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FIVE-YEAR REVIEW REPORT FOR SILRESIM CHEMICAL CORP. SUPERFUND SITE LOWELL, MIDDLESEX COUNTY, MASSACHUSETTS

U.S. Environmental Protection Agency
REGION 1
BOSTON, MASSACHUSETTS

James T. Owens, III, Division Director for

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09/08/14

Date

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
BAV	Benchmark Assessment Value
bgs	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COCs	Contaminants of Concern
COPCs	Contaminants of Potential Concern
CSF	Cancer Slope Factor
CUGs	Cleanup Goals
CVOC	Chlorinated Volatile Organic Compound
CZA	Capture Zone Analysis
EPA	United States Environmental Protection Agency
ERH	Electrical Resistance Heating
ESD	Explanation of Significant Differences
FYR	Five-Year Review
gpm	Gallons per Minute
GWTP	Groundwater Treatment Plant
HDPE	High Density Polyethylene
HHRA	Human Health Risk Assessment
ICs	Institutional Controls
IRIS	Integrated Risk Information System
LI&S	Lowell Iron & Steel
LTRA	Long-Term Response Action
MADEQE	Massachusetts Department of Environmental Quality Engineering
MADWPC	Massachusetts Department of Water Pollution Control
MassDEP	Massachusetts Department of Environmental Protection
MCLs	Federal Maximum Contaminant Levels
MCP	Massachusetts Contingency Plan
mg/kg	Milligrams per Kilogram
MOM	Management of Migration
MRS	Metals Removal System
MSL	Mean Sea Level
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
OU	Operable Unit
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethylene
POTW	Publicly Owned Treatment Works
PPE	Personal Protection Equipment
ppb	Parts per Billion
ppm	Parts per Million
PRP	Potentially Responsible Party
RA	Remedial Action

RAC	Remedial Action Contractor
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
SARA	Superfund Amendments and Reauthorization Act
SC	Source Control
SDWA	Safe Drinking Water Act
SVE	Soil Vapor Extraction
SVOC	Semi Volatile Organic Compound
TCE	Trichloroethylene
TCLP	Toxicity Characteristic Leaching Procedure
TTO	Total Toxic Organics
TTVO	Total Toxic Volatile Organics
UCL	Upper Concentration Limit
µg/kg	Microgram per Kilogram
µg/L	Microgram per Liter
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

This is the fourth Five-Year Review (FYR) for the Silresim Chemical Corp ("Silresim") Superfund Site (the "Site") located in the city of Lowell, Middlesex County, Massachusetts. The purpose of this FYR is to review information to determine if the remedy is, and will continue to be, protective of human health and the environment. The triggering action for this statutory FYR was the signing of the previous FYR on September 8, 2009.

The Site, as defined by the areal extent of groundwater contamination, is approximately 16 acres and is located in an industrial area of Lowell, Massachusetts (Figure 1). The 4.5-acre Silresim property is located at 86 Tanner Street (Figure 2). Silresim Chemical Corp. operated a chemical reclamation facility from 1970 until its abandonment in 1978. At the time, the Site contained over 30,000 drums and thousands of gallons of waste in above ground storage tanks. The Site was added to the National Priorities List in 1982. The Remedial Investigation (RI) identified over 100 individual contaminants in groundwater and soils, predominantly volatile organic compounds (VOCs). Other types of contaminants included: semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, herbicides, pesticides, and dioxin.

EPA issued the remedy for the Silresim Site in a 1991 Record of Decision (ROD) which detailed both a Management of Migration (MOM) component, and a Source Control (SC) component. The MOM portion of the remedy consists of extraction and treatment of contaminated groundwater; this activity is on-going. The SC portion included the excavation and relocation of off-property soil contamination, operation of a soil vapor extraction (SVE) system, construction of a RCRA Subtitle C landfill cap, and implementation of institutional controls (ICs). EPA issued an Explanation of Significant Differences (ESD) in September 2008 which identified thermally-enhanced SVE as the preferred SC remedy. This ESD also acknowledged the Engineered Barrier performance standards per MassDEP Guidance in lieu of the RCRA Subtitle C cap requirements.

The Groundwater Treatment Plant (GWTP) has been operational since its construction in November 1995. Based on the most recent comprehensive groundwater sampling report (Status Report No. 37) in 2012, the total quantity of VOCs removed since its construction is 113.5 tons. Routine groundwater monitoring has not been conducted since 2012 due to both the construction and subsequent operation of the thermal remediation system (2010 to 2013) as well as the slow rate of cooling of the heated area. The excavation of off-property soils containing non-VOC contaminants was completed in the fall of 2005.

Electrical Resistance Heating (ERH), a form of thermally-enhanced SVE, was performed from July 2010 to June 2013 (inclusive of system construction and post-treatment monitoring). The ERH remedial action consisted of heating approximately 60,000 cubic yards of soil and groundwater. Within the heated area, groundwater and soil vapor were extracted and vapors treated with an on-site thermal oxidizer. The ERH remedy removed between 55,780 and 91,080 pounds of VOCs (depending on the method used to assess system performance). Commensurate with the ERH remedial action, a final cover system was constructed over a portion of the Silresim property; this was completed in August 2013.

