FIVE-YEAR REVIEW REPORT
LOVE CANAL SUPERFUND SITE
CITY OF NIAGARA FALLS
NIAGARA COUNTY, NEW YORK

Prepared by
U.S. Environmental Protection Agency
Region 2
New York, New York

Approved by:

Walter E. Mugdan, Director
Emergency and Remedial Response Division

JAN. 15, 2014
Date

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FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Love Canal		
EPA ID: NYD980768717		
Region: 2	**State:** NY	**City/County:** Niagara Falls/Niagara

SITE STATUS	
NPL Status: Deleted	
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes

REVIEW STATUS
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:** N/A
Author name (Federal or State Project Manager): Damian Duda
Author affiliation: EPA
Review period: 09/29/2008 – 09/29/2013
Date of site inspection: 07/11/2013
Type of review: Policy
Review number: 3
Triggering action date: 09/29/2008
Due date *(five years after triggering action date)*: 09/29/2013

Five-Year Review Summary Form (continued)

Issues/Recommendations

Issues and Recommendations Identified in the Five-Year Review

OU(s): 01	Issue Category: No Issue			
	Issue: N/A			
	Recommendation: N/A			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	PRP	EPA	N/A

Protectiveness Statement(s)

Operable Unit: 01	*Protectiveness Determination:* Protective	*Addendum Due Date (if applicable):* N/A
Protectiveness Statement: The OU-1 remedy at the Love Canal site is protective of human health and the environment.		

Sitewide Protectiveness Statement (if applicable)

For sites that have achieved construction completion, enter a sitewide protectiveness determination and statement.

Protectiveness Determination: Protective	*Addendum Due Date (if applicable):* *N/A*
Protectiveness Statement: The implemented remedies for the Site protect human health and the environment.	

EXECUTIVE SUMMARY

This is the third five-year review for the Love Canal Superfund site (Site), located in the City of Niagara Falls, Niagara County, New York.

Based upon the results of this review, the U.S. Environmental Protection Agency concludes that the remedies implemented at this Site adequately control exposures of Site contaminants to human and environmental receptors to the extent necessary for the protection of human health and the environment. The continued operation and maintenance at the Site ensures that there are no site-related exposures of hazardous materials to human or environmental receptors.

I. Introduction

This is the third five-year review (FYR) for the Love Canal Superfund site (Site), located in the City of Niagara Falls (Niagara Falls), Niagara County, New York.

This review was conducted by Damian Duda, the U.S. Environmental Protection Agency (EPA) Region II, Remedial Project Manager (RPM) for the Site. A FYR is required at this Site because hazardous substances, pollutants or contaminants remain at the Site above levels that do not allow for unlimited use and unrestricted exposure. It is the policy of the EPA to conduct FYRs of pre-Superfund Amendments and Reauthorization Act of 1986 (SARA) remedies which result in hazardous substances remaining on-site. This FYR was conducted in accordance with the Comprehensive Five-Year Review Guidance, OSWER Directive 9355.7-03B-P (June 2001). The purpose of a FYR is to ensure that the implemented remedies protect human health and the environment and that they function as intended by the Site decision documents. This report will become part of the Site file. In accordance with Section 1.3.3 of the FYR guidance, a subsequent policy FYR is triggered by the signature date of the previous FYR report. The trigger for this FYR is the date of the previous FYR, September 29, 2008.

This FYR reviews the Site remedies that have left waste on-site above levels that do not allow for unlimited use and unrestricted exposure and, therefore, primarily focuses on effectiveness of the containment of wastes within the Love Canal landfill (LCL) area, which is identified as the full 70-acre fenced area that includes the landfill cap remedy, the leachate collection and treatment facility (LCTF) and a number of monitoring wells.

The lead agency for this review is EPA Region 2.

II. Site Chronology

The chronology of Site events is shown in Table 1.

III. Background

Site Location and Physical Description

The Site is in an urban area in the southeast corner of Niagara Falls, approximately 1/4 mile north of the Niagara River in Niagara County, New York (see Figure 1). Approximately 2,000 people live within a mile of the LCL, and 10,000 people live within three miles. The area is served by a public water supply system; the Niagara Falls water treatment plant serves 55,000 people.

Geology/Hydrogeology

In general, the groundwater hydrogeology at the Site consists of silty sand and silt fill, underlain by a confining layer of hard clay, transition clay, soft clay and glacial till and further underlain by the Lockport dolomite bedrock and the relatively impermeable Rochester shale. The shallower layer, located above the clay layer, is bounded towards the north and west by Black, Bergholtz and Cayuga creeks and towards the south by the Little Niagara River.

Land and Resource Use

The fenced 70-acre LCL is not available for reuse or redevelopment. The term "Emergency Declaration Area" (EDA) was used to describe the entire 350-acre, primarily residential, neighborhoods, which surrounded the original Love Canal disposal area. Since the release of the New York State Department of Health (NYSDOH) Habitability Decision, described in more detail below, and the subsequent resettlement of the EDA neighborhoods, the EPA often refers to the "former EDA" to describe these neighborhoods because the area is no longer under an emergency declaration. The former EDA was eventually divided into seven areas (see Figure 1). Residential use is permitted in EDA Areas 4 through 7. Properties located within the EDA Areas 1 through 3 require remediation prior to any residential use but are considered suitable for commercial and/or industrial use without remediation. Currently, there are few commercial operations in the former EDA.

History of Contamination

The Site includes a 3,200 feet by 80 feet canal section (one of two discontinuous sections) that was excavated by William T. Love in the late 1800s for a proposed direct current hydroelectric power project. Subsequently, Mr. Love abandoned this project upon the availability of alternating current electric power. Between 1942 and 1952, the Hooker Chemicals & Plastics Corporation (now Occidental Chemical Corporation (OXY)) disposed of approximately 22,000 tons of drummed and liquid chemical wastes, including polycyclic aromatic hydrocarbons (PAHs), halogenated organics, pesticides, chlorobenzenes and trichlorophenols containing 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD or dioxin), into the abandoned canal originally excavated by Mr. Love. This abandoned canal is now identified as the original Love Canal disposal area. In 1953, the original disposal area was covered with soil and deeded by Hooker Chemicals to the Niagara Falls Board of Education (NFBE). Subsequently, the area adjacent to the original disposal area was extensively developed with the construction of numerous homes and an elementary school, the 99th Street School.

Problems with odors and residues in the basements and backyards of residential properties in the area were first reported in the 1970s. Also, during the 1970s, unusually high precipitation in the region caused the water table within the original disposal area to rise, which allowed contaminants to spread laterally in surficial soils and along utility bedding, eventually seeping into the basements of nearby homes. Various studies, conducted at this time, verified that numerous toxic chemicals had migrated into the surrounding area directly adjacent to the original disposal area. Dioxin and other contaminants also migrated from the original disposal area to the sanitary and storm sewers which extended beyond the boundary of the original disposal area, some had outfalls into nearby Black, Bergholtz and Cayuga creeks, as well as the Niagara River.

Extensive investigation of the groundwater was conducted via the numerous monitoring wells, both on-site and off-site. Levels of contaminants of concern in groundwater were found not to be of concern outside the original disposal area.

In 1978, NYSDOH identified more than 80 chemicals in the original disposal area and adjacent soils. Subsequently, in order to define the Site further, homes which directly abutted the original disposal and those across the street from them were identified as the Rings I and II homes, respectively.

Initial Response

In August 1978, further sampling prompted the New York State (NYS) Commissioner of Health to order the closure of the 99th Street School and to recommend that pregnant women and children under two years of age who lived in the Rings I and II homes immediately evacuate the area and that residents avoid the use of their basements as much as possible and avoid consuming home-grown produce.

Also, in August 1978, President Carter issued the first of two emergency declarations at the Site. The first emergency declaration provided Federal funding for remedial work to contain the chemical wastes at the Site and for the relocation of the residents living in Rings I and II.

In May 1980, President Carter issued the second emergency declaration at the Site, which specifically established the boundaries of the EDA and authorized $20 million of federal funds for the purchase of homes for those residents who were evacuated and/or who wanted to leave. The Federal Emergency Management Agency (FEMA) disbursed these funds and, together with the New York State Department of Environmental Conservation (NYSDEC), relocated hundreds of the affected families. Eventually, after further evacuation, an eight-foot-high chain-link fence was installed around the original disposal area and the Rings I and II homes. All but two families within Rings I and II were evacuated. After the evacuation, demolition equipment was mobilized to the Site, and the Rings I and II vacant houses were demolished. The resulting nonhazardous debris materials were either placed under the cap or used as fill on-site. Overall, approximately 950 families, of the more than 1,050 families affected, were eventually evacuated.

In addition, in 1980, a 22-acre clay cap, with a minimum three-foot thickness, was installed over the original disposal area after a barrier drain collection system was installed to intercept and to collect any chemicals that were migrating from the area.

In December 1980, the contamination problems discovered at the Site and other sites led to Congress enacting the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to address thousands of hazardous waste sites nationwide. The law established a "Superfund" Trust Fund based on excise taxes from crude oil and certain commercially-produced chemicals. Based on state referrals, the EPA began a National Priorities List (NPL) of sites requiring comprehensive hazardous waste cleanup.

In 1981, the EPA proposed adding the Site to the NPL, making it available for funding under the Superfund legislation. The Site was added to the NPL in 1983.

EDA Habitability, Property Acquisition and Maintenance and Technical Assistance

In August 1983, the EPA, in order to address Congressional concerns raised by the May 1982 Love Canal Environmental Monitoring Study (EMS), established the multi-agency Love Canal Technical Review Committee (TRC) to act as a management group to provide interagency coordination and oversight for further remedial and habitability activities for the Site. The TRC was comprised of senior-level representatives from the EPA, the Centers for Disease Control, NYSDOH and NYSDEC. The principal task of the TRC was to determine the habitability of the EDA surrounding the Site. The EDA was subsequently divided into seven distinct sampling areas.

To ensure that the criteria for habitability were reasonable, practical and scientifically sound and to assist in the development of the criteria, the TRC convened senior-level representatives from the EPA and sought the advice of an expert panel of scientists from a variety of disciplines, along with the suggestions and recommendations of representatives of industry, other government agencies and the public. For the habitability criteria, the experts reviewed the environmental media data, past cleanup actions, planned cleanup actions and any published health studies.

In December 1986, the Superfund Amendments and Reauthorization Act (SARA) to CERCLA were enacted. Section 312 of SARA codified the EPA's response at the Site by including specific provisions for future Site actions, including:

- Completion of a study of the habitability of the EDA;
- Acquisition of those properties which were not eligible for government acquisition under the FEMA acquisition program;
- Maintenance of property acquired under the FEMA and SARA acquisition programs; and
- Provision of technical assistance to the Love Canal Area Revitalization Agency (LCARA)[1] to facilitate its efforts to revitalize the EDA.

In July 1988, the EPA issued the five-volume, peer-reviewed Love Canal EDA Habitability Study (Habitability Study). In September 1988, using the results of the Habitability Study, the NYS Commissioner of Health issued a Decision on Habitability (Habitability Decision), which identified appropriate land uses for the seven designated areas of the EDA. Areas 1 through 3 were declared not suitable for residential use, *i.e.*, nonhabitable, but were suitable for commercial and/or industrial use. Areas 4 through 7 were deemed habitable, *i.e.*, suitable for residential use.

In 1987, the EPA entered into the first of two cooperative agreements with LCARA to implement the mandates of Section 312 of CERCLA. The property acquisition cooperative agreement dealt with LCARA's EDA property acquisition program, which is documented in the EPA's September 1996 Remedial Action Report for the Site. Under the cooperative agreement, LCARA purchased approximately 100 properties. Prior to this, LCARA purchased approximately 500 properties under the FEMA acquisition program.

In 1989, the EPA entered into the second cooperative agreement with LCARA to implement the maintenance and technical assistance mandates of Section 312 of CERCLA. Under this

[1] A NYS Agency designated as the lead agency in the rehabilitation effort of the properties in the Love Canal EDA. LCARA was also identified in Section 312 of the SARA Amendments.

cooperative agreement, the EPA provided LCARA with funds to maintain improved and unimproved EDA properties. While the majority of these funds were used to maintain EDA homes slated for rehabilitation, a portion of the funds were also used to demolish deteriorated EDA homes that presented safety concerns or a net loss to the overall property value. Under this program, LCARA demolished over 250 homes. The EPA closed out this agreement in May 2003.

The EPA's technical assistance supported LCARA's efforts to revitalize the EDA. The offices of LCARA were located in the EDA. LCARA's Board of Directors conducted monthly meetings in a public forum on the progress of the revitalization of the EDA. The final meeting of the LCARA Board was held in May 2000. LCARA sold approximately 260 homes in the areas slated for residential use and prepared a master plan for the areas slated for commercial and/or industrial use. Having completed its original mission of rehabilitating the EDA, LCARA was formally abolished on August 31, 2003 by a June 2003 act of the NYS legislature.

Risk Basis for Taking Action

In 1978, after NYSDOH and NYSDEC had requested EPA technical assistance at the Site, the EPA and NYSDOH sampled indoor air, stream sediments, biota, soils, groundwater and surface water. NYSDOH also sampled sumps, and the EPA evaluated ambient air and storm sewers around the original disposal area. This additional sampling showed significant chemical contamination in Rings I and II homes adjacent to the original disposal area.

In 1982, the U.S. Department of Health and Human Services and NYSDOH determined that the homes outside Rings I and II could be reoccupied. This decision was based on data presented in the EMS, prepared by EPA's Office of Research and Development, which evaluated the nature and extent of contamination throughout the EDA, including air, soils, groundwater, surface water, sediments and biota sampling. However, because the 1982 study was heavily criticized, EPA initiated additional studies in 1983 to determine the habitability of the EDA, which became the preliminary stages for developing the Site evaluation, subsequently referred to as the Habitability Study, as discussed above.

In addition to the investigations described above, there were other field investigations and studies conducted at the Site, which included the following:

- Environmental Information Document - Site Investigations and Remedial Action Alternatives - Love Canal, Malcolm Pirnie, October 1983, which evaluated contamination in creeks and sewers and alternatives for remediation.
- Love Canal Sewer and Creek Remedial Alternative Evaluation and Risk Assessment, CH2M Hill, March 1985, which evaluated risks posed by contamination in creeks and sewers and alternatives for remediating the creeks and proposed a remedial action plan, representing the Feasibility Study for the May 1985 Record of Decision (ROD).
- Long-Term Monitoring Program Design for the Love Canal Remedial Project, E.C. Jordan, August 1985, which evaluated groundwater contamination and effectiveness of the barrier drain/cap system and involved the installation of hundreds of monitoring wells during the 1985-87 time frame.

- Love Canal EDA Habitability Study, May-July 1988, which evaluated indoor air and soil contamination in the EDA and comparison neighborhoods, using the developed habitability criteria.
- 93rd Street School Remedial Investigation and Feasibility Study (RI/FS), March 1988, which evaluated the nature and extent of contamination at the 93rd Street School site (a nearby NFBE facility which was investigated separately) and alternatives for remediating this contamination.

The Habitability Study was designed to determine whether any chemicals from original disposal area had migrated or were transported to the EDA which would limit the residential use of the properties therein. In order to determine whether the EDA areas had been specifically impacted by the original disposal area and not some other contamination area, Love Canal indicator chemicals (LCICs) were identified. These compounds were culled from the entire list of various chemical compounds which were known to have been disposed of in the original open canal. The Habitability Study included testing soil and residential indoor air samples for evidence of chemical contamination in the EDA. This data was compared to results from areas sampled outside the EDA. The results of the analysis addressed current and potential routes of exposure and considered potential cancer risks and non-cancer health hazards to individuals from exposures at the Site.

As noted above, in September 1988, the NYS Commissioner of Health issued the Habitability Decision, which identified appropriate land uses for the seven designated areas of the EDA. The Habitability Decision thoroughly assessed the results of the Habitability Study and concluded that EDA Areas 4 through 7 met all of the habitability criteria and could be used for residential or other similar purposes. EDA Areas 1 through 3 did not meet the criteria for habitability and, as such, were not suitable for normal residential use without remediation or cleanup of contaminated soils. EDA Areas 2 and 3 exceeded the comparison criteria for habitability to a lesser extent than EDA Area 1. These determinations were used to support potential remediation. At the time of the release of the Habitability Study on which NYSDOH's Habitability Decision is based, the conclusions drawn were that EDA Areas 1 through 3 were not considered appropriate for unrestricted residential use but could be used for other purposes, *i.e.*, commercial and/or industrial. Some remediation would be necessary before these areas could be considered for any residential use. The assumptions utilized in the Habitability Study are not substantially different from the residential exposure assumptions currently used in the EPA's risk assessment process.

The 1988 ROD for the 93rd Street School site was based upon a risk assessment derived from the Public Health Evaluation Manual, a precursor to the current Risk Assessment Guidance for Superfund (RAGS). The ten indicator chemicals for soil evaluated in the baseline risk assessment were metals (antimony, arsenic, lead and mercury), PAHs (benzo(a) anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, indeno (1,2,3-cd) pyrene), pesticides (benzene hexachloride (BHC) isomers) and dioxin. The baseline risk assessment found risks posed by the ingestion of soil were 2.3×10^{-4} and 1.3×10^{-3} for the undisturbed and disturbed site scenarios, respectively. The primary contaminants contributing to this unacceptable risk were arsenic, PAHs and dioxin, and the primary route of exposure for these contaminants was through inadvertent ingestion of soils, *e.g.*, children playing at 93rd Street School site. A noncancer health

assessment was not conducted. Exposure via use of groundwater as a source of drinking water was not evaluated because the 93rd Street School site is served with a public water supply.

The 1991 ROD Amendment for the 93rd Street School site stated that, since the signing of the September 1988 ROD, the Habitability Decision and the development of an EDA land use master plan by LCARA resulted in the need to re-evaluate the remedy. The re-evaluation reported that additional sampling was conducted for dioxin at the 93rd Street School site. The conclusion from this sampling, outlined in the 1991 ROD Amendment, was that no dioxin was present in soils above the one part per billion (ppb) action level, which is discussed in more detail below.

Records of Decision Findings

In July 1982, the EPA issued a Decision Memorandum: Cooperative Agreement with the State of New York for Love Canal (1982 DM), which was a precursor to the 1985 ROD. The 1982 DM documented the remedial activities that had been previously performed by NYSDEC, approved additional Federal funding and identified a phased approach for conducting eight additional tasks for the Site, which included the following:

- Undertake Site containment via an expanded leachate collection system and/or other containment option;
- Investigate and remediate contamination in the north end storm and sanitary sewer system;
- Investigate and remediate contamination in Black and Bergholtz creeks;
- Investigate and remediate contamination in the south end storm sewers;
- Investigate and remediate contamination in the western sanitary sewers and lift stations;
- Develop long-term monitoring to ensure the effectiveness of the cleanup activities;
- Investigate/remediate 102nd Street outfall; and
- Prepare summary document of the actions taken, with conclusions.

In 1983, EPA and NYSDEC determined that the original barrier drain system did not require expansion as recommended in the 1982 DM. However, in order to ensure that the system would continue to perform according to its rigid specifications, the original system was high-pressure cleaned.

The EPA issued the 1985 ROD with a selected remedy to remediate the sediments in the sewers and the creeks in the EDA. The selected remedy for this ROD included the following:

- Hydraulically cleaning the sewers;
- Dredging and hydraulically cleaning the Black Creek culverts;
- Removing Black and Bergholtz creeks' sediments with dioxin concentrations exceeding one ppb;
- Constructing an on-site interim storage facility for the creek and sewer sediments; and
- Remediating the 102nd Street outfall area (which was subsequently addressed under the remedial action performed on the 102nd Street Landfill Superfund site, a separate NPL site).

In October 1987, the EPA issued a second ROD (1987 ROD) and selected a remedy to address the destruction and disposal of the dioxin-contaminated sediments from the sewers and creeks. This ROD called for the following:

- Construction of an on-site facility to dewater the sewer and creek sediments and to contain the dewatered sediments;
- Construction of a separate on-site facility to treat the dewatered sediments through high temperature thermal destruction;
- On-site thermal treatment of the residuals stored at the Site from the leachate treatment facility and other associated Love Canal waste materials; and
- On-site disposal of any nonhazardous residuals from the thermal treatment or incineration process.

In 1989, the EPA published an Explanation of Significant Differences (ESD) to the 1985 and 1987 RODs, which specified that creek sediments were to be dewatered at creek side, placed in polyethylene bags and then transported to OXY's Niagara Falls Main Plant for temporary storage, followed by thermal destruction in a high temperature thermal destruction unit that was to be constructed at that plant. In addition, other Love Canal wastes, including the sewer sediments and other remedial wastes originally targeted for thermal treatment at the Site, were also to be thermally treated at OXY's Niagara Falls Main Plant rather than at the Site.

In 1989, the United States, the State of New York and OXY entered into a Partial Consent Decree filed in the U.S. District Court for the Western District of New York, which dealt with only part of the Site remedy. Among other matters, the Partial Consent Decree required OXY to implement the modifications to the 1985 and 1987 RODs, specifically with respect to handling the sediments from the sewers and creeks cleanup. Niagara Falls, Niagara County and the NFBE were also parties to the Partial Consent Decree.

In 1994, OXY agreed to a settlement of the claims of the State of New York. Under an Order on Consent approved by a NYS court, OXY became responsible for the continued operation and maintenance (O&M) of the LCTF and the cap and appurtenances, including the functionality of the monitoring wells and piezometers and the sampling and analysis of the groundwater.

In November 1996, the EPA issued a second ESD for the 1987 ROD. This ESD authorized thermal treatment and/or land disposal of the stored Love Canal waste materials at an off-site commercial incinerator and landfill rather than at OXY's Niagara Falls Main Plant.

In December 1998, the EPA issued a third ESD which provided notice that the EPA was granting a treatability variance to OXY to eliminate the requirement that the stored Love Canal waste materials, which contained dioxin at concentrations between one ppb and 10 ppb, be incinerated. As a result of this variance, these materials could be disposed at a commercial hazardous waste landfill without treatment. Materials containing dioxin at concentrations greater than 10 ppb were required to be incinerated, with residues approved for disposal to a permitted landfill.

In September 1988, the EPA issued a ROD (1988 ROD) for the 93rd Street School site, which selected a remedy for contaminated soils. The selected remedy included the following actions:

- Excavation of approximately 7,500 cubic yards of contaminated soil adjacent to the school;
- On-site solidification and stabilization of the contaminated soils; and
- Return of the stabilized soils to the excavated area.

After the issuance of the 1988 ROD, the NFBE raised concerns that leaving the treated soils on-site would limit its options for reuse of the property. In 1990, subsequent sampling indicated that dioxin was not present in soils around the 93rd Street School site above the one ppb action level. As a result, in May 1991, the EPA issued an amendment to the 1988 ROD (1991 Amendment), which modified the 1988 remedy to include off-site disposal of the approximately 7,500 cubic yards of the contaminated materials from hot-spot areas at the 93rd Street School site.

IV. Remedial Actions

Between 1978 and 1982, a number of remedial cleanup measures were conducted at the Site by NYSDEC and its contractors. As indicated above, these early remedial activities were formally memorialized and documented by the EPA in its 1982 DM which, as discussed above, identified further necessary remedial tasks to be conducted. These future cleanup measures were specified in the RODs which were issued for the Site subsequent to the EPA's 1982 DM.

Improvements to the Containment System

By June 1982, the Rings I and II homes and the 99th Street School, adjacent to the original disposal area, had been demolished.

In December 1984, technical and structural modifications were made to the LCTF. These actions are documented in the Final Report Love Canal Remedial Action Project - Northern and Central Sectors, November 1985.

Also, in 1985, a second and expanded engineered 40-acre cap consisting of a 40-millimeter high density polyethylene liner was installed over the already existing clay cap to further reduce infiltration of precipitation. Additionally, approximately 18 inches of clean soil and vegetation were installed over the 40-acre cap to create the present configuration. The overall fenced LCL area is 70 acres and includes a vegetated buffer zone outside of the boundaries of the 40-acre cap.

Removal of Contaminated Creek and Sewer Sediments

The remediation of the contaminated sewers was performed during 1986 and 1987. A total of 68,000 linear feet of storm and sanitary sewers were cleaned of contaminated sediments. An on-site facility was constructed to dewater the sewer sediments. From 1987 until 1989, Black and Bergholtz creeks were dredged of approximately 14,000 cubic yards of sediments. An on-site facility was constructed to dewater the creek sediments. Subsequently, clean soils and riprap were placed in the creek beds, and the banks were replanted with grass. These remedial actions conformed with the selected remedy of the 1985 ROD which required the removal of dioxin-contaminated sediments from the creeks and the sewers. Some additional sewer cleanup work

was completed in 1987. The creek work is documented in the Final Engineering Report - Love Canal Black and Bergholtz Creeks Remediation, October 1990.

Interim Storage and Treatment/Disposal of Creek and Sewer Sediments and Other Love Canal Waste Materials

The treatment and disposal of the sewer and creek sediments represents the last remedial action that was completed for the Site. In 1988, concurrent with the excavation of the creek sediments by Sevenson Environmental, Inc., contractor to NYSDEC, OXY's contractor, Conestoga-Rovers & Associates Limited (CRA), received the sediments at a staging area at the 93rd Street School site. At this staging area, the creek sediments were dewatered, stabilized, bagged and transported to OXY's Niagara Falls Main Plant for temporary storage in its RCRA-permitted storage buildings prior to thermal treatment and/or final land disposal. The dewatered and stabilized sewer sediments and other Love Canal wastes targeted for treatment under the 1987 ROD were also re-bagged and transported for storage with the creek sediments to OXY's Niagara Falls Main Plant. A total of 15,496 bags, representing approximately 39,000 cubic yards of Love Canal waste materials, were stored at OXY's Niagara Falls Main Plant. In February 1998, OXY began shipping the bagged Love Canal wastes from its storage facilities for final disposal. In August 1999, the last remaining bags of wastes were shipped for final disposal, either for thermal destruction or for landfilling at facilities outside of New York State. Of these, 10,262 bags were directly land disposed in a Subtitle C facility at the Grassy Mountain Landfill, Utah. The remaining 5,234 bags were incinerated at Deer Park, Texas and Originate, Utah, prior to land disposal of the ash residue in Subtitle C facilities at Deer Park, Texas and Grassy Mountain, Utah, respectively. This remedial action was completed in August 1999 and is documented in the March 2000 Remedial Action Report (RAR): Final Treatment/Disposal of Love Canal Sewer and Creek Sediments and Other Remedial Wastes.

Excavation and Off-site Disposal of Contaminated Soils at the 93rd Street School Site

In 1992, the contaminated soils at the 93rd Street School site were excavated; these materials were used for alternate grading material below the final cap that was installed at the 102nd Street Landfill Superfund site. This remedial action was completed in September 1992 and is documented in the September 1992 Final Report for the Remediation of the 93rd Street School Site.

Short-Term Remedial Projects

In November 1988, 10 cubic yards of dioxin-contaminated soils were removed from a location in EDA Area 2, identified as Lot C on 100th Street. The contamination was suspected to have resulted from a spill from a truck that was being used during the remediation of the sewer sediments. The excavated soils were drummed and stored at the Site, prior to final disposal off-site.

In September 1993, three other short term projects were also completed: 1) the Frontier Avenue Sewer Project required the excavation and disposal of contaminated pipe and bedding and the replacement with new pipe and bedding. Excavated materials were transported for off-site thermal treatment and/or land disposal. Also, a small section of the Frontier Avenue sewer which

ran along the outskirts of the containment system was rerouted in 1992; 2) the EDA 4 Project required the excavation and off-site disposal of a hot spot of pesticide-contaminated soils in the EDA Area 4 followed by backfill with clean soils; and, 3) the Love Canal Cap Repair required the liner replacement and regrading of a portion of the cap. These actions are documented in the Remedial Action Report for the Love Canal Site: EDA 4, Frontier Avenue/100th Street and the Love Canal Cap Repair, September 1993.

V. Operation and Maintenance

The O&M of the remedial systems at the Site ensures that there is no off-site migration of chemical contaminants from the Site. Figure 2 shows the overall Site plan. In October 1978, remedial operations first began at the Site with the installation of a barrier drain along the east and west sides of the south section of the original Love Canal disposal area. The barrier drain was later extended to completely encompass the 40-acre capped landfill (see Figure 3). The barrier drain, designed to intercept the shallow lateral groundwater flow, consists of a trench that is 12 to 25 feet deep and four feet wide. Within the trench are six-inch and eight-inch diameter perforated clay tile drains, centered in two feet of uniformly sized stone, which is overlain to the surface with sand. Twenty-five lateral trenches filled with sand were excavated perpendicular to the barrier drain in the direction of the LCL. The tile drain is graded toward a series of manholes and wet wells (PC-1A/PC-2A North/Central Sector and wet wells 7 and 8) where the leachate is collected. The wet well collection system consists of two sectors, the North/Central Collection System and the Southern Collection System. The leachate is then pumped from the wet wells to two underground holding tanks (PC-3A North/Central and PC-3 South) where it is held prior to being treated at the on-site treatment facility and subsequently discharged into the Niagara Falls sanitary sewer system. Quarterly effluent sampling is conducted. All results are well below the permitted discharge limits.

In April 1995, responsibility of the O&M of the Site was transferred from NYSDEC to OXY. Until July 1, 1998, OXY's affiliate, Miller Springs Remediation Management, carried out the day-to-day operations at the Site. Since July 1, 1998, OXY's responsibility at the Site has been carried out by Glenn Springs Holdings, Inc. (Glenn Springs), a subsidiary of Occidental Petroleum Corporation. Glenn Springs contracted with CRA to perform the daily operation, maintenance and monitoring activities.

NYSDEC oversees Glenn Springs' O&M activities and provides direction to Glenn Springs on the scope and extent of the annual monitoring and reporting tasks, including groundwater quality monitoring at various wells on or around the Site to evaluate the effectiveness of the LCL containment system; groundwater elevation measurement at piezometers located on the Site; O&M of the LCTF; and, an annual performance assessment of the LCTF and the associated barrier drain system and appurtenances. Figure 4 shows the process schematic of the LCTF.

The Site Management Periodic Review Report, aka, the O&M report, that is completed annually by Glenn Springs provides an overview of the long-term monitoring program that is in effect for the Site and examines both the hydrogeologic and the chemical data from the Site in order to evaluate the effectiveness of the containment system. To date, 18 annual O&M reports have been

prepared by or on behalf of OXY, which cover O&M activities conducted from 1995 through 2012.

Water levels are measured through various piezometers in and around the Site. The piezometers show the overburden groundwater flow conditions. Overall, the groundwater level data shows that groundwater flow direction in the vicinity of the barrier drain is towards the barrier drain. The barrier drain is successfully capturing horizontal groundwater flow from the LCL and is also drawing groundwater from outside the drain. The 2012 O&M report showed that the inward hydraulic gradient at each of the six-nested piezometer strings demonstrated that the barrier drain is effectively capturing leachate from the Site and preventing the off-site migration of contamination. The presence of this overall inward hydraulic gradient, as well as a review of groundwater quality, demonstrates Site containment (see Figure 6).

Hazardous wastes that are generated at the Site include the following:

1) Spent carbon from the treatment process;
2) Debris, filters and personal protective equipment;
3) Non-aqueous phase liquid or NAPL and other sludge-type materials from both the LCL and 102nd Street Landfill; and
4) Soil and debris from sampling activities. These wastes are transported to a permitted incinerator and/or landfill for final disposal.

Overall, for the years 2008-2012, NYSDEC and Glenn Springs recommended various maintenance, repair and replacement corrective actions. Table 7 presents a summary of maintenance activities performed during 2012. The 2012 O&M report data results show that there has been no significant change in chemical concentration conditions and that the barrier drain system is successfully capturing leachate from the Site and preventing off-site migration of contamination. Hence, monitoring results continue to confirm that the remediation and containment system, *i.e.*, the leachate collection and treatment system, is functioning properly.

Subsequent to the 2008 FYR, Glenn Springs performed a Global Positioning System survey of all active wells; the survey data can be used at any time under all weather conditions. Further survey information will be compiled during future years, evaluated and integrated into a geographic information system for the Site, which will make it possible to integrate data and information that is difficult to associate through any other means. The information can then be visualized through different mapping techniques. Similar data and information have been recorded for the previous years' O&M reports.

VI. Progress Since Last Five-Year Review

The second FYR concluded that the remedies implemented at this Site adequately control exposures of Site contaminants to human and environmental receptors to the extent necessary for the protection of human health and the environment. Since the last FYR, there has been no significant change in chemical and hydrological conditions at the Site.

The Site has ongoing O&M activities which are subject to routine modifications and/or adjustments. The previous FYR did not require any recommendations or follow-up actions which would be necessary to protect human health or the environment.

While there were no follow-up actions required by the last FYR, the Niagara Falls Water Board (NFWB) was performing some ongoing sanitary sewer repair work in the EDA. During the course of one sewer line repair on Colvin Boulevard, the contractor encountered what was eventually determined to be some residual contamination which had migrated from the original disposal area years ago. A few homeowners in the area were concerned about this finding and questioned the effectiveness of the containment system. As a result, the EPA and NYSDEC performed follow-up work to assess the finding of contamination. The original event and follow-up work are summarized below.

In early January 2011, the NFWB initiated repairs to the Colvin Boulevard sanitary sewer east of 96th Street within EDA Area 5. These repairs were part of a larger project being implemented by the NFWB throughout Niagara Falls as part of its overall sewer project to improve the conditions of the sewer piping and to reduce groundwater infiltration into the sewers. At the location of the repair work, NFWB's contractor was in the process of replacing a section of the sewer in order to eliminate a low spot when a chemical odor at approximately 20 feet below the ground surface was encountered. The contractor ceased the excavation work and secured the area. Since the repair work was within the former EDA, Glenn Springs, CRA, the EPA, NYSDEC and NYSDOH were notified of the activity.

Sewers in the EDA neighborhoods had been in place as early as the 1950s and, as described earlier, the investigation and subsequent flushing of these sewer lines of contaminated sediments was one component of the remedial action for the Site. Based on visual observations of the trench, it was apparent that, over time, the piping had settled into the bedding material, and the joints had become compromised allowing materials to seep out of the pipes. The sewer bedding surrounding the pipe had been impacted by historical materials that appeared to have NAPL consistency.

Another NFWB contractor, Stohl Environmental, analyzed the soils/sediments that had been placed in a roll-off container for volatile organic compounds (VOCs) and semi-VOCs (SVOCs), including any LCICs. In order to be protective and proactive, Glenn Springs and CRA inspected the excavation site and immediately began a review of the current operations of the LCTF to determine if Site operations could potentially have had an impact on the section of sewer being repaired. CRA also conducted an historical search of Love Canal activities to determine if any activities had taken place in and around this sanitary sewer area. No evidence of any such activities conducted there was found.

In late January 2011, Glenn Springs and CRA met with representatives from Niagara Falls, the NFWB, the EPA, NYSDEC and NYSDOH to present the preliminary results of the investigation, to address any contaminants found and to identify plans to replace the 50-foot section of sewer line.

In February 2011, Glenn Springs replaced the 50-foot section of the sewer on Colvin Boulevard between 96th and 97th streets, conducted the cleanup of the sewer trench, removed sediments

from within the Colvin Boulevard sewer from 97th Street to the 91st lift station and conducted a video inspection of the sewer line. This work was performed under the oversight of NYSDEC and NYSDOH. Subsequently, the EPA reviewed the data and documentation of the sewer repair work in order to confirm that the cleanup was performed in a comprehensive and appropriate manner.

By March 2011, Glenn Springs completed the cleanup and submitted a final report, Sanitary Sewer Investigation and Remediation Report, to Niagara Falls, the NFWB, the EPA, NYSDEC and NYSDOH which identified the activities that Glenn Springs and CRA had performed during the cleanup of the sewer, including the following:

- Replaced approximately 50 feet of sanitary sewer beneath Colvin Boulevard between 97th and 96th Streets;
- Removed impacted soil materials down to bedrock (22-foot depth) to the extent possible from within the sewer trench;
- Removed liquids from the excavation, which included sanitary sewer wastewater and an amount of NAPL;
- Hydraulically cleaned the sanitary sewer beneath Colvin between 97th Street at the 91st Street lift station;
- Conducted a video inspection of the sanitary sewer from 97th Street to the 91st Street lift station to verify the sewer was free of sediment;
- Restored the Colvin Boulevard road surface; and
- Performed continuous air monitoring of the excavation area during all intrusive repair activities to monitor for worker safety. In addition, air monitoring was performed at the perimeter of the work zone at 1-hour intervals to ensure the safety of the residents of the neighborhood.

Glenn Springs and CRA also performed these follow up activities:

- Installed two new bedrock groundwater monitoring wells, north and south of Colvin Boulevard repair area (MW-1 and MW-2). These wells are now part of the annual sampling program's array of wells;
- Installed one flush-mount overburden well (MW-3) within the bedding material of the newly installed Colvin Boulevard sanitary sewer line to monitor potential NAPL conditions; and
- Installed three soil borings and sampled soil to the east of the repair area long Colvin Boulevard sewer line to verify no additional contamination was present in the soils there.

The work was performed under the oversight of NYSDEC and NYSDOH. Subsequently, the EPA reviewed the data and documentation of the sewer repair project in order to confirm the cleanup was performed in a comprehensive and appropriate manner. Overall, the investigation and remediation that was conducted by Glenn Springs and CRA confirmed that, after the repair work was completed, no sediments were present in the section of the sanitary sewer between 97th Street and the 91st Street lift station and, therefore, there would be no future potential for sediments to impact water quality in the sewer or air quality in the vicinity of the sewer. Although some residual soil contamination may be located 20 feet below the ground surface at the bottom of the sewer trench on competent bedrock, because it is within clay walls and capped

by the asphalt paved road, there is no potential for mobilization through the sewers or in soil vapors nor does it pose a threat to human health and the environment.

The results of the sewer line repair work and the subsequent supplemental investigation confirmed that the contamination found at the Colvin Boulevard repair area was not the result of recent migration from the Site nor was it the result of a failure of the containment remedy. Rather, the likely source was an isolated pocket of historical contamination in the sewer line bedding material outside of the fenced area that had not been addressed during the Site sewer cleanup work. The LCTF treated effluent does not flow through the section of sewer that was repaired and was not the source of contamination observed. Analytical monitoring data and hydraulic monitoring data collected under the current O&M program show that the remedial systems at the Site are effective, operating as designed and was not the source of the contamination found in the section of sewer pipe on Colvin Boulevard.

VII. Five-Year Review Process

Administrative Components

The agency's FYR team consisted of Damian Duda (RPM), Sal Badalamenti (supervisor), Marian Olsen and Chuck Nace (risk assessors), Sharissa Singh (hydrogeologist), Henry Guzman (attorney) and Mike Basile (community involvement coordinator).

Community Notification and Involvement

The EPA published a notice on June 26, 2013, in the *Niagara Gazette*, the local newspaper, notifying the community of the FYR process. The notice indicated that the EPA would be conducting the third FYR of the remedy for the Site to ensure that the implemented remedy remains protective of human health and the environment and is functioning as designed. It also indicated that once the FYR is completed, the results will be made available in the EPA Public Information Office, the local Site repository, located in Buffalo, New York. In addition, the notice included the RPM's address, telephone number and e-mail address for questions related to the FYR process for the Site.

Document Review

In order to provide as thorough an assessment as possible of the Site, Appendix C of this report provides a list of references which outlines the major documents that were produced during the roughly 35-year period of activities that have been conducted at the Site. Many of these documents were referenced during the preparation of this FYR report.

Monitoring and Data Review

The Love Canal treatment system (see Figure 4) consists of the following: clarification through gravity settling of the collected leachate which separates out the sludges and NAPLs from the contaminated wastewater; removal of solids through bag filtration; and, and filtration of organics through 40,000 pounds of granular activated carbon prior to the effluent discharge to the sanitary

sewer system under a permit issued by Niagara Falls. Any collected sludges and NAPLs are sent off-site to OXY's permitted Niagara Falls liquids incinerator or to RCRA-permitted incinerators outside the state.

As part of the permit requirements, Niagara Falls and Glenn Springs personnel completed an annual verification sampling; quarterly effluent sampling was also performed. The sample results were submitted to the Niagara Falls and federal and state agencies; analytical results were below permitted limits for the sampled parameters during all events. The leachate collection system continues to function as designed, drawing groundwater toward the underground drain system from both the landfill and the surrounding area beyond the cap.

Currently, there are 153 active monitoring wells for the Site (132 overburden and 21 bedrock). In order to cover all 153 active monitoring wells in and around the Site. A subset of about 30 to 40 monitoring wells is sampled each year by rotating through the monitoring well network. As shown in Figure 5, the areawide view of the Site identifies the locations of the select monitoring wells which were sampled, both inside and outside of the containment or fenced area although not all monitoring wells shown were sampled each year of the five-year period from 2008-2012. The groundwater applicable and relevant and appropriate requirements, federal and state MCLs, were waived in the 1991 93rd Street School ROD Amendment. Therefore, the purpose of monitoring the groundwater is to evaluate trends in contaminant data and ensure that the containment system is effectively capturing contaminated water and leachate from the LCL.

Table 2 presents the 2012 summary of detected compounds in sampled monitoring wells. NYSDEC can split sample select monitoring wells at its discretion. Compounds, detected during 2012, were found to be at similar concentrations to those compounds detected in previous years. Some wells, as part of the long-term monitoring program, are routinely sampled every year, *i.e.*, 10210A, 10210B, 10210C and 10135. Data from 1990 to 2012 from these wells are presented in Tables 3, 4, 5 and 6, respectively.

Historically, LC-10135 is the most contaminated of the various long-term monitoring wells located within the Love Canal containment area. LC-10135 is also used as a comparison well in order to confirm that any presence of low levels of contamination in other monitoring wells.

In June 2012, groundwater samples were collected from 11 overburden and 20 bedrock monitoring wells. The 2012 data from both the overburden and bedrock wells are consistent with the previous data, *i.e.*, at or below detection limits. The data from three other long-term monitoring wells (MW-10210A, MW-10210B and MW-10210C), located off-site to the south, showed some concentrations at or below detection limits for Site constituents, consistent with previous years.

In June 2013, NYSDEC split-sampled nine monitoring wells with Glenn Springs. These wells were tested for VOCs, SVOCs, organochlorine pesticides and polychlorinated biphenyls or PCBs. The 2013 data from these wells, similar to that found by Glenn Springs, showed some SVOC contamination at or below detection limits, as part of the EPA method 8270, in seven monitoring wells (MWs 7161, 8106, 8130, 9115, 9140, 5221, 10225A) located both inside and outside the containment area.

Monitoring well 10225A, which is located adjacent to the Site Administration Building, did show low detections of a few SVOCs in the 2012 sampling as well. These SVOCs were not detected in samples collected from this well in previous years. There is no historic trend of these compounds being detected at this well. The adjacent bedrock wells of 10225B and 10255C showed non-detects for these SVOCs. Well 10225A will continue to be included in the annual sampling program.

The 2012 data indicate that there was no significant change in chemical and hydrological conditions at the Site. The barrier drain is successfully capturing leachate from the Site and preventing off-site migration of chemicals. The remediation system is functioning as designed with 4,149,060 gallons of leachate treated and discharged from the Site during 2012, of which 3,867,868 gallons of leachate were collected on-site and the remaining 281,192 gallons were collected from the adjacent 102nd Street Landfill site. O&M activities during the past five years have been mostly routine in nature. The collection system has maintained inward gradients and has been effective in preventing chemical migration. The LCTF has met all conditions of the sewer use discharge permit.

Site Inspection

A Site inspection of the landfill cap and the LCTF was conducted on July 11, 2013. The Site inspection team included the following personnel: from the EPA: Damian Duda (RPM) and Sharissa Singh (hydrogeologist); from NYSDEC: Brian Sadowski and Greg Sutton; from Niagara County Health Department: Paul Dicky, from Glenn Springs: Clint Babcock and Joseph Branch and from CRA: John Pentilchuk and Darrell Crockett. Glenn Springs, together with its contractor, CRA, prepares the annual O&M reports.

The LCTF, which include both the Operations Building and the Administration Building, was inspected, and the various segments of the collection, treatment and discharge process were identified. It was noted during the treatment process tour that very little sludge or NAPL is being collected. The bag filters are changed twice a year, and the spent carbon in one of the two carbon beds is replaced every other year. The entire process treats and discharges approximately 150-175 gallons per minute up to approximately three to four million gallons per year, as reflected in the annual O&M reports.

The inspection team also performed a walk-through across the cap and inspected some of the monitoring wells, wet wells and piezometers, as identified in the Sampling Manual, Love Canal Site, Long-Term Groundwater Monitoring Program (January 1996, updated June 2013), both immediately within the Site fence line and outside the Site fence line in the former EDA. The inspection team also performed a drive-through of the former EDA area, including both the Black and Bergholtz creeks and the 93rd Street School site locations. Community baseball fields occupy the area where the 93rd Street School building once stood.

Institutional Controls

The NFBE and Niagara Falls are the owners of the property within the containment area of LCL. Niagara Falls granted NYS a permanent easement on the Site property, providing NYS with exclusive use and occupancy of the Site property. NYS, pursuant to a 1994 Consent Decree,

granted OXY exclusive use and occupancy of the Site property for the purpose of providing continued O&M for the remedy of the Site. OXY will retain exclusive use and occupancy as long as the Consent Decree is in effect.

EDA Areas 1 through 3 remain limited to commercial and/or industrial use only. The institutional controls are maintained by notices on the deeds and the area zoning in order to comply with the original Habitability Decision. The deeds also indicate that all identified use limitations shall run with the land and bind the current owner and any successors in perpetuity or until such time as NYSDEC shall determine that such institutional controls are no longer necessary for the protection of human health and the environment. If any use, other than what is specified above, is considered for these properties, a minimum of six inches of surface soil must be removed and a minimum of six inches of new clean soil must be placed back on the property before any such use can be initiated. These properties are owned by various entities, including Niagara Falls and other parties. Prior to any redevelopment in this area, the EPA and NYSDEC will be notified about its intended use. EDA Areas 4 through 7 remain suitable for normal residential use without any restrictions.

VIII. Technical Assessment

Question A: Is the remedy functioning as intended by the decision documents?

Yes, the remedy is functioning as intended by the 1985 ROD (including the 1982 DM), the 1987 ROD, the 1988 ROD, the 1991 ROD Amendment and the 1989, 1996 and 1998 ESDs.

The remedies involved a number of actions, including installation of a landfill cap, fencing, Site drainage, a leachate collection and treatment system and many monitoring wells to identify contaminant concentrations at the edge of the LCL. The remedies described above are all intact and in good repair. The barrier drain is successfully capturing leachate from the Site and preventing off-site migration of chemicals. The data from the on-site monitoring wells and those surrounding the Site indicate that contaminated groundwater and NAPL releases from the LCL are being contained by the collection and treatment system. Proper institutional controls are in place. Overall, the remediation system for the Site is functioning as designed. Continued monitoring at the Site ensures that no exposures to human or environmental receptors will occur in the future.

The NYSDEC Division of Environmental Remediation performs yearly oversight sampling and overview of operations at the LCTF. NYSDEC provides the oversight information, including any split-sampling data and Site inspections, and its review of Glenn Springs O&M reports to EPA. In each annual O&M report for the 2008-2012 period, NYSDEC concluded that, for both inside and outside the containment area, the Site remedy continues to be effective.

The Site community receives its potable drinking water from the Niagara Falls public water supply. The groundwater in the EDA is not used for drinking water purposes. Monitoring wells, located both inside and outside the LCL property throughout the Site, indicate that contaminated groundwater and NAPL released from the LCL are being contained by the collection and treatment system and that exposure to the contaminated groundwater, on-site, is not occurring.

Institutional controls, in the form of deed notices and zoning restrictions, are in place on the vacant parcels of land in EDA Areas 1 through 3 to comply with the Habitability Decision, identifying commercial and/or industrial use only, unless the parcels are remediated. There are no such restrictions on the land use for EDA Areas 4 though 7. The remedial actions and institutional controls have addressed or interrupted the direct exposure pathways of direct contact with the contaminated groundwater and soils. The remedies are functioning as intended in the decision documents.

Question B: Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives used at the time of the remedy still valid?

Remedial actions have been conducted at the Site to interrupt potential exposures. These included the following: containing Site contaminants; limiting discharges to various media; placing a three-foot thick cap over the landfill to reduce water infiltration and to retard the formation of leachate and contaminated surface runoff; the cleaning and plugging the sewers within Rings I and II and removing them from further service to prevent the spread of contamination into nearby creeks and the Niagara River; and, the removal of contaminated creek sediments.

Human Exposure Assumptions

Carcinogenic risks and noncancer hazards that could result from exposure to Site chemicals are considered separately. Carcinogenic risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a carcinogen. The risk characterization identifies contamination with concentrations which exceed acceptable levels as an excess lifetime cancer risk greater than 1×10^{-4} to 1×10^{-6} or one in ten thousand to one in one million.

Noncancer risks are evaluated using a Hazard Index (HI). An HI greater than 1.0 indicates that the potential exists for noncarcinogenic health effects to occur as a result of site-related exposures, with the potential for health effects increasing as the HI increases.

Consistent with the current EPA policy, the cancer and noncancer risks associated with exposures to individual contaminants are summed to indicate the potential risks and hazards associated with mixtures of potential carcinogens and noncarcinogens, respectively.

Soils: The previous FYRs identified the procedures that were used to evaluate exposures to Love Canal contaminants in soils and air under residential conditions, without institutional controls, at the LCL and at the surrounding properties in the EDA. The Habitability Study was developed subsequent to the various remedial actions that had already been conducted at the Site, including the installation of a cap and fencing.

Deed notices were placed on properties in EDA Areas 1 through 3, since these areas did not meet the criteria for habitability under a residential scenario without further remediation. Areas 2 and 3 exceeded the comparison criteria for habitability although to a lesser extent than Area 1. The majority of the properties in Areas 1 through 3 are owned by various entities, including Niagara

Falls and other parties. The EPA and NYSDEC will review any planned development in these areas in order to ensure that institutional controls are enforced. The EPA and NYSDEC will be particularly sensitive to any projected development which may involve children, *e.g.*, day care facilities and schools. Therefore, the exposure assumptions for these areas are still valid.

Sediments: The removal of the sediments from Black and Bergholtz creeks ensures that these water bodies are no longer sources of contamination and do not present a direct exposure threat.

Groundwater: Both NAPLs and groundwater contamination are being contained on-site through the use of an extensive barrier drain and leachate collection and monitoring system. In addition, residents in the area receive their drinking water from the Niagara Falls public water supply. The use of an alternative water supply interrupts exposure. The ongoing Site O&M continues to interrupt exposures to the contaminated groundwater.

Vapor intrusion: Indoor air sampling was performed as part of Habitability Study which did not find any indoor air issues within the homes in the EDA. The current groundwater VOC data, collected at off-site monitoring wells, are primarily nondetect. Buildings on-site include project administration offices and the LCTF. The closest residential buildings to the Site are over 100 feet away. Consistent with the EPA Soil Vapor Intrusion Guidance, inhabited buildings located more than 100 feet laterally or vertically from known or interpolated soil gas or groundwater contaminants are screened from further consideration for monitoring for soil vapors. Based on the distance to the nearest residences, *i.e.*, greater than 100 feet, further evaluation of vapor intrusion is not necessary.

Remedial Action Objectives

The 1985 ROD for OU 1 did not identify remedial action objectives for the Site. However, the document discusses a one ppb level for dioxin in soils and sediments, *i.e.*, a cleanup goal of one ppb for dioxin in soils and sediments as a basis for taking remedial action. The surface soils and sediments exceeding this value were excavated, treated and disposed of off-site or placed under the LCL cap. As a result of the EPA's dioxin reassessment, released since the last FYR in 2008, the new reference dose (RfD) for noncancer risks has resulted in lower residential and commercial soil cleanup levels. This change as it relates to protectiveness is discussed in more detail below.

Changes in Toxicity Values

The 1988 93rd Street School ROD identified several metals (antimony, arsenic, lead, and mercury), PAHs (benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, chrysene, and indeno(1,2,3-cd)pyrene), pesticides (BHC isomers) and dioxin as contaminants of concern.

Metals: The toxicity assessment for arsenic is currently being updated through the Integrated Risk Information System or IRIS process (www.epa.gov/iris). IRIS is the Agency's consensus database of toxicity values for chemical compounds.

PAHs: The toxicity assessment for PAHs is being updated through the IRIS process. Specifically, an assessment of PAH mixtures is being developed along with a specific update for benzo(a)pyrene alone.

Dioxin: The EPA's dioxin reassessment has been developed and undergone review for many years, with the participation of scientific experts in the EPA and other federal agencies, as well as scientific experts in the private sector and academia. The Agency followed current guidelines and incorporated the latest data and physiological/biochemical research into the reassessment. On February 17, 2012, the EPA released the final human health noncancer dioxin reassessment, publishing an oral non-cancer toxicity value, or RfD, of $7x10^{-10}$ mg/kg-day for TCDD in IRIS. The dioxin cancer reassessment will follow thereafter. The dioxin RfD was approved for immediate use at Superfund sites to ensure protection of human health.

The 1985 ROD identified exposure to chemicals, including dioxin, in the sewers and creeks were a threat to children playing in the creeks. Actions at the creeks and sewers were designed to remediate dioxins to a cleanup level of one ppb. The sewers were flushed of sediments and, as a result, all contamination was removed. Approximately, 14,000 cubic yards of creeks' sediments were excavated, dewatered and disposed of off-site; clean soils and riprap were placed back into the creek beds. The creeks' banks were replanted with grass. As identified in the 1985 ROD, the clean soils and riprap prevent exposure to residually contaminated sediments.

The 1988 ROD and the 1991 ROD Amendment addressed soil contamination at the 93rd Street School site. Prior to the issuance of the 1991 ROD Amendment, the EPA performed additional dioxin soil sampling at the 93rd Street School site which confirmed that the dioxin levels did not exceed the one ppb dioxin action level. As a result, approximately 7,500 cubic yards of mostly PAH-contaminated soils were excavated and disposed of off-site. Thus, any possible potential dioxin exposure was eliminated by this action.

To evaluate the impact of the revised toxicity values on previous decisions, predominantly the Habitability Study, the EPA analyzed data from EDA Areas 1 through 3 based on industrial exposures and EDA 4 through 7 based on residential exposures.

In 1988, during the Habitability Study field work, a total of 2,274 surface soil samples were collected in the EDA and analyzed for dioxin. The results of this sampling are presented and further discussed in the Volume IV, Soil Assessment 2,3,7,8-TCDD of the Habitability Study (March 1988). As a result of a thorough review of the data from the 1988 report, EPA determined that approximately 97 percent of the surface soil samples collected or 2,211 samples did not contain detectable levels of dioxin. The maximum possible concentration (MPC), a term used to refer to nondetect concentrations in the 1988 report, varied with sample locations. The detection limit for many MPCs were in the range of 20 parts per trillion (ppt) to 50 ppt with an average detection limit of 39 ppt. Consistent with the EPA's Risk Assessment Guidance, one-half of the detection limit is used in the calculations of exposure point concentrations or EPCs.

EDA Areas 1 through 3

The 1988 Habitability Decision limited EDA Areas 1 through 3 to commercial and/or industrial land use. In addition, notices were placed on the deeds of these properties to prevent residential

use of the area without remediation. These actions prevent potential exposures and, thus, are protective of human health. The Habitability Study identified approximately 894 TCDD samples collected within EDA Areas 1 through 3. Approximately, 1.3 percent of these samples had detected concentrations. The calculated EPC for this area was 23.7 ppt. This concentration is below the screening level for industrial properties of 600 ppt for TCDD. The screening level assumes an adult worker is exposed to soils for 225 days/year for 25 years and the new oral RfD for TCDD. The concentration of 600 ppt is associated with a noncancer HI = 1, the goal of protection.

EDA Areas 4 through 7

The Habitability Study identified approximately 1,380 TCDD samples within EDA Areas 4 through 7. Approximately 1.4 percent of these samples had detected concentrations. The EPC for EDA Areas 4 through 7 was 23.2 ppt. This concentration is below the residential screening level of 50 ppt for TCDD. The residential screening level assumes residential exposures of 350 days per year for 30 years with six years as a young child, *i.e.*, one to six years of age, and 24 years of age as an adult. The residential screening level is based on the new oral RfD for TCDD. The screening level concentration of 50 ppt is associated with a noncancer HI = 1, the goal of protection.

Conclusions: Dioxin Reassessment and Data Evaluation

Actions taken at the Site, including remediation and placement of institutional controls, have interrupted exposures to Site contaminants and, based on the IRIS RfD, residual dioxin concentration are more stringent than soil cleanup levels that are now considered protective at the Site.

Ecological Risk

Ecological risk assessments were not conducted for the Site. However, the potential for exposure to ecological receptors has been eliminated, *i.e.*, any potentially completed pathways have been remediated or interrupted. Specifically, the excavation and removal of the Black and Bergholtz creek bed sediments, as well as the placement of clean backfill and rip/rap in the beds, prevented any exposure to potential residual contamination. Also, substantial portions of the creeks' banks were also removed and newly sodded which also provided assurances that no further contamination remains. The sewers were scoured of contaminated sediments and cut off from the LCL EDA. The contaminated soils at the 93rd Street School were removed. Hence, any potential pathways for ecological receptors have been interrupted.

Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Based on the evaluation of the potential exposures to human and ecological receptors at the Site, there is no new information that has been developed that could call into question the protectiveness of this remedy.

IX. Technical Assessment Summary

The implemented remedies at the Site protect human health and the environment. The leachate collection and treatment system is in good repair and in good operational order. Access to the Site is controlled within the fenced LCL, and extensive monitoring indicates that there are no unacceptable exposures of contaminated materials to human or ecological receptors. The area sewers and creeks were cleaned of Site contaminants.

The vacant parcels in EDA Areas 1 through 3 are properly zoned and have notices in place on their deeds which limit development to commercial and/or industrial uses and require notice to NYSDEC before lease or conveyance of these properties. These properties are owned by various entities, including Niagara Falls and other parties. Prior to any redevelopment in this area, the EPA and NYSDEC will be notified about its intended use. The EPA and NYSDEC will review any planned development in these areas in order to ensure that institutional controls are enforced. The EPA and NYSDEC will be particularly sensitive to any projected development which may involve children, *e.g.*, daycare facilities and schools. As discussed above, EDA Areas 1 through 3 are limited to commercial and/or industrial use, and EDA Areas 4 through 7 remain suitable for unrestricted residential use.

X. Issues, Recommendations and Follow-up Actions

The remedies have been implemented and are functioning as intended by the Site decision documents. There are no additional actions required. The ongoing O&M program is part of the selected remedy. As expected by the decision documents, the O&M activities are subject to routine modifications and/or adjustments.

There are no recommendations or follow-up actions necessary to protect human health or the environment.

XI. Protectiveness Statement

The implemented remedies for the Love Canal Superfund site protect human health and the environment.

XII. Next Five-Year Review

The next FYR will be completed within five years of the signature date of this FYR.

APPENDIX A

TABLES

TABLE 1 – Chronology of Love Canal Site Events	
Event	**Date**
President Carter issued the first Emergency Declaration at the Love Canal landfill.	August 1978
Construction of the LC leachate collection system and treatment facility (LCTF).	October 1978 - December 1979
President Carter issued the second Emergency Declaration at the LCL. The Emergency Declaration Area (EDA) surrounding the Love Canal landfill was established.	May 1980
Love Canal Area Revitalization Agency (LCARA) created to revitalize the EDA.	June 18, 1980
The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) enacted. A National Priorities List (NPL) of Superfund sites established.	December 1980
NYSDEC assumes control of LCTF from Elia Construction Company, using contractor Conestoga Rovers and Associates.	March 1981
Love Canal site proposed to the NPL.	1981
EPA issued Environmental Monitoring at Love Canal study.	May 1982
Rings I and II homes and 99th Street School demolished.	June 1982
EPA issued a Decision Memorandum: Cooperative Agreement with the State of New York for Love Canal (1982 DM), a precursor to the Superfund Record of Decision (ROD).	July 1982
EPA opened a Public Information Office in Niagara Falls to manage Superfund sites in the City of Niagara Falls area.	September 1982
New York State Department of Environmental Conservation (NYSDEC) opened a Public Information Office in the EDA.	March 1983
EPA initiated Love Canal EDA Habitability Study (LCHS).	1983
Love Canal Superfund site was added to the NPL.	1983
EPA established multi-agency Love Canal Technical Review Committee (TRC) [EPA, Centers for Disease Control, NYSDOH and NYSDEC].	August 1983
Collection system cleaned [high pressure] by OH Materials with NYSDEC oversight.	1983
NYSDEC installed 40-acre high-density polyethylene liner cap over the Love Canal landfill.	November 1984

Technical modifications made to the LCTF.	December 1984
EPA issued a ROD (ROD 1985) to remediate the EDA sewers and Black Creek and Bergholtz Creek.	May 1985
Superfund Amendments and Reauthorization Act (SARA): Section 312 Provisions for Love Canal: Love Canal EDA Habitability Study (LCHS), Property Acquisition and Maintenance and Technical Assistance Cooperative Agreements.	1986
Sewer sediments' remediation.	1986-1987
Construction of a new Administration Building at the LCTF.	1987
EPA entered into first cooperative agreement with LCARA to implement the property acquisition mandates of Section 312 of SARA.	June 1987
EPA issued ROD (ROD 1987) to address final disposal of sewer and creek sediments.	October 1987
EPA issued a ROD (ROD 1988) for the 93rd Street School selected remedy [separate study].	September 1988
The NYS Commissioner of Health issued a Decision on Habitability of the EDA, determining that EDA Areas 1-3 were nonhabitable but available for commercial and/or industrial use; EDA Areas 4-7 were deemed habitable.	September 1988
Creek sediments remediation: 1) dewatered, 2) stabilized and 3) bagged at 93rd Street School staging facility. Previously remediated sewer sediments were bagged during this operation.	1987-1989
All dewatered, stabilized and bagged sewer and creek sediments stored at Occidental Chemical Corporation's (OXY) Niagara Falls Main Plant.	1989-1998
OXY and EPA sign partial consent decree for OXY to perform part of the Love Canal cleanup activities.	May 1989
EPA entered into second cooperative agreement with LCARA to implement the maintenance assistance mandates of Section 312 of SARA.	May 1989
EPA published an Explanation of Significant Differences (1989 ESD) to the 1985 and 1987 RODs.	1989
Rehabilitated EDA homes offered for sale by LCARA.	1990
EPA issued an amendment to the 1988 ROD for the 93rd Street School to excavate soils and dispose of off-site.	May 1991
Programmable Logic Controller system installed at LCTF to operate field pumps, holding tank and process tanks.	Summer 1991

Collection system was high pressure cleaned and videotaped with NYSDEC oversight.	November 1991
93rd Street School soils' remediation completed, as identified in the 1991 ROD Amendment.	September 1992
NYSDEC closed its public information office in the EDA.	March 1993
NYSDEC cost recovery settlement with OXY: $130 million.	1995
OXY begins operation of LCTF monitoring program and issuance of periodic operation and maintenance reports.	April 1995
EPA cost recovery settlement with OXY: $129 million plus interest.	March 1996
EPA issued the second ESD (ESD 1996), authorizing thermal treatment and/or land disposal of Love Canal waste materials at off-site commercial incinerator and landfill.	November 1996
OXY shipped bagged Love Canal wastes for final disposal.	February 1998-August 1999
EPA issued the third ESD (1998 ESD), granting a treatability variance to OXY to eliminate requirement that Love Canal waste materials containing dioxin at concentrations between 1 ppb and 10 ppb be incinerated.	December 1998
Love Canal Preliminary Close-Out Report [construction completion].	September 1999
Bagged Love Canal wastes incineration [completed].	October 1999
First Five-Year Review Site Inspection.	June 2003
LCARA, as an agency of NYS, formally dissolved by NYS statute.	August 27, 2003
Five-Year Review Report issued.	September 30, 2003
Remedial Action Report for LCARA.	September 30, 2003
Love Canal Final Close Out Report.	March 4, 2004
Love Canal Superfund Site was deleted from the NPL.	September 30, 2004
Second Five-Year Review Site Inspection.	April 10, 2008
Third Five-Year Review Site Inspection.	July 11, 2013

TABLE 2

SUMMARY OF DETECTED COMPOUNDS - 2012
LOVE CANAL LONG-TERM GROUNDWATER MONITORING PROGRAM
GLENN SPRINGS HOLDINGS, INC.

		Number of Parameters Detected		
Overburden Wells	*Well Group*	*VOCs*	*SVOCs*	*Pesticides/PCBs*
7115	*B-II*	U/U	U/U	U/1
7125	*B-II*	U	1	2
7130	*A*	U	U	U
7132	*A*	U	U	U
8106	*A*	U	U	U
8115	*B-II*	U	U	U
8125	*B-II*	U	U	U
9105	*B-II*	U	U	U
9113	*B-II*	U	U	U
9118	*B-II*	U	U	U
10135	*A*	4	7	8
Subtotal Overburden Well Detections		4	8	11
Bedrock Wells		*VOCs*	*SVOCs*	*Pesticides/PCBs*
3257	*A*	1	U	U
5221	*A*	U	1	U
6209	*A*	1	U	U
7205	*A*	U	U	U
8210	*A*	1	U	1
9205	*A*	U/U	U/U	U/U
9210	*A*	1	U	U
10205	*A*	2	1	U
10210A	*A*	1	U	U
10210B	*A*	1	1	U
10210C	*A*	U/1	U/U	U/U
10215	*A*	3	1	U
10225A	*A*	3	3	3
10225B	*A*	1	1	U
10225C	*A*	3	1	U
10270	*A*	U	U	U
10272	*A*	U	U	1
10278	*A*	2	1	3
MW-01	*X*	1	U	U
MW-02	*X*	U	U	U
Subtotal Bedrock Well Detections		22	10	8
Total # of Detections		**26**	**18**	**19**

Notes:

U	No parameters detected at or above detection limits.
A	Annual Well.
B-II	Biannual Well Group II.
X	Additional annual well added to program in 2011.
PCBs	Polychlorinated biphenyls.
SVOCs	Semi-volatile organic compounds.
VOCs	Volatile organic compounds.

TABLE 3

SUMMARY OF DETECTED COMPOUNDS IN SELECT WELLS
LOVE CANAL LONG-TERM MONITORING PROGRAM
GLENN SPRINGS HOLDINGS, INC.

Well Number:	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A	102I8A
Sample Date:	07/24/90	08/22/91	08/26/92	08/11/93	05/25/95	07/01/96	07/16/97	06/26/98	06/23/99	06/21/00	05/18/01	06/13/02	05/27/03	06/03/04	06/28/05	07/06/06	07/26/07	07/17/08	07/15/09	06/24/10	07/15/11	06/22/12
Volatiles (ug/L)																						
1,1,2,2-Tetrachloroethane																						
1,1,2-Trichloroethane																						
1,1-Dichloroethane																						
1,2-Dichloroethene (total)																						
2-Butanone									7J					4J								
2-Hexanone									3J													
Acetone	14C			13B				120J			10J									5.2 J		
Benzene																						
Carbon Disulfide					20	310					6J			6J	1.6 J	1 J	8J	24				2.7 J
Chlorobenzene																						
Chloroform																						
Ethylbenzene																						
Methylene Chloride																						
Tetrachloroethene																						
Toluene									2J						2.3 J							
Trichloroethene																				6.3		
Vinyl Acetate																						
Vinyl Chloride																						
Xylene (total)																						
Semi-volatiles (ug/L)																						
1,2,4-Trichlorobenzene																						
1,2-Dichlorobenzene																						
1,3-Dichlorobenzene																						
1,4-Dichlorobenzene																						
2-Butanone (Methyl Ethyl Ketone)												3J										
2,4,5-Trichlorophenol																						
2,4,6-Trichlorophenol																						
2,4-Dichlorophenol																						
2,4-Dimethylphenol																						
2-Chloronaphthalene																						
2-Chlorophenol																						
2-Methylphenol																						
2-Nitrophenol																						
4-Chloro-3-methylphenol																						
4-Methylphenol																						
Benzoic Acid							12J							3J	2.7 J				5.8 J			
Benzyl Alcohol																						
Bis(2-Chloroethyl)Ether																						
bis(2-Ethylhexyl)Phthalate		12	21	31	51									1J	1.7 J	8 J			2.5 J			
Diethyl phthalate																						
Dimethyl Phthalate	16																					
Di-n-Octyl Phthalate	3B																					
Hexachlorobenzene																						
Naphthalene																						
Pentachlorophenol																						
Phenol									1J					1J	1.7 J							
Pesticides/PCBs (ug/L)																						
4,4'-DDD																						
Aldrin																						
Alpha-BHC									0.28											0.14 J		
Alpha-Chlordane																						
Beta-BHC									0.035J					0.011J				0.015 J		0.12 J		
Delta-BHC														0.043J						0.12 J		
Dieldrin																						
Endosulfan I									0.046J													
Endosulfan II																						
Endosulfan Sulfate																						
Endrin																						
Gamma-BHC (Lindane)									0.10J											0.12 J		
Gamma-Chlordane																						
Heptachlor																						
Heptachlor epoxide																						

Notes:

J - Estimated.

B - Detected in the blank sample.

Blank - Not detected

TABLE 4
SUMMARY OF DETECTED COMPOUNDS IN SELECT WELLS
LOVE CANAL LONG-TERM MONITORING PROGRAM
GLENN SPRINGS HOLDINGS, INC.

Well Number:	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B	10210B
Sample Date:	07/24/90	08/22/91	08/26/92	08/11/93	06/15/94	06/01/95	07/05/96	07/01/97	06/18/98	06/24/99	06/15/00	05/17/01	06/18/02	05/23/03	06/07/04	06/24/05	06/28/06	07/26/07	07/17/08	07/15/09	6/15/10	7/14/11	6/22/12
Volatiles (µg/L)																							
1,1,2,2-Tetrachloroethane																							
1,1,2-Trichloroethane																							
1,1-Dichloroethane																							
1,2-Dichloroethene (total)																							
2-Butanone														23									
2-Hexanone																							
Acetone			31		12B	23						12J											
Benzene																							
Carbon Disulfide									8J	2J		1J	3J	2J		1.4 J	1 J	6J			4.0 J	4.6 J	6.1 J
Chlorobenzene															1J								
Chloroform																							
Ethylbenzene																							
Methylene Chloride																							
Tetrachloroethene															9J								
Toluene										2J	1J					1.1 J							
Trichloroethene																							
Vinyl Acetate																							
Vinyl Chloride																							
Xylene (total)																							
Semi-volatiles (ug/L)																							
1,2,4-Trichlorobenzene														3 J									
1,2-Dichlorobenzene																							
1,3-Dichlorobenzene																							
1,4-Dichlorobenzene																							
2-Butanone (Methyl Ethyl Ketone)																							
2,4,5-Trichlorophenol																							
2,4,6-Trichlorophenol																							
2,4-Dichlorophenol																							
2,4-Dimethylphenol																							
2-Chloronaphthalene																							
2-Chlorophenol																							
2-Methylphenol																							
2-Nitrophenol																							
4-Chloro-3-methylphenol																							
4-Methylphenol																							
Benzoic Acid																	2 J						
Benzyl Alcohol																							
Bis(2-Chloroethyl)Ether																							
bis(2-Ethylhexyl)Phthalate	7B	13		11				55	6J						4J	1.5 J	3 J						
Diethyl phthalate																							1.8 J
Dimethyl Phthalate																							
Di-n-Octyl Phthalate												3J											
Hexachlorobenzene														1 J									
Naphthalene																							
Pentachlorophenol																							
Phenol		3																					
Pesticides/PCBs (ug/L)																							
4,4'-DDD															0.011J								
Aldrin																	0.0089J						
Alpha-BHC														19		0.37	0.58	0.016J		0.064/0.050		0.048 J	
Alpha-Chlordane																							
Beta-BHC														1.9	0.53	0.082 p	0.082						
Delta-BHC														0.56 J	0.15		0.047 J			0.032 J/0.028 J	0.050 J	0.042 J	
Dieldrin														0.14 J									
Endosulfan I														0.11 J									
Endosulfan II																							
Endosulfan Sulfate																							
Endrin																							
Gamma-BHC (Lindane)														2.1	0.39	0.046 J	0.099			0.058 J/0.033 J		0.061 J	
Gamma-Chlordane														0.15 J									
Heptachlor														0.35 J								0.053 J	
Heptachlor epoxide																							

Notes:

J - Estimated.

B - Detected in the blank sample.

Blank - Not detected

TABLE 5

SUMMARY OF DETECTED COMPOUNDS IN SELECT WELLS
LOVE CANAL LONG-TERM MONITORING PROGRAM
GLENN SPRINGS HOLDINGS, INC.

Well Number:	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*	*10210C*
Sample Date:	*07/25/90*	*08/22/91*	*08/26/92*	*08/11/93*	*08/08/94*	*06/01/95*	*07/01/96*	*07/01/97*	*06/22/98*	*06/24/99*	*06/15/00*	*05/17/01*	*06/10/02*	*05/23/03*	*06/07/04*	*06/23/05*	*06/28/06*	*07/26/07*	*07/16/08*	*07/15/09*	*06/15/10*	*07/14/11*	*06/22/12*
Volatiles (µg/L)																							
1,1,2,2-Tetrachloroethane																							
1,1,2-Trichloroethane																							
1,1-Dichloroethane																							
1,2-Dichloroethene (total)																							
2-Butanone																							
2-Hexanone																							
Acetone			10B	23B	19B					210J	8J	9J				1.9 J							
Benzene																							
Carbon Disulfide											3J								2 J				U/1.4 J
Chlorobenzene									L								2 J						
Chloroform																							
Ethylbenzene																							
Methylene Chloride																							
Tetrachloroethene																	6 J						
Toluene															29								
Trichloroethene																							
Vinyl Acetate																							
Vinyl Chloride																							
Xylene (total)																							
Semi-volatiles (µg/L)																							
1,2,4-Trichlorobenzene																	6 J						
1,2-Dichlorobenzene																							
1,3-Dichlorobenzene																							
1,4-Dichlorobenzene																							
2-Butanone (Methyl Ethyl Ketone)																							
2,4,5-Trichlorophenol																							
2,4,6-Trichlorophenol																							
2,4-Dichlorophenol																							
2,4-Dimethylphenol																							
2-Chloronephthalene																							
2-Chlorophenol																							
2-Methylphenol																							
2-Nitrophenol																							
4-Chloro-3-methylphenol																							
4-Methylphenol						29	110	62	0.6J														
Benzoic Acid																							
Benzyl Alcohol																							
Bis(2-Chloroethyl)Ether																							
bis(2-Ethylhexyl)Phthalate	7B	13		3B											5J		5 J						
Diethyl phthalate																					4.4 J		
Dimethyl Phthalate																					0.87 J		
Di-n-Octyl Phthalate																							
Hexachlorobenzene																							
Naphthalene																							
Pentachlorophenol																							
Phenol		6				22		22															
Pesticides/PCBs (µg/L)																							
4,4'-DDD																							
Aldrin																	0.061 J						
Alpha-BHC																0.083	0.45 J						
Alpha-Chlordane																							
Beta-BHC															0.017J		0.048 J						
Delta-BHC																	0.052 J			0.048 J			
Dieldrin																							
Endosulfan I																							
Endosulfan II																							
Endosulfan Sulfate																							
Endrin																	0.14 J						
Gamma-BHC (Lindane)																	0.11 J						
Gamma-Chlordane																	0.018 J						
Heptachlor																							
Heptachlor epoxide																							

Notes:

J - Estimated.

B - Detected in the blank sample.

Blank - Not detected

TABLE 6

SUMMARY OF DETECTED COMPOUNDS IN SELECT WELLS
LOVE CANAL LONG-TERM MONITORING PROGRAM
GLENN SPRINGS HOLDINGS, INC.

Well Number:	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*	*10135*
Sample Date:	*05/24/92*	*05/19/93*	*06/22/94*	*06/01/95*	*06/27/96*	*07/07/97*	*06/17/98*	*06/16/99*	*06/22/00*	*05/11/01*	*06/12/02*	*05/19/03*	*05/28/04*	*06/17/05*	*06/26/06*	*07/18/07*	*07/23/08*	*07/15/09*	*06/16/10*	*07/13/11*	*06/22/12*
Volatiles (µg/L)																					
1,1,2,2-Tetrachloroethane		12			26		94J	33/29	27J/26J	100J/120J	500U/56	38				16J		24/25			
1,1,2-Trichloroethane					14		29J	15/12	14J/16J	29J/34J	500U/27					15J		8.7 J/9.1 J			
1,1-Dichloroethane		15						4J/3J	4J/4J	4J/4J	500U/4J	3 J				2J					
1,2-Dichloroethene (total)	700	840			560		58J	67/70	67J/70J	60J/59J		490 J			682 J	50J	11J J	106/109	158	55 J	
2-Butanone		5200							10UJ/10J	12J/11J								5.8 J/6.1 J			
2-Hexanone																					
Acetone		270	100B		60		110J		28J/46J		500U/72	74			200 J	53J		42/37	39		
Benzene			6000E	4900D	4800	5600/5000	5300J	5600/5700	6400/6900J	7600/8500J	5900/6400	5500			6800	7100	5300	7600/7500	3400	2200	5900
Carbon Disulfide								ND/2J								2J					
Chlorobenzene	2600	1700		2000D	1500	2300/ND	1900J	1800/1900	2300J/2500J	2700J/3000J	2200/2100	1900		2000	2400	2100	1400	2900 J/3000 J	1300	1100	2500
Chloroform		100			110		150J	120/110	100J/130J	150J/160J	500UJ/160	110			110 J	140J	99 J	96/97	160	67	130 J
Ethylbenzene		13					12	10J/9J	12J/12J	22J/24J	500U/15	10				10J		10/10	13		
Methylene Chloride		41			11				24J/24J		500U/39	26			44 J	32J		25/24	38	16 J	
Tetrachloroethene							40J	13/12	16J/14J	50J/61J	500UJ/38	18				13J		14/14	19	9.5 J	
Toluene	2700	1700E	21500BE	18000D	14000	19000/17000	16000J	16000/17000	21000J/21000J	22000/24000	20000J/19000	15000		16000	21000	25000	13000	25000/24000	11000	3100	14000
Trichloroethene		24			36		170J	70/58	60J/72J	140J/180J	130J/160	91			66 J	89J	27 J	89/91	140	52	
Vinyl Acetate	6800		12B																		
Vinyl Chloride					50		48J	62/61	110J/85J	75J/66J	500U/48	51						27/17	31		
Xylene (total)		47	10B		28		55J	43/44	42J/44J		500U/51	29				37J		44/53	51		
Semi-volatiles (µg/L)																					
1,2,4-Trichlorobenzene		74	87B				78J	65J/45J	45J/36J	42J/65J		97 J		4.5 J	63	47J	28	110/110	78 J	76 J	74 J
1,2-Dichlorobenzene		35						30J/24J	22J/18J	ND/48J		59 J		36 J	37	31J	10 J	52/68	57 J	45 J	
1,3-Dichlorobenzene															3 J	87J		4.1 J/5.5 J			
1,4-Dichlorobenzene	110	94	91					74J/61J	59J/52J	69J/110J		160 J		100 J	100	84J	24	100 J/150 J	150 J	130 J	110 J
2-Butanone (Methyl Ethyl Ketone)																		5.8 J/6.1 J			
2,4,5-Trichlorophenol		70					38J		0.9J/ND						8 J						
2,4,6-Trichlorophenol									1J/ND								6 J	23/28			
2,4-Dichlorophenol	1200B	420	610	150		2100/2100	3000	610/690	1400J/470J	620J/1200J	1500J/1400J	1700		420	250	490	150	1100/1200	780	590	240
2,4-Dimethylphenol									ND/2J												
2-Chloronaphthalene				150						370J/550J											150 J
2-Chlorophenol							28J	25J/ND								18	17 J	26/31			
2-Methylphenol		51					55J	35J/42J	160J/ND	ND/41J		50 J		25 J	33	34J	14U	50 J/66 J	42 J	30 J	
2-Nitrophenol									ND/1J												
4-Chloro-3-methylphenol								33J/25J				81 J					26	97/95	31 J		
4-Methylphenol		80					130J	120/95J	99J/300J	86J/130J		210 J		49 J		120J	11U	140 J/170 J	130 J	83 J	
Benzoic Acid				6400D	4000	30000J/27000J	25000J	5000/5300	19000J/4700J	6400J/6200J	25000/31000	24000		1400 J	1400 J	14000	7600 J	54000 J/39000 J	9500	11000	8700
Benzyl Alcohol				380		1900/1600	2700	540/660	14000/3200J	330J/630J	1700J/2000	640		23 J	48	580	38	1200/1300	610	450	600 J
Bis(2-Chloroethyl)Ether		23					24J	26J/25J						24 J	24	30J	16 J	28/29	34 J	28 J	
bis(2-Ethylhexyl)Phthalate		50							41J/24J						53			4.4 J/4.2 J			
Diethyl phthalate																					
Dimethyl Phthalate																					
Di-n-Octyl Phthalate																					
Hexachlorobenzene																					
Naphthalene								2000J/1400J	4000J/1800J	1100/1400				1800 J							
Pentachlorophenol		52																			
Phenol		96	91	140				120/96J		ND/51J		180 J			140	130J	96	140 J/160 J	100	82	89 J
Pesticides/PCBs (µg/L)																					
4,4'-DDD								0.026J/0.21	0.07J/0.13J					0.19 J		0.08J	0.13 J		0.048 J		0.036 J
Aldrin	0.53	0.24P						0.21J/0.74JN		0.95JN/3.5JN	0.12J/0.12J					0.07J	0.052 J	0.55 J/0.55 J	0.063 J		
Alpha-BHC	84	42C	24CEP	28D	29	39/39	59	37J/40	50/50	43J/50J	39/45	49		15		12	17	27 J/32 J	4.0	21	7.1 J
Alpha-Chlordane											0.03IJ/0.017J					0.01IJ					
Beta-BHC				10D	11	8.1/8.6	12	11J/12	15/16	16J/16J	13J/14J	15 J		3.4	7.1	3.2	4.4	9.1 J/11 J	4.1	7.1	3.1
Delta-BHC	15	9.8P	7.5CE	4.7	5.2	ND/5.1	8.9	9.6J/11	14/13	10J/12J	9.0J/11J	12		9.1	13	4.7	6.3	11 J/12	0.28	7.3	1.6 J
Dieldrin																					
Endosulfan I								0.43J/0.34		1.5JN/1.6JN											
Endosulfan II									0.52J/0.69J					0.15 J				1.6 J/2.3			
Endosulfan Sulfate		0.43P						0.17J/0.18	0.17J/0.10UJ			1.3 J				0.34J	0.37 J	1.5 J			
Endrin			0.15P													0.03IJ		1.3 J/1.9			
Gamma-BHC (Lindane)	33	19.5	20.4CE			13.2/14.8	6.5J	6.1J/5.5	8.0/6.4	5J/7.3	6.1J/7.1J	7.1			4.8	2.1	2	6.2 J/7.4 J	0.92	4.1	1.4 J
Gamma-Chlordane									0.16J/0.18J		0.34J/0.29J				3.3 J	0.01IJ					
Heptachlor								0.68JN/0.63				0.61 J		0.053		0.09IJ	0.19 J				0.71
Heptachlor epoxide								0.058J/0.043J	0.029J/0.031J		0.016J/0.025J	2.2 J				0.29	0.13 J	1.6 J/1.7 J	0.10 J		0.089 J

Notes:

J - Estimated.

B - Detected in the blank sample.

Blank - Not detected

TABLE 7

LOVE CANAL MAINTENANCE ACTIVITIES CONDUCTED DURING 2012

PROCESS ACTIVITIES

- Removal and disposal of hazardous waste.
- Calibration of Filter Feed Tank level controller.
- Cleaning of all pump chambers.
- Cleaning of all storage tanks and clarifier.
- Change out carbon bed V2.
- Removal of all sludge and spent carbon from V2.
- Cleaning of PC-1 and PC-2 flow meters.
- Replacement of PC-1 flow meter.
- Repair 102nd Street flow meter.
- Adjustment of floats in DCF sump pump #4.
- Calibration of PC-3A level indicator.
- Repair and calibration of PC-3 level probe.
- Repaired the drum barn sump pump controls.
- Checked floats and alarms.

NON-PROCESS ACTIVITIES

- Preventative maintenance.
- Replaced lighting in all buildings, including the process building.
- Removed all domes from drum barn lighting.
- Repaired main gate light.
- Repaired drum barn fan.
- Repaired Love Canal phones and fire alarm service in the Administration Building.

APPENDIX B

FIGURES

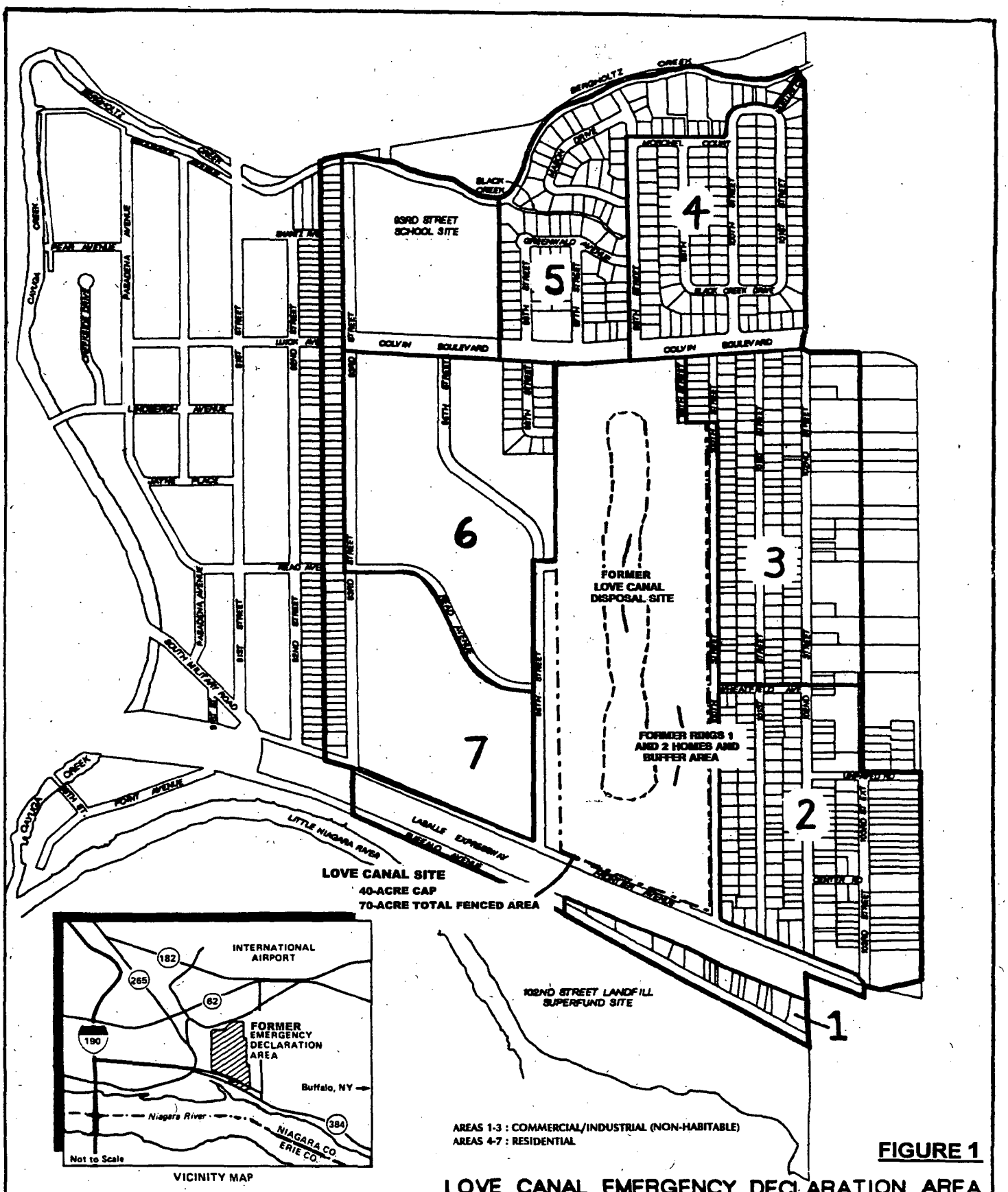


FIGURE 1

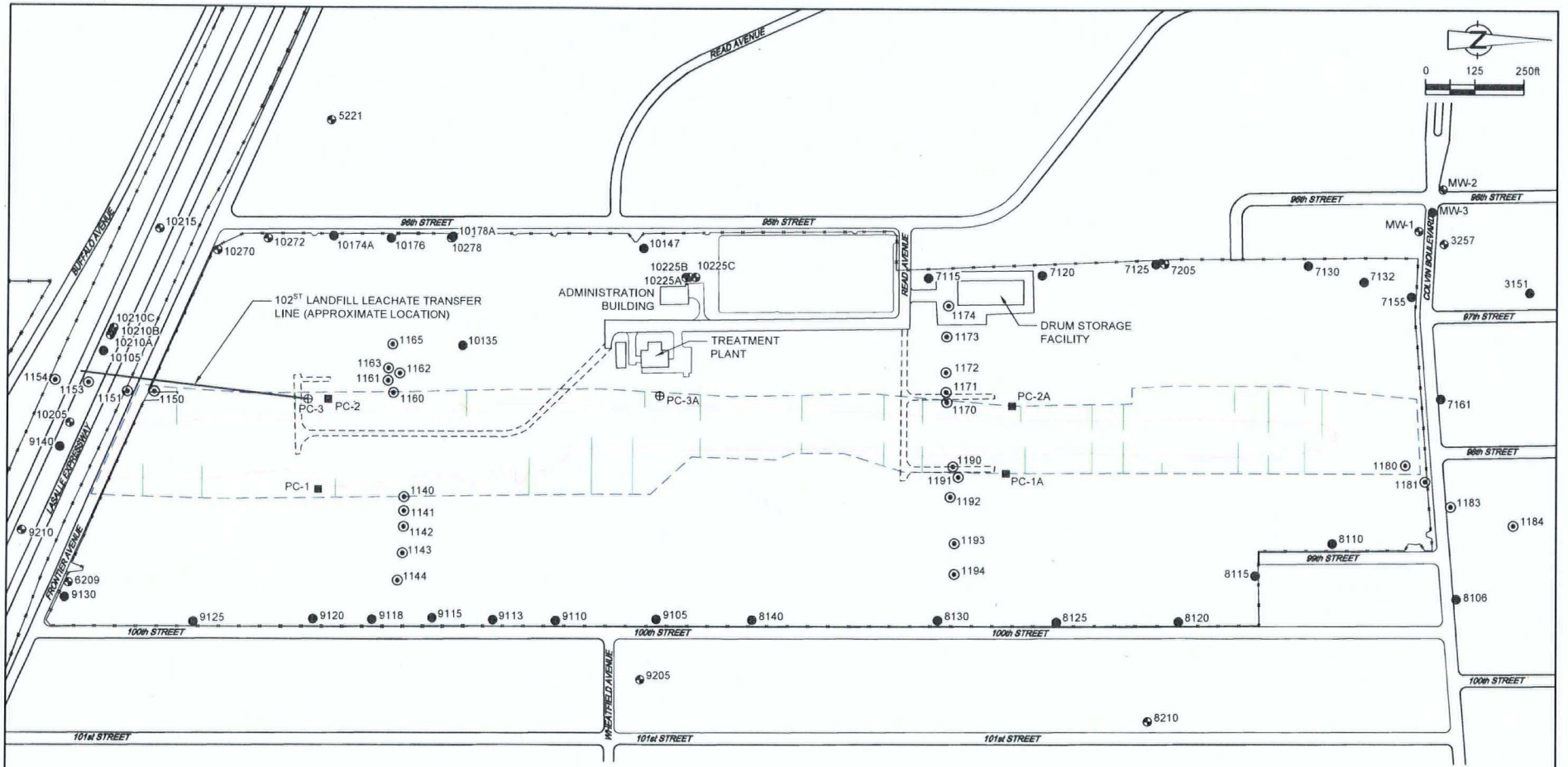
LOVE CANAL EMERGENCY DECLARATION AREA

NIAGARA FALLS, NEW YORK SCALE: 1"=750' (SEVEN EDA NEIGHBORHOODS)

LEGEND

EMERGENCY DECLARATION AREA (EDA) BOUNDARY

SOURCE:
EDA BOUNDARIES TAKEN FROM NEW YORK STATE REAL PROPERTY TAX LAW ARTICLE 17, SECTION 1702



LEGEND

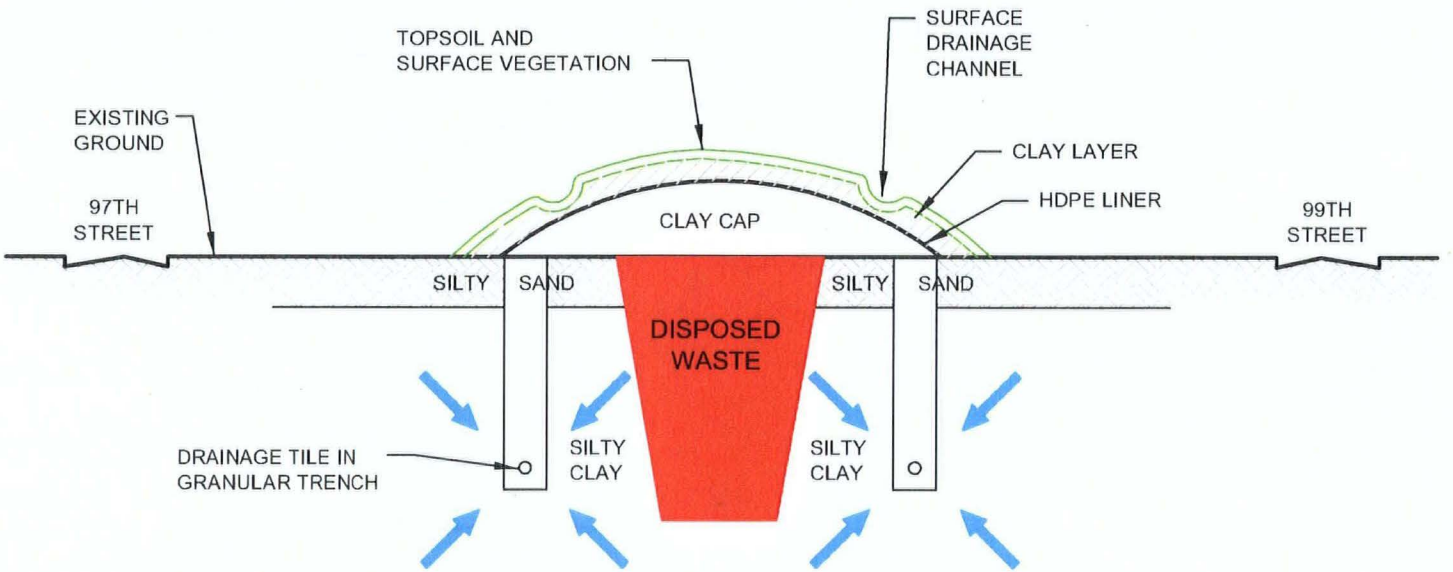
- FENCE LINE
- BARRIER DRAIN
- LATERAL TRENCH
- 7105 PIEZOMETER
- 9120 OVERBURDEN OBSERVATION WELL
- 10270 BEDROCK OBSERVATION WELL
- PC-1 PUMP CHAMBER FOR LEACHATE COLLECTION
- PC-3 PUMP CHAMBER / UNDERGROUND LEACHATE STORAGE TANK FOR LEACHATE COLLECTION AND TRANSFER
- APPROXIMATE LIMITS OF DISPOSED WASTE

NOTE:
WELL 3151 IS UNABLE TO BE LOCATED
(ASSUMED TO BE PAVED OVER)

FIGURE 2

SITE PLAN
LOVE CANAL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

09954-D23101(026)GN-WA001 MAR 14/2013



LEGEND

GROUNDWATER FLOW

FIGURE 3

TYPICAL BARRIER COLLECTION SYSTEM CROSS-SECTION
LOVE CANAL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

09954-D213101(016)GN-WA005 MAR 04/2010

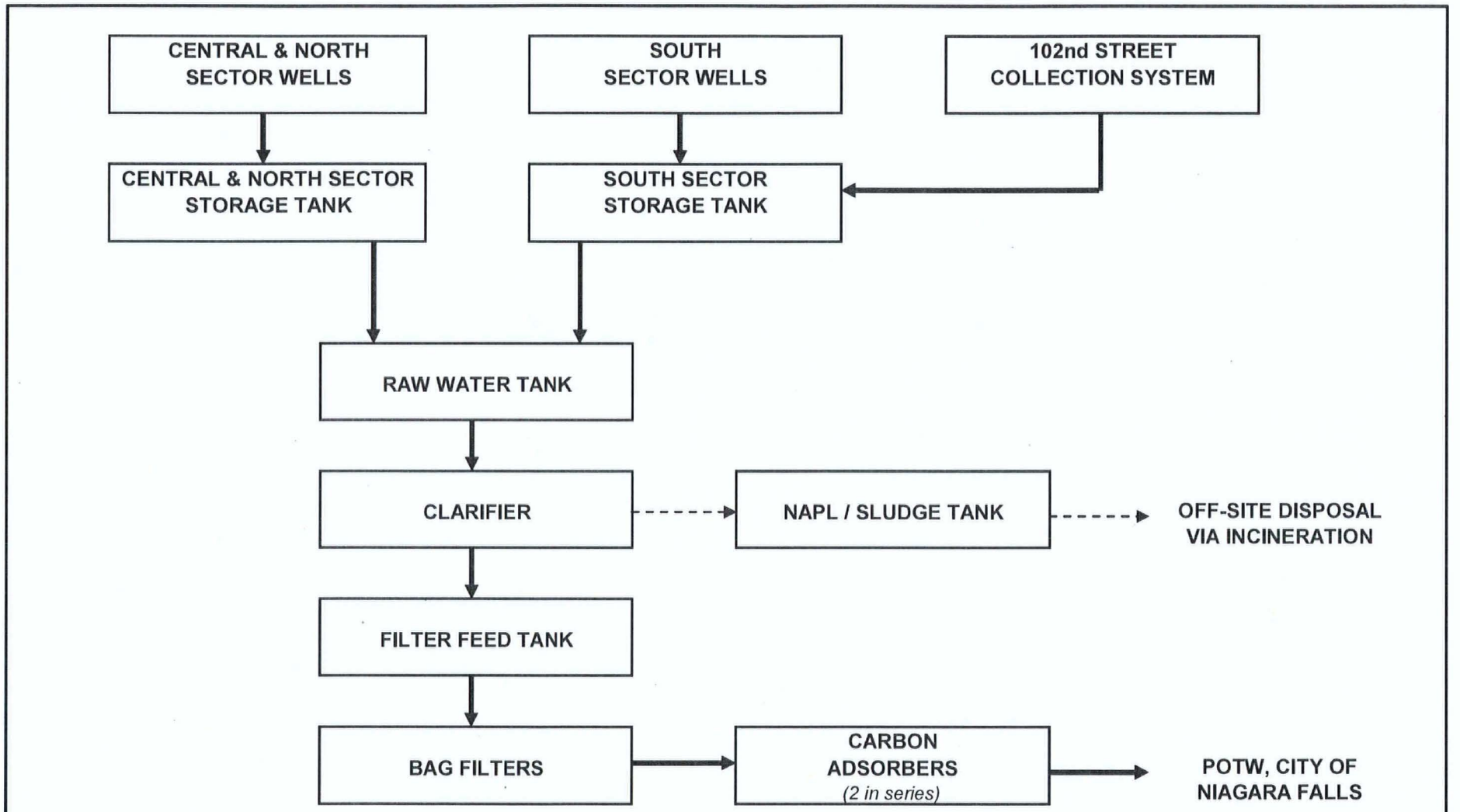
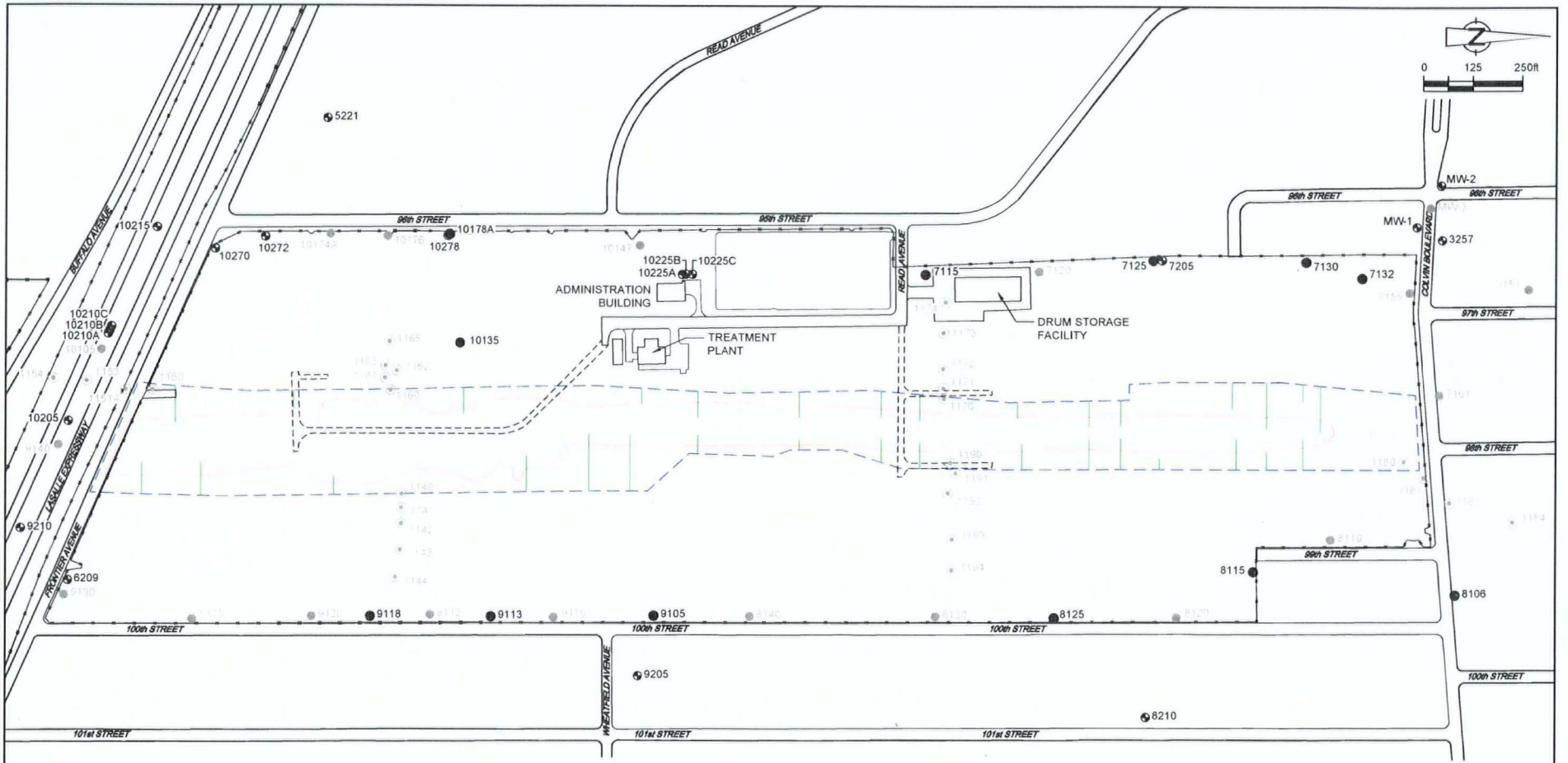


FIGURE 4

PROCESS SCHEMATIC - LOVE CANAL TREATMENT FACILITY
LOVE CANAL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

09954-D213101(016)GN-WA013 MAR 04/2010



LEGEND

- FENCE LINE
- BARRIER DRAIN
- LATERAL TRENCH
- PIEZOMETER
- OVERBURDEN OBSERVATION WELL
- BEDROCK OBSERVATION WELL
- 9205 OVERBURDEN OBSERVATION WELL SAMPLED IN 2012
- 10270 BEDROCK OBSERVATION WELL SAMPLED IN 2012
- APPROXIMATE LIMITS OF DISPOSED WASTE

NOTE:
WELL 3151 IS UNABLE TO BE LOCATED
(ASSUMED TO BE PAVED OVER)

FIGURE 5

2012 GROUNDWATER MONITORING LOCATIONS
LOVE CANAL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

09954-D23101(026)GN-WA003 MAR 14/2013

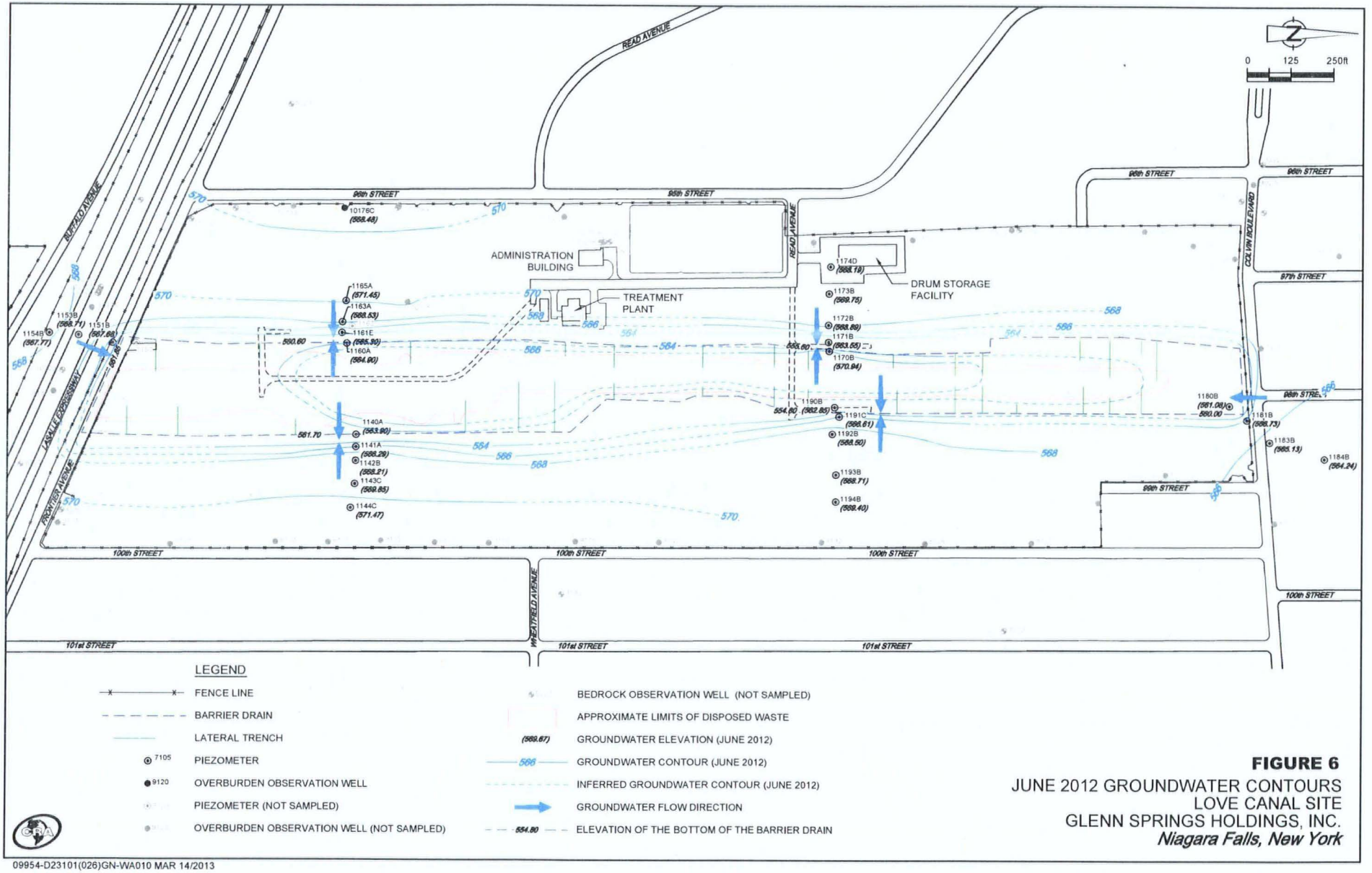


FIGURE 6
JUNE 2012 GROUNDWATER CONTOURS
LOVE CANAL SITE
GLENN SPRINGS HOLDINGS, INC.
Niagara Falls, New York

09954-D23101(026)GN-WA010 MAR 14/2013

APPENDIX C

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