

The Community LOOW Project:
A Review of Environmental Investigations and Remediation
at the Former Lake Ontario Ordnance Works

Report prepared for:

The Community LOOW Project
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by

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EXECUTIVE SUMMARY

The Project

This report presents the results of the Community LOOW Project (CLP). The CLP was a community sponsored effort to critically evaluate the environmental condition of the former Lake Ontario Ordnance Works (LOOW) property in Niagara County. The former LOOW is a 7,500 acre area within the Towns of Porter and Lewiston, approximately 3 miles from Lake Ontario and 2 miles from the Niagara River.

Initially developed to manufacture TNT for the World War II war effort, the central portion of the area was subsequently used for a number of Department of Defense and Atomic Energy Commission projects. This varied history has led to the current situation where environmental contamination remains. Investigations and remedial planning are underway in some areas, led by the U.S. Army Corps of Engineers (USACE). Currently, the area consists of property owned by federal and local governments, active waste disposal operations, commercial businesses, private homeowners, and recreational or cultural activities. A hazardous waste disposal operation (CWM Chemical Services, LLC), a municipal solid waste landfill (Modern Corporation) and a radioactive waste containment facility (Niagara Falls Storage Site) occupy neighboring properties in the central portion of the LOOW.

The project was initiated during 2005 by the Niagara County Department of Health (NCDOH). A unique collaboration of local, state and federal officials funded this project with the purposes of evaluating the environmental status of the LOOW and to create a Geographic Information System (GIS) database of the environmental data. The goal was to examine the available information and to identify data gaps in past investigation and remediation activity. No new data was collected for this project. Documents were reviewed to gain an understanding of past work and to determine which information might be useful to include in the GIS mapping system.

There were three main components of the project:

- To identify and compile relevant data from past LOOW historic activity, investigations and clean-ups into a Geographic Information System (GIS) database
- To perform a “Gap Analysis” of the LOOW data, and involve independent expert review of the work.
- To identify and recommend solutions to the lead agencies, which are the U.S. Army Corps of Engineers, NYS Department of Environmental Conservation and NYS Department of Health.

Over the course of the project four public meetings were held to transfer information and provide opportunities for people to comment or discuss the issues. An internet-based GIS was developed to enable public access to LOOW data. The site can be accessed at the internet site www.communityloowproject.com. The

LOOW GIS Mapping website enables users to view geographic information about the LOOW and surrounding area, visualize the data locations of recent environmental studies and perform queries of the database.

Findings

The relationship between those responsible for investigations and remediation, and the surrounding community is important in conveying information and ensuring a successful resolution of LOOW-related concerns. A general lack of trust has existed between some members of the community and those in government charged with overseeing monitoring, investigation and clean up. Sharing of information and input to decision making appear to be stumbling blocks.

There has been a multi-year delay in publishing the NFSS Remedial Investigation report since the time the data was collected. Resources need to be available to complete the Formerly Used Site Remedial Action Program (FUSRAP) and Defense Environmental Restoration Program for Formerly Used Sites (DERP-FUDS) investigations, so that fundamental information is available to the community for decision-making in a timely manner.

As a result of the separate and distinct purposes and regulatory requirements, it appears that there is also fragmented jurisdictional oversight. The issues in play include delegation to USACE from DOE for radiologic and chemical investigations under the FUSRAP; USACE investigation of past DOD sites under the DERP-FUDS program; involvement of multiple branches and offices of NYS DEC (headquarters in Albany and Region 9 in Buffalo) concerning regulation of air, solid waste, hazardous waste, surface water, and wildlife; separate regulation of radiologic and drinking water quality issues by different parts of NYSDOH; and occasional limited involvement by USEPA. The responsibility for the approval process for USACE activity on the LOOW and identification of “who is the regulator?” needs to be better explained to the public.

Long term safety of the waste sites (including the NFSS, Modern Landfill, CWM and legacy materials) and offsite migration is of concern. Therefore, the adequacy of monitoring programs to detect contaminant transport in potential offsite pathways is important. Potential offsite migration of contamination could likely occur via four pathways: surface water drainage, groundwater migration, air, and sediment transport. Offsite migration of contaminated sediment and surface water occurred during past operations on LOOW. Each landfill has monitoring requirements which reflect their waste activities, but there does not appear to have been a unified attempt to include radiologic or common contaminants related to the shared historical use of portions of all three landfill properties.

Three other properties totaling nearly 1,000 acres are not within the USACE authority to investigate at the present time and they have been addressed under another program: the DERP Installation Restoration

Program (IRP). These properties contain the former TNT storage igloos north of Balmer Road , the former Air Force Plant 38, which is now occupied by the NYS Army National Guard Weekend Training Site (WETS), a small parcel transferred to the Town of Porter, and the launch area of the former NIKE missile base at the corner of Balmer and Center-Porter Road. Although these properties have been subject to some previous environmental investigation by their respective Department of Defense site owners, there does not appear to have been coordination in approach, methodology, or data quality objectives comparable to the USACE FUSRAP or DERP-FUDS investigations elsewhere on the LOOW.

At the WETS, there have been no groundwater investigations on the property, the thoroughness of the historical review for AFP 38 was insufficient to fully describe site activities, and the number of samples collected is not sufficient to be confident that all potential sources of contamination have been identified.

We found no information concerning the environmental status of the Town of Porter property.

The former NIKE base has been characterized and found to have few environmental problems. There was, however, no testing for hydrazine or missile fuel in the fueling area and the composition of the waste dumps represents an unknown risk. This property was recently sold to a private party.

South of Balmer Road at CWM, concern exists that previous remediation of radiologic contaminants was insufficient and that site development has disturbed soil on the property. DOD related contamination is present, has and is being investigated; however some areas have been awaiting remediation for more than 10 years. Despite several surveys and decontamination efforts, the location of buried radioactive waste associated with the Rochester Burial area (located on CWM) may be in a different location than previously investigated (Appendix G).

The Occidental property, west of CWM, has had only limited investigation and a former storage/disposal area remains unexplained.

The NFSS, south of CWM and west of Modern Landfill, has undergone an extensive remedial investigation which indicates that the site contains widespread contamination of surface soil and groundwater. Data gaps have been noted concerning characterization (e.g. geophysical surveys, West Ditch sampling, delineation of groundwater plumes), monitoring (e.g. insufficient annual groundwater sampling, lack of air particulate monitoring), contaminant fate and transport, and coordination of groundwater level monitoring with neighboring properties. The Baseline Risk Assessment Report for the NFSS was not reviewed as part of the CLP.

Modern Landfill is well monitored in accordance to its permit, but there has been a lack of radiological legacy contaminant monitoring. Construction activities involving pumping of groundwater should be coordinated

with the NFSS to contemporaneously measure water levels. Soil screening for radiologic parameters during construction should also be implemented.

The LewPort school campus has been evaluated for a number of environmental issues over the years. Remaining areas of concern are the 30 inch outfall pipeline from the former LOOW waste water treatment plant that crosses the campus and has never been evaluated for contaminated residue on the school property west of the Southwest Ditch. The Southwest Drainage Ditch has had insufficient sediment characterization for potential constituents from NFSS. Mounds in the wooded area should be assessed or removed. Some areas of the property used for running trails near the Southwest Drainage Ditch should be surveyed for radiologic and chemical constituents as a precautionary measure.

The question of whether there is potential for historical contamination remaining within the buffer area remains a concern that is difficult to definitively answer. We are not aware of other LOOW related contamination in the residential areas of the LOOW buffer areas. However, the slag gravel used for parking lots at Fin, Feather and Fur Conservation Society and Fatima Shrine contains non-LOOW related naturally occurring, elevated radiation levels above background.

Conclusions

Based on the information available to us the following conclusions have been drawn:

1. An extensive and overwhelming volume of information from many branches of government has been generated since the formation of the LOOW. Enhancing and maintaining a complete archival record of site activities should be considered to build on the work already completed by USACE. This effort should be supported and accessible to the community.
2. There is an extensive record of environmental sampling that has occurred over several decades. More than 350,000 records have been entered into the LOOW GIS mapping system. Use of a GIS approach to store, visualize and analyze this environmental data is a useful way in which to understand the work that has occurred. Sharing of information in an accessible format between those generating the data, regulators and the public should enhance efforts to remediate the former LOOW area.
3. There has been multi-year delays in getting information to the public and proceeding with decision-making and actual remediation.
4. There are four main pathways of concern for potential offsite impact from operations and contamination at the LOOW: air, groundwater, surface water, and sediment. Data gaps have been noted that might improve air monitoring at CWM and NFSS. Annual groundwater monitoring at

NFSS has used an insufficient number of wells to monitor the groundwater plumes which have now been presented in the NFSS RI document. Each waste disposal operation has its own monitoring and regulatory requirements, however an effort to coordinate and enhance monitoring to provide better overall understanding of groundwater flow and the presence of legacy contaminants would be beneficial. Discharge of shallow groundwater to surface water deserves further scrutiny as a potential pathway for contaminant migration. Surface water monitoring of ditches that traverse different properties (such as Central Drainage ditch) should have common set of parameters which reflect legacy contamination. Migration of sediment through storm flow should be considered. Previous investigation techniques for sediment sampling that did not use vertical coring profiles would not have been sufficient to identify all potential sediment contamination.

5. The DOD marker compound list used in the DERP-FUDS investigations is too specific and insufficient to reflect the actual breadth of materials and potential contaminants that would have been used at LOOW during all DOD activities;
6. Background chemical and radiologic data has been collected from some areas which may not be free of contamination;
7. Some of the vicinity Properties should not have been released for unrestricted use due to legacy radiation levels. A portion of the Central Drainage Ditch upstream of Four Mile Creek was never remediated;
8. Contamination at the NFSS is widespread in surface soil and groundwater, including radiologic constituents, metals, boron and chlorinated solvents. Previous remediation of the West Ditch appears to have been incomplete.
9. Useful and sophisticated groundwater modeling has been performed which addresses groundwater flow, leaching of contaminants, failure scenarios and contaminant transport. However, there has been insufficient geochemical work presented in the report concerning groundwater conditions to be confident that the critical transport parameters (K_d and biodegradation rate) used in the model were appropriate.
10. There has been insufficient investigation to fully characterize the distribution of contaminants at the NFSS.

Recommendations

Based on the conclusions above, the following recommendations are offered:

1. A complete archival record of LOOW and post-LOOW records should be created to improve on the current record availability and as a resource for all residents of Niagara County;
2. Appropriate funding should be allocated to maintain the LOOW GIS mapping system, and to update it in the future as monitoring data and the results of investigations are received. Training of staff at county libraries, or other methods to assist members of the public in accessing the system via internet should be considered.
3. The limiting and rigid definition of DOD marker compounds used in the DERP-FUDS investigations should be broadened in view of the much larger number of materials and potential contaminants that would have been used at LOOW (such as chlorinated solvents and petroleum hydrocarbons);
4. Improvements to the monitoring programs at NFSS for air, surface water and groundwater as discussed in this report (Appendices C, D, F) should be considered;
5. The final downstream portion of the Central Drainage Ditch should be resurveyed and remediated as necessary. The West Ditch should also be remediated.
6. Additional specific studies should be undertaken to provide the information required to determine whether the critical transport parameter, K_d , as used in the groundwater modeling are actually appropriate and if not, a current, scientifically valid method should be used to model radionuclide transport in groundwater.
7. Appropriate funding should be allocated so that the NFSS Baseline Risk assessment report should be reviewed by a skilled risk assessor to ensure that the methodology and results are correct.
8. Evaluation of the environmental data collected at the former LOOW site by multiple parties would greatly benefit from coordination of data reporting standards and quality objectives, including geographic spatial data.
9. Appropriate funding should be allocated by Congress to USACE for continuing the necessary investigations and studies required to complete the remediation of the former LOOW properties in a timely manner.
10. Additional investigation should be performed at the NFSS to delineate the distribution of contaminants (such as uranium in groundwater and the presence of KAPL related waste).

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Acknowledgements

This work would not have been possible without the efforts and support of many people. The vision and commitment of a few community members that was required to initiate this project should not be underestimated. Active citizens wrote grant applications, pushed local, state and federal officials to recognize a problem and provide funding, resulting in a unique combination of support with the goal of getting independent opinion about a significant environmental issue affecting the lives of many in western Niagara County.

In particular, gratitude is extended to Congresswoman Louise Slaughter, the Community Foundation for Greater Buffalo, State Senator George Maziarz, State Representative Francine Delmonte, the western New York Assembly and Senate delegation, the University at Buffalo Environment and Society Institute, the Towns of Porter and Lewiston, and Niagara County for funding this project.

The Niagara County Department of Health took on the role of administering the work in an impartial manner under the enthusiastic leadership of former Director Paulette Kline and her successor, Director Dan Stapleton. The interest and support of members of the Health Department Environmental Health Division under Director Jim Devald is much appreciated.

Information was asked of, and received from most of the major stakeholders involved: the US Army Corps of Engineers, the LewPort School Board, CWM Chemical Services, LLC, Modern Landfill Corporation, the US Air Force, US Army National Guard, and NYS Department of Environmental Conservation.

In the often divisive area of environmental activism and local political realities, it is hoped that this project will provide the citizens of Niagara County with useful information and tools to provide a meaningful contribution to the ongoing environmental investigations and remediation of the former LOOW. The LOOW Geographic Information System mapping website is now accessible to the community through internet and is a powerful tool to better understand site data

K. Scott King

Project Coordinator

1. Introduction

This report presents the results of the “Community LOOW Project”, referred to hereafter as CLP. The CLP was a community sponsored effort to critically evaluate the environmental condition of the Lake Ontario Ordnance Works (LOOW) property in Niagara County. The former LOOW is a 7,500 acre area within the Towns of Porter and Lewiston created during World War II to manufacture TNT explosives. Currently, the area consists of property owned by federal and local governments, active industrial operations, recreational and cultural properties, and private homeowners.

The project was initiated during 2005 in response to concerns in the community related to perceived health risks from legacy or current activities, apparent fragmented jurisdictional issues concerning investigation and remediation of environmental problems, a legacy of mistrust with federal agencies, and perceived potential conflicts of interest by some agencies that supervise activity at the LOOW site. In addition, the NYS Dept. of Health Environmental Radiation Protection Bureau in 2004 indicated apparent gaps in the adequacy of previous radiological remediation.

The Niagara County Department of Health (NCDOH) administered the project. The NCDOH has no significant benefit or liability with respect to historical or current activities on the LOOW. The NCDOH is committed to ensuring public safety and increasing trust in the restoration process through a comprehensive approach to the entire former LOOW area.

A unique collaboration of local, state and federal officials funded this project with the purpose of evaluating the environmental status of the LOOW and to create a Geographic Information System (GIS) database of environmental data. The goal was to examine the available information and to identify data gaps in past investigations and remediation activity. Access to information about the LOOW was also very important. No new data was collected for this project. The additional scrutiny is meant to provide another outside viewpoint, and encourage accountability by those conducting and overseeing environmental investigations and monitoring. The overall goal is to increase trust in the community, and confidence that the investigation/remediation process is thorough, ensuring that this site is safe.

The former LOOW is located in western New York, within the Towns of Lewiston and Porter, 3 miles from Lake Ontario, and two miles from the Niagara River. The approximate population of Niagara County is 220,000.

In 1942, the U.S. Dept. of War purchased 7,500 acres from Niagara County residents to construct and operate a TNT production facility. After only 9 months of operation, TNT production was discontinued. During the

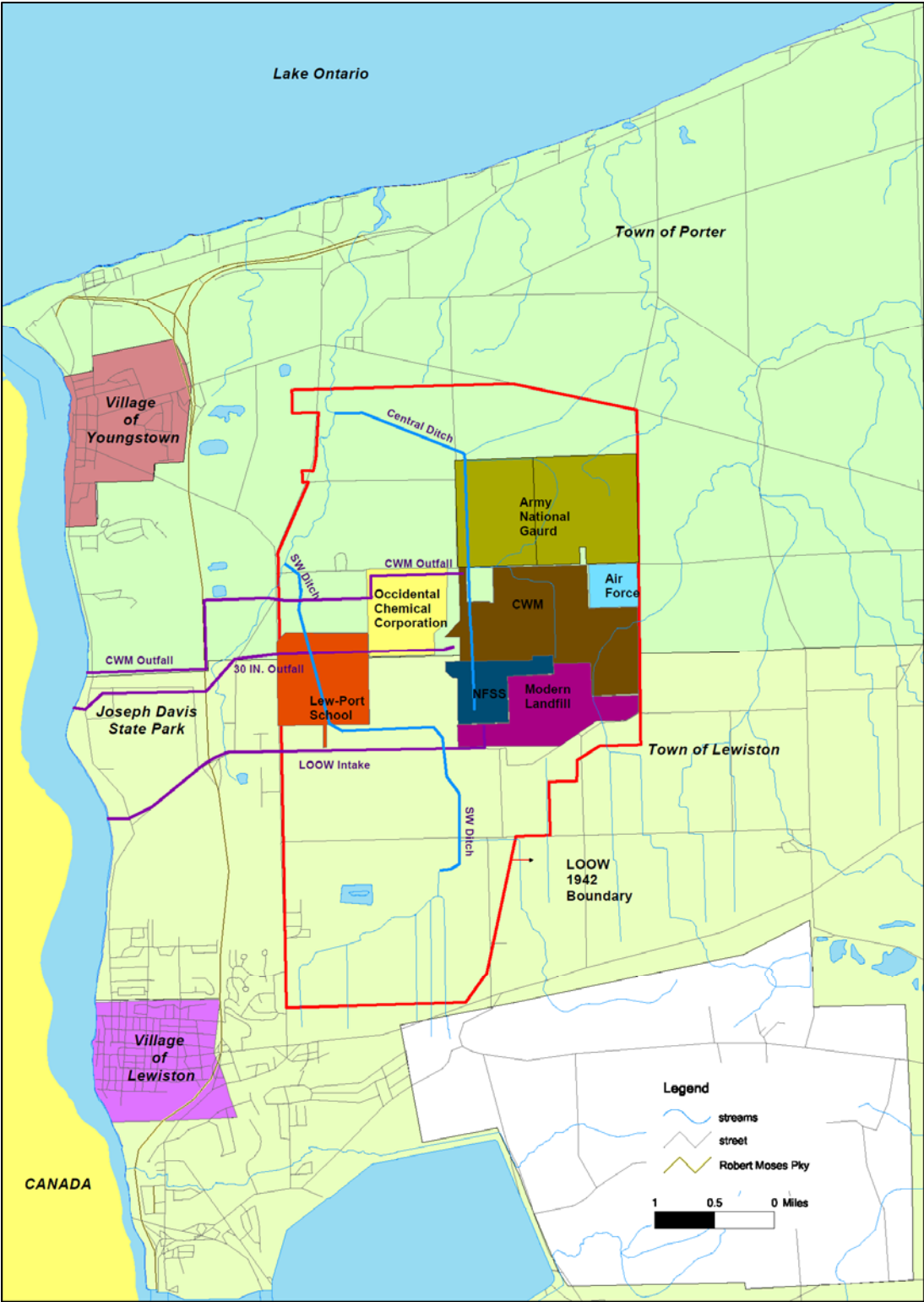


Figure 1 Location of Lake Ontario Ordnance Works property

latter part of World War II, the Manhattan Engineering Division (Manhattan Project) began using part of the LOOW site for the storage of highly radioactive uranium and radium residues, and the Northeast Chemical Warfare Depot operated on a portion of the property (EA Engineering Science and Technology Inc., 1997).

A large portion of the LOOW property was used as a “buffer zone” to protect the public from the hazards of TNT production. From 1946-1948, 5,000 acres of this “undeveloped” land was divided up and sold by the Federal government to the general public. Additional property was transferred to government agencies or sold to the public in the 1960’s. The Lewiston-Porter School Board obtained 376 acres in 1948 within the formerly undeveloped zone for construction of primary, elementary, middle and high schools. Today numerous residences, farms and other commercial activities are located on former LOOW property.

Within the “developed” area of the former LOOW, current activities include storage of radioactive waste at the Niagara Falls Storage site (NFSS), active solid waste landfilling by Modern Corporation, and active hazardous waste treatment and disposal by CWM Chemical Services, LLC (CWM). Activities at the former LOOW have included:

- TNT Manufacturing Plant (water filtration, production, waste water treatment)
- Northeast Chemical Warfare Depot (storage and transshipment)
- 1944-Present Manhattan Project /Atomic Energy Commission / NFSS radioactive storage
- U.S. Air Force Plant 38 (rocket engine testing)
- U.S. Air Force Plant 68 (high energy fuels)
- Navy Interim Pilot Production Plant (high energy fuels)
- Boron-10 Production Plant
- NIKE Missile Base NF-03 and NF-05
- Ransomville Test Annex - USAF
- 1966-Present Youngstown Test Annex -USAF
- 1979-Present Army National Guard weekend Training Site
- 1972-Present Chemtrol / SCA / CWM Chemical Services, LLC (Hazardous waste disposal)
- 1983-Present Modern Landfill (municipal solid waste disposal)

This varied history has led to a current situation where environmental contamination remains. Formerly used Department of Defense properties are being evaluated under the Defense Environmental Restoration Program for Formerly Used Defense Sites (DERP-FUDS). There are LOOW-related areas still actively owned by the Department of Defense, but which are not being investigated under the same program. Since the former LOOW property was used for storage of radioactive materials, there are areas (some overlapping) which must be investigated separately under the Formerly Utilized Sites Remedial Action Program (FUSRAP). Other former or current Department of Defense properties have been investigated under the Installation Restoration Program (IRP). Some former LOOW properties now owned by private entities (e.g. CWM Chemical Services, Modern Corporation) have been investigated separately under DERP-FUDS but also operate under their individual state regulatory requirements. Thus, there is a perceived shortcoming that the USACE environmental investigations are restricted by law in what and where they can investigate, according to the applicable program. As an example, DERP-FUDS has been limited in not being able to test for radiologic contaminants even if an area may have also been used to store radiologic materials. A private landowner with contamination caused by legacy federal government activities could ultimately be held responsible for cleanup by New York state if the cause of the contamination is disputed and not addressed by the federal investigation or cleanups.

The timeline for further investigation and remediation of formerly used Department of Defense property contamination by the U.S. Army Corps of Engineers is anticipated to extend to 2016. Although the site's complexity is recognized, the long period of time to deal with the issues is of concern to members of the community.

Niagara County has above-average rates of some cancer incidences compared to other parts of the state. Niagara County rates for cancer Incidence and Mortality, combined, exceed NYS averages for 19 of 24 cancers tracked, according to the NYS Dept of Health web site. The relationship, if any, of activities on the LOOW and NFSS to these health issues is unknown, but it remains a perceived issue of concern to many citizens.

2. Approach to Project

There were three main components of the project. These were:

- To identify and compile relevant past LOOW historic activity, investigations and clean-ups into one Geographic Information System (GIS) database
- To perform a “Gap Analysis” of LOOW data using GIS and other evaluations, and involving independent expert review of the work.
- To identify and recommend solutions to the lead agencies, which are the U.S. Army Corps of Engineers, NYS Department of Environmental Conservation and NYS Department of Health.

This approach is somewhat different from past initiatives since it was intended to be “blind” to jurisdictional limitations of the agency programs, and took a site-wide approach to look at the “big-picture” using independent outside experts. A community participation component was part of the project through public meetings and website postings. A key aspect of the project was to provide the community with an assessment that will be viewed as independent by the community. This project was very unique in that a broad source of support was obtained from local, county, state and federal governments, and a community foundation. This wide community support indicated the need and desire for a project such as this.

This report is one of three tangible products which have resulted from the project. The other two included

- An internet website available to the public and members of the community which describes project progress, and contains LOOW information
- A Geographic Information System available via internet that contains selected relevant environmental data for use by members of the public, restoration advisory board members, regulators or other interested parties to better understand the work and condition of the site.

2.1 Project Team

Scott King of King Groundwater Science, Inc. was retained to act as Project Coordinator and to conduct the project with assistance from the Niagara County Department of Health. The NCDOH administered the project and was the agency through which funding was channeled. During the work, King worked with others to provide assistance, review comments and the Geographic Information System. Assistance to the project was provided by Dr. Joseph Gardella of the University at Buffalo, Dr. Sherri Mason of Fredonia State University, geophysicist Dr. John P. Greenhouse, Dr. Ron J. Scudato of R&M Technology, Inc., and Dr. Marvin Resnikoff of Radioactive Waste Management Associates. Dr. Gardella provided in-kind funding for GIS assistance through a grant from the UB Environment and Society Institute. A graduate student, Ms.

Gunwha Oh, provided GIS support and assistance in the early development of prototype maps and database construction. Mr. J. Kwoka of NCDOH also provided GIS assistance to the project.

Also during the summer of 2006, Niagara County began the process of retaining a GIS consultant for a county-wide enterprise GIS and it was decided to include the Community LOOW Project in the scope of work for that project. Ecology and Environment, Inc. was selected by the county and began work on the Community LOOW Project in January 2007. E&E developed a LOOW GIS Management Plan and began developing the GIS using various databases provided by the CLP, with the goal of making the GIS available to the project team and interested public via the internet.

2.2 Methodology

The CLP initially began by identifying sources of information and soliciting various government agencies and landowners for relevant data. A letter from Ms. Paulette Kline, then Director of NCDOH, was sent to individuals, agencies and entities informing them of the project and seeking information. Over the course of the project four public meetings were held to transfer information and provide opportunities for people to comment or discuss the issues (Table 2-1).

Date	Purpose
21 November 2005	Introduction of project and request for information
25 September 2006	Update on progress and demonstration of GIS application
13 June 2007	Update on progress, description of E&E GIS efforts and report on review of radiologic issues
30 January 2008	Introduction and demonstration of the LOOW GIS mapping website www.communityloowproject.com

Table 2-1 Public meetings held during the project.

Notices and copies of presentations made at the public meetings were posted to the NCDOH website (www.niagaracounty.com/health) and were available for public download. Notices and press releases of the meetings are available in Appendix A.

Responses were received from several agencies and citizens. The USACE provided electronic copies of their sampling database and GIS files. The NYSDEC provided electronic database information concerning groundwater monitoring at the CWM site. U. S. Air Force sent copies of documents concerning the former missile base and the NYS Army National Guard allowed access to their files and copies of past investigations.

Mr. Alan Truesdale of the LewPort School district provided copies of soil sampling reports. Ms. Ann Roberts, a former member of the community, provided historical documents and knowledge of the site, and Dr. William Boeck provided copies of documents concerning the NFSS.

Documents were reviewed to gain an understanding of past work and to determine which information might be useful to include in the GIS mapping system. In view of the large number of previous investigations and remediation efforts that have occurred in the past, it was decided to map the most recent studies to indicate the presence of currently known contamination, rather than include all past contamination that had been removed or remediated.

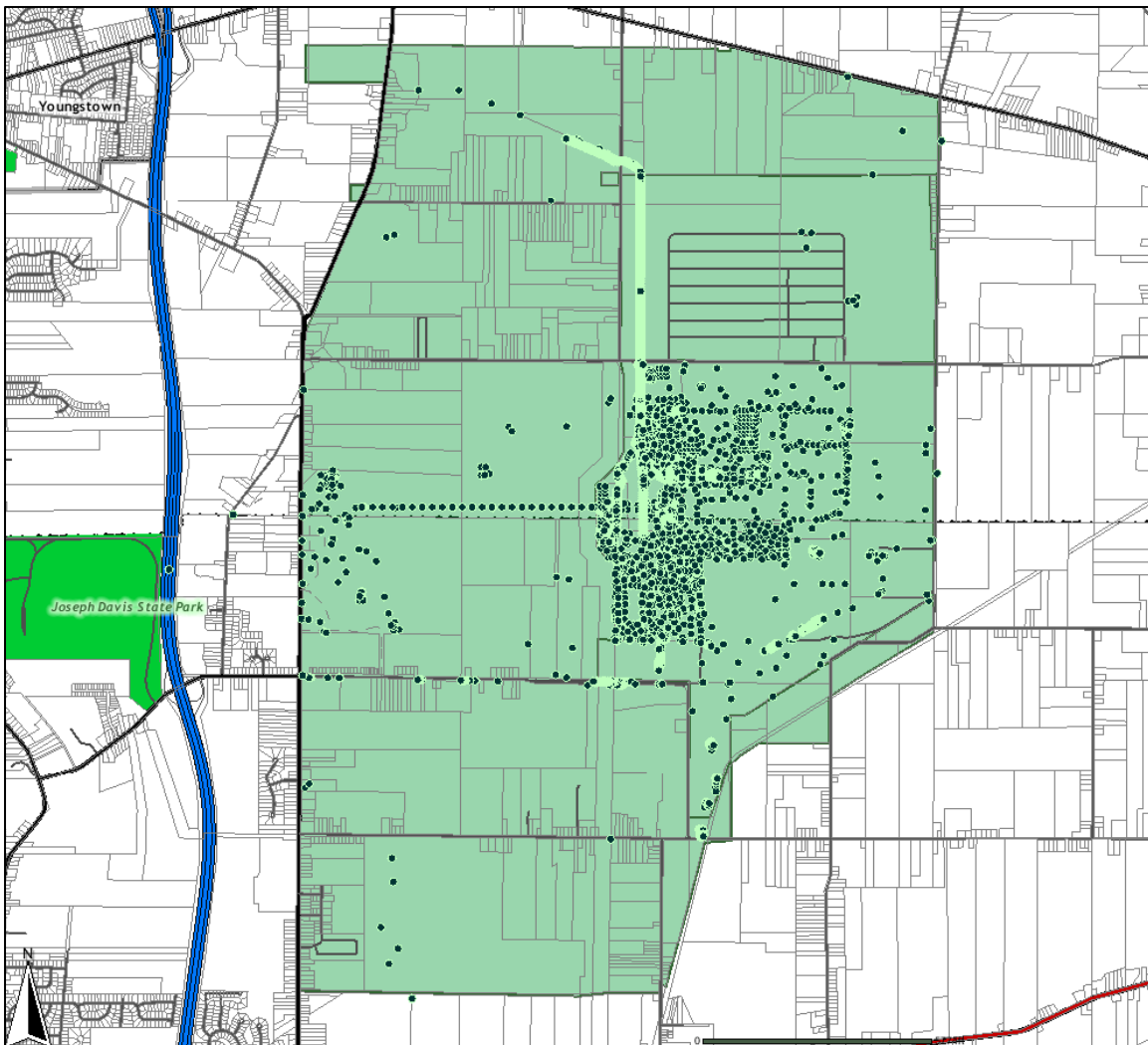


Figure 2 Location of sampling data in LOOW GIS

2.3 LOOW GIS Mapping site

An internet based geographic information system was developed to enable public access to LOOW data. The site was developed by Ecology & Environment, Inc and became accessible on January 30, 2008. A description of the LOOW GIS mapping system is contained in Appendix B. The site can be accessed at the internet site www.communityloowproject.com. The LOOW GIS Mapping website enables users to view geographic information about the LOOW and surrounding area, visualize the data locations of recent environmental studies and perform queries of the database.

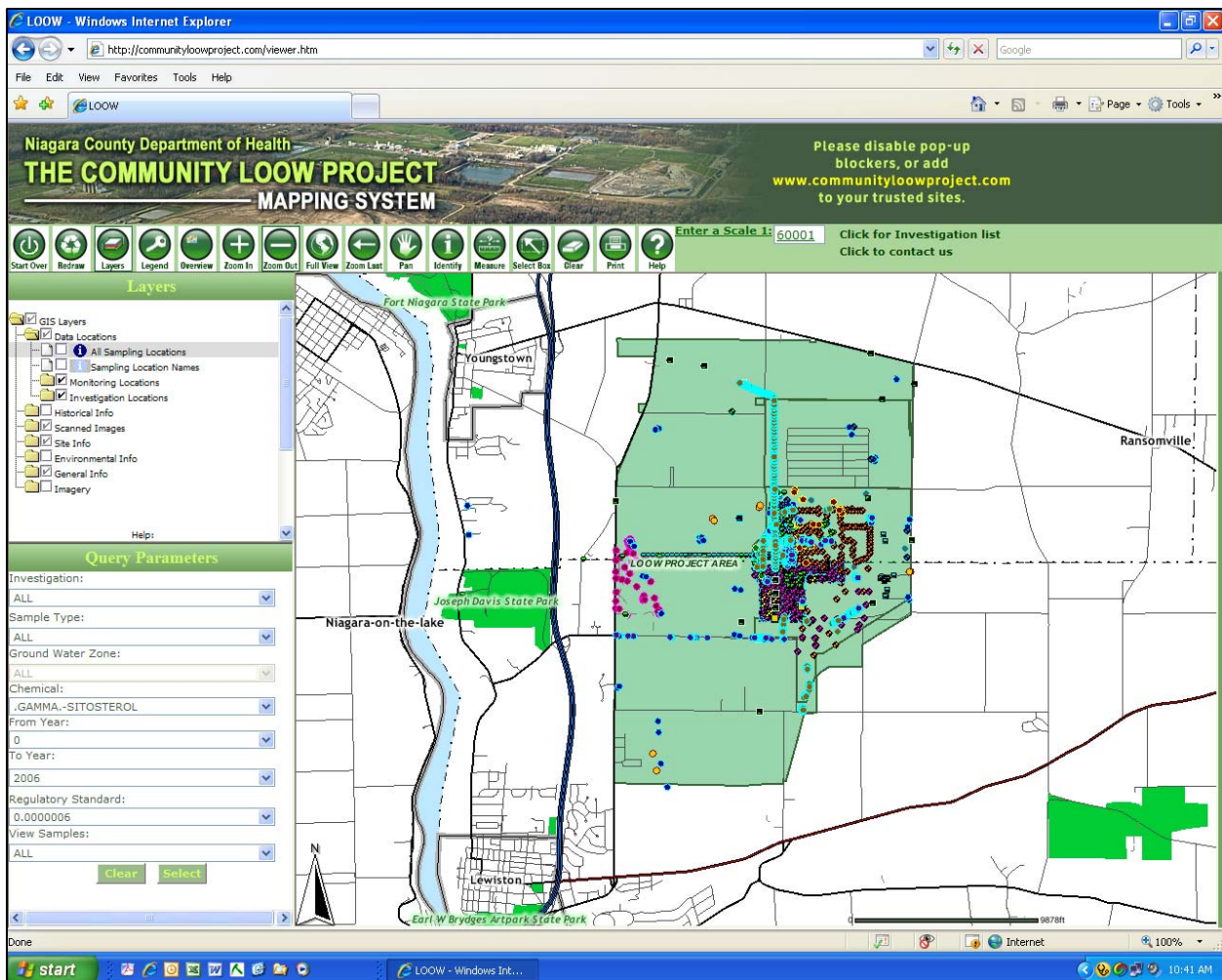


Figure 3 Screenshot of LOOW GIS Mapping website

3. Discussion of Results

3.1 General Issues of Concern

There are several issues of concern that have been identified and which provide a context for evaluating the environmental work that has been carried out at the former LOOW.

Perhaps the most important single issue that affects progress with regard to environmental remediation at the LOOW is the relationship between those responsible for investigations and remediation, and the surrounding community. A general lack of trust appears to exist between some members of the community and those in government charged with overseeing monitoring, investigation and clean up. Sharing of information and input to decision making appear to be stumbling blocks. The USACE has worked with a Restoration Advisory Board (containing members of the public), but after a first RAB was dissolved following a contentious period, a second RAB, in operation for three years, was recently declared to not be “official” by USACE. The New York State Attorney General has become concerned that the USACE action may be illegal (State of New York Office of the Attorney General, 2008), but the Corps cites federal regulation in operation of a RAB (U. S. Army Corps of Engineers, 2008b). A third RAB might have been formed by the USACE to meet their regulations if there was sufficient interest in the community (U. S. Army Corps of Engineers, 2008a). However in July 2008, the USACE District Commander informed the community that after reviewing the input received and after careful consideration, an official DOD RAB will not be formed (U. S. Army Corps of Engineers, 2008c). The Corps does plan continued outreach and public involvement.

The LewPort school campus and hundreds of residents live on property that was within the “buffer” area of the former LOOW. The question of whether there is potential for historical contamination remaining within the buffer area remains a concern that is difficult to definitively answer. Part of these concerns may come from a perception that the historical record of activities that occurred at LOOW may not be fully known, or that information is hidden from the public.

The CWM property remains under a 1972 NYS Health Department Order (amended in 1974) to not move soil due to the presence of contamination. An application by CWM for relief from the Order has led to requirements for specific investigations, monitoring and soil handling requirements. However, development of the site did proceed with approval from both NYSDEC and NYSDOH and currently operates under a Permit renewed in 2005. The CWM permit application for a new hazardous waste landfill has also caused contention in the community, as the specter of more waste coming to Niagara County is disagreeable to many. Long term safety of all of the waste sites (including the NFSS, Modern Landfill, CWM and legacy materials) from leakage and offsite migration is of concern. Therefore the adequacy of monitoring programs to detect contaminant transport in potential offsite pathways is important to evaluate.

Potential offsite migration of contamination could likely occur via four pathways: surface water drainage, groundwater migration, air (volatile and particulate), and sediment transport. Offsite migration of sediment and surface water has occurred during past operations on LOOW. Monitoring programs have been in place at CWM, Modern and NFSS for more than 20 years, but each was developed within the context of the needs of the current use of the site and regulatory requirements. For example CWM is regulated under 6 NYCRR Part 373, Modern Landfill is regulated under 6 NYCRR Part 360 and NFSS is regulated under Department of Energy regulations. Each landfill has monitoring requirements which reflect the waste activities, but there does not appear to have been a unified attempt to include radiologic and common contaminants from shared historical use of portions of all three landfill properties. CWM has in recent years been required to perform radiologic surveys and implement a radiologic monitoring plan, but Modern does not perform any radiologic monitoring of air, groundwater or surface water.

Two other properties totaling nearly 1,000 acres are not within the USACE authority to investigate at the present time. Because these properties were owned by the DOD after 17 October 1986, they are addressed under the DERP Installation Restoration Program (IRP). These properties contain the former TNT storage igloos north of Balmer Road, the former Air Force Plant 38, which is now occupied by the NYS Army National Guard Weekend Training Site (860 acres), and the launch area of the former NIKE missile base¹ (98 acres) at the corner of Balmer and Center-Porter Road. Although these properties have been subject to previous environmental investigation by their respective Department of Defense site owners, there does not appear to have been coordination in approach, methodology, or data quality objectives comparable with the USACE FUSRAP or DERP-FUDS investigations elsewhere on the LOOW. There has been no recent community outreach or discussion concerning the results obtained from the IRP investigations.

As a result of the separate and distinct purposes and regulatory requirements, it appears that there is also fragmented jurisdictional oversight. The issues in play include delegation to USACE from DOE for radiologic and chemical investigations under FUSRAP; USACE investigation of past DOD sites under the DERP-FUDS program; involvement of multiple branches and offices of NYS DEC (headquarters in Albany and Region 9 in Buffalo) concerning regulation of air, solid waste, hazardous waste, surface water, and wildlife; separate regulation of radiologic and drinking water quality issues by different parts of NYSDOH; and occasional limited involvement by USEPA. The responsibility for the approval process for USACE activity on the LOOW and identification of “who is the regulator?” needs to be better explained to the public. At the moment, it appears that although state agencies provide comment to USACE, the USACE is under no obligation to act on this advice.

¹ The NIKE missile base launch area property was recently sold to a private party.

The two active waste disposal operations and the NFSS do not use a common coordinate system and elevation datum. Instituting such a basic requirement would make evaluations and oversight of the entire LOOW property much easier, as monitoring locations and data could be readily linked.

An apparent lack of consistent funding and resources to USACE has resulted in a multi-year delay in publishing the NFSS Remedial Investigation report, which contains fundamental information for decision-making, and completing the DERP-FUDS and FUSRAP investigations. The main NFSS data collection and groundwater modeling exercises had been essentially completed by June 2003 when the Technical Project Planning Team met to begin discussing feasibility studies. The remediation process has become long and drawn out which leads to public fatigue and frustration. In addition, the data that will be used for the feasibility study and management decisions will reflect conditions as they existed at the time of collection.

Contamination discovered, but determined to be non-DOD by USACE, results in ceasing further investigation and is left to the legal process to identify Potentially Responsible Parties to continue investigation and cleanup. Ultimately, the current landowner is responsible for cleaning contamination unless the federal government takes responsibility, or is found to be responsible for it. This is an issue now for CWM and part of the Somerset properties. DOD contamination in the DERP-FUDS program has been strictly defined and as a result, investigations may be stopped or incomplete, even if DOD is likely responsible since the criteria ignores common contaminants that large DOD infrastructure would have used.

An impressive amount of historical records review has been carried out by the USACE and their contractors. However, some aspects remain apparently incomplete. For example, the USACE History Search Report (EA Engineering Science and Technology Inc., 1997) is not accurate with respect to the location of the North East Chemical Warfare Depot which occupied land to the north and south of Balmer Road. Concern from the public that the USACE assumed the buffer areas were unaffected by DOD operations led to a review of air photography which indicated activity in the buffer area during DOD ownership and led to the Small Bermed Clearing Investigation (U. S. Army Corps of Engineers, 2004). The 2007 NFSS Remedial Investigation Report (Science Applications International Corporation, 2007) refers to the “possibility” of fission products on the NFSS, when in fact the Knolls Point Atomic Power Laboratory (KAPL) has already confirmed that fission products were sent to LOOW and stored on the NFSS (Hanner, 1958; Sweeney, 1958). The issue of plutonium waste, other than the small amounts contained in the fission product waste sent to the LOOW deserves further assessment. The location of the Rochester burial area containing plutonium and/or other waste has been investigated several times, but there appears to remain locations which have not been investigated thoroughly (Appendix G).

3.2 Data Gap Analysis

The goal of the data gap analysis is to identify issues that might lead to recommendations for further investigation, clarification or presentation of additional information not readily apparent in the available studies. For the purposes of this report, a “data gap” is considered to be lack of data concerning a particular issue, such as chemical analyses, an insufficient number of samples, or data required to make an interpretation, inappropriate methodology, and/or inappropriate application or interpretation of certain results. A gap could also be identified in procedures or may be of a systemic or random nature.

3.2.1 Monitoring Programs

Potential offsite migration of contamination could occur via four pathways: surface water drainage, sediment transport, groundwater migration and air. Monitoring programs have been in place at CWM, Modern and NFSS for more than 20 years, but each was developed within the context of the needs of the current use of the site and regulatory requirements. For example CWM is regulated under 6 NYCRR Part 373, Modern Landfill is regulated under 6 NYCRR Part 360 and NFSS is regulated under DOE Order 5400.5.

3.2.1.1 Air

Three properties have air monitoring programs in place: CWM, Modern landfill and the NFSS.

Modern Landfill operates under a Title V air monitoring permit that addresses emissions from landfill gas collection and combustion system, a rubble processing plant, a leachate storage tank, and other provisions related to complaints or other nuisances associated with MSW landfills. Emissions monitoring (particulate monitoring, sulfur dioxide, ozone, nitrogen oxides and carbon monoxide), record keeping and maintenance procedures are to be followed to remain in compliance. There is currently no air monitoring requirement or known issue associated with prior historical activities.

The CWM property operates six perimeter air monitoring stations situated around the main landfill/process area of the property. Currently, CWM is only required to monitor for total suspended PM10 particulates. A one-time analysis of PM10 particulates for isotopic uranium, thorium, radium and gamma spectroscopy on composited filter dust was performed in July 2005 in accordance with the approved Radiation Environmental Monitoring Plan. During CWM operations, air monitoring studies have been performed to evaluate PCB (1987-1996), Semi-Volatile Organic Compounds (SVOC, 1991-1992), Volatile Organic Compounds (VOC, 1984-2000) and metals (1991) in air at the facility.. Chemical-specific monitoring has been suspended with NYSDEC approval based on the data collected, changes to facility operations, and disposal restrictions. The various reasons for terminating the CWM VOC in air program were described in Zayatz(2000). NYSDEC suspended this program in August 2000 (Rostami, 2000). Among the reasons cited, it was noted that regional

ambient concentrations were elevated. A review of the final 12 months of VOC monitoring at CWM indicated that two carcinogens (carbon tetrachloride and benzene) were consistently above state ambient guidelines and two other carcinogens were occasionally above the AGC. If other regional sources, and not CWM, are the source of these elevated concentrations of carcinogens in air, then this indicates a potential larger issue for the local community and it would be of benefit to the community to know the source(s), and implications of their presence, and to monitor them.

The NFSS monitors external gamma radiation, radon gas concentrations and radon-222 gas flux from the IWCS at the site fence line and above the IWCS. Airborne particulates are not monitored, and radiation doses are estimated using models and off-site meteorological data.

Review comments concerning air monitoring at NFSS and CWM are contained in Appendix C.

Data gaps and concerns noted regarding air monitoring include:

- the number and locations of current air monitoring (PM) stations on CWM property were previously approved and permitted by NYSDEC. . A re-assessment of the air monitoring program has been requested by NYSDEC, and this is considered to be appropriate.
- A re-evaluation of particulate monitoring and analytical equipment should be included in the NYSDEC assessment of CWM air monitoring to determine whether PM_{2.5} monitoring is a more appropriate approach than PM₁₀;
- A re-evaluation of ‘background’ air sampling locations (use of comparative stations located at sites off the former LOOW property);
- There is a need for PM monitoring stations at NFSS;
- The need for chemical, as well as radiological, analysis of collected PM samples at CWM and NFSS;
- a re-evaluation of mathematical procedures used to calculate community dose exposures should be considered;
- For radiologic monitoring of NFSS, the USACE should be using a lower exposure guideline. The guideline currently used is 100 mrem/y, which is appropriate for operating nuclear facilities. Since the NFSS resembles a disposal or decommissioned site, a guideline of 25 mrem/y would be more appropriate;
- The most recent VOC monitoring at CWM (ended in 2000) indicated carcinogens in air that may be due to regional sources. It is unknown if the elevated compound levels remain and if they do, the sources should be identified.

3.2.1.2 Surface Water

Prior to construction of the IWCS on NFSS, surface water on the LOOW and downstream was contaminated with radionuclides and some metals above background levels (Battelle Columbus Laboratories, 1980; Oak Ridge National Laboratory, 1979b). Since development of the landfill operations, surface water quality monitoring programs have been implemented by CWM, Modern Landfill and operators of the NFSS. Prior to closing of AFP 38, the plant was subject to a SPDES monitoring requirement of surface water leaving the outfall at the northwest corner of the current USANG WETS, and no monitoring has occurred since 1983. CWM monitors discharge to four external outfalls (Niagara River, two tributaries to Four Mile Creek, one tributary to Twelve Mile Creek). CWM is currently undergoing a SPDES permit modification. The Modern Landfill monitors surface water quality at five locations (three sedimentation basins and two tributaries to Twelve Mile Creek). The USACE monitors surface water quality on the NFSS property at four locations in the Central Drainage Ditch and one upstream location in Ditch 31 (east boundary with Modern) on an annual basis.

Data gaps and concerns noted regarding surface water monitoring are:

- CWM has had a history of detectable PCB in surface water at the SPDES outfalls. Installation of carbon cloths and maintenance have essentially eliminated PCB detections since August 2004 at Outfall 002. However, removal of sources in upland areas before PCB reach surface or groundwater would be preferable to ongoing active control.
- The approved SPDES permit for CWM has a Calculated Limit water quality standard for Total PCBs of 0.001 ng/L which is below the approved method detection limit of 65 ng/L. Consideration should be given to adopting USEPA Method 1668A which can provide lower detection limits and congener analysis;
- NYSDEC should consider including potential legacy contaminants boron, lithium and radionuclides as part of long-term monitoring activities at CWM and Modern Landfill ;
- NFSS does not monitor the West ditch (directly west of the IWCS) even though the recent investigation found West Ditch to be contaminated with radiologic constituents (Science Applications International Corporation, 2007).

3.2.1.3 Groundwater

There are groundwater monitoring programs in place at NFSS, Modern landfill and CWM. Each site has different requirements with regard to analytes, frequency, and water level measurements.

Data gaps and concerns noted regarding groundwater monitoring are:

- The number of monitor wells monitored at NFSS for quality is strikingly low compared to the adjoining landfill operations and the contents of the IWCS. NFSS monitors only eight monitor wells and all are completed in the upper water bearing zone (in September 2008, the USACE indicated that they have increased the number of wells monitored). By contrast, Modern Landfill monitors the Upper till (4 wells), the glaciolacustrine silt and sand (20 wells) and bedrock (one well). CWM has a network of over 300 wells of which 67 monitor the Upper Clay till and 68 monitor the lower glaciolacustrine silt and sand. Notwithstanding the much larger scale of Modern and CWM operations, the widespread groundwater and soil impact at NFSS as described in Science Applications International Corporation (2007), the USACE should be monitoring many more wells around the IWCS, throughout the site, and the lower water bearing zone (known as the glaciolacustrine silt and sand).
- Downgradient monitoring wells at the property line should be installed at NFSS;
- Each of the three groundwater level monitoring programs operates on different frequency and timing. Levels at NFSS and Modern are monitored quarterly, CWM monitors water levels annually but not all wells during the same time period. CWM and Modern coordinate the dates of monitoring. For the purposes of understanding groundwater flow across the entire LOOW area, there should be coordination of the timing of groundwater level measurements between the three monitoring programs and the NYSDEC. Otherwise, the information remains compartmentalized and potential offsite impacts cannot be distinguished.
- Due to the historic presence of radiologic materials on each of the three disposal facilities, radiologic parameters should be included in the monitoring programs, in addition to boron and lithium. CWM now has an approved Radiation Monitoring Plan (August 2007) and initiated groundwater radiation monitoring at selected wells in 2005.
- The NFSS should include multilevel groundwater monitoring locations adjacent to the Central Drainage Ditch and the West Drainage ditch for the purpose of monitoring groundwater-surface water interaction. Discharge of groundwater from the upper clay till to surface water is an important pathway that appears to be underappreciated and not monitored;
- There are no monitor wells in the southwest portion of the IWCS, where construction difficulties may have affected the integrity of the clay dikes. There is also elevated uranium in groundwater in this area;

- There are no water level monitoring devices within the IWCS. Without this information, it will be extremely difficult to verify expected behavior of the cap with regard to infiltration, driving force for groundwater inside the IWCS, or expected time to fill the waste storage bays. Geophysical surveys should be considered with the purpose of targeting the water table, or installation of measuring devices.
- The spacing of monitor wells at CWM was specified in the 1980's based on assessments of likely plume dispersion which would be considered to be excessive today. A review of well spacing and requirements should be undertaken in context of current understanding of plume behavior and fractured surficial clayey aquitards.
- Major ion chemistry has been analyzed in the annual NFSS monitoring. However, charge balance calculations suggest that the quality of the data could be improved. This is important to better understand the migration of contaminants from the IWCS. For example, trends at OW15B (adjacent to the West Ditch) show rising sodium, magnesium and sulfate concentrations, perhaps indicating arrival of a contaminant plume. The uranium residues stored at NFSS are associated with sulfate, and good geochemical data and interpretation will be required to assess, understand and predict migration of plumes from the IWCS or related areas.
- Areas of known contamination on the CWM property (e.g. related to AFP 68, Olin Burn area) have been investigated (Acres International Corporation, 1990) and remediation plans made (Acres International Corporation, 1995), but have not been remediated yet. No monitoring of these areas has been performed since the early 1990's. This would be the responsibility of the USACE to implement and NYSDEC to ensure the work proceeds.

3.2.2 DERP-FUDS Phases I and II

A review of the DERP-FUDS Phase I and II remedial investigation and related documents by Dr. Ronald J. Scudato is contained in Appendix D. A number of issues have been identified concerning the investigations and the overall former LOOW property. The reader is referred to the Appendix D for details, but the conclusions are reproduced below.

“With the required construction materials and development of infrastructure required to support the original use of the LOOW property, a wide range of materials were imported to the TNT manufacturing facility. Imported chemicals included raw materials, fuels, solvents, construction materials, equipment maintenance and supplies, waste management facilities and treatment processes, chemical waste management and a broad range of organic and inorganic chemicals. The required chemicals extended beyond the boron, lithium and TNT utilized in direct manufacturing.”

The post 1943 uses of the LOOW properties included a range of activities that also required use, management and disposal of materials required to support the array of activities conducted at the LOOW properties over the following 65 years.

The LOOW properties also became a storage facility for radioactive waste materials and essentially established the sites destiny as a waste management facility by excessing portions of the property to large and expanding waste management firms.

Despite the range of chemicals required to conduct the of activities carried out by the military over the past 65 years, the DoD responsibilities for the COPC at the LOOW properties is restricted to lithium, boron and TNT/explosives.

Background concentrations of COPC were determined by sampling at locations within the LOOW to areas of the site believed to be free of military sources of contaminants. This deduction was developed and implemented in the site characterization phases of the site despite the lack of understanding of the past uses of sites where background samples were collected or how surface and groundwater may have played a role in contaminant migration and accumulation within and offsite of the LOOW.

The network of large drainage ditches were developed on the site and the limited sampling conducted on ditch sediments, it is evident that the ditches transported COPC in the past and likely continue to transport contaminants offsite including to the Niagara River and Lake Ontario. Failure to conduct additional sampling of the ditches in the Phase II Remedial Investigation was based on limited information and assessment of the likely role played by the ditches to transport contaminants from the military and non-military activities conducted at the LOOW over the past 60 plus years.

Ditch construction for pipeline development can significantly modify surface and near surface water migration and serve as conduits for contaminant migration. Additional investigation of the role played by pipelines needs to be conducted to ensure there is a clear understanding of the migration and redistribution of shallow groundwater along pipeline ditches.”

Data gaps or issues of concern related to site characterization issues include:

- Insufficient sediment sampling of the Southwest drainage ditch, and vertical coring techniques should be used in all sediment sampling;
- The DOD marker compound list should be broadened;
- Congressional funding is critical to continuing the investigation and remediation;
- Background chemical data should be established from areas known to be free of contamination;

- Sediment samples should be collected near the mouth of creeks discharging to Lake Ontario from the LOOW for the purpose of characterizing presence of contamination and age dating;

3.2.3 Analysis by Property

3.2.3.1 U.S. Army National Guard Weekend Training Site

The currently active U.S. Army National Guard WETS consists of the approximate 860-acre area north of Balmer Road that contains the former LOOW storage igloos and former Air Force Plant 38. Initially this property was developed to store TNT in 25 concrete “igloos”. This entailed construction of the igloos, connecting roads and drainage ditches, support buildings and railroad. Following the closure of the TNT plant, this area was used by the Chemical Weapons Service for storage of materials in the North East Chemical Weapons Depot (NECWD). The materials temporarily stored at the NECWD may have consisted of incendiary bombs, phosgene and impregnite (EA Engineering Science and Technology Inc., 1997).

The USAF subsequently used the eastern portion of the site for the construction, operation, and eventual closure of AFP-38 during the period 1950 to 1992. The AFP 38 was operated by Bell Aircraft Corporation as a rocket, missile and laser development site, test facility for rocket research and activities included storage and loading of missile fuels, and test-firings.(EA Engineering Science and Technology Inc., 1997) Plant operations ended in 1983. The AFP 38 installation included administration, maintenance, chemistry laboratory and flush buildings, underground fuel storage tanks, container storage pad and an incinerator. Incineration of wastes from various facilities occurred, such as isopropyl alcohol, monomethyl hydrazine and unsymmetrical dimethyl hydrazine (Ecology and Environment Inc., 1988).

The Army re-acquired the western 331.78 acres of the igloo storage area from the USAF in January 1979 for the Army National Guard WETS. Operations and activities may have involved the use of hazardous materials or disposal of hazardous waste through open air pit detonations, drum storage and weapons testing (Roy F. Weston Inc., 1993; Savage, 1987).The Army acquired the remaining 528.89 acres from the USAF in August 1992.

The site is primarily used for Reserve and National Guard field training which involves outdoor training and weapons familiarization. The facilities include areas for vehicle and helicopter training, storage bunkers, an explosive ordnance disposal (EOD) range and a 25 m small arms range. Currently the WETS is fenced and posted, but the fence visible from roadways appears to be in poor repair around portions of the property.

The Central Drainage Ditch runs north-south approximately 150 m inside the western property boundary. The CDD was documented to be contaminated with radionuclides in 1981 and was remediated by excavation (Bechtel National Inc., 1986). Of particular interest is the Magazine Ditch which transects the central igloo

area and drains the vast majority of the western and central portion of the property. The Magazine ditch receives surface water from the main outfall of the CWM operation at Balmer Road. Magazine Ditch travels northeast and later turns west along the northern property boundary before joining the Central Drainage Ditch at the Northwest corner of the property. A small dam stores surface water from the Magazine Ditch prior to entering the CDD. The remaining portion of the property east of the igloo area drains northward to Six-Mile Creek.

Surface water was once monitored through a SPDES permit, but this ceased in 1983 after the Bell Aerospace test operation was shutdown.

The known presence of radiologic materials north of Balmer road was brief and involved storage of four train carloads of K-65 residue in drums within igloo 9050. This was soon stopped as monitoring indicated excessive radon levels (Aerospace Corporation, 1982). A subsequent survey found no radiation in building 9050 for alpha, beta and gamma on February 25 2004 (MJW Corporation Inc., 2004).

Environmental assessment was to be done by the Air Force before final transfer to Army National Guard (McKenna, 1991). Leaks of heating oil from above ground tanks have been noted (Dicky, 1993).

Phase I Records Search and Phase II Surveys were conducted by the Air Force (The Earth Technology Corporation, 1986). The Phase II, Stage I investigation addressed drainage ditches (6 sediment, 6 water samples), the salvage yard (2 soil samples), burn pits (1 composite soil sample from each), Maintenance and flush building (2 soil and 1 water sample) and the fuel storage tanks and electrical transformers (one oil sample). Fluoride, lead and chlorinated hydrocarbons were detected in drainage ditches and PCBs was detected in the transformer. Possible influences from neighboring properties was noted as potential sources. Additional sampling was recommended near the Flush Building and Salvage Yard. (Ecology and Environment Inc, 1988). An interim closure action for RCRA units involved removal of underground tanks, soil, sludge and resampling of excavated soils (The Earth Technology Corporation, 1989). A limited analytical program tested for purgeable organics, petroleum hydrocarbons, lead, pesticides and PCBs, volatile organic compounds and RCRA characteristics. Underground storage tanks were removed. Two heating oil storage tanks were exempted from federal regulations. Figure 1-4 of Hargis & Associates Inc.(1989) indicates the locations of 31 fuel oil storage locations on AFP 38, however their fate is not known.

Phase II confirmation studies for RCRA regulated units (the incinerator pad area and container storage pad area) were performed in 1988 and 1989 (The Earth Technology Corporation, 1991). Twenty-nine samples were collected from two excavations of pit soil and pit water. Analyses included purgeable aromatics, VOC, TPH, lead, EP toxicity, and pesticides. No hazardous constituents were detected. Total Petroleum

Hydrocarbons was found in soil, so soils were excavated, spread, aerated, and then backfilled into the excavations.

The drainage ditches were assessed using six sediment, six surface water and no groundwater samples. Five sediment samples were collected from the Containment basin and analyzed for TOC, TOX, nitrates and Oil and Grease. Two burn pits (for hydrazine wastes) were assessed using two composite soil samples collected at a depth of 1 ft. The container storage pad was assessed using four soil samples. Petroleum hydrocarbons were found at a depth of 5 ft. The incinerator pad was investigated, and concluded to be of no risk. Low permeability soil and low groundwater movement suggested a low potential for contamination and risk to public health. The Air Force determined that no further action was required for AFP 38 (ASD/CEV, 1992).

An investigation of the western portion of the property (referred to as Youngstown WETS) sampled locations related to the explosive ordnance range, the small arms range, the former drum pile, storage bunkers and drainage ditches (Roy F. Weston Inc., 1993). No surface water or groundwater samples were obtained. It was concluded that surface water and sediment contamination existed, but the source was unclear due to presence of neighboring “environmentally significant” operations. Additional sampling was recommended.

Asbestos abatement, building demolition and removal of PCB contaminated soil was undertaken in 2005. A spill (#05-313) was reported to DEC in April 2005 and cleared in March 2007 of an unknown petroleum product. PCB were found in pits at building 9001 and removed in fall of 2005 (Clough Harbour & Associates LLP, 2005).

Based on the available information, the following data gaps or issues of concern have been noted:

- There have been no groundwater investigations on this property. Monitor wells were installed for background purposes during the DERP_FUDS Phase I;
- The thoroughness of the historical review of the AFP 38 operation should be expanded to better explain the activities and potential contaminants that may have been present. For example, “test area deluge waters” are undefined and the reasons for neutralization of spills or discharges would be helpful in understanding the processes. Reference to fuelling of Minuteman missiles using liquid fuel is referenced, but Minuteman missiles were the first solid-fuel intercontinental ballistic missiles. If solid fuel rocket engines were tested at AFP 38, then ammonium-perchlorate (or potassium-perchlorate) based materials were undoubtedly used. There has been no testing for perchlorate or ammonia and other related compounds at the US ANG property.
- If liquid fuel rockets were tested using monomethylhydrazine and unsymmetrical dimethylhydrazine, as has also been referenced, then there are likely other compounds involved in the chemistry of the

reactions, such as cyano- or amino- compounds. In either case, rocket fuel related compounds have only been analyzed in a limited number of samples;

- Apparently chlorinated solvents were used for “flushing”. If so, then potential DNAPL issues should be addressed and have not been.
- The number of samples that have been collected to assess drum piles, burn pits, rifle range, etc. is too limited to be confident that all potential sources of contamination have been discovered.

3.2.3.2 Town of Porter

In 1985, approximately 3.4 acres located in the southeastern portion of the original 860-acre igloo area were conveyed to the Town of Porter for use of a water tower on the parcel. The USAF constructed the tower on the parcel during the operation of AFP-38 (EA Engineering Science and Technology Inc., 1997).

We are not aware of any environmental surveys conducted on this small parcel.

3.2.3.3 Air Force Nike Missile Base Launch Area

The former NIKE Missile Base was operated by the U.S. Army from 1954 to 1966. The NIKE Base occupied a north-south oriented rectangular-shaped parcel approximately 310 acres in size located in the east-central portion of the former LOOW TNT production area. This area was also the eastern portion of the land parcel owned by the USACE (EA Engineering Science and Technology Inc., 1997)e. The base was divided into two areas, Launch Area and Control Area. The Launch Area was located in the northern section of the base at the southwest corner of the intersection of Balmer and Porter Center roads. The Control Area was located in the southern portion of the base. The Launch Area contained 6 silos housing 6 surface-to-air missiles. This section concerns the Launch area, as the Control Area is now owned by CWM. The former Launch Area was decommissioned and transferred to the US Air Force in 1966 for the construction and operation of the YTA . The property was sold on 14 February 2008 to Southport Rail Transfer LLC for \$160,000. Future plans for the site are unknown.

A Preliminary Assessment (PA) was conducted in 1989, followed by a Site Inspection (SI) completed in 1994 and reported in the Environmental Baseline Survey (Lu Engineers, 2000). The investigations were carried out to meet ASTM guidance E-1527-97 for Site Assessments. Six areas of potential concern were identified: Dump Sites, Sanitary Sewer Drainage System; Nike Missile Site; Underground Storage Tanks; Property Fence Line Site; Missile Fueling Site. A field investigation was undertaken consisting of soil borings, soil sampling and analysis, monitoring well and piezometer installation and sampling, sampling of water and sediment in the site drainage system and former missile silos, and sampling and analysis of various other site media relating to the listed areas of concern (Lu Engineers, 2000).

The environmental investigation also involved removal of underground storage tanks, asbestos and lead paint assessment, and removal of water and hydraulic oil from the silos. Sediment samples indicated the presence of acetone and 1,4 dichlorobenzene and some PAHs. PCBs were detected in some hydraulic oil, and disposed of. Apparently, NYSDEC concurrence on the assessment and remediation efforts was obtained (Lu Engineers, 2000).

Based on the available information, the following data gaps or issues of concern have been noted:

- There has been no testing for hydrazine or other missile fuel components in the vicinity of the fueling area;
- The composition of the waste dump sites is unknown and represents a potential risk.

3.2.3.4 CWM Chemical Services, LLC

CWM currently owns and operates a Treatment, Storage, Disposal, and Recovery (TSDR) Facility permitted under the Resource Conservation and Recovery Act (RCRA). The 710-acre facility is located on the south side of Balmer Road in the former TNT production area of the former LOOW. Previous activities included manufacture of TNT as part of the LOOW, temporary storage and transshipment of munitions and chemicals as part of the Northeast Chemical Warfare Depot, storage and burial of radioactive materials, burial and burning of waste from U. S. Air Force and Navy high energy fuel projects (Golder Associates Inc., 1993). Development as a private hazardous waste operation began in 1972 as Chem-Trol Pollution Services, Inc., then SCA Chemical Waste Services Inc. SCA Chemical Services, Inc., and then CWM Chemical Services, LLC. Ten closed landfills and one operating landfill are present on the site.

Interestingly, the property was initially transferred from the General Services Administration with their provision that the land not be used for waste disposal. A 1972 Order from the State Department of Health directed that land on the property not be disturbed due to the presence of residual contamination, and the Order has not yet been removed. The Order was amended to allow disturbance under certain conditions in 1974. Since 1975, NYSDEC has had primary jurisdiction to regulate radioactive materials not subject to federal regulation. A Radiation Environmental Monitoring Plan for CWM was approved by NYSDEC in August 2007 and annual radiation monitoring of groundwater in selected wells was initiated in 2005. Portions of the property have been the subject to investigation under the DERP_FUDS and FUSRAP programs ((EA Engineering Science and Technology Inc., 2002; Science Applications International Corporation, 2007).

A RCRA Facility Investigation (Golder Associates Inc., 1993) indicated contamination on the site by PCBs, aromatic compounds, halogenated aromatic compounds, halomethanes, halogenated aliphatics (most

frequently found compounds), ketones, pesticides, PAHs, phenol and bis(2-chloroethyl)ether. Pre-1980 spills and leaks have been thought to be the source of most contamination rather than the regulated landfills. Corrective measures authorized by NYSDEC addressed contamination in twelve Solid Waste Management Areas, including the former west Drum area, the Process Area, the Lagoons and the area south of SLF3. Another eighteen SWMUs were deemed to be the responsibility of the DOD (Golder Associates Inc., 1993).

The former DOD facilities on CWM property have been subject to past and ongoing investigations regarding chemical contamination related to the TNT production (LOOW) and advanced fuels (AFP 68). Buried infrastructure and utilities from the LOOW are under investigation to address potential TNT residue in buried pipelines.

The CWM property was once very active with DOD and AEC activity and contained several “Vicinity Properties” which were related to the NFSS. Radiologic contamination had previously been found at CWM and remediated (Bechtel National Inc., 1986; Bechtel National Inc., 1989). All Vicinity Properties, except for three, were assessed for radiologic contamination and deemed to be appropriate for unrestricted use (Bechtel National Inc., 1992). The three properties were not included because they had not been accessible for assessment: Vicinity Property E, E’ and G. A critique of the certification docket is attached in Appendix E.

The main conclusions of Appendix E are shown below:

“As evidenced by the qualitative analyses of the past surveys performed on the properties as well as the quantitative analysis it is difficult to conclude that these vicinity properties should have been released for unrestricted development in 1992. Several of the properties still have areas that would cause a potential resident to receive a dose over the 25 mrem/yr limit set by the EPA.

Fully comprehensive surveys were not performed and they seemingly excluded areas that were stated as having extremely high points of contamination on these properties. Further surveys, analysis, and remediation should have been done on these properties and the CDD before they were released for unrestricted development in the early 1990s.”

Based on the available information, additional data gaps or issues of concern have been noted:

- Results of recent radiologic surveys across the entire property have not yet been released (due December 2008), and three former vicinity properties not yet fully investigated due to site encumbrances,
- The Rochester Burial area may have been located further east than the areas previously excavated. Comments on burial areas on Vicinity Property G are located in Appendix G;

- PCBs in sediment and surface soil remain that may be released to surface water requiring ongoing measures to control dissolved concentrations in surface water. Although the control measures are apparently effective, the long term implication of the PCB contamination is that these measures will be required indefinitely. Identification and effective remediation of PCBs in the upland soil or sediment should be considered to prevent PCBs from entering surface water in the first place.
- DOD contamination remains on the CWM property and is subject to ongoing investigation (i.e. underground utilities investigation). However, some DOD contaminated areas which have previously been investigated and remediation plans prepared, are not yet implemented (e.g. Olin Burn Area).
- TNT and other residues remain in buried pipelines from former LOOW
- Groundwater level measurements are carried out on an annual basis and should continue to be coordinated with adjoining properties with the purpose of understanding groundwater flow across neighboring properties.

3.2.3.5 Somerset

The Somerset Group property consists of approximately 39 acres and is located in the west central portion of the former LOOW TNT production area. The property is located north of the former fifth and sixth TNT production lines. Following closure of LOOW, the Somerset Group property was part of the approximate 1,500-acre parcel acquired by the U.S. Atomic Energy Corporation for various storage activities. The USAEC parcel was declared excess and transferred to the GSA in 1955. Later, the land was used by the U.S. Air Force and U.S. Navy for production of High Energy Fuels. The GSA sold a 775-acre parcel containing the current Somerset Group property to the Fort Conti Corporation in 1966. Approximately 159 acres of this parcel was then sold to the Somerset Group in 1970. The Somerset Group sold the parcel except 39 acres to CWM in 1980(EA Engineering Science and Technology Inc., 1997).

3.2.3.6 Occidental

Occidental Chemical Corporation (Occidental) owns 303.84 acres in an area west of the CWM Chemical Services property and northwest of the NFSS. Hooker Chemical and Plastics Corporations (Hooker) purchased the land from a private landowner in 1975 and later sold it to Occidental Chemical Corporation (EA Engineering Science and Technology Inc., 1997). The property remains essentially undeveloped. Very limited investigations have been performed other than those associated with USACE DERP-FUDS investigations (Phase 1 and Small Beamed Clearings investigation). Three areas were investigated by the DERP_FUDS: a fenced storage area, a pond and small bermed clearings(U. S. Army Corps of Engineers, 2004).

Based on the available information, the following data gaps or issues of concern have been noted:

- There remains no explanation for activities or use of the isolated storage/disposal area.
- Groundwater has not been tested in the vicinity of the storage area
- Previous analyses of the drum contents were all non-detect, but the detection limits were well above the criteria. This suggests that an additional attempt to analyze the material should be made.
- The elevated zinc concentration in surface soil samples 3, 4, and 10 were unusually and exceptionally high (0.3 to 1.1 wt%);

3.2.3.7 Niagara Falls Storage Site

The current NFSS is located in the southwestern portion of the former LOOW TNT production area. The property is 191 acres and is used to store residual radioactive materials stored at the site and generated during the remedial actions that occurred between 1953 and 1992. Radioactive materials are currently encapsulated onsite in the NFSS within an engineered interim waste containment structure (IWCS). The IWCS is located in the western portion of the NFSS and includes buildings from the former LOOW freshwater treatment plant, which have been used to store the uranium waste materials. The western boundary is adjacent to the right-of-way for National Grid (formerly Niagara Mohawk) and the West Drainage Ditch. The Central Drainage Ditch is oriented north-south through the central portion of the NFSS and is located directly east of the IWCS.

The NFSS property also has areas where historical activities occurred which may have affected soil, sediment or groundwater, such as: the Acid Area from the former TNT plant, shops area, Baker-Smith Area where waste from the Knolls Point Atomic Power Laboratory (KAPL) was stored, the Power plant area which also stored radioactive material and housed a Boron-10 isotope separation plant, the new naval waste disposal area, two radium storage vaults, storage, sawing and cleaning of uranium rods (Aerospace Corporation, 1982) and a silo once used for water, but later used to store K-65 uranium residues containing high radium activity, and an organic material burial area.

The NFSS has a long and interesting history which has included many environmental investigations (Aerospace Corporation, 1982; EA Engineering Science and Technology Inc., 1997). The recent Remedial Investigation (Science Applications International Corporation, 2007) describes previous investigations, and the results of a significant effort to describe the nature and extent of contamination. The results of the RI have been used in a Risk Assessment which puts risk to human health and environment in perspective². The RI

² The NFSS Baseline Risk Assessment report has not been reviewed as part of this project.

report included a records review and a phased approach to fieldwork. A major geophysical survey was undertaken to locate buried debris, utilities, and geologic features and to assess integrity of the IWCS. A computerized model of groundwater flow and transport was developed to assess the migration of contaminants from the site over an extended time period of up to 10,000 years.

Review comments concerning the geophysical surveys, monitoring, remedial investigation report and groundwater modeling are contained in Appendix F.

In addition to the uranium and radium residues derived from the African pitchblende ores, the storage, incineration and burial of waste from KAPL also occurred and its potential presence should have received more consideration as part of the investigation process. Waste containing plutonium, fission products and other radioactive materials (estimated to have activity of more than 400 Curies) was shipped to the NFSS property in the early 1950's, stored onsite, combustible materials were burned and buried, and the remainder should have been shipped to Oak Ridge for final disposal. However, poor storage and container conditions suggest that accidental releases may have occurred while at the LOOW (Appendix H). At the least, a thorough review of KAPL related waste shipment and handling activities should be part of the assessment of the former LOOW property.

Based on the available information, the following data gaps or issues of concern have been noted:

- Limitations on the application of geophysical techniques are not adequately explained. The conclusion that no anomalous zones attributable to a contaminant plume, sand and gravel channels or inconsistencies in the clay wall were found, were not stated within the context of the ability to detect their presence;
- Ground penetrating radar would have limited applicability in detecting burial areas greater than 2 m depth or from widely spaced survey lines;
- An exposure guideline less than 100 mrem/y should be used since the NFSS is not an operating nuclear facility;
- Use of soil criteria for sediment samples is inappropriate and separate criteria should be used;
- Airborne particulate monitoring is not included in the monitoring program;
- Elevated Ra-226 in surface soil occurs throughout the NFSS and in particular at the fence line
- The number and location of groundwater monitor wells is insufficient. There is currently no chemical analysis and monitoring of groundwater from the lower aquifer zone. The widespread contamination

by uranium and others, in the upper water bearing zone would have been unknown to the public if there was only the results of the annual monitoring program and not the results of the RI;

- The IWCS was constructed over old buildings, former buried utilities and a large number of investigation boreholes. Appropriate “sealing” of these infrastructure elements is claimed, but there is no monitoring plan in place that would detect their failure or enhanced contaminant migration along these potential pathways. Discretization of the groundwater model is insufficient to simulate the potential pathways along buried infrastructure;
- The site hydrogeological conceptual model and monitoring network should reflect the complexity of fractures in the upper till, sand lenses and potential interaction with surface water. Aquitard integrity of the Glaciolacustrine clay layer, which forms the bottom of the IWCS has not been assessed in detail (Cherry, 2005).
- Some groundwater plumes require further delineation;
- The previous remediation of West Drainage Ditch was incomplete;
- The use of K_d values, based on laboratory batch experiments to assess the mobility of inorganic species, is problematic and therefore, the predicted results for radionuclide and metals travel time and concentration should not be considered to be accurate. Further assessment of the geochemical controls and reactions should be required to properly assess whether the K_d approach is appropriate and useful, particularly at an important site such as the NFSS. Collection of the data which would be able to defend or provide insight into the geochemical processes should have been foreseen as a data quality objective, since it was known that a transport model was going to be used in the risk assessment;
- Coordination of groundwater level monitoring should be considered with Modern Landfill and CWM to better recognize and understand regional groundwater levels and response to offsite activities (such as dewatering)
- A thorough review and characterization of the KAPL wastes sent to the NFSS and their subsequent handling should have been included as part of the design of the remedial investigation. It now appears that there are gaps in knowledge of the significance of the potential presence of plutonium and other fission products from KAPL (such as ^{90}Sr analyses in soil which had a detection limit that was too high). It appears that a standard approach of a thorough historical review guiding subsequent radiologic surveys and sampling was not followed for KAPL wastes ;

3.2.3.8 Town of Lewiston Waste Water Treatment Plant

The Town of Lewiston owns a portion of the LOOW which was formerly the waste water treatment plant (WWTP). The treatment plant was originally constructed to treat acid sewer and sanitary waste from the LOOW TNT plant. Buildings were constructed for chlorination, pump house, an Imhoff tank, acid neutralization, sludge beds, and mixing house (EA Engineering Science and Technology Inc., 1997). Treated wastewater was discharged through a 30 inch diameter pipeline which extended westward across what is now the LewPort school campus to Creek Road. From there it went southwest to River Road and discharge to the Niagara River. The WWTP was later used by AFP 68, the Navy Interim Pilot Production Plant, the Boron-10 plant and the NIKE Base for sewage treatment.

Adjacent to the WWTP is the WWTP Vicinity Shops. This area was investigated during the LOOW RI (EA Engineering Science and Technology Inc., 1999; EA Engineering Science and Technology Inc., 2002) and found to contain elevated concentrations of PAH and metals (boron, lithium, copper and manganese) in soil, and boron and antimony in groundwater.

Based on the available information, the following data gaps or issues of concern have been noted:

- This property should be further evaluated during the underground utilities investigation;
- The use of this property by AEC for radioactive waste storage should be reviewed;
- The West Ditch which lies directly east of the WWTP has had no sediment or surface water sampling;
- Dangerous conditions exist around pits and the old structures. The area should be fenced and secured.

3.2.3.9 Modern Landfill

Modern Disposal Services, Inc., currently operates a New York State Part 360 permitted solid waste landfill identified as Modern Landfill. The landfill occupies 380 acres of land northeast of the intersection of Pletcher and Harold Roads, adjacent to and south of the CWM Chemical Services LLC and directly east of the NFSS. Landfill construction began in 1983, and most recently began construction of Phase IV in 2006. The landfill receives non-hazardous industrial and household wastes.

Based on the available information, the following data gaps or issues of concern have been noted:

- lack of monitoring for radiologic or legacy contaminants in groundwater. The NFSS RIR refers to finding high levels of uranium in two wells on Modern – these were discounted

during the background ground water study but raise the question of whether radiologic or other parameters entered groundwater from surface contamination prior to surficial cleanups.

- the effect of pumping bedrock wells for under drain and construction – drawdown extends to the boundary with the NFSS (e.g. Environmental Solutions(2006)). Coordination of groundwater level monitoring and data collection should be encouraged.
- Screening of soil for radiologic constituents during construction should be considered;

3.2.3.10 LewPort School Campus

LewPort Schools obtained 4 parcels of land in the summer of 1948 for the construction of public schools on the east side of Route 18 at the Lewiston-Porter Township line. The school district currently maintains 376 acres for three school campus. The acreage that the LewPort Schools currently occupies was part of the buffer zone of the former LOOW.

The Lewiston-Porter school campus is located on the far western portion of the former LOOW property, with entrances from Creek Road. The campus contains a complex of five main buildings which house pre-school, elementary, middle and high school populations. The property was part of the LOOW buffer areas and 376 acres was transferred to the School district in 1948 (EA Engineering Science and Technology Inc., 1997). In addition to the buildings, there are wide grass playfields, playground equipment, baseball diamonds, soccer, and football fields. A large portion of the property owned by the school district is treed and extends to the east across the southwest drainage ditch. Students occasionally cross the SW drainage ditch to use running trails through the woods.

The campus is bisected by the 30 inch outfall sewer line which drained from the LOOW wastewater treatment plant to the Niagara River. The 30 in outfall is not exposed on the main campus, but passes between the elementary and middle school buildings. This outfall was used for wastewater disposal during the time of TNT production and subsequent operations. The school campus has also used this line for disposal of sanitary waste between 1950 and 1976. It has been inactive for some time, but the portion east of the SW ditch has recently been investigated by the USACE during their Underground Utilities Investigation (not yet published).

The school property and health of children and staff has been the subject of much interest over the years with concern expressed over potential buried waste or radioactivity from LOOW property activities. A summary of environmental studies prepared by a former school district administrator (Polka W. D., 2002) indicates that between 1989 and 2001 there were various studies investigating air quality (bacteria, mold, fungi in buildings, effect of school bus exhaust), water quality (brown water in supply, iron and lead), asbestos, and soil

sampling (USACE investigations, lead and arsenic, radiologic). In addition, testing of the school water supply (March 13, 2002), soil sampling along the western side of the drainage ditch behind the school campus (May 30, 2002), radon testing in school buildings (June 6, 2002), soil testing for inorganics and organics on proposed playground site (December 26, 2002).

Soil sampling identified elevated arsenic in the northern portion of the campus. Subsequent delineation sampling by Chopra-Lee laboratories was performed in the summer of 2001. The school board initiated a program for further testing with public outreach and involvement through the University at Buffalo Environmental and Society Institute (Gardella et al., 2004). A stakeholder listening committee was formed, five public meetings were held and a sampling plan was developed. Forty soil sampling locations were identified and samples were collected on July 21 2003 . Samples were analyzed for semivolatile organic compounds, metals, pesticides and PCBs. A Geographic Information System was used to present and interpret the results. It was found those elevated arsenic and PAH in soil were limited to a small area in the north part of the campus. PCBs were generally not detected except near the roadway and other pollutants of concern were at levels typical of background.

Concerns regarding potential radiologic contamination of the school campus have been addressed by USACE through their conduct of a gamma walkover survey performed in December 2001. This survey was a background study performed in conjunction with the gamma walkover survey of the NFSS survey and was reported in Science Applications International Corporation(2003). The survey was conducted using a gamma detector and GPS equipment as a technician walked along survey lines spaced 20 m apart across the open accessible portions of the property and along the banks of the SW ditch. Activity levels between 3,051 and 38,222 counts per minute were observed and attributed to natural materials contained in bricks, granite curbs and rocks. Activity levels were not considered to be hazardous to the public. Mounds of debris in the wooded area and two isolated areas under asphalt paving and granite curbing contained the highest activity levels. A comparison with measurements obtained on the WETS property in much smaller areas (10 m x 10 m) suggested to the USACE that levels on the school property were significantly lower than at WETS. In either case, it was assumed that there was no reason to believe that any radiologic burials or other DOE activity had occurred on the properties that would cause elevated gamma activity.

Based on the available information, the following data gaps or issues of concern have been noted:

- The arsenic hot-spot appears to be isolated and a definitive origin has not been identified. It is our understanding that the hot spot will be remediated by excavation of soil (J. Gardella, pers. comm.).
- A 30 inch outfall pipeline extending from the Lewiston WWTP westward across the school campus has not been investigated west of the Southwest Drainage Ditch. This pipeline was used during the

TNT plant and during subsequent activity to discharge waste water. Potential leakage from the 30 in outfall or residue inside or surrounding the pipeline should be investigated on the main school campus.

- Origin and content of mounds in the wooded areas should be investigated and removed if appropriate.
- As a precaution, there should be some chemical and radiologic surveys of running trails in wooded portions of property, and on east side of Southwest drainage ditch.
- The existing number of sediment samples along the Southwest drainage ditch is insufficient to determine the presence or absence of chemical or radiologic contamination from NFSS. Additional sediment sampling in southwest drainage ditch for chemical and radiologic parameters, including use of vertical coring delineation techniques should be performed.

3.2.3.11 Other: Acome Landfill; Walleye Hatchery; Fin, Feather and Fur Society

The inactive Acome Landfill operated between 1958 and 1960 in the buffer area south of Balmer Road, west of the TNT production area of the former LOOW and directly west of the LOOW wastewater treatment plant (WWTP). This landfill was operated and owned by Carl Acome. When operated, the wooded area was cleared for construction of an access road and the landfill. Apparently the Acome parcel was approximately 31 acres in size, but the landfill was approximately 3 acres.

Long's Walleye Hatchery is located on 61.3 acres approximately 2,000 ft south of Balmer Road, west of the former TNT plant production area. Soil was excavated to form fish ponds and appears as rectangular ponds on air photos. The hatchery is used primarily for recreational purposes. Mr. John Long reported bunkers used for TNT disposal by detonation east of the hatchery property, but no evidence of the bunkers was visible in 1988 although evidence of disposal activity was observed (Acres International Corporation, 1989).

The Fin, Feather, and Fur Conservation Society, also referred to as the Three F Conservation Society (3F), is located at 904 Swann Road on approximately 340 acres. The Three F Conservation Society is a recreational sportsmen's club. A large rectangular pond exists on the property due to previous clay mining. The Fin, Feather and Fur Club has not been the subject of a significant investigation as the USACE determined that there was no reason to suspect that DOD activities created an impact to the property (EA Engineering Science and Technology Inc., 1997). The 1978 Aerial radiologic survey indicated anomalously high radiation levels in the vicinity of the parking lot suggesting that radioactive slag may have been present (EG&G Inc., 1979). A follow-up survey indicated this to be non-LOOW radiation (Oak Ridge National Laboratory, 1979b). A review of air photography suggested three small bermed clearings on the property and two were investigated. Two composite soil samples were collected and analyzed for TNT, DRO and one sample for radiologic

parameters during the USACE Small Bermed Clearing investigation (U. S. Army Corps of Engineers, 2004). The results were within the range for background.

The Lady of Fatima shrine located on Swann Road, northeast of the Three F conservation society, contains religious shrines and is the home of the Barabite Brothers seminary. There is no known reason for concern from LOOW or NFSS activities on the property. However, a 1978 aerial survey did detect a radiologic anomaly over the gravel parking area (EG&G Inc., 1979). A follow-up sampling in 1978 analyzed one rock sample from the parking lot and determined that the material is a crushed slag, not related to materials stored at NFSS (Oak Ridge National Laboratory, 1979a). The U-238 concentration in the slag was 52.7 pCi/g, which is approximately 55 times higher than background levels. Ra-226 was also very high and similarly above background at $53.7 \pm 1\%$. The source of the material was attributed to waste cyclo-wollastonite slag from an electro-chemical process for extracting phosphorous from phosphate rock. A plant using this process operated in Niagara Falls for many decades. Since the slag was not considered to be related to the LOOW or NFSS operations, there has been no further investigation by the federal government.

4. Conclusions and Recommendations

Based on the information available to us the following conclusions have been drawn:

- a) An extensive and overwhelming volume of information from many branches of government has been generated since the formation of the LOOW. Enhancing and maintaining a complete archival record of site activities should be considered to build on the work already completed by USACE. This effort should be supported and accessible to the community.
- b) There is an extensive record of environmental sampling that has occurred over several decades. More than 350,000 records have been entered into the LOOW GIS mapping system. Use of a GIS approach to store, visualize and analyze this environmental data is a useful way in which to understand the work that has occurred. Sharing of information in an accessible format between those generating the data, regulators and the public should enhance efforts to remediate the former LOOW area.
- c) Insufficient funding and resources of the US Army Corps of Engineers has resulted in multi-year delays in getting information to the public and proceeding with decision-making and actual remediation.
- d) There are four main pathways of concern for potential offsite impact from operations and contamination at the LOOW: air, groundwater, surface water, and sediment. A re-assessment of the air monitoring programs at CWM and NFSS is warranted (and underway at CWM). Annual groundwater monitoring at NFSS has used an insufficient number of wells to monitor the groundwater plumes which have now been presented in the NFSS RI document. Each waste disposal operation has its own monitoring and regulatory requirements, however NYSDEC should seek to improve coordination and enhance monitoring to provide better overall understanding of groundwater flow and the presence of legacy contaminants on a LOOW-wide scale. Discharge of groundwater to surface water deserves further scrutiny as a potential pathway for contaminant migration. Surface water monitoring of ditches that traverse different properties (such as Central Drainage ditch) should have a common set of parameters which reflect legacy contamination. Migration of sediment during storm flow should be considered in monitoring programs. Previous investigation techniques for sediment sampling that did not use vertical coring profiles would not have been sufficient to identify all potential sediment contamination.
- e) The DOD marker compound list used in the DERP-FUDS investigations is too specific and insufficient to reflect the actual breadth of materials and potential contaminants that would have been used at LOOW;

- f) Background chemical and radiological data has been collected from some areas which may not be free of contamination;
- g) Some of the vicinity Properties should not have been released for unrestricted use due to legacy radiation levels. A portion of the Central Drainage Ditch upstream of Four Mile Creek was never remediated;
- h) Contamination at the NFSS is widespread in surface soil and groundwater, including radiologic constituents, metals, boron and chlorinated solvents. Previous remediation of the West Ditch appears to have been incomplete.
- i) Useful and sophisticated groundwater modeling has been performed which addresses groundwater flow, leaching of contaminants, failure scenarios and contaminant transport. However, there has been insufficient geochemical work presented in the report concerning groundwater conditions to be confident that the critical transport parameters (K_d and biodegradation rate) used in the model were appropriate.
- j) There has been insufficient investigation to fully characterize the distribution of contaminants at the NFSS.

Based on the conclusions above, the following recommendations are offered:

1. A complete archival record of LOOW and post-LOOW records should be created to improve on the current record availability and as a resource for all residents of Niagara County;
2. Appropriate funding should be allocated to maintain the LOOW GIS mapping system, and to update it in the future as monitoring data and the results of investigations are received. Training of staff at county libraries or other method to assist members of the public in accessing the GIS system via internet should be considered.
3. The limiting and rigid definition of DOD marker compounds used in the DERP-FUDS investigations should be broadened in view of the much larger number of materials and potential contaminants that would have been used at LOOW (such as chlorinated solvents and petroleum hydrocarbons);
4. Improvements to the monitoring programs at NFSS for air, surface water and groundwater as discussed in this report should be implemented within the next year;
5. The final downstream portion of the Central Drainage Ditch should be resurveyed and remediated as necessary. The West Ditch should also be remediated.

6. Additional specific studies should be undertaken to provide the information required to determine whether the critical transport parameter, K_d , as used in the groundwater modeling are actually appropriate and if not, a current, scientifically valid method should be used to model radionuclide transport in groundwater.
7. Appropriate funding should be allocated so that the NFSS Baseline Risk assessment report should be reviewed by a skilled risk assessor to ensure that the methodology and results are correct.
8. Evaluation of the environmental data collected at the former LOOW site by multiple parties would greatly benefit from coordination of data reporting standards and quality objectives, including geographic spatial data.
9. Additional investigation should be performed at the NFSS to delineate the distribution of contaminants (such as uranium in groundwater and the presence of KAPL related waste).
10. Appropriate funding should be allocated by Congress to USACE for continuing the necessary investigations and studies required to complete the remediation of the former LOOW properties in a timely manner.

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Appendix A Notices of Public Meetings



NIAGARA COUNTY DEPARTMENT OF HEALTH
5467 Upper Mountain Road, Suite 100
Lockport, New York 14094-1894

PAULETTE M. KLINE, R.N., M.Ed., M.P.H.
Public Health Director

(716) 439-7435
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-- NEWS RELEASE --

NIAGARA COUNTY HEALTH DEPARTMENT

5467 Upper Mountain Road
Lockport, New York 14094

FOR IMMEDIATE RELEASE

November 15, 2005

CONTACT:

Paulette M. Kline, R.N., M.Ed., M.P.H.
Public Health Director
(716) 439-7435

COMMUNITY LOOW PROJECT - PUBLIC MEETING

The Niagara County Department of Health will be holding a Community LOOW Project public meeting on Monday, November 21st at 6:30p.m., at the Lewiston Senior Center, 4361 Lower River Road, in Lewiston.

The former Lake Ontario Ordnance Works, or "LOOW," site originated as 7,500 acres purchased by the federal government in 1942 to support WWII and subsequent Defense operations. Today, roughly 400 residences, schools, a federal radioactive storage site, commercial landfills, and Defense properties are situated within the former LOOW boundary. Numerous investigations, cleanups, and monitoring by various agency programs have been conducted on limited areas of the LOOW since 1944.

"In response to community concerns, the Niagara County Health Dept. launched *The Community LOOW Project* to assess the LOOW in a way that is 'blind' to jurisdictional limitations of agency programs. This site-wide approach has never been undertaken at the LOOW," according to County Health Director Paulette Kline.

Kline and *Community LOOW Project* Coordinator Scott King will host a program reviewing past and present uses of the LOOW site and introduce the science team reviewing LOOW remediation work to date. Dr. Joseph Gardella of the University at Buffalo Environment & Society Institute will discuss how the construction of a LOOW Geographic Information System (GIS) Data Base and mapping can be tools for the LOOW Project team and promote information sharing between the various regulatory agencies at the LOOW.

The program will also note how the *Community LOOW Project* differs from or compliments other LOOW initiatives such as the Lew-Port School Soil Study, the NCHD Well Testing Program, the LOOW Restoration Advisory Board (RAB,) the Lewiston Museum Archives Project, the CWM Community Advisory Committee (CAC) and the upcoming NYS Dept. of Health Cancer Surveillance study of Lewiston and Porter.

Lee Simonson, Chairman of the Economic Development Committee of the Niagara County Legislature, stated, "This Project will finally look at the big picture. We must rectify the history of contamination at the LOOW site so we can plan an economic future based on sustainable land use compatible with the quality of life we want for our children."

The \$200,000 two-year Project was created to address the complex history of LOOW contamination with equally complicated government supervision. The Community Foundation for Greater Buffalo awarded the Niagara County Department of Health a grant in the amount of \$30,000 for the Community LOOW Project. Over \$100,000 has been raised to date from private, academic and local government sources. The remaining funds are expected from the federal government.

Niagara County Legislature Vice Chair Clyde Burmaster (Porter) noted, "After 50 years, the community deserves both a comprehensive review of LOOW clean-up efforts and more importantly, an independent review by qualified experts not beholden to the entities that helped contaminate the site. The Community LOOW Project will hold Albany and Washington agencies accountable to our local community -- and it's about time."



NIAGARA COUNTY
DEPARTMENT OF HEALTH
5467 UPPER MOUNTAIN ROAD, SUITE 100
LOCKPORT, NEW YORK 14094-1894

Paulette M. Kline, R.N., M.Ed., M.P.H.
Public Health Director
(716) 439-7435
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November 10, 2005

Subject: **The Community LOOW Project: Public Meeting – Monday, November 21st 6:30p.m.**
Lewiston Senior Center, 4361 Lower River Road, Lewiston, NY

I am pleased to invite you to a public meeting introducing an important Project to independently evaluate the former Lake Ontario Ordnance Works ("LOOW") site located in the Towns of Lewiston and Porter, NY.

As you may know, the LOOW site originated as 7,500 acres purchased by the federal government in 1942 to support WWII and subsequent Defense operations. Today, roughly 400 residences, a federal radioactive storage site, commercial landfills, and Defense properties are situated within the former LOOW boundary.

Numerous investigations, cleanups, and monitoring by various agency programs have been conducted on limited areas of the LOOW since 1944. In response to community concerns, the Niagara County Department of Health (NCDOH) launched *The Community LOOW Project* to assess the LOOW in a way that is "blind" to jurisdictional limitations of agency programs. This site-wide approach has never been undertaken at the LOOW.

We are engaging independent experts and compiling data into a Geographic Information System for analysis of LOOW restoration work to date. We anticipate the GIS database will act as a tool in promoting information sharing between various regulatory agencies and enhancing risk management at the LOOW.

The Community LOOW Project differs from or compliments other LOOW initiatives such as the Lew-Port School Soil Study, the NCDOH Well Testing Program, the LOOW Restoration Advisory Board (RAB), the Lewiston Museum Archives Project, the CWM Community Advisory Committee (CAC) and the NYS Dept. of Health Cancer Surveillance study of Lewiston and Porter.

The meeting is an opportunity for members of the public to provide us with data or information they may have that will assist our efforts. If you cannot attend but have questions or information to contribute please contact our Project Coordinator, Scott King at (716) 913-8950. We hope to see you Monday, November 21st.

Sincerely,

Paulette M. Kline R.N., M.Ed., M.P.H.

Paulette M. Kline, RN, M.Ed., M.P.H.
Public Health Director

cc: Gail Johnstone, President, The Community Foundation For Greater Buffalo
Alan Rabideau, Director, University at Buffalo Environment & Society Institute
State Senator George Maziarz and Assemblywoman Francine DelMonte
William Ross, Chair, Legislators Clyde Burmaster and Lee Simonson, Niagara County Legislature
Fred Newlin, Supervisor, Town of Lewiston and Merton Wiepert, Supervisor Town of Porter



**NIAGARA COUNTY
DEPARTMENT OF HEALTH
5467 UPPER MOUNTAIN ROAD, SUITE 100
LOCKPORT, NEW YORK 14094-1894**

**Paulette M. Kline, R.N., M.Ed., M.P.H.
Public Health Director
(716) 439-7435
(716) 439-7402 Fax**

September 12, 2006

**MEETING NOTICE
The Community LOOW Project**

2nd Public Meeting

7:00 p.m., Monday, September 25 2006

Lewiston Senior Center, 4361 Lower River Road, Lewiston, NY

Dear Concerned Citizen:

I am pleased to invite you to a public meeting to discuss progress of the Community LOOW Project concerning the former Lake Ontario Ordnance Works ("LOOW") site located in the Towns of Lewiston and Porter, NY. The first meeting to introduce the project was held in November 2005 and this will be the second meeting.

The purpose of the meeting is to provide an update to members of the community on progress so far, with specific discussion concerning development of the Geographic Information System and how we intend to use it for our gap analysis.

Further information concerning the Community LOOW Project and the LOOW in general can be found at the project website. If you have internet access, go to www.niagaracounty.com/health and click on "Hot Topics", then click on "Community LOOW Project". You can also find links to other LOOW websites at our website.

The meeting will also be an opportunity for members of the public to provide us with data or information they may have that will assist our efforts. If you cannot attend but have questions or information to contribute please contact our Project Coordinator, Scott King at (716) 913-8950. We hope to see you Monday, September 25, 2006.

Sincerely,

Paulette M. Kline, RN, M.Ed., M.P.H.
Public Health Director

cc: Congresswoman Louise Slaughter
Gail Johnstone, President, The Community Foundation For Greater Buffalo
State Senator George Maziarz and Assemblywoman Francine DelMonte
William Ross, Chair and Clyde Burmaster, Vice Chair, Niagara County Legislature
Fred Newlin, Supervisor, Town of Lewiston and Merton Wiepert, Supervisor Town of Porter

NEWS RELEASE



NIAGARA COUNTY DEPARTMENT of HEALTH
5467 UPPER MOUNTAIN ROAD, SUITE 100
LOCKPORT, NEW YORK 14094-1894

Daniel J. Stapleton, M.B.A.
Public Health Director

For Immediate Release: 6/7/2007 8:44 AM

Contact: Daniel J. Stapleton – 439-7435

COMMUNITY LOOW PROJECT – PUBLIC MEETING

The Niagara County Department of Health will be holding a Community LOOW Project public meeting on Wednesday, June 13, 2007 at 7:00 p.m. at the Lewiston Senior Center, 4361 Lower River Road, Lewiston. Public Health Director Daniel J. Stapleton and Project Coordinator Scott King will host the meeting and presentation.

The Community LOOW Project was created to address the complex history of contamination at the former Lake Ontario Ordnance Works, or “LOOW” site, and community concerns. The LOOW site originated as 7,500 acres purchased in the Towns of Porter and Lewiston by the federal government in 1942 to support WWII and subsequent defense operations. Today the LOOW site contains residences, schools, landfills and a federally owned radioactive waste storage site.

The evening’s presentation will demonstrate how mapping of data from various soil, air and groundwater investigations at the LOOW site is being used to in a Geographic Information System (GIS) to better understand the previous work and to identify data gaps that could potentially impact the environment and public health. Mapping of the LOOW site will be presented by the project GIS consultant, Ecology & Environment Inc.

The program will also update the community on the progress of the review work being conducted by independent experts. Dr. Marvin Resnikoff will give an update on his review of radiologic issues associated with the Niagara Falls Storage Site and vicinity.

In June 2005, the Community Foundation for Greater Buffalo awarded the Niagara County Department of Health a grant in the amount of \$30,000 for the Community LOOW Project. In 2006 Congresswoman Louise Slaughter arranged a federal grant of \$100,000. In September 2006 the members of the Western New York Assembly Majority Delegation awarded the Niagara County Department of Health \$12,500. The Project will be completed in 2007.

PUBLIC HEALTH: PREVENT. PROMOTE. PROTECT



NEWS RELEASE

Daniel J. Stapleton, M.B.A.
Public Health Director

NIAGARA COUNTY DEPARTMENT of HEALTH
5467 UPPER MOUNTAIN ROAD, SUITE 100
LOCKPORT, NEW YORK 14094-1894

For Immediate Release: 1/22/2008 10:34 AM

CONTACT:

Daniel J. Stapleton, M.B.A.
Public Health Director
(716) 439-7435 or
James Devald, P. E.
Director Environmental Health Division
(716) 439-7444

COMMUNITY LOOW PROJECT - PUBLIC MEETING

The Niagara County Department of Health will be holding a Community LOOW Project public meeting on Wednesday, January 30, 2008 at 7:00 p.m. in Room 127 of Dunleavy Hall on the campus of Niagara University in Niagara Falls. Public Health Director Daniel J. Stapleton and Project Coordinator Scott King will host the meeting and presentation.

The Community LOOW Project was created to address the complex history of contamination at the former Lake Ontario Ordnance Works, or "LOOW," site, and community concerns. The LOOW site originated as 7,500 acres purchased in the Towns of Porter and Lewiston by the federal government in 1942 to support WWII and subsequent Defense operations. Today the LOOW site contains residences, schools, landfills and a federally-owned radioactive waste storage site.

The evening's presentation will include a review of work carried out so far and a demonstration of the LOOW Geographic Information System (GIS) which will be internet accessible by the community. Mapping of data by GIS from various soil, air and groundwater investigations at the LOOW site is being used to better understand the previous work and to identify data gaps that could potentially impact the environment and public health. The mapping of data at the LOOW site will be presented by the GIS consultant, Ecology & Environment Inc.

In June 2005, the Community Foundation for Greater Buffalo awarded the Niagara County Health Department a grant in the amount of \$30,000 for the Community LOOW Project. In 2006, Congresswoman Louise Slaughter arranged a federal grant of \$100,000. In September 2005 and 2006, the members of the Western New York Assembly and Senate Delegation awarded the Niagara County Health Department \$12,500 for each year. The project is expected to be completed later this year.

PUBLIC HEALTH: PREVENT. PROMOTE. PROTECT



NIAGARA COUNTY DEPARTMENT OF HEALTH
5467 Upper Mountain Road, Suite 100
Lockport, New York 14094-1894

DANIEL J. STAPLETON, M.B.A.
PUBLIC HEALTH DIRECTOR

(716) 439-7435 TELEPHONE
(716) 439-7440 FAX

MEETING NOTICE

The Community LOOW Project
4th Public Meeting
7:00 p.m., Wednesday, January 30, 2008
Room 127, Dunleavy Hall
Niagara University

Dear Concerned Citizen:

I am pleased to invite you to a public meeting to discuss progress of the Community LOOW Project concerning the former Lake Ontario Ordnance Works ("LOOW") site located in the Towns of Lewiston and Porter, NY. The first meeting to introduce the project was held in November 2005. Subsequent meetings were held in September 2006, June 2007, and this will be the fourth meeting.

The purpose of the meeting is to provide an update to members of the community on our progress, with emphasis on the Geographic Information System and how we intend to use it for our gap analysis. A live demonstration of the LOOW GIS mapping website is planned. This website is being used by the project team to better understand the environmental investigations that have occurred and will ultimately be made accessible via internet to the entire community.

Further information concerning the Community LOOW Project and the LOOW in general can be found at the project website. If you have internet access, go to www.niagaracounty.com/health and click on "Health Resources"; then click on "Niagara County Community LOOW Project". You can also find links to other LOOW websites at our website.

The meeting will also be an opportunity for members of the public to provide us with data or information they may have that will assist our efforts. If you cannot attend but have questions or information to contribute, please contact our Project Coordinator, Scott King at (716) 913-8950. We hope to see you Wednesday, January 30, 2008.

Sincerely,

Daniel J. Stapleton
Public Health Director

cc: Congresswoman Louise Slaughter
Gail Johnstone, President, The Community Foundation For Greater Buffalo
State Senator George Maziarz
Assemblywoman Francine DelMonte
William Ross, Chair, Niagara County Legislature
Clyde Burmaster, Vice Chair, Niagara County Legislature
Fred Newlin, Supervisor, Town of Lewiston
Merton Wiepert, Supervisor Town of Porter
Gregory Lewis, Niagara County Manager

PUBLIC HEALTH: PREVENT. PROMOTE. PROTECT

Appendix B Niagara County LOOW Community GIS Project



NIAGARA COUNTY LOOW COMMUNITY GIS PROJECT

FINAL REPORT

Prepared by



GIS Department
Lancaster, NY

May 2008

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1 Introduction

The Lake Ontario Ordnance Works site (referred to as the "LOOW") site is an area of land 7,500 acres in size, located in the Towns of Porter and Lewiston, in Niagara County. It was acquired by the federal government in 1942 as part of World War II and Defense Department efforts. This land has been utilized for a number of projects since then.

YEARS	PROJECT
1942-1943	TNT Manufacturing Plant
1944-1946	Northeast Chemical Warfare Depot
1944-Present	NFSS Radioactive waste storage (Manhattan Project, Atomic Energy Commission, Department of Energy)
1950-1992	U.S. Air Force Plant 38
1957-1959	U.S. Air Force Plant 68
1956-1960	Navy Interim Pilot Production Plant
1953-1971	Boron-10 Production Plant
1954-1966	NIKE Missile Base NF-03 and NF-05
1958-1973	Ransomville Test Annex-U.S. Air Force
1966-Present	Youngstown Test Annex-U.S. Air Force
1979-Present	Army National Guard Training Site
1972-Present	Hazardous waste treatment/disposal (Chemtrol,SCA,CWM Chemical Service)
1983-Present	Modern Corp. Solid waste disposal

Table 1.1 List of LOOW site activities

LOOW PROJECT OVERVIEW

The LOOW project has three main objectives:

1.1a: GIS Data Base: Identify and compile a relevant radiological and geological inventory of samples in the area, throughout the period. The result will be one centralized GIS database of spatial information. This dataset will be used to identify gaps in the existing data. Beyond just a database, the aim of the project was to present this information to the public, in an easy to digest format. This will be in the form of a public web mapping interface, to allow the user to display sample information via the Internet..

1.1b: Gap Analysis: Using the GIS data, and other information, identify areas where data may be lacking, and investigate where this may be remedied.

1.1c: Recommendations: The report will recommend and promote long-term solutions for managing the LOOW site to the maximum level of safety.

Ecology & Environment, Inc. (E&E) was retained by Niagara County in January 2007 as the County's GIS Consultant. E&E's charge is to provide GIS support to Niagara County on a variety of levels, including application design and development, database implementation, GIS Steering Committee coordination, and the development of an Intermunicipal agreement with Erie County. One of the major tasks of this project was participation in the Community LOOW GIS project.

E&E's work on the LOOW Site project is primarily directed at task 1.1a (The GIS Database Development). To that end, this document will primarily focus on those efforts.

2 DATABASE

One of the main steps in the Community GIS LOOW Project was the assembly and inventory of available GIS data, preparation of relevant datasets, and the digital capture of some additional datasets that currently exist only in PDF format. This section will summarize what datasets, both sample related, and external supporting GIS datasets and imagery, were assembled.

2.1 Supporting GIS Vector Datasets

The following is a list of vector based GIS datasets that are used in the LOOW GIS mapping website (discussed in more detail in Section 3). The infrastructure of the site is such that updates / new layers that become available can easily be integrated onto the site.

The Site's GIS Layers Table of Contents is organized into "Groups". These group folders are an additional way to categorize the layers that are available into sections of similar data.

GIS Group	GIS Dataset	Description	Source
Historical Info	Site Drawing	Converted CADD drawing of old site infrastructure	USACE
	DOD Areas of Concern	Areas of concern as specified by DOD	USACE

Site Info	1997 Parcel Owners	Area parcel layer as of 1997	USACE
	LOOW Area	Boundary of LOOW Project Area	USACE
Environmental Info	Floodplains	100 and 500 year Flood Zones	US FEMA
	Land Use/Land Cover	Vectorized version of National Landuse dataset	US NRCS
	National Wetland Inventory	Wetland information from federal government	US FWS
	NYS DEC Wetlands	Wetland information from New York	New York State DEC
	NYS DEC Streams	Local streams and waterways	New York State DEC
	Soil Units (SSURGO)	Detailed soil regions from the SSURGO survey	US NRCS
General Info	Road Names	Road name and highway shield layer for Niagara County Roads	NY State CSCIC
	Niagara County Roads	Road Centerlines from Niagara County	NY State CSCIC
	Ontario Road Names	Highway Shields for Ontario Roadways	Natural Resources Canada GeoGratis
	Ontario Roads	Ontario Provincial Roads	Natural Resources Canada GeoGratis
	Parcels	2007 (to be updated) Niagara County parcels with Real Property Assessment data	Niagara County Real Property Tax Department
	Town Boundary	Niagara County Town boundaries	Niagara County Real Property Tax
	Village Boundary	Niagara County Village Boundaries	Niagara County Real Property Tax
	Parks	Parks and Recreation areas within Niagara County	New York State GIS Clearinghouse
(Not in folder)	Ontario Regional Municipalities	Regional Municipality boundaries in Ontario	ESRI

Table 2.1 Other GIS Database to be utilized for the Community LOOW GIS Project

2.2 Supporting GIS Raster Imagery

The LOOW GIS site also makes use of raster aerial imagery to assist users in locating and analyzing points on the site.

The site takes advantage of the latest aerial imagery to be flow as part of the New York State Digital Orthophotography Program. (Online link: <http://www.nysgis.state.ny.us/gateway/orthoprogram/index.cfm>)

These photographs were taken in the Spring of 2005. The images were downloaded from the New York State GIS Clearinghouse site, and mosaicked using ERDAS into one color MrSID image, and one B&W MrSID image, for maximum speed.

GIS Group	GIS Dataset	Description	Source
Imagery	BW Air Photos (2005)	2 foot Black and White air photos in rural areas of Niagara County - April 2005	NYS GIS Clearinghouse
	Color Air Photos (2005)	1 foot Natural Color air photos in rural areas of Niagara County - April 2005	NYS GIS Clearinghouse

Table 2.2:

2.3 GIS Layers Representing Sampling Locations

The layers discussed in Sections 2.1 and 2.2 are background supporting GIS information for the Community LOOW GIS website. However, the main reason for the site is the display and query of sampling locations – providing the project team and the public an easy way to browse the location of where these investigations have occurred, and what the results were. These point layers are listed on the GIS site in the “Data Locations” sub-folder. This folder contains a layer called “All Sampling Locations”, which is a point feature class showing each location that was sampled.

In addition to having one dataset with all sample locations, it became evident that it would also be useful to differentiate on the site locations that were involved with specific projects and investigations. These layers are in two sub-folders beneath “Data Locations”, that are called “Monitoring Locations”, and “Investigation Locations”. In these folders is a layer which depicts the locations where samples from that SPECIFIC investigation, and sampling type (“matrix”) were taken. These layers are for visual purposes only ... querying is done using the “All Sampling Locations” layer (this will be described in detail in the Functionality Section). Section 2.X will also summarize the investigations that are included on the site.

Data from each report was provided to E&E via Scott King. E&E then integrated this data into our Geodatabase normalized database

schema. This procedure was described in the initial LOOW GIS Implementation Plan, and will be summarized in this document in Section X.

GIS Group	GIS Dataset	Source
Data Locations	All Sampling Locations	E&E developed using source data provided by Scott King
	Sampling Location Names	E&E developed using source data provided by Scott King
Data Locations > Monitoring Locations	CWM Air Monitoring Stations	" "
	CWM Ground Water	" "
	Modern Landfill Ground Water	" "
	Modern Surface Water	" "
	NFSS Annual Ground Water	" "
	NFSS Annual Sediment	" "
	NFSS Annual Surface Water	" "
Data Locations > Investigation Locations	Bechtel 1983 Soil	" "
	Bechtel 1985 Soil	" "
	DERP_FUDS Phase 1 Ground Water	" "
	DERP_FUDS Phase 1 Sediment	" "
	DERP_FUDS Phase 1 Surface Soil	" "
	DERP_FUDS Phase 1 Surface Water	" "
	DERP_FUDS Phase 2 Ground Water	" "
	DERP_FUDS Phase 2 Sediment	" "
	DERP_FUDS Phase 2 Sludge	" "
	DERP_FUDS Phase 2 Subsurface Soil	" "
	DERP_FUDS Phase 2 Surface Soil	" "
	DERP_FUDS Phase 2 Surface Water	" "
	Lewport Schools Surface Soil	" "
	NFSS Investigation Ground Water	" "
	NFSS Investigation Sediment	" "
	NFSS Investigation Soil	" "
	NFSS Investigation Surface Water	" "
	Small Bern Clearing Soil	" "

2.4 Normalized Sampling Database

The Community LOOW GIS data was developed with a normalized database structure, to be incorporated into Niagara County's Enterprise Geodatabase. Using a normalized database format ensures the highest quality data integrity, reduces data redundancy, and is easiest to update. Tables stored in the LOOW Database are related by common primary foreign keys. The following is a summary of each proposed table, its function, and how it relates to other LOOW Project Tables.

All samples are tied to a physical location – the point at which they were taken. This spatial information is found in the "SamplingLocations" dataset, a GIS Geodatabase Feature Class. All samples themselves are stored in the 'tblSamples' SQL Server table, which has nearly half a million samples. These two tables are joined by the "LOCID" field. A variety of additional table, summarized below, contain additional information about the samples, such as Chemical, Matrix (type of Sample)

Table Name	Description	Key Attributes	Relationships	Spatial ?
tblProjectToChem	Relationship Table: Projects to Chemicals	Project and Chemical Keys	Many to Many relationship between fcSampleProjects, tblParamters	No
tblParameter	Parameters sampled	Parameter Names, Threshold, Units, CAS#	Relationship to tblProjectToChem (PROTOCHEMID), for many to many relationship with fcSampleProjects ... related to tblSamples by CHEMID	No
tblSamples	Individual Samples	Sample Date, Lower/Upper Depth, Parameter Value, Error, Lab Flag Code	SamplingLocations (LOCID): to sample Location Point, tblParameter(CHEMID): to list of Parameters, tblParamters, tblMatrix (MATRIXID): to list of Matrix Types, tblDataSources(DATA	No

			SOURCEID) to list of data sources, tblAcceptance(ACCEPTID): to list of acceptance codes, tblLabFlag (LABFLAGID): to lab flag codes	
SampleLocations	Sample Locations	Sample Geometry (Point), Easting, Northing, Sample Code	To tblSamples (SAMPLEID)	Yes
tblMatrix	Matrix Types	Matrix Type and Description	To tblSamples (MATRIXID)	No
tblDataSources	Data Source Types	Data Source Type and Description	To tblSamples (DSID)	No
tblAcceptables	Acceptance level for each sample	Acceptance Code and Description	To tblSamples (ACCEPTID)	No
tblFlags	Lab Flags	Lab Flag Code and Description	To tblFlags (FLAGID)	No
ThreshHold	Regulatory Thresholds	Chemical, Criteria, Threshold	To tblParamater (CHEMID)	No

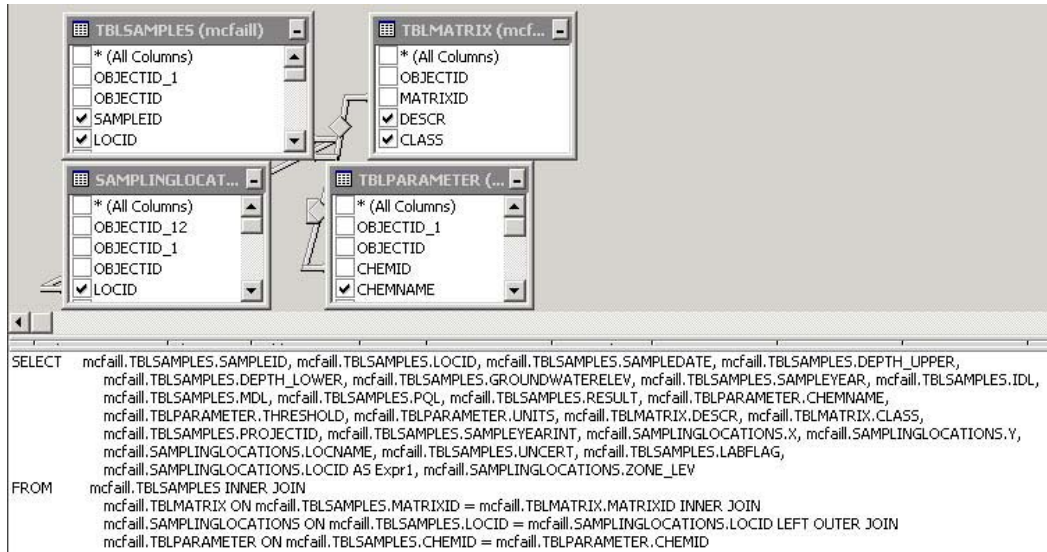
2.5 Views and Feature Classes

Information is gathered from the tables mentioned above and displayed on the LOOW Community GIS website as one record. This occurs through the use of SQL Stored Procedures, and through the use of prepared feature classes, specific to each investigation/monitoring project and sample type (matrix). This section will describe where these procedures were utilized.

Stored Procedures Microsoft SQL Server Stored Procedures can be used to build "SELECT" queries, to retrieve data from a table, or in this case, a group of tables. The SELECT queries combines elements from the tables above to present the user with one record, with information from the above tables combined. This method is employed in the following functionality.

- Query Filter Tools
- Data Identify Tool
- Data 'Select Box' Tool

These stored procedures run off a query behind the scenes called vw_Parameter_Matrix. This SQL View brings together related information from all the normalized tables into one record.



Standalone Feature Classes. One of the goals of the site is to provide for the user, via a layer, an easy way to see where samples from a particular study, using a particular matrix, were taken. These layers are distinguished by monitoring and investigation locations, and are found in the “Data Locations” folder.

The original intent was to create these as ArcSDE “Views”. These are spatial datasets that are subsets of the entire dataset of sample locations, filtered by a SQL Query. Initial testing indicated that response time was by far too slow for this approach. In fact, the inclusion of these views would often case the website to time out.

As a result, it was necessary to create individual ArcSDE feature classes for each combination of matrix and project. This is much more involved and time consuming, but this process also makes the website display much faster. The process to create these views is outlined below.

The aforementioned views are still created, using ArcSDE and SQL Server. We need to still perform this step, building the view, and then exporting it as a standalone feature class.

1. Spatially enabled SQL Views (Views that have a “shape” field, so that they can store geographic data) were created using the standard ArcSDE DOS command. The shapes are based off the “SAMPLING LOCATIONS” dataset, which is the location of each sample that is taken.

```

Command Prompt
ArcSDE 8.3      Build 1090 Tue Nov 19 11:26:36 PST 2002
Attribute      Administration Utility
-----
sdetable -o create_view -I <view_name> -t <table1,table2...tablen>
-c <table_col1,table_col2...table_coln>
[-a <view_col1,view_col2...view_coln>] [-w <"where_clause">]
[-i <service>] [-s <server_name>] [-D <database>]
-u <DB_User_name> [-p <DB_User_password>] [-N] [-q]

sdetable -h
sdetable -?

P:\>sdetable -o create_view -I SBC_SOIL_2 -t SAMPLINGLOCATIONS -c shape -a shape
-u mcfaill -p _____ -D gis_LO0W

ArcSDE 8.3      Build 1090 Tue Nov 19 11:26:36 PST 2002
Attribute      Administration Utility
-----
Successfully created view SBC_SOIL_2.

P:\>

```

- SQL Server views are created that show only samples that were part of that particular project, and that particular type of matrix (soil, ground water, etc.)

The screenshot shows the ArcSDE Administration Utility interface. Two tables are displayed: TBLMATRIX (mcf...) and TBLSAMPLES (mcfaill). The TBLMATRIX table has columns: * (All Columns), OBJECTID, MATRIXID, DESCR (checked), and CLASS. The TBLSAMPLES table has columns: * (All Columns), OBJECTID_1, OBJECTID, SAMPLEID, and LOCID (checked). Below the tables is a table with columns: Column, Alias, Table, Output, Sort Type, Sort Order, and Criteria. The table contains three rows of data:

Column	Alias	Table	Output	Sort Type	Sort Order	Criteria
LOCID		TBLSAMPLES	✓			<> 0
DESCR		TBLMATRIX	✓			= 'GF'
PROJECTID		TBLSAMPLES	✓			= 'M'

Below the table is the SQL query for the view:

```

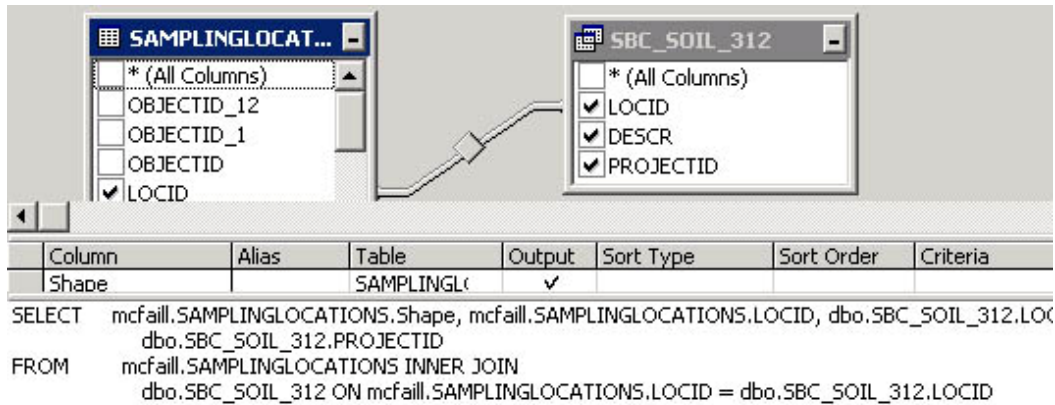
SELECT DISTINCT mcfaill.TBLSAMPLES.LOCID, mcfaill.TBLMATRIX.DESCR, mcfaill.TBLSAMPLES.PROJECTID
FROM mcfaill.TBLMATRIX INNER JOIN
mcfaill.TBLSAMPLES ON mcfaill.TBLMATRIX.MATRIXID = mcfaill.TBLSAMPLES.MATRIXID
WHERE (mcfaill.TBLMATRIX.DESCR = 'GROUND WATER') AND (mcfaill.TBLSAMPLES.PROJECTID = 'MODERN LANDFILL')
(mcfaill.TBLSAMPLES.LOCID <> 0)

```

At the bottom, a table shows the results of the query:

LOCID	DESCR	PROJECTID
6820	GROUND WATER	MODERN LANDFILL
6821	GROUND WATER	MODERN LANDFILL
6822	GROUND WATER	MODERN LANDFILL
6823	GROUND WATER	MODERN LANDFILL

- The views in Step 1 and 2 are then combined. This gives us a “spatially enabled” view, that contains the point locations of samples taken from that particular project. This is performed through a SQL Inner Join, which restricts the points in the view to only those matching the matrix and project criteria.



4. These spatial views can be viewed by ArcGIS ArcCatalog. They are 'ready', but these are the views that display very slowly in ArcIMS on the LOOW GIS site. So they are exported, using the GIS tools in ArcCatalog, to their own separate dataset. These standalone feature classes are displayed on the site much quicker.

2.6 Projects

This section lists the projects, investigations, and monitoring studies whose samples are represented in the Community LOOW Database.

- LewPort School Campus soil sampling (2000-2004)**
- DERP-FUDs Phase I Remedial Investigation (1999)**
- DERP-FUDs Phase II Remedial Investigation (2002)**
- DERP-FUDs Phase III - Underground Utilities (2006)**
- Modern Landfill Groundwater (2002 - 2006)**
- NFSS Remedial Investigation (2007)**
- NYSDEC Sediment PCB Sampling (2006)**
- DERP-FUDS Small Bermed Clearing Investigation (2004)**
- Bechtel Post-Remediation Sampling (1983-84)**
- Bechtel Post-Remediation Sampling (1985-86)**
- NFSS Annual Environmental Surveillance (2000-2006)**
- CWM Groundwater Monitoring (1995-2005)**
- Modern Groundwater Monitoring (2000-2005)**

3 INTERNET MAPPING

This section describes the development and implementation of the Community LOOW GIS Mapping Site

3.1 Internet Mapping Introduction

A major component of the Community LOOW GIS Project is the requirement to easily disseminate the wealth of sampling information to the County's general public. The easiest way to readily share this information is through an Internet Mapping Website, which can serve all of the sampling data, and associated background mapping layers, in an internet browser format that does not require GIS software on the client side to run. This section will outline the software that E&E proposes to use, the functionality that the site will implement, and the process by which the site will be developed.

3.2 ArcGIS Server vs. ArcIMS

The intent was to develop the internet mapping site using ESRI's **ArcGIS Server 9.2** technology. The reasoning was that this is the latest release of mapping software by ESRI, insuring that the LOOW GIS site be developed with the richest suite of functionality, and with the new software, also ensure that the site's architecture will remain in current usage for the maximum period of time.

However, problems arose during the implementation. As a result, it was decided to implement this site using the older ESRI **ArcIMS** technology for a few important reasons.

- Speed was the main reason. The development team was unable to get response times that were acceptable using ArcGIS Server. There is a large amount of data to be queried on this site (almost 500,000 samples), and ArcGIS Server did not handle this in a timely fashion. The large amount of data also tended to make the site crash, more than it did for ArcIMS. The data is able to be displayed on ArcIMS in a timely fashion.
- The best way to increase performance in ArcGIS Server is to "cache" layers, build pre-existing maps that can be retrieved and

displayed quickly. Because of the dynamic nature of the sample data, this was not possible.

In summary, because of reliability and speed issues, the Community LOOW GIS Project was implemented using ESRI ArcIMS. It is the intent to implement an ArcGIS Server version of the site when speed issues are resolved.

3.3 Physical Infrastructure

The Community LOOW GIS Site will be hosted by the Erie County Office of GIS server infrastructure. This arrangement is being defined as per the Intermunicipal Agreement between Erie and Niagara Counties for sharing of GIS assets, that is currently being developed. Erie County will also host Niagara County's general ArcGIS Server site that is being developed, and also will be host to the SQL Server Enterprise Geodatabase that will house all of Niagara County's Enterprise spatial data (including the LOOW GIS). During an interim period, the Community LOOW GIS site has been hosted by Ecology and Environment, Inc., the GIS consultant for the project.

For the public's convenience, an easy URL was chosen for the site's address:

<http://www.communityloowproject.com>

3.4 Basic Map Functionality

The ArcIMS Community LOOW site uses basic map functionality standard in internet mapping sites.

- Zoom In / Zoom Out
- Pan
- Full Extent
- Last Extent
- Measurement
- Change Layer and Group Layer Visibility
- Print map view

3.5 Extended Map Functionality

One of the advantages of developing a custom ArcIMS site was the addition of functionality and applications specifically tailored to the needs of the LOOW GIS User. This section will detail the proposed additional functionality to improve the useability of the site.

- a. *Layer Filtering Tool.* By default, each layer in the "Samples" group will display all samples which monitored for that specific parameter. The site user may often want to filter these parameters by specific criteria. Users can filter based on these criteria:
 - a. *None.* All samples of that parameter will be displayed, even if the result is 0
 - b. *Project.* Specific investigations and monitoring studies.
 - c. *Matrix.* Type of sample (surface water, soil, etc.)
 - d. *Parameter:* Type of parameter or chemical.
 - e. *Ground Water Zone:* Whether the sample is in the upper or lower zone
 - f. *From/To Year:* Year range of samples
 - g. *Regulatory Standard:* Samples above several regulatory standards.
- b. *Sample Information Tool.* The user can click, using this tool, on a sample location on the map, and view a pop-up displaying information about each sample at that location, in a sortable grid.
- c. *Sample Select Box Tool.* The user can drag a box using this tool, to view a pop-up displaying information about each sample found with that box, in a sortable grid.
- d. *Zoom To Scale:* Users can zoom to a specific map scale

3.6 Help

Given the complex nature of the site, a full help system was developed, using RoboHelp. This can be accessed from the site's welcome screen, or from the "Help" button on the GIS site. Each function on the site is discussed in detail.

4 Summary

The Community LOOW GIS Project has successfully provided the public an easy way to access an organized repository of the hundreds of thousands of samples that have been taken in the LOOW area. The benefits of the project have been many:

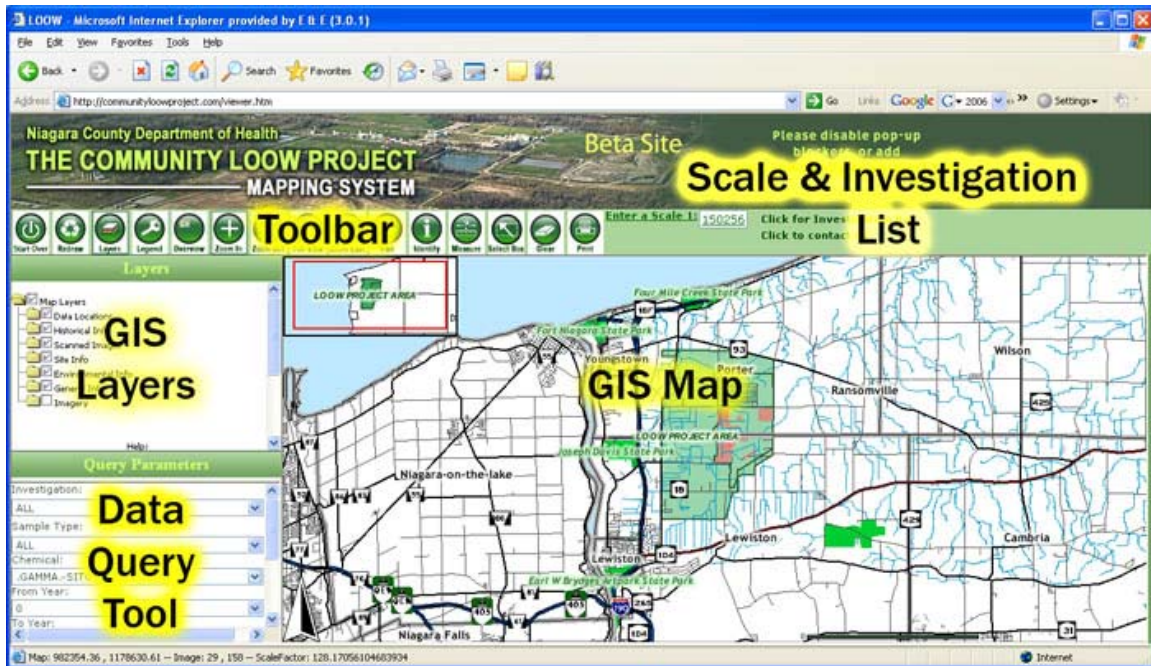
- The inventory of samples taken as part of monitoring sites and investigations provides a comprehensive list and summary of the detailed chemical study of the area.
- Organizing all of the samples into one geodatabase provides a level of standardization, so that analysis across multiple projects can be performed much more easily. Future projects can also be integrated into analysis much more smoothly.
- The web mapping site allows the public to browse a variety of mapping layers on the site, see where samples have been taken, and query the results of these samples.

The Community LOOW GIS site has been developed in a way that can be updated and kept current. A dynamic web mapping site can have updated layers and samples loaded into the geodatabase. It is our hope that this site is only a beginning – that as new information becomes available, the site will continue to be used to inform the public in Niagara County.

APPENDIX A

The following are screen shots showing some of the key features of the Community LOOW GIS Site. For more detail, please visit the Help section on the Community LOOW GIS site.

Introduction. *This is a view of the Community LOOW GIS Mapping Tool. Key sections of the page are identified on this screen shot. To find more detail about that particular section of the Mapping Tool, click on it's topic in this help document...*



Main Map. The main map, which takes up most of the page is where your map can be viewed. In this map, you will be able to view the map layers that are visible (checked-on) in the Table of Contents.

Most of the other features on the website interact with the map in different ways. Click on the help for those specific topics to see more information!



Table Of Contents. The Table of Contents lists what layers can be viewed on the GIS Map. It also is where the user controls whether specific layers are visible, or not.

Each "Layer" in the Table of Contents represents a GIS Layer, showing a distinct set of information. For example, "Roads" is a GIS Layer that is shown in the Table of Contents.



Layers are organized into "Groups". These Groups present sets of data layers in an organized format. Group names appear just to the right of the folder icons. Pictured below is the group "Geology", and the layers that it contains.



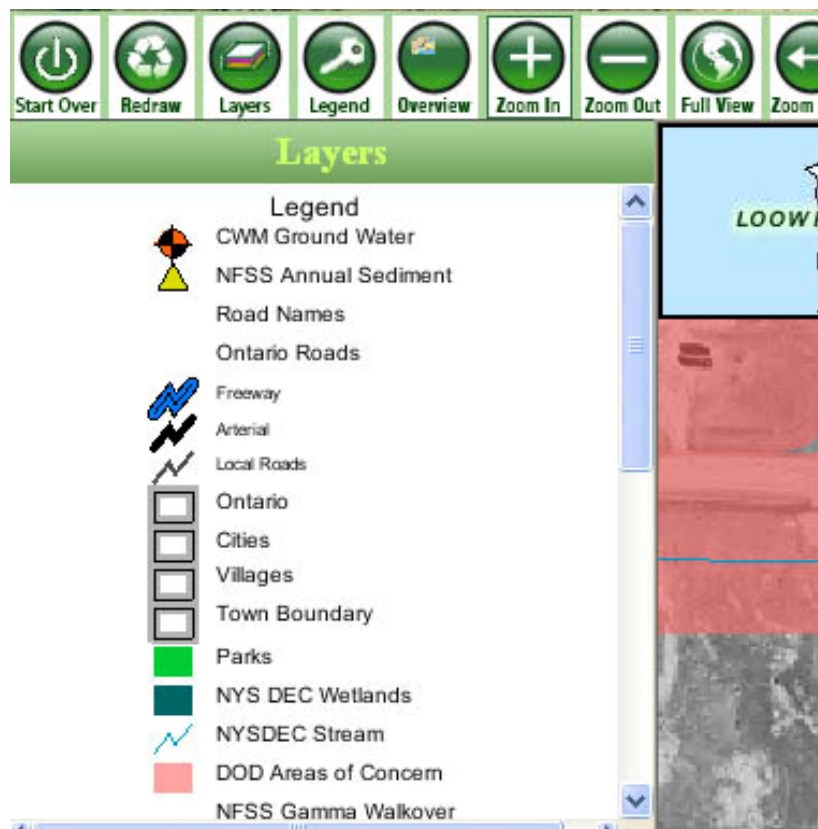
Click on the sub-headings of the "Table Of Contents" help topic for more information on how to use the Table of Contents

Legend. The legend is used to show the site user what each symbol that is visible on the map represents. Use the legend to determine what layers the symbols on the map are coming from.

The legend will appear in the area where the Map Layer of Table of Contents is usually located. To display the legend, click the "LEGEND" button on the



Here is an example of how the legend might look (This will depend, of course, on what layers you have visible)

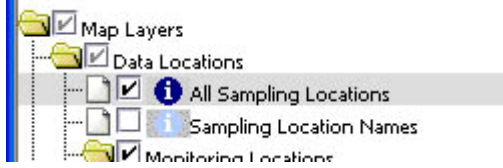


Toolbar. The toolbar is the series of buttons running horizontally across the top of the map. Many of the commands that allow the user to interact with the map screen are located on the toolbar. This section of the help document explains the usages of each of these tools. Choose the subtopics beneath the "Toolbar" category for more information. You can also click on tools pictured below to link directly to that help topic.



Information Tool. This tool gives the user a general information screen showing database information about each visible feature present where the user clicked on the map.

What this tool displays depends on which is the "Active Layer"



All Sampling Locations is active

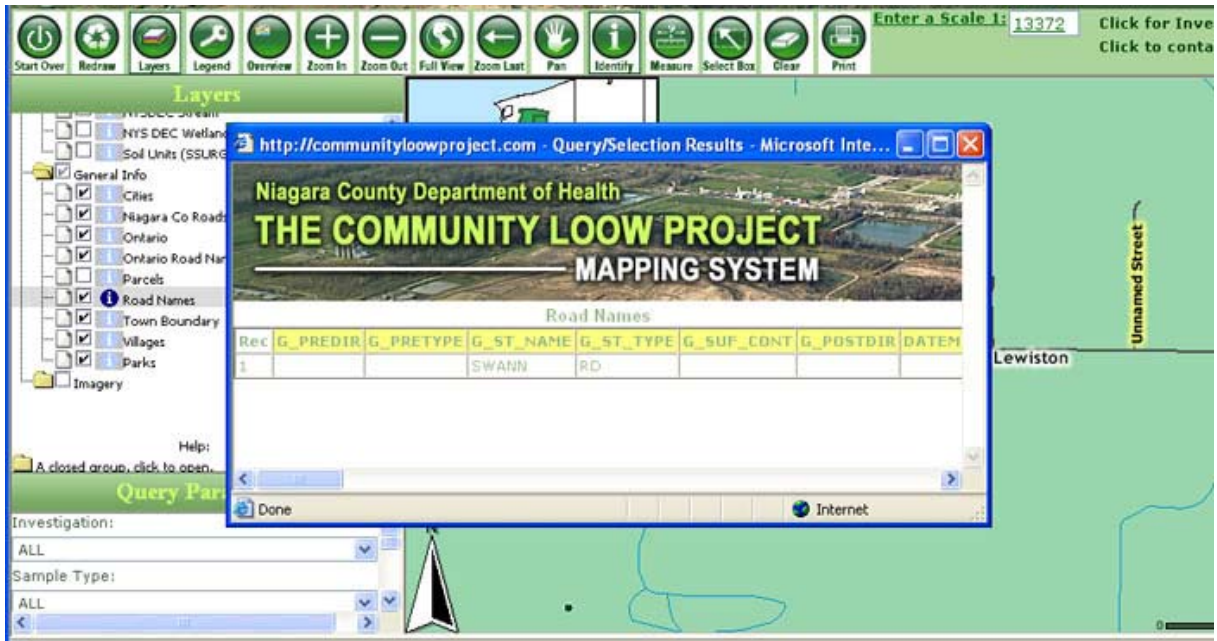
1. Sampling Location Information: If you would like specific and detailed information about the samples recorded at the point you clicked, make sure that "All Sampling Locations" is the active layer. With All Sampling Locations turned on, and active, click one of the points on the map where sampling occurred. A pop-up sampling results window will appear, with a list of samples at that location that are loaded into the LOOW Geodatabase

A screenshot of a web browser window displaying a query results table. The browser address bar shows 'http://communityloowproject.com - QueryResults - Microsoft Internet Explorer provided by E.B.E (3.0.1)'. The page title is 'Niagara County Department of Health THE COMMUNITY LOOW PROJECT MAPPING SYSTEM Beta Site'. Below the title is a table with columns: PROJECTID, LOCATION, CHEMNAME, MATRIX, RESULT, UNITS, THRESHOLD, QUALIFIER, UNCERTAINTY, UPPER DEPTH, LOWER DEPTH, ZONE, SAMPLE YEAR, X, Y, and SAMPLED. The table contains three rows of data for Bechtel (1983) samples.

PROJECTID	LOCATION	CHEMNAME	MATRIX	RESULT	UNITS	THRESHOLD	QUALIFIER	UNCERTAINTY	UPPER DEPTH	LOWER DEPTH	ZONE	SAMPLE YEAR	X	Y	SAMPLED
BECHTEL 1983	Bechtel (1983) Table 13 (X: 405,Y: 4280)	RADIUM-226	SOIL	0.7	PCI/G 0			0.2				1983	1041018.54651	1176919.60870	
BECHTEL 1983	Bechtel (1983) Table 13 (X: 405,Y: 4280)	THORIUM-232	SOIL	0.4	PCI/G 0			0.3				1983	1041018.54651	1176919.60870	
BECHTEL 1983	Bechtel (1983) Table 13 (X: 405,Y: 4280)	URANIUM-238	SOIL	0	PCI/G 0			0				1983	1041018.54651	1176919.60870	

2. General Layer Information: Having any other map layer active will return information about that map layer's attributes at the point you click.

To retrieve information about another map layer, make sure that layer is active, then activate the Identify window, and click on a feature of that type on your map.



Query Parameter. The Query Parameter tools allow the user to explore the large LOOW Samples dataset, by adding filters to the data, to only view samples that match that criteria. These tools are located

The user can add filter information about

- **Investigation (Project)**
- **Sample Type (Soil, Ground Water, etc.)**
- **Ground Water Zone (Upper, Lower, Bedrock)**
- **Chemical**
- **From / To Year (Search by sample year)**
- **Regulatory Standard (Search for samples above a standard)**
- **View Samples (all over just over threshold)**

NOTE: If you need more room for the Query Parameter Tools, you can drag the "frame" larger, click with your left mouse at the top of the 'Query Parameters' title (drawn as a red line on the graphic below), and drag the menu larger.

Query Parameters	
Investigation:	ALL
Sample Type:	ALL
Ground Water Zone:	ALL
Chemical:	.GAMMA.-SITOSTEROL
From Year:	0
To Year:	2006
Regulatory Standard:	0.0000006
View Samples:	ALL
<input type="button" value="Clear"/> <input type="button" value="Select"/>	

Here, the user has also chosen "SURFACE WATER", and "1,2-DICHLOROBENZENE". The rest of the filtering parameters are narrowed down to fit what the user chose (i.e From and To Year, and Regulatory Standard)

Query Parameters	
Investigation:	CWM
Sample Type:	SURFACE WATER
Ground Water Zone:	ALL
Chemical:	1,2-DICHLOROBENZENE
From Year:	1997
To Year:	1998
Regulatory Standard (Units: UG/L)	37
View Samples:	ALL
<input type="button" value="Clear"/> <input type="button" value="Select"/>	

Appendix C Comments Concerning Air Monitoring.

Memo

To: Scott King
From: Marvin Resnikoff
Date: April 27, 2007
Re: 2003 – 2005 Environmental Surveillance Technical Memoranda

This memo discusses our review of the 2003, 2004 and 2005 Environmental Surveillance Technical Memoranda for the NFSS site. We discuss the USACE guidelines, the sampling methods on NFSS, Groundwater issues, Radon Flux, and general issues.

Guidelines: In its survey of the NFSS property, the Army Corps of Engineers (USACE) adopts DOE Order 5400.5 requiring total effective radiation doses to be maintained less than 100 millirems/year (mrem/y). To calculate this total effective radiation dose¹, one determines the radiation doses due to ingestion and inhalation of radioactive materials through all pathways (incidental ingestion of soil, food, water, inhalation of particulates) plus a direct gamma dose. Based on its assumptions, USACE then determines that the likely dose is far less than 100 mrem/y in 2003, 2004, and 2005. The 100 mrem/yr is the same standard used by the NRC for operating nuclear reactors and facilities. It is inappropriate for a site like NFSS. Another standard generally applies to decommissioned facilities, 25 mrem/y. USACE has used the NRC regulatory standard, 25 mrem/y, at other facilities it has decommissioned, Maywood and Wayne, New Jersey sites. Since the NFSS site is closed, the 25 mrem/y guideline should apply.

To calculate a radiation dose to the nearest resident, USACE starts with average radionuclide concentrations in soil, including biased samples it has taken in preparation for the Remedial Investigation Report due out later this year. The location of these biased samples and the concentrations at each location were not specified. USACE then determines the fugitive dust emissions due to wind erosion from the NFSS site. This dust emission source, which is really an area source, is then located at the center of the NFSS site. To determine dispersion from this point source to the nearest resident, USACE employs the program CAP88-PC, which can only be employed for a point source. CAP88-PC then calculates the radiation dose due to different pathways, such as inhalation. The methodology can best be described as a crude approximation to the radiation dose. Disturbance of soil at NFSS can also occur when people and vehicles move on the NFSS site, but that was not included in the USACE analysis. A more sophisticated analysis would take into account area sources and vehicle movement in order to calculate air concentrations. A more fundamental question is whether this is the appropriate analysis for a Remedial Investigation for a decommissioned waste storage facility, since the analysis assumes a secure, guarded facility for the indefinite future and residents at the periphery. That assumption is not consistent with EPA guidance on risk, where active site management is not to be assumed after 100 years. In other words, for a Remedial Investigation, one should assume a future resident or farmer is located on the site and receives a radiation dose due to ingestion of water and food grown in a garden, incidental soil ingestion, inhalation of radioactive dust particles and direct gamma.

¹ The total effective dose is a sum of the weighted radiation dose to all organs. The total effective dose is a sum of the committed dose to all organs due to ingestion and inhalation of radioactive particles plus the direct gamma dose. By "committed dose" we mean the total dose over a 50-year period due to the intake of radioactive particles.

USACE also has specific standards for specific media and for specific radionuclides. Order 5400.5 also has a radium-226 guideline of 5 pCi/g for the top 15 cm of soil and 15 pCi/g below 15 cm. USACE and the EPA have applied this standard to many sites across the country. If the situation is such that contaminated land will be disturbed so that the soil below 15 cm is brought to the surface, the 5 pCi/g guideline should apply. Such disturbance has occurred in Vicinity Property E² in which there are several sections that have been disturbed due to burial or excavation of storage tanks and new developments on the property by the new owner, SCA; much of the original land surface has been disturbed.

USACE follows the drinking water standard guidelines set by EPA (40CFR141.66(b) and (e)). The standard is 5 pCi/L for combined Ra-226 and Ra-228 and 30 µg/L for total uranium; these guidelines apply to public drinking water supplies, but serve here as a reference for concentrations found on the NFSS site. In 2004 some of the surface water samples had elevated levels of Ra-226, total Uranium, and Th-230. USACE attributed this elevation to turbidity; this argument may have some merit since the samples were unfiltered and the local soil had elevated radioactivity levels. That is, the turbidity argument supports the proposition that the soil has elevated radioactive concentrations.

In 2003, 2004, and 2005 there was some radiation picked up from surface water on the NFSS site. In 2003 the entrance concentration was 0.45 pCi/L and the exit concentration was 0.68 pCi/L of Ra-226. In 2004 the Ra-226 measurement at SWSD021 at the entrance to the site was 0.32 pCi/L, while the measurement at the exit of the site, SWSD011 was 0.493 pCi/L. This is also evidenced in the 2005 report where the entrance measurement at SWSD021 was 0.08 pCi/L and the exit measurement at SWSD011 was 0.330 pCi/L (duplicate is 0.380 pCi/L) of Ra-226; this shows that the Central Drainage Ditch (CDD) picked up radioactivity on the NFSS property. Analysis of vicinity properties through which the drainage ditch flows may also show an increase in concentrations near the CDD upon exiting those properties as compared to the concentrations when entering the property.

NFSS Sampling: USACE monitors direct gamma with TLD chips that are collected every six months. Over time these chips accumulate gamma energy and the total accumulated energy is read at a lab by the light emitted from the chip. This is a standard method for determining the gamma energy absorbed. The measured TLD monitoring results were not high.

Both water and sediment are being sampled at 5 locations at the NFSS site, 2 upstream, 2 along the Central Drainage Ditch, and 1 downstream. One of the upstream locations, SWSD009, is chosen as a background (see attached figure), however, it is questionable whether or not that should be counted as background. Using that as a background may have accounted for negative numbers when subtracting SWSD009 'background' concentration from other concentrations. In the 2003 report USACE mentions 'biased' wells that are located at places where the soil concentrations were high; USACE decided not to monitor these wells in 2003, but apparently did so in subsequent years. These elevated concentrations were used in the source term development calculations³, but USACE has not shown the locations of these biased wells.

Instead of monitoring airborne particles, particulates in air were estimated entirely by modeling. As mentioned above, such practice is acceptable if there is no human activity occurring at the NFSS site, but the methodology is wrong, as discussed above. Using soil data and meteorological conditions, USACE developed a soil erosion formula to determine particulate concentrations in air. An air dispersion model, CAP88PC was used to determine the particulate air concentrations at the site fence line. Using such a complex way to sample for air concentrations instead of sampling directly is unsatisfactory; such an approach allows for large

² Berger, J.D., *Comprehensive Radiological Survey: Off-Site Property E*; Lewiston, NY, September 1983.

³ Source term development calculations determine what should be remediated; 2003, 2004, and 2005 calculations do not consider humans living on the property; radionuclide concentrations in 2004 & 2005 differ from those in 2003; this is assumed to be true because 2004 and 2005 include biased numbers, whereas the concentrations in 2003 do not include biased numbers

errors in the final concentrations. USACE could use high volume air samplers, which draw air in through a filter that captures particulates. The filters could be measured at a laboratory. Such a method should be set up as soon as possible so that a 'background' can be established before any work is done on NFSS or vicinity properties

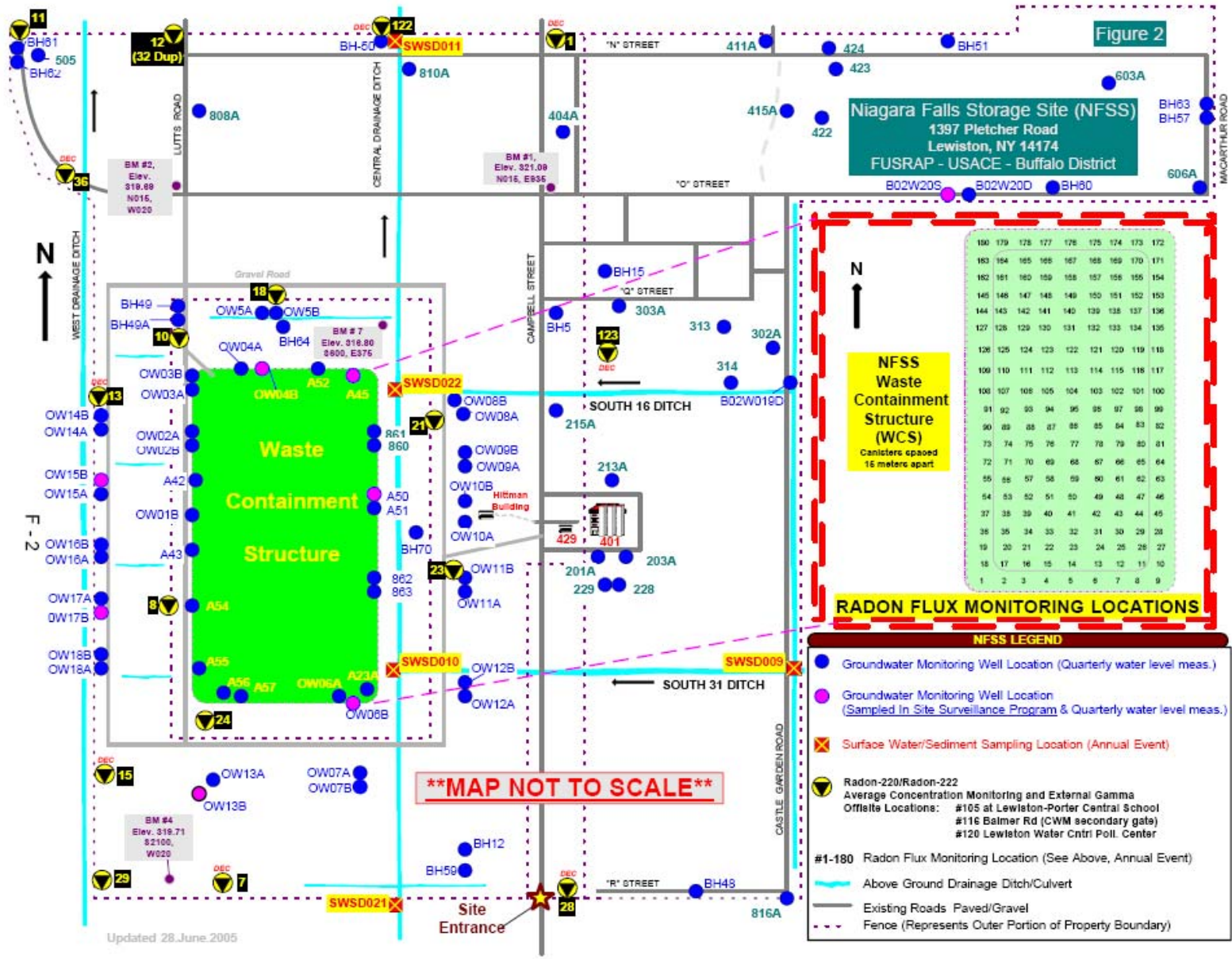
Groundwater: USACE states in the 2005 report that the upward vertical gradients of the water bearing zones work to impede downward migration of contaminants into the lower zone that would come from potential contaminant sources in the upper zone. Hence, their claim is that there would be less of a need to have annual testing of the groundwater in the lower zone. However, if the drinking water standards are to apply to these groundwater concentrations both zones should be tested, especially if there may be future inhabitants of the site who would tap into the lower zone groundwater.

In 2005 the total dissolved solids (TDS) of sulfate and sodium in the groundwater exceeded the NYSDEC groundwater quality standards. TDS results in all the wells, including the background wells, frequently exceeding NYSDEC standards. Sodium concentrations ranged from 43.6mg/L to 78.5mg/L, which exceed the groundwater quality standard of 20mg/L. Concentrations of radionuclides in groundwater also exceeded drinking water standards. Two wells had an excess of total Uranium concentration levels. In well OW04B, located on the northwest side of the waste contaminant structure, the concentration was 40.1 pCi/L; in well A45, located on the northeast side of the waste contaminant structure, the concentration was 27.33 pCi/L. Both were over the standard concentration for drinking water, which is 30µg/L (27 pCi/L), specified in 40 CFR part 141.66. These two wells have exceeded the standard drinking water standards in the past; in 2003 well OW04B had a concentration of 51.56 pCi/L and in 2004 the same well had a concentration of 44.78 pCi/L. Well A45 had a concentration of 29.10 pCi/L in 2003 and, in 2004, well A45 did not exceed the standard concentration but had a concentration of 26.51 pCi/L, which is just below the standard of 27.33 pCi/l. These results show that there has been a decreasing trend in well OW04B but the results are inconclusive about the Uranium concentration in well A45. Analytical results for all other radionuclides were either non-detectable or well below the standards.

Radon: Radon flux is an important indicator of whether a structure is punctured or torn. In 2005 the average flux was 0.029 pCi/m²/s. This is considerably less than the flux in 2004 of 0.066 pCi/m²/s and the flux in 2003 of 0.080 pCi/m²/s, indicating that the structure has not been punctured. The EPA standard for radon flux is 20pCi/m²/s, specified in 40 CFR part 192.02.

General: Surface water and sediment concentrations of radionuclides were consistent with historical analytical results and were usually non-detectable or indistinguishable from background concentrations according to the 2003, 2004, and 2005 NFSS reports.

Figure 2



Niagara Falls Storage Site (NFSS)
 1397 Pletcher Road
 Lewiston, NY 14174
 FUSRAP - USACE - Buffalo District

RADON FLUX MONITORING LOCATIONS

100	179	178	177	176	175	174	173	172
163	164	165	166	167	168	169	170	171
162	161	160	159	158	157	156	155	154
145	146	147	148	149	150	151	152	153
144	143	142	141	140	139	138	137	136
127	126	129	130	131	132	133	134	135
126	125	124	123	122	121	120	119	118
100	110	111	112	113	114	115	116	117
100	107	108	105	104	103	102	101	100
91	92	93	94	95	96	97	98	99
90	89	88	87	86	85	84	83	82
73	74	75	76	77	78	79	80	81
72	71	70	69	68	67	66	65	64
55	56	57	58	59	60	61	62	63
54	53	52	51	50	49	48	47	46
37	38	39	40	41	42	43	44	45
38	35	34	33	32	31	30	29	28
19	20	21	22	23	24	25	26	27
18	17	16	15	14	13	12	11	10
1	2	3	4	5	6	7	8	9

- NFSS LEGEND**
- Groundwater Monitoring Well Location (Quarterly water level meas.)
 - Groundwater Monitoring Well Location (Sampled In Site Surveillance Program & Quarterly water level meas.)
 - ⊗ Surface Water/Sediment Sampling Location (Annual Event)
 - ⚠ Radon-220/Radon-222 Average Concentration Monitoring and External Gamma Offsite Locations: #105 at Lewiston-Porter Central School #116 Balmer Rd (CWM secondary gate) #120 Lewiston Water Centri Poll. Center
 - #1-180 Radon Flux Monitoring Location (See Above, Annual Event)
 - Above Ground Drainage Ditch/Culvert
 - Existing Roads Paved/Gravel
 - - - Fence (Represents Outer Portion of Property Boundary)

****MAP NOT TO SCALE****

Updated 28 June 2005

**Air Quality Monitoring Review
Former Lake Ontario Ordinance Works Site
October 2005, Revised September 2008**

Prepared by: Dr. Sherri A. Mason, SUNY- Fredonia, Department of Chemistry

1. Introduction

In response to community concerns about potential health risks from prior or current operations occurring on the former property of the Lake Ontario Ordinance Works (LOOW) site, the Niagara County Health Department created 'The Community LOOW Project.' The charge given to this project is to independently assess, on a site-wide basis, existing environmental monitoring efforts being employed by various agencies that are currently responsible for former LOOW site property. The purpose of this memorandum is to review and analyze current air monitoring efforts with regard to their ability to accurately assess potential human health risks. Reviews of other environmental monitoring efforts, such as ground water surveillance, are covered under separate evaluations.

2. History

During World War II the army purchased 7,567 acres of land, which is currently overlapped by the towns of Lewiston and Porter, upon which was built the Lake Ontario Ordinance Works (LOOW), a TNT factory. After nine months of operation the plant was shut down, reportedly due to overcapacity. The property was then used to store radioactive waste from the Manhattan Project (some within a concrete water tower, some buried, and some was simply disposed of directly upon the ground). After the war more than half of the property was sold to private owners, while the remaining continued to be used as a dumping ground for radioactive materials. In addition to TNT production, a variety of other Defense-related chemical operations took place on the LOOW site from WWII through the 1970's. During the 1950's mixed fission products as well as segregated plutonium were shipped to the LOOW site from the Knolls Atomic Power Laboratory in Schenectady, NY. Some of this waste was burned in an open area on the LOOW. Containers were known to have been badly damaged while stored on the surface. Remains of animals injected with plutonium from experiments at the University of Rochester (1940's-50's) were also shipped to the LOOW site. Some of the fission products and plutonium were shipped offsite (Oak Ridge), but records are incomplete.

In 1966, hundreds of acres of the land, still owned by the army, were sold to various businesses. Currently, the Lew-Port schools and several businesses, including: CWM Chemical

Services, LLC, the Niagara Falls Storage Site (NFSS), and Modern Landfill and Recycling, are housed on the former LOOW site property.

Of particular interest in regard to current air quality issues in the Lew-Port area are the NFSS and CWM industrial waste sites. NFSS is a 191-acre nuclear waste storage facility, which currently houses ~25,000 cubic yards of radioactive residue, including: Radium-226, and various Thorium and Uranium isotopes. In addition, there is ~235,000 cubic yards of less radioactive material. These residues and wastes are the process by-products of uranium extraction from pitchblende (uranium ore). The residues originated at other sites and were transferred to the LOOW site for storage in buildings and onsite pits and surface piles beginning in 1944. Since 1971, activities at the LOOW site have been confined to residue and waste storage and remediation. There have been several attempts to consolidate radioactive waste on the LOOW site on the NFSS. In the early 1980's a large silo containing high-activity radium-226 was dismantled with contents moved to a temporary underground storage facility on the NFSS where it remains today. Other contaminated soils and debris are also housed in this area. All onsite and offsite areas with residual radioactivity have undergone several remediation attempts between 1955 and 1992. Materials generated during remedial actions are encapsulated in a 9.9 acre waste containment structure (WCS), which was designed to provide interim storage of the material. The U.S. Army Corps of Engineers (USACE) is currently in charge of its environmental monitoring.

Also housed on the former LOOW property, CWM is a fully-operational 710-acre Treatment, Storage, and Disposal Facility (TSDF), including a currently active hazardous waste landfill (with mounds up to 110 feet tall), which accepts waste from more than 2,000 customers and has a permit limit of 425,000 tons per year.

3. Current Air Quality Monitoring Activities

Based upon the history of the LOOW site the most serious concern with regard to environmental impact, in general, and air quality monitoring, as specifically focused upon herein, is radiological material. Nevertheless, owing to the nature of CWM's business there are additional concerns with regard to the release of air toxics.

While USACE is currently in charged of remediation on the NFSS site, based upon historical record it is extremely likely that chemical and radiological contamination extends beyond the NFSS site onto land currently under use by CWM. A 1972 NYS Health Department

Order restricted the movement of soil on CWM property, though the 1974 amendment of the order allowed for such movement given Department of Health's (DOH) approval. CWM requested that the order be vacated in 2004, but owing to concerns about the adequacy of the prior remediation performed on the site, the Department of Conservation (DEC), with DOH concurrence, included a condition in CWM's permit (August 2005) requiring radiation scanning be performed during all site excavations. With such activities there is a heightened probability (as compared to leaving the site dormant and allowing for secondary succession) of chemically or radioactively contaminated particulate matter becoming airborne even within the confines of CWM's Fugitive Dust Control Plan.

The purpose of this memorandum is to review and analyze current air monitoring efforts being conducted by CWM and NFSS with regard to basic scientific principles including: adequacy and location of necessary equipment, monitoring methods employed, and validity of data analysis techniques. We begin by reviewing current activities occurring at both sites.

3.1. CWM

CWM currently has 6 air monitoring locations, one of which, based upon a prevailing southwesterly wind direction, is classified (by CWM) as being upwind, with the remaining 5 locations being classified (by CWM) as downwind, of the waste management facility. Each air monitoring station is equipped with a high volume PM10 air sampler. Particulate matter with diameters less than or equal to 10 micrometers (PM10) is collected over a 24-hour sampling period every 6 days on glass fiber filters. Following standard protocol the mass concentration of PM10 (in $\mu\text{g}/\text{cm}^3$) is obtained from each sample at every monitoring location. The influence of CWM site activities upon PM mass concentration could be determined by subtracting background or upwind values from those concentrations measured at downwind locations.

The CWM radiation environmental monitoring plan (approved on 8/24/07) calls for the aggregation of PM10 filters for one typically dry month (e.g., July 2005), segregated according to the air monitoring site location, to be further analyzed for radiological content by an independent laboratory. The specific elemental and isotopic species to be monitored are: Uranium (234, 235, and 238), Thorium (228, 230, and 232), and Radium-226.

Though not currently active it is also important to note that CWM has in the past maintained an atmospheric monitoring program for {years as noted}: Volatile Organic Compounds (VOCs) {1984-2000}; Polychlorinated Bi-Phenyls (PCBs) {1987-1996}; Semi-

Volatile Organic Compounds (SVOCs) {1991-1992}; a special evaluation for 10 metals {1991}; and real-time VOC monitoring of an active landfill {1990-1994}. Based upon the species being evaluated it is presumed that: the VOC monitoring occurred within gaseous samples, the PCB and SVOC studies entailed determination of quantities within both gaseous and particulate matter samples, and that particulate matter samples were analyzed for their metal composition. These past air monitoring programs, with the exception of PM10, have been suspended as the data obtained did not demonstrate that CWM was a significant source for those compounds being evaluated due, in part, to elevated regional ambient concentrations.

3.2. NFSS

At the NFSS, USACE air monitoring efforts are focused upon external gamma radiation, radon gas concentrations and radon-222 gas flux. In addition to these measurements, dose rates for external gamma radiation and airborne particulates are calculated. Both the measurement methodology and the basis for the calculations will be reviewed herein.

Cumulative external gamma radiation is measured at fence-line locations, as well as perimeter locations of the WCS, through thermoluminescent dosimeters over a period of ~6 months. Measured values are corrected to a period of one year, less background values (taken from similar measurements taken at the Lew-Port schools). These corrected data are used to calculate effective dose rates as a function of the measured site fence-line dose, a theoretical distance from the fence-line, and a theoretical time of exposure. The latter two variables are approximated for two distinctly separated scenarios, that of an average worker and that of an average resident. For these calculations corrected values that are less than zero (owing to a higher measured “background” level than that obtained at fence-line) are retained as negative values.

As with the cumulative external gamma radiation, radon gas measurements at NFSS occur at fence-line locations, as well as perimeter locations of the WCS. The Lew-Port schools are used for obtaining background levels. Passive measurements are obtained through the use of Radtrak® canister detectors, which are designed to collect alpha particle emissions of both isotopes of Radon (220 and 222), integrated over the period of exposure (~ 6 months). After sampling, Radtrak® canisters are returned to the parent company for analysis and radon gas concentrations are determined from the alpha particle exposure.

Radon-222 flux is measured once, annually, using activated charcoal canisters placed along a 15-m grid across the surface of the WCS for a 24-hr exposure period.

To determine the dose from airborne particulates potentially released from NFSS during 2003, airborne particulate release rates were calculated using historical data for site soil contamination and weather data from the National Weather Service. (Contributions from radon gas, which is not a particulate, are not considered in this calculation.) The total airborne particulate release rate is then entered into the USEPA's CAP88-PC (version 2.0) computer model to calculate (1) an individual particulate dose and (2) the collective dose to a population within 80 km.

4. Air Quality Monitoring Issues

4.1. CWM

From a purely scientific standpoint the issues that arise with regard to current air quality monitoring efforts occurring on the CWM site can be summarized into three main points.

4.1.1. Air Monitor Locations

Firstly, while current air monitoring (PM10) equipment sites were chosen based upon legal standards, owing to the prevailing wind directions, as well as the size and shape of the CWM property and the number of emission points, the number and locations of the air monitoring sites needs to be re-evaluated (which as of the revision date of this review is currently underway). This re-evaluation is being recommended based upon the fact that there are 25 emission points on the CWM property, but only 6 monitoring stations, as well as the need to specify upwind and downwind monitor locations in order to determine the impact of CWM on the local air quality. While it is questionable to refer to air monitoring equipment located on former LOOW property as "background" with regard to chemical analysis (owing to the possible soil contamination), it would be acceptable in terms of a simple mass quantity of particulate matter being released owing to CWM activities. However, having only one air monitoring site, which based upon any given wind direction, can be labeled as "background" does not adequately account for possible abnormalities in air sampling. This would not only affect particulate matter sampling, but also the previous compositional data (i.e., VOCs, PCBs, etc.) even in the absence of the above mentioned issue with regard to the sampler being located on former LOOW property. Without an adequate "background" or "upwind" value, the impact of CWM activities cannot be properly evaluated. In line with this idea, in reporting their data CWM should clearly

indicate whether each air monitoring site would be/was considered an upwind or downwind location for the particular meteorological conditions present during the particular sampling period.

4.1.2. Particulate Matter Sampling and Analysis

While CWM is only required to collect and report on total PM10 mass, based upon human health concerns this review calls for additional sampling and analysis. From the outset PM10 mass would seem to be the most directly linked concern to CWM activities given the influx and movement of soil and debris that is the nature of their business (the majority of the waste they receive is soil and debris from remediation projects). However, in light of the chemical composition of much of that material (hazardous waste), additional considerations need to be taken. Given the ability of hazardous air pollutants (HAPs) to lead to secondary organic aerosol (SOA) formation, along with the growing awareness as to the greater human health impacts of fine particulate matter as compared to coarser air particles, monitoring of PM_{2.5} levels is warranted. Furthermore, given the nature of the waste for which they are responsible, as well as the history of the site as former LOOW property, all particulate matter samples should undergo both chemical and radiological analysis.

4.1.3. Gaseous Sampling and Analysis

Over a 16 year period (1984-2000) CWM was involved in a number of air monitoring efforts, some of which involved evaluation of gaseous compounds (most notable VOCs and SVOCs). These programs were suspended as the data obtained therein seemed to indicate that CWM was not a significant source of measured atmospheric pollutants. When evaluating the impact of CWM upon local air quality the location of “background” air samplers is extremely important. Given the questionable location of current “background” air samplers being located on former LOOW property, as well as the above mentioned need for the re-evaluation of the numbers and locations of air sampling equipment, this review calls for the need to re-visit sampling of gaseous emissions upon CWM property. The starting point for this re-evaluation is the need for “background” air samplers which are removed from the former LOOW site as the previous studies noted unusually high ambient concentrations, which would, thus, lower the apparent impact of CWM activities. Furthermore, while current Toxic Release Inventory (TRI) regulations do not require additional monitoring in order to submit the required emission

estimates, monitoring data is preferred and is more reliable than current, somewhat questionable estimation methods.

4.2. NFSS

With regard to air monitoring efforts on the NFSS site of the former LOOW property a number of significant issues exist. Firstly, for the calculation of both external gamma radiation and radon gas concentrations a monitoring site located at the Lew-Port schools is being used for “background” levels. As the Lew-Port schools are located on property that was once part of the LOOW site the use of this location for “background” levels is simply not appropriate. This point is further exemplified by following the mathematical operations entailed within the data analysis. On numerous occasions “background” levels are higher than those measured at/on the NFSS site (leading to negative values for the “corrected data”). This issue is very likely to be owing to the choice of the Lew-Port schools for background values. Even further, negative values obtained within the corrected data (i.e., measured values less background values) are so retained in the calculation of external gamma radiation dose rates, in effect, lowering those values. There is no sound, logical, mathematical reasoning for manipulating the data in this way. Thus, based upon these first two points, this review calls for a re-evaluation of the location of the “background” monitor, as well as the mathematical manipulations within the calculations of gamma radiation dose rates.

This review, furthermore, calls for a re-evaluation of monitoring equipment being employed, as well as an increase in the overall monitoring efforts. Owing to human health concerns, USACE should evaluate the accuracy and detection limits of the Radtrak® canister detectors as compared to other methods and make such an evaluation available to the public. Additionally, owing to possible sampling artifacts, seasonal variability, and/or possible public impact, radon flux should be monitored multiple times throughout the year. Similarly, rather than calculating, using somewhat questionable methods, possible airborne particulate doses this review calls for the monitoring of, at least, PM10 mass concentration.

5. Conclusions

Current air quality monitoring efforts occurring on the former LOOW site are minimal. Analysis of obtained air samples are based upon dated procedures and, in general, cannot accurately account for potential human health risks. Both CWM and USACE present data and

analytical procedures in public forums which are intended to skew perceptions in their favor. At the minimum this review calls for:

- A re-evaluation in the number and locations of current air monitoring (PM) stations on CWM property;
- The need for PM monitoring stations at NFSS;
- A re-evaluation in the particular analytical equipment being employed;
- A re-evaluation of 'background' air sampling locations (these should be located at sites off of the former LOOW property);
- The need for chemical, as well as radiological, analysis of collected PM samples;
- And, a re-evaluation of mathematical procedures used to calculate community dose exposures (NFSS).

These nominal modifications to the current air monitoring programs occurring on the former LOOW site are primarily focused upon releases and exposures to particulate matter. Further attention with regard to air quality monitoring should also be paid to possible gaseous emissions, such as PCBs, Dioxins, and other volatile and semi-volatile organic pollutants, especially in regard to on-going hazardous waste disposal occurring on the CWM property.

6. References

1. CWM Sampling Methodology (dated May, 2005)
2. CWM Toxic Release Inventory, Annual Report for 2004
3. CWM Site Wide Radiological Survey Plan (dated April, 2005)
4. CWM Generic Small Project Soil Excavation Monitoring Plan (dated April, 2005)
5. CWM Radiation Environmental Monitoring Plan (dated April, 2005)
6. NFSS 2003 Environmental Surveillance Technical Memorandum
7. Current land use of the former LOOW site (as of 1997)

Appendix D Review Comments By R.J. Scrudato, Ph.D.

LOOW-- Review of Reports and Remedial Investigations/Site Characterizations

Ronald J. Scrudato, Ph.D.

August 2007, Revised February 26, 2008

1.0 Introduction

The Lake Ontario Ordnance Works (LOOW) is an approximate 7500 acre site located in northwestern New York State near the junction of the Niagara River and Lake Ontario. In the early 1940s, approximately 2500 of the original 7500 acres were used to produce TNT. During the subsequent 65 years, the LOOW properties have been used by the Department of Defense (DoD) and private corporations for the development of high energy fuels (HEF), propellants, chemical warfare development, storage of radioactive materials, boron production, siting of missile silos and more recently, for military training and the treatment and containment of solid and hazardous wastes.

Although TNT production lasted about nine months, the LOOW property was significantly modified to support the earliest DoD operations. Initial DoD modifications of the LOOW properties related to the TNT production included construction of manufacturing facilities and support infrastructure including buildings, roads, electrical generating stations, storage facilities for raw materials and product, transportation corridors, storm water and waste material management and disposal including construction of a waste water treatment plant (WWTP) and a network of interconnected ditches that conveyed storm and waste water to three area creeks. These ditches connected to Four Mile, Six Mile and Twelve Mile Creeks that discharge to Lake Ontario.

Currently, the northern region of the original LOOW property is used for week-end military training. Additionally, the Niagara Falls Storage Site (NFSS) is a 191 acre interim storage facility for radioactive materials consolidated from various locations within the LOOW properties. Segments of the excessed properties of the original LOOW properties are currently used for the treatment and containment of solid and hazardous wastes.

The Defense Environmental Restoration Program (DERP) authorized the U.S. Army Corps of Engineers to investigate and remediate formerly used defense sites (FUDS) consistent with requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Congress amended CERCLA in 1986 with the Superfund Amendments and Reauthorization Act and established DERP. Formerly used defense sites include properties previously owned, leased, possessed or operated by the U. S. Department of Defense (DoD). Located throughout the United States and six U.S. territories, these sites

“may contain hazardous, toxic and radioactive wastes in the soil and water or in containers. “Such wastes can contribute to mortality and serious illness, or pose a threat to the environment (U.S. GAO, 2001).”

The USACE identified 9,171 properties for possible inclusion in the FUDS cleanup program. Most FUDS properties consist of multiple contaminated areas, sometimes 30 or more within the larger site, that require investigation and cleanup. Of the approximate 9,171 FUDS properties, about 2,743 have been identified by the COE as eligible for “responsive action” (U.S. GAO, 2001). Congress appropriated an average of \$238 million per year within the DoD budget during fiscal years 1997-2001 for cleanup of formerly used defense sites. Funding amounted to \$266 million in 2005 and \$256 million in 2006. It is estimated (USACE) that it will cost at least 15-20 billion dollars to remediate the remaining contaminated FUD sites identified as eligible for cleanup (U.S. GAO, 2003). At the current funding, it will require at least 80-90 years to remediate the inventory of sites requiring remedial action.

When considering remedial options at FUDS, cost is an integral part of the assessment and final decision (Record of Decision or Final Plan) process made by the USACE. At the current funding level, the FUDS program remedial objectives are significantly affected by budgetary constraints often resulting in remedial decisions that fall far short of site “cleanup”.

Although the term cleanup is commonly used when describing the remediation of contaminated sites, few, if any FUDS will ever be cleaned up. Cleaned up is but one form of remediation and is invariably the most expensive. Cleanup implies all contaminants will be removed or destroyed to pre-impacted conditions. The vast majority of impacted sites will not be “cleaned up”. Most FUDS will be remediated using the budgetary constraints within the current under funded FUDS budget. The limited FUDS budget results in the selection of less expensive remedial options including: No Further Action (NFA), Natural Attenuation (NA), Institutional Controls (ICs) and other less costly remedial alternatives. The remedial alternatives selected for most impacted military sites are, therefore, severely constrained by the FUDS budget and result in the selection of inadequate measures to effectively protect human health and the environment.

2.0 Documents Reviewed

In preparation of this report, the following documents (reports, slide materials, PowerPoint presentations, photos) were reviewed. Additional reference material is also included in the following comments and are referenced in the text as “Additional References Cited”, Table 1a.

FUSRAP NFSS, Env. Surv. Tech Mem. 2005

FUSRAP NFSS Env. Surv. Tech. Mem. 2003

RI @ NFSS PowerPoint 6/2003

Report of Results for Phase II RI at LOOW, Niagara Co. NY Vol. 1 of 3, 2002

DOD & DOE LOOW Site Highlights

LOOW Phases I and Phase II RIs

Report of Results for Phase 1 RI at LOOW July 1999
History Search Report, LOOW, Niagara Co.NY USACE, EA Eng. Sci.& Technology.
August, 1998
Work Plan for Phase I RI for the LOOW, Niagara County, NY August 1998.
PCB Surface Soil and Surface Water Drainage Course Investigation, CWM,
Chemical Services, Inc., Model City, NY, 1990.

Table 1.a. Additional References Cited

Chiarenzelli, J., Pagano, J., Milligan, M., Hopke, P., Holsen, T., Scudato, R., 2001.
Enhanced airborne PCB concentrations and chlorination downwind of Lake Ontario. Env.
Sci. Tech. 35, 3280-3286.

Chiarenzelli, J., Scudato, R., Bush, B., Bushart, S., Carpenter, D.O., 1998. Do large-scale
remedial dredging events have the potential to release significant amounts of semi-volatile
compounds to the atmosphere? (commentary) Environmental Health Perspectives 106, 47-
49.

Hermanson, Mark, H. and Glenn W. Johnson,; Polychlorinated biphenyls in tree bark near a
former manufacturing plant in Anniston, Alabama, Chemosphere, 2006.11.068)

Thomas W. Clarkson, Bernard Weiss, Christopher Cox,1983 Public Health Consequences of
Heavy metals in dump sites, Environmental Health Perspectives, Vol. 48, Feb., pp. 113-127.

U. S. General Accounting Office, 2001, Environmental Contamination: Cleanup Actions at
Formerly Used Defense Sites, GAO-01-557.

U.S. General Accounting Office, 2003, Environmental Contamination: Department of Defense
(DOD) GAO-03-146.

USGS, October, 2002, Mercury in the Environment, Fact Sheet 146-00..

Former Uses of the LOOW Properties

(Table 1 summarizes the use of the LOOW properties during the past approximate 65 years.
This summary is excerpted from the summary slide entitled “DOD and DOE Related
Highlights of the LOOW Site”).

Table 1. Uses of the LOOW properties from 1942 to present.

1942. The 7453 acre LOOW property acquired by the War Department.

1942-1943. TNT plant on **2,500 acres. Operated for 9 months, the nitration area of the
plant became heavily contaminated with TNT residues. (now CWM Chemical Services
LLC, or referred to as CWM)**

1944-5. 5,000 acres excessed by DoD.

1944. Manhattan Engineering District (“MED”) **took control of 25 acres of the LOOW site and began storing radioactive sludge from uranium ore processing (at Linde, Tonawanda) put in a concrete reservoir at the LOOW water treatment plant (now part of the federally-owned 191-acre Niagara Falls Storage Site known as the “NFSS.”)**

1944-1946. Northeast Chemical Warfare Depot was used for the temporary storage of incendiary bombs and chemical warfare products. This area included the “igloo area” north of Balmer Rd. (now National Guard) and extended south of Balmer Rd., as far as H Street (now CWM property.) In a 1979 report, DOD claimed to have found no evidence of waste disposal activities on the LOOW site that were associated with the Northeast Chemical Warfare Depot. However, the report did not explain the discovery in 1970 of empty chemical warfare gas (phosgene) cylinders buried on the LOOW properties.

1948 Atomic Energy Commission (“AEC,”) **as successor to MED, indicated storage of radioactive materials at LOOW has contaminated the water reservoir and surrounding area to such a degree that it is impractical and uneconomical to restore it to its original condition.** AEC takes charge of 1,517 acres of the LOOW south of Balmer Rd., **thereby avoiding the regulatory requirement for decontamination of that area.** AEC correspondence to Lew-Port Central School District says they, “know of no reason” **not to construct schools on current property.**

1948 – 1955. Atomic Energy Commission Expansion – 1,517 acres South of Balmer Rd.

The Atomic Energy Commission radically expanded operations. The LOOW site became a principal repository for Manhattan Project waste for the Eastern U.S. as well as for nuclear reprocessing waste from a GE pilot nuclear reprocessing plant at Schenectady. Some radioactive waste was buried, but much was left on the surface.
Rochester Burial Site: **Remains of animals and laboratory waste used in the Rochester University animal experimentation program, where animals were injected with a variety of radioactive materials, including plutonium, were buried (1951) at the LOOW site, now CWM property.**

Reportedly, radiologic wastes were forwarded by the University of Rochester to the LOOW property as early as the 1940s although there are no records where these wastes were buried.

Knolls Atomic Power Laboratory (KAPL): **Nuclear reprocessing waste from the Navy’s reactor program at Schenectady, NY was stored at the LOOW and led to Cesium 137 contamination on the LOOW site. Segregated Plutonium was also shipped to areas now owned by CWM, NFSS and former LOOW WWTP (now Town of Lewiston property.)**
Burial Grounds on Vicinity Property E’ (now CWM property)

Castle Garden Dump: **Radioactive scrap and waste from many locations, including demolition waste from the Linde site in Tonawanda, NY (former Vicinity Property G, now on CWM property.)**

1950-1992. Air Force Plant 38, also known as the Bell Test Center. Air Force Plant 38 was located north of Balmer Rd. in the “igloo area” and operated from 1952 to 1982.

Plant 38 occupied all of the area north of Balmer Rd., approximately 860 acres, to carry out a variety of operations including RASCAL missile development and production and propellant handling, testing and hot firing of rocket propulsion systems.

1979, the principal use of the facility was to provide production support for the Minuteman III Propulsion System rocket Engine.

Jan., 1979 AFP 38 was reduced in area to approximately 530 acres with the transfer of the western section of the property to US Dept of Army. This western portion became known as the Army National Guard Week- end Training Site (WETS) property.

1992, US Air Force transferred the remaining 530 acres (eastern section) to the U.S. Army for expansion of the WETS.

1985, 3.4 acres containing a water tower were conveyed to the Town of Porter.

1953-1971. **Boron-10 Production Plant (at Building 401 – former LOOW Steam Plant) operated isotope separation plant for production of boron-10, used as a neutron absorber in nuclear reactors. The Plant was placed in stand-by condition in 1958; it was reactivated in 1964 and operated by Nuclear Materials Inc. until 1971. It is currently located on the NFSS.**

1954-1955. **(1,517 acres South of Balmer Rd.)**

Atomic Energy Commission attempted to clean up and consolidate radioactive contamination to accommodate the Boron-10 plant start-up and proposed site development by the U.S. Navy. A large amount of radon-producing Radium 226 was stored in an open-topped silo (until 1985.) “Decontamination” involved covering over burials to reduce exposure to workers and manually picking up radioactive scrap from the surface. Burials of radioactive materials were charted for the first time. (Hooker Chemical conducted the clean up under the direction of AEC)

1954-1966. NIKE Missile Base NF-03 and NF-05 310 acres immediately to the west of Porter Center Rd. The Launch area containing 2 batteries and 3 missile silos is now Air Force property. The Control area (south) is now CWM and Modern property.

1958. 89-acre parcel, immediately to the east of Harold Road was transferred to the Army. This property was sold to Town of Lewiston for \$1.00 in May 1960.

1957-1959. U.S. Air Force Plant 68 boron-based high energy fuels R&D (jet/rocket engines) “North Plant.” Constructed by Olin Mathieson in 1957 as a commercial production facility, but the project was cancelled in 1959 before full scale production could begin. (now Somerset and CWM)

USAF owned 5.7 acres on the Niagara River for the former LOOW pump house.

1956-1960. Navy Interim Pilot Production Plant, also boron-based high energy fuels R&D (for jet/rocket engines.) Also constructed by Olin Mathieson. “South Plant” built along “M” street utilized some former TNT buildings on 389-acres (now CWM)

1958-1973. Ransomville Test Annex, a 126-acre site along Pletcher Rd. was used by the U.S. Air Force for experimental Troposcatter defense communications testing (now Modern Corporation property.)

1966. Atomic Energy Commission land sold by the U.S. government **to the Fort Conti syndicate. No warning of radioactive contamination was given; however, the government inserted the following 1966 deed restriction requiring Fort Conti “not use the land conveyed hereby as a garbage dump and it will not litter or deposit any refuse or residuals on said land that would tend to breed vermin or cause noxious fumes or odors.”** Land is subsequently sold to the Somerset Group, and separately to Chem-trol, a waste-disposal firm and predecessor to SCA Chemical, later acquired by CWM.

1966 –Youngstown Test Annex, now U.S. Air Force. Located at SW corner of Balmer and Porter Center Rds. Consists of 98 acres of the former NIKE Missile Base NF-03 and NF-05 that were transferred to the US Air Force in 1966. Active until 1982.

Most recently used for Troposcatter communications testing. This property was under investigation under the USAF Installation Restoration Program (IRP) as of 1998.

1970 Radiological survey of the LOOW by AEC **(1,517 acres South of Balmer Rd.) in response to local reports of radiation on privately owned land. Radioactive contamination is “rediscovered.”**

1971-1972, AEC conducts a decontamination program **using local contractors. About 4000 cubic yards of earth and materials were removed from the LOOW site.**

1972 NYS Dept. of Health (“DOH”) **issues restrictions on LOOW property after the Atomic Energy Commission refuses to meet NYS clean-up standards. The DOH orders state “to protect public health and safety and minimize danger to life and property from radiation hazards,” that 614 acres (now CWM property) “not be developed or used for industrial, commercial or residential purposes, . . .” and, “that any intentional movement, displacement or excavation, by whatever means, of the soil of said lands is hereby prohibited . . .”**

1973 Hazardous landfill operations commenced **(by SCA Chemical) in the central part of the LOOW on above 614 acres under the NYS DOH Order**

1974 NYS DOH amends the 1972 Order **to permit commercial and industrial development, but excavation remains prohibited unless specific consent is obtained from DOH.**

1979 - present Army National Guard weekend Training Site (WETT) (formerly NE Chemical Warfare Depot)

1979 Steve Washutta purchases what is now Modern Corporation property. Residential and industrial waste landfilling operations in this southern portion of the LOOW, commenced 1983.

1981. Approval by NYS DEC of SCA Chemical Waste Services hazardous waste landfilling application: “The entire site has not been subjected to radiation testing. Some radiation testing using a Geiger-counter at all points where borings or test pits were dug for the Wehran study found no evidence of radiation above minimal natural background levels.”

1982. The U.S. Dept. Of Energy (as successor to AEC) re-surveys all “vicinity properties” around its 191-acre (“NFSS”) property. In sharp contrast to the 1981 NYS DEC conclusion, in 1982 the Dept. of Energy finds further radioactive contamination and evidence it was dispersed by landfill operations on CWM property.

1983 –1986. The U.S. Dept. Of Energy conducts more radiological remediation on “Vicinity Properties” located primarily on CWM and NFSS property. Certification is issued for these Vicinity Properties with the exception of properties E, E’ and G, all located on CWM. An interim waste containment facility is constructed on the NFSS to contain radioactive materials.

2000. About 90,000 tons of PCB-contaminated waste materials shipped and managed at the CWM facility at the former LOOW property.

1998-2003. U.S. Army Corps of Engineers investigates the NFSS and finds property (outside the storage cell) is still contaminated with radioactivity. Further clean-up of residual radioactivity is anticipated.

2004. U.S. Army Corps of Engineers discovers elevated levels of radioactive contamination above background levels, but within Dept. of Energy clean-up guidelines, on a previously DOE-certified Vicinity Property X during routine worker safety monitoring for a DERP-FUDS chemical investigation.

Further investigation planned for 2005. See Town of Lewiston investigation report on USACE website.

Nov. 2004. U.S. Army Corps of Engineers finds elevated levels of radioactive contamination above Dept. of Energy guidelines on a previously certified Vicinity Property (H’) during routine worker safety monitoring for a DERP-FUDS chemical investigation. (See CMSA Pad Fact Sheet on USACE website.)

2005. CWM seeks Dept. of Energy and USACE decision to “re-open” the radiological certification of Vicinity Property H’. Inclusion of VP H’ would expand the jurisdiction of USACE’s radiological (or FUSRAP) program to include 4 of 16 former NFSS vicinity properties located on CWM property.

U.S. Army Corps of Engineers, Small Bermed Clearing Report for possible former activity on the 5,000 acre “Undeveloped Area” of the LOOW site – 120 unexplained ground scars identified in historical aerial photographs. Twelve were investigated and sampled.

4.0 Discussion

Based on the review of the above-listed documents and summary of the former LOOW property uses, this report focuses on five factors including:

- DOD Chemicals (constituents) of Potential Concern (COPCs) and
- Use of Background concentrations of contaminants;
- The inter-relationships of the multifaceted uses of the LOOW properties including manufacturing, storage, solid and hazardous waste management, chemical warfare development, military training and public education centers on and in proximity to the military and waste management sites;
- Site characterization including locations, depths and interrelationships of the LOOW site contaminants with focus on surface and near surface drainage; and
- Future of the LOOW site including offsite contaminant migration, adverse impacts to area natural resources and potential impacts to residents and students residing and located in proximity to the former LOOW properties.

4.1 Contaminants of Potential Concern (COPC).

The earliest recorded use of the 7500 acre LOOW property by the military was for the manufacture of TNT explosives in the early 1940’s. This earliest phase lasted less than two years (9 months operational) and involved the design and construction of about 2500 acres to manufacture TNT in support of the war effort.

In order to manufacture TNT, significant modifications and infrastructure was required to support the construction of facilities, import of raw materials involved with the manufacture of the product as well as facilities and accommodations in support of workers involved with the overall production. Infrastructure in support of the manufacturing facilities and site workers required the importation, storage and use of a wide range of chemicals and facilities directly and indirectly involved with the TNT manufacturing processes including electric power production and distribution, fuel importation and storage, potable water access and distribution, waste management and transport, storage and treatment of waste products and residues directly related and ancillary to the manufacturing processes.

Chemicals directly involved with the production of the TNT explosives included chlorinated organics and acids used in the manufacturing process. It is important to note that other

chemicals were required to effectively operate and maintain the manufacturing facility and worker's daily requirements including non-chlorinated volatile organics, petroleum products, a wide range of metals including, but not limited to, lead, arsenic, mercury, and others. Additionally, the manufacture of the TNT resulted in the production of waste materials directly and indirectly related to and involving the production processes and required means to transport chemicals and waste products to either treatment facilities or transferred directly/indirectly to the Niagara River and/or Lake Ontario via ditches and pipelines. Conveyance and disposal of wastes required the construction of buried and surface pipelines and a network of surface ditches that directly and/or indirectly carried waste waters to area groundwater and surface waters including the near surface groundwater to the surficial sands and surface waters of Four, Six and Twelve Mile Creeks.

Production of TNT at the 2500 acre parcel of the LOOW ceased in 1943 and portions of the 7500 acre property were declared excess and large tracts transferred to other DoD and private enterprises and used for DoD and non-DoD purposes. As can be seen from Table 1, during the past 65 years the LOOW properties were used by a host of military and non-military related purposes involving the storage, use and disposal of a wide range of chemicals.

During the past 65 years at the 7500 acre LOOW facility located near Niagara Falls NY, the DoD and/or their contractors:

- manufactured TNT and Boron,
- conducted chemical warfare development
- imported and stored radioactive materials
- constructed, operated and maintained missile bases,
- worked on high energy fuels and advanced propellant developments,
- conducted research and development on advanced communications systems, and
- established the Army National Guard WETS facilities at the northern end of the property

Activities conducted at the LOOW over the past 65 years involved the use of a range of raw materials and chemicals. Product development and manufacture required construction of manufacturing facilities, import of raw materials as well as use of materials and supplies required to maintain the facilities and manage the range of activities that were conducted at the LOOW properties. These materials included fuels to power generators, heating and cooling facilities, manufacturing facilities and offices and chemicals used to operate and maintain machines, equipment and in support of operating and support personnel. In addition, all of the activities conducted at the LOOW produced waste materials requiring effective management and disposal. Waste management practices during that time were more focused on disposal with little if any actual treatment.

The military presence and manner in which waste materials were managed had a direct effect on the LOOW natural resources. Until the early to mid-1970s, there were few, if any, federal or state waste management constraints or guidelines. Additionally, the 2500 acres involved with the TNT production were significantly altered by changes in surface and near surface drainage patterns, interrelationship of surface and groundwater. These changes persist to the

present time. The vast array of chemicals required to support the TNT manufacturing as well as other military-related activities on the LOOW properties resulted in the dissemination of a wide range of chemicals to the local environment that extended beyond the raw products involved with the original manufacturing processes.

Multiple site assessments have been conducted at the LOOW involving collection and analysis of diverse samples including surface and deeper soils, sediments, air, surface and groundwater for metals, organic compounds and a range of radionuclides. These investigations indicate soils, sediments, surface and groundwater have been impacted due to previous military releases of organic compounds, inorganic substances and radionuclides.

Areas of the former LOOW properties currently being used by private waste management organizations were once contaminated by radioactive materials related to DoD activities yet radionuclides are not included in the monitoring requirements for all of the properties owned and operated by LOOW-based, waste management companies.

DoD, and evidently the state and federal agencies concur, that unless portions of the LOOW were impacted by distinct marker compounds including TNT/explosives, boron and/or lithium, they are not eligible for further remedial consideration by the DoD within the Hazardous Toxic, Radioactive Waste (HTRW) program. The military originally acquired the 7,500 acres for the manufacture of DoD products which evolved over the subsequent 65 years to radionuclide storage and containment, development of HEF and propellants, chemical warfare agent development, interim waste storage, and established missile bases and a National Guard Week-end training center. These activities invariably had an effect on all subsequent uses of the properties resulting in contamination by a wide range of petroleum products, solvents, fuels, acids, raw materials and other organic and inorganic substances used by the DoD over the 65 year period. Modification of the LOOW near-surface geology and hydrology also had a profound effect on the migration and distribution of chemicals used by the military as well as subsequent site owners. It is documented that radioactive materials were brought to properties currently occupied by CWM at the LOOW property. Further involvement and responsibilities of the DoD within the HTRW program should, therefore, not be restricted to the presence of boron, lithium and explosives.

DoD responsibilities within the HTRW program should, therefore, not be limited to the presence of select chemicals or whether there were subsequent uses of the properties formerly modified and impacted by non-DoD activities. Table 11-2 of the Final RI Phase II Report prepared by E & A Science & Technology, 2002, lists those sites recommended for no further action under the HTRW program. As can be seen from this table, many of the proposed no further action (NFA) recommendations are based on uses by, or possible uses by, non-DoD users and recommendations of responsibilities were proposed on possible or inferred sources of the contaminants.

Clearly, subsequent uses to the DoD should be considered in the overall remedial actions required to effectively reduce contaminant exposures to humans and natural resources. However, DoD responsibilities should not be discounted based of the presence or absence of a limited suite of select "DoD-related" COPCs.

Additionally, it has been documented that the DoD-contaminated properties with radionuclides on portions of the central developed portions of the LOOW are now owned and operated by private entities. All of the properties currently being used for waste management should be required to monitor for radionuclides, including liquid by-products including leachates and the military should not be excused of their responsibilities to reduce exposures resulting from historic actions that have contributed to the contamination of LOOW and surrounding properties.

4.2 Background Contaminant Concentrations

Descriptions of the potential sources of military and non-military contaminants to LOOW area soils, air, surface water, groundwater and biota within and adjacent to the LOOW property during the past 65 years make it difficult to determine what areas and/or resources have or have not been impacted by COPCs.

Effective site characterizations are further complicated at LOOW sites where the surface and near surface hydrology have been significantly altered and modified by surface grading. The construction of underground pipelines provided preferred liquid migration pathways. Construction of extensive interconnected drainage ditches not only affected surface runoff, but because of the shallow groundwater and depth of the drainage ditches, altered the migration of surface water as well as shallow groundwater.

The 7500 LOOW acres have been used for a range of activities during the past 65 years, and because it is not clear how the array of materials and chemicals were managed at the various facilities, including the 5000 acre buffer zone, it is also not clear if, or whether, the background samples collected at designated “clean” sites within and adjacent to the 7500 acre LOOW are representative of the pre-1942 impacted regions. Background chemical data should be established from samples collected in areas known to be free of contaminants including non-DoD COPC.

Because uncertainty exists on waste management practices conducted by the DoD and subsequent uses by private corporations at the LOOW, sites assumed to be free of waste materials or assumed to represent upgradient samples without a full understanding of the past uses and/or interrelationships to other impacted sites, should not be used to define background concentrations of contaminants. This is evident in the ditch sampling conducted during the Phase I Remedial Investigations in which background samples collected from the ditches contained elevated PAHs, trichloroethylene, PCBs, and other COPCs. The presence of these COPC demonstrate that the background samples are not representative of pre-LOOW conditions and that the drainage ditches were, and likely continue to be, conveyors of contaminants to the waters of Lake Ontario.

Additionally, samples collected and analyzed from areas and systems known to have been affected by releases of contaminants on the LOOW property where insufficient information is available on past uses or impacts should not be used to assess background concentrations. Because uncertainty exists on precise locations for the storage and/or disposal of materials

used at the LOOW properties and because there is uncertainty on how drainage ditches and constructed pipeline corridors affected the distribution of storm and/or waste water, it is not known whether the sampled background samples are representative of site background concentrations.

4.3 Interrelationships of LOOW Property Uses

Over the past 65 years, the central areas of the LOOW properties have been used for a wide range of military-related and non-military uses. Most of non-DoD uses have and continue to be involved with solid and hazardous waste management. The 7500 acre site has been considered a favorable setting for the range of waste management enterprises based on the area's history and regional geology and hydrology. The future of the LOOW was essentially established by the military in the early 1940s when it was not only used as a manufacturing facility for explosives, but also when tracts within the LOOW were used to contain and store radioactive and chemical waste materials.

More recent uses of the central developed portion of the LOOW by the private sector has focused on waste management including demolition and construction materials, municipal solid wastes, interim storage for radiological wastes, hazardous waste treatment and containment and human waste treatment required for the workers involved with the various military and non military uses of the 7500 acre property.

The military laid the foundation for the LOOW's waste management future in the early 1940s and in concert with the state regulatory agencies, further defined its legacy. The NFSS interim storage site is likely to remain in place into the foreseeable future considering the costs associated with its removal as well as the concerns that will be advanced by the agencies that relocation of the radiometric material will pose a greater environmental threat than leaving the site in place. The large waste management enterprises established and continue to operate solid and hazardous waste management facilities in the LOOW region because it had an established waste management history and is located in a low population density region of the state.

There is a broad range of organic, inorganic and radiometric substances contained in the soils, sediments and shallow groundwater within the LOOW resulting from past and current waste management uses. From the early 1940s to the present, the DOD and private sector managed waste management facilities within the 7500 acre region. This area of the state has become known as a waste management center because of the number of companies and volume and character of the managed material treated, stored and contained at and within the boundaries of the former LOOW. Currently, waste management is the primary industry of the former LOOW properties.

Radiometric monitoring of the air, soils, groundwater and surface water within the Interim Waste Containment System (NFSS) area is ongoing. However, the same level of monitoring is not conducted to assess the concentrations of organic and inorganic contaminants currently managed onsite by the waste management companies operating the solid and hazardous waste management facilities on the LOOW properties. One of the commonly overlooked

transport mechanisms for contaminants is through volatilization including organic and inorganic COPC such as PCBs, chlorinated and non-chlorinated organic compounds and select trace metals. Lower chlorinated PCBs (congeners) readily volatilize and are transported as vapors (Chiarenzelli, et al, 1998, 2001). The lower chlorinated congeners are also more soluble than the more chlorinated PCBs. Mercury becomes more volatile and soluble as it is methylated and can therefore become more mobile in air and water.

The NFSS facility contains radioactive materials consolidated into a 191 acre containment structure. Because of the character, quantity and concentration of the radioactive materials within the NFSS containment site, monitoring is required to ensure the store of gas phase radioactive materials and associated organic and inorganic waste materials does not pose a threat to residents living in proximity to the LOOW. For example, select isotopes including radon 220, 222, are being monitored and dust-sorbed radionuclides (uranium, radium, thorium, plutonium, cesium and others) are transported by air and therefore pose potential exposures to persons, wildlife and domestic animals. Perimeter air, soils, surface water and groundwater monitoring is conducted at the NFSS to ensure exposure to the airborne, soluble and sorbed radionuclides and organic and inorganic contaminants is minimized. Despite the well recognized volatility of PCBs and mercury, these COPC are not included in any of the required monitoring of the waste management industries operating within the LOOW properties. Air monitoring of PCBs and methyl mercury and other potential volatile compounds and elements is not a requirement.

Based on sampling results reported in 2003, the soils, surface water and groundwater within the surrounding areas of the NFSS were impacted by a range of organic, inorganic and radioactive materials. These releases were either a result of releases from the interim containment structure and/or from residual chemicals and/or during the time the waste materials were being consolidated and the site was actively used or being developed as a storage facility (see NFSS COE PowerPoint presentation, 2003). The Central Drainage Ditch runs through the NFSS and the connecting, smaller ditches drain to the Central Drainage Ditch contain a range of contaminants known to have been used at the LOOW. These contaminants are likely being flushed and transported to Four Mile Creek and eventually to Lake Ontario. The soils, sediments and groundwater in the immediate NFSS area have been impacted by PCBs yet air monitoring of PCBs is not a monitoring requirement for this facility.

Many of the materials managed at the LOOW properties were historically considered to be insoluble, non-volatile and highly stable. Compounds, including PCBs, a wide range of chlorinated pesticides, methylated metals, including lead and mercury are now recognized to be more mobile than originally considered and therefore require improved air and water monitoring to ensure human populations are not being exposed.

Air monitoring of non-radiometric materials, including large volume air samplers, should be established and maintained to gauge the concentrations and exposures to volatile compounds to residents living and attending school in proximity to the LOOW. Tree bark sampling and analysis for PCBs should also be routinely sampled at select areas located in proximity to the former LOOW properties including Lew-Port school grounds (Hermanson, et al, 2006).

Although the waste management firms currently operating at the LOOW are not actively involved with the management of radioactive materials, they are involved with a wide range of compounds and elements known to cause impacts to health when ingested, breathed or come in contact with humans. CWM reportedly managed over 90,000 tons of PCB-contaminated waste materials during 2000. Sampling and analysis of surface soil and surface water drainage sediments (ditches and small drainage streams) for PCBs and organic and inorganic contaminants conducted on CWM properties (1990) demonstrated contaminants are contained in soils and sediments in the drainages located on the CWM property. The drainages on the CWM are connected to the original ditches constructed on the former LOOW properties and provide a conduit for the transport of waste materials to Lake Ontario. One of the major flaws in the investigations conducted by CWM of the surface water drainages is that the assessments did not include aqueous phase contaminants which even at low concentrations, the large volume of water transported in ditches and natural drainages can result in the transfer of large quantities of contaminants to receiving waters. Although State Pollutant Discharge Elimination System (SPDES) sampling of water discharges are required, non direct discharges including leachate, stormwater runoff, and others, are not integrated or included in SPDES monitoring.

Groundwater and surface water monitoring should be expanded to the former LOOW boundaries and include sampling and laboratory analysis of aqueous phase PCBs, pesticides and herbicides including, but not limited to, chlorinated and brominated compounds, metals and metal-containing compounds including lead, mercury, arsenic, chromium, and others found in common household and industrial products and known to be included in household and industrial waste materials.

Because the waste materials that have been deposited and are currently stored at the LOOW, including CWM and Modern Landfills as well as the NFSS, and because these wastes will remain on the LOOW site in perpetuity, a comprehensive monitoring system should be designed and implemented to ensure exposures to area residents and to the regional and global resources are minimized.

4.4 Site Characterization

Based on the characterization of the surface and groundwater of the LOOW and surrounding areas, the primary surface water runoff is to Four, Six and Twelve Mile Creeks. The relevant groundwater consists of a near surface and deeper system defined as the silt and sand unit. The LOOW site is underlain by 30-60 feet of unconsolidated materials overlying shale bedrock (E & A Science and Technology, 1999). The near surface upper alluvium is up to five feet thick in some areas of the LOOW, but due to regrading and filling, in places, this unit is absent or overlain by fill material. Areas of the LOOW site have been filled with a variety of material to depths of eight to twelve feet.

Although limited in distribution and thickness (up to 5 feet) and affected by grading, the upper alluvium may play a significant role in surface and near surface migration of water and associated contaminants. Discharges or spills into the alluvium would redistribute

contaminants beyond the original spill or discharge site to the many intermittent surface water bodies. Based on the relative permeable character of the surface silts and sands, it would be helpful to have spoil maps of the area to gain an appreciation of the distribution of the upper alluvium to assess possible migration pathways from areas that have been impacted by contaminants.

Drainage ditches were constructed by the military on the LOOW to convey surface water runoff and waste materials off site. The ditches connected production facilities to the three streams that drain to the Niagara River or to Lake Ontario. The main ditches were about 20 feet wide at the surface, tapered to about 15 feet at their base and were 10-15 feet deep. Secondary ditches connected to the three primary ditches including the Central Ditch, Magazine Drainage Ditch and the Southwestern Ditch. The Central Ditch extends for about 10,000 feet to the north and then diverts to the northwest for about an additional 5000 feet where it connects to Four Mile Creek (see figure 13-1 of Phase 1 RI).

The three primary drainage ditches and interconnecting smaller ditches constructed and maintained by the DoD and non-DoD land owners are likely one of the major pathways for the offsite migration of contaminated sediments and water to the receiving waters of the Niagara River and Lake Ontario.

The Magazine Drainage Ditch extends in a northeast direction across the US Army National Guard Week-end training area and then diverts to a west trending arc for about 8,500 feet across the TNT storage site, north of Balmer Road. This ditch connects to the Central Drainage Ditch which drains to Four Mile Creek. Six Mile Creek was sampled at two downgradient sites from the Magazine Drainage Ditch during the Phase I remedial investigation (RI) where two sediment samples were collected.

As the name implies, the Southwestern Ditch drains the southern and western portion of the LOOW extending north for about 6,000 feet and then due west for an additional 4,000 feet and then north/northwest for about another 7,000 feet where it also joins Four Mile Creek. As a part of the RI Phase I Investigation, the Southwestern Ditch was sampled at three approximately 1,000 foot spaced locations near the junction where the ditch turns to the west from the northern extension. One surface water sample and three sediment samples were collected at each location. No other samples were collected along the Southwestern Drainage Ditch.

The Central Drainage Ditch was sampled at 12 separate locations during the Phase I RI as well as seven of the connecting drainage ditches located east of the Central Ditch. Two additional surface samples were collected and analyzed from Twelve Mile Creek along the southeastern property boundary of the LOOW.

At the three sediment and surface water background sampling sites collected from the Southwestern Ditch, the PAH concentrations of the sediments exceeded the NY Bioaccumulation standard by several orders of magnitude indicating the PAH concentrations in the sediments were elevated. At one of the background sediment sampling locations

collected from the Southwestern Ditch, trichloroethylene was slightly below the NY Bioaccumulation guidance.

Based on the results of the sampling conducted in the three primary drainage ditches, it was decided that additional sampling of the drainage ditches would not be continued in the Phase II RI. This decision was made despite the lack of sampling along about 15,000 feet of the Southwestern Drainage Ditch, orders of magnitude elevated PAH concentrations at multiple ditch sampling locations, elevated Boron (more than 8 times background) and Lithium concentrations at select ditch locations relative to background concentrations and elevated PCBs in sediment.

This decision was made without full and adequate sampling of the primary and secondary drainage ditches, including the impact to the receiving waters of Four Mile, Six Mile and Twelve Mile Creeks. No samples related to the three large drainage ditches were collected offsite of the LOOW even though these ditches were one of the main pathways for the migration of waste materials to the creek receiving waters discharging to the Niagara River and Lake Ontario.

The Central Ditch was likely the main conveyor of waste materials originating from DoD and non-DoD sources and the presence of elevated PAHs and PCBs in ditch sediments indicate that either the DoD is the source of the compounds and/or the non-DoD waste materials have been discharged to the ditches originally designed, constructed and maintained by the military. The Southwest Ditch drains the largest area of the LOOW and crosses portions of the Lew-Port school grounds.

Failure to effectively characterize contaminants in the Southwest Ditch, including sections of the ditch in proximity and on the school property, represents a major flaw in the assessment of the role played by the ditch in conveying contaminants onto and through the school property. Recommendations to forego additional sampling of the ditch systems in the Phase II Remedial Investigation resulted in a less than comprehensive understanding of the large and interconnecting ditches designed and constructed by the military to convey surface waters offsite of the LOOW properties.

The depth of the three main ditches are deep enough to intercept the saturated glaciolacustrine silts and sands that cover parts of the LOOW properties providing pathways for the exchange of contaminants to and from the underlying, near surface groundwater. There was no attempt in the Phase I and II RIs to determine whether the shallow groundwater associated with the surficial alluvium or deeper, saturated silt and sand horizons were impacted by contaminants carried by the ditches and intruding into the near surface saturated horizons.

The series of ditches constructed and maintained by the military were designed to carry runoff and any associated contaminants offsite of the LOOW. The sampling protocols used to assess the role played by the ditches in transporting military and non military waste materials was simply inadequate to determine the impacts contributed by the ditches to area resources

including the soils, sediments and near surface and groundwater within the Lew-Port school properties, the creeks, Niagara River and to Lake Ontario.

Failure to adequately assess the distribution and concentrations of contaminants including the potential impacts to school resources and receiving creeks, the Niagara River and Lake Ontario resulted in a major flaw in the overall Phase I RI sampling and adversely affected the Phase II RI planned sampling. The Ditch systems were likely the major conduits for the transport of contaminants offsite of the LOOW. The poor design and approach followed in the Phase I RI Ditch Assessment failed to adequately assess the impacts caused by the construction and use of the ditches to manage onsite surface water and associated discharged wastes.

The LOOW Ditch systems require far more assessment considering the limited sampling conducted in the earlier Phase I RI and the potential long term effects to the area and state's resources. Sampling sites of the large ditches were limited in distribution and no samples were collected offsite to determine whether offsite migration of contaminants impacted local surface water. Aqueous phase sampling of the large ditch water for organics, including those considered to be insoluble (PCBs), inorganic and radionuclides should be conducted on a routine basis (quarterly) and the volume of water should be gauged at multiple sites at each of the three larger ditches at established and maintained stream gauges. Off site sampling of the receiving water creeks (Four, Six and Twelve Mile Creeks) should also be monitored to assess the offsite migration of contaminants from the LOOW.

In order to determine whether contaminants derived from the DoD and non-DoD activities have accumulated within the drainage ditches and in the offsite creek sediments, additional, focused sampling of the ditch sediments and associated surface waters is required. The extent and degree of offsite migration of DoD and Non-DoD contaminants can be effectively determined with sediment cores collected at the mouths of the three creeks that drain the LOOW properties.

4.5 Public Concerns and Future of the LOOW site.

Many of the public's concerns were expressed in the Community LOOW Project presentation. The former LOOW property has become a center for the management of municipal, industrial, solid and liquid hazardous and radioactive wastes. The 191 acre NFSS was designed as an interim storage facility to contain the consolidated radioactive waste materials used and transferred to the LOOW properties suggesting the materials contained at the site will, at some time, be relocated to a permanent and secure facility. In addition to radionuclides, the NFSS is also known to contain volatile organic compounds, semi-volatile organic compounds, metals, PCBs, pesticides and explosive residues. These compounds, metals and radionuclides have been found in the soils, sediments, groundwater and surface waters in proximity to the NFSS site (see COE NFSS PowerPoint presentation, 2003).

The 191 acre NFSS is being monitored to ensure the exposure to area residents is minimized. Uncertainty exists on the future of the NFSS since it was originally designated as an interim radioactive waste storage site and there is public concern whether the contained radioactive

materials consolidated from past military activities will ever be removed. The use of the term "Interim" conveys temporary and implies ultimate removal resulting in public expectations that site materials will at some time be relocated.

The drainage ditches bordering the NFSS site contain contaminants and because the drainage ditches were not effectively sampled during the Phase I and II Remedial Investigations, the extent and source of the contaminants is not well understood. Effective site characterization is essential to the development and implementation of feasibility studies. Without a clear understanding of the interrelationship of LOOW area sites and history of waste storage, contaminant migration and disposal, it is not possible to design and implement effective remedial actions to reduce exposures.

Area residents are concerned about past and ongoing exposure to the stored waste materials including effects to adjoining properties and resources. Proactive action is needed to inform the interested public about the long term maintenance or removal options that are being considered for the NFSS. As noted above, there is sampling evidence that the area resources in proximity to the NFSS have been impacted by organic, inorganic substances and radionuclides. If plans are not in progress, action should be initiated to develop options related to the long term disposition of the NFSS waste containment site to address interested public concerns and expectations.

Segments of the 7500 acre, former LOOW properties have transitioned to privately operated waste management facilities and that these properties will be used into the foreseeable future to treat, contain and manage wastes. Additional containment structures are proposed to treat and control hazardous and municipal waste materials within the former LOOW properties currently owned and operated by waste management firms. Area concerned citizens recognize that waste management will be a part of the Lewiston-Porter communities and want assurances that the waste materials including air, water and soil emissions from the waste management sites will not adversely impact the area residents and resources.. Verifiable assurances must be provided by the site owners and managers and state and federal agencies that offsite migration of waste materials has not occurred nor will occur.

Resident confidence in the ability of the state and federal agencies to provide the verifiable assurances that offsite migration of airborne and/or water derived sources of contamination will not occur until a comprehensive air, water and soil/sediment monitoring program is designed and implemented. Monitoring programs are needed that realistically assess the air and water resources and pathways for the wide range of waste materials that are currently being managed and for those that will be treated and contained at the waste management facilities in the future.

The Phase I and II Remedial Investigations (RI) of the LOOW and NFSS sites indicates contaminants continue to impact area resources. Based on the data and information covered in those reports, contaminants continue to impact the resources of the former LOOW properties. The connections to the Niagara River and Lake Ontario via the Four Mile, Six Mile and Twelve Mile Creeks and connection of the LOOW surface and groundwater to the

creek systems increases the need to ensure past, current and future waste management operations do not adversely impact the resources of the region.

5.0 Conclusions

With the required construction materials and development of infrastructure required to support the original use of the LOOW property, a wide range of materials were imported to the TNT manufacturing facility. Imported chemicals included raw materials, fuels, solvents, construction materials, equipment maintenance and supplies, waste management facilities and treatment processes, chemical waste management and a broad range of organic and inorganic chemicals. The required chemicals extended beyond the boron, lithium and TNT utilized in direct manufacturing.

The post 1943 uses of the LOOW properties included a range of activities that also required use, management and disposal of materials required to support the array of activities conducted at the LOOW properties over the following 65 years.

The LOOW properties also became a storage facility for radioactive waste materials and essentially established the sites destiny as a waste management facility by excessing portions of the property to large and expanding waste management firms.

Despite the range of chemicals required to conduct the of activities carried out by the military over the past 65 years, the DoD responsibilities for the COPC at the LOOW properties is restricted to lithium, boron and TNT/explosives.

Background concentrations of COPC were determined by sampling at locations within the LOOW to areas of the site believed to be free of military sources of contaminants. This deduction was developed and implemented in the site characterization phases of the site despite the lack of understanding of the past uses of sites where background samples were collected or how surface and groundwater may have played a role in contaminant migration and accumulation within and offsite of the LOOW.

The network of large drainage ditches were developed on the site and the limited sampling conducted on ditch sediments, it is evident that the ditches transported COPC in the past and likely continue to transport contaminants offsite including to the Niagara River and Lake Ontario. Failure to conduct additional sampling of the ditches in the Phase II Remedial Investigation was based on limited information and assessment of the likely role played by the ditches to transport contaminants from the military and non-military activities conducted at the LOOW over the past 60 plus years.

Ditch construction for pipeline development can significantly modify surface and near surface water migration and serve as conduits for contaminant migration. Additional investigation of the role played by pipelines needs to be conducted to ensure there is a clear understanding of the migration and redistribution of shallow groundwater along pipeline ditches.

6.0 Recommendations

In order to effectively remediate the more than 2700 nationwide FUDS properties, the annual federal appropriations in support of the FUDS program needs to be significantly increased. Congressional and senate representatives need to be contacted and made aware of the FUDS program to accelerate and effectively remediate formerly used, military-impacted sites.

DoD responsibilities within the HTRW program should not be limited to the presence of select chemicals (COPC) or whether there were subsequent uses of the properties originally modified and impacted by DoD activities. Joint and several liability guidelines should be used to assess and assign responsibilities. Further involvement and responsibilities of the DoD within the HTRW program should, therefore, not be restricted to the presence of boron, lithium and/or explosives.

Background chemical data should be established from samples collected in areas known to be free of contaminants including non-DoD constituents of potential concern (COPC). Contaminant associations and clusters should be used to define impacted areas utilizing GIS analysis.

Air, water, soils and sediment monitoring should be extended beyond the CWM and landfilling operations and include all properties where DoD wastes were deposited and/or used. This includes establishing and maintaining a network of well placed sediment, soil, water and air sampling sites. These sites are to be sampled at frequent intervals to ensure confidence in the vertical and areal distribution of media sampling equipment including air monitoring systems to effectively gauge releases to the local air resources. State Pollutant Discharge Elimination System (SPDES) were designed and are operated to monitor wastewater discharges and not sufficient to determine releases from storm waters affected by contaminants and/or uncontrolled releases including those that derive from leachate migration to surface and/or groundwater.

The LOOW drainage ditch systems require more assessment considering the data included in the earlier Phase I RI and the potential long term effects to the area and state's resources.

Sediment cores should be collected within and at or near the mouths of Four, Six and Twelve Mile Creeks. Each collected core sample should be vertically sectioned into one centimeter segments, dated (e.g. by using ¹³⁷Cesium isotopes) and each sectioned segment analyzed for a range of organic, inorganic contaminants and radionuclides.

Sediment core analysis will provide a history of contaminant contributions to the canals and to Lake Ontario receiving waters downgradient of the LOOW and determine whether the drainage ditches served and continue to serve as conduits for the offsite transport and accumulation of DoD and non-DoD-derived waste materials.

Large volume air samplers and tree bark sampling and analysis for PCBs should be routinely conducted at select areas located in proximity to the former LOOW properties including Lew-Port school grounds

Verifiable assurances must be provided by the site owners and managers and state and federal agencies that offsite migration of waste materials has not occurred nor will occur as waste management continues at the LOOW properties.

Groundwater and surface water monitoring should be expanded to the former LOOW boundaries and include sampling and laboratory analysis of aqueous phase PCBs, pesticides and herbicides including, but not limited to, chlorinated and brominated compounds, metals and metal-containing compounds including lead, mercury, arsenic, chromium and others found in common household and industrial products and known to be included in household and industrial waste materials.

Because the waste materials that have been deposited and are currently stored at the LOOW, and because these wastes will remain on the LOOW site in perpetuity, a comprehensive monitoring system should be designed and implemented to ensure exposures to area residents and to the regional and global resources are minimized

Monitoring programs are needed that realistically assess the air and water resources and pathways for the wide range of waste materials that are currently and will be treated and contained at the waste management facilities at the former LOOW properties.

Appendix E Critique Of Certification Of Vicinity Properties

**Critique of Certification of Vicinity Properties
Lake Ontario Ordnance Works Site**

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**For the
Community LOOW Project
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Abstract

This report reviews the certification of vicinity properties adjacent to the Niagara Falls Storage Site (NFSS) for unrestricted use in 1992, determining whether federal criteria and regulations were met. We provide a detailed synopsis of the various surveys of the vicinity properties as well as the Central Drainage Ditch (CDD) which were contaminated from past storage and burial of radioactive wastes on those properties. In order to do this we analyzed data from the various surveys, remediation reports, and verification dockets provided. We determined whether radium exceeded federal limits and did a quantitative analysis using radionuclide concentrations from the reports as input into the RESRAD 6.3 modeling program; this program calculated radiation doses for each of the properties to determine whether or not the radionuclide concentrations would cause a dose over the 25 mrem/yr limit. Concentrations from the 1984 surveys of the properties exceeded 25 mrem/yr, most of them by more than 100 times. However, after remediation, the 1986 post-remediation survey showed that significantly less of the vicinity properties yielded doses exceeding 25 mrem/yr. Finally, with the results from the 1989 survey it was found that properties' D, E' G, H' and T and the excavated and unexcavated portions of the CDD still exceeded the 25 mrem/yr guideline. Therefore, it seems that by the release date of the vicinity properties in 1992 those properties were not yet ready to be released for unrestricted development. Also, when comparing the contamination maps to the latest maps of remediation on vicinity properties, it appears that some of the highest points of radionuclide concentrations were not remediated. The surveys are unclear and further investigation should be done to ensure that these properties are fully remediated before unrestricted use.

Several of the properties still have areas that would cause a potential resident to receive a dose over the 25 mrem/yr limit set by the EPA. Also, fully comprehensive surveys were not performed and they seemingly excluded areas that were stated as having extremely high points of contamination on these properties. Further surveys, analysis, and remediation should have been done on these properties and the CDD before they were released for unrestricted development in the early 1990s.

Introduction

The Lake Ontario Ordinance Works (LOOW) was formerly used by the wartime Manhattan Engineer District (MED) for the storage and transshipment of radioactive materials. It consisted of the Niagara Falls Storage Site (NFSS), a U.S. Department of Energy (DOE) facility used for the storage of radioactive residues and contaminated soils and rubble, and vicinity properties. The vicinity properties surrounding the NFSS were also contaminated and used for storage of radioactive wastes. In 1992 all of the vicinity properties were decommissioned or certified for unrestricted development. Discussed later in this report are a few sections of certain vicinity properties that were not released.

The goal of this report is to examine the remediation efforts on the vicinity properties and the Central Drainage Ditch (CDD) and determine whether these properties were properly certified for unrestricted use. In the next section, we discuss the history of the vicinity properties, the surveys of those properties, the remediation results, and compare the results to the EPA radium cleanup criteria. In the following section, we calculate the radiation doses from those properties using the DOE software, RESRAD, assuming a full-time resident, and compare the doses to current federal regulations. The data input into RESRAD were obtained from past surveys and remediation reports, which discussed in detail the work done throughout the years to clean the vicinity properties and the CDD.

The main vicinity properties to be discussed in detail are properties' D, E, E', G, F, H, and H'. These properties have been characterized and studied in detail. In terms of the Central Drainage Ditch other vicinity properties will be discussed as necessary. The vicinity properties through which the CDD runs are properties' S, T, U, V, and P. Figure 1 shows the location of the vicinity properties. These properties have also been studied in detail. For our purposes we will only discuss these properties in relation to the CDD.

Background

During the late '40's and early '50's, the LOOW site was used for disposal and storage of radioactive materials. Mill tailings and uranium ore processing wastes from Linde and other locations, and wastes from Knolls Atomic Power Laboratory (KAPL) and the University of Rochester were sent to LOOW. Subsequently, the vicinity properties were partially decontaminated at different times using successively more restrictive clean-up criteria, and improved radiation survey techniques. Despite continued decontamination work over the years, some radioactive contamination remains on the vicinity properties.

This section of the report discusses the radiological surveys conducted on vicinity properties D, E, E', F, G, H, and H' as well as the Central Drainage Ditch (CDD), which runs through and adjacent to vicinity properties P, S, T, U, and V. (See Fig. 1.) These surveys were performed by Oak Ridge Associated Universities (ORAU) for the Department of Energy. The focus is on these properties because of their proximity to the NFSS site, the possible contamination of these sites from buried contaminants and the CDD, and because of potential development on these properties. The surveys of these properties informed us of the type of contaminants that were prevalent on those properties in the eighties, if the radionuclides were over regulatory limits, and if these properties have been sufficiently cleaned to be in compliance with federal regulatory standards and to be released for unrestricted development.

To understand further whether or not these properties are in compliance with federal regulatory standards we conducted a separate quantitative analysis in the following using the RESRAD program, developed by the Environmental Assessment Division of the Argonne National Laboratory¹. A discussion of the methods, assumptions, and results from this program is included in that section of the report.

Common Attributes of the Vicinity Properties

In the early 1980s all of these properties were suspected to have contaminated materials since several of the properties had been surveyed previously and had elevated levels of radiation. Over time, the regulatory standards had become more restrictive, requiring additional remediation work. Some of these properties had been cleaned but surveyors were unsure of how well they were cleaned or if there was further contamination. Since the LOOW site was used for disposal of tailings from extraction of uranium from ore at local chemical plants during the Manhattan Project, it is not surprising that U-238 and its decay products were the primary contaminants.

According to their surveys, background concentrations of Ra-226, U-235, U-238, Th-232, and Cs-137 in Lewiston were typical of those in that area of New York. The background surface soil and surface water radiation levels were also commensurate with surface soil and surface water radiation levels elsewhere. Information collected from all the properties included direct radiation exposure rates and surface beta-gamma dose rates, locations of elevated surface residues, concentrations of radionuclides in surface and subsurface soil, and concentrations of radionuclides in surface and ground water. The primary radionuclide contaminants were Ra-226 and U-238; the concentrations of these radionuclides and decay products from these surveys are what we used in our quantitative analysis. .

Vicinity Property D

¹ RESRAD 6.3 Developed at the Environmental Assessment Division of Argonne National Laboratory. August 25, 2005.

At the time of the survey by ORAU², conducted from May through August of 1983 the western portion of property D (Figure 2) was largely occupied by landfills accessed by unpaved roads (Figure 3). There were also two major drainage ditches, the one near the western boundary of the property had been recently constructed. The property also contained four waste treatment or retention ponds. A small, badly deteriorated, wooden structure remained on the property from munitions operations that were on the site before it was used by MED/AEC. In 1983 the land was relatively level and most of it had been cleared although there were some areas of trees and brush along the northern perimeter.

Direct radiation levels measured at 40 m intervals at 1 m above the surface ranged from 6-10 $\mu\text{R/h}$ while surface contact gamma and beta-gamma exposure rates ranged from 5-10 $\mu\text{R/h}$ and 5-35 $\mu\text{rad/h}$, respectively. Because measurements performed with the shielded detector averaged about 20% less than those measured with the unshielded detector it is an indication that only a small portion of the surface dose rate was due to non-penetrating or low-energy photon radiations. The walkover survey identified several isolated spots of elevated contact radiation levels having surface contact gamma exposure rates ranging from 29-3000 $\mu\text{R/h}$; exposure rates at 1 m above the surface ranged from 8-110 $\mu\text{R/h}$ and beta-gamma dose rates ranged from 29-6450 $\mu\text{rad/h}$. Contact exposure and beta-gamma dose rates were reduced by soil sampling at several of the locations indicating that most of the contamination was in small, discrete pieces of material rather than diffused throughout the soil. The hot spots identified by the 1983 walkover scan may coincide with those found in the 1971-1972 survey and in the 1980 walkover scan.

Concentrations of Ra-226 measured in surface soil from 40 m grid intervals ranged from <0.16 pCi/g to 2.44 pCi/g. Although a few samples contained Ra-226 concentrations exceeding baseline levels, none of them were more than 5 pCi/g above the baseline level, the applicable regulatory limit. There were several areas of elevated radionuclides on property D (Figure 6). Several of these samples also contained slightly elevated U-238 concentrations. Ra-226 concentrations in samples from locations of above criteria contact readings had radiation concentrations that ranged from 0.95-11,200 pCi/g with the highest concentration in a piece of rock-type material, B8 (460N, 742E) that was taken from an unpaved road near the northernmost pond (Figure 7). High Ra-226 concentrations were identified in pieces of this material, which also contained elevated levels of U-238 and Th-232; the rock sample, B1B, which intersects with the main drainage ditch on the northwestern part of the property (539N, 222E), contained 403 pCi/g of U-238 and 553 pCi/g of Th-232, which were the highest levels of these two radionuclides measured on property D.

Results of gamma scintillation measurements indicated no subsurface contamination. None of the boreholes (Figure 4) contained radionuclide concentrations differing from the ranges in baseline samples. Surface water results had concentrations exceeding baseline levels but they

² Boerner, A.J. *Off-Site Property D Niagara Falls Storage Site*, Lewiston, New York, Final Report March 1984; Berger, J.D. *Off-Site Property E Niagara Falls Storage Site*, Lewiston, New York, Final Report March 1984; Berger, J.D. *Off-Site Property E' Niagara Falls Storage Site*, Lewiston, New York, Final Report September 1983; Berger, J.D. *Off-Site Property F Niagara Falls Storage Site*, Lewiston, New York, Final Report February 1984; Berger, J.D. *Off-Site Property G Niagara Falls Storage Site*, Lewiston, New York, Final Report April 1984; Boerner, A.J. *Off-Site Property H Niagara Falls Storage Site*, Lewiston, New York, Final Report March 1984; Berger, J.D. *Off-Site Property H' Niagara Falls Storage Site*, Lewiston, New York Final Report June 1983; Berger, J.D. *Off-Site Property P Niagara Falls Storage Site*, Lewiston, New York Final Report March 1984; Berger, J.D. *Off-Site Property S Niagara Falls Storage Site*, Lewiston, New York Final Report February 1984; Boerner, A.J. *Off-Site Property T Niagara Falls Storage Site*, Lewiston, New York Final Report March 1984; Boerner, A.J. *Off-Site Property U Niagara Falls Storage Site*, Lewiston, New York Final Report March 1984; Boerner, A.J. *Off-Site Property V Niagara Falls Storage Site*, Lewiston, New York Final Report April 1984.

did not exceed the EPA drinking water standards of 15 pCi/l of gross alpha and 50 pCi/l of gross beta. Samples from subsurface water samples ranged from 1.02-6.19 pCi/l of gross alpha and 5.52-65.4 pCi/l of gross beta with sample H11 (west of Castle Garden Road) exceeding the EPA guideline of 50 pCi/l for gross beta (Figure 7); the other samples were within EPA criteria with most having concentrations within the range of baseline levels. Because several of these samples contained high concentrations of dissolved solids the gross alpha analysis may have larger relative errors than usually associated with that procedure. These samples were rough-filtered through Whatman No. 2 filter paper and remaining suspended solids were removed by subsequent filtration through 0.45 µm membrane filters.

Sediment samples (Figure 5) collected from drainage ditches were all comparable to baseline concentrations.

According to the post-remedial action report published in January of 1989³ eight areas of property D were subsequently decontaminated. Results from six of the eight areas indicated that remedial action guidelines had been met. The seventh area was decontaminated and backfilled in 1984, but, because it is part of a larger contamination area on property U the results were reported as part of results for property U instead of property D. The eighth area contained several pieces of slag material that had a uranium to radium ratio similar to that of MED/AEC materials. This material was removed during the verification survey and a near-surface gamma survey conducted after removal indicated there was no contamination present.⁴ There was one area that was not indicated on the map of excavated areas on property D that may still have an above-criteria radionuclide level; this point is highlighted in Figure 7. It was also indicated in the 1983 report as the area that had the highest concentration of Ra-226. Also, several changes to the site by SCA Chemical Services may have prevented testing of areas that were previously identified as contaminated areas on vicinity property D.

In 1989 ORAU verified several vicinity properties of the NFSS site⁵. Vicinity property D was one of the properties verified at the time. Therefore, according to DOE, D is in compliance with the standards and guidelines applicable to the remedial actions at NFSS, but since one area of the vicinity property D with high Ra-226 concentrations was not decontaminated, in our opinion this property should not have been certified.

Vicinity Property E

Direct radiation levels on property E measured at 40 m grid intervals found that gamma exposure rates at 1 m above the surface ranged from 5-9 µR/h. Surface contact (gamma rates taken at the surface of the land) gamma (direct radiation) exposure rates and beta-gamma (indirect radiation) dose rates were 5-12 µR/h and 5-38 µR/h, respectively. Surface contact gamma exposure rates measured at much smaller, 5 m, intervals along the retention pond berm, had areas of elevated surface radiation levels and 'hot spots' (Figure 8), with a greater spread of dose rates, ranging from 8-21 µR/h. Contact gamma exposure rates and beta-gamma dose rates measured at 1 m above the surface ranged from 8-18 µR/h and 8-190 µrad/h, respectively; several hot spots in this

³ Kaye, M.E. and Feldman, A.M., *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties-1985 and 1986*, Bechtel National, Inc., Oak Ridge, TN, January 1989.

⁴ On the west central portion of the site residual pieces of slag materials having elevated direct radiation levels were identified by gamma scans of a pile of dirt. These pieces of material were removed by ORAU and BNI personnel. Follow up readings confirmed that the actions taken were effective with radionuclide concentrations in the ranges of baseline soil.

⁵ Certification Docket for the Remedial Action Performed at the Niagara Falls Storage Site Vicinity Properties in Lewiston, New York, from 1983 through 1986, Department of Energy Former Sites Restoration Division Oak Ridge Field Office, July 1992.

area ranged from 27-1150 $\mu\text{R}/\text{h}$. The hot spots were all well above background levels and exceeded the NRC's standard of about 4 $\mu\text{R}/\text{h}$.⁶

At several locations of elevated surface radiation near the retention pond berm the shielded detector measurements were 3-30% of the unshielded measurements, suggesting that a large fraction of the radiation was due to beta particles, which are non-penetrating particles. This differed from the measurements taken at 40 m grid intervals that did not have elevated radiation levels where the shielded and unshielded detector implied that only a small portion of the surface dose was due to non-penetrating beta or low-energy photon radiations.

Contact exposure rates were reduced by soil sampling at many of the hot spots, however, at some of the points, exposure rates were unchanged, indicating contamination at some locations extended greater than 15 cm below the surface and was diffused.

In general, in the surface soil samples, the Ra-226 levels did not differ from those in the baseline samples from the 40 m grid intervals. Samples collected from the areas with elevated radiation levels contained Ra-226 concentrations exceeding baseline levels, ranging from 4.23 to 514 pCi/g; these samples also had elevated U-238 levels with the highest in sample B15A, containing 22,600 pCi/g of U-238 (Figure 12). These concentrations exceed EPA's guidelines for cleanup. Small pieces of debris were separated from some of the samples collected at locations of elevated direct radiation (Table 1). These samples contained levels of Ra-226 activity too high to permit analysis by the routine gamma spectrometry procedures. These samples contained 0.55 to 11.6 μCi of Ra-226. Sampling along the southern portion of the retention pond berm (Figure 9) identified the presence of metal containers 20 to 30 cm below the surface; measurements indicated that these containers were contaminated or contained contaminated residues. There is no indication in remediation reports that these containers were removed or the pond berm was cleaned after this survey was published in 1984. Therefore, we assume that these contaminated containers are on Property E today.

Ground penetrating radar indicated the presence of 22 buried targets. It also identified possible utility services at several proposed borehole drilling locations. The boreholes indicated that contamination was confined to the upper 15-30 cm of soil. However, one borehole, H8 (Figure 10), located near the southwestern border of the property, had elevated radiation levels at a depth of 90 cm. None of the boreholes located for representative coverage of the property contained elevated subsurface radionuclide concentrations. Boreholes on the western edge of the property near the retention pond berm had Ra-226 concentrations ranging from 0.88 to 4.88 pCi/g. It is our understanding that these buried materials are still present.

Samples from standing water had elevated gross alpha and beta concentrations. Two of the three samples from the property interior contained elevated gross alpha and gross beta concentrations (Figure 11). However, only one sample, from borehole H8, exceeded 50 pCi/l for gross beta; the concentration for gross beta was 63.5 pCi/l. The water samples also contained high concentrations of dissolved solids, which resulted in larger errors than usual for the gross alpha analysis.

Sediments collected from the west-central portion of the property did not contain radionuclide levels significantly different from the levels in the baseline soil (Figure 11). Soil sediments along the southern edge of the property contained concentrations of U-238 ranging from 3.69-5.68 pCi/g and Ra-226 concentrations ranging from 0.85-2.25 pCi/g.

Several samples for surface and subsurface water contained radionuclide concentrations exceeding EPA interim drinking water standards for gross alpha and/or gross beta. The Ra-226

⁶ Based on the NRC regulatory standard of 25 mrem/yr on decommissioned site properties at Maywood and Wayne, New Jersey sites; assuming a person resided on the site 365 days a year; for Ra-226 and decay products, a roentgen is equal to 0.7 rems.

levels were less than the criteria and, after additional sampling, it was determined that contamination of the ground water system was not occurring. Although the contaminated residue on small portions of this property exceeded the guidelines established for release of the site under restricted use by the general public, under the conditions of use in 1983 the contaminants did not pose potential health risks to the public or site workers.

In January, 1989 a post-remedial action report of the vicinity properties was published by Bechtel National, Inc.⁷. However, this report revealed that no remedial action was taken on two previously-determined contaminated areas on property E because the contamination was not in excess of the generic guidelines. All of the contamination noted was in the form of small pieces of metal or plaster-like chips buried more than 15 cm beneath the ground surface and no measured subsurface concentrations of Ra-226 were in excess of 15 pCi/g when averaged over a 100 m² area. The verification report confirms the findings of the BNI report. Although it is suspected that contamination is beneath the pond berm or in certain sections of the berm, the DOE has decided not to perform further investigations until the berm is decommissioned (it has not been decommissioned to date). In the 1989 report, however, it is unclear to which berm DOE is referring since there are six ponds on Property E. In the 1983 survey most of the sampling was done on the pond berm on the southwestern part of Property E; we believe that this is the berm to which DOE is referring when stating that there is contamination beneath it. Although property E had high radionuclide concentrations in the ORAU report, the 1989 Bechtel report states that these high concentrations were not remediated because contamination was not in excess of the 100 m² guidelines. However, because those high points on property E would put the dose in excess of 25 mrem/yr we are of the opinion that no part of the property should have been certified until those hotspots were remediated

Vicinity Property E'

The current owner of Vicinity E' is CWM Chemical Services LLC. This company actively uses the central part of this property, which contains several buildings, storage tanks, and drum storage pads. Radiological surveys of this property were conducted in June and July of 1982 and in 1989. In 1982, there were still five buildings that remained on-site from previous MED/AEC operations. Much of the following summarizes the ORAU report.⁸

Direct radiation levels on E' were relatively low, with several levels being below the background measurements measured in the NFSS area. A walkover survey identified several small, isolated areas with elevated surface radiation levels. Exposure rates in contact with these isolated areas range up to 470 µR/h with the maximum level at location 13 (Figure 17). Beta-gamma dose rates range from 89 to 28,100 µrad/h with the maximum level at location 33 (Figure 17). ORAU determined that only a small portion of the surface dose rate was due to non-penetrating beta or low-energy photon radiations. Because the shielded detector levels were less than 10% of the unshielded measurements it is believed that there was a large fraction of the radiation due to beta particles. Although some contact exposure rates were reduced by soil sampling others were unchanged or increased following sampling suggesting that contamination at some locations extend greater than 15 cm below the surface and/or is diffused.

Radionuclide concentrations in soil from 20 m grid lines had several samples containing Ra-226 concentrations exceeding those in the baseline soil samples but only three of these samples actually exceeded 5 pCi/g above the baseline level, EPA's regulatory standard, 40CFR192.12(a) (Figures 20, 21, and 22). These samples with Ra-226 concentrations exceeding EPA's regulatory standard also contained elevated U-235 and U-238 concentrations. At a finer 5 m grid, Ra-226 concentrations at the grid line intersections exceeded the maximum levels measured in

⁷ Kaye, M.E. and Feldman, A.M., *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties-1985 and 1986*, Bechtel National, Inc., Oak Ridge, TN, January 1989.

⁸ Berger (1983).

the baseline samples. Seven samples at this finer grid spacing contained more than 5 pCi/g above baseline levels⁹ (table 2). Taking biased samples (locations where direct radiation was elevated), thirty-two samples contained Ra-226 concentrations above the baseline levels; concentrations ranged from 2.53 to 3190 pCi/g for 27 soil samples. Five of the samples contained small pieces of debris with levels of Ra-226 activity too high to permit analysis by routine gamma spectroscopy procedures (Table 3).

According to the ORAU report, gamma scintillation measurements indicated contamination is confined to the upper 1 m of soil. This appears to conflict with a memo by the same author, in which he states "near grid location 460E, 40N a layer of subsurface contamination was found,...approximately 2 feet below the surface and appears to be a blackish deposit about 10 inches thick. The layer extends over an area of approximately 30m x 15 m. A soil sample from this layer contained Ra-226 at concentrations in the range of 300 pCi/g."¹⁰ To the best of our knowledge, this contamination has not been removed.

None of the boreholes located to provide representative coverage of the property contained elevated subsurface radionuclide concentrations (Figures 13, 14, and 15). Boreholes in areas where burials had been previously conducted contained elevated concentrations of Ra-226 with the highest concentration 171 pCi/g at a depth of 5 m. At 1 m the level decreased to 7.51 pCi/g. Boreholes in areas with generally elevated radiation indicated Ra-226 contamination at many of the drilling locations. The highest concentration was 954 pCi/g at 0.5 m deep. Boreholes drilled along the section of railroad tracks in property E' did not contain radionuclide levels differing from baseline levels; one sample contained an elevated concentration of Ra-226, 7.54 pCi/g. Finally most boreholes drilled in isolated spots of elevated direct radiation contained less than 3.3 pCi/g of Ra-226; the highest sample contained a subsurface concentration of 8.94 pCi/g at the 0.5 m depth. It is not clear if any of these materials were removed from E'.

Most of the surface water samples (Figure 16) had gross alpha and gross beta concentrations in the range of the baseline levels, although one sample contained a gross alpha of 8.78 pCi/l and 11.0 pCi/l of gross beta; the same sample also had 0.25 pCi/l of Ra-226. Most of the subsurface water samples from the property interior contained elevated gross alpha and gross beta concentrations (Figures 17, 18, 19). The highest levels were a gross alpha at 920 pCi/l and gross beta at 635 pCi/l; this sample also contained 31.6 pCi/l of Ra-226. This exceeds drinking water standards where gross alpha for Ra-226 should not exceed 5 pCi/l and gross alpha for Uranium should not exceed 15 pCi/l, 40 CFR 141.26(5). Subsurface water samples at the railroad tracks contained 128 pCi/l of gross alpha, 158 pCi/l of gross beta, and 14.4 pCi/l of Ra-226 (Figure 16). This indicates that contaminated materials may have been dropped during transportation or unloading operations. Samples collected from the perimeter of the property had lower concentrations, which did not exceed the EPA drinking water standards. Note that the 15 m x 30 m contamination region mentioned above had very high radium-226 concentrations in water, approximately 20,000 pCi/L in unfiltered samples. Only filtered samples were reported in the ORAU report, possibly accounting for the increased concentrations reported by Berger and the difference between the Berger memo and the ORAU report.

The 1982 survey data of vicinity E' suggest that there are buried radioactive residues¹¹. In earlier decontamination work, buried residues were not removed. Although there were numerous small, isolated areas of direct elevated radiation and surface soil contamination, the average levels of contamination over a contiguous surface area of 100m² resulted in levels below concentration

⁹ Values in table 1 are an excerpt from table 6 in Berger report of site E'

¹⁰ Memo from J Berger to C Yarbro, ORAU, July 26, 1982.

¹¹ "Ground penetrating radar was also used to identify subsurface anomalies which might suggest buried radioactive residues" (pg 15 of 1982 Berger survey); "Although buried objects were not identified by the ground penetrating radar, there are isolated spots and one general area where subsurface residues contain Ra-226 concentrations exceeding 15pCi/g and U-238 concentrations exceeding 40 pCi/g" (pg 14 of 1982 Berger survey).

guidelines, except for the 15 m x 30 m area mentioned above. The area near the railroad spur contained numerous hot spots and exceeded Ra-226 and U-238 concentration criteria. There were no significant radiation levels or surface contamination in the buildings on this property. Despite the elevated levels of radiation found on this property, ORAU concluded that there was no evidence that migration of the radioactive materials is adversely affecting adjacent properties or the groundwater. It is unclear to us how ORAU can come to this conclusion since water below the surface must eventually migrate to the north, off the property.

The 1989 report by Bechtel National, Inc.¹² states that sixteen areas on property E' were decontaminated and backfilled. After remediation the average Ra-226 concentration in the soil was 2.3 pCi/g, which includes the background concentration of 1 pCi/g. Therefore, the average concentration was only 1.3 pCi/g above the background and well below the guideline of 15 pCi/g in soil more than 15 cm beneath the ground surface. However, there were two areas on property E' that were inaccessible at the time and contaminated. One area was beneath two PCB storage tanks and another was beneath a road. The contamination in these areas is in a 0.3 m thick layer and is approximately 0.6 m beneath the ground surface and is in the form of small white chips, with a chemical composition suggesting that they may be lead cake residues. Concentrations of Ra-226 in these chips are above 15 pCi/g but they do not exceed the guideline because when averaged over contiguous areas of 100 m² the concentrations are below 15 pCi/g. Although remedial actions were conducted near these two areas to reduce radiation levels to as low as reasonably possible the decision was made to leave the residual contamination remaining under the PCB tanks and roadway in place. The verification report confirms the findings of BNI and goes further to state that "continuous occupancy at the location of maximum exposure rate could not result in a dose from external radiation in excess of the average criteria of 100 mrem/y above background"¹³. As we discuss later, 100 mrem/y is not the appropriate standard for uranium fuel cycle facilities according to the EPA, and is not the appropriate standard for long-term storage or disposal¹⁴.

U. S. Army Corps of Engineers Report March 1999

A March 1999 report by the US Army Corps of Engineers (ACE)¹⁵, with assistance by SAIC, disagrees with the Bechtel analysis concerning residual contamination under the PCB tanks. In early 1994, CWM closed and dismantled the PCB storage tanks, allowing the area previously under the tanks to be characterized, including the taking of soil samples. The area within the berm surrounding the former tanks was found to be radioactively contaminated. Some locations showed greater contamination at 0.5 to 1 feet, than at the surface, 0 to 0.5 feet. The maximum concentration was 230 pCi Ra-226 per gram soil. Areas outside and on the berm were within the 5 pCi/g Ra-226 guideline set by the EPA.

Based on soil samples and averaging the radioactive soil concentrations within the berm, ACE proceeded to determine the likely radiation doses under various exposure scenarios: remedial worker, industrial worker and resident. ACE also evaluated these exposures under four specific remedies: no action, cover (1 foot), excavate, and excavate and cover (1 foot). ACE employed RESRAD 5.82 to calculate radiation doses. The calculated doses under various exposure scenarios, assuming no cover, were 52 mrem/yr (current worker), 371 mrem/yr (industrial worker), and 1,230 mrem/yr (resident). For the other three remediation alternatives (cover, excavate and dig and cover), the radiation doses within the berm were less than 15 mrem/yr. The conclusion is that remediation should take place, but it is not clear any action has occurred since the ACE report was prepared, March 1999. It is clear that it should not have been certified

¹² Kaye, M.E. and Feldman, A.M., *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties-1985 and 1986*, Bechtel National, Inc., Oak Ridge, TN, January 1989.

¹³ Berger, J.D. *Excerpts from Verification of 1985 and 1986 Remedial Actions: Niagara Falls Storage Site Vicinity Properties*, Lewiston, New York, Final Report July 1990.

¹⁴ 40 CFR 192.32(a)(3)(i)

¹⁵ ACE (1999)

in the early 1990s with the other properties. Also, it is unclear whether certain parts of the property said to have high contamination were remediated in the Bechtel remediation (i.e. 30 x 15 m transect containing 300 pCi/g of Ra-226). Also, the highest point on property E was still over criteria in 1989.

Vicinity Property F

During the time of the survey SCA Chemicals, Inc owned Vicinity Property F. This particular radiological survey on which this memo is based was conducted from April-June of 1983. The property was almost entirely occupied by landfills, salt areas, and waste treatment ponds and there were no permanent buildings on the site (Figure 23). The southwest corner of the property was covered by a swamp. The land was essentially free of brush and weeds. Although portions of this property were used for temporary storage there was no evidence of contaminated waste burials. Although Vicinity F had a great amount of land disturbance there was not a concentration of Ra-226 that exceeded EPA's regulation of 5 pCi/g below 15 cm of the surface for disturbed land.

Background exposure rates and baseline radionuclide concentrations in the soil and water were typical of those found in that area of New York and encountered in surface soils and water.

Direct radiation levels that were measured at 40 m intervals were generally higher along the southern boundary near the southeast corner of the property. A walkover survey identified two areas of elevated direct radiation levels. Higher radiation levels in these two areas were believed to be due primarily to the presence of fly ash, which was a substance mixed with chemical wastes prior to disposal. Ten additional isolated locations of elevated contact radiation levels were noted with exposure rates ranging from 14 to 2900 μ R/h (Figure 24). The locations of elevated contact were well above 4 μ R/h, which is roughly equivalent to NRC's standard of 25 mrem/y.¹⁶ At one grid location surface soil sampling was effective in greatly reducing the radiation level, however several other grid locations of soil sampling did not significantly change exposure rates; this indicated contamination extended more than 15 cm below the surface and was diffused. Many of these areas were located near the main roads suggesting spillage of small quantities of residues or wastes from containers during transportation, loading and unloading, or temporary roadside storage.

The surface soil samples showed that Ra-226 concentrations were in the range of the baseline samples with only a few exceptions for the samples collected around the scope of the area. However, all samples in the areas of elevated contact contained elevated concentrations of Ra-226 with the highest samples containing small chips of lead cake residue having Ra-226 levels of 20 pCi and 2.8 pCi.

Borehole measurements (Figure 25) did not help to identify evidence of subsurface contamination. None of the soil samples from boreholes contained Ra-226 or other gamma emitting radionuclides outside the ranges determined in baseline soil.

Most of the surface water samples contained gross alpha and gross beta concentrations greater than those in the baseline water samples. All of the samples contained high concentrations of dissolved solids adversely affecting the detection sensitivities of the gross alpha procedure. It was found that the maximum Ra-226 concentration was 1.47 pCi/l, which is well below the EPA interim drinking water standard of 5 pCi/l, specified in 40 CFR 141.66 (Figure 26).

¹⁶ Based on NRC regulatory standard of 25 mrem/yr on a decommissioned site properties at Maywood and Wayne, New Jersey sites; for every Roentgen there are approximately 0.7 rems.

Berger *et al*¹⁷ concluded that elevated radiation levels on the southern portion of the property were primarily due to the residues, containing Ra-226, stored in the water tower on the adjacent DOE site. However, the maximum level of $\mu\text{R/h}$ is still within the NRC guideline for unrestricted areas. Although isolated surface areas had Ra-226 soil contamination exceeding 5 pCi/g, an average over an area of 100 m² would still be within the acceptable criteria. Finally, according to Berger, there is no evidence that migration of the radioactive material is adversely affecting adjacent properties or the ground water.

A January 1989 post-remedial action report¹⁸ of the vicinity properties stated that a small area on Property F was decontaminated and backfilled. The average Ra-226 concentration in the soil samples after remediation was only 0.8 pCi/g, which was below the background levels. Therefore, the remedial action guideline was met. In Figure 26, the part of Property F that was excavated is circled. However, in that figure there are also areas that were above EPA criteria in the 1983 survey of the site. These areas were not mentioned as having been decontaminated or excavated in the 1989 report. It is unclear from the reports whether or not the other above-criteria areas on Property F have been cleaned.

In 1989 ORAU verified several vicinity properties of the NFSS site¹⁹. Vicinity property F was one of the properties verified at the time. Therefore, according to DOE, F is in compliance with the standards and guidelines applicable to the remedial actions at NFSS. However, although property F had very little contamination on it, the highest point on the property that brought it over criteria in the ORAU survey was not mentioned as being remediated in the 1989 Bechtel survey. Therefore, it should have not been verified until it was clear that said point was remediated.

Vicinity Property G

Vicinity Property G is a rectangular (409m X 293m) tract of the LOOW site which occupies an area of 12 hectares (Figure 27). It is bordered on the north by M Street, Castle Garden Road on the east and Campbell Street on the west with the Niagara Falls Storage Site forming its southern boundary (See Figure 28). The original construction of the Lake Ontario Ordnance Works TNT plant in 1942, did not result in any surface development of the area now designated Vicinity property G, it being located between the nitration area of the LOOW TNT plant to the north and the acidification area to the south. Following on from the closure of the TNT operation in 1943 the area was used for the disposal of radiological waste. Documents indicate that the University of Rochester began using the LOOW site as a disposal site for its radiological waste as early as 1944^{20 21}. A 1953 memo refers to most of the buried waste being dead animals (area 3, Figure 28) from the University of Rochester, polonium (area 2, Figure 28) and sizeable quantities of debris from Linde and Electromet (area 1, Figure 28)²².

¹⁷ Berger, J.D. *Off-Site Property F Niagara Falls Storage Site*, Lewiston, New York, Final Report February 1984

¹⁸ *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties – 1985 and 1986*. January 1989. Prepared for United States Department of Energy, Oak Ridge Operations Office under contract No. DE-AC05-81OR20722 By M. E. Kaye and A. M. Feldman, Bechtel National Inc. Oak Ridge, Tennessee. Bechtel Job No. 14501.

¹⁹ Certification Docket for the Remedial Action Performed at the Niagara Falls Storage Site Vicinity Properties in Lewiston, New York, from 1983 through 1986, Department of Energy Former Sites Restoration Division Oak Ridge Field Office, July 1992.

²⁰ Memorandum from F. Epp, Tonawanda Area to J. S. Quidor, Director, Office of Administrative Operations, New York. "Disposition of Contaminated Scrap." May 11, 1948.

²¹ Memorandum from Gordon Boyd to Task Force Staff, New York State Assembly, "Sources of Cesium Contamination/University of Rochester Virtually Ruled Out, Manhattan Project Records Lost." June 26, 1980.

²² Memorandum to W. B. Harris from Paul B. Klevin, "Disposal of Surplus Land at LOSA". May 28, 1953.

In late 1952 the US military made a request to use a portion of the AEC site, south of Balmer Road; this area included Vicinity Property G. A radiation survey carried out in July 1953²³ found the property to be contaminated and in need of cleanup. It was decided Hooker Electrochemical would conduct the remediation effort²⁴. In the course of this clean-up, technical assistance was requested²⁵ which resulted in another radiation survey being carried out in October 1954²⁶; the survey concluded that sources of waste exceeded the permissible level and recommended a number of further remediation actions. All burials of contaminated wastes were to be accurately recorded and the information passed to the U. S. Navy and any future land owners. A further radiation survey was carried out in April 1955 to verify that the remediation efforts were satisfactory²⁷. The survey found further remediation of the area was required, which was subsequently carried out by Hooker personnel²⁸.

In 1966 Vicinity Property G was sold to the Fort Conti Group, as part of a 614 acre purchase. No information was provided to the new land owner of the location of radioactive burials on the property. Subsequently in 1970 an AEC radiological survey on its adjacent Niagara Falls Storage Site revealed areas of the AEC property that were radioactively contaminated. A series of spot checks on the surrounding properties revealed that elevated radiation was present on these areas, now in private ownership, as well. This "rediscovery" by the AEC of contamination on private property was subsequently confirmed by a series of surveys. These surveys revealed several areas of private property where radioactivity exceeded the limits for uncontrolled release of land to the public. Efforts were made to remediate several areas including Vicinity Property G^{29 30 31 32}.

Between 1979 and 1980, following public concerns about the storage of radioactive residues at the NFSS site, a comprehensive survey of the 191 acre tract and the Central and West Drainage ditches, both on and off site, was carried out by Battelle Laboratories, Columbus, Ohio. The survey identified areas of the NFSS site, along with the ditches, which were still contaminated in spite of the previous 1972 remediation by the AEC. This unexpected finding called into question the previous remediation carried out by the AEC on the adjacent private property, which included Vicinity Property G. Detailed reviews of past findings were carried out to help address the issue and identify which properties would require further remediation.^{33 34}

²³ Memorandum from Merrill Eisenbud, Director Health and Safety Division to J.S. Quidor, Director, Admin. Oper. Div., THRU Virginia C. Duncombe, Asst. General Counsel. "Radiation Survey of Contaminated Scrap and Waste Buried or Stored at LOSA, Model City, New York. July 10, 1953.

²⁴ Memorandum from F. W. Malone, Administrative Officer, Cleveland Area to files." Health & Safety Meeting Between Hooker, NYOO & Cleveland." September 17, 1953.

²⁵ Memorandum from C. W. Showalter, Site Representative, Cleveland Area, Niagara Falls site to W. B. Harris, Chief, Industrial Hygiene Branch, New York Health & Safety Laboratory. "Radioactive contaminated Material". September 24, 1954.

²⁶ USAEC New York Operations Office, "Location and delineation of Radioactivity Mathieson-Navy Area" November 2, 1954. Health and Safety Laboratory.

²⁷ Visit Report by P.B. Klevin, Industrial Hygiene Branch, Health & Safety Laboratory, NYOO to W. B. Harris, Chief, Industrial Hygiene Branch, Health & Safety Laboratory, NYOO. "Niagara Falls Site, Model City, New York -Visit of April 26-27, 1955.

²⁸ Letter to F. W. Malone, Site Representative, Niagara Falls Site from A. P. Walker, Dept. Head, Plant 31, Hooker Electrochemical Company. "Clean-up of radioactive waste deposits in Olin-Mathieson-Navy Area." July 15, 1955.

²⁹ Letter from W. A. Johnson, AEC Health and Nuclear Safety Branch to Wiley A. Johnson, Chief AEC Health and Nuclear Safety Branch, "Radiation Survey of LOOW Site, October 1970", October 26, 1970.

³⁰ "Notes on Radiation Survey of LOOW Site", - October 12- 16, 1970.

³¹ "Radiation Survey and Decontamination Report of the Lake Ontario Ordnance Works Site, 1972". US Atomic Energy Commission, Oak Ridge Operations.

³² "Lake Ontario Ordnance Works, Niagara Falls Site. January 15, 1971". AEC Report.

³³ "Background Report and Evaluation of Resurvey Requirements for the Former atomic Energy Commission Portion of the Lake Ontario Ordnance works." August 1980. Environmental and safety engineering Division, Office of Environment, U.S. Department of Energy, Washington D.C. 20545.

A comprehensive radiological survey of Vicinity Property G was carried out by Oak Ridge on behalf of the DOE in April through June 1983.³⁵ The survey identified several areas on the property which required remediation. Forty five areas were decontaminated and backfilled on Vicinity property G, according to the post-remedial action report.³⁶ Verification of the remediation work carried out on Vicinity Property G was carried out between 1986 and 1987 and documented as being satisfactory apart from that area of Vicinity Property G, where testing could not take place owing to the presence of CWM's facultative ponds 1 and 2.³⁷ Documents contained in the subsequent certification docket for the NFSS Vicinity Properties suggest there was some confusion as to the certification status of Vicinity Property G.³⁸ This may have been compounded by the unexpected discovery of buried radioactive drums on the property in August 1986.³⁹ The survey done on Property G in 1983 was not comprehensive, failing to address the drum burial in the southern section of the property, which was later found during the verification process. This indicates that the entire property may need to be surveyed again for surface and subsurface contamination. This is especially true since CWM has proposed to upgrade the storm water system, which would involve the modification of the ditch that runs along the northern edge of property G (Figure 28); this ditch is just to the north of facultative ponds 1 and 2, which may mean there could be a potential contamination issue.

Following on from the DOE work in the 1980s, USACE again reviewed Vicinity Property G in response to community concern over the potential existence of a contaminated animal burial site on the LOOW. As part of this review, a number of historical aerial photographs were examined.⁴⁰ The USACE investigation also involved the use of electromagnetic surveys.⁴¹ The investigation is detailed in a USACE hand out⁴² and a comprehensive fact sheet, dated April 2004.⁴³

In January 1989 Bechtel National, Inc stated in its post-remedial action report that forty-five areas on Property G were decontaminated and backfilled. After remediation the average Ra-226 concentration was 1.1 pCi/g above background, which is well below the guideline of 15 pCi/g of

³⁴ "Background and Resurvey Recommendations for the Atomic Energy Commission Portion of the Lake Ontario Ordnance Works." November 1982. Prepared for Public Safety Division, Office of Operational Safety, Assistant Secretary for Environmental Protection, safety and Energy Preparedness, U.S. Department of Energy by Environment and Conservation Directorate, Eastern Technical Division, The Aerospace Corporation, Washington D.C. Contract No. DE-AC01-82-EP15100.

³⁵ "Comprehensive Radiological Survey, Off-site Property G, Niagara Falls Storage Site, Lewiston, New York." Prepared for US DOE as part of Formerly Utilized Sites- Remedial Action Program. J. D. Berger, Oak Ridge. Final Report, April 1984.

³⁶ "Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties – 1985 and 1986". January 1989. Prepared for United States Department of Energy, Oak Ridge Operations Office under contract No. DE-AC05-81OR20722 By M. E. Kaye and A. M. Feldman, Bechtel National Inc. Oak Ridge, Tennessee. Bechtel Job No. 14501.

³⁷ Excerpts from "Verification of 1985 and 1986 Remedial Actions Niagara Falls storage Site Vicinity Properties Lewiston, New York by J. D. Berger. Environmental Survey and Site Assessment Program, Energy/Environment Systems Division. Final Report July 1990.

³⁸ Excerpts from "Certification Docket for the Remedial Action Performed at the Niagara Falls Storage Site Vicinity Properties in Lewiston, New York, from 1983 through 1986." Department of Energy, Former Sites Restoration Division, Oak Ridge Field Office, July 1992.

³⁹ Response by S. W. Ahrends, Director, Technical Services Division, DOE, Oak Ridge Operations to Ted Gable, Air and Waste Management Division, EPA. "Excavation of Drums From Vicinity Property G

⁴⁰ "Former Lake Ontario Ordnance works, NY. Examination of Historical aerial Photography – Selected Sites". Final Report, September 2002. Prepared for the US Army Corps of Engineers, Buffalo District, New York by US Army Topographic Engineering Center, operations Division, Hydrologic & Environmental Analysis Branch, 7701 Telegraph Road, Alexandria, Virginia 22315-3864.

⁴¹ "Gamma Walkover survey and Geophysical Survey" Continued Remedial Investigation, Characterization Report" May 30, 2003. Prepared for US Army Corps of Engineers, Niagara Falls Storage Site (FUSRAP) by Science Applications International Corp. (Dublin, Ohio) Chapter 14: Vicinity Property G.

⁴² "Vicinity Property G (VPG) Update to LOOW RAB", Monday, March 1, 2004.

⁴³ FUSRAP fact sheet "Former University of Rochester Burial Area Investigation, Vicinity Property G (VPG)

Ra-226 in soil 15 cm beneath the ground surface. U-238 concentrations exceeded 44 pCi/g in two samples. Soil samples in locations contiguous to one of the samples indicated that the average concentration of U-238 over 100 m² was 30 pCi/g, which is within the remedial action guidelines. However, the other sample exceeding 44 pCi/g of U-238 met the hot spot criterion⁴⁴; it is unclear from the report whether actions were performed to clean up the 'hot spot'. The report goes on to state that all of Property G was cleaned up in 1986 except for one small area containing several buried drums. After one drum was removed and analyzed it was found that its contents were radioactively contaminated and may have been used to store K-65 residues. In 1987 the area of the drums was excavated. Thirty-one additional drums were removed and placed in over-packs and ninety drums of soil contaminated with material from the original drums were also removed from the property. It seems that the areas containing contaminated metal and animal carcasses, areas 2 and 3, (see Figure 28) respectively, were decontaminated from the 1985/1986 remediation of the property. The verification reports recommend an evaluation of the surface beneath the pond on the eastern portion of the property, area 1, once the pond is removed from service. There is potential for contamination in this area since the former Linde Scrap Yard facility was located on a portion of the site covered by the pond and the pond was inaccessible (Figure 28).

In 1989 ORAU verified several vicinity properties of the NFSS site. Vicinity property G was one of the properties verified at the time. However, in a 1992 letter it states that the verification was only meant for the areas on the property that were remediated at the time and met guidelines but it did not mean that the entire property was verified for release. This letter is referring to the soil beneath the liquid treatment pond on the eastern edge of property G.⁴⁵

Vicinity Property H

There has been no history of contaminated waste burial on Vicinity H. However, temporary storage or spillage may have occurred along the railroad tracks near its southern boundary and along Wesson Road, I Street, and 5 Street. (See Fig. 29) Previous surveys identified spotty contaminated and elevated direct gamma levels along portions of the boundary roads and interior areas of the site. There were some above background conditions in certain areas of the property but these were believed to be of natural origin and not from previous MED/AEC activities. When the survey was conducted in 1983 the property was not in use and was partially overgrown with brush and trees, especially in its northwest corner. Several small deteriorated structures, concrete pads, and foundations of buildings previously demolished, as well as building rubble and debris were located on different portions of the property.

Direct radiation levels from 20 m grid intervals at 1 m above the surface ranged from 5-22 μ R/h while contact gamma rates and beta-gamma rates were 5-27 μ R/h. A walkover of the property identified several small, isolated surface areas with elevated radiation levels (Figure 32). Surface gamma exposure rates ranged from 17-150 μ R/h and exposure rates at 1 m above the surface ranged from 10-29 μ R/h; almost all of these exposure rates exceeded NRC's dose rate of 4 μ R/h even after background was subtracted. Measurements from a detector that was shielded and unshielded indicated that a small portion of the surface dose rate was due to non-penetrating beta or low-energy photon radiations while a very large portion of the surface dose was due to high energy, penetrating photon radiations. Surface soil samples measured from 20 m grid intervals contained elevated levels of Ra-226 but less than 3% of these samples contained levels greater than 5 pCi/g above the baseline level. However, the concentrations that did exceed 5 pCi/g above the baseline level were high. Concentrations of Ra-226 ranged from 5.23-865 pCi/g.

⁴⁴ "Hot spot criterion is determined by multiplying the remedial action guideline for the respective radionuclide by a factor of $(100/A)^{1/2}$, where A is the area of the hot spot" (Kaye and Feldman, 1989)

⁴⁵ Certification Docket for the Remedial Action Performed at the Niagara Falls Storage Site Vicinity Properties in Lewiston, New York, from 1983 through 1986, Department of Energy Former Sites Restoration Division Oak Ridge Field Office, July 1992.

In most of the other samples there were elevated concentrations of U-238. The samples also indicated that the elevated direct radiation levels were associated with building rubble (Figure 33).

Gamma scintillation measurements indicated contamination in the property is confined to the upper 30 cm of soil. Although gamma count rates were reliable indicators of elevated subsurface radionuclide levels the data was not useful in quantifying radionuclide concentrations in the subsurface soils because of varying ratios of Ra-226, U-235, U-238, Th-232, and Cs-137 occurring in soils from the site. Six boreholes that provided a representative coverage of the property had radionuclide concentrations in the range of the baseline levels. The boreholes drilled over the area identified as having elevated levels from the walkover survey contained elevated concentrations. The highest were of Ra-226 (21.4 pCi/g) and U-238 (14.7 pCi/g) at a depth of 0.5m (Figure 30).

All of the surface water measurements (Figure 31) were within the EPA drinking water standards of 15 pCi/l of gross alpha and 50 pCi/l of gross beta. However subsurface water measurements contained elevated levels of radiation ranging from 1.09-12.3 pCi/l of gross alpha and 1.5-14.8 pCi/l of gross beta. Those measurements also had high concentrations of dissolved solids, which increased the errors in the alpha concentrations.

Researchers concluded that most of the elevated levels of radiation in surface soil were attributable to a form of crushed rock, which is believed to be a chemical processing material commonly used in the Niagara Falls areas as a fill and paving base. Therefore, they did not attribute the elevated levels to past waste handling and storage activities at NFSS. There were also individual pieces of rock-type material with elevated levels of radiation that were probably associated with MED/AEC operations but the report claims that only one area of contamination actually remains on the property. Finally, because surface and subsurface water samples did not contain concentrations exceeding EPA drinking water standards, Boerner concluded that contamination of groundwater would not occur or was not occurring at the time.

Vicinity Property H'

On the eastern portion of property H' there had been suspicions that waste incinerator operations were performed on a pad of the site before 1954. A survey from 1971-72 identified radiation levels of 20-50 $\mu\text{R/h}$. As a result of that finding contaminated scrap was removed from the site. In 1978 an aerial radiological survey did not identify significant gamma radiation levels on the property, but a mobile scan of accessible roads, conducted in 1980, confirmed the earlier findings; elevated radiation levels were found along M Street, Wesson Road, and 5th Street. The land on property H' is level except for areas with drainage ditches near the center of the property and low areas or shallow depressions south of the railroad track and scattered locations throughout the site (Figure 33). Because some areas of the vicinity are below the level of adjacent properties that indicates that there may have been surface excavation; most of these low-lying areas were covered by water at the time of the survey. SCA Chemical Services, Inc owned the property when the survey was conducted in June and July of 1982; the company was not using the property at the time of the survey.

Gamma exposure rates at 1 m above the surface ranged from 0.2-18 $\mu\text{R/h}$ and surface contact rates ranged from 5.7-22 $\mu\text{R/h}$. According to NRC's standards on decommissioned properties, dose rates should be approximately 4 $\mu\text{R/h}$.⁴⁶ Only a small portion of the surface dose was due to non-penetrating or low-energy photon radiation, indicated by measurements performed with the shielded and unshielded detector. A walkover of the property identified small, isolated areas with elevated surface radiation levels (Figure 37). Exposure rates increased following soil samples indicating that contamination extends greater than 15 cm below the surface and that it is diffused. Direct radiation levels at grid line intersections were generally higher on the

⁴⁶ Based on NRC regulatory standard of 25 mrem/yr on a decommissioned site properties at Maywood and Wayne, New Jersey sites; for every roentgen there are approximately 0.7 rems.

southeastern and eastern portion of the site and along 'M' Street and 5th Street; such findings coincide with the survey conducted in 1980 indicating elevated levels of radiation along M Street, Wesson Rd, and 5th Street.

Measurements of the surface soil concentrations of radionuclides were from the grid line intersections on the property and selected locations of elevated radiation levels. Samples from the grid lines contained concentrations of Ra-226 ranging from 0.51-15.7 pCi/g; half of these samples contained Ra-226 concentrations exceeding those in the baseline soil samples. Several samples also contained elevated U-235 and U-238 concentrations. All 21 of the surface soil samples contained Ra-226 concentrations above those in the baseline samples. The highest Ra-226 concentration was 1750 pCi/g, which was sample B6 located near the southeast corner of property H' (See Fig. 34).

Out of 6 boreholes taken on the outer edges of the property only one borehole, H3, located on the southwestern edge of H', contained elevated levels of radionuclide concentrations (Figure 35). However, most of the boreholes taken at locations where the walkover survey identified probable surface contamination contained elevated levels of Ra-226 concentrations, with a maximum concentration of 18.1 pCi/g in borehole H8 (Figure 35).

Surface water samples (Figure 36) contained gross alpha and gross beta concentrations above baseline levels but well within the EPA drinking water criteria of 15 pCi/l and 50 pCi/l, respectively. Subsurface waters also contained above-baseline gross beta and gross alpha concentrations.

Although ground penetrating radar suggests buried radioactive residues on the southeastern portion of the property (Figure 38), the researchers of this survey concluded that there was no evidence that migration of radiation materials was adversely affecting adjacent properties or groundwater. Despite such a conclusion Bechtel National, Inc.⁴⁷ reported that the large, contaminated area on property H' was decontaminated and backfilled. Following the decontamination, soil sample analyses indicated that the remedial action guideline was met with an average Ra-226 concentration of 1.9 pCi/g, which included the background concentration of 1 pCi/g. Although five soil samples exceeded the guideline of 15 Ci/g a review of these samples at their five locations indicated that concentrations averaged over 100 m² were less than 15 pCi/g. Hence, the remedial action guideline was met throughout the decontaminated area on H'. However, although the average radionuclide concentration on property H' yields a small dose, the highest concentration on H' yields a dose ten times that of 25 mrem/yr. Therefore, in our opinion, believe this property should not have been verified until the high points were remediated

Central Drainage Ditch

The central drainage ditch (CDD) originates on the NFSS property and flows northward through vicinity properties S, T, U, V, and P before exiting the LOOW site, crossing Lutts Rd and finally ending at Fourmile Creek, which discharges into Lake Ontario. We focus on radioactive contamination of the part of the central drainage ditch that flows from M street, the northern boundary of NFSS, to Balmer Road, the northern boundary of properties P and V. (See Figure 39.) We also discuss the part of the CDD lying west of Lutts Road, from 1500 feet west of Lutts Road to Four Mile Creek, that has never been excavated. As we discuss below, the northernmost part of the CDD, past Lutts Road, is contaminated and was never remediated. Properties along the CDD are owned by several different entities.⁴⁸

⁴⁷ Bechtel National, Inc., *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties—1983 and 1984*, Lewiston, New York, December 1986

⁴⁸ Properties located along the CDD owned by the Somerset Group, Inc, New York Army National Guard, Mr. Roderick T. Tower, Mr. George J. Wolf, Mr. Richard Kahl and Robert Hille, Town of Porter, and Niagara Falls County.

The CDD is 10 feet to 15 feet deep and up to 40 feet wide and drains a good part of the NFSS site and vicinity properties. It is not clear how the ditch became contaminated, either through surface water runoff from contaminated areas, or underground seepage. It was decontaminated in the early 1970's to guidelines applicable at the time, but not to present-day guidelines.

A table from a report believed to be from the 1971-1972 survey⁴⁹ shows that 18,000 ft² of the CDD was decontaminated and not backfilled. During this excavation of contaminated soil from NFSS property line to 1500 feet west of Lutts Road, the upper 14 inches of soil was removed from the ditch and banks. Excavated soil was placed in the Waste Contaminant Facility of the NFSS property. Before excavation the maximum direct gamma dose rate was 650 $\mu\text{R/h}$ and after excavation it was 120 $\mu\text{R/h}$. Although this was a drastic reduction in radioactivity this dose rate was still very high. It is not claimed that anyone is living in the CDD, but as a guide, this implies potential yearly doses greater than 700 mrem/yr. This exceeds the allowable radiation dose of 100 mrem/yr from an operating nuclear facility or 25 mrem/yr from a decommissioned facility.

A 1980 background report⁵⁰ goes into some details about the contamination on properties S, T, U, and V⁵¹, through which the CDD passes. On property S, areas at the ditch bank indicate gamma activity as high as 120 $\mu\text{R/h}$. Although an area in the northern section of property S underwent decontamination in 1972, gamma levels there remained as high as 45 $\mu\text{R/h}$. The CDD remained contaminated after the 1972 decontamination of property T, with the primary locations of elevated direct gamma contamination near culverts from L street to I street. There were also elevated gamma levels along the railroad track and along Wesson Street. (See Figures 40-44) Areas in the west-central, northwestern, and northeastern sections did not meet the 20 $\mu\text{R/h}$ guidelines even after 1972 cleanup operations.⁵² On property U the CDD and the area to the west remained contaminated with a gamma activity dose rate of 45 $\mu\text{R/h}$. There was also spotty contamination along H Street and east of Wesson Street and the intersection of H and 5th Streets with gamma activity up to 50 $\mu\text{R/h}$. Finally, the part of the CDD on property V had gamma activity as high as 60 $\mu\text{R/h}$. Elevated gamma activity was also detected along Wesson Street and one unnamed east-west street.

A January 1989 remedial action report⁵³ states that there were 37 areas on property T that were excavated and backfilled. A diagram showing the locations of the 37 areas shows that most of the excavated areas surrounded the CDD and the Western Drainage Ditch, which intersected on property T. In a December 1986 remedial action report⁵⁴ properties' S, U, and V had areas on them that were decontaminated. Property S had a small area on its eastern border excavated and backfilled, while properties' U and V had a combination of 8 areas remediated and backfilled. Of the areas decontaminated and backfilled on those properties it is unclear from the report whether or not the areas mentioned in the 1972 report surrounding the CDD on those properties were also decontaminated and backfilled.

⁴⁹ Although there are no dates on the tables, specific details from these tables are referred to in the 1980 background report, which says its information is from the 1971-1972 survey. Oak Ridge Operations, U.S. Atomic Energy Commission, Radiation Survey and Decontamination Report of the Lake Ontario Ordinance Works Site, Oak Ridge, TN, January 1973.

⁵⁰ Vierzba, E. A. and Andrew Wallow III, *A Background Report and Evaluation of Resurvey Requirements for the Former Atomic Energy Commission Portion of the Lake Ontario Ordinance Works*, The Aerospace Corporation, Germantown, MD, August 1980

⁵¹ Although the CDD runs to the east of property P, the 1980 report states that no contamination from the CDD was detected on property P.

⁵² The 20 $\mu\text{R/h}$ or 170 mrem/y guideline in 1972 is now 25 mrem/y for decommissioned properties.

⁵³ Kaye, M.E and A.M. Feldman, *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties—1985 and 1986*, Bechtel National Inc., Oak Ridge, TN, January 1989.

⁵⁴ Bechtel National Inc, *Post-remedial Action Report for the Niagara Falls Storage Site Vicinity Properties-1983 and 1984*, Lewiston, NY, Oak Ridge, TN, December 1986.

However, the December 1986 remedial action report⁵⁵ does state that the CDD was decontaminated from the northern boundary of the NFSS property to a location 1500 feet west of Lutts Road. Soil sample analyses in this report show that the average concentration of Ra-226 was 1.2 pCi/g above background, which is below the remedial action guideline of 5 pCi/g above background. However, of the 1750 sediment samples collected within the ditch, 101 of them exceeded 5 pCi/g above the background levels. Each of these results were evaluated using contiguous soil samples and near-surface gamma measurements to determine the average concentrations per 100 m² of surface soil as required by USEPA guidelines. The report mentions that after this evaluation seven areas were identified where the average Ra-226 concentration still exceeded the 5 pCi/g guideline but was less than 15 pCi/g. It is unclear why the 15 pCi/g guideline is mentioned in this section, since that is the guideline applicable to contamination below 15 cm. It is important to mention that if the land is disturbed so that the soil below 15 cm is brought to the surface, the 5 pCi/g guideline should apply. Hence, because the land surrounding the Central Drainage Ditch has been disturbed for previous excavations and not backfilled, we are of the opinion the 5 pCi/g guideline should apply for the CDD.

The Bechtel (1986) report also states that the most realistic scenario of human exposure to radiation from the ditch would assume that a house was built beside the ditch on sediment dredged from the bottom of the ditch and spread along the bank. This was the scenario deemed best for the purpose of developing a specific remediation guideline for the ditch. Based on this scenario, the guideline was set to 20 pCi/g above background as the maximum permissible concentration of Ra-226 in soil in the CDD. The Bechtel (1986) report assumed mixing of contaminated and uncontaminated soil. The computed yearly gamma dose was 1.1 mrem/yr. Hence, under this guideline the report states that the resulting radiation dose from this scenario would be less than the DOE radiation protection standard of 100 mrem/yr. The problem is that 100 mrem/yr is a standard that is used for operating facilities. However, the vicinity properties discussed in this memo have been decommissioned and released for private development. For decommissioned facilities, USACE has used the NRC regulatory standard, 25 mrem/yr, at Maywood and Wayne, New Jersey Sites. Since the NFSS site and vicinity properties are closed, the 25 mrem/yr guideline should apply.

A more fundamental problem is that the calculations are wrong. The Bechtel calculations take into account thorium-230 and radium-226 and ignore the decay products, such as bismuth, polonium and lead. As seen in the attached Table 4, the most important radionuclides are Bi-214 and Pb-214 (99.7% of the direct gamma dose) and these radionuclides appear to be ignored by Bechtel. The direct gamma yearly dose for an adult that we calculate in Table 4 for the exposure scenario is approximately 57.6 mrem/yr. Since the table itself is somewhat cryptic, a discussion of the table appears in Appendix A. The direct gamma calculation is under the assumption an adult is exposed 365 days per year, but ignores other pathways, such as gardens, milk and meat ingestion, and incidental soil ingestion. Since a child's organs are closer to the ground, the NCRP has recommended that the direct gamma dose be increased by 30% for children. Thus, the radiation doses could potentially be greater.

Our conclusion is that at least the unexcavated portion of the CDD must be decontaminated since our calculated dose of 57.6 mrem/y (see Table 4) exceeds the 25 mrem/y guideline. Further, all sections of the previously excavated section of the CDD, from 1500 feet past Lutts Road down to the NFSS property line, where the Ra-226 concentrations exceed 5 pCi/g should also be decontaminated.

Quantitative Analysis

⁵⁵ Ibid

In this section of the report we determine the exposure to the concentrations of radionuclides on the vicinity properties and compare the doses to the 25 mrem/yr EPA standard⁵⁶ before and after their release. Since 1983, EPA regulations require that radiation doses due to the uranium fuel cycle be less than 25 mrem/y. To carry out this analysis, we used DOE's software RESRAD 6.3 to analyze data from the 1984, 1986, and 1989 surveys of the various vicinity properties and the CDD discussed in this report.

Data Collection

We collected data from each of the surveys performed on these properties during the 1980s. We did a separate dose analysis for each of the three years the surveys were conducted. Although a large portion of each vicinity property was below the regulatory limits, we focused on sections of each vicinity property that do not appear to be properly certified, that is, the concentrations led to calculated doses that appear to be above regulatory limits. In our view, if a part of a vicinity property exceeds regulatory limits, then the entire vicinity property should not have been certified. From our analysis we produced a range of doses for each of the vicinity properties, which will be discussed later. All of the vicinity properties we discuss in this report had a 1984 survey; the only area that did not have a 1984 survey was the CDD. However, because the CDD runs through and adjacent to properties' P, S, T, U, and V, an analysis of contamination on these properties seemed sufficient for that time period.

The 1986 survey analyzed the unexcavated and excavated portions of the CDD as well as properties' H', S, U, and V. From these surveys we gathered the lowest and highest values from the data points obtained from samples of the excavated portions of the properties for our RESRAD analysis. Therefore, we have a range of direct gamma doses in mrem/yr that would be received by a resident per year for each of the surveyed properties and the CDD.

Finally, the 1989 survey analyzed properties' D, E', F, G, P, and T. We collected the data from this survey the same way we collected it from the 1986 survey. Hence, we also have a range of direct gamma doses in mrem/yr that would be received by a resident per year for each of those properties. The data that we employed is listed in Tables I, II, III, and IV.

Methods

Because the properties have been released for unrestricted development, we assumed the scenario of a person residing on the property, with a garden. This is the standard farmer-resident scenario and yields the highest dose. When entering the data into RESRAD we assumed all of the pathways, except radon, were available. Radon was excluded, since it is not part of the 25 mrem/yr EPA regulation. The pathways we include are external gamma, inhalation, plant ingestion, meat ingestion, milk ingestion, drinking water, and incidental soil ingestion. Inhalation and drinking water do not give a significant dose; therefore, the doses we included from RESRAD are direct gamma and plant, meat, milk, and incidental soil ingestion. We used data that were available, but otherwise retained RESRAD default values. The data we inputted were the soil concentrations, the square meters of the contaminated zone, the thickness of the contaminated zone, irrigation mode, and the hydraulic conductivity value. We chose a range for values for the soil concentrations, inputting the highest and lowest concentrations observed in soil samples from the hotspots on the properties when they were being surveyed before and after remediation.

The radionuclide soil concentrations varied by vicinity property. We only recorded concentrations for the two main radionuclides mentioned throughout the surveys: Ra-226 and U-238. RESRAD inputs the decay products. Because the data for the initial surveys were collected along 20 m to

⁵⁶ Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended: Provisions.40 CFR 192.32(a)(3)(i)

40 m gridlines we used 400 m² and 1600 m² as the contaminated areas for RESRAD⁵⁷. For remedial action surveys, data were collected in an area of 81m², which we used as the value for the contaminated areas. Several of the samples collected from the properties were taken in the top soil layer, from 0 to 15 cm of the surface. Therefore, we defined the thickness of the contaminated zone as 15 cm or 0.15 m. For the hydrological data we changed the hydraulic conductivity to 0.38 m/year, based on information from the 2005 NFSS report. We also changed the irrigation mode from overhead to ditch.

Results

The calculated doses from the 1981-1985 ORAU surveys appear in Table I a-b. Using the average concentrations in each specific area that was not decontaminated, sections of all of the vicinity properties have doses exceeding 25 mrem/yr. The averages of doses were calculated from samples collected from the elevated areas of concentrations on each of the properties. Then we used the area of one grid box as the contamination zone for that average. We used this same area for the high and low points we collected from each of these properties. The doses range from a low as 1.48 mrem/yr (property U) to as high as 79417.36 mrem/yr (property E).

Table II a-b has the results of doses received with radionuclide concentrations from the 1986 survey and table III a-b has the results of doses received with radionuclide concentrations from the post-remediation 1989 survey. After excavation and remediation of these properties several of the doses were reduced from what they previously were in the 1981-1985 surveys. All of the properties except E and H were remediated and re-surveyed. The CDD was also included in the 1986 remediation and survey. The highest dose measured in the high dose range on these properties was on property H'; a resident-farmer would receive a dose of 266.11 mrem/yr. The dose measured in the low dose range was on the CDD with a dose of 0.43 mrem/yr.

Conclusions

The dose results from the 1981-1985 ORAU surveys show that there were still areas on each of the properties that exceeded the 25 mrem/yr dose from hundreds to almost a thousand times. . Even after remediation several of the properties still had areas on them that exceeded the 25 mrem/yr guidelines. These properties include D, E', G, H' and T. Therefore, we conclude these vicinity properties were not properly certified and further remediation of these properties will be necessary

Also, the excavated and unexcavated (Table IV) portions of the CDD were both found to be higher than the guidelines. It is important to note that our calculation of direct gamma from the CDD is about 2 times higher than that calculated from RESRAD. This may be due to the fact that we did not use the confined contamination zone that was used in RESRAD to calculate our number. Instead, we assumed an infinite area of contamination, which would make the number larger than the RESRAD result.

Vicinity properties that appeared not to have exceeded the guidelines from the surveys taken after remediation might also be misleading. Although the remediation was supposed to remove the areas with elevated radiation levels some of the highest levels of radiation on some of the properties were not necessarily excavated. Since sampling after excavation was only usually done on the excavated portions it is hard to tell whether or not the areas that were mentioned as having high radionuclide concentrations still remained high after the various vicinity excavations. Property D had an extremely high Ra-226 concentration in the 1984 survey that resulted in a very

⁵⁷Some properties were surveyed using a 20 m grid, while others were surveyed using a 40 m grid system; therefore we used either the area of 400m² or 1600m² relative to the property being surveyed.

high direct gamma dose according to the RESRAD results. However, this very point on property D seems to have been ignored in the excavation of the property in the 1989 survey. The same is true for property E, which had two high radionuclide areas that were not remediated because the concentrations of radionuclides on that property did not exceed the generic guidelines of averaging more than 5pCi/g of contamination in the first 15 cm of soil over an area of 100 m².

Besides the parts of property E' that have been remediated but would still cause a direct gamma dose over the EPA limit, another area of contamination on property E' also seems to not have been fully remediated as evidenced by conflicting reports about contamination on the property. This includes the 30 X 15 m transect that is stated to have Ra-226 contamination in the range of 300 pCi/g in one memo about property E' but is not mentioned in the survey report published in the same year by the same author. That particular point was also not mentioned in the most recent surveys done on property E'.

Property F had one of the lowest direct gamma dose levels before and after remediation of the property. However, the point on property F that had the highest Ra-226 concentration, resulting in a dose above 25 mrem/yr, was not mentioned as having been excavated in the 1989 survey of the property.

Property H also had high Ra-226 contaminated areas according to its ORAU survey. Because researchers attributed most of these areas to a chemical processing material used as fill and paving base, further analysis was not performed on this property. The direct gamma dose from the contamination on the property is 40 times that of the EPA limiting dose of 25 mrem/yr.

As evidenced by the qualitative analyses of the past surveys performed on the properties as well as the quantitative analysis it is difficult to conclude that these vicinity properties should have been released for unrestricted development in 1992. Several of the properties still have areas that would cause a potential resident to receive a dose over the 25 mrem/yr limit set by the EPA.

Fully comprehensive surveys were not performed and they seemingly excluded areas that were stated as having extremely high points of contamination on these properties. Further surveys, analysis, and remediation should have been done on these properties and the CDD before they were released for unrestricted development in the early 1990s.

Tables and Figures

Table I a.* Vicinity Property Concentrations and Calculated Doses to a Resident-Farmer (1981-1985 Surveys) (Pre-remediation)

1981-1985 Property	Area (m ²)	Ra-226 avg (pCi/g)	U-238 avg (pCi/g)	RESRAD Average mrem/yr	High Ra-226 (pCi/g)	Low Ra-226 (pCi/g)	High U-238 (pCi/g)	Low U-238 (pCi/g)	High mrem/yr	Low mrem/yr
D	1600	165.36	21.73	1172.53	11200	0.95	403	1.47	79417.36	6.74
E	1600	18.65	30.71	136.04	514	4.25	22600	4.03	3749.40	31.00
E'	400	141.60	25.53	794.34	3190	2.53	12900	1.32	17895.15	14.19
F	1600	5.77	6.57	41.69	22	1.41	13	0.86	161.82	10.19
G	1600	33.63	8.04	238.97	1400	1.06	1410	0.36	9948.35	7.53
H	400	25.69	35.04	147.04	865	0.92	71	1.55	4951.19	5.27
H'	400	92.09	15.07	516.41	1750	2.14	1480	2.32	9813.72	12.00
P	400	27.96	26.01	158.84	199	0.68	192	0.74	1130.39	3.86
S	1500	22.98	28.11	166.12	168	4.33	126	2.56	1214.35	31.30
T	400	28.38	7.53	159.45	570	0.91	272	0.41	3202.24	5.11
U	400	35.31	30.05	200.37	894	0.26	254	0.34	5073.01	1.48
V	400	76.57	44.12	432.43	4280	23.70	95	19.00	24170.01	133.84

Table I a: This tables shows the doses calculated in RESRAD from the average concentrations of Ra-226 and U-238 on the various vicinities in surveys done by ORAU from 1981-1985. The table also has the highest and lowest dose values extrapolated from the RESRAD values using the highest and lowest Ra-226 concentrations from each property.⁵⁸

* bold numbers are doses over the limit of 25 mrem/yr

⁵⁸ To simplify the calculations we extrapolate the values for the high and low range of doses using only Ra-226 concentrations and decay products because U-238 has a much smaller or negligible contribution to the dose.

Table I b.* Pathways of Radiation Dose from RESRAD Calculation For Average Concentrations in Vicinity Properties (1981-1985 Surveys)

1981-1985 Property	Direct Gamma mrem/yr	Plant mrem/yr	Meat mrem/yr	Milk mrem/yr	Soil mrem/yr	RESRAD Average mrem/yr
D	839.9	288.1	3.875	2.853	37.8	1172.53
E	96.89	33.26	0.4542	0.3556	5.079	136.04
E'	681.1	98.77	0.8305	0.6129	13.03	794.34
F	29.75	10.21	0.1387	0.1065	1.487	41.69
G	171.1	58.7	0.7902	0.5846	7.792	238.97
H	125.8	18.25	0.1553	0.1203	2.715	147.04
H'	442.8	64.22	0.5399	0.3981	8.455	516.41
P	136	19.73	0.1672	0.1273	2.815	158.84
S	118.5	40.72	0.519	0.3999	5.978	166.12
T	136.7	19.82	0.1668	0.1236	2.639	159.45
U	171.6	24.88	0.2107	0.1599	3.522	200.37
V	370.5	53.74	0.4537	0.3405	7.395	432.43

* bold numbers are doses over the limit of 25 mrem/yr

Table II a.* Vicinity Property Concentrations and Calculated Doses to a Resident-Farmer (1986 Survey) (Post-Remediation)

1986 Property	Area m ²	Ra-226 avg (pCi/g)	U-238 avg (pCi/g)	RESRAD average mrem/yr	High Ra-226 (pCi/g)	Low Ra-226 (pCi/g)	High U-238 (pCi/g)	Low U-238 (pCi/g)	High mrem/yr	Low mrem/yr
CDD (excavated)	81	2.24	2.145	9.63	24.3	0.1	34.6	0.1	104.47	0.43
H'	81	1.94	8.254	8.77	58.8	0.4	45.6	1.3	266.11	1.81
S	81	4.47	5.3	19.28	5.3	2.8	5.3		22.88	12.09
U and V	81	1.35	2.9	5.91	5.2	0.6	2.9		22.70	2.62

Table II a: This table shows the doses calculated in RESRAD from the average concentrations of Ra-226 and U-238 on the various vicinities in surveys done after remediation by Bechtel in 1986. The table also has the highest and lowest dose values extrapolated from the RESRAD values using the highest and lowest Ra-226 concentrations from each property.

* bold numbers are doses over the limit of 25 mrem/yr

Table II b.* Radiation Dose Pathways from RESRAD Calculation For Average Concentrations in Vicinity Properties (1986 Survey)

1986 Property	Direct Gamma mrem/yr	Plant mrem/yr	Meat mrem/yr	Milk mrem/yr	Soil mrem/yr	RESRAD Average mrem/yr
CDD (excavated)	9.261	0.3202	0.002714	0.002069	0.04581	9.63
H'	8.421	0.2913	0.002547	0.002179	0.05463	8.77
S	18.54	0.6411	0.005447	0.00419	0.09379	19.28
U and V	5.682	0.1965	0.001685	0.001344	0.03136	5.91
CDD (unexcavated)	28.79	3.411	0.02866	0.02088	0.4679	32.72

Table II b: This table shows the breakdown of the doses that are included in the final average dose for each property

* bold numbers are doses over the limit of 25 mrem/yr

Table III a.* Vicinity Property Concentrations and Calculated Doses to a Resident-Farmer (1989 Survey) (Post-Remediation)

1989 Property	Area m ²	Ra-226 avg pCi/g	U-238 avg pCi/g	RESRAD average mrem/yr	High Ra-226 pCi/g	Low Ra-226 pCi/g	High U-238 pCi/g	Low U-238 pCi/g	High mrem/yr	Low mrem/yr
D	81	2.34	0	9.91	8.4	0.7	0	0	35.51	2.96
E'	81	2.35	4.946	10.29	41.5	0.3	18.6	0.9	181.34	1.31
F	81	0.80	1.8	3.51	0.8	0.8	1.8	1.8	3.51	3.51
G	81	2.07	13.33	9.66	15	0.4	52	1.5	69.94	1.87
P	81	0.80	0	3.39	0.8	0.8	0	0	3.39	3.39
T	81	2.53	5.475	11.08	8.1	0.7	7.5	2.8	35.50	3.07

Table III a: This table shows the doses calculated in RESRAD from the average concentrations of Ra-226 and U-238 on the various vicinities in surveys done after remediation by Betchel in 1989. The table also has the highest and lowest dose values extrapolated from the RESRAD values using the highest and lowest Ra-226 concentrations from each property.

* bold numbers are doses over the limit of 25 mrem/yr

Table III b.* Radiation Dose Pathways from RESRAD Calculation For Average Concentrations in Vicinity Properties (1989 Survey)

1989 Property	Direct Gamma mrem/yr	Plant mrem/yr	Meat mrem/yr	Milk mrem/yr	Soil mrem/yr	RESRAD Average mrem/yr
D	9.535	0.3296	0.002766	0.002025	0.04261	9.91
E'	9.885	0.3418	0.00293	0.002334	0.05436	10.29
F	3.372	0.1166	0.001001	0.000801	0.01878	3.51
G	9.268	0.3207	0.002857	0.002599	0.06887	9.66
P	3.26	0.1127	0.000946	0.000692	0.01457	3.39
T	10.65	0.3683	0.003159	0.002521	0.05887	11.08

Table III b: This table shows the breakdown of the doses that are included in the final average dose for each property

Table IV* Unexcavated CDD Concentrations and Calculated Dose to a Resident-Farmer (1986 Survey) (Post-Remediation)

Year 1986 Property CDD	Area m ²	Avg Conc. Ra-226 pCi/g	Avg Conc. Th-230 pCi/g	RESRAD dose after 1 year (mrem/yr)
(unexcavated portion	320	6.1	6.1	32.72

Table IV: This table shows the dose calculated in RESRAD from the average concentrations of Ra-226 and Th-230 collected from samples in an area of the unexcavated portion of the CDD.

* bold numbers are doses over the limit of 25 mrem/y

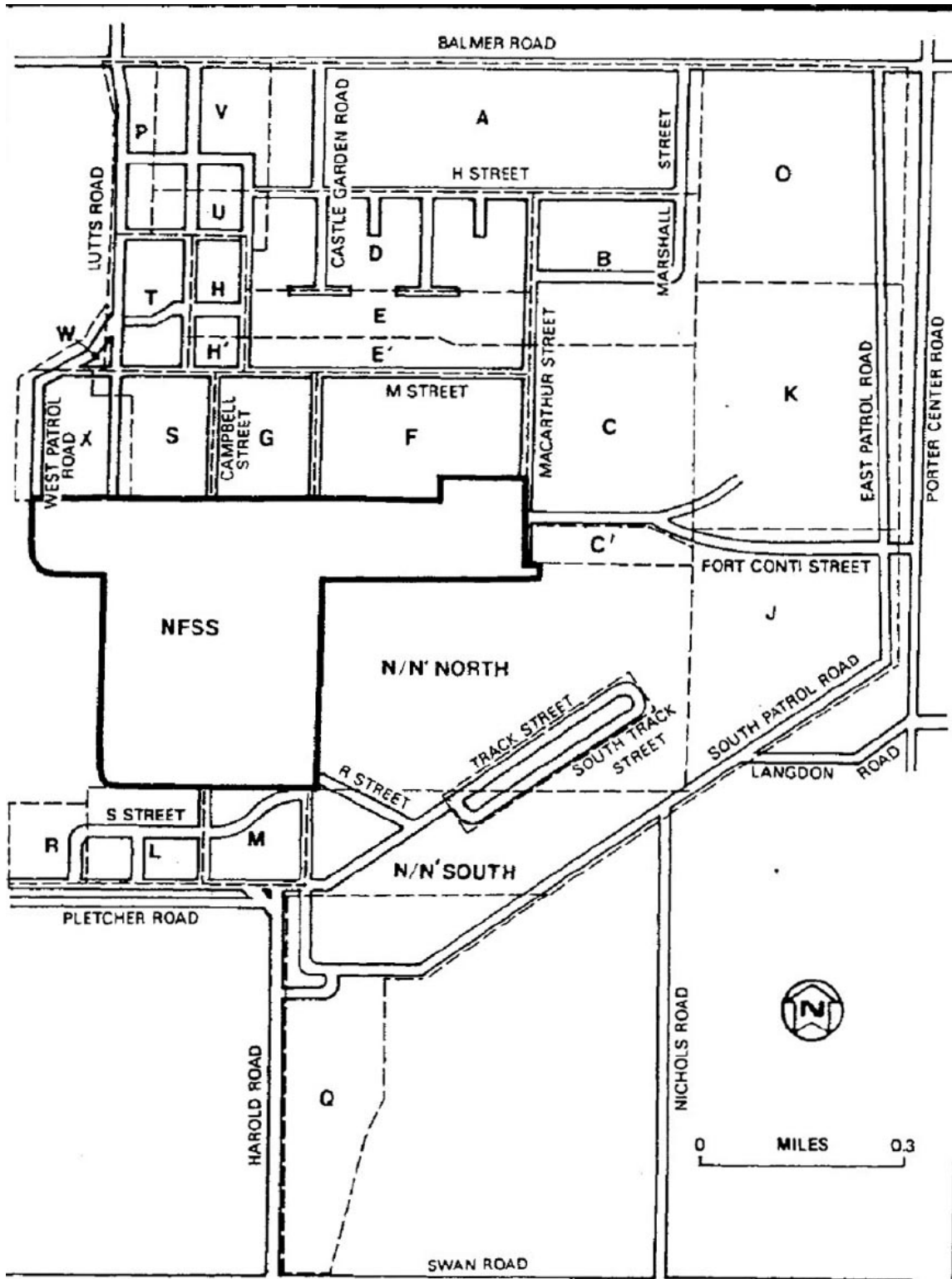


Figure 1: LOOW NFSS property and vicinity properties

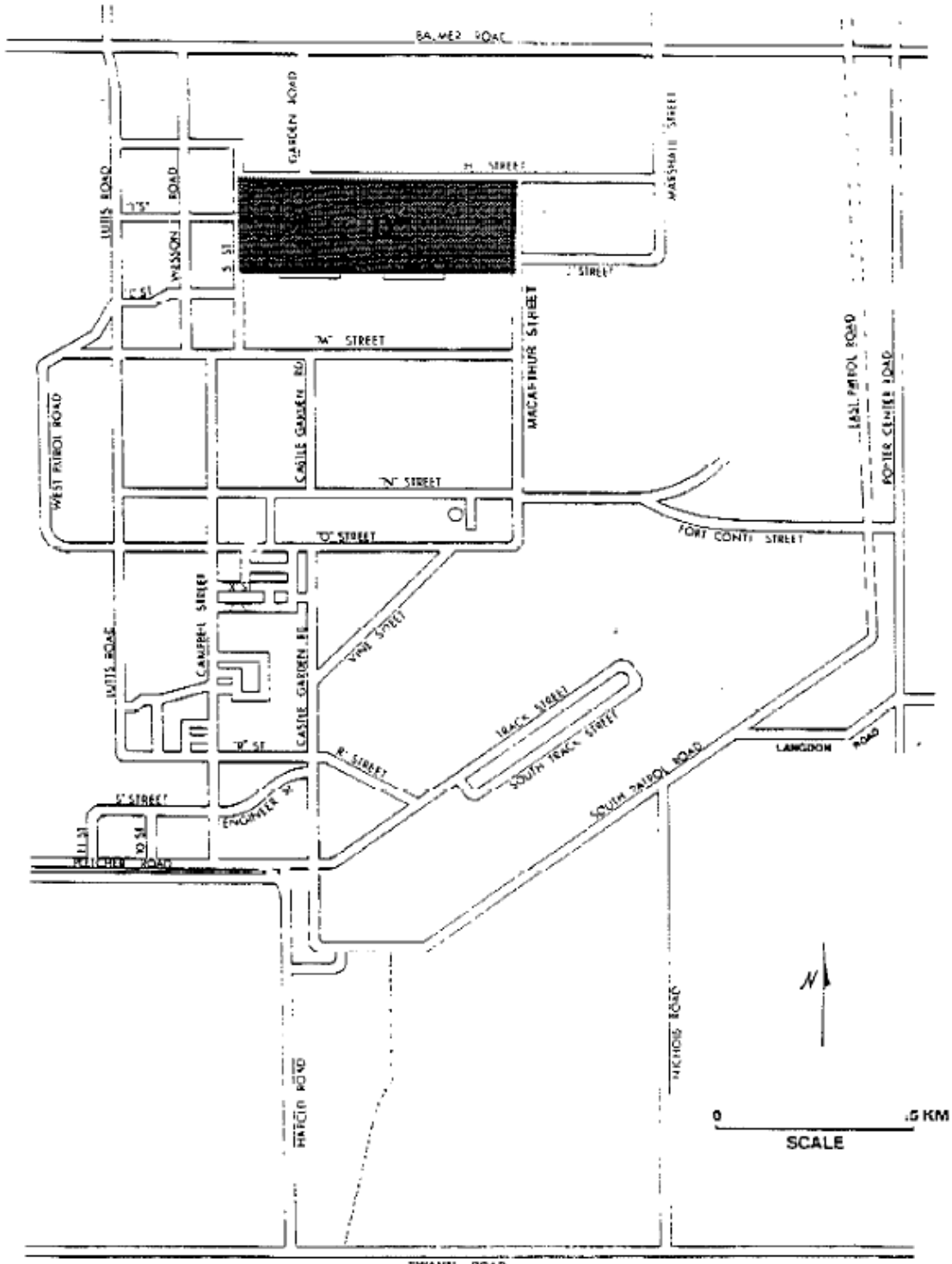


Figure 2: Map of NFSS and surrounding vicinity properties; Vicinity D is shaded

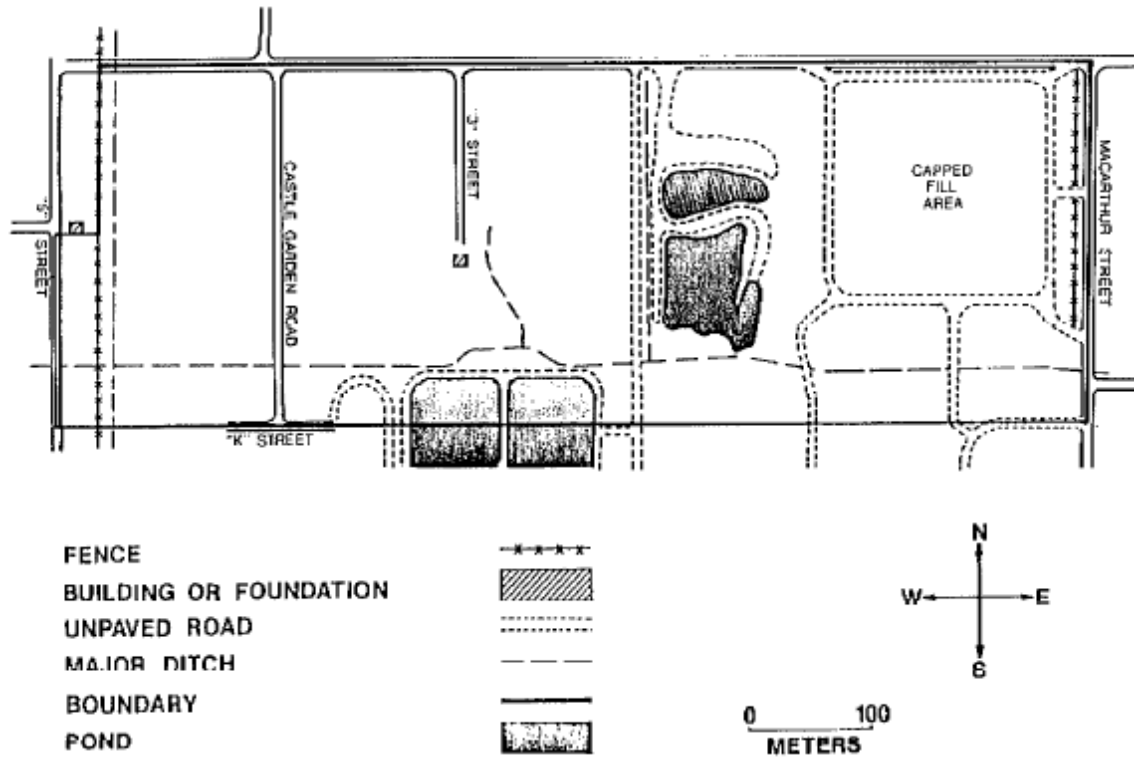


Figure 3: Map of vicinity D with major surface features outlined

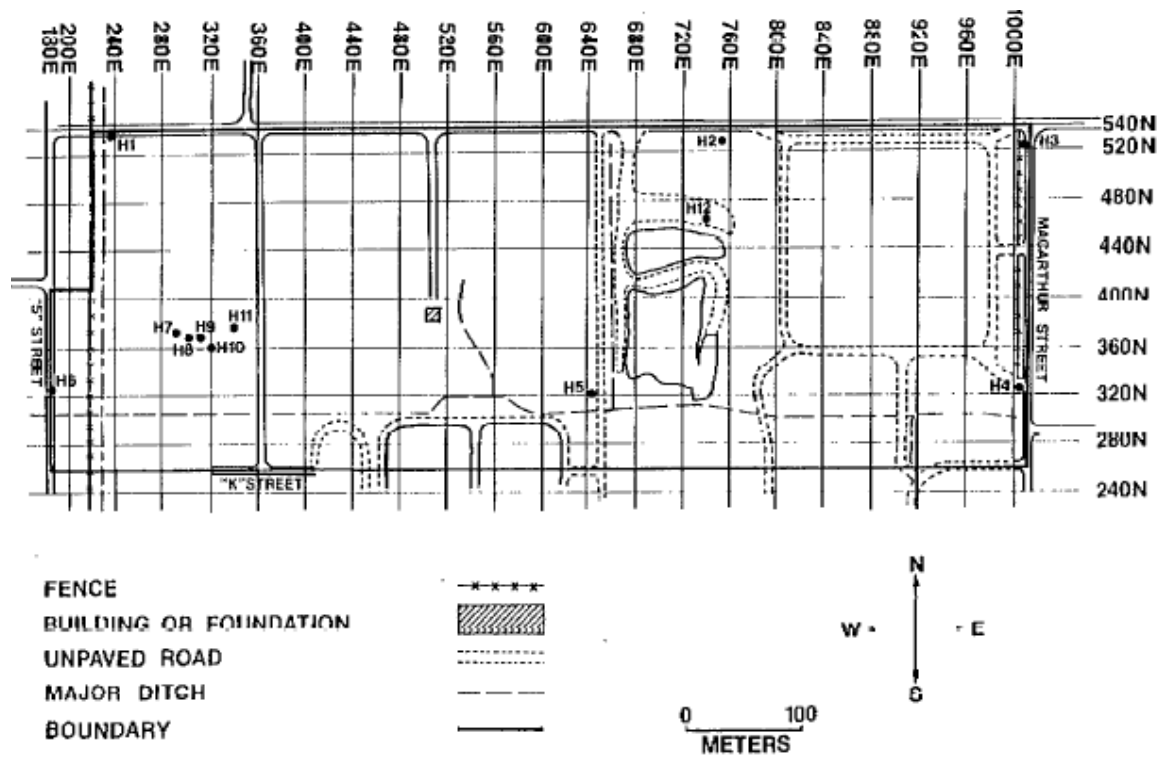


Figure 4: Locations of boreholes on vicinity property D

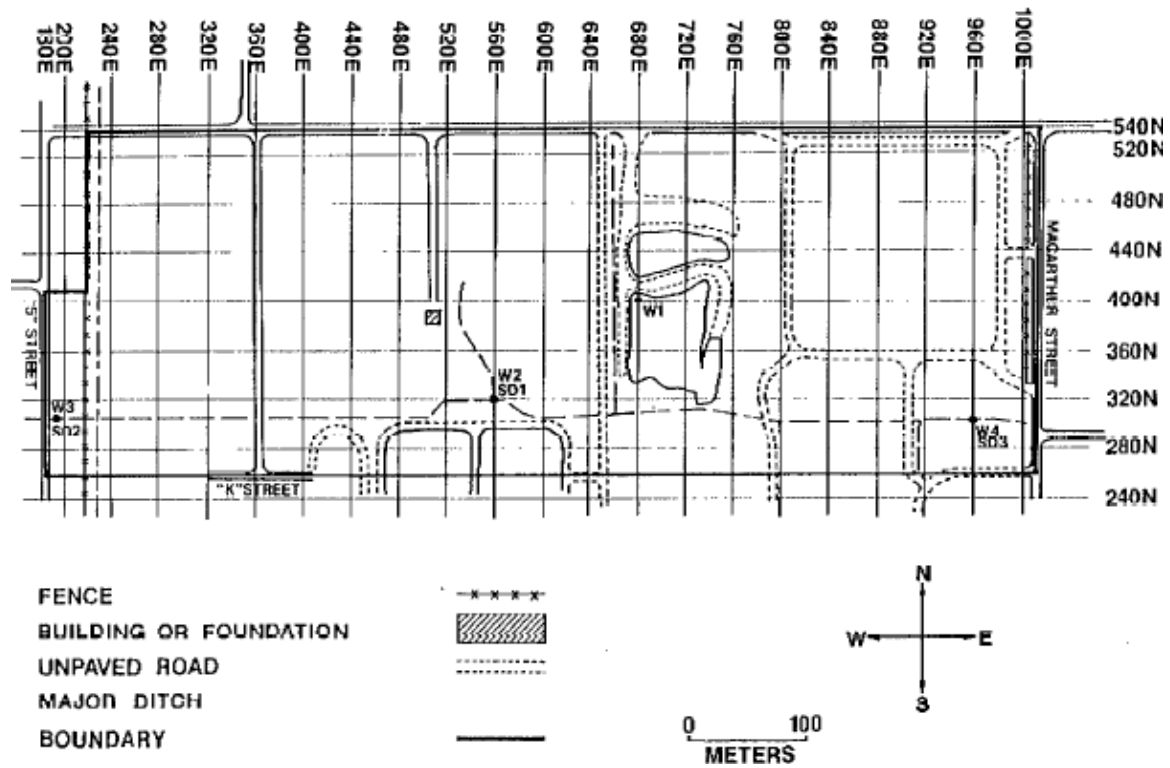


Figure 5: Locations of water and sediment samples on vicinity D

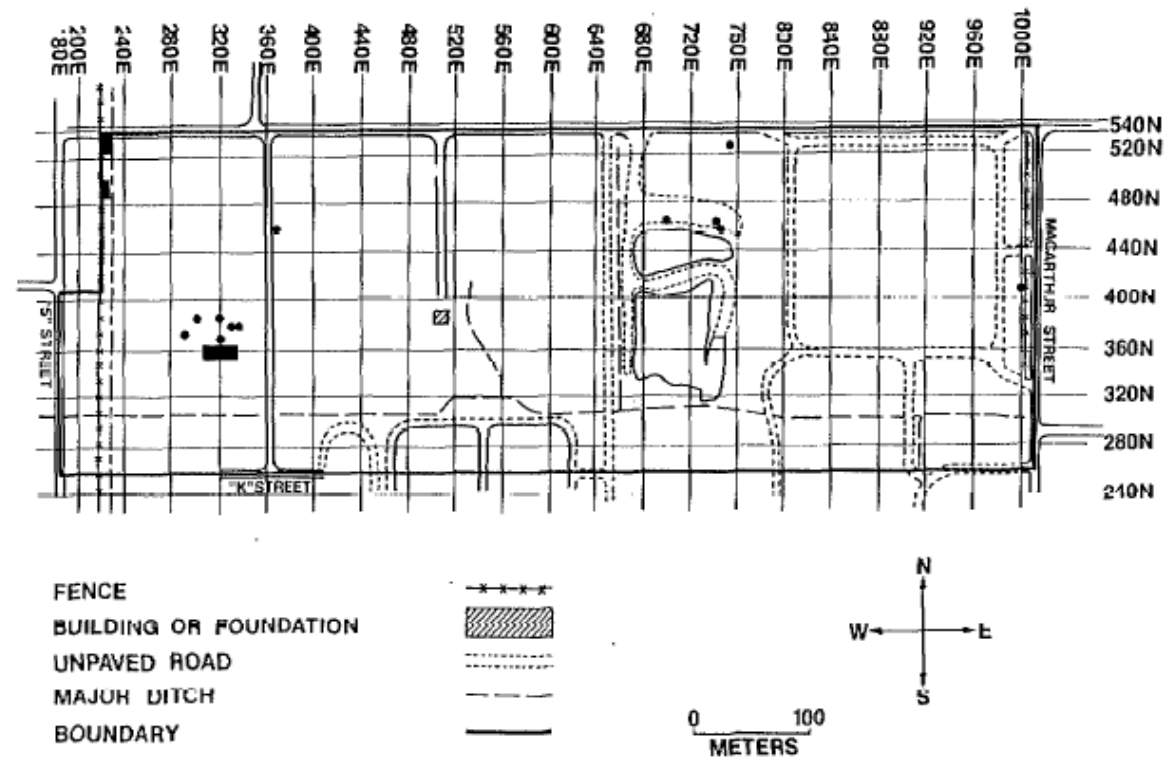


Figure 6: Locations of elevated areas of radiation; dark boxes indicate areas where there are several points of elevated radiation

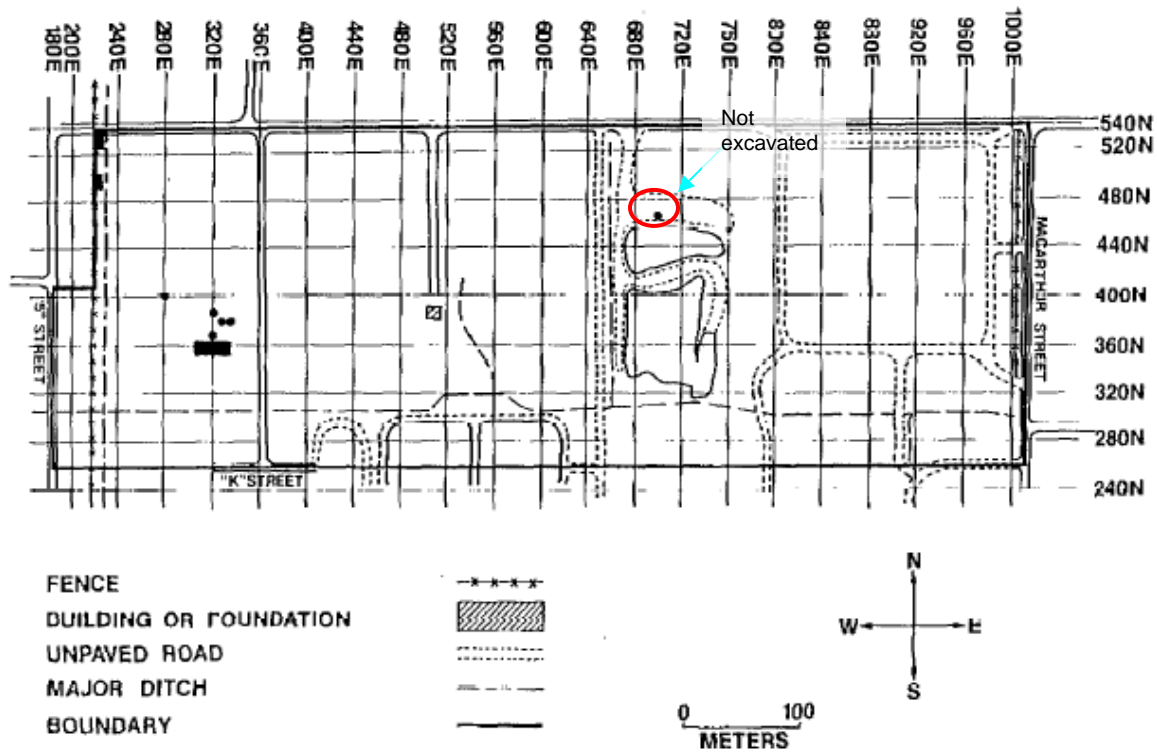


Figure 7: Locations of radionuclide concentrations that exceed criteria levels

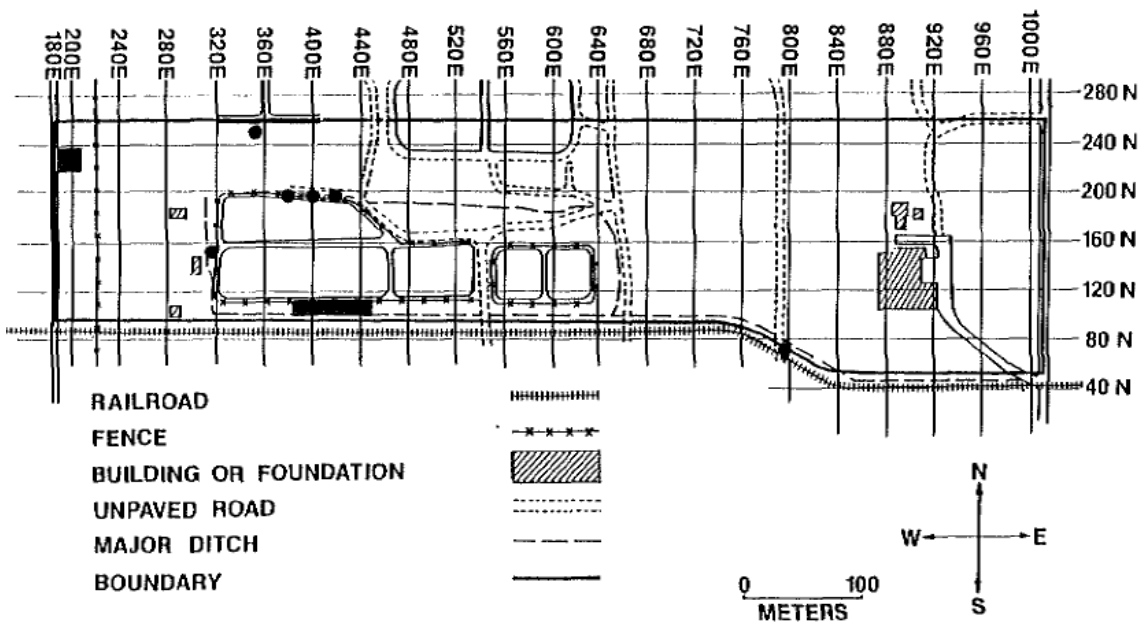


Figure 8: Property E; areas of direct elevated radiation (darkly shaded areas are regions of generally elevated radiation levels; dots indicate isolated hot spots)

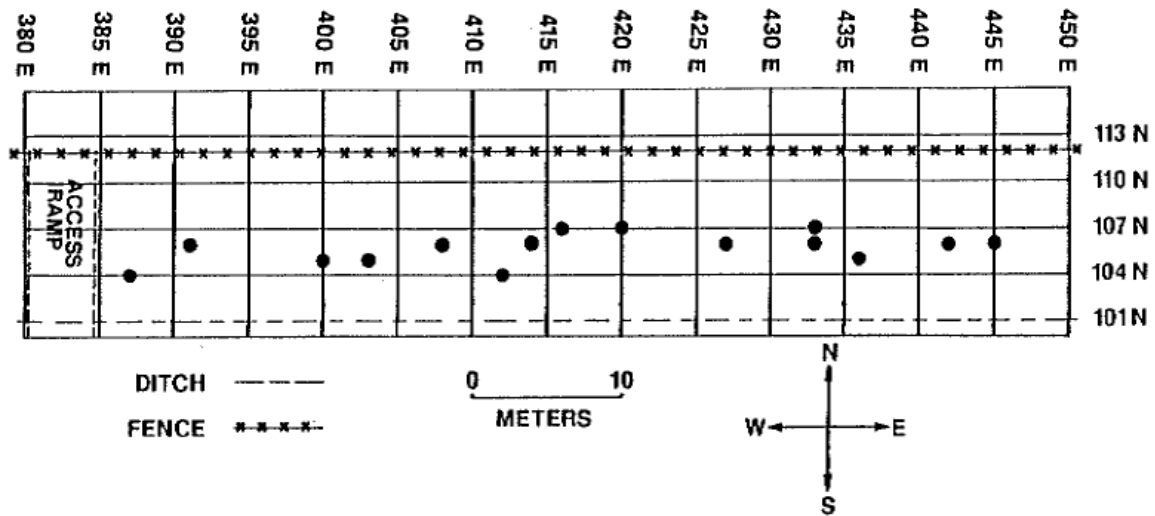


Figure 9: Property E; Section of retention pond berm containing numerous areas of contamination

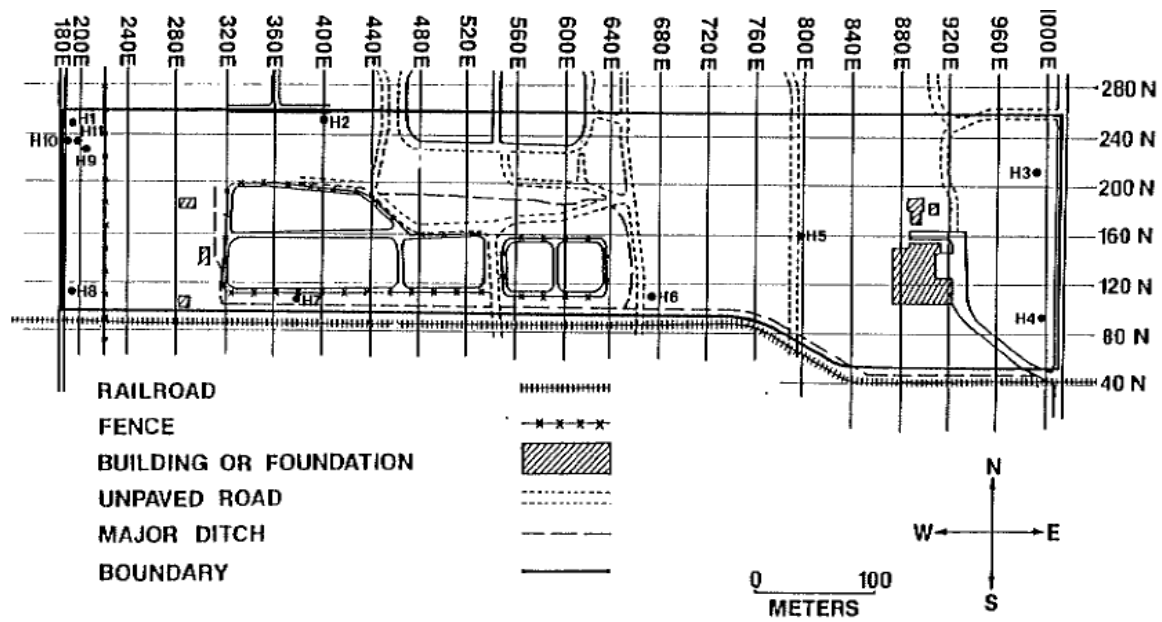


Figure 10: Property E; Locations of boreholes for surface investigation

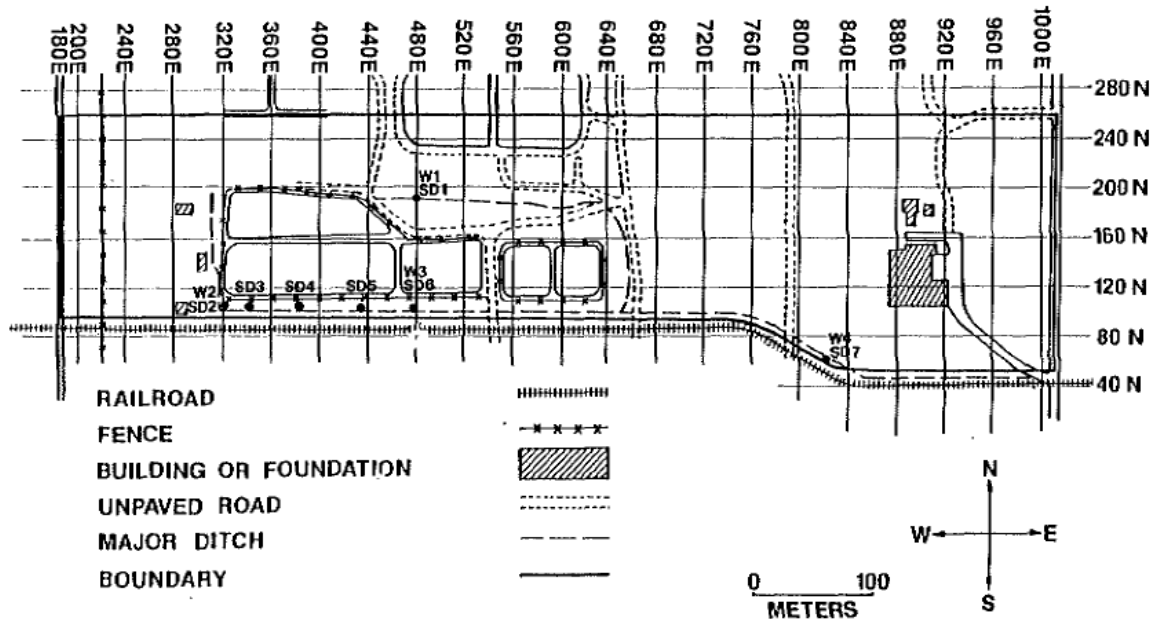


Figure 11: Property E; Locations of sediment and water samples from ditches

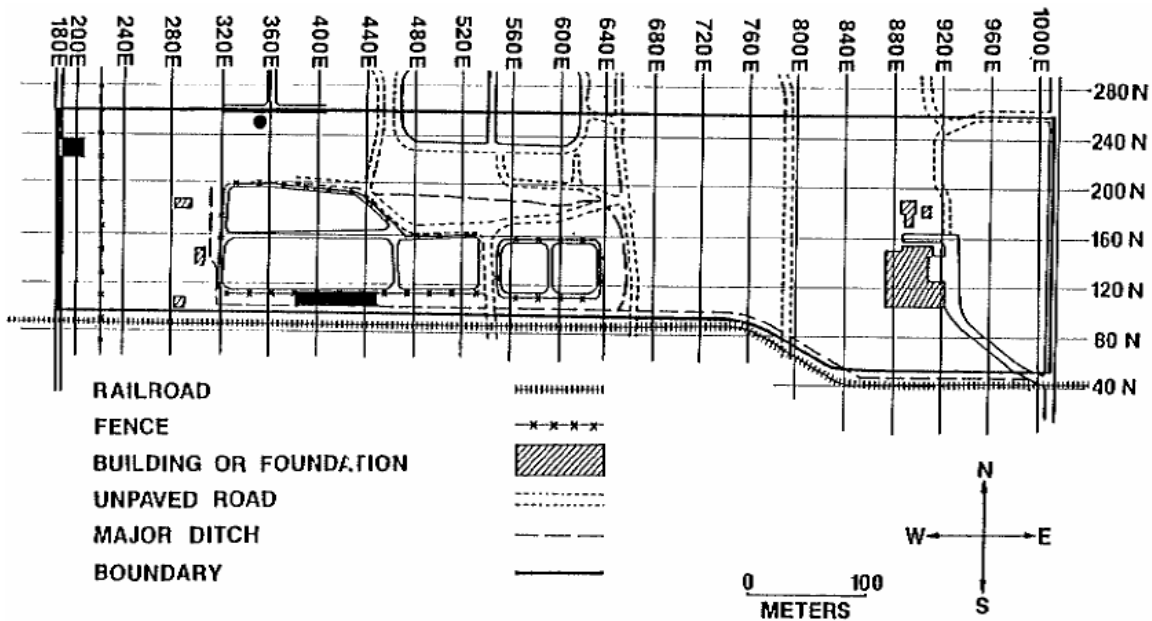


Figure 12: Property E; Areas where radionuclide concentrations in soil exceed criteria; darkly shaded areas represent regions of generally elevated radiation levels and dots indicate 'hot spots'

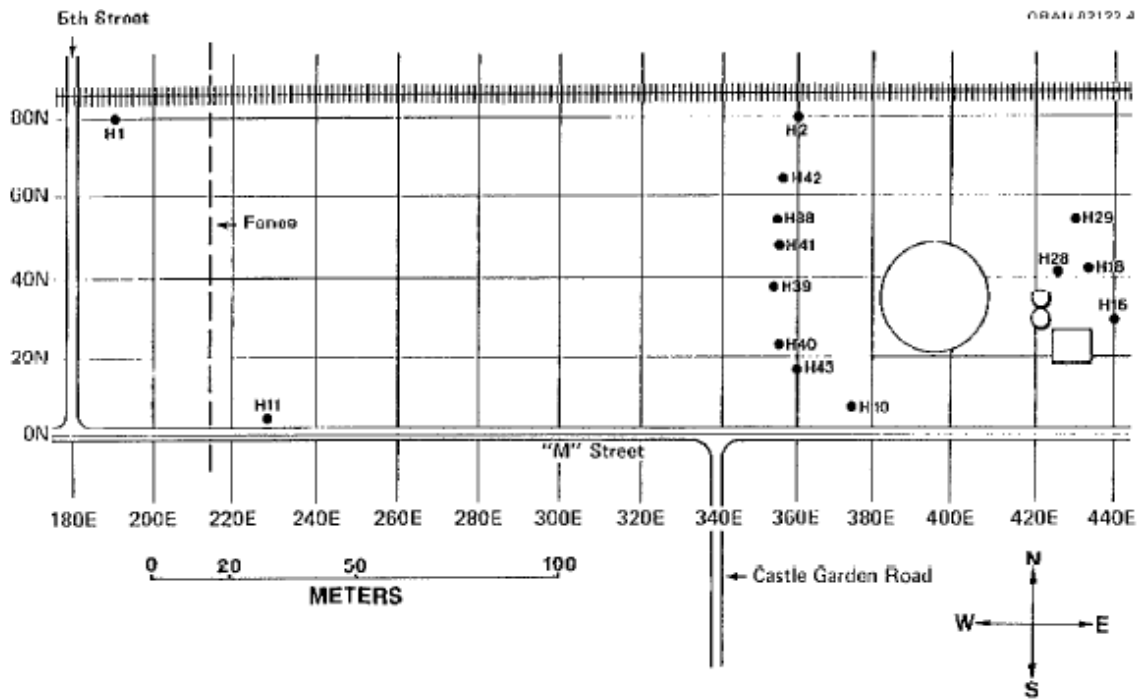


Figure 13: Map of Western portion of Vicinity E' showing borehole locations

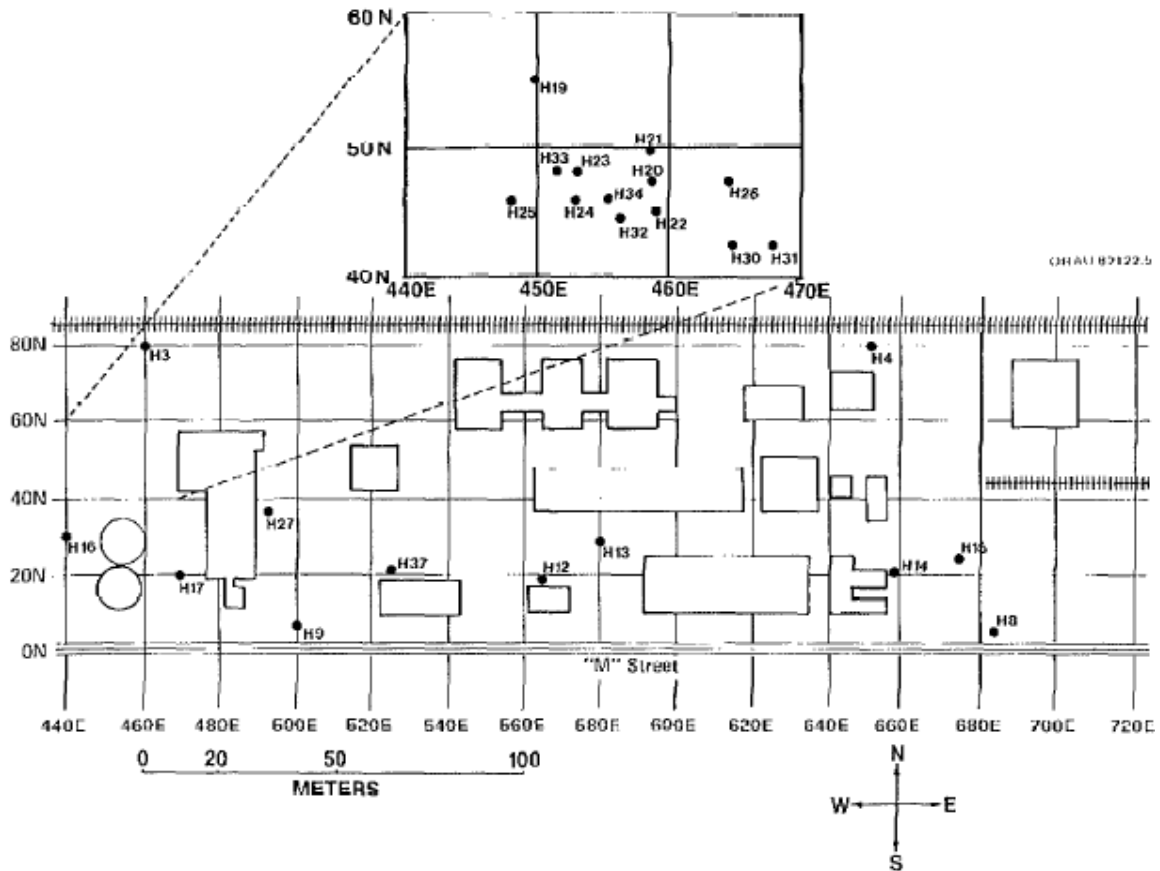


Figure 14: Central portion of Vicinity E' showing borehole locations

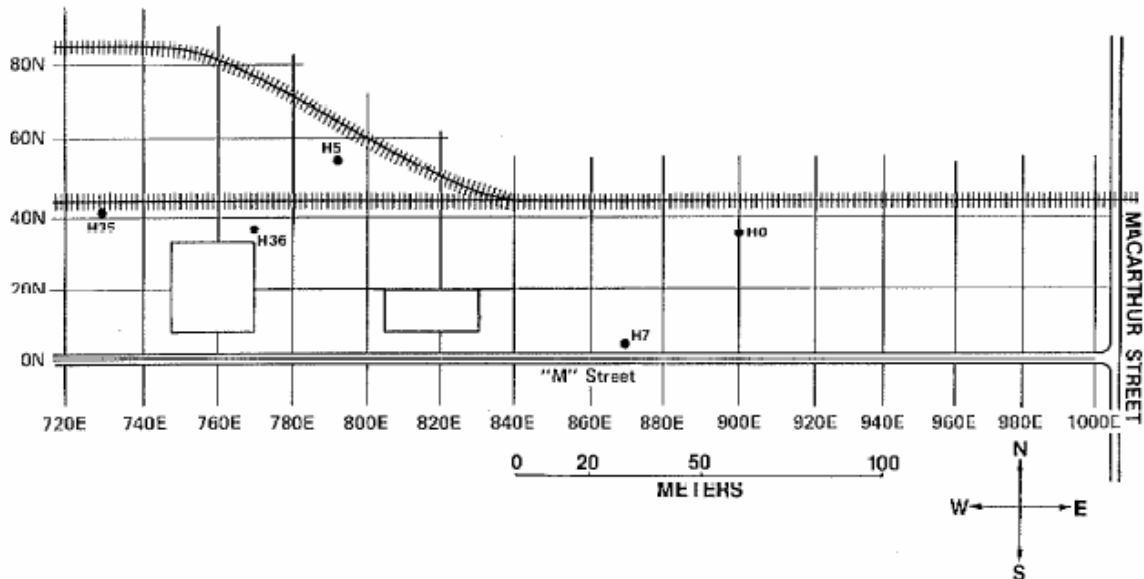


Figure 15: Eastern portion of Vicinity E' showing borehole locations

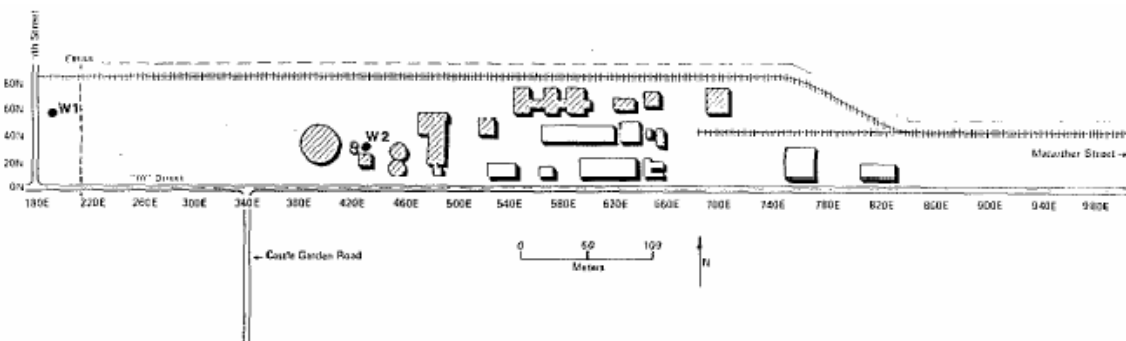


Figure 16: Location of surface water samples on Vicinity E'

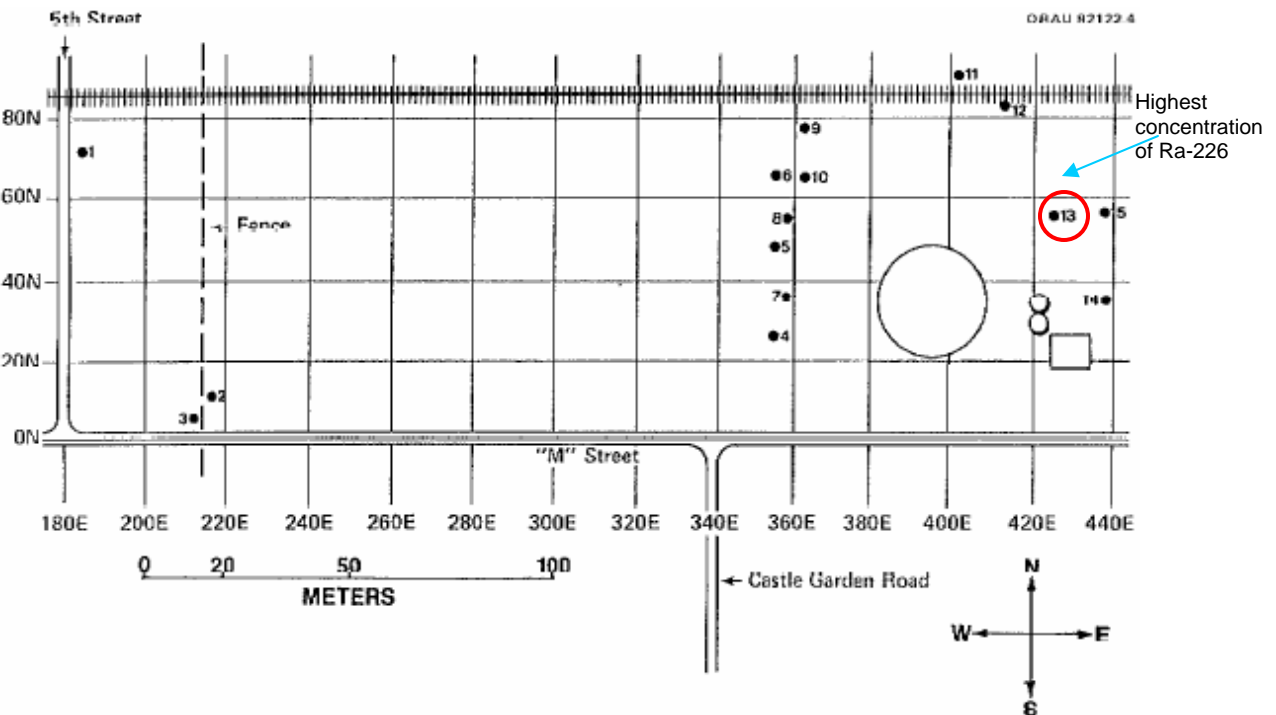


Figure 17: Western portion of Vicinity E' indicating areas of elevated surface radiation levels

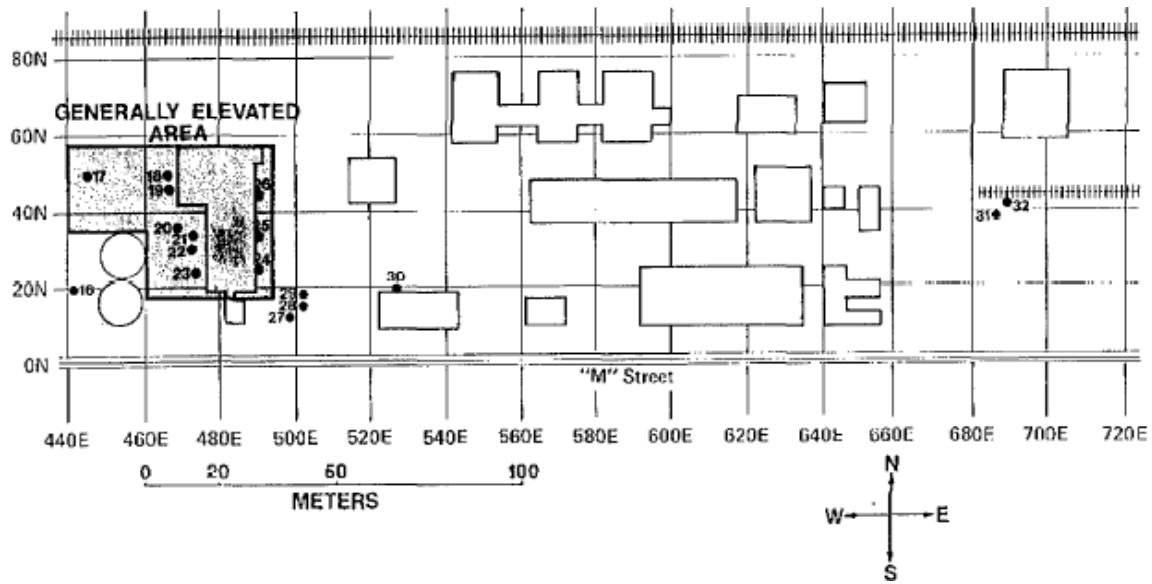


Figure 18: Central portion of Vicinity E' indicating areas of elevated surface radiation levels.

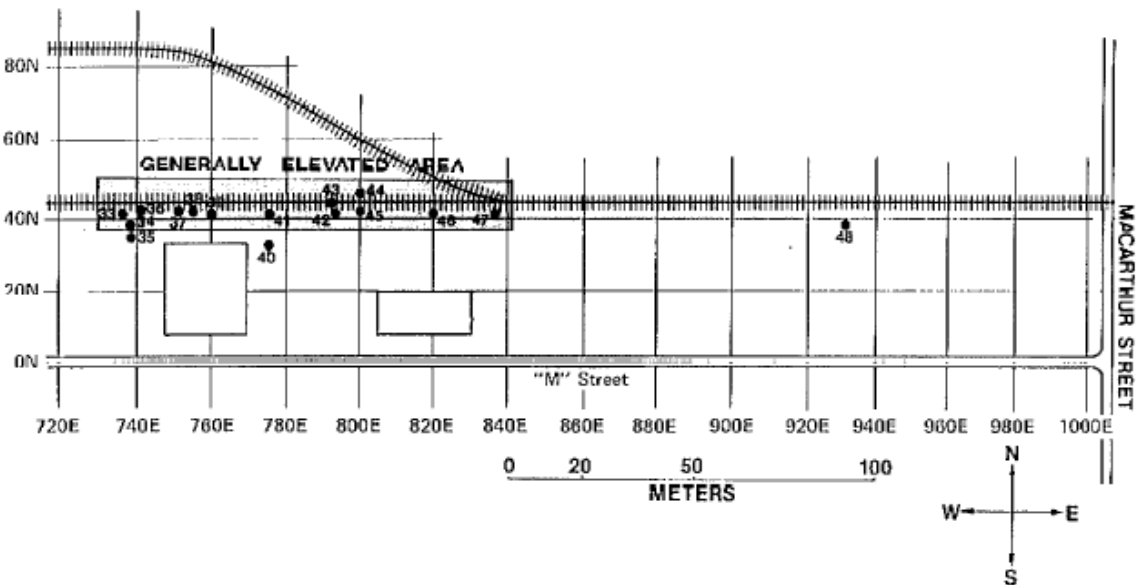


Figure 19: Eastern portion of Vicinity E' indicating areas of elevated surface radiation levels.

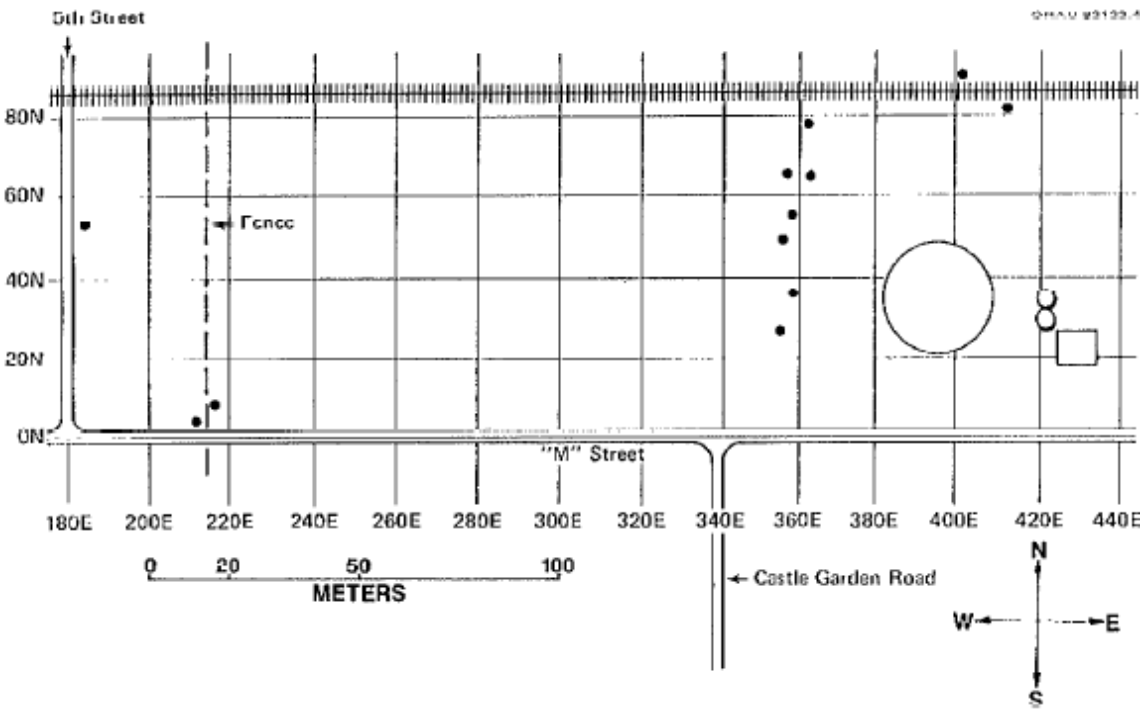


Figure 20: Western portion of Vicinity E' indicating where surface soil exceed criteria or locations of 'hot spots'

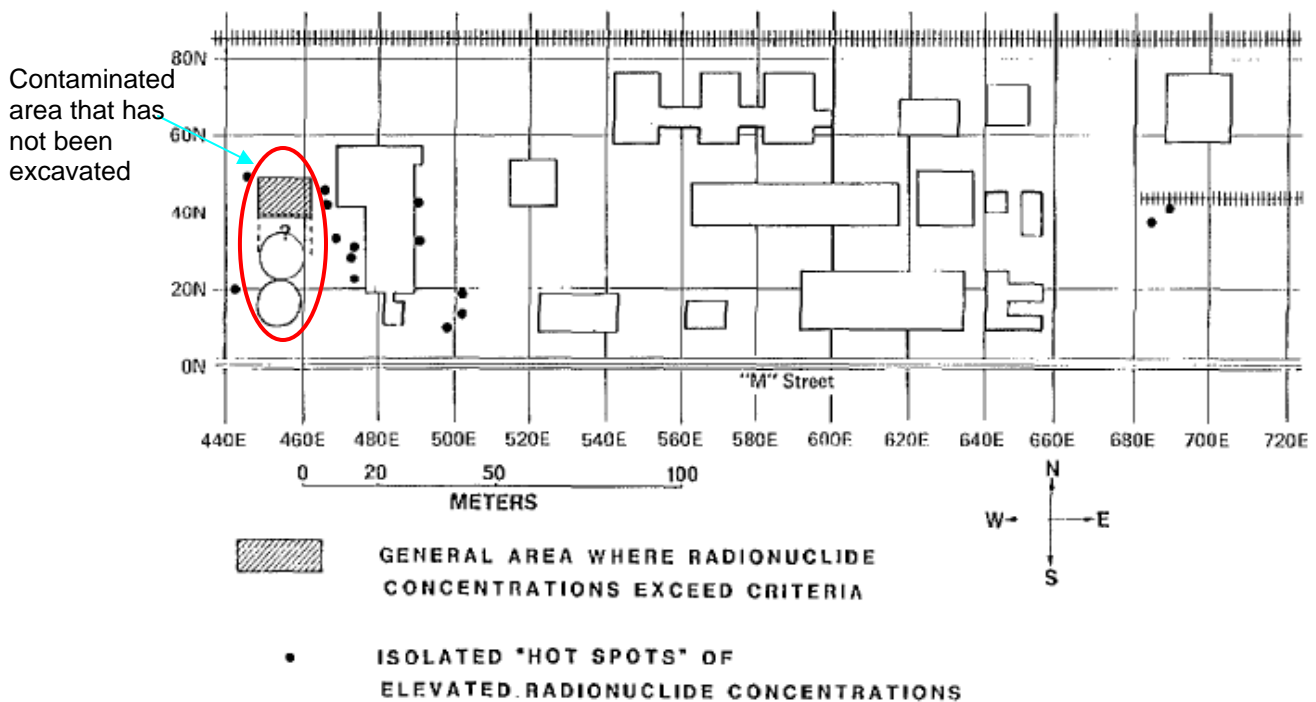


Figure 21: Central portion of Vicinity E' indicating 'hot spots' and areas of elevated radionuclide concentrations

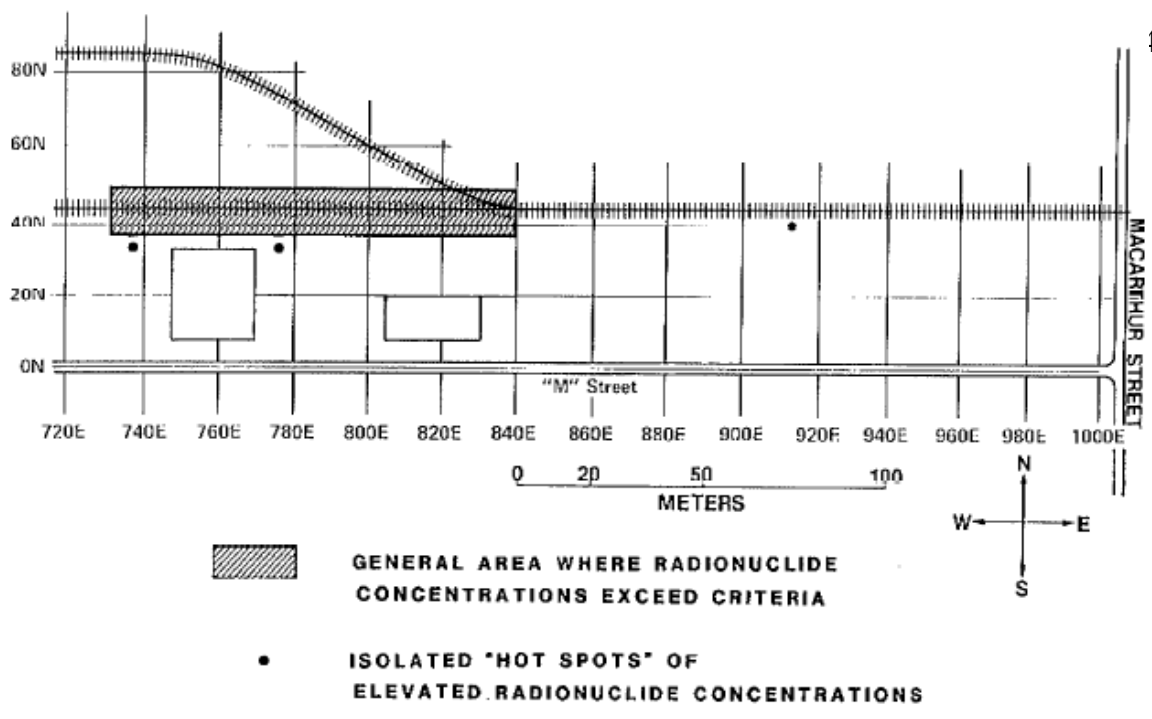


Figure 22: Eastern portion of Vicinity E' indicating 'hot spots' and areas of elevated radionuclide concentrations

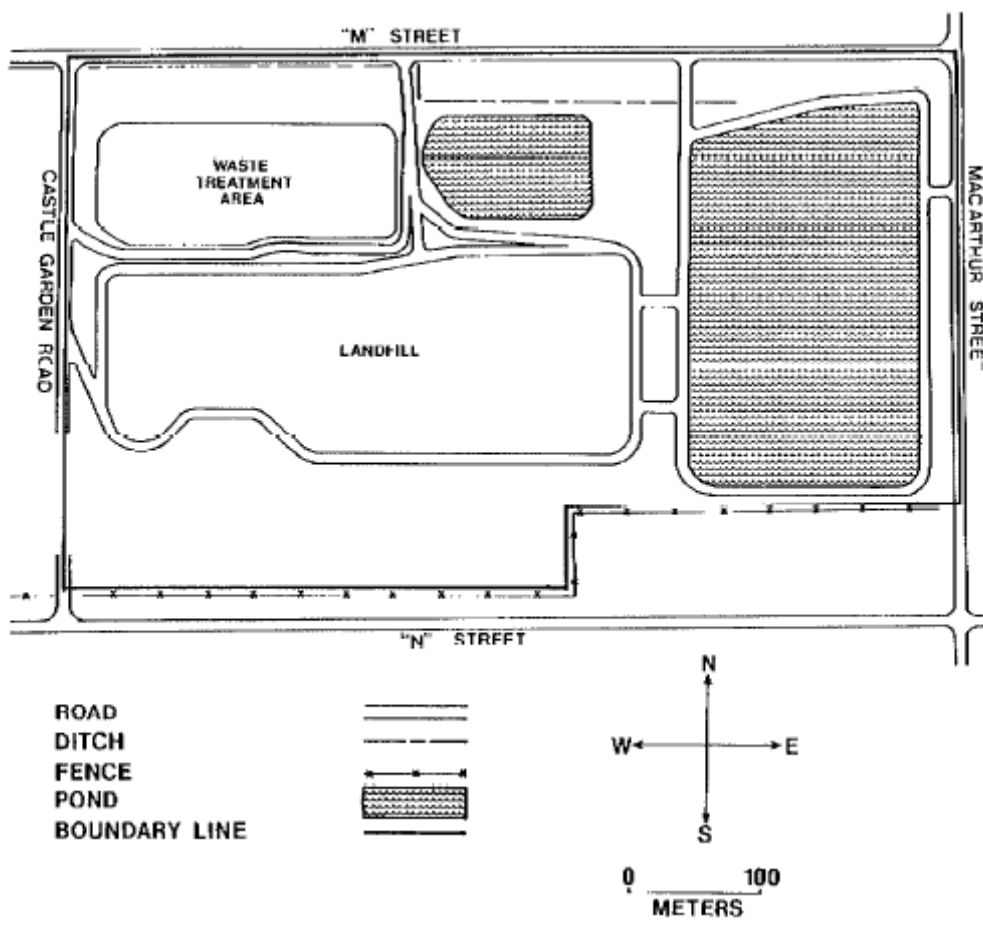


Figure 23: Major surface markers and boundaries of Vicinity F

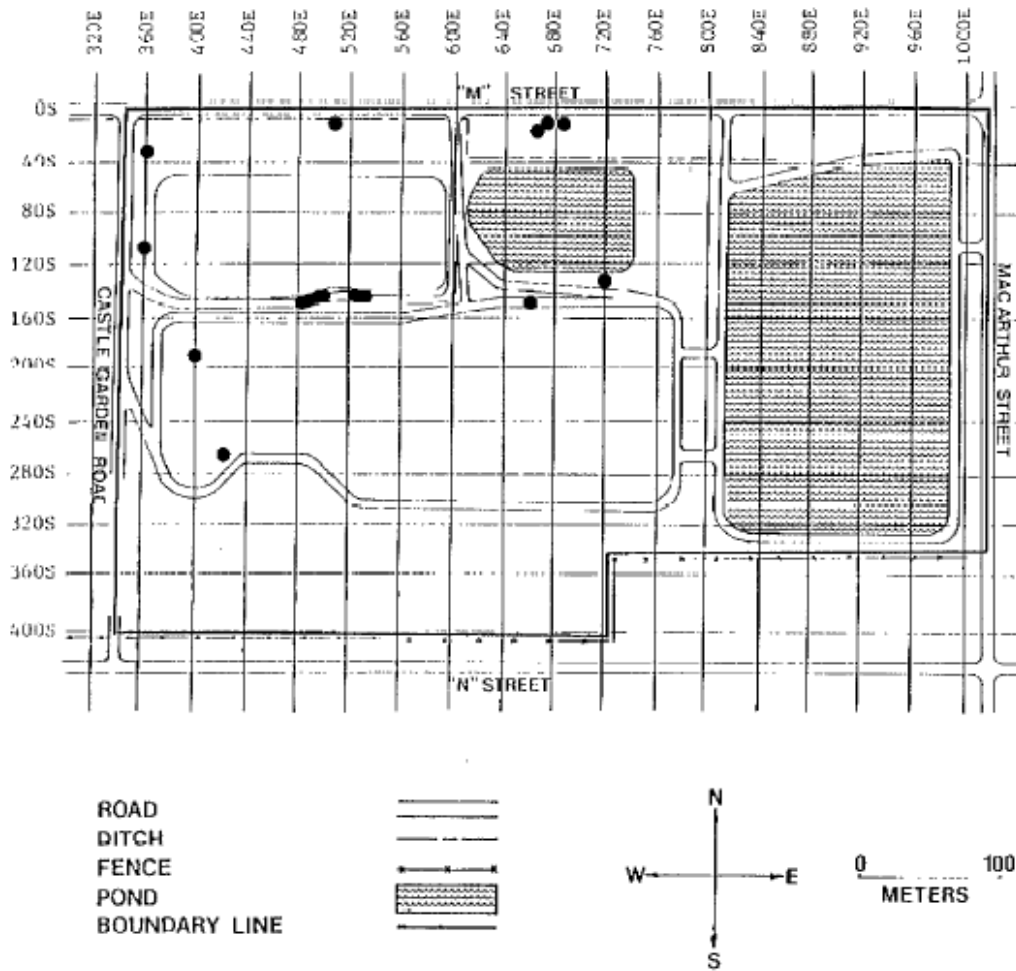


Figure 24: Property F; Locations of elevated surface radiation identified by the walkover scan

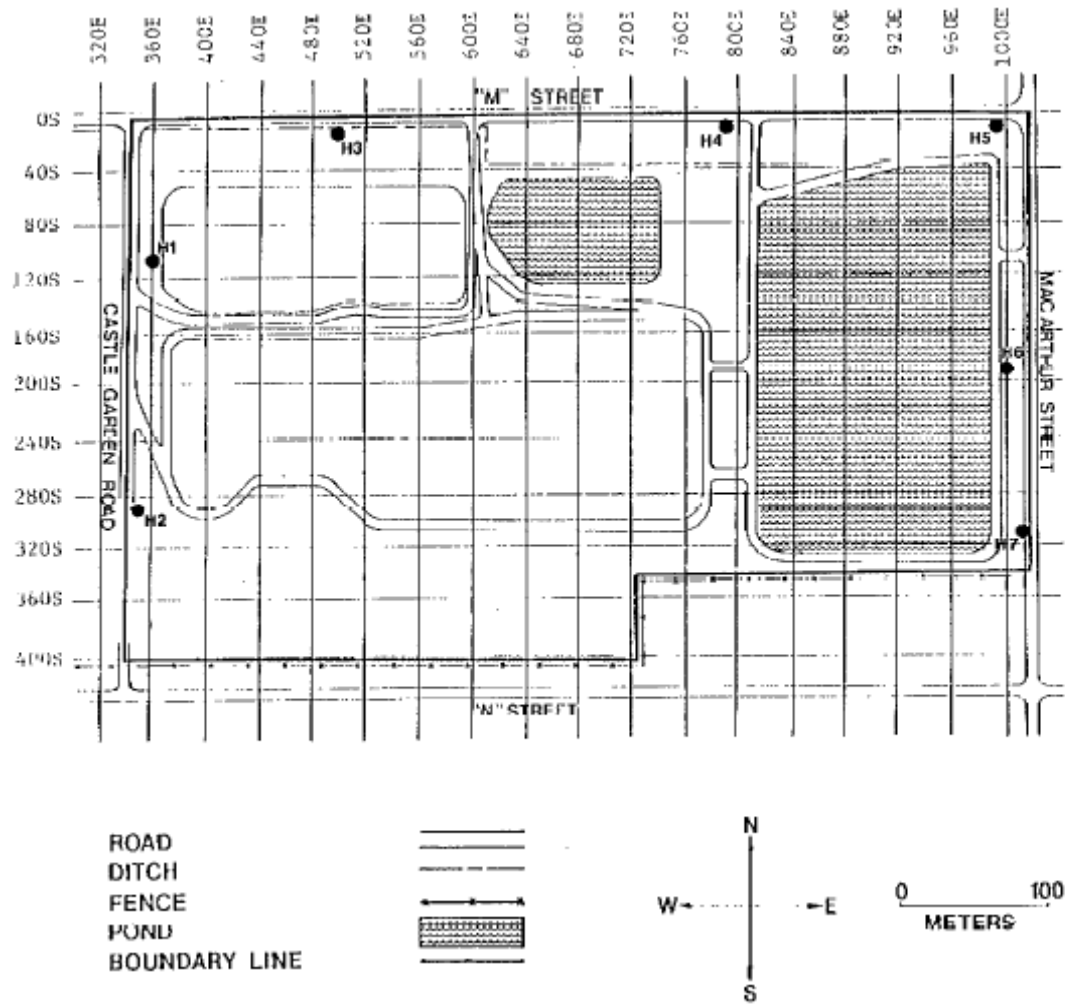


Figure 25: Property F; Locations of boreholes for subsurface investigations

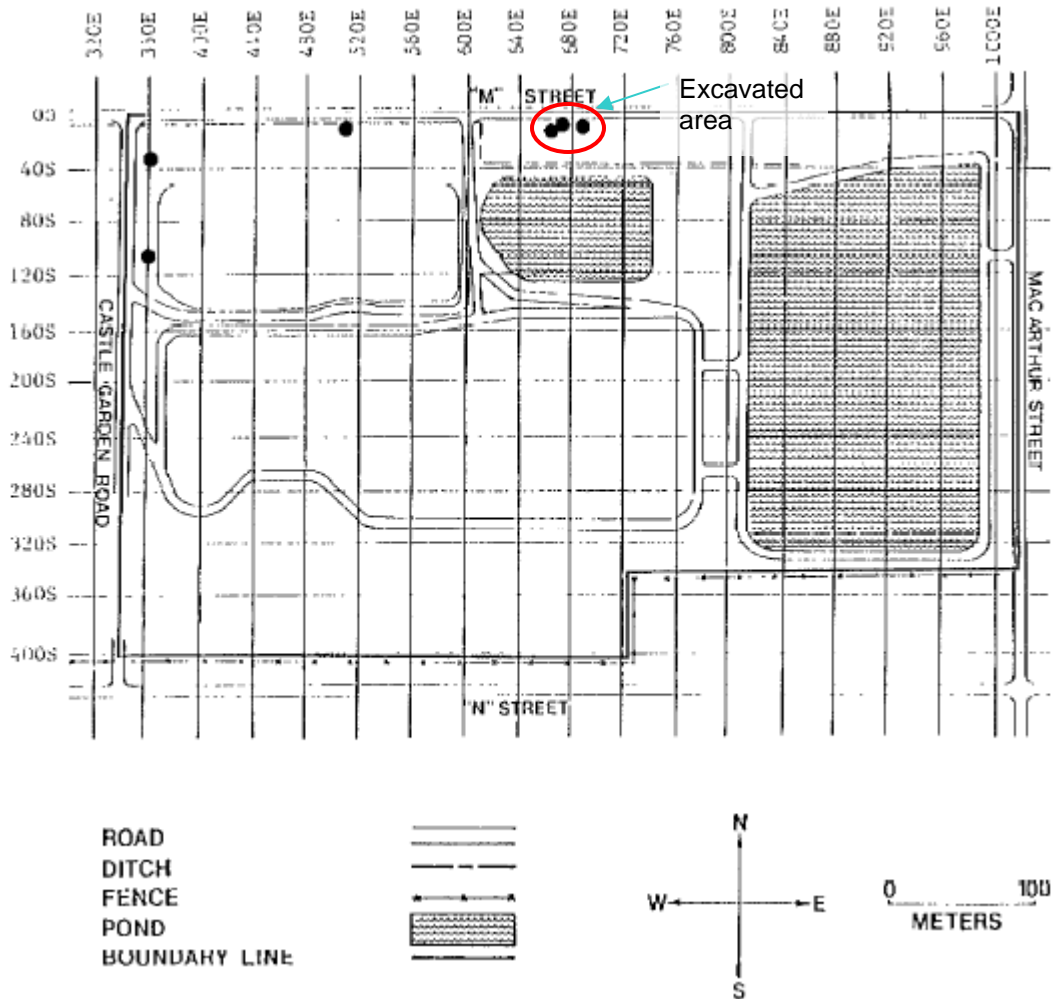


Figure 26: Locations where radionuclide concentrations exceed criteria for formerly utilized sites.

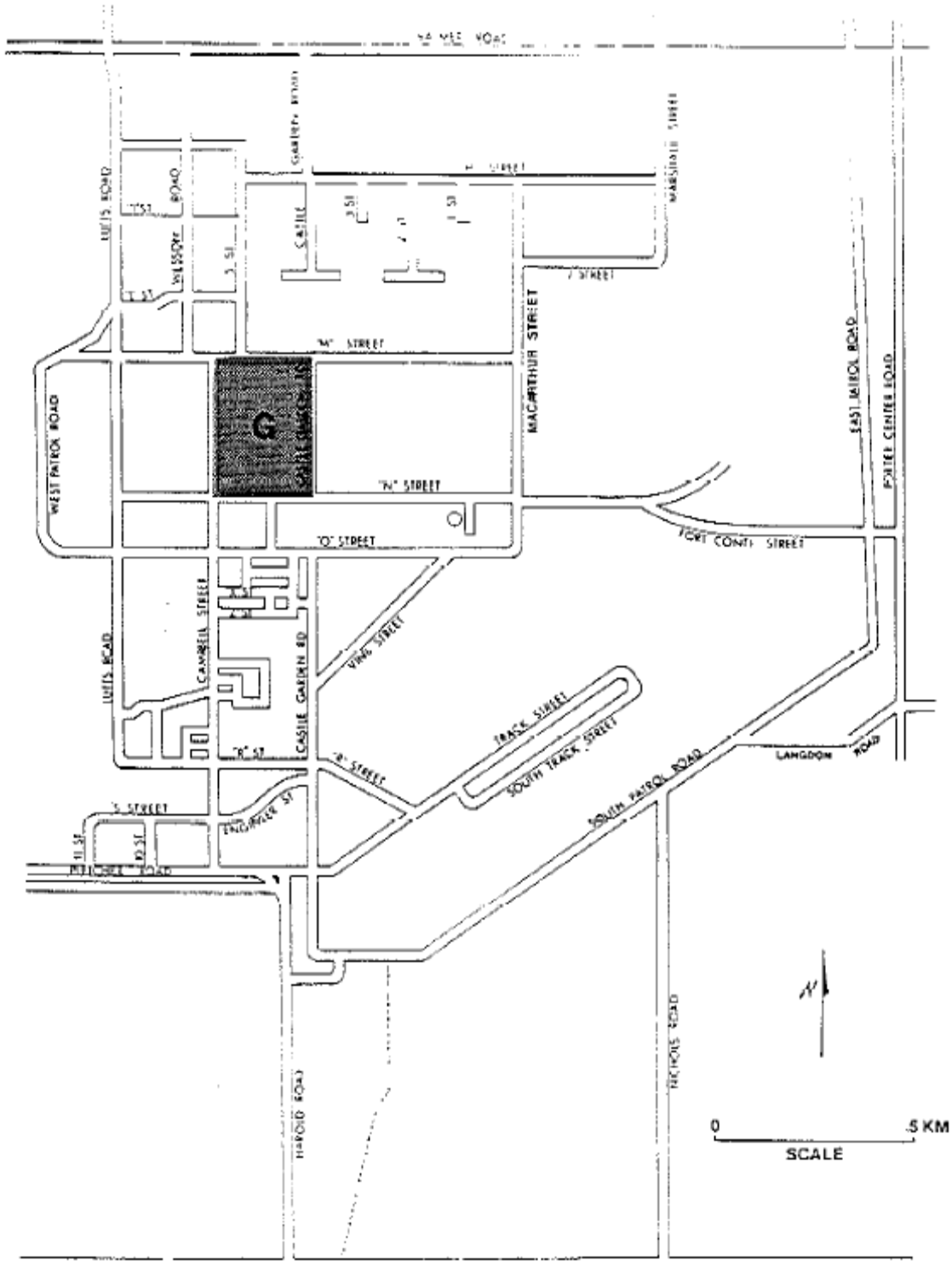


Figure 27: The NFSS site and surrounding vicinity properties with vicinity property G shaded to indicated its location

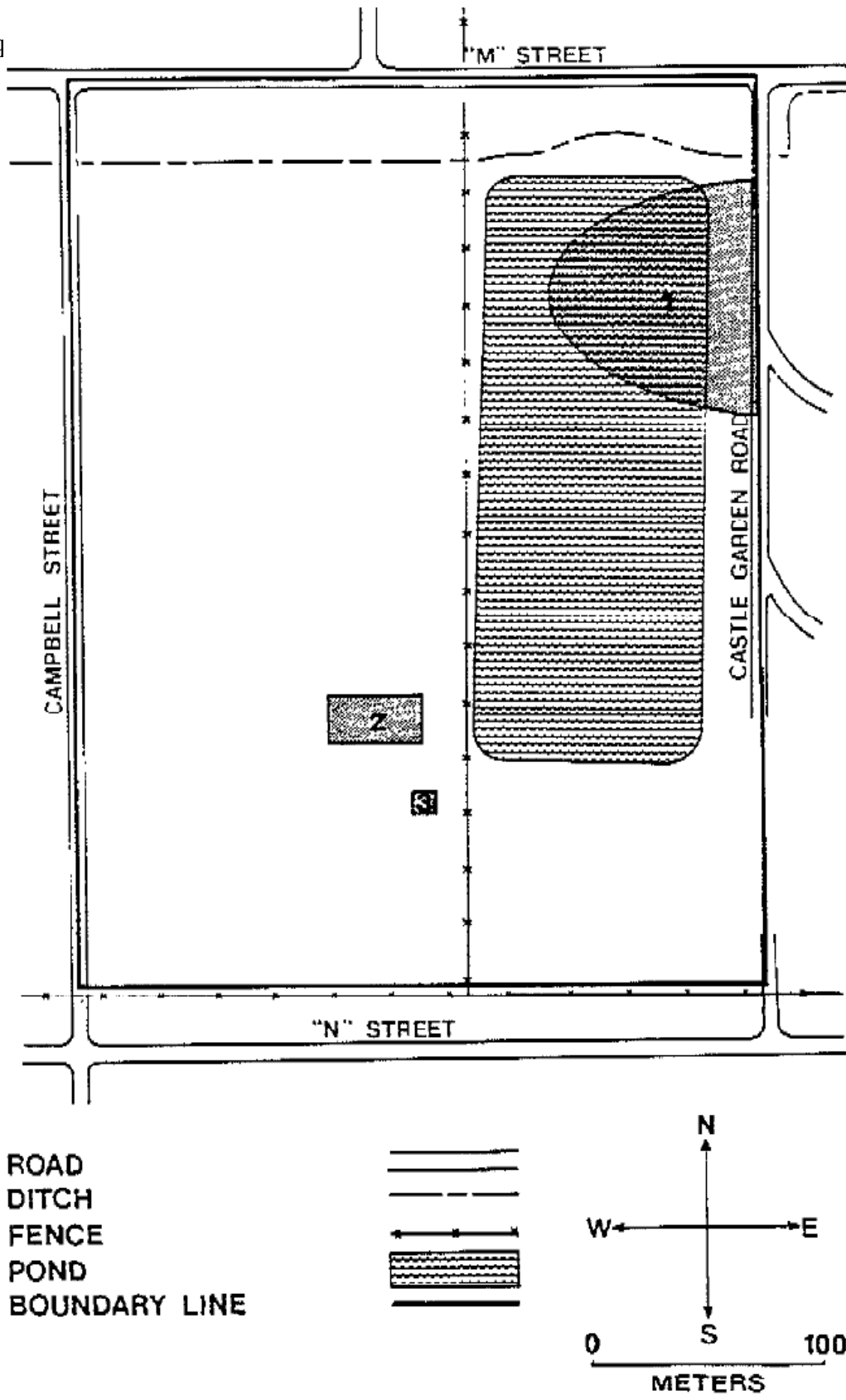


Figure 28: Vicinity G with labeled, shaded areas representing areas of contamination.

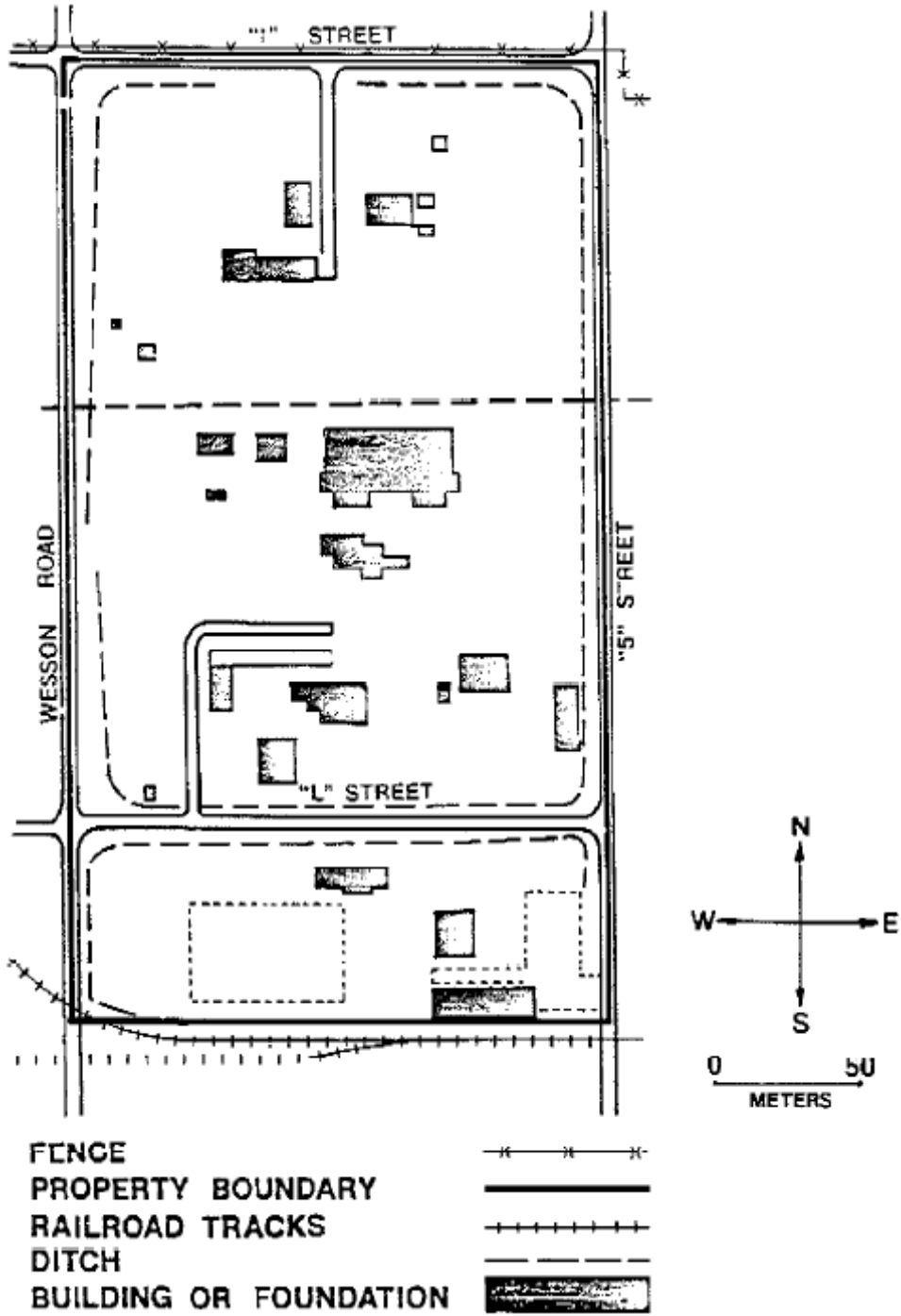


Figure 29: Map showing boundaries and landmarks of Vicinity H

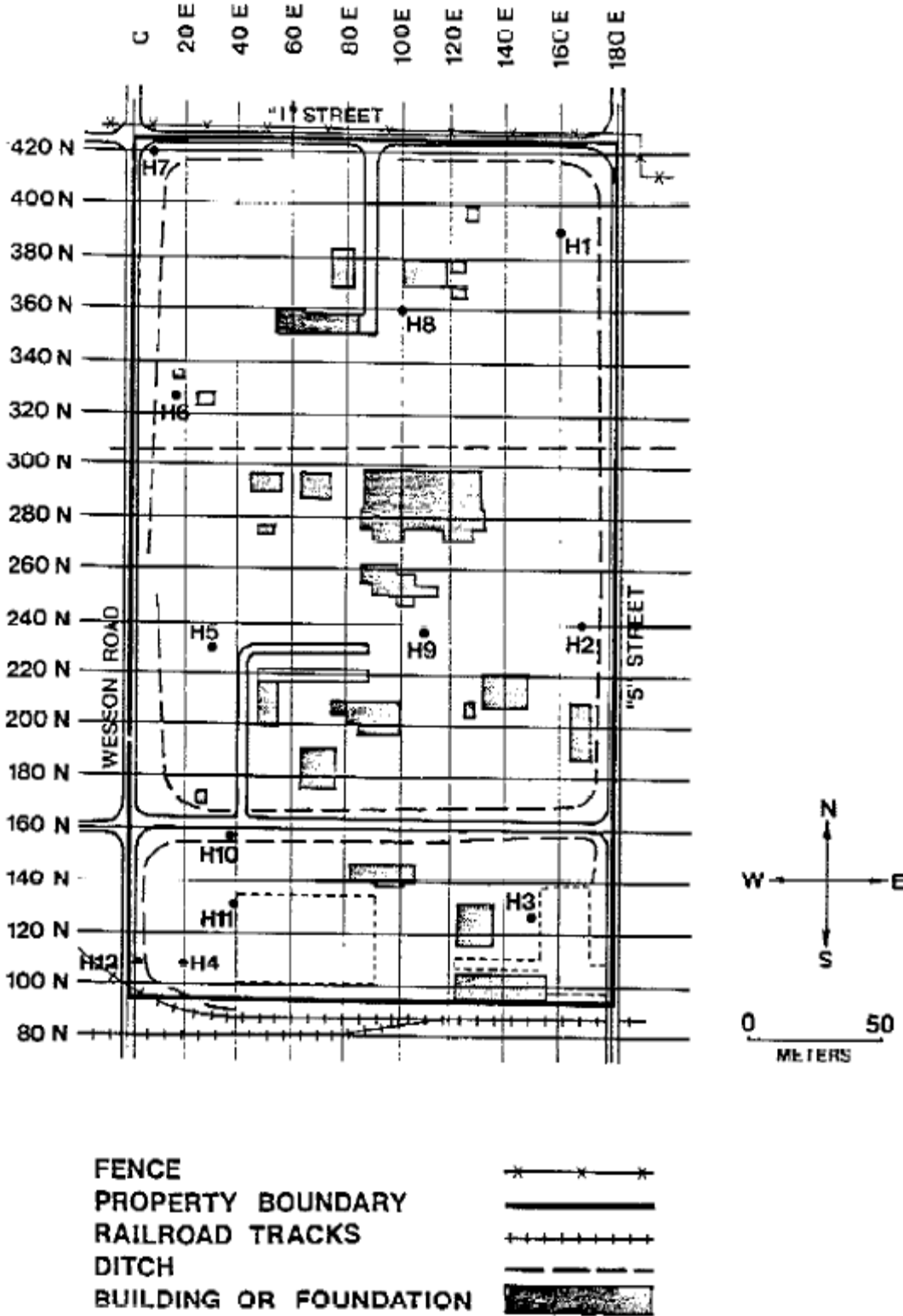


Figure 30: Locations of boreholes for subsurface investigations

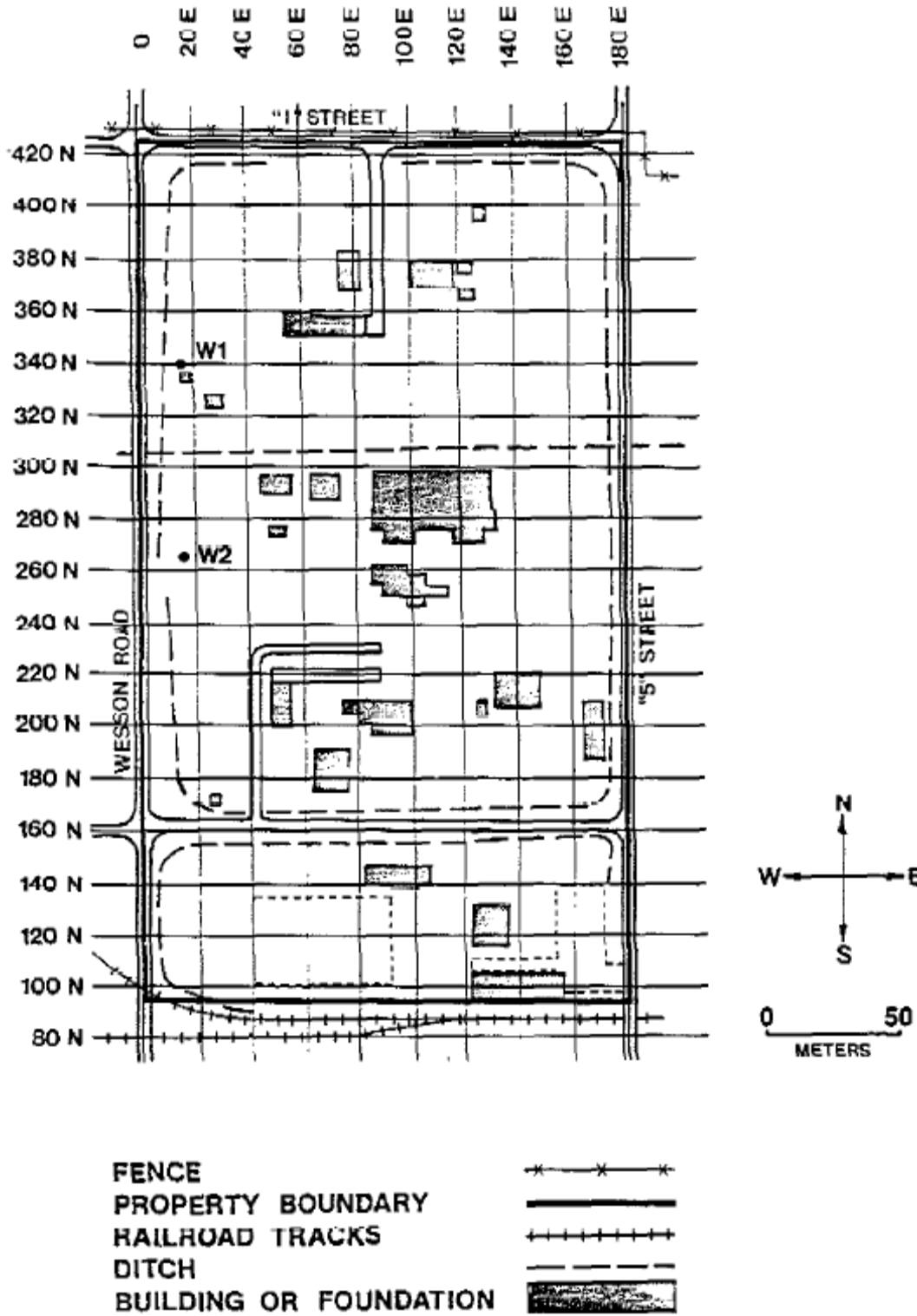


Figure 31: Locations of water samples from sanitary sewer manhole and standing water

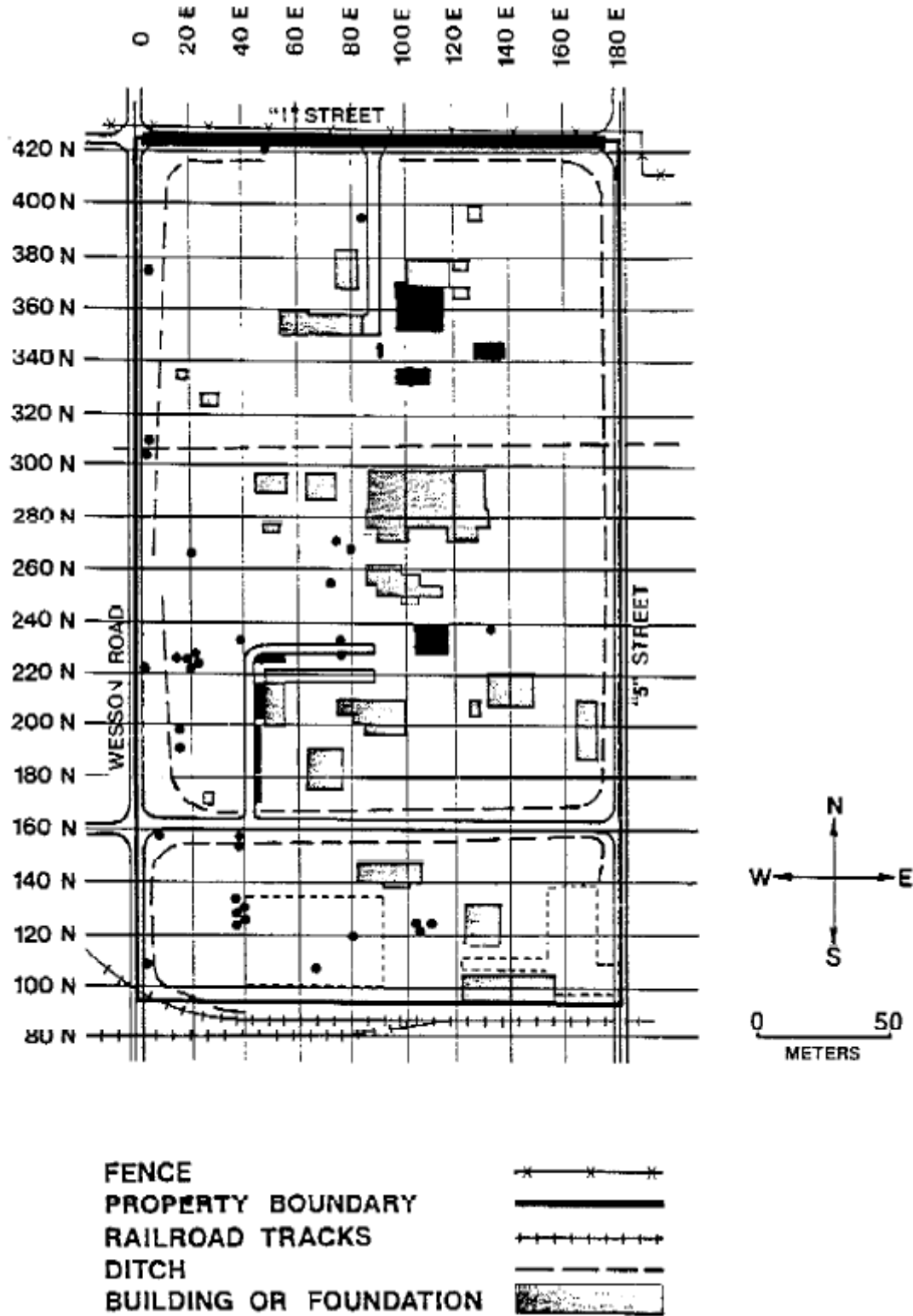


Figure 32: Locations of areas of direct elevated radiation

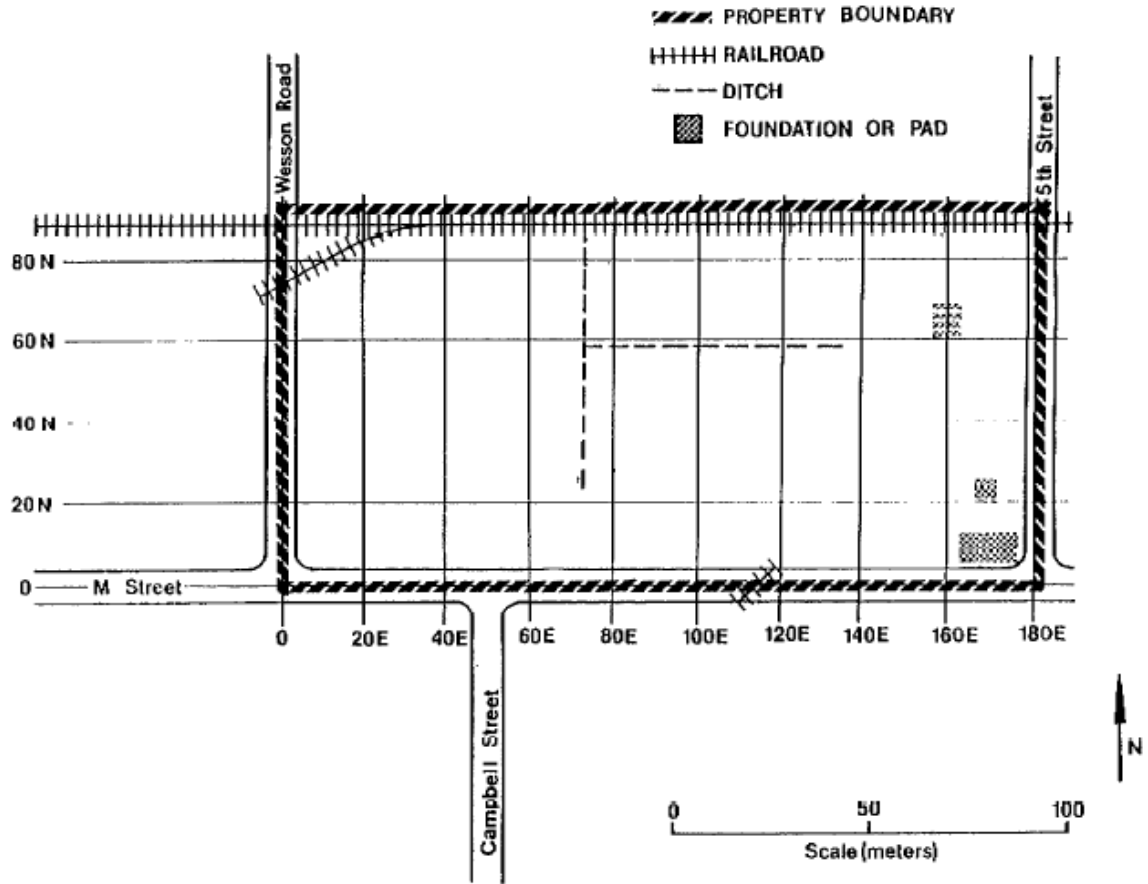


Figure 33: Vicinity H' with major land features and grid

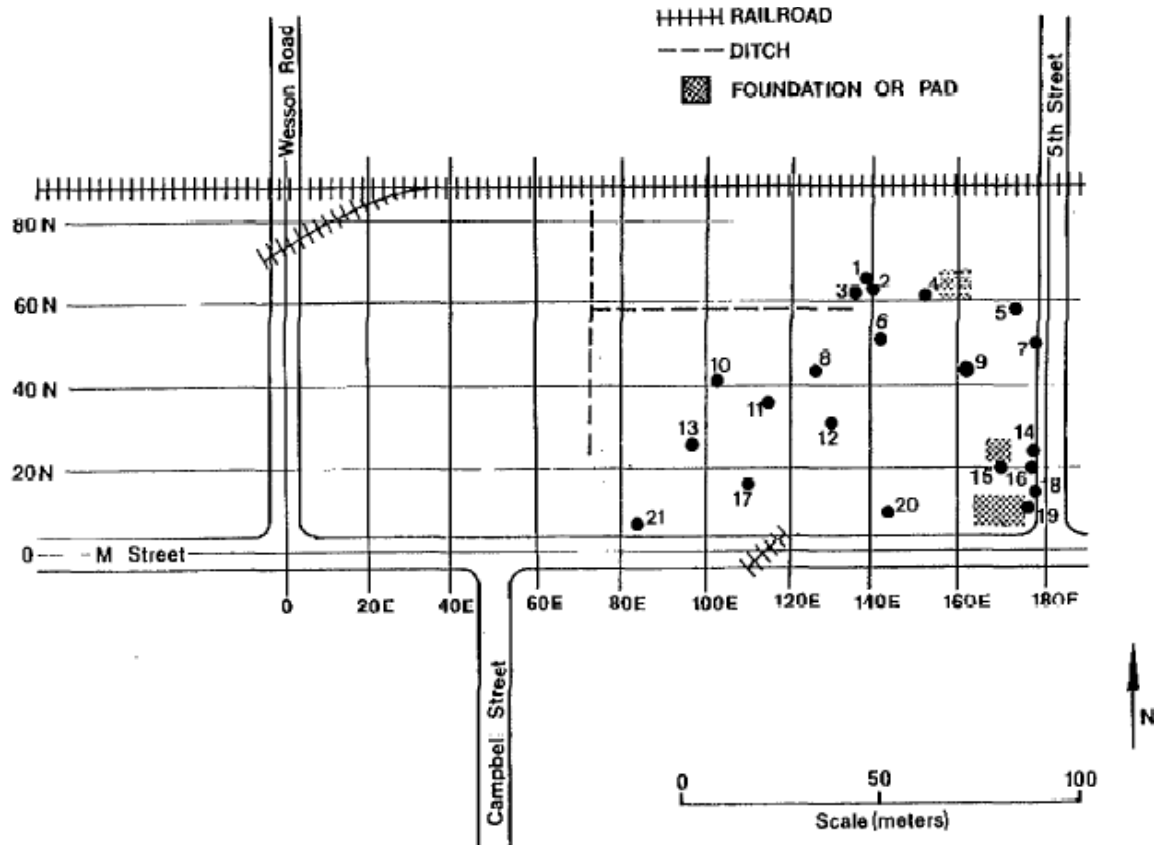


Figure 34: The 21 areas of elevated direct radiation levels

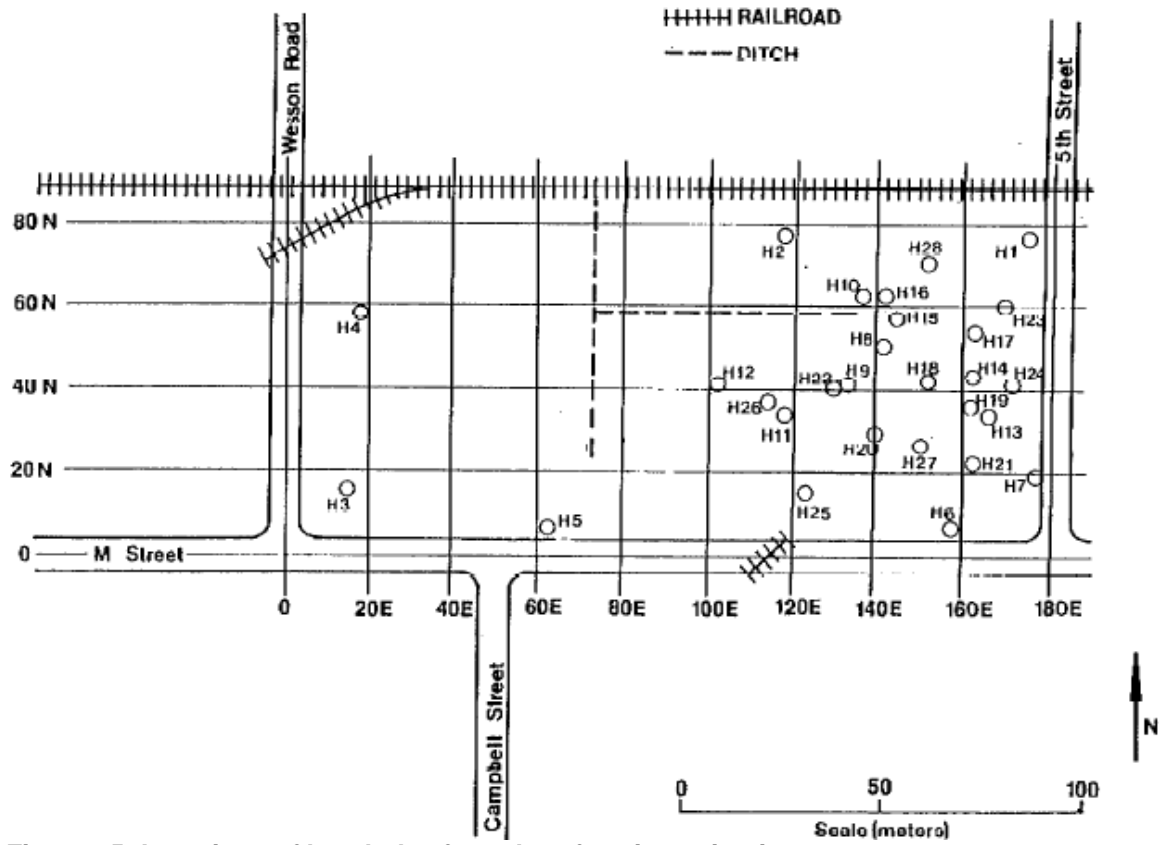


Figure 35: Locations of boreholes for subsurface investigations

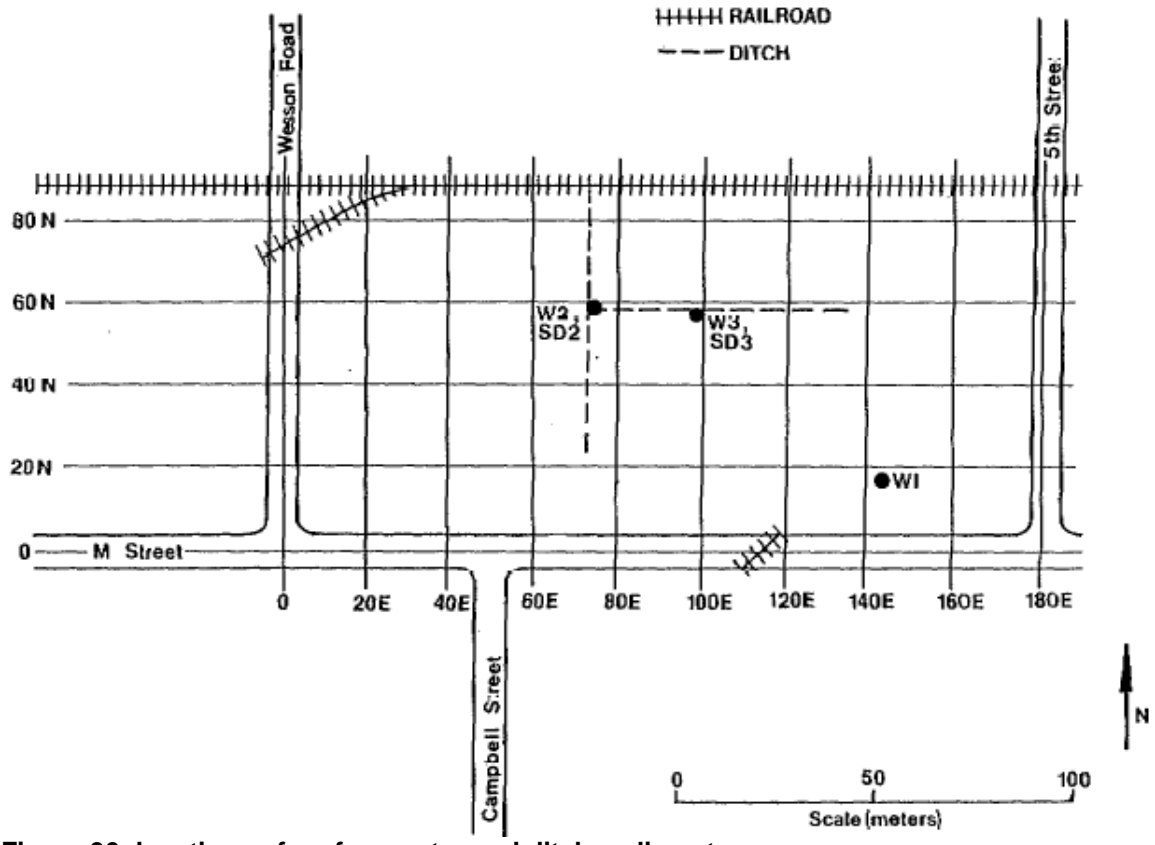


Figure 36: locations of surface water and ditch sediment

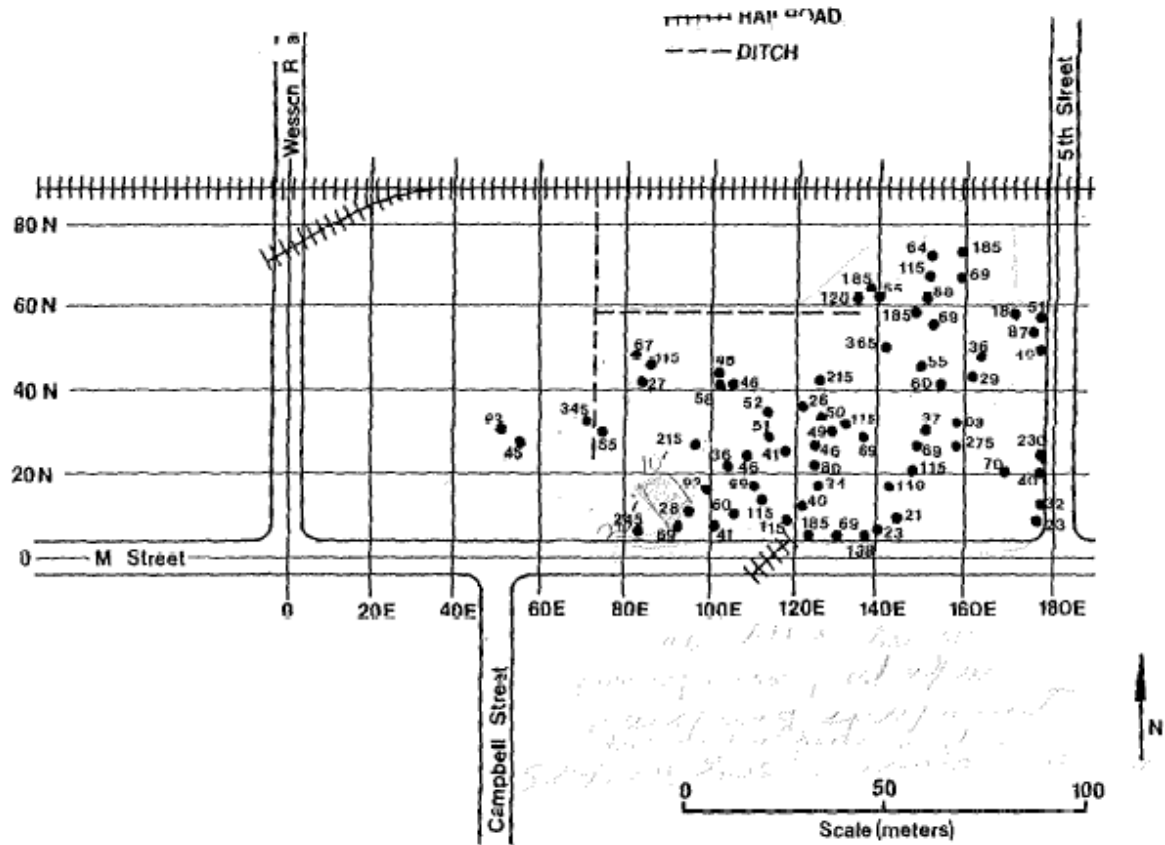


Figure 37: Locations of elevated radiation levels identified by walkover scan

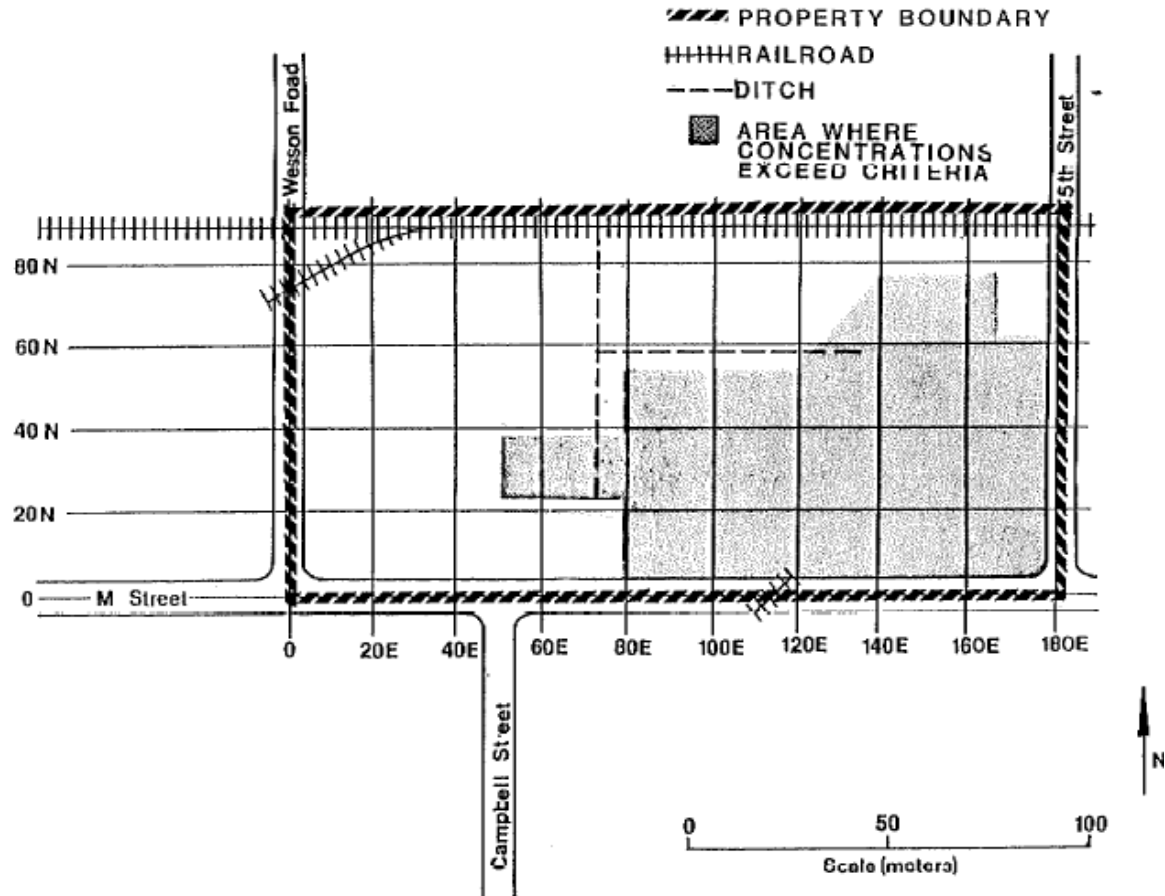


Figure 38: Areas where radionuclide concentrations in soil exceed criteria

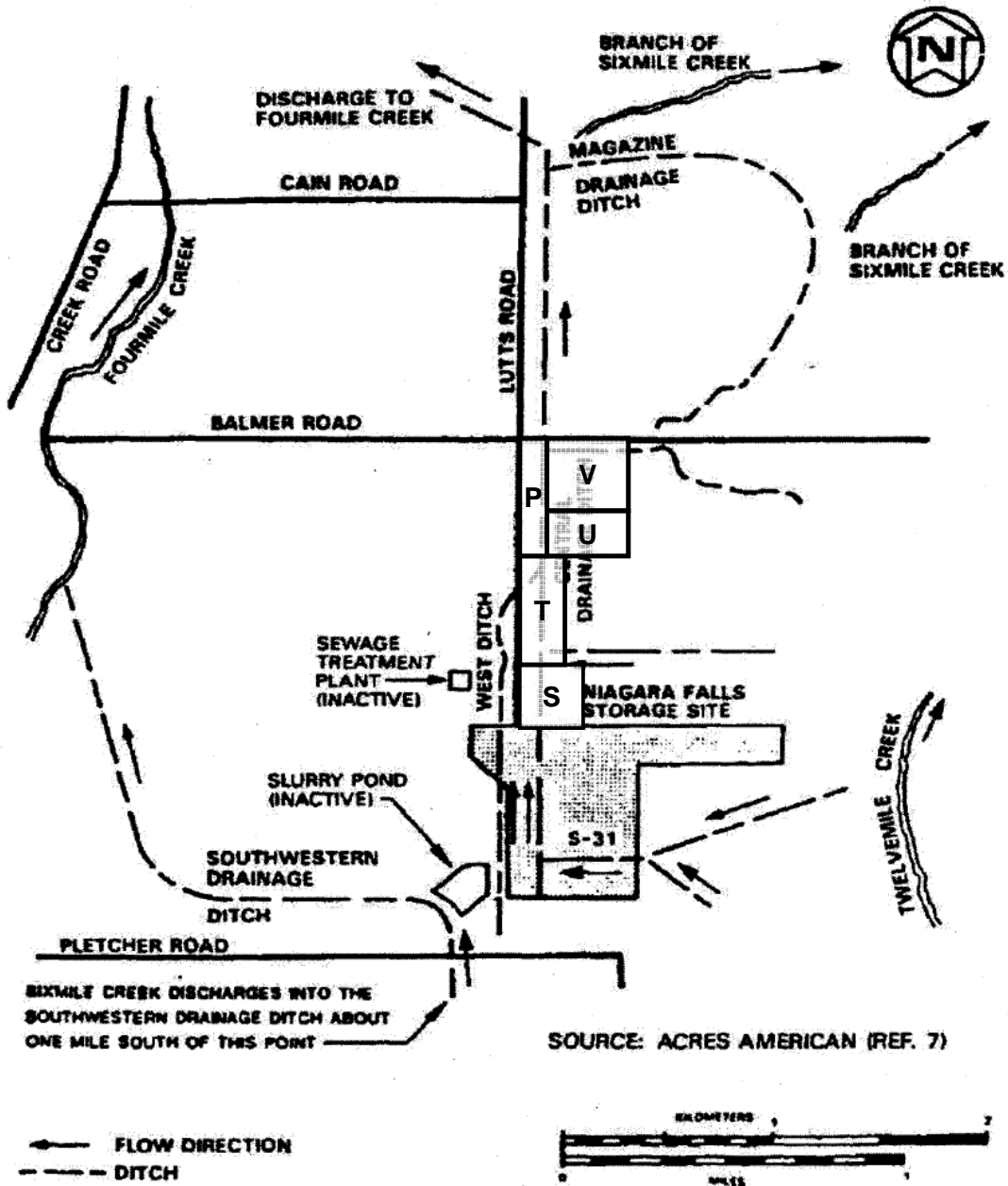


Figure 39. Central Drainage Ditch and Vicinity Properties

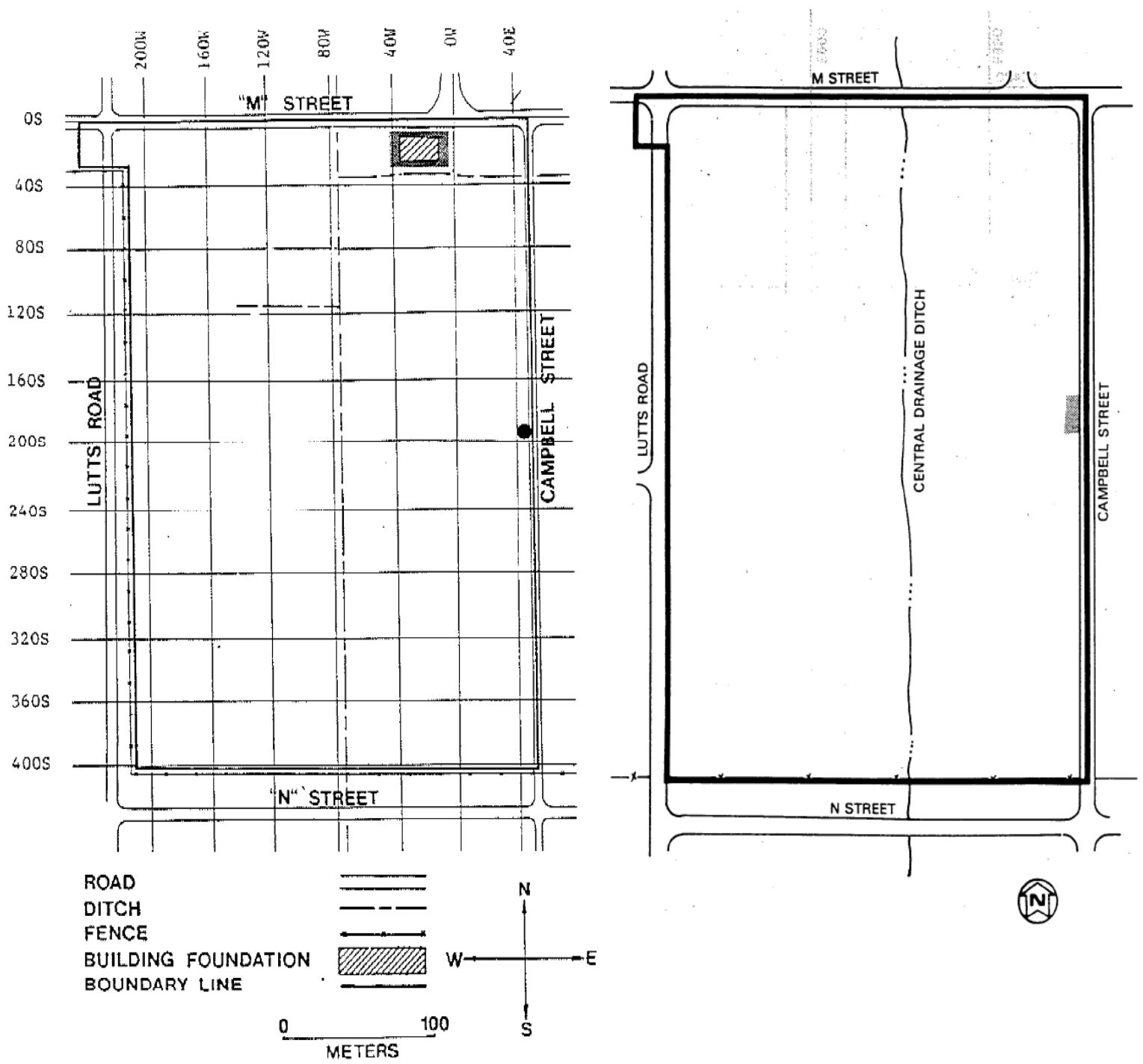
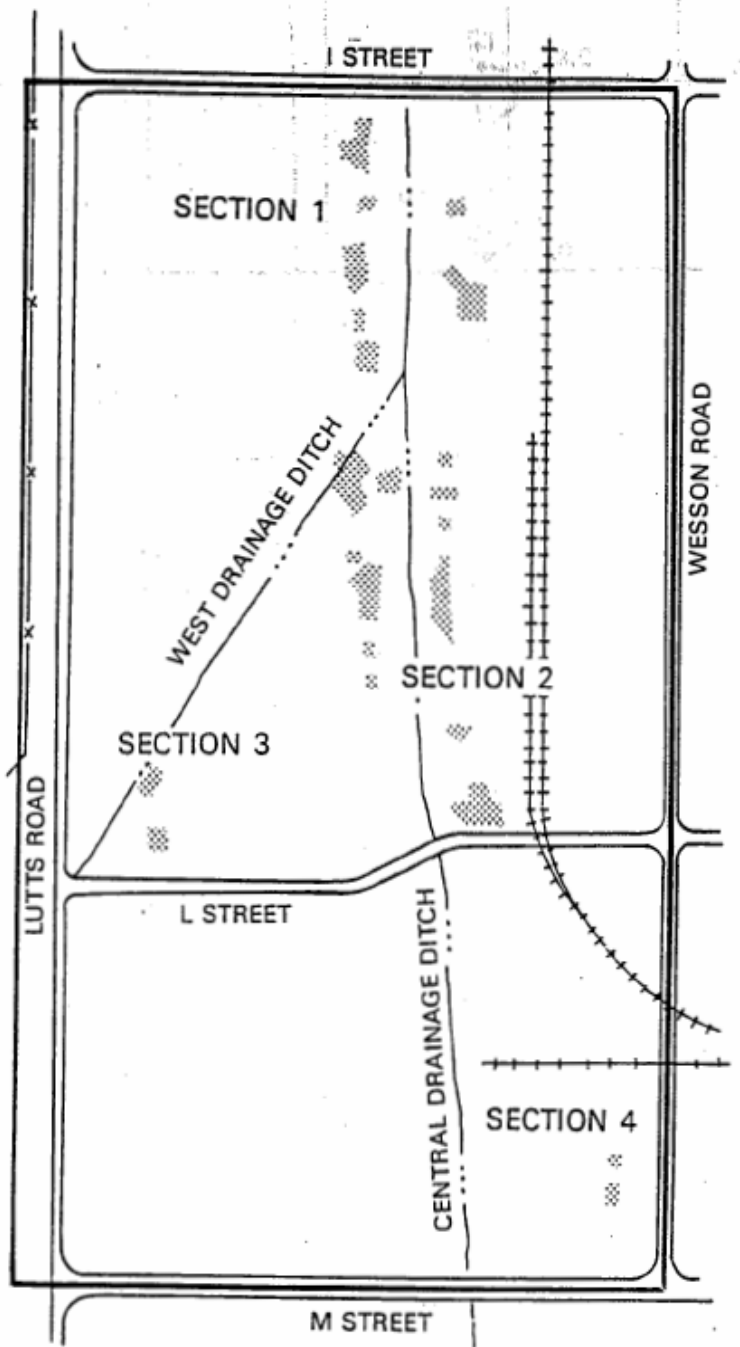
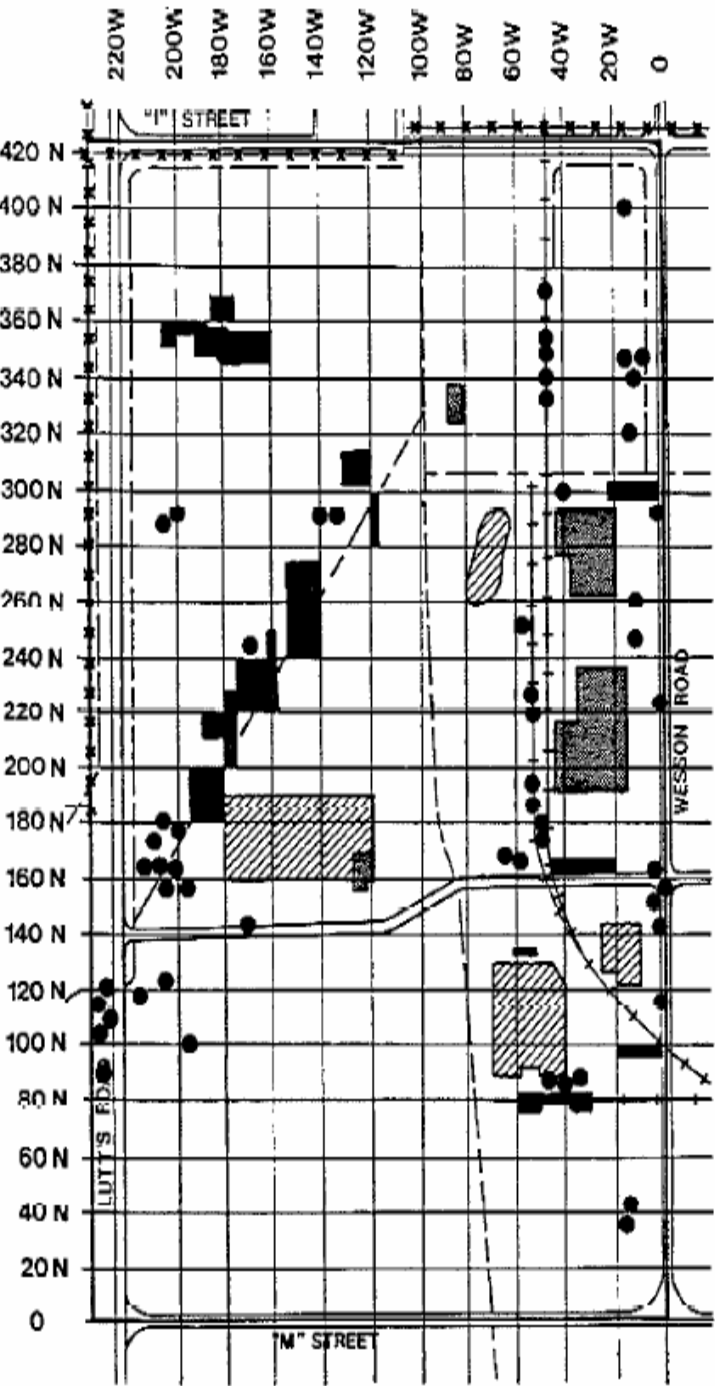


Figure 40 a-b: a. contaminated areas on property S; b. excavated portion of property S



18'0"

Figure 41 a-b: a. areas of elevated and above criteria radiation on property T; b. excavated areas on property T



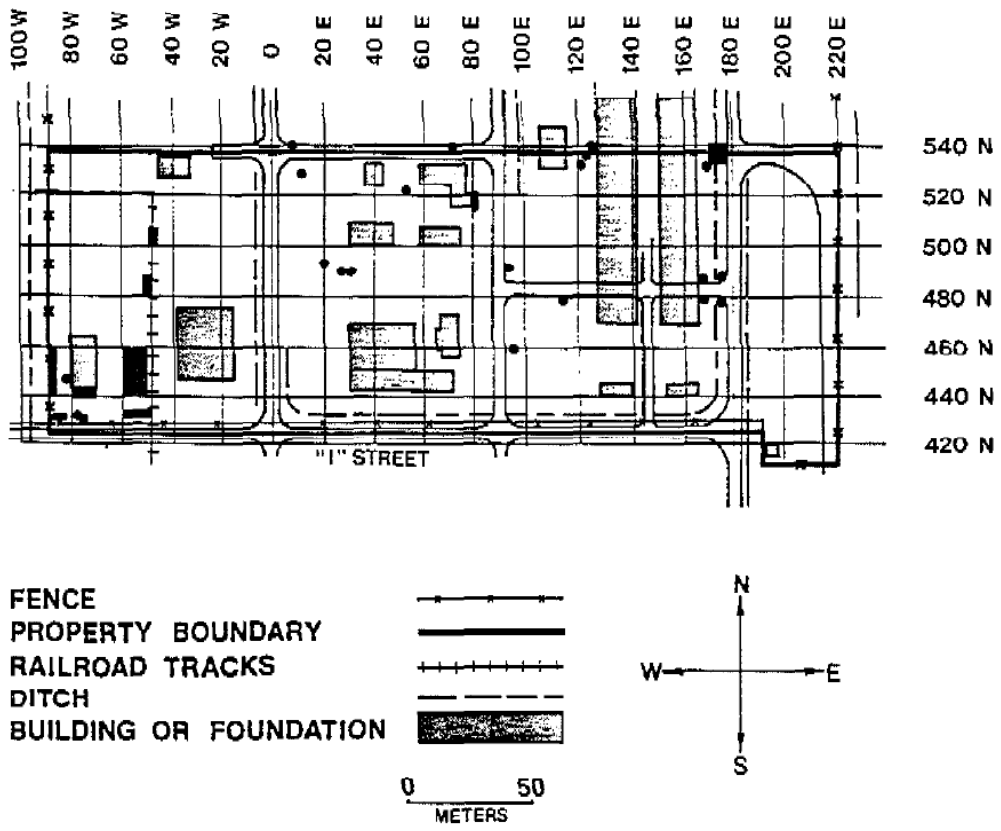


Figure 42: Areas where radionuclides exceed criteria on property U.

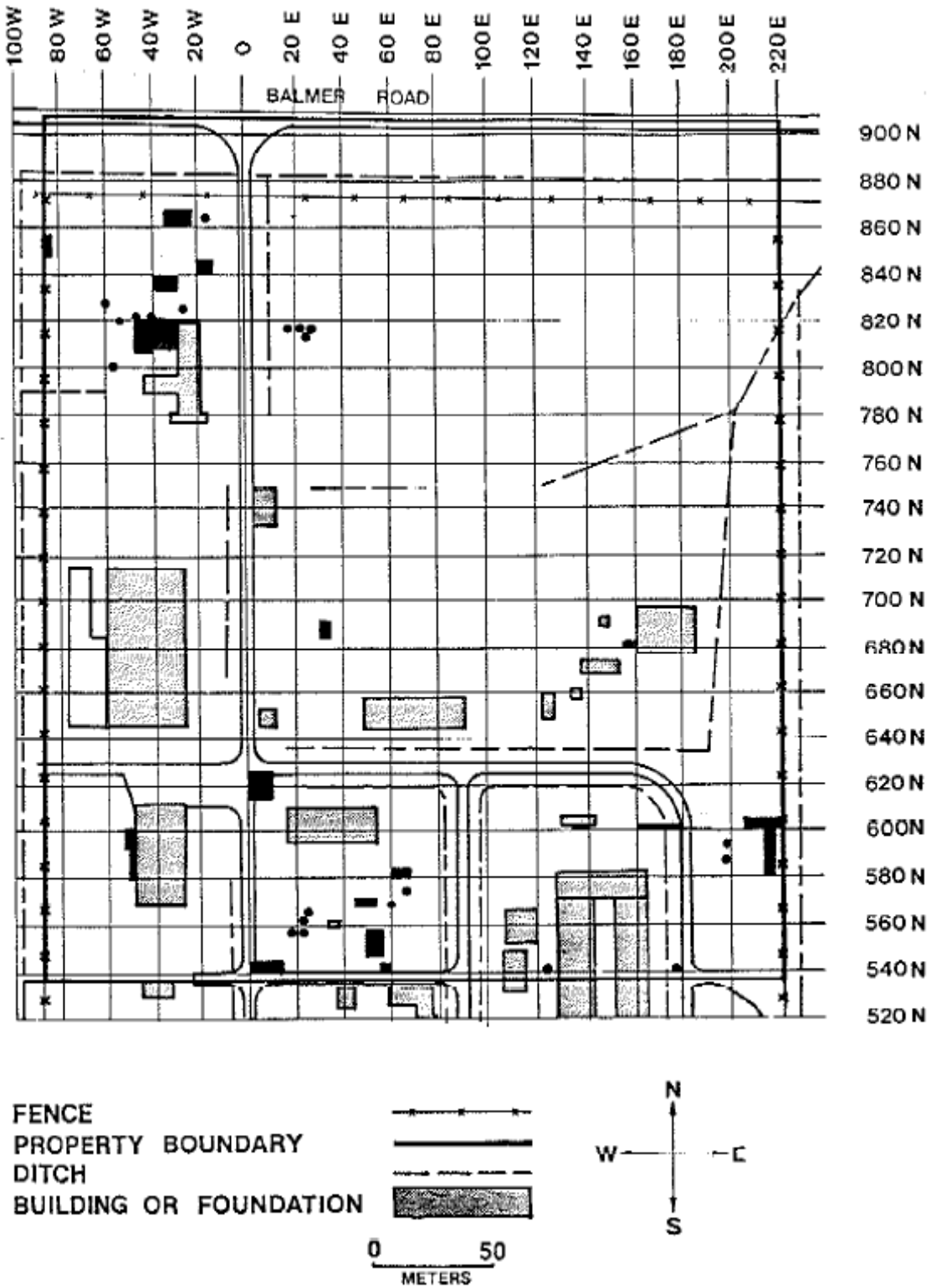


Figure 43: Areas where radionuclides exceed criteria on property V

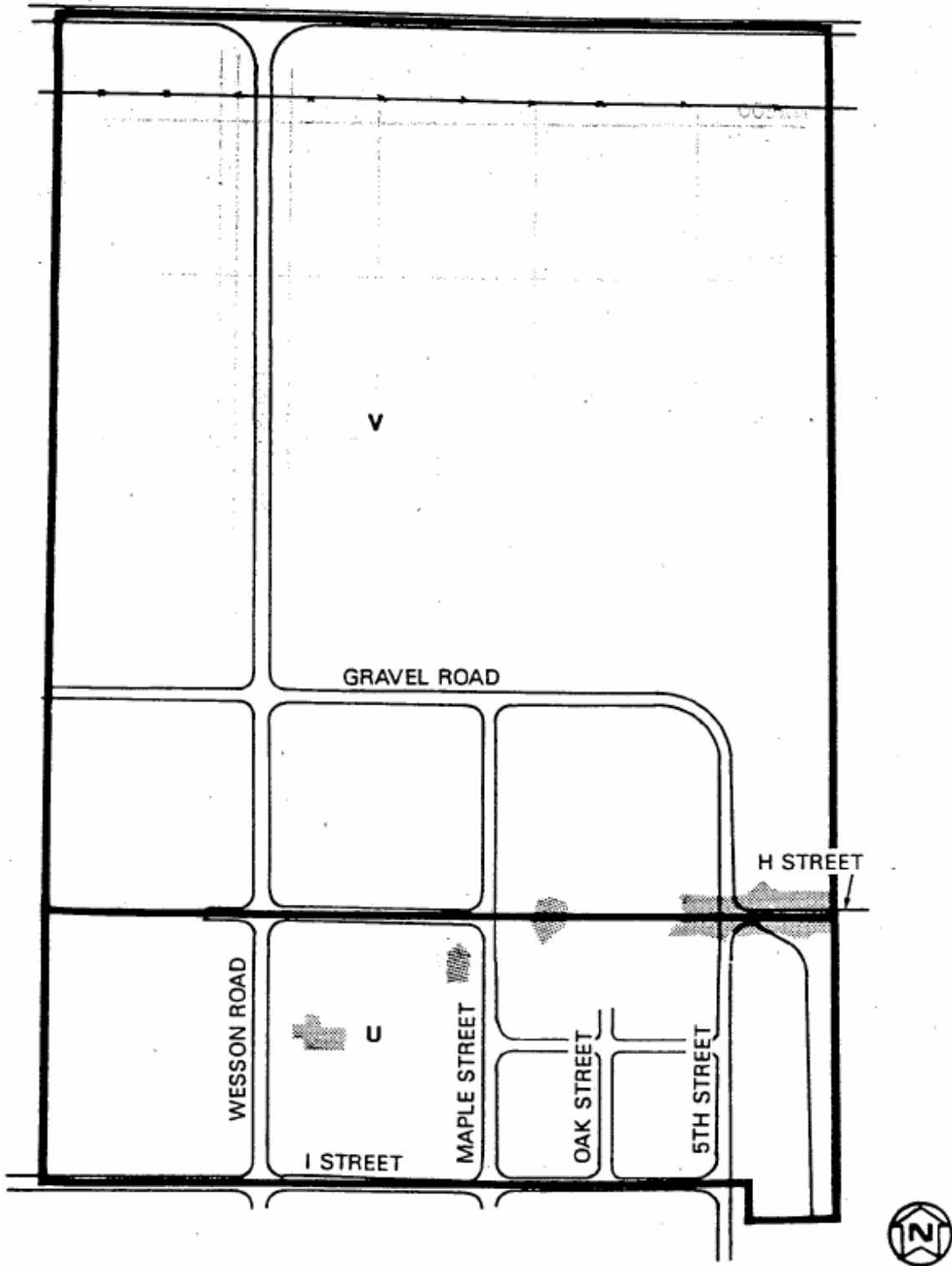


Figure 44: Excavated areas on properties' U and V

RA-226 ACTIVITY IN SAMPLES FROM
LOCATIONS OF ELEVATED DIRECT RADIATION LEVELS

Sample	Grid Location		Nature of Sample	Ra-226 (μ Ci)
	N	E		
B3	197	376	White Chips	2.09
B5	197	416	" "	2.14
B7	107	416	" "	1.06
B8	107	420	" "	0.55
B10B	106	391	" "	11.6
B11	106	408	" "	1.64
B13	106	427	" "	8.82
B14	106	442	" "	1.18
B15B	105	403	" "	2.06
B17	104	412	" "	2.65
B18	66	798	" "	1.12

Table 1: Ra-226 activity in samples from locations of elevated direct radiation levels.

N	E	Ra-226 pCi/g	Error pCi/g
20	475	5.72	0.42
20	480	9.84	0.42
25	475	6.49	0.47
30	435	6.30	0.40
35	475	8.30	0.45
40	465	6.53	0.42
40	470	6.36	0.40

Table 2: Radionuclide concentrations in surface soil samples above 5 pCi/g of the baseline

RA-226 ACTIVITY IN SAMPLES FROM
LOCATIONS OF ELEVATED DIRECT RADIATION LEVELS

Sample	Grid Location		Nature of Sample	Ra-226 (μ Ci)
	N	E		
B9	36	438	Plaster-like chip	1.62
B10	48	438	Pipe fitting	17.7
B18	26	475	Plaster-like chip	2.55
B19	27	487	Plaster-like chip	0.49
B24	39	685	Metallic rock	0.89

Table 3: Ra-226 activity in samples with debris from locations of elevated direct radiation levels

Radionuclides	Sv m ³ /Bq s	mrem g/ μ Ci y	mrem g/ pCi y	mrem/y
Ra-226	1.65E-19	3.08E+04	3.08E-02	1.88E-01
Th 230	6.39E-21	1.19E+03	1.19E-03	7.28E-03
Pb 210	1.31E-20	2.45E+03	2.45E-03	1.49E-02
Pb 214	6.70E-18	1.25E+06	1.25E+00	7.63E+00
Bi 210	1.86E-20	3.47E+03	3.47E-03	2.12E-02
Bi 214	4.36E-17	8.14E+06	8.14E+00	4.97E+01
Po 210	2.45E-22	4.58E+01	4.58E-05	2.79E-04
Po 214	2.40E-21	4.48E+02	4.48E-04	2.73E-03
			Total =	5.76E+01

Table 4: Direct Gamma Yearly Dose for Top 15 cm Contaminated Soil

Appendix. Discussion of Table 4.

In Table 4 the direct gamma rate, in terms of millirems per year (mr/y) is calculated. The calculation is for an adult. Each radionuclide in the first column is assumed to be in secular equilibrium, that is, the same number of curies of each. The second column is a listing of dose conversion factors, from FGR No. 12. This is a standard compendium of dose conversion factors developed by the EPA.⁵⁹ For a given radioactive concentration, in units of Bq/cubic meter, the column provides the radiation dose, in units of Sieverts per second. The fourth column provides the more convention units for dose conversion factors. Given the soil concentration in units of pCi/g, the dose conversion factors provide the radiation dose to an adult in units of mrem/y. Note: this assumes the person is present 365 days per year. These are upper bound numbers for an unrestricted area. For a child, the dose should be increased by 30%.⁶⁰ The soil concentration we assume for the unexcavated portion of the CDD, from 1500 feet west of Lutts Road to Four Mile Creek, is 6.1 pCi/g. We multiply the dose conversion factors in column 4 by 6.1 pCi/g, to get the results in column 5. The total dose is 57.6 mrem/y.

⁵⁹ Environmental Protection Agency, "External Exposure to Radionuclides in Air, Water, and Soil, Federal Guidance Report No. 12, EPA 402-R-93-081 (1993).

⁶⁰ National Council on Radiation Protection and Measurements, "Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies," NCRP Report No. 129 (1999), p. 56.

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Appendix F Comments Concerning NFSS

F.1 Remedial Investigation Report

F.2 Hydrogeologic and Transport Model

F.3 Geophysical Surveys I

F.4 Geophysical Surveys II

F.1 Remedial Investigation Report

Review of Report

“Niagara Falls Storage Site Remedial Investigation Report”

Comments Prepared by K. S. King, King Groundwater Science, Inc.

This report describes the investigation work carried out at the NFSS by USACE under the FUSRAP (Science Applications International Corporation, 2007b). The purpose was to define the identity, amount, allocation of chemicals of concern and radionuclides of concern at the NFSS. A groundwater modeling study was also prepared to assess contaminant fate and transport. A baseline risk assessment of both chemical and radionuclide contaminants of concern was also prepared. The results described in the report will be used to prepare a Feasibility Study to identify and evaluate various remedial action alternatives for the site which will be both protective and cost-effective. The geographic limits of the work are the NFSS property and the Niagara-Mohawk right-of-way located immediately to the west of the NFSS. The USACE is conducting this work in accordance with CERCLA.

Comments

1. P1-10 The fact that there were no criteria for U or Cs-137 until 1988, which is after most of the previous NFSS cleanup was done, is troubling and raises questions about the adequacy of previous cleanups. The apparent widespread presence of surficial contamination and some subsurface contamination found at NFSS supports this concern.
2. P1-11 The underdrain from Building 411 (currently storing radioactive residues) must have drained somewhere and should have been sealed. This should be documented and an indication provided that exterior drains were sealed adequately in order to last for the duration of the facilities life and that monitoring of potential leaks can occur.
3. P2-6 The fact that deposits of sand and gravel up to 20 feet in thickness occur in the Brown Clay Unit is important, as that nears the total thickness of the unit. This reduces potential low-permeability protection of this layer.
4. P2-11 Climate data used for NFSS monitoring and analyses should be collected on site. Use of data from Niagara Falls Air Force Base located seven miles southeast and above the Niagara Escarpment is inappropriate and is a significant data gap. The incremental cost of installing a basic meteorological station at NFSS is negligible compared to the cost of ongoing maintenance and value of site data.
5. P3-3 The annual dose limit of 100 mrem/yr above background for the public is the DOE primary standard (DOE Order 54005), and applies to all exposures pathways. For NFSS, which contains a fenced storage area, some public exposure could occur only through airborne emissions. In that case, the exposure should be limited to only 10 mrem/year. If NFSS is a disposal facility, then the appropriate dose would be 25 mrem/yr. The rationale as to why the dose limit is 100 mrem/yr should be explained.

6. P3-6 The fact that Outfall 2 was a banded wooden pipe suggests that there were other wooden pipes installed at the time of LOOW plant construction. The inevitable loss of integrity of the wooden pipes is a concern due to the likelihood of enhancing subsurface migration.
7. P3-7 It is stated that enough unbiased samples were collected to ensure adequate data coverage for each constituent and media in each EU for risk assessment purposes. It is not clear how the number and locations of samples were determined.
8. P3-8 There is a discrepancy between the down hole gamma logging (Appendix K) and the borehole logs in Appendix N . For example, Boring 211 has a depth of 15 ft bgs, but the gamma log profile shows a depth to > 131 ft. Also, SB 214. The gamma log for SB811 indicates a depth of 231 ft bgs.
9. P3-9 Selection of Lew-Port school and ANG WETS as background locations for gamma radiation raises concerns since both properties were once part of the LOOW.
10. Fig 3-14 The choice of background location BKGD-8 appears inappropriate since although it was in buffer areas, it was actually very close to roads and infrastructure associated with the TNT explosives storage and AFP-38 incinerator, railway and a drum storage area. There would seem to be other locations that could have been selected that were isolated from known activity areas. Use of Modern landfill groundwater wells as background also raises doubts since the Modern property was formerly associated with transport and unloading of materials in the LOOW and there was a former waste disposal area (Town of Lewiston landfill) which was not constructed to modern containment standards.
11. P 3-24 In 2000, the well development protocol was changed to maximize water clarity and reduce development time. It is hard to understand how reducing the number of well volumes removed would result in better development. However, the 2003 development criteria was appropriate in determining representative groundwater was sampled.
12. P3-27 The groundwater sampling protocols used were generally appropriate, however, the choice of using a bailer for VOC collection is puzzling as it is the device with most variability and negative sampling bias.
13. P3-38 Ten drums of investigation derived waste contained sufficient fission products that they required separate disposal. The locations where the material in the ten drums that contained Pu-239/240 and Sr-90 originated is not noted here. The presence of these compounds at the LOOW is significant, and efforts to determine where the material came from should be pursued.
14. P4-5 Including potential outliers of Ra-226 and thorium-230 at SDBKGD-2 in the sediment background data set requires further explanation. This location is at the upgradient portion of the West Ditch on NFSS, yet had the maximum sediment concentration values for Ra-226 and Th-230 found at NFSS and is located only 300 ft west of elevated Ra-226 in soil (67.9 pCi/g). It would seem reasonable to conclude that this area had been affected by activities at NFSS and would not be considered to be background conditions.
15. P 4-7 The methodology for determination of SRCs appears to include any description of, or review of historical activities and likely contaminants that might have been

associated with those activities. This should be a key element of any attempt to identify site-related contaminants.

16. P 4-11 Use of groundwater monitor wells on Modern Landfill property because they are upgradient and east of NFSS is not entirely appropriate. In particular five monitor wells (PZ-21D,M and S, PZ-25S, MW-17) were chosen that are located within an area known as the LOOW classification yard, and is identified as a DOD area of concern in the DERP-FUDS investigations. Radiologic contamination of surficial soil did occur on the property now occupied by Modern landfill and has been remediated ((Bechtel National Inc., 1983; Bechtel National Inc., 1986; Keller E. L., 1981; Stukenbroeker, 1981). It seems more judicious selection of background locations could have been made.
17. Fig 4-20 Very few of the groundwater locations in either the UWBZ or LWBZ do not have an exceedance of an SRC.
18. Fig 4-25a No soil samples are shown below 5' depth.

Nature and Extent of SRCs

19. The presentation of the data is organized around the 18 EU which were defined for the BRA. However, it is unclear if the designation of the EUs occurred before or after the investigation. Further clarification should be made as to the role of historical information to guide the investigation and then to divide the site into EUs after review of the data.
20. p5-3 The essential human nutrients listed (Fe, Mg, Ca, K, Na) are also significant elements in minerals, and are considered major cations which make up the geochemistry of groundwater and surface water. Therefore, their importance goes beyond nutrition as they are also important in understanding groundwater conditions and processes affecting subsurface contaminant fate and transport. The statements made are not incorrect, but to imply that these elements as only of concern as human nutrients is inappropriate.
21. p5-4 The discussion regarding contaminated groundwater and plumes is reasonable. It is a difficult thing to draw delineated plume maps in the shallow groundwater as the site contains many complicating factors. For example, the presence of buried pipelines or infrastructure, vertical fractures in the upper clay till, unknown distribution of surface releases, groundwater-surface water interaction at ditches, non-uniform sand lens distribution may all affect the follow of groundwater and hence the migration of contaminants leading to a complicated distribution. The site hydrogeologic conceptual model should reflect this complex and difficult to monitor conditions. The plume maps that are shown only place lines around the locations where contamination was discovered, and it should be recognized that this may be incomplete and simplistic.
22. p 5-5 The uncertainty around the location of the radium storage vault suggests that a grid based soil sampling plan would have been more appropriate to determine if contamination is present from this historical activity.
23. p 5-6 The presence of VOCs, metals and radionuclides at depths in soil greater than 10 ft invites explanation. If radionuclides had the sorption coefficient assigned by the modeling (HydroGeoLogic Inc., 2007; Science Applications International Corporation, 2007a) and actually migrated downward from the surface over a period of only 60 years,

- this would exceed expected travel times. This comment also applies to the presence of Cs-137 found in groundwater in EU1.
24. Fig 5-1 to 5-4 The inferred uranium plumes shown in these figures indicates that the presence of uranium in shallow groundwater is widespread across the NFSS (with exception of northeast portion).
 - a. The plumes are not fully delineated and could be much larger than shown.
 - b. Elevated uranium occurs in shallow groundwater near the boundaries of the NFSS indicating either potential offsite (northwest) or onsite (from south or east) migration.
 - c. There is a clear presence of uranium in groundwater along the west and north boundaries of the IWCS
 - d. The interpreted elevated Uranium along buried pipelines southeast of the IWCS is likely correct, indicating the importance of buried utilities as potential groundwater pathways.
 25. p5-13 The fact that a former sellite manufacturing area was present should have been included in the discussion of whether sodium was a site related contaminant (and not just a nutrient). Sellite is sodium sulfite.
 26. p 5-19 The presence of slag or gravel and the resulting groundwater infiltration that inhibited further excavation indicates the importance of either natural or manmade deposits of coarse grained materials as groundwater pathways which could affect the migration of groundwater and contamination in a non-uniform manner.
 27. p 5-20 The presence of enriched uranium at a depth of 5.5 feet should be further investigated. The implications that such material is a) present and b) could have migrated or been buried to that depth is significant as it represents a different class of nuclear waste than typically associated with this site.
 28. sec 5.3.1.4 The figures summarizing the occurrence of SRCs in groundwater are Figures 4-18 and 4-19, not as shown.
 29. p5-21 The presence of elevated manganese or iron in groundwater does not need to be justified by the presence of elevated Mn or Fe in soil. Reductive dissolution of iron and manganese from soil is a common process that can cause elevated Mn and Fe in groundwater. The Mn plume is poorly defined since it is defined by only two locations (Fig 5-5). A more likely explanation that should be investigated is the potential presence of organic matter in the subsurface soils, or released organic compounds.
 30. p 5-22 Figures 5-8 to 5-12 show groundwater plumes for chlorinated ethenes and vinyl chloride. The compounds are part of the degradation chain of tetrachloroethane which occurs under reducing conditions in groundwater. The presence of methane in groundwater at MW 415A confirms that reducing conditions exist. The plume isopleths as drawn are merely interpretations as there is insufficient delineation of the plume to be confident of its extent. However, of more important significance for these VOC plumes is that the dissolved concentrations are at a level indicating the potential presence of a tetrachloroethane (PCE) fluid in the subsurface. PCE, a chlorinated solvent, behaves as a dense non-aqueous phase liquid (DNAPL) in groundwater and the observed

concentration of 103.3 **mg/L** is approaching 50 % of the solubility of PCE in water. The likely presence of a DNAPL source and dissolved plume should be further investigated in both the UWBZ and, because it is a DNAPL, the LWBZ as well. Contrary to the fate and transport modeling discussed in section 7.3.4, the modeling only addresses dissolved phases and does not account for DNAPL transport.

31. p 5-26 The compound 1,1,2-TCE is likely meant to be 1,1,2-TCA (i.e. trichloroethene).
32. p 5-35 Since the lone subsurface soil sample exceeded background UTLs for radiologic parameters, this indicates the need for further delineation at depth.
33. p 5-38 The detection of RDX should be further investigated.
34. p 5-49 The significance of Cs-137 in groundwater appears to have been minimized since it was observed in wells below the derived MCL. However, what is not addressed is that Cs-137, a radiogenic isotope often associated with atmospheric fallout or nuclear fission and the KAPL waste was found in groundwater. If the Cs-137 came from atmospheric fallout (perhaps Chernobyl in 1986?) and recharged to groundwater, then its usefulness as a tracer may be important. Otherwise the presence of fission products at NFSS, must be assumed.
35. p 5-50 Actually, higher dissolved oxygen in MH09 would be more conducive to greater solubility and mobility of uranium, contrary to what is stated in the text. The statement in the text should be clarified.
36. p 5-52 It is noted that there is a lack of soil samples collected to evaluate the high gamma areas noted. This should be investigated further.
37. p 5-53 EU 12 may be wooded now, but photographs from the 1940's suggest that most land in this area had been cleared. Can it be confirmed that this area remained wooded and had no activity for the duration of the past 65 years?
38. p 5-61 the presence of Pu-239 in the floor of building 401 is significant as it confirms the presence of KAPL waste and fission products at NFSS.
39. p 5-63 The presence of Americium-241 in West Ditch surface water is significant. It appears that Am-241 should have been part of the analytical program for surface water at NFSS.
40. p 5-64 It appears to be a reasonable conclusion that historical operations on NFSS property have caused the impact by metals and radionuclides on the Niagara Mohawk property.
41. Section 5.9 The evaluation of transuranic and fission product data raises several points for discussion. USACE created strip charts for Am-241, Cs-137 and enriched U and identified "outliers." It then intends to go back to the sampled locations and determine the reason for this "outlier" status. This methodology is completely backwards. The preferred and more systematic approach by the EPA, NRC and DOE under MARSSIM is to start from the historical record, to determine which parts of the NFSS site are likely to be contaminated, which parts may be contaminated and which parts had no contamination. Parts of the site that were likely contaminated would be thoroughly examined, the number of samples and the gamma survey determined to give a statistically

significant result. Areas with no contamination would be explored in a more cursory fashion. In this way, the USACE would home in immediately on problem areas.

The absence of Am-241 does not imply the absence of transuranics, such as Pu-239. This again depends on a review of the historical records. Since the waste from Schenectady was due to separation of Pu from the waste materials, one does not expect to have a correlation. Am-241 would generally follow the high-level waste and, to a lesser extent, the uranium product stream. Am-241 decays to Np-237, not Pu-239.

42. p 5-74 The conclusion that the previous remediation of West Ditch was incomplete appears correct. Transport of contaminated sediment should be investigated further.
43. p 5-76 The presence of radiological and other SRCs in the LWBZ is significant by itself, and whether or not it exceeds its UTL is important with respect to exposure. However, the fact that it is present in the lower aquifer suggests that explanations of how it got there as it is contrary to expectations based on information in the RI.
44. p 5-77 Ballast by the rail road tracks has a correlation with Ra-226. ACE appears to believe it is due to slag. Another possibility is that the contamination is due to loading and unloading of railroad cars. Again, the historical record and sample locations should shed light on this issue.

Fate and Transport

45. The half-lives presented in Tables 6-1 to 6-3 are not site-specific rates of degradation. Many organic compounds degrade in the environment, however, most processes are microbially-mediated and appropriate environmental conditions must be present and maintained for the degradation to occur. For example, there are important differences between degradation rate of a compound in surface water (exposed to oxygen and sunlight) compared to groundwater where conditions would be much different. Therefore if these tabulated values are to be used to infer degradation half-lives at NFSS, then only those half-lives that were determined under field and environmental conditions to be similar to NFSS should be considered. Rates derived from laboratory microcosm studies have only limited applicability to predicting degradation in the field. Similarly, distribution coefficients (K_d) are not necessarily transferable between sites, or laboratory and field. Therefore, results derived from use of these tabulated values should be considered very carefully as they are unlikely to represent true behavior at the NFSS.
46. p 6-2 The dismissal of acetone and 2-butanone as contaminants of concern due to “tendency to quickly degrade in the atmosphere and to biodegrade easily”, and that they are potential laboratory contaminants appears unreasonable. The data was reviewed and verified as being valid. The fact that these compounds were detected decades after operations ceased at the site suggest that the assumption of rapid degradation and low migration concern are doubtful.
47. p6-4 I disagree that a “complete understanding of the specific metal mobility and chemistry is beyond the scope of this RI”. Knowledge of a contaminants site-specific fate and transport characteristics is precisely what the RI is intended to demonstrate.
48. Section 6.6 A Remedial Investigation report should contain a description of the site conceptual hydrogeologic model, and is missing from this report.

F.2 Hydrogeologic and Transport Model

Review of Report

“Groundwater Flow and Contaminant Transport Modeling, Niagara Falls Storage Site, Lewiston New York” prepared by HydroGeoLogic, dated December 2007

Comments prepared by K. S. King, King Groundwater Science, Inc.

This report describes the Remedial Investigation effort at Niagara Falls Storage Site. The groundwater modeling investigation was completed to predict the migration of contaminants originating from the NFSS under baseline conditions and for hypothetical worst-case scenarios. The authors, (HydroGeoLogic Inc., 2007), prepared a conceptual site model, a calibrated mathematical model of groundwater flow and a transport model of dissolved constituents in groundwater.

The authors compiled an impressive amount of hydrogeologic information from the NFSS and nearby properties: CWM chemical Services, LLC. and Modern Landfill Inc., and from previous investigations. The model was used to simulate groundwater flow and estimate the migration of contaminants from the NFSS over a long period of time (in excess of 1,000 years).

Review Comments

1. **Subsurface Geologic Conditions.** It is rare that modelers have such a wealth of subsurface data as is available for the NFSS, CWM and Modern sites. More than 700 boreholes were evaluated to assess the geologic conditions and related data needed for input parameters to the flow and transport models. However, as in all geologic sampling exercise, the information and knowledge gained is derived from discrete locations where the samples were taken. It is often necessary to make assumptions as to what conditions exist between boreholes, and it is important that subsurface data be available to provide a three-dimensional understanding of the geologic lithology, stratigraphy and characteristics. As shown in the report (see HGL Fig 2.8), many borehole locations are available on the NFSS, CWM and to a lesser degree on the Modern Landfill. However, there is a paucity of data to the west and northwest of the NFSS, which also happens to be the general direction of groundwater flow. Therefore, there is uncertainty as to actual conditions in this important region of the model and requires modelers to make assumptions as to continuity of geologic units and their properties. This can be considered to be a data gap in knowledge of subsurface conditions.

The presence of fractures in the upper Clay till to a depth of approximately 9 ft (2.7 m) is noted and characterized as minor. However, discontinuities in the clayey matrix due to fracturing is commonly observed in surficial clay tills and their role in contaminant fracture has been found to be significant

2. **Hydraulic Properties.** The evaluation of hydraulic conductivity values provides a reasonable estimation of the characteristics for the various hydrostratigraphic layers. However, it is important to point out that there is variability associated with each layer's

properties, and therefore any estimates of groundwater velocity or flux should reflect that variability. For example, it is clear from the distribution of K_H values that the alluvial sand and gravel unit generally has a K_H ten times higher than the upper Clay till unit, but the range of values also overlaps. So, there may be areas where the two units have essentially the same K_H . In the big picture, use of geometric mean values is reasonable; however, the variability that may occur at the smaller, local scale should not be overlooked when interpreting groundwater flow and transport.

As noted in HGL table 2.4, the K_H for UCT and GLC have equivalent geometric means and same values were used in the model (HGL Table 2.5). But, the variability of K_H in the UCT extends over six orders of magnitude. The GLC is believed to be more homogeneous than the UCT, but there are apparently only five hydraulic conductivity measurements. Since the GLC is part of the underlying natural “containment” of the IWCS, there should be better characterization of the properties of the GLC unit.

The GLC has also been described as containing occasional laminations of silt, and sand and gravel (Golder Associates Inc., 1988; Wehran-Envirotech, 1990; Wehran Engineering Corporation, 1977). These small scale features can be important in transmitting groundwater or contaminants on a local scale.

The distribution of K for the Alluvial Sand and gravel unit (HGL Figure 2.23) appears to rely on only three values in the direct vicinity of the IWCS. Since the IWCS is a repository of contaminants, the ASG is a significant aquifer unit and modeling of the transport from this location is very important, this lack of localized K data appears to be a deficiency.

Lastly, the distribution of hydraulic conductivity shown on HGL Figures 2.21 to 2.25 are inferred from the available data, and should be regarded as reasonable estimates given the available data. Different values than shown may exist between the borehole locations, and there are no data locations outside of the NFSS, CWM and Modern property lines.

3. The distribution of sand lenses in the Upper Clay till is an important feature. The presence of the more-permeable sandy zones within a low-permeability clayey unit holds the implication that there could be pathways or increased migration of groundwater flow and contaminant migration through the sand lenses. Of particular interest, is that for the three waste disposal facilities, the NFSS happens to sit directly over an area which appears to have a higher frequency of sand lens occurrence. The reason as to why more sand lenses were apparently observed in the vicinity of the IWCS may not be known or real, but could be due to the increased density of boreholes on the NFSS, differences in investigation techniques, or just plain bad luck. If a similar density of boreholes were installed in nearby properties, a similar pattern of sand lens occurrence might be observed. The significance of the sand lenses relate to understanding groundwater flowpaths, selection of the hydraulic conductivity values used in the model and proper positioning of groundwater monitoring well locations.

The authors have evaluated the sand lenses using geostatistics in order to determine the spatial extent of the sand lenses and ultimately whether they are connected flowpaths (see Appendix B). The compilation of sand lens data is extensive and thorough. However the semivariogram approach used is not convincing that the sand lenses are not interconnected.

4. Water Budget. One potential scenario to be considered in the Feasibility Study is to leave the IWCS residues in place. In that case an assessment of the long term potential climate change issues and effect on precipitation, temperature, evapotranspiration and recharge should be addressed.
5. Sec 3.3.3.3 The stream boundary for the Central Drainage Ditch is incorrect. The CDD drains to Four Mile Creek, and not Six-Mile Creek as shown on figures 3.1 and 3.4.
6. Sec 4.3.2.1 The use of K_d isotherm based sorption models to simulate the migration of metals and radionuclides is a common approach but has strong limitations. The interaction between dissolved ions in solution with solid mineral phases can be described through the use of isotherms. An isotherm is a plot of the mass sorbed on the solid surface versus the concentration of the constituent in solution, at a fixed temperature. As the concentration of the sorbate is increased, the mass sorbed also increases in a linear or non-linear manner. Isotherms are empirically derived from laboratory batch or column experiments. The slope of a linear isotherm is known as K_d or the distribution coefficient. The distribution coefficient approach uses one parameter to describe partitioning between solution and solid matrix that may be due to several geochemical processes, and it is usually assumed to be constant in an aquifer. Equilibrium and reversibility of reactions is assumed. Site mineralogy is an important factor, but is neglected (Zhu and Burden, 2001). This simple method of describing ion sorption can be easily incorporated into a mathematical solution of the advection-dispersion equation, that can be solved analytically or by numerical methods. As a result most groundwater solute transport model codes (including the one used for this project) use an isotherm approach to describe surface-solute interaction and retardation. However, the assumptions and difficulties associated with K_d 's make the applicability of these models to environmental problems concerning metals questionable.

Deficiencies in the K_d approach have been known for some time (Bethke and Brady, 2000); (Brady and Bethke, 2000); (Cherry et al., 1984); (Reardon, 1981)), models using K_d are still applied to metals in groundwater problems ((Sandia National Laboratories, 1999); (U. S. EPA, 1996a); (U.S. EPA, 1999); (U.S. EPA, 2001)). Attempts have been made to make the K_d approach more appropriate through the use of generic K_d vs. pH relationships and selectivity coefficients derived from a geochemical model (U. S. EPA, 1996b) or including non-linearity and probabilistic approaches (U. S. EPA, 1996a).

Some factors which most affect dissolved metal concentrations are the total concentrations of metal in the soil, soil solution pH, organic matter content, and the presence of iron and manganese oxides (Sauve et al., 2000b). Redox conditions are also important. Distribution coefficients of a metal can vary over several orders of magnitude for given pH, total metals in soil or organic matter content. Given the multivariate influences that affect metal concentration in solution, it is unlikely that empirical approaches alone will be successful in predicting metal transport at a particular contaminated site (Sauve et al., 2000a).

There are however, some advantages of the K_d based model approach which include:

- Simple and easy to include in transport models
- Many models are available with this formulation

- Retardation concept is easily understood
- Works best for weakly sorbing, low concentration, contaminants which participate in few reactions and where chemical conditions and pH do not vary.

Some disadvantages of the K_d based model approach include:

- simplistic and compromises the role of geochemistry
- can only simulate one solute at a time (Zhu and Anderson, 2002)
- assumes an unlimited number of sorption sites and does not include competition
- a site specific K_d does not ensure correct assessment of fate under transient system conditions
- changes in aqueous speciation and temporal variations are not accommodated (Langmuir, 1997)
- typically overestimate plume advance and underestimate “tailing” (Brady and Bethke, 2000)The characterization requirements for contaminated sites which contain metals and radionuclides, in either soil or groundwater should be enhanced to include geochemical measurements of groundwater and characterization of all solid phases and aquifer mineralogy. This has not been done at NFSS. Screening level and detailed risk assessments for the migration of metals in groundwater should be supported by geochemical calculations and reactive transport modeling. K_d -based transport models should not be relied on as the only modeling tool unless the very specific conditions for K_d use can be demonstrated at the site.

The minimum approach for screening metals-contaminated sites should include use of equilibrium models (e.g. MINTEQA2) to identify potential reactions, characterization of mineral phases present and provide an opportunity to verify that reactions are actually occurring. In general, for an important site such as NFSS, simple coupled reactive transport models, or even more sophisticated models, could be applied to better understand issues of metal/radionuclide transport.

7. It appears that the same K_d value was used in all of the model layers. This is inappropriate as each layer will have different lithology and other characteristics.
8. Sec 4.4.3.4 The model calculations for organic contaminants which include a biodegradation rate should only be considered to be for information or bounding purposes rather than a simulation of likely behavior. Additional site-specific information would need to be collected and evaluated in order to provide confidence that the model decay rates are reasonable for site conditions, and that NFSS aquifer conditions would remain conducive for continued biodegradation in the future. Inclusion of a no-decay case would be useful to bound the likely behavior of the organic contaminants.
9. Sec 4.4.3.5 Use of the MINTEQA2 geochemical model is appropriate to estimate the solubility of elements and complexes at NFSS. However, it appears that the methodology used involved the measured geochemistry of only one groundwater sample (Appendix D). The selected well was OW04B, completed in the Upper Clay till. Unfortunately there are no other geochemical analyses presented for the UWBZ, or the LWBZ, so there is no confidence that the one selected geochemistry is in fact

representative of groundwater at NFSS. In addition, Table 3 of Appendix D does not indicate the critical parameters pH, dissolved oxygen or redox conditions at which the simulations were performed. The mineralogy of the NFSS aquifers is not documented.

10. Sec 4.6 An explanation for the choice of parameters subject to sensitivity analysis should be provided. The variation in K_d only involved the increase in value. The site-specific work by (Seeley, 1984) also indicated that laboratory derived distribution coefficients were as low as 1.1. Testing a lower K_d would help assess poor sorption (faster migration) conditions.
11. Conclusions. The development of the hydrogeologic modeling tools has been undertaken in a very thorough and thoughtful manner. With the exception of comments noted above, considerable insight into the behavior of ground water and solute transport from the IWCS is possible. Due to disagreement over the applicability and meaningfulness of the use of K_d values without further geochemical insight, the predicted times of migration and concentration values should not be accepted as accurate. Since there is disagreement over the solute transport issues, the understanding and interpretation of groundwater flow based on the model could have received more emphasis. In particular, since large drainage ditches are located so close to the IWCS, the potential for groundwater discharge to surface water would appear to be high. This seems to be a higher and faster source of risk exposure that has not been fully discussed in the report.

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F.3 Geophysical Surveys I

Mr. Scott King
King Groundwater Science, Inc.
Buffalo, New York

June 24, 2006

Dear Scott:

I have examined the materials you forwarded or referred to me regarding the geophysical survey of the Niagara Falls Storage Site. Specifically these materials are:

1. A report on the geophysical work prepared by Science Applications International Corp for the US Army Corps of Engineers, dated May 30, 2003. This very large document consists of the report proper, sections 1 and 3 of which I read carefully, and a number of Appendices, dealing with routine matters such as data handling and presentation, that I leafed through and spot-checked. I also read most of section 2 on the Gamma Walkover Survey out of interest, although this material was not included in the scope of work assigned.
2. Two Power Point presentations to a Restoration Advisory Board meeting, undated.
3. Miscellaneous data available the Lake Ontario Ordnance Works and the (included) Niagara Falls Storage Site on the USGS web site:
<http://www.lrb.usace.army.mil/fusrap/nfss/index.htm>
4. Parts of a 1982 report by the Bechtel Corporation "Geotechnical Post-construction Report, Niagara Falls Storage Site, Lewiston, New York" describing the construction of the cut-off wall.

Regarding the questions posed in the Scope of Work.

a. Were the geophysical surveys generally carried out in an appropriate or reasonable way.

Yes, to the best of my knowledge. The authors were clearly aware of best practice procedures (as prescribed by the EPA, CERCLA, etc) and, while much of Appendix A is simply "boiler plate" there is no reason to believe that they did not follow these procedures. The data collection and filing also appear to have been carried out in a systematic way.

b. Are there any significant discrepancies, deficiencies or gaps in the work which might limit the conclusions that have been made.

Geophysical surveys in these situations can be likened to x-rays, ultrasounds and MRI scans in the medical field. The alternatives are cutting the patient open (digging, trenching) or exploring randomly with hypodermic tissue samples (drilling exploratory holes). The non-invasive solutions have obvious advantages. They don't disturb the patient (ground) and they serve as a guide to the intrusive follow-up. However, they will never achieve the visual resolution of a sample. They average a property (water content, tissue or bone density, electrical conductivity, magnetic susceptibility, etc.) of the interior over some volume; depending on the money and/or time one has to spend that volume

can be larger or smaller but it does not achieve the resolution of a core or a visual examination of a ditch face. In medical radiology, there is a lower limit to the size of tumor or bone fracture you can detect, just as there is a lower limit to the size of cut-off wall breach or contaminant plume conductivity that a given geophysical technology will image.

The SAIC geophysical survey is very extensive. They must have worked to a budget that most contractors would envy, one that allowed them to throw all sorts of technologies at the problem. Nevertheless, there was a limit to that budget, one that may have required trade-offs; that they run electrical imaging surveys across the Zone II cut-off wall on a 7m line spacing rather than (say) a 3m spacing, or magnetometer line spacings of 5 m within the WCS instead of (say) 2m. Because geophysical detection depends – amongst other things - on the distance from the object to the surface measuring equipment these choices inevitably result in some lack of resolution of targets between lines relative to below the lines. The trick is to be able to say not just what has been detected, but what could have been missed given the survey choices made.

My main criticism of the SAIC report concerns this last point. The authors have done a good job of gathering data from a wide variety of geophysical techniques, and they have interpreted those data well. Not so well done, in my opinion, is explaining to the reader the limitations of these interpretations. This would have been best accomplished through the use of simple sensitivity analysis, using numerical models that would have been available to the authors. These limitations (minimum detectable size of breach in the cut-off walls, minimum size and electrical conductivity of plume, etc.), once established, could then be compared to the expectations of the client as to what constitutes a significant problem for the site.

A second criticism is that there appears to be no site-specific investigation of the physical properties of the overburden strata, such as might have been provided by borehole geophysical logs. These data can help define what is and is not anomalous in the field surveys.. Table 9-1, for example, provides electrical conductivity ranges for certain geological materials in general, but not for the brown clay, gray clay, red silt and sand and gravel layers identified (Section 3.2) for the site. While not critical to an interpretation of the data this omission is unusual in a project of this size and scope.

As to “gaps”, the obvious one is that there does not appear to have been a follow up investigation of the anomalies identified by this report. Because a geophysical anomaly measured on the surface can have several subsurface explanations, field verification of a small subset of these anomalies can often improve the interpretation of the others.

Returning to the original question, are these “gaps and deficiencies” significant? The most important point in my opinion is that the clients for this work understand the difference between a statement such as “the geophysical surveys found no anomalies that we believe to be associated with a breaches in the cut-off wall “, and “there are no breaches in the cutoff wall”. Specific examples follow.

c. Was the work adequate to conclude that the IWCS is not leaking or that the clay dike walls are performing as expected?

Section 15-1, page 95, para 3. “SAIC did not interpret any anomalous zones within the WCS that may be attributed to a contaminant plume, sand and gravel channels, or inconsistencies within the clay cutoff wall.”

I would agree in general with this statement based on a review of their data. However, regarding the contaminant plume, the reader should be aware that:

(a) this conclusion refers to electrically conductive leachate and it is not clear that the radioactive contaminants or their associated materials (e.g. the slurry) would be highly conductive. I could find nothing in the report on the properties of these materials, and certainly the average conductivity of the interior of the WCS – ignoring the building foundation areas where rebar, metals etc. were probably present - was not dissimilar from background (e.g. Figure 5.3). If the interior of the WCS is contaminated but not conductive then a plume leaving WCS would presumably also be non-conductive and invisible to the geophysics. In that case the statement on page 98, section 15.1.1.6, para 1 that “ there is no significant subsurface release occurring from the WCS moving laterally away from the WCS” could be misleading.

(b) there are size and depth constraints on detection even of a highly conductive, laterally moving contaminant plume with the techniques used. The best chance for detection would certainly be within a thick, near surface sand and gravel lens in the brown clay. A conducting plume within a small lens at depth in the brown clay, or in the sand and gravel unit beneath the gray clay (section 3.1.2.3) would almost certainly not have been detected by the geophysical surveys.

Regarding the cut-off walls, paragraph 2, section 15.1.1.3, page 97 states that “Based upon the geophysical data, the cutoff wall is interpreted to be intact and not compromised.” I agree with the earlier statements to the effect that they had identified no anomalies in the geophysical data that would suggest significant breaches, but not this statement which could be taken to imply that the cutoff wall is intact.

The cut-off walls are constructed of compacted brown clay taken from the excavation and from other locations on site (reference the Bechtel report referred to above) This material is emplaced within the brown clay unit and then a further one or two feet into the Grey Clay unit below. So we have compacted clay within uncompacted clay. The EM-31 (Figure 5-3) and Electrical Imaging (Figs 9-2ff) data exhibit no consistent conductivity contrast across the cut-off wall (for example, along the eastern cut-off wall in Figure 5-3). The compacted clay wall and native clay appear to be undifferentiated.

So, what would a “breach” look like electrically? And how large a breach at what depth might be detected with this technique? Put another way, is there agreement on what is

and is not a “significant” breach. Without a discussion of these points I believe the statement quoted at the beginning of this paragraph is misleading.

Returning to the initial question “Was the work adequate..?”, the answer is no, but nor was it meant to be. I am sure that the authors are aware that there are limitations to detectability of geophysical methods, but they have not - in my view - made them clear in the report. Perhaps there was some understanding with the original client for the work as to what minimum acceptable leakage, breaching, etc. would be acceptable. But these understandings, if indeed they existed, are not passed on to the general reader.

d. Were the surveys adequate to draw any conclusions regarding the presence, absence or distribution of sand lenses within the till or clay deposits?.

“SAIC did not interpret any anomalous zones within the WCS that may be attributed to a contaminant plume, sand and gravel channels, or inconsistencies within the clay cutoff wall” (underlining mine)

The statement with regard to the sand/gravel lenses is reasonable, once again, as long as it is understood that it only rules out lenses below a certain size and depth and having a resistivity contrast with their surroundings below some limit. Two dimensional numerical modeling methods are available for the Electrical Imaging (EI) technique that could have been used to give the reader some idea as to what these limitations would be.

Table 9-2 does address this issue partially. The electrical resistivity contrasts associated with various materials and features such as faults and voids are tabulated. But no mention is made of detection limits, and a more quantitative sensitivity analysis – which I believe could have been done – is not presented.

e. Are there additional studies that should be considered?

I emphasize that the geophysical surveys are extensive, well conducted and the data well presented.

Some field verification (digging, trenching, drilling) of identified geophysical anomalies is normally undertaken, mainly for metallic targets but also for conductive, potentially contaminated areas. If verification has not been undertaken then the client should be asked why?

I would recommend a restatement of the conclusions in the report to indicate as quantitatively as possible the limitations of the interpretations as to size, depth, property contrast, etc.. My sense is that, if this were done, the survey would still be judged very useful by having eliminated many potentially significant failings at the site.

Other surveys and objectives.

I have concentrated on the questions asked in your “scope of work”. I have not commented on the metal detection surveys (magnetometer, EM31 quadrature phase, EM61); these seem to have been well done although I have the same issues regarding what targets could have been missed. Similarly you did not ask specifically for comment on the work (seismic, CSAMT) that was mainly designed to look at the geology below the waste and overburden. The authors have pointed out that vertical migration of contaminants through sand and gravel deposits into the bedrock – should downward hydraulic gradients exist - would be very difficult to detect. No anomalies that could be associated with “major” faults or fracture zones in the bedrock(s) were identified. Again the resolution of the bedrock surfaces with CSAMT or seismic methods has limits and some reference should be made to these limits.

SUMMARY OF MAIN POINTS

- *The SAIC geophysical surveys are well conducted and the data well presented and interpreted.*
- *The limitations of these geophysical interpretations when used to infer hydrogeological conditions may, however, not be clear to the reader.*
- *Specific examples:*
 - *The absence of interpreted electrically conductive geophysical plume anomalies from the WCS does not preclude the presence of non-conducting groundwater plumes. It is not clear that the radioactive contaminants of interest are conductive, or that they associated with associated with conductive materials.*
 - *It is not clear that breaches in the cut-off wall would be more or less conductive than the wall itself, given that it as clay wall emplaced in a clay formation.*
 - *Plumes, breaches in the cutoff wall and sand/gravel lenses, even if they have conductivity contrasts with their surroundings, must be of a certain minimum size and depth of burial to be detected with a given geophysical technique.*
- *These shortcomings in the report could be remedied fairly easily by sensitivity analysis, numerical modeling of the geophysical responses of the targets (plumes, cutoff walls, etc.).*
- *If these limitation of the geophysical interpretations were explained, it is my opinion that the survey would still be judged very useful by having eliminated many potentially significant hydrogeological failings at the site.*
- *Normally field verification is carried out for some subset of the geophysical anomalies identified in the survey. If this has not occurred the client should be asked why.*

Yours Truly

John P. Greenhouse, P.Geo(Ontario), PhD

F.4 Geophysical Surveys II

Mr Scott King
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August 22, 2007

Dear Scott:

I am writing with comments pertaining to your emailed queries of May 10 and July 20, 2007, regarding geophysical surveys of the LOOW site. I have broken these responses into three sections.. The first addresses your questions regarding Ground Penetrating Radar surveys. The second addresses questions regarding seismic surveys and groundwater levels, and the third

A: GROUND PENETRATING RADAR

“I am interested in your opinion of the techniques used, their applicability at this site and whether there is enough information to determine if their surveys could have detected (or missed) waste burial areas.”

I have reviewed the reports 1, 2 ,3 and (relevant parts of) 5 listed in the bibliography at the end of this letter. They describe Ground Penetrating Radar (GPR) surveys at Vicinity Properties E,G,H,L and M. The GPR technique was around in the early 1950s but its modern development really began in the 1970s. These 1982-83 surveys of reports 1-3 were run in the early stages of this development. The physics of GPR has not changed but recording and processing technologies are greatly advanced compared to 20 years ago, as is our experience in interpretation.

The 1982-83 GPR surveys were carried out to:

- (i) inspect potential borehole locations for subsurface obstacles prior to drilling
- (ii) verify the existence of buried pipes and utilities shown on the site map
- (iii) search for evidence of buried materials, usually in selected area of the site, including utilities not shown on the site map.

The “buried materials” that produce the strongest radar reflections are metals such as drums, rebar, pipes, etc.. The category also includes variations in ground conditions – for example, localized contamination by leachate or DNAPLs, or areas back-filled with foreign materials – that can produce recognizable changes in the character of the radar records. (Natural contacts between geological strata can also produce measurable reflections but these are usually separable from the real targets of these surveys by their planar nature.)

Applicability of GPR.

GPR surveys were appropriate for objectives (i) and (ii) where detection at very specific location and depth ranges was required. These surveys seem to have addressed objectives (i) and (ii) successfully. GPR was not, in my view, the most appropriate technology for

objective (iii) but, since the equipment was mobilized for objectives (i) and (ii) it was reasonable to use it for objective (iii).

Nevertheless, the issue to be addressed here is objective (iii) and whether or not the GPR surveys have adequately characterized the buried materials in these areas. My conclusions are given in the Summary section below, and my reasoning follows.

a. **Penetration.** Electromagnetic (EM) waves travel huge distances through empty space to bring us pictures from the Moon and Pluto, but when one tries to transmit them downwards into the Earth there are serious limitations. Anions and cations in the soil can be moved back and forth by the alternating electric fields but they extract energy in the process. At radar frequencies it is also possible to stretch molecules that have an offset in their positive and negative charge distribution, and this also absorbs energy from the downgoing wave. The EM fields can also lose energy in magnetizing materials having appreciable magnetic permeability. Thus the electrical conductivity σ , the dielectric permittivity ϵ , and the magnetic permeability μ all influence the penetration of the EM radiation aimed downwards by a GPR transmitter. The actual mechanisms of energy loss are fairly complicated, and also frequency (f) dependent. Higher frequency antennae (e.g. 500MHz) produce sharper images but have less penetration. Lower frequency antennae (e.g. 100MHz) penetrate farther but have poorer resolution of small objects.

Of the four properties σ, ϵ, μ and f , σ is almost always the most important. So in evaluating the applicability of GPR to a site the first question is always – “what is the electrical conductivity of the shallow subsurface”.

My first comment on the three reports is that not one of them address this question! I therefore looked through the EM-31 (terrain conductivity) data presented in the SAIC (2003) report. This device reads a more-or-less average electrical conductivity to a depth of a 1-2 metres. With reference to Figure 5-3 in that report, it appears that a reasonable background value for near-surface conductivity is in the range 20-35 milliSiemens per metre (mS/m). Locally, in vicinity G in particular, the conductivity is considerably higher.

Peter Annan, President of Sensors and Software and a pioneer of the GPR technique, used a very simple and conservative rule of thumb that penetration was probably not going to be much more than a depth (D):

$$D = 35/\sigma. \quad (1)$$

In our case, this translates into 1-2 metres. Equation (1) does not take frequency into account and is probably more appropriate for the equipment of the 1980s than for today.

Figure 1 shows the depths listed for GPR anomalies (excluding known utilities) at the 5 Vicinity Property sites. Note that the median depth of detection falls well within the range predicted by equation (1). It is, of course, quite possible that there are no

significant targets for the radar below 2 metres, but the preponderance of evidence also suggests that these 20 year old data are not “seeing” below 2 metres.

b. Sampling. The second point to make about these data is they are only sampling a portion of the subsurface. They do not provide complete coverage of the subsurface below the grid area and in most cases the survey grid did not extend over the entire vicinity.

DEPTH OF DETECTION STATISTICS

AREAS G,L,E,H AND M

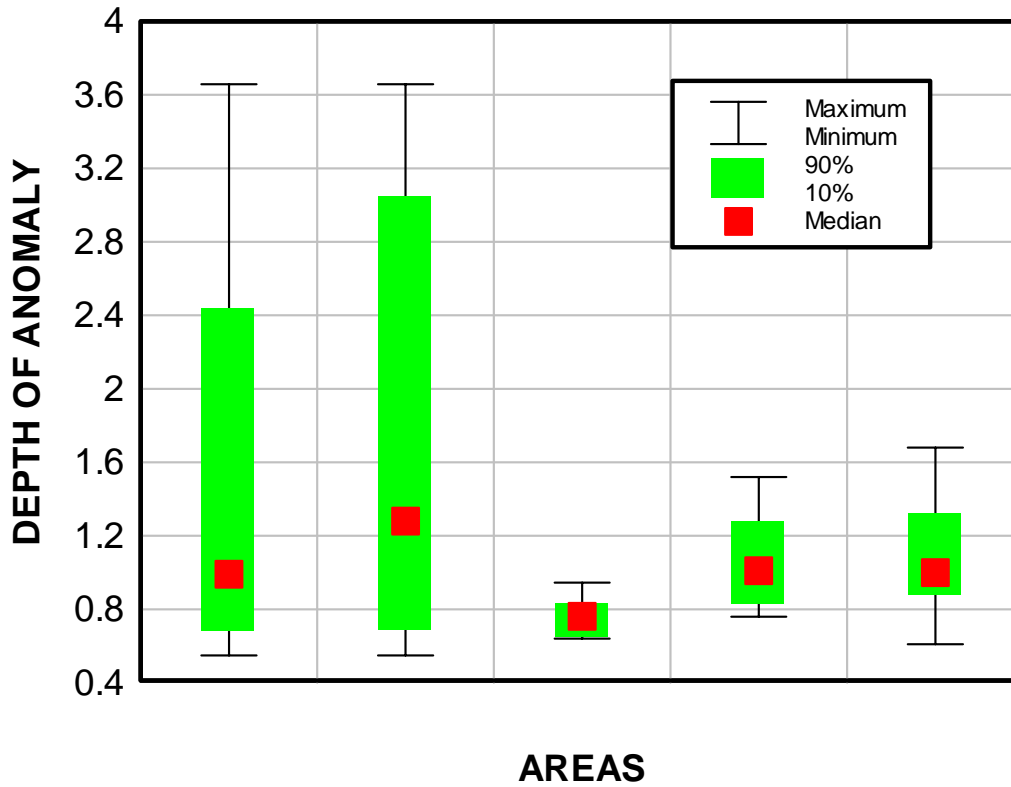


Figure 1. The range of depths for targets identified in the Vicinity Property areas (from left to right): G(north), G(south), G(swamp), L and M combined and H (vicinity E had no targets). Small squares denote median value. 80% of the depths lie within the shaded bars.

The spacings of the radar survey lines at each site are given in Table 1. The beam of a GPR transmitter (the analogy being to a flashlight illuminating the subsurface) is quite complex, but it is fair to say that the illumination does not in general extend beyond 45° on either side of the vertical. So,

VICINITY	SURVEY LINE SPACING
E	5m
G	Mainly 10m, some 5
H	10m
L	20m with some 5m coverage
M	20m with some 5m coverage

Table 1. GPR survey line spacings for the 5 vicinity properties.

if the survey lines are L metres apart, there is a triangular area (the central one in Figure 2) within which targets are less likely to be detected. In that sense, particularly for lines spaced by 10 or 20 metres, the survey should be viewed only as a sampling of the subsurface beneath the grid to a depth of 1-2 metres.

c. **Reliability of the interpretations.** No actual records are provided so it is not possible to independently check the interpretation of the targets. However the contractor, Detection Sciences Group(www.detectionosciences.net), is still in business 24 years later, which strongly suggests that they were (and are) competent geophysicists

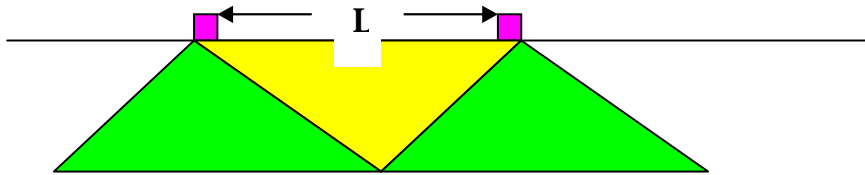


Figure 2. Schematic radar illumination (outer triangles) for two transmitters (red) run along lines spaced by L metres. The volume not surveyed is shown in the central inverted triangle.

Summary

My conclusion is that the 1984 GPR surveys were appropriate for objectives (i) and (ii) but that terrain conductivity methods, such as were employed by the SAIC group 20 years later, were much more appropriate for objective (iii), a regional scan for buried waste in the upper few metres. The Terrain Conductivity method is faster, less expensive, and provides better coverage than widely spaced GPR lines.

That said, these GPR surveys do provide a reasonable image of subsurface conditions under the survey grids, subject to the following limitations.

- (i) The depth of penetration was most probably less than 2 metres. Waste materials below that depth are unlikely to be well characterized.
- (ii) There are “blind spots” between widely spaced lines that are not likely imaged. The GPR surveys are therefore only providing a statistical sampling of the subsurface beneath the gridlines.
- (iii) Without the original data the interpretations claimed can not be independently checked.

Could GPR do a better job in 2007?

There is no doubt that modern GPR technology could do a better job of imaging the subsurface than the 1980s equipment. The full spectrum of oil field seismic processing techniques can now be applied to radar data. Radar tomography can provide three dimensional imaging of subsurface targets under suitable conditions.

The fundamental limitations remain the same, however; these surveys are expensive, illuminate with a narrow beam that requires closely spaced lines for complete coverage, and the penetration is low and often variable over the site (depending on conductivity).¹

In 2001 the SAIC group performed limited GPR surveys in “Area IV”, which lies to the west of the IWCS, and in Vicinity G. These surveys are described in sections 13 and 14 of the SAIC(2003) report.²

The signal penetration in Vicinity G is described as “extremely poor” for both 200 and 500 MHz antennae, and no reflections were observed. In Area IV a number of anomalies were observed with the high frequency (500MHz) antennae, but penetration was limited to 1.5 metres. The 200 MHz antennae did record reflections from geological strata to an estimated depth of 9 metres.

GPR is still best used to investigate in detail targets that have been selected as in objectives (i) and (ii), or detected by other means, for example magnetic or terrain conductivity surveys.

“Do you think that you could estimate the coverage or percentage of subsurface imaged in the surveys? Or comment on the size of an object that could be “detected””? (Your follow-up question from an email of July 20)”

I would prefer not to hazard a guess on either issue because the GPR beam depends on the equipment and on the local ground conditions. In large scale surveys today (for example, for unexploded ordnance) it is good practice to establish a small test site in the area of interest and place within it, and at various depths, typical objects that are of concern. Surveys run over the test site give the client and the geophysicist more confidence in the capabilities and limitations of the equipment.

B. SEISMIC REFRACTION DATA: INTERPRETED WATER TABLE VERSUS WELL DATA OUTSIDE THE WCS.

“Can the water table be detected inside the IWCS using the seismic work”

On the telephone we had discussed the issue of detecting the water table inside the IWCS using seismic refraction techniques, and comparing those data with water levels measured outside the IWCS to infer the integrity of the cut-off wall. Seismic refraction, using P- (compressional) and S- (shear) wave modes, is in principle a very good technique for detecting the water table. The presence of a P-wave refracting horizon separating

¹ It should be noted that when surveys for unexploded ordnance are to be carried out over very large areas (a firing range, for example) a statistical approach is often used. That is, the survey grid is designed to provide coverage of only a certain percentage of the subsurface. The number of UXO present under the entire area is inferred from those detected in the sampling survey. GPR surveys could be run on widely spaced lines using this approach; however, statistical data are not always well received by laymen!

² Oddly, the SAIC report does not refer to the earlier Detection Sciences Group report on GPR surveys.

materials with velocities less than and greater than 1500 m/sec (5000 ft/sec), coupled with the absence of that horizon on the S-wave records, is strong evidence for a water table. (Shear waves do not detect the water table (SAIC, 2003, section 12.2.1, p77 para. 5)). The accuracy of depth calculations for that horizon from the P-wave data should be about 10% under favourable circumstances.

As far as applying this to the existing data from the IWCS, I have advised you of some unresolved issues. One note made by a board member and provided to me appears to have compared water table levels from wells with S-wave (rather than P-wave) data from pages 21 and 41 of Appendix D of the SAIC report, and may have drawn some incorrect conclusions as a result. We had hoped to sort this out with the individual in question but this has not yet happened.

I am not able to locate the seismic P-wave survey lines from Appendix C on the IWCS and thereby compare them directly with the S-wave data. However, another set of figures were provided to me, identified as Figures 5-1, 5-3, 5-5, 5-7 and 5-9 from a SAIC report (but not the one I have) show P-wave cross-sections along lines 5,6,7 and 8. (My SAIC report lists data for P-wave lines 7 through 29 in Chapter 10 and Appendix C, but the lines 7 and 8 here do not coincide with those lines in the aforementioned set of figures.)

An examination of these Figures 5-3, 5-5, 5-7 and 5-9 report will show that, for the most part, the correspondence between water tables in nearby wells and the seismic horizon above the 5000-6000ft/sec layer is good.

In answer to your question, then, I conclude that in principle seismic P- and S-wave surveys can be used to monitor the water table in the IWCS with an approximately 10% accuracy, and that the data would appear to confirm this is the case in practice. I will reserve a final judgment on that last point until I can sort out the issues described.

C. VICINITY G OVERALL.

“Have you looked at the entire packet of work that SAIC did for that area from the perspective of whether their interpretations of locating potential burial areas makes sense? This is the area of the infamous Rochester Burial Area (laboratory debris and animal carcasses disposed of from experiments at University of Rochester during the 1950's, and also plutonium isotopes). My perspective is that I would like to be assured that the subsequent excavations based on the geophysics were in the most likely spot to find the burial area”.

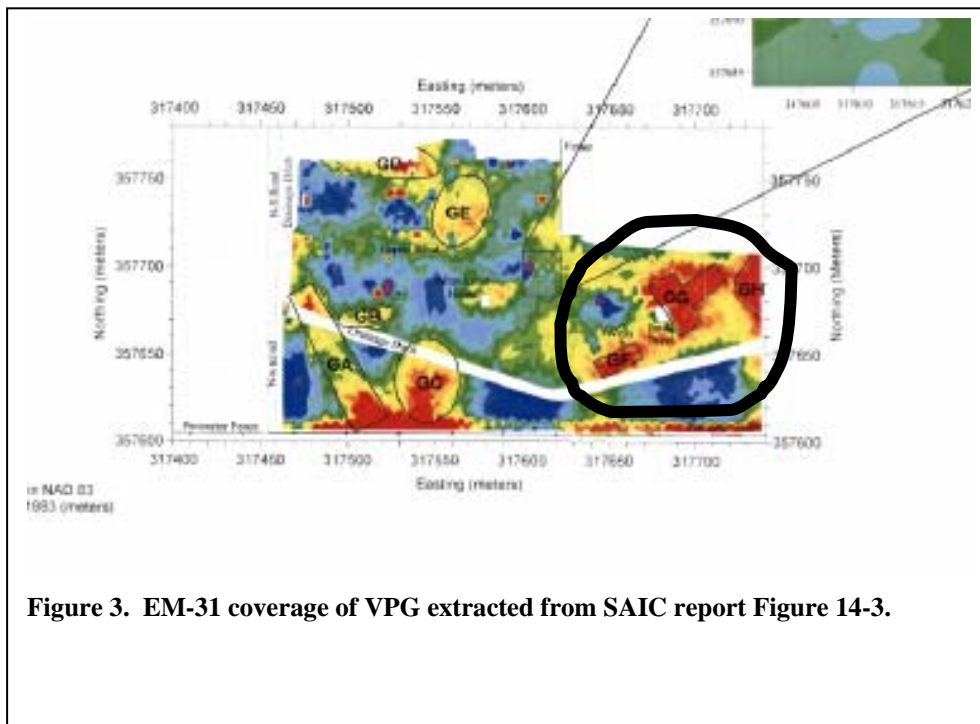
The relevant documents for geophysics are again the 1982 Detection Sciences Report (1), the 2003 SAIC (4) report and, for trenching, the 2004 FUSRAP fact sheet (5). The EM-31 scans of this area provided in SAIC Figures 14-3 and 14-4 are an excellent overview of the physical properties of the upper one or two metres. As stated earlier, I do not believe the GPR data have contributed any useful data.

Excavation and later infilling of an area would be expected to leave the soil with slightly different electrical properties. Typically the infill is less compact, capable of holding more moisture, and hence slightly more conductive than its surroundings.

In the FUSRAP document they state:

“The Corps’ team identified one near-surface area of interest (where electrical conductivity readings were higher than background) within the vicinity of the former U of R burial area, indicating possible buried metallic debris.

The Corps targeted this area for trenching activities. The excavation of soil was selected to investigate the suspect burial area since it allowed for better physical identification and investigation of a larger amount of soils than standard drilling techniques. “



With reference to Figure 3, it is not clear that there is an area of high conductivity in the supposed site of the University of Rochester burial area (outlined by a square). To the east, on the other hand, there is a broad area of higher conductivity (circled and identified as anomalies GF, GG, GH) which the original SAIC report “attributes this ...response to a change in the soil and/or fill material”.

The decision to trench primarily in the suspected burial site does not seem to have been based on the historical rather than the geophysical data. Is there any chance that the former is flawed?

D. OTHER ISSUES

On a broader front, do you think there are aspects of the overall geophysical surveys that you think you should look at in detail that you didn't before? I was specific in my requests before, but based on what you think my concerns are with the site, if there are issues that occur to you, let me know.

None come to mind..

Sincerely



John P. Greenhouse, PhD, P.Geo(Ontario)

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Appendix G Comments Concerning Vicinity Property G

Vicinity Property G, the Castle Garden Dump and the Rochester Burials

During the 1940s and early 1950s, part of the LOOW site was used by the Atomic Energy Commission (AEC) for waste disposal.

“The land shown on Map A-53 which includes the areas bounded by Campbell Street, Wesson Street on the east; ”H” Street on the north; McArthur Street on the west; and the line 100 feet north of “N” Street was used by the Commission in the past as a burial or as an above ground dump” (U. S. Atomic Energy Commission, 1954 page 3, para 2) .

A 30 acre portion, known as Vicinity Property G (VPG), of this rectangular area north of the NFSS was used for the disposal of some specific radioactive materials. This area is delineated by M Street to the north, the fence line with the neighboring NFSS to the south, Castle Garden Road to the east and Campbell Road to the west. The Castle Garden Dump, within VPG, is located south of M Street and west of Castle Garden Road. The dump area contained contaminated and uncontaminated debris and extensive building rubble (some from the Linde site in Tonawanda), ashes, bricks, residue, process material, drums, transite, insulation, cesium gaps and assorted scrapped equipment (U. S. Atomic Energy Commission, 1954 page 4 (e)).

From 1953 onward, several attempts at clean-up of VPG and its neighboring vicinity properties were made (Thornton W. T., 1970; U. S. Atomic Energy Commission, 1954). Comments on the various efforts on VPG follow.

1953-1954 Clean-up

Hooker Electrochemical Co. acting as site caretaker and in close collaboration with the Atomic Energy Commission, (AEC) removed surface contamination and disposed of it in one of two locations (a) the New Navy Dump area in the northern section of the NFSS site or (b) a burial area on VPG itself, located approximately 150 feet due north of the abandoned farmhouse on VPG (Malone F. W., 1953 page 1, item 4).

The location of this burial area was recorded on a Hooker map, A-53, along with the location of a prior burial of animal remains from the University of Rochester. There is conflicting evidence as to the location of the animal burial. A 1953 memorandum describes the location of the Rochester animal disposal as being 200 feet east of the farmhouse, the location to be included on the Hooker A-53 map (Malone F. W., 1953 page 2, item 5). However, the A-53 map subsequently produced by Hooker shows it to be 88 feet due east of the abandoned farmhouse, as shown in U. S. Army Corps of Engineers(2004 Fig. 2).

1970-1972 Decontamination.

In 1970 the AEC investigated reports of elevated radioactivity levels on private property, including VPG by carrying out spot check radiation surveys on lands surrounding the AEC Niagara Falls site (Thornton W. T., 1970). A follow up radiological survey in June 1971 confirmed VPG was still contaminated with both surface contamination and subsurface contamination and investigated the two VPG burial areas specified on the Hooker A53 map.

Area A.- University of Rochester Animal Burial as recorded on 1954 Hooker Map. An area approximately 25' X 25' was excavated to a depth of 5' and revealed 6 garbage cans contain primarily a soft whitish material but including a few small bottles and test tubes. Only one can had significant contamination on it – a small spot reading 30r/hr. Contaminated can was removed to AEC site. No further decontamination in this area is required. (No stakes in this area.)

Area B – Recorded as contaminated metal burial area on 1954 Hooker Map. Contaminated drums were found in an area 20' X 70' to a depth of 10'. Maximum radiation level found was 50mr/hr and several readings of 10 – 20 mr/hr were observed in this area. Decontamination is estimated to require removal and back fill of about 500 cu yds. (Area marked by stakes #103, 104 and 105.)”

No animal remains were found in the location identified as the Rochester Animal Burial on the Hooker A53 map.

The decontamination effort in 1972 removed contaminated timbers and rubble from two locations on VPG and soil to a maximum depth of 18” in 5 other VPG locations (U.S. Atomic Energy Commission, 1973 Appendix I, Table V).

One spot on VPG, which was located during the June 1971 survey was found during the June 1972 cleanup to have been disturbed by the property owner such that the radiation level was below a level requiring decontamination(U.S. Atomic Energy Commission, 1973 Appendix I page 17).

1983-1986 Survey and Decontamination.

Following a 1980 Battelle survey of the NFSS site, where areas supposedly decontaminated by the AEC in 1972 were found to be still contaminated, the Department of Energy (DOE) resurveyed all private land which had formerly been used by the AEC at the LOOW site. This included VPG, where the radiological history of the property was reviewed and three major areas of concern were identified (Oak Ridge Associated Universities, 1984 Fig. 2)

- (a) The Castle Garden Dump where miscellaneous contaminated and uncontaminated scrap, building debris and equipment from a variety of sources, including the Linde Plant, was dumped on the surface.
- (b) The contaminated metal area from 1953, 150 feet north of the farmhouse.
- (c) The University of Rochester animal burial area, 88 feet east of the farmhouse.

A comprehensive survey of VPG was carried out in April through June 1983 by the Radiological Site Assessment Program of Oak Ridge Associated Universities. The survey noted that the two previous burial sites had been excavated in 1972. The survey included surface radiation scans, measurements of direct radiation levels and analyses for radionuclide concentrations in soil and water samples, both surface and subsurface. Ground penetrating radar surveys were carried out in two sections, a north and a south section of VPG (Oak Ridge Associated Universities, 1984 page 20).

The purpose of the ground penetrating radar survey was to (i) identify any potential subsurface obstructions in the area of proposed boreholes for subsurface testing and (ii) identify any material still buried in the metal burial area, 150 feet north of the farmhouse.

Part of the eastern section of VPG could not be surveyed because of the presence of large aeration ponds (fac ponds 1 and 2), which had been constructed on VPG subsequent to the 1972 survey.

The ground penetrating radar survey in the northern section showed extensive buried concentrations of solid material, thought to be similar to the construction debris noted on the east side of Castle Garden Road, along with two areas of non-ionic liquids, buried under 5.5 feet of earth (Detection Sciences Group, 1983).

The ground penetrating radar survey of the southern section showed several buried objects whose signature was consistent with that exhibited by a 55 gallon drum. Visual inspection of the surface of this southern section showed the rusted remains of several 55 gallon drums either partially or totally exposed above ground. The presence of these drums suggested that the area may have been used as a disposal area. Those objects suspected of being buried drums were all located 2 to 3 feet below ground (Detection Sciences Group, 1983).

The results of the comprehensive survey of VPG showed contamination in numerous areas of the western section of VPG exceeded guideline levels. On the west central portion of the site the contamination was associated with pieces of rock-like material and building rubble. In the southwestern portion of the property the contamination appeared to be associated with pieces of debris and scrap metal, close to the location of the 1953 metal burial, which was excavated in 1972 by the AEC. Ground penetrating radar showed several subsurface metal targets, located 3 to 4.5 feet below ground, which resembled disposal containers in the previous burial site area.

In 1986, in its capacity as DOE's Project Management Contractor for the NFSS, Bechtel National Inc. removed radioactively contaminated soil from VPG (Bechtel National Inc., 1989).

Forty five areas on VPG were decontaminated and backfilled (see figs 19 through 24 describing excavation and backfilling in sections 1 through 5 of VPG.) Excavation was to a depth of 0.5 feet except for one small excavation to a depth of 1.3 feet in section 2, one excavation to a depth of 1.5 feet in section 3, four small excavations to a depth of 1.0 foot in section 4 and four excavations in section 5: one to a depth of 5.6 feet, one to a depth of 4.5 feet and two to a depth of 1.0 feet (Bechtel National Inc., 1989 pages 28 - 33).

Reviewing the details of the remediation work carried out by Bechtel in 1986, it is clear that no attempts were made to remove buried drums or investigate subsurface anomalies on VPG, despite the previous ground penetrating radar study in April 1983, which identified subsurface metallic objects remaining in a previous burial site.

There appears to be no detailed record of the exact location the drum excavation subsequently undertaken by Bechtel in 1987, as described in an investigation report sent to the EPA by a Bechtel representative (Ahrends, 1987).

This investigation report suggests that Bechtel were still unaware of the earlier April 1983 ground penetrating radar study at the time of their VPG drum removal exercise. The 1987 drum removal operation appears to have focused on one localized area where drums had been accidentally spotted at the end of the remediation effort.

Analytical test data for the drums recovered revealed that the drums contained remnants of K65 residues and organic tar-like materials (Ahrends, 1987). Thirty one radiologically contaminated drums were removed, along with 90 drums of spilled organic sludges (Ahrends).

2001-2002 USACE University of Rochester Burial Area Investigation.

In 2001 the US Army Corps of Engineers (USACE) conducted an investigation into the University of Rochester Burial Area on Vicinity Property G. A focused frequency domain electromagnetic (EM-31) survey over the southern portion of VPG, south of the gravel road was carried out in order to look for buried metal or changes in soil, which might indicate a burial location (U. S. Army Corps of Engineers, 2004).

The survey indicated one area of possible metallic debris burial in the vicinity of the University of Rochester burial area, as described in the Hooker A-53 map – 88 feet east of the disused farmhouse. A 65 foot long by 12 feet deep (at its maximum depth) trench (TG01) was dug to explore the burial site. At a second trench site (TG02) a rusted metal trashcan was found at a depth of between 6 inches and 3.5 feet below the surface. The can contained laboratory debris, consistent with material which would have been generated by the U of R in the mid 1940s. In all 6 trenches were dug over the course of the investigation.

Trenching in TG 01 revealed a contaminated pelvic bone from a small mammal one foot below the surface. The bone exhibited elevated strontium-90 and plutonium-239/240 (Sr-90 detected at 306 pCi/g and Pu 239/240 at 8.08pCi/g)

USACE carried out a comprehensive investigation of the area identified by Hooker Electrochemical as being the location of the University of Rochester Burial site. However, USACE did not adequately investigate the earlier documented report of the University of Rochester Burial being 200 feet east of the farmhouse. This area in the vicinity of the southern part of the CWM facultative ponds and close to an original small pond on site corresponds to a 1954 reference to the location of the University of Rochester Burial (U. S. Atomic Energy Commission, 1954 Fig 3).

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Appendix H Historical Notes Concerning Radioactive Waste from
The Knolls Atomic Power Laboratory on the LOOW Site

Historical Notes Concerning Radioactive Waste from the Knolls Atomic Power Laboratory on the LOOW Site

Radioactive contamination on the LOOW site is usually associated with the presence of radium, thorium and uranium from the storage of radioactive residues and wastes in connection with the Manhattan Project. However, from the late 1940s up until 1954, the Atomic Energy Commission (AEC) used the LOOW site (also known as LOSA or Lake Ontario Storage Area) as a storage and disposal site for a variety of nuclear wastes, including nuclear reprocessing wastes from the Knolls Atomic Power Laboratory (KAPL) at Schenectady, NY, which was operated by General Electric on behalf of the Atomic Energy Commission (AEC).

The KAPL wastes generated by the Separations Process Research Unit (SPRU) at KAPL contained fission products and transuranic materials including plutonium. The SPRU facilities were built between 1947 and 1949 in response to a request by the Hanford Reservation to construct a pilot plant for the new REDOX chemical extraction process to separate plutonium and uranium from mixed fission products in irradiated reactor fuel. KAPL successfully established the REDOX process using the SPRU facilities, then went on to modify the facilities to develop a new continuous solvent extraction process called PUREX, which was subsequently adopted by the Savannah River project. By the summer of 1953, KAPL terminated SPRU research activities and placed it on standby. Clean-up of the KAPL SPRU facilities is currently underway at a cost of \$67 million dollars.

During the three year time period the SPRU operated, it soon became apparent that disposal of the radioactive wastes generated by KAPL was going to be problematic. A KAPL Radioactive Waste Committee was set up to address waste issues. A 1951 report describes incineration, liquid waste disposal and high level solid waste storage as well as detailing difficulties in development of satisfactory methods of incineration of radioactive wastes, a growing back log of combustible wastes and the problem of ultimate disposal of solid radioactive wastes.

In the case of the problem of ultimate disposal of wastes the report states, *“Progress was made on the problem of ultimate disposal; it now appears that there is a good possibility that the Lake Ontario Ordnance site, which is under the jurisdiction of the AEC, may be used for disposal of all solids except highly radioactive combustible waste”* (1).

The use of the LOOW site for storage of KAPL wastes was confirmed in a meeting between Schenectady Operations Office, New York Operations Office and the Reactor Development Operations Office, Washington D.C. in November 1951. An accumulated 20 tons of combustible radioactive waste and 150 tons of non-combustible radioactive waste were to be moved from the banks of the Mohawk River, where it constituted a hazard to the public water supply, to a more remote and less hazardous location at the LOOW site (2).

According to the meeting report, *“The question of using the incinerator at LOSA for burning the combustible waste was discussed. However, Mr. Cherubin opposed this on the grounds that a specialized incinerator is needed for this type of operation. The one at*

LOSA is not adaptable and should not be used. Schenectady representatives agreed that about 50% of highly contaminated waste will be incinerated at their own plant and 50% of low level combustible waste will be stored at LOSA. They will do everything to hold the volume of highly contaminated waste to a minimum” (2).

KAPL issued recommendations on the segregated, under cover storage of the wastes and agreed Building 8451 (the concrete compressor building), was suitable for storage.

Future operations at KAPL were expected to produce additional wastes of 85 drums of hot slurry (fission product material) a year while combustible waste would be at current levels. Other wastes would comprise 20 boxes (4' x 4' x 4') of cold incinerator ash and 82 boxes of non-combustible wastes (2).

Shipment of KAPL wastes to LOOW commenced in January 1952. A detailed report of the shipment, involving 7 rail cars of wastes, was issued, describing the storage of wastes and documenting personnel exposures (3). The wastes included 191 stainless steel drums of hot slurry fission product waste, 217 carbon steel drums of solid radioactive waste, nine 275 gallon storage tanks and 207 waste boxes of solid combustible and non-combustible wastes. The storage tanks may have been used to store canned contents of some of the carbon steel drums under water, as described in the 1951 KAPL waste disposal report (1). This possibility is supported by the 1952 waste shipment report referring to empty carbon steel drums stored with the waste boxes along one wall of the compressor building (3). The unstated implication is that there may have been non-low level waste from the carbon steel drums that was stored under water to reduce radiation exposure.

Further details of the radioactive waste disposal practices of KAPL are described in a 1958 paper (4). The paper puts forward a careful and considered approach to waste disposal by KAPL, but this may not be entirely accurate. For example, discharge of liquid radioactive wastes to the Mohawk river was, according to the paper, inaugurated in June 1955 after considerable investigation by the U.S. Geological Survey and co-operation between New York State Health Department, General Electric and Harvard University, but in fact, liquid radioactive wastes were being discharged to the river as early as 1951.

During 1952, the Reactor Development Division, Washington D.C. made efforts to identify Commission-wide disposal facilities for radioactive wastes and visited the LOOW site to discuss the further use of the LOOW for the disposal of various types of laboratory and production radioactive wastes (5).

In August 1952, it was agreed that the abandoned boiler plant at LOOW, Building 401, could be used for storage of additional radioactive wastes, which had accumulated at KAPL since January 1952. The 225 tons of contaminated material in the original shipment to LOOW from KAPL, was to be followed by an estimated 100 tons per year, to be shipped every 6 months (6).

In September 1952 concerns were raised regarding the long term use of Building 401 for KAPL waste storage, owing to the possibility of alternative use of the Boiler Plant in the near future. Washington was also advised, *“Your attention should be called to two facts about the LOSA. Experience has shown that because of prevailing weather, long term, outdoor storage is not feasible, even in steel containers and also that a previous study of*

the local geology indicated that any method of storage which would permit uncontrolled seepage into the ground would not be advisable” (7).

In June 1953 KAPL requested permission to ship a third consignment of radioactive wastes to LOOW, which gave rise to complaints that the Division of Reactor Development had not formulated a long-range program to dispose of such wastes.

“On November 19, 1951, a meeting was held with KAPL representatives and Mr. J. A. Lieberman, Sanitary Engineer, Division of Reactor Development, AEC Washington. It was our understanding at that time that we agreed to store the accumulated wastes at KAPL up to that date but that the Division of Reactor Development would formulate a long-range program for the disposal of such wastes in general. Since that time, additional wastes have been sent to LOSA for storage with the understanding that each one would be the last shipment” (8).

A June 1953 radiological survey confirmed the presence of KAPL wastes stored in the Boiler Plant (Building 401) and the Compressor House (Building 8451). The survey noted that, *“Radiation emitted from the Schenectady wastes stored in the boiler house supplied the highest readings. Values from 0.1 mr/hr found at the West door of the boiler house (approximately 150 feet from the storage area), to 2,300 mr/hr found on top of one of the waste drums” (9).* The presence of plutonium, zirconium and lanthanum was also noted. The survey went on to recommend that the Schenectady wastes should be moved to another location in the newly designated AEC area, provided the new storage building was completely covered by roof and walls, was fairly dry and appropriate precautions were taken to protect personnel (9).

In August 1953, Washington was advised that there would be space at LOOW for only three of the nine carloads of waste being prepared for shipment to LOOW from KAPL (3rd requested consignment). Plans were made to approve outdoor storage of the drummed wastes.

“Quidor said NYOO had some reservation about storing boxes and bales of combustible radioactive material out of doors, but was agreeable to outside storage of the steel drums holding radioactive sludges. He said if KAPL would approve outside storage of these drums there would be adequate inside storage at LOSA for all the earlier KAPL waste in boxes and those in the proposed nine-car shipment. This inside storage would be within the area at LOSA for current and future use and would include the two areas studied by the USGS as possible sites for a burial ground for radioactive wastes.”

This plan was modified when additional indoor storage became available in the LOOW sewage treatment plant buildings.

“On August 25 Quidor called again and said NYOO had decided to enlarge the area to be used for its new operations, and this would include the sewage treatment plant of the former Lake Ontario Ordnance Plant. The buildings have been stripped of most of the plant operating facilities such as pumps and motors. It is now proposed to store KAPL combustible wastes in the abandoned pumping station at this plant” (10).

The third consignment of KAPL waste, nine rail car loads, was shipped to LOOW starting on August 27, 1953 (11).

In September 1953, a health and safety meeting was held between NYOO, Hooker and the Cleveland office of AEC, where the designation of buildings in the Baker Smith area for storage of the KAPL Schenectady wastes was discussed. The need for repair of the buildings in the Baker Smith area was noted (12). The poor state of repair of buildings in this area is again referenced in a December 1953 letter, which discusses a suggestion by Hooker, the site custodian, to burn down one of the KAPL storage buildings, radioactive contents and all.

“It is hoped that the building as a whole can be fired.....”

“I would not like to make any categorical statement on this at this time pending the results of some of our tests. However, it is my belief that these bales of combustible material will probably have to be broken open before they can be expected to burn. After they are broken open, it may be necessary to fire them singly or in small groups because of the possibility of spark hazard from flowing paper wafted upward from the flames.” (13).

Following on from these remarks, a controlled open burning experiment was conducted on the LOOW site in April 1954. The purpose of the experiment was to determine the feasibility of evaluating the potential hazards inherent in disposing of large quantities of radioactive wastes in this manner. Five crates containing a total of 10 compressed bales of combustible material were measured, weighed, stacked on a concrete pad at the site selected for burning, saturated with fuel oil and ignited. The burn site location was along M Street, just east of Campbell Street (14). A further burning study, involving ten times as much material was carried out on June 17-18 1954 with inconclusive results regarding fallout activity (15).

In August 1954 a further request to ship more KAPL waste to LOOW was made (16). The Cleveland Area Office, which was responsible for LOOW at that time agreed to accept the additional waste, but in September 1954 informed Oak Ridge of the unsatisfactory conditions under which KAPL wastes were being stored at LOOW.

“When the Cleveland Area Office assumed responsibility for LOSA, we found the KAPL material stored in the Baker-Smith area of LOSA in a non-segregated manner, in combustible buildings, and outside of the area of fire hydrant protection established at the Ordnance Plant. Shipments continued to be received from Schenectady about one every three months and non-segregated storage continues in the Baker-Smith area.” (17).

The Cleveland Office went on to recommend

- 1. LOSA not be used as storage area for KAPL wastes.*
- 2. Arrangements should be completed so that combustible wastes may be reduced in volume by burning and the ashes therefore combined with the non-combustible wastes shipped from Schenectady and this total residue buried at LOSA rather than stored in above-ground deteriorating buildings.”(17).*

Oak Ridge responded to this information by discontinuing the use of the LOOW as a storage site for KAPL contaminated materials and requesting specific information from KAPL on the amounts and specifications of the materials shipped to LOOW (18).

KAPL provided a full list of the materials shipped and the dates of shipment (11).

January 22, 1952: 207 waste boxes

191 drums of hot slurry (fission product waste)

217 drums of solid waste

9 storage tanks

October 16, 1952: 132 waste boxes

57 bales

August 27, 1953: 123 waste boxes

88 drums of hot slurry (fission product waste)

248 drums of liquid contaminated waste

2 pallets of 5 gallon contaminated material

1 pallet of 15 gallon liquid contaminated waste

39 pallets of contaminated filters/baled paper

April 16, 1954: 138 waste boxes

April 23, 1954: 38 waste boxes

June 4, 1954: 24 drums of contaminated oil

58 waste boxes

Sept. 9, 1954: 64 drums of solid waste

412 waste boxes

KAPL also estimated the activity of waste sent to LOOW in the hot slurry (mixed fission product) waste as 408 Curies (19). According to KAPL, 394 drums of slurry were sent to LOOW. This estimate did not address the radioactivity of the approximately 500 drums of solid wastes and liquid wastes that was also sent to LOOW, and may also have been radioactive.

The deterioration of the buildings used to store KAPL wastes continued over the next few years and one building in particular, a construction warehouse, was the subject of much discussion at the end of 1956. Several alternatives including repair of the building, offsite disposal or on-site elimination of the storage problem were suggested. There were two suggestions for on-site elimination:

1. *“ The digging of a large pit into which the materials can be dumped and covered with appropriate earth. We presume this is geologically feasible because of the past record of burial of other contaminated materials at the Niagara Falls site.”*

2. “ A proposal which has been suggested a number of times in the past i.e., that we set fire to the building and reduce the contents to a reasonable volume before attempting further disposition means. There may well be some real merit to such a plan, although the destruction of government property, i.e. the building, and the health and safety aspects of this scheme will need further resolution.” (20).

By 1957 the costs of off-site disposal of the 38,500 cu ft of combustible KAPL wastes (estimated weight 350,000 lbs) stored in buildings 446 and 448 (21) made the alternative of on-site reduction in volume of wastes by burning very attractive (22). Consideration was also given to the disposal of the drummed KAPL wastes stored at LOOW. The urgency of addressing this issue was highlighted in an October 1957 memo.

“I believe at this time it is almost imperative that something be done about removing the liquid wastes that are stored in the regular 55 gallon steel drums which are rapidly rusting away. If something is not done before next summer, I feel sure that we will involuntarily have a radioactive storage area that could probably never be cleaned up. You are probably aware that these liquid wastes are highly radioactive and dosage rates are anywhere from 500 to 1500 MR’s” (23).

In December 1957 arrangements were made to ship the drummed KAPL wastes to Oak ridge for burial (24). Deteriorated carbon steel drums were placed in over-sized light weight steel drums in order to prevent leakage of drums in transit (25). A total of 490 over-sized drums were purchased (26), indicating the scale of the problem. KAPL were informed of the impending waste shipment from LOOW and requested to provide technical support to Hooker Electrochemical, whose employees were inexperienced in the handling of radioactive materials. A specific request was made for assistance from D. A. Manieri (27).

The drummed waste was removed from the Baker Smith Area and the Waste Water Treatment plant (sewage treatment) buildings, to a railroad siding in preparation for shipment to Oak Ridge (28). In January 1958, three rail cars containing a variety of KAPL drummed wastes were shipped offsite (29). A fourth rail car was shipped to Oak Ridge in February 1958 (30). The wastes transported were accompanied by the following bill of materials:

“Solid waste – Composed of high level mixed fission products and includes miscellaneous scrap

Slurry – Composed of high level mixed fission product from evaporator bottoms from KAPL Liquid Waste Process

Plutonium – Composed of all materials contaminated with Plutonium or Thorium. This type of waste is packaged into 1 gallon paint cans, and placed into carbon steel drums

Oils – Ashes – Contaminated with low level mixed fission products

Uranium residues, formerly packaged in 5 gallon cans, packed in 65 gallon carbon steel capsules

Filters – Spun glass air filters packed in wooden boxes

Gaps – Cesium and strontium gaps capsuled in 65 gallon carbon steel drums”

D. Manieri (KAPL) was informed of this waste shipment and invited to attend the start of the burning of the combustible KAPL wastes, scheduled for February 19, 1958 (31). The burning of combustible KAPL wastes at LOOW was discussed at a site conference held on February 27, 1958. Using the 1954 burning studies in conjunction with further experimental burning trials of low level radioactive waste conducted on February 26 and 27, 1958, instructions were issued to burn “low dose rate” (6mr/hr or less) packages, retain “high dose rate” packages for future burning studies, retain any plutonium contaminated packages, and drum all ashes for future disposal. Burning was to be done in the open or in the LOOW incinerator (32).

Beginning with the burning of “no dose rate” material, Hooker Electrochemical, under instruction from the AEC, proceeded to begin burning the low dose rate KAPL wastes (33). The burning operation was scheduled to be complete by June 30, 1958 (34). However, Hooker experienced problems with burning some of the wastes, requiring a resurvey of the burn operation by the Health & Safety Laboratory (35).

Some of the problems encountered by Hooker are described as follows:

“In your letter of March 10 you authorized us to burn the low-level Wastes and made reference to the conference on the subject with the New York Office and KAPL Personnel of March 4.

The assumption was made at that time that each package would have a dose rate marking. We have proceeded on that assumption and burning activities have continued as agreed. However, many of the crates in building 444 are so badly weathered that the original markings have disappeared and we find it impossible to proceed on the outlined basis.

Since we have been warned that some of these crates contain plutonium and we are to avoid these because of potential fall-out, we now find it impossible to do so by observing external markings ” (36).

A second conference was held on April 3, 1958 to determine the disposition of both unmarked waste packages and the non-burnable scrap and ashes from incineration. An Oak Ridge representative described the present LOOW disposal activity as involving no risk on the part of the AEC or Hooker to either personnel or surroundings.

“The assistance which has been given (including Mr. Schoen’s visit) was described as being insurance against any hazard developing, and to ease our (Hooker’s) mind. As a further precautionary measure, Mr. Schoen suggested that the personnel involved in waste handling submit two urine samples- one now and one at the completion of the project. The analysis of the urine will show a minute quantity of ingested contamination. This analysis is suggested for assurance only, since it is the AEC’s contention that there is no hazard involved in the present work ” (37).

“The following directions were given as to the completion of the disposal program:

1. *Boxed ashes received from KAPL – dump in pit on site and cover with earth; no marking required. (These ashes are not contaminated- they resulted from incineration of office material at KAPL).*
2. *Ashes from LOOW burning- drum and ship to Oak Ridge*
3. *Scrap metal-package and ship to Oak Ridge.*
4. *Packages marked “Pu possible”– ship to Oak Ridge.*
5. *Packages with no visible marking – ship to Oak Ridge.*
6. *Packages marked as having a dose rate – retain for experimental burning by New York Health & Safety” (37).*

A subsequent letter to Hooker from Oak Ridge directs Hooker to continue burning the “low dose rate” material and ship material in excess of 6mr/hr to Oak Ridge (38). However, D. Manieri of KAPL, who assisted Hooker in packaging and shipment of KAPL wastes to Oak Ridge from LOOW states Hooker Electrochemical Company, under the direction of the AEC, burnt all of KAPL’s combustible wastes (39).

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