Institutional Controls (in the form of multiple "Grants of Environmental Restrictions and Easements") are in place for much of the area where groundwater is contaminated (i.e., abutting properties to the Silresim property). These ICs were obtained by Potentially Responsible Parties (PRPs) in 1995; however the lack of a viable owner of the Silresim property specifically (due to its abandonment) has prevented any restrictions from being recorded for this property. Further, while the ICs obtained at abutting properties do not contemplate potential risks from vapor intrusion (VI), there are notification requirements prior to any new construction that would alert EPA of any changes in property use. The existing commercial and industrial buildings are inspected annually to assess that their current use (i.e., commercial/industrial) has not changed.

Operation and maintenance (O&M) of the final cover have been transferred to the MassDEP, thus MassDEP has O&M of all components of the Silresim remedy, excluding acceptance of the existing property easement. All immediate threats at and from the Silresim Site have been addressed.

Short-term protectiveness has been achieved through the operation of the Groundwater Pump and Treat system; the construction of a final cover; the adoption of institutional controls; and periodic assessment of abutting properties for potential vapor intrusion. However, because the remedial action at OU1 is not yet protective in the long-term, the Site is not protective of human health and the environment in the long-term until follow-up actions noted for OU1 are completed.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site Name: Silresim Chemical Corp.		
EPA ID: MAD000192393		
Region: 1	**State:** MA	**City/County:** Lowell/Middlesex

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

REVIEW STATUS
Lead agency: EPA ***[If "Other Federal Agency", enter Agency name]*:**
Author name (Federal or State Project Manager): Dan Keefe
Author affiliation: US EPA
Review period: 9/9/2009 - 9/8/2014
Date of site inspection: 11/20/2013
Type of review: Statutory
Review number: 4
Triggering action date: 9/8/2009
Due date *(five years after triggering action date)*: 9/8/2014

Issues/Recommendations
OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU2 - All construction activities for the Off-Property Soil Excavation were completed in May 2005.

Issues and Recommendations Identified in the Five-Year Review:

OU(s): 1	Issue Category: Monitoring			
	Issue: The sewer line, which traverses the North Study Area, may serve as a preferential pathway for the migration of contaminated groundwater.			
	Recommendation: Check on depth of trench and pipeline. Compare (in the same datum) to the groundwater contamination migrating from the Site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	12/31/2015

OU(s): 1	Issue Category: Monitoring			
	Issue: Increasing contaminant trends in some monitoring wells in the North Study Area.			
	Recommendation: Increase frequency of data collection to verify historical groundwater results. Evaluate the need for additional and/or relocated extraction wells and monitoring wells and update the Capture Zone Analysis.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	12/31/2015

OU(s): 1	Issue Category: Institutional Controls			
	Issue: Institutional Controls are still needed for the 4.5-acre Silresim property.			
	Recommendation: In order to ensure long-term protectiveness, ICs should be recorded against the Silresim property deed as soon as a viable property owner (possibly the city of Lowell) takes title to the property.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	EPA/State	EPA	9/1/2019

OU(s): 1	Issue Category: Monitoring			
	Issue: Vapor intrusion is a potential concern in areas north of the site.			
	Recommendation: Continue periodic assessments of abutting property uses, and groundwater monitoring data as they relate to the potential for vapor intrusion into indoor air.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Party Responsible**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	9/1/2019

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
1	Short-term Protective	

Protectiveness Statement:
The remedy at OU1 is currently protective of human health and the environment because the Groundwater Pump and Treat (GWPT) system continues to collect and treat groundwater, institutional controls remain in place at abutting properties, routine O&M is performed by MassDEP on both the GWTP and the Final Cover, and an annual assessment of buildings located on abutting properties is conducted to evaluate any property use changes that may result in a complete VI pathway. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: further evaluation of contamination in vicinity of sewer pipeline; additional data collection and evaluation of capture and extraction well network; completion of Institutional Controls on the Silresim property; and, continued periodic assessments of abutting property uses and groundwater monitoring data as they relate to the potential for vapor intrusion into indoor air.

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
2	Protective	

The remedy at OU2 is protective of human health and the environment because all construction activities for the Off-Property Soil Excavation were completed in May 2005. Excavated soil has been moved onto the Site and covered by the newly constructed Final Cover.

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):*
Protectiveness Statement: Short-term protectiveness has been achieved through the operation of the Groundwater Pump and Treat system; the completion of a Final Cover; institutional controls on abutting properties; and periodic assessment of building uses on abutting properties for changes which might result in potential increase concern for vapor intrusion. However, because the remedial action at OU1 is not yet protective in the long-term, the Site is not protective of human health and the environment in the long-term until follow-up actions noted for OU1 are completed.	

I. INTRODUCTION

The purpose of a Five-Year Review (FYR) is to evaluate the implementation and performance of a remedy in order to determine if the remedy will continue to be protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in five-year review reports. In addition, FYR reports identify issues found during the review, if any, