- To conclude the survey, perform an operational check of the instrument by taking a background and source count. Record the data on the Daily Calibration Worksheet.
- Review the field data sheets to check for completeness, erroneous data points and/or trends. In addition, check instrument stability by comparing operational check data for background and efficiency before and after the survey. Data should be within 20%.
- Complete survey documentation including data sheets, field notes, unusual conditions and survey descriptions.

4.4 Removable Contamination Survey

Removable contamination will be evaluated through the use of swipe samples. Swipes will be collected using 4.7 cm diameter filter papers (or equivalent) passed over an area of approximately 100 cm² (4"x 4") using moderate pressure. To collect swipe samples, the following steps will be taken:

- Don gloves and other protective clothing as required by the task specific work plan or Radiation Work Plan prior to collecting swipes.
- Label swipe samples (e.g., consecutive numbers, object names, etc.) prior to use to ensure correct identification. Be sure field documentation reflects the same nomenclature and description of each swipe. Swipes collected for alpha or beta analyses can be labeled on the back (smooth side) of the filter paper. Swipes that will be counted in vials (i.e, counted in Liquid Scintillation Counters (LSC)) must be labeled on the envelop container and/or the vial top (**Not** on the swipe itself or the side of the LSC vial).
- Swipe samples must be labeled with unique identifiers and the sample location logged to identify exactly where they were collected, by whom and when.
- On rough surfaces, care must be taken to avoid damaging the filter paper as it is passed over the surface.
- Care will be taken to avoid excess loading of the swipe with dirt or water in heavily soiled areas. This may require swiping a smaller area which must be recorded in the swipe documentation.
- Place used swipes in small envelopes or other sleeves to segregate and protect the swipe samples. Swipes placed in counting vials (H-3, C-14, etc.) must be placed with dirty side facing the outside of the vial.
- Swipe sample Chain of Custody (COC) forms must be completed before delivery to the laboratory for analyses.
- When counting swipes in the field for gross alpha or beta contamination, a suitable calibrated counter of known efficiency and background, will be used (Ludlum 2929 or equiv.)
- Swipes counted in the field will be placed in a counting planchet. The filter should be laid flat to avoid counting errors due to geometry and the planchet changed or cleaned between samples.
- Record all required data, including sample counts, instrument serial number and model and counting instrument background and efficiency on the appropriate sample data sheets.

4.4.1 Tritium and Carbon-14 Swipe Sampling

Swipes for low energy beta emissions (H-3, C-14 etc.) will be collected in the same manner as described in section 4.4 above using moistened swipes. Swipes should be moistened with a small amount of clean (Deionized water preferred) water prior to collection. After collection, place the filter directly into the counting vial, dirty side out, or a separate coin envelope pending analysis by the laboratory. Label the container with the sample identification.

Note: Low energy beta swipes cannot be evaluated with a field counter (i.e., Ludlum 2929 etc.)


5.0 RECORDS

5.1 Each type of survey described above will require the generation of specific data records and survey narrative. The records that are expected to be generated as a result of implementation of this procedure include:

- Daily instrument field operability and calibration sheets. (Attachment 1)
- Complete Alpha/Beta or beta/gamma survey data sheets and maps (Attachment 2)
- Removable contamination survey data and location map (Attachment 2)
- Scanning survey results describing pre and post operational data, background levels, survey unit averages and range, the locations of elevated or anomalous readings, and survey description with a map of the area
- Sample Chain of Custody forms
- Calculations for instrument MDCs, scan MDCR, and sample numbers if appropriate
- Project survey log including daily activities and issues
- Data assessment and evaluation work sheets

All the records generated as a result of implementation of this procedure will be maintained as part of the MJW Corporation project file that will include the associated Project Work Plan.

Attachment 5. MJWRCP-40 Performing a GPS Enhanced Gamma Radiation Survey, Rev. 4

		MJWRCP RCP-40 Rev. 4
Performing a GPS Enhanced Gamma Radiation Survey and Data Assessment		FIELD PROCEDURE
Effective Date: 10/29/21	Approved By: <i>M.J. Willett</i>	

1.0 PURPOSE/DISCUSSION

The purpose of this procedure is to establish protocols and data collection requirements necessary to perform reproducible low-level radiation overland gamma surveys.

Overland gamma radiation surveys are often enhanced with the coupling of radiation and satellite geographical location measurements collected from global positioning and radiation instrumentation and software. The use of both instruments simultaneously allows rapidly recorded radiation readings to be precisely located across varied terrain and large areas. MJW uses the ERG 105G handheld GPS surveying system and accompanying software.

The 105G is a simple to use GPS mapping system for performing outdoor gamma radiological scans. It consists of an interface tablet containing all necessary software to acquire position correlated radiological scan data from a gamma detector and export the data for processing using a variety of applications, such as Microsoft Excel, or ESRI ArcGIS. The handheld logger comes installed with two applications necessary for collecting data and exporting to a removable disk drive. The ERG RadScout is used to collect gamma data and couple it to a GPS position. The RadSync software is also included on the handheld computer and is used to export all field data to a single removable disk. Using the ERG RadScene software, the data can be managed, analyzed, and merged from a single processing computer.

The 105G uses off-the-shelf Ludlum equipment for radiological detection. The system uses the Ludlum model 2221 meter. An optional setup uses a 2221 with Bluetooth radio incorporated to allow a completely wireless interface between the data logger, 2221, and sub-meter GPS receiver. If the survey is performed in a location where projection information is not available, then the user will be required to apply the spatial correction during data evaluation and download.

2.0 SCOPE

This procedure is applicable for general or discrete radiation surveys intended to measure direct radiation and/or contamination levels of areas expected to be at or near background levels. It is also applicable for sites where radiological contamination may be extensive.

Gamma or alpha/beta survey procedures, including grid layout, coverage and instrument use and data DQOs will be detailed in job specific work plans. Standard or typical survey methodology is described in MJW Corporation instrument and survey procedures.

3.0 RESPONSIBILITIES

- 3.1 All survey instruments used to determine direct radiation levels or contamination levels shall have been calibrated within twelve months prior to performing the survey.
- 3.2 Surveys shall be performed in accordance with all applicable standards as listed in Section 8.0 (references).
- 3.3 Persons performing the survey shall be responsible for proper instrument checks and operation, properly recorded measurements, and map per Section 4.0 of this procedure.

4.0 PROCEDURE

4.1 Equipment List

- Surveying and staking materials (subcontract to licensed surveyor)
- Bicron microRem LE (or equivalent)
- Ludlum Model 2241 survey meter (or equivalent) with Ludlum 44-10 2"x2" NaI detector (or equivalent)
- Area maps as appropriate (topographic, street, quadrangle, etc.)
- Mason's line marked at designated intervals (for detailed area surveys)
- Ludlum 44-10 Lead Collimator (Optional)
- Ludlum 1000/2200 with 43-10 and 44-40 smear counters
- Miscellaneous marking and recording equipment
- 100-foot tape measure
- Protective clothing as appropriate
- Smears (1 box)

4.2 MEASUREMENT PROTOCOLS

- 4.2.1 Perform a battery check, source check and calibration data check prior to use of survey instrument per the requirements of Section 3.1.
- 4.2.2 At a minimum of three (3) separate locations known to be free of contamination, make several background measurements, recording data, time, survey instrument serial number, surveyor and general survey area location noting any significant landmarks. Record data on Form RCP 40-1.
- 4.2.3 In consultation with a licensed surveyor establish the primary reference point for the survey and any second reference points required to adequately describe the site and allow for creation and recreation of the survey grid. The reference point shall be designated as point 0, 0 or equivalent with magnetic north indicated clearly in reference to point 0,0. Compass points shall be used such as ON, OE, OS, OW, etc. depending upon the reference point location.
- 4.2.4 From the primary and any secondary reference points, establish area survey points using stakes, flags and/or marked string lines at the predetermined survey interval. All other grid locations will be designed in alphanumeric sequence from the reference point (i.e., 5 feet due east of reference point ON, OE would be designated as ON, 5E; 5 feet north and 5 feet east as 5N, 5E etc.). Use Form RCP 40-2 to show survey grid, detailing the primary reference point, any secondary points, landmarks and grid spacing. Use accurate area maps or any available CAD drawing to lay out grids.

NOTE: Grid pattern spacing should be no more than ten (10) meters apart for complete coverage for sites with a known or suspected radiological history. Grid spacing may be increased up to 100 meters for large sites where no radiological involvement is expected.

Minimum detectable activity will be dependent upon background levels and instrument efficiencies. Decreasing the grid spacing will give higher detection probability for low activity or diffuse sources.

For a uniformly distributed Co-60 source the predicted exposure rate at one meter above the surface is $5.79 \text{ E-04 Sv/yr per Bg/cm}^2$ (NUJREG/CR-1918). This translates to $\sim 43 \text{ microR/hr per uCi/m}^2$.

- 4.2.5 Measure the gamma radiation level at the reference location at a distance of one meter (approximately waist height) and at ten centimeters from the ground surface.

CAUTION: Survey instruments must not come into contact with any potentially contaminated surfaces. Precautions must be taken such as bagging the instrument should such potential exist.

- 4.2.6 Record measurements from designated survey locations on Forms RCP 40-3 and 3A, including alphanumeric survey locations, gamma radiation readings at 1 meter and 10 cm and any remarks for the location. Complete the top of each form with the following data: job number, date, surveyor and relevant instrument data (model, serial number, etc.) as discussed in section 4.2.4.
- 4.2.7 Proceed at a slow pace (approximately 0.5 m per second) to the next survey point, continually checking the instrument readout for any strong fluctuations.
- 4.2.8 Once four grid points forming a square have been measured perform an intragrid survey of the square with the meter at a distance of 10cm from the surface. Begin in one corner of the grid and using a zig-zag or cross-crossing pattern at 1m ($\sim 3'$) intervals survey the grid on the diagonal at a slow pace $\sim 0.5 \text{ m per second}$.
- 4.2.9 If during the intragrid survey a significant survey meter response is encountered, take readings from a distance of one centimeter to define the area of the increased activity. Use spray paint, flags, string or another method to mark the area(s) of elevated activity. Also mark the location of this/these intragrid area(s) on Form RCP 40-2. The point of the most elevated reading as well as the apparent boundaries of any area(s) of elevated activity should be thoroughly marked and described.
- 4.2.10 After all initial survey points have been recorded, return to any areas of elevated readings. Perform a detailed survey to define the areas and note the upper limits of the measurements using one of the following methods: (document all results on Forms RCP 40-4 and 4A).
- Using concentric circles, define the center and then the radius of contamination and record this on the survey form, or

- Using a small-spaced grid pattern of 1 meter or less, find the center and general outline of the area of contamination and record this information on the survey form, RCP 40-4 or 4A as appropriate.

NOTE: Per step 4.2.8 use spray paint, string or other suitable medium to define the physical limits of the contamination/radiation. Use standard precautions to avoid personal or equipment contamination during the survey.

- 4.2.11 Check the survey map for complete coverage. Notify the appropriate client personnel if immediate posting or cleanup actions may be required.
- 4.2.12 Remove all nonpermanent markers and stakes only after all data has been checked and verified. Grid markers should be maintained if further action is required or if additional surveys are to be performed by regulatory agencies, etc. Monitor all personnel and materials for potential radioactive contamination before they leave any areas of suspected or confirmed contamination.

4.3 INSTRUMENT CALIBRATION

- 4.3.1 All instruments shall be calibrated annually and shall have a valid calibration sticker at the time of use. Survey instruments used for overland gamma surveys shall be calibrated within six months of the actual survey date.
- 4.3.2 Instruments will be tagged “out of service” for:
 - Failure to properly respond to check sources, or
 - Instrument damage, or
 - Suspect operation of the instrument

Any instrument tagged “out of service” shall be repaired or replaced and shall be calibrated before use.

- 4.3.3 All instruments will be operationally checked in the field at the beginning of each workday and each time the meter is turned on.

5.0 PRE-SURVEY PREPARATION

5.1 Instruments and Equipment

- 5.1.1 GPS instrument case –ERG Model 105G, serial cables, external antenna cable, USB cable.
- 5.1.2 Wheeled cart and/or backpack mounting equipment and measuring tape.
(Carts are stored on shelves in storage garage)
- 5.1.3 GPS antenna and cable
- 5.1.4 Stakes, flagging, markers, field notebooks, etc.

5.2 Check List Items

- 5.2.1 Check to be sure GPS and radiation instruments, check source, log book, cables, carrier equipment, antenna, tremble software and batteries are available, charged and in good condition and calibrated (green light on battery charger indicates batteries are fully charged) . **Note: Batteries take 24 hours to fully charge.**

- 5.2.2 Determine Survey sensitivity and geological coordinate system requirements (i.e., WGS83, State Plane, NAD83, etc.)
 - 5.2.3 Review terrain conditions from proposal, client contact or via Google Earth or maps to identify accessibility and survey method (cart vs walking/backpack mount)
 - 5.2.4 Identify survey grid coverage and spacing.
 - 5.2.5 Prepare grid marking or line-of sight aids (e.g. cones, paint, rope, etc.) to facilitate walkover coverage and maintain speed.
 - 5.2.6 Prepare map of survey area.
- 5.3 Preparing the Instruments to Begin GPS Enhanced Gamma Survey
- 5.3.1 Setting up the Field Equipment
 - 5.3.1.1 Power on the Rad Scout by pressing the power button once, located on the bottom right-hand corner of the front of the device. To unlock the device and reveal the homes screen, slide a finger upwards on the display. Open the Rad Scout program by tapping on its icon on the desktop.
 - 5.3.1.2 The typical radiological instruments used with the system are the Ludlum Model 2221 Counter with a gamma detector (44-10).
 - 5.3.1.3 Source check the instrument and record background and source check count rate data in the daily source check logbook located in the instrument case. Evaluate the source count rate to ensure instrument sensitivity is within the required range (dpm/cpm = +/- 20% of source calibration dpm count rate).
 - 5.3.2 Connecting the Meter to Tablet
 - 5.3.2.1 When using the wireless 2221 option, the meter incorporates a Bluetooth device that syncs with the RadScout. To connect to a specific meter, ensure the meter you wish to connect to is turned on and that the Bluetooth modem has a flashing blue light. In the RadScout software tap the Program Settings option from the File menu, and select the button next to the METER SOURCE drop down box as shown in Figure 1. Note that for this option to be available, the meter must be disconnected. Connect and disconnect the meter from the Settings menu in the main form. The window, as shown in Figure 2 will appear with all discovered Bluetooth devices. Click on the serial name that matches the Bluetooth device of the 2221 you want to connect to and click SELECT. If the pairing is successful, the device name will show up in the drop down box. Save the project settings and connect to the meter through the settings menu in the main form by clicking on , METER – OPEN. If the meter is opened successfully, the values will be displayed next to the trifoil symbol in the bottom left-hand corner of the screen. A red error icon indicates there is no connection.
 - 5.3.2.2 Once the Bluetooth device is paired and selected in the drop down box, the device will be connected on every startup of the software.
 - 5.3.3 Connecting to Goede GPS
 - 5.3.3.1 The internal GPS is adequate for most surveying needs, but if sub-meter accuracy is desired, the external Geode sub-meter receiver may be used as the GPS source. To connect the Geode receiver,

press the power button on the receiver to turn the unit on. From the File menu, tap Program Settings and select Geode from menu labeled GPS SOURCE as shown in Figure 3. Note that this option is only available when the GPS is disconnected. The GPS may be connected and disconnected through the settings menu. If the Geode being used is different than the one in the drop down menu, the new Geode must be paired by clicking on the button to the right of the drop down box and selecting the proper device. The Geode serial number may be found on the bottom of the receiver as a six-digit number. Once selected, click on the Settings menu, and tap GPS, then CONNECT to connect the new device. The internal tablet GPS may also be used as the primary GPS source to reduce hardware. To select the internal GPS open the Program Settings window and select the Internal Mesa GPS in the drop down menu. Note that the GPS must be disconnected for this option to be available.

5.3.3.1.1.1 Note that once a successful connection is established, the software will reconnect the last device used upon starting the software.

5.3.4 Refer to ERG User Guide for further reference

6.0 PERFORMING A SURVEY

6.1 The Rad Scout software is used to view, collect, and analyze spatially correlated radiological data with superior accuracy and data quality. Using the position of the GPS receiver, or internal tablet GPS, collected radiological data are viewed in real-time. In addition, the program provides the ability to apply a legend to background and survey data to provide real-time mapping of the gamma levels.

6.2 *Defining a Coordinate System*

- 6.2.1 By default, the software will use the WGS84 longitude latitude geographical system for all mapping and log file collection. There are times, however, where it is necessary or practical to define a projected coordinate system. For instance, when adding a geotagged world image file, it is necessary to set the coordinate system to the same system as defined in the image. The coordinate system will also be beneficial when collecting point features, which will be discussed in more detail below.
- 6.2.2 To define a coordinate system, click on FILE, then COORDINATE SYSTEM. Select the desired System and Zone, then click Save to set the project coordinate system. Once set, the saved coordinate system will be applied every time the software is opened.

6.3 *Defining a Legend*

- 6.3.1 The legend can be used to define specific colors to ranges of count rate data. Although the 2221 records both ratemeter and one-second scalar data, only the ratemeter will be evaluated and displayed using the legend. To apply a legend, tap Legend in the Settings menu. To add a new legend break, tap the Add button. Enter the new threshold, desired point size, and the color, then tap Save. The threshold is defined as the count rate at which the data will be colored if it is equal to, or exceeds.

- 6.3.2 To edit an existing break, tap on the break you wish to edit, and tap the edit button , or simply double tap on the break to bring up the legend properties. Make the necessary changes to the threshold, point size, or color and tap the Save button to apply changes. Note that the default map point will be defined by the ≥ 0 cpm break. The color and size of the point may be modified, but the threshold must be zero, and the break may not be deleted. Up to 10 breaks may be added to the legend. Once the legend is defined, tap the Save button to apply changes.
- 6.3.3 The legend will be applied to both the background layers and the real time data. When adding background layers, the legend breaks will be ordered from smallest to largest values when being drawn on the map. This allows the larger, and typically more important values, to be more visible when viewing the data that are on top of each other spatially.
- 6.3.4 If multiple legends are being used, use the menu in the legend editor to save and recall legends.

6.4 Creating a Survey File and Collecting Data

- 6.4.1 Prior to collecting survey data, a file must be created that will store all the records. To create a file, tap on the Create File tool from the File menu. The filename will be automatically created using the date, time, and the system ID of the Rad Scout. The system ID is provided as an integer to distinguish files easily when multiple data loggers are used for a single survey. The system ID for each data logger is predefined and may not be modified. If desired, add additional information to the beginning of the filename string, however it is highly recommended that the numerical fields are not modified. If necessary, enter additional information in the following textboxes, such as the survey unit, the technician, and any additional comments. Tap the Create button to create the file. Once a survey file has been created, survey data may be collected. Tap the Collect tool to start collecting data. Logged data will appear on the map in real time as individual points and the tablet will produce an audible beep when a new data point has been logged. Volume can be adjusted using the P1 and P2 hardware buttons on the front of the tablet. The total number of records logged to the file is also shown in the status bar. To pause the data collection, press the Stop tool. When surveying is complete, close the file by tapping the Close tool in the File menu. Once a file is closed, it may not be reopened to append data, however all collected files may be opened as background layers.

6.5 Data Features

- 6.5.1 The Data Feature function is useful for displaying points that are used for navigational or informational purposes. For instance, it might be necessary to navigate to previously defined sample locations as a shapefile. To open a feature file, select Data Feature from the file menu, then tap Open Feature File. A list of available shape files will appear. **To add custom shapefiles to the menu, the file must be copied into the RadScout folder in the My Documents directory.** Select a file, then tap Open. The points will be displayed on the map as shown in Figure 10. Unlike the background files, the data features allow user interaction through the map interface.
- 6.5.2 Click on the feature to bring up the sample window. From the menu,

select one of the three options as described

6.5.2.1 The Edit tool may be used to edit information about a previously added data feature point.

6.5.2.1.1 This option only available for points added manually.

6.5.2.2 The Select tool may be used to select a specific data feature. Once selected, the data feature can be navigated to by clicking FILE, DATA FEATURE, NAVIGATE TO.

6.5.2.3 The Visibility tool may be used to turn individual samples on and off. This feature is useful to determine when tasks at specific locations have been completed.

7.0 DOWNLOADING, ANALYZING AND EDITING THE SURVEY DATA

Following the collection of data, it is often necessary to transfer all field data to a central computer used for processing and reporting. This section discusses the process for transferring field data from multiple field tablets to a single removable disk.

7.1 Synchronizing Data

7.2 The Mesa tablet includes the ERG RadSync software which greatly simplifies the data exporting process and ensures no data are overwritten or deleted.

7.3 To export field data, place a removable disk in the USB slot on the bottom of the Mesa tablet and open the RadSync application. The application will display the gsf survey files and data feature shapefiles that will be transferred to the removable drive. The application will only display and attempt to transfer files that do not already exist on the removable drive. If the data feature shapefiles on the tablet are determined to be larger than the files on the disk (for instance, if features were added since the last transfer) then the shapefiles will be replaced with the newer file. All original files will always be maintained on the field tablet.

7.4 The application also provides an easy method of getting data onto the field computer to be used as background files or data files. To synchronize import data, place the desired files (.gsf, .jpg, .tif, or .shp) on the removable drive in the directory "<Drive>:\RadScout\". The software will copy these files to the field computer if they do not already exist.

7.4.1 Note that when this approach is used for synchronizing world image files, only the name will be used to determine if the file already exists

7.5 Editing and Reviewing the Data

7.5.1 Projects

7.5.1.1 The Radscene software utilizes projects which will keep files organized and retain project settings, such as coordinate systems.

7.5.2 Creating a New Project

7.5.2.1 To create a new project, click File, Project, Create. A New Project window will be displayed. Choose the project name and a directory and click the Create button. The software will create a folder in the directory matching the project folder along with all sub folders used to store data.

7.5.3 Opening and Modifying Existing Projects

7.5.3.1 To open or delete an existing project, click File, Project, Open/Modify to show the Open Project window. The drop-down box will contain all projects created on the computer. To open an existing project, select the desired project and click the Open button. To delete an existing project, select the project in the front down box and click the Delete button. Note that when a project is deleted the project is removed from the project list, but all folders and survey data are retained in the original file path. If a project has been deleted but it becomes necessary to reopen the project, open the Create New Project window and enter the old project name in the Project Name textbox. The software will ask if you would like to associate the file data to the project. Click yes to reopen the project

7.5.4 Defining a Coordinate System

7.5.4.1 To define a coordinate system, click the Setting tool and select the SYSTEM AND Zone. The coordinate system will be saved with the project and is primarily used for exporting data to a specific system.

7.6 Importing Data

7.6.1 Once a project is defined, field data may be imported. Insert the removable drive used to store field data from the RadExport software and click the Import Data tool to load the Import Data window as. If data is discovered on the drive, the computer names of all data loggers used to export data will be shown in the window. Click the Import button to copy all survey files and feature data from the USB drive to the project directory. The application will only copy files that do not already exist in the project directory. If the Data Features on the USB drive are determined to contain more data than the data feature files currently in the project folder, a message box will be displayed asking whether to replace the existing file or not.

7.6.1.1 Note that if you choose to replace the existing file, the file in the project directory will be overwritten.

7.7 Data Analysis

7.7.1 Once data has been imported, it will become available to be added to the map. Click the Add or Filter Add tool to add survey data to the map. Refer to the RadScene Interface section for information on viewing survey file details, tables, and defining legends.

7.7.2 Click the Analysis tool to bring a histogram and statistics of all data displayed in the map window as. Note that the Scalar data tab will only be available if a scaler enabled 2221 was used to collect data. Click and hold

on the blue cursor to drag in either direction. The corresponding cursor location value will be displayed in the blue text above the cursor.

7.8 Exporting Data

7.8.1 Click the Export Data tool to export all survey files currently loaded into the map. The Files to Export text box will display all files that are being exported. Click whether to use the project coordinate system or the WGS system (longitude/latitude). Also choose the time zone that the survey was performed in to correctly offset the time of each file record. The Use UTC time check box can also be used if it is preferable to keep data in UTC GPS time. Finally, choose the output file type as either a comma separated file (.csv) or ESRI shapefile (.shp) and select the directory. By default, the exported file will be named using a date string. When all parameters have been selected, click the Export button to export all survey files.

7.8.2 Unlike the survey files, which are collected in binary format, the data feature files are already created as shapefiles and therefore do not require exporting. After importing the survey data, the feature data files will exist as shapefiles in the [project directory]/[project name]/Features folder.

7.8.2.1 Note that if any manipulation is performed on the feature data shapefiles, it is recommended that the files be copied to a new directory. This will prevent the import process from overwriting data which is recognized as different than the USB data.

7.9 Data Tools

7.9.1 Merging and exporting gsfm files

7.9.1.1 Commonly, it is necessary to display the survey progress on a data logger to prevent resurveying an area that is already complete. This is particularly important when there are multiple surveyors for a single area. Review ERGModel 105G procedures for further information.

7.9.2 Repairing a Corrupt File

7.9.2.1 In very rare scenarios, a log file (.gsf) may become corrupt, preventing it from being able to be exported as a shapefile. This most commonly occurs if the data logger shuts down unexpectedly or freezes while a record is being written to the file. To repair a corrupted file, click the Tools – Repair GSF File. Select the file from the open file dialog. If errors are detected, the repair form will be displayed. Click the Repair button to repair the file. The tool will create a backup of the original file, which will have the suffix ‘backup’, and will be copied to the same folder location as the original

8.0 REFERENCES

- 8.1 National Council on Radiation Protection and Measurements, NCRP Report No. 50, "Environmental Radiation Measurements", December 1976.
- 8.2 National Council on Radiation Protection and Measurements, NCRP Report No. 58, "A Handbook of Radioactivity Measurements Procedures", 2nd Ed., 1985.
- 8.3 Kocher, D.C., 1979, "Dose-Rate Conversion Factors for External Exposure to Photons and Electrons", NUREG/CR-1918.

9.0 ATTACHMENTS

Attachment 1 – ERG Setup and Operation of the ERG Model 105G

Attachment 6. MJWRCP-66 Soil Sampling Protocols, Rev 0

 THE MJW COMPANIES <small>Radiological Consulting Professionals and Expert Technical Services</small>		MJWRCP-66 Rev. 0
PROCEDURE FOR SOIL SAMPLING FOR RADIOACTIVE MATERIAL		FIELD PROCEDURE
Effective Date: 12/16/20	Approved By: <i>M. J. Willett</i>	

1.0 PURPOSE

This procedure describes the general and specific procedures, methods and considerations to be used and observed when collecting soil samples for field screening and/or laboratory analysis.

2.0 SCOPE

The procedures described in this document are to be used by qualified field personnel when collecting and handling soil samples in the field. If MJW field personnel determine if any of the procedural steps may be inappropriate, they will contact their field supervisor immediately to discuss and resolve the issue. Any and all such issues will be recorded in the field logbook.

3.0 SAFETY PRECAUTIONS

Proper safety precautions must be observed when collecting soil samples. Field personnel must refer to the RECON Project Health & Safety Plan Rev 1 for guidelines on safety precautions to be followed for this type of field work.

4.0 PROCEDURAL PRECAUTIONS

Special care must be taken not to contaminate collected samples. This includes but it not limited to storing samples in a secure location to preclude conditions which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment. Collected samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party. If samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished.

5.0 FIELD OPERATIONS

5.1 General

These sampling methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface (BGS). The most common interval is 0 to 6

inches BGS, however, the data quality objectives of the investigation may dictate another interval, i.e., 0-3 inches BGS, for risk assessment purposes. The shallow subsurface interval may be considered to extend from approximately 12 inches BGS to a site-specific depth at which sample collection using manual collection methods becomes impractical.

5.2 Soil Collection Using Spoons

Stainless steel spoons may be used for surface soil sampling to depths of approximately 6 inches BGS where conditions are generally soft and non-indurated and there is no problematic vegetative layer to penetrate. If the soil being sampled is cohesive and crumbles when removed from the ground surface, consider using a hand auger to collect the sample.

When compositing a sample, make sure each composite location consists of equal volumes, i.e., same number of equal spoonfuls. If a thick matted root zone is present at or near the surface, it should be removed before the sample is collected.

5.3 Soil Collection Using Hand Augers

Hand augers may be used to advance boreholes and collect soil samples in the surface and shallow subsurface intervals. Typically, 4-inch stainless steel auger buckets with cutting heads are used. The bucket is advanced by simultaneously pushing and turning using an attached handle. Auger buckets may be used with a handle alone or with a handle and extensions. The bucket is advanced to the appropriate depth and the contents are transferred to the homogenization container for processing.

The practical depth of investigation using a hand auger depends on the soil properties and depth of investigation. For example, sandy soil may flow out or collapse at depth. Conversely, tight clays and cemented sands may offer too much resistance to sampling and powered equipment may need to be used.

Because of the tendency for the auger bucket to scrap material from the sides of the auger hole while being extracted, the top several inches of soil in the auger bucket should be discarded prior to placing the bucket contents in the homogenization container for processing. The hand auger assembly must be decontaminated between each borehole that is advanced per Section 5.5.

5.4 Sample Collection, Identification and Documentation

A nominal 500-gram (1.1 lb) sample will be collected and placed into a double-lined plastic bag or sealable laboratory containers. When necessary, additional borings will be placed adjacent to the original location to obtain adequate sample volume for laboratory testing. When multiple borings and core samples are required to obtain adequate sample volume, a composite sample from similar materials and at approximately equal depths of the cores used, will be collected for analysis.

All samples will be labeled to include:

- Location ID
- Depth
- Date/time
- Sampler
- Sample number
- Radiation readings (Gross CPM)
- Analyses required

Sample bags or containers will be transported in totes, coolers, or similar to the radiological storage area pending completion of GEL laboratories Chain-of-Custody (COC) forms (Attachment 1), and shipment for analysis. COC forms will be completed as required and will reflect laboratory analysis for gamma spectroscopy using method 901.1 (HASL 300) and/or alpha spectroscopy for U and Th isotopic. All samples will be submitted via contract carrier.

Sample IDs will consist of an alpha-numeric code including the location, boring ID, sample matrix, sample type, sample depth, and an identifier for composite sample.

- Location: This will be site coordinate and map location
- Sample ID: A sample designation starting with SU1 or BRA (survey unit designation) followed by dash and a two-digit number separated by dash for sample ID, followed by depth designation (A =0-6, B=6-12, C=0-12, D=12-18, as appropriate)
- Sample Matrix: So (soil), Con (concrete) or other.
- If the sample is a composite sample, the sample ID will have the letter C at the end.

Example #1: SU1-2-1ASoC. A soil sample (So) collected at soil sampling location (2-1), from 0.0 to 6 inches bgs (A), composite (C).

Samples will be analyzed by a ELAP certified laboratory. Sample custody will be documented, and analysis requirements communicated using laboratory provided Chain of Custody Forms

5.5 Step for Sampling Equipment Decontamination

Decontamination efforts will follow a four-step approach for hand tools and equipment used to collect samples. The four-step approach for sampling equipment decontamination is as follows:

- A detergent and water wash to remove all visible particulate matter and residual oils and grease.

- ## Attachment 1. GEL Laboratories Chain of Custody Form

MJWRCP-66

Attachment 7. Soil Sample Data Sheet



Date: _____ Project: _____ Project No.: _____

RCT Name: _____

1. Sample ID: _____
2. Sample Type: Composite/Grab Sample Vol.: _____ grams
3. Laboratory Analyses Requested: (circle) Gamma Spec Alpha Spec Isotropic: _____
4. Sample Location:
Description/Coord: _____
Land Marks: _____ Depth _____ Location ID: _____
5. Visual Characteristics of Sampled Material
Texture: _____ Color: _____ Grain Size: _____
Other: _____
6. Background 2x2 NaI (CPM) and Bicron (uRem/hr):
7. Sample Radiation Readings:


Identifier	2x2 NaI (CPM)			Bicron (uRem/hr)		Notes
Sample No.	Count time (min)	1 cm	1 m	1cm	1m	

8. Sample Information
 - a. Sample containers (bags) [all samples will be labeled per PDIWP] Label will include: Location ID, Depth, Type, Date/Time, Sampler, Sample No., Radiation Readings
 - b. Sample ID Format

Sample No.	Depth Interval (cm)	Soil Type (slag, soil, etc.)	Sample ID	Comments

Sample Recorded on Laboratory COC form and Container Labeled: (Y) (N)

Attachment 8. GEL Chain of Custody Form

Page: _____ of _____						 Laboratories LLC <small>Chemistry Radiochemistry Radiobioassay Specialty Analytics</small> Chain of Custody and Analytical Request								GEL Laboratories, LLC 2040 Savage Road Charleston, SC 29407 Phone: (843) 556-8171 Fax: (843) 766-1178																							
Project # _____																																					
GEL Quote #: _____																																					
COC Number ⁽¹⁾ : _____																																					
PO Number: _____						GEL Work Order Number:								GEL Project Manager:																							
Client Name: _____ Phone # _____						Sample Analysis Requested ⁽⁵⁾ (Fill in the number of containers for each test) <div style="display: flex; justify-content: space-between;"> <div style="width: 15%;">Should this sample be considered:</div> <div style="width: 15%; font-size: small;">Total number of containers</div> <div style="width: 60%; text-align: right;"><-- Preservative Type (6)</div> </div> <div style="margin-top: 10px; text-align: center; font-weight: bold;">Comments</div> <p>Note: extra sample is required for sample specific QC</p>																															
Project/Site Name: _____ Fax # _____																																					
Address: _____																																					
Collected By: _____ Send Results To: _____						This area is covered by the Sample Analysis Requested section above																															
Sample ID	*Date Collected (mm-dd-yy)	*Time Collected (Military) (hhmm)	QC Code ⁽²⁾	Field Filtered ⁽³⁾	Sample Matrix ⁽⁴⁾																			Radioactive (if yes, please supply isotopic info.)	(7) Known or possible Hazards	Total number of containers											
Chain of Custody Signatures									TAT Requested: Normal: Rush: Specify: (Subject to Surcharge)																												
Relinquished By (Signed) Date Time			Received by (signed) Date Time			Fax Results: [] Yes [] No																															
1			1			Select Deliverable: [] C of A [] QC Summary [] level 1 [] Level 2 [] Level 3 [] Level 4																															
2			2			Additional Remarks:																															
3			3			For Lab Receiving Use Only: Custody Seal Intact? [] Yes [] No Cooler Temp: ____ °C																															
> For sample shipping and delivery details, see Sample Receipt & Review form (SRR.)									Sample Collection Time Zone : [X] Eastern [] Pacific [] Central [] Mountain [] Other:																												
1.) Chain of Custody Number = Client Determined 2.) QC Codes: N= Normal Sample, TB = Trip Blank, FD = Field Duplicate, EB = Equipment Blank, MS = Matrix Spike Sample, MSD = Matrix Spike Duplicate Sample, G = Grab, C = Composite 3.) Field Filtered: For liquid matrices, indicate with a - Y - for yes the sample was field filtered or - N - for sample was not field filtered. 4.) Matrix Codes: DW=Drinking Water, GW=Groundwater, SW=Surface Water, WW=Waste Water, W=Water, ML=Misc Liquid, SO=Soil, SD=Sediment, SL=Sludge, SS=Solid Waste, O=Oil, F=Filter, P=Wipe, U=Urine, F=Fecal, N=Nasal 5.) Sample Analysis Requested: Analytical method requested (i.e. 8260B, 6010B/7470A) and number of containers provided for each (i.e. 8260B - 3, 6010B 7470A - 1). 6.) Preservative Type: HA = Hydrochloric Acid, NI = Nitric Acid, SH = Sodium Hydroxide, SA = Sulfuric Acid, AA = Ascorbic Acid, HX = Hexane, ST= Sodium Thiosulfate, If no preservative is added = leave field blank 7.) KNOWN OR POSSIBLE HAZARDS																																					
RCRA Metals			Characteristic Hazards			Listed Waste			Other			Please provide any additional details below regarding handling and/or disposal concerns. (i.e.: Origin of sample(s), type of site collected from, odd matrices, etc.)																									
As = Arsenic Hg= Mercury			FL = Flammable/Ignitable			LW= Listed Waste			OT= Other / Unknown																												
Ba = Barium Se= Selenium			CO = Corrosive			(F,K,P and U-listed wastes.)			(i.e.: High/low pH, asbestos, beryllium, irritants, other misc. health hazards, etc.)																												
Cd = Cadmium Ag= Silver			RE = Reactive			Waste code(s):			Description:																												
Cr = Chromium MR= Misc. RCRA metals			TSCA Regulated																																		
Pb = Lead			PCB = Polychlorinated biphenyls																																		

Attachment 9. MJWRCP-04_Rad Contamination Survey Map and Data Sheet

MJW Corporation Inc.

Radiation / Contamination Survey Map and Data Sheet

MJW Job #:

Surveyor:

Date:

Time:

Survey Map (Indicate North)

Survey Location (Description)	Instrument Number	Radiation Levels CPM or mR/hr	Physical Form	Remarks
<p>*Note: All Radiation Readings will be made in the same units noted for the instrument, unless noted otherwise in the remarks column.</p>				
RCP No. 4 Revision: 0		Date: <u>05/24/91</u>		Attachment 3

Attachment 10. NYSDOH BERP Radiation Guide 10.10_1986

New York State Department of Health
Bureau of Environmental Radiation Protection

RADIATION GUIDE 10.10

GUIDE FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT
PRIOR TO RELEASE FOR UNRESTRICTED USE OR
TERMINATION OF LICENSES FOR RADIOACTIVE MATERIALS

INTRODUCTION

A. Purpose of Guide

The instructions in this guide, in conjunction with Table 1, specify the radioactivity and radiation exposure rate limits which should be used in accomplishing the decontamination and survey of surfaces of premises and equipment prior to abandonment or release for unrestricted use. However, no decontamination procedures shall be used which may generate air-borne radioactive material without specific authorization from the New York State Department of Health to do so. The Department may be consulted as to the appropriate equipment performance characteristics to be used in determining that the levels specified in Table 1 are met. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control will be considered on a case-by-case basis.

B. Applicable Regulations

The regulations pertaining to this use of radioactive material are found in Title 10, Chapter 1, Part 16, New York Code of Rules and Regulations (10 NYCRR 16). Chapter 1 is entitled, "State Sanitary Code" and Part 16 is entitled, "Ionizing Radiation." The statutory authority for the rules and regulations is found in the New York State Public Health Law, Section 225.

PROCEDURES

A. Contamination

The licensee shall make a reasonable effort to eliminate residual contamination.

Radioactivity on equipment or surfaces shall not be covered by paint, plating or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to applying the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

The radioactivity on the interior surfaces of pipes, drain lines, or duct-work shall be determined by making measurements at all traps and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or duct-work. Surfaces of premises, equipment or scrap which are likely to be contaminated, but are of such size, construction or location as to make the surface inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the limits.

B. Relinquishing Control Above Limits

Upon request, the Department may authorize a licensee to relinquish possession or control of premises, equipment or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

1. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent and degree of residual surface contamination.
2. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations, such as prospective use of the premises, equipment or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

C. Reporting

Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the New York State Department of Health, Bureau of Environmental Radiation Protection, 2 University Place, Room 325, Albany, New York 12203, no less than 30 days prior to the planned date of abandonment. A copy of the survey report shall also be provided to the landlord or subsequent tenant, pursuant to Section 16.10 (b), New York State Sanitary Code (10 NYCRR 16).

The survey report shall:

1. Identify the premises and indicate the date of the survey.
2. Show that reasonable effort has been made to eliminate residual contamination.
3. Specify the manufacturer and model number of the survey instrument and the procedures used to calibrate the instrument, and include the last calibration date.
4. Describe the scope of the survey and general procedures followed.
5. State the findings of the survey in units specified in Table 1.
6. Confirm that the radiation levels shown in the survey will not be increased as a result of activities following the performance of the survey.

Following review of the report, the Department will consider visiting the facility to confirm the survey.

Table 1
Radioactive Surface Contamination Limits
(see notes below)

Application	Alpha (dpm/100 cm ²)		Beta/Gamma	
	Total	Removable	Total (mR/hr)	Removable (dpm/100 cm ²)
Controlled Area				
Basic Guide	15,000 max. 5,000 avg.	500	1.0	5,000
Clean Area	1,000	100	0.5	1,000
Non-controlled Area				
Skin, Personal Clothing	500	N.D.	0.1	N.D.
Release of Material or Facilities	2,500 max. 500 avg.	100	0.2	1,000

Notes to be used when using Table 1:

- a. Where surface contamination by both alpha- and beta-emitting nuclides exists, the limits established for alpha- and beta-emitting nuclides should apply independently.
- b. As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material 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 one square meter. For objects of less surface area, the average should be derived for each such 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 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.
- f. N.D. means non-detectable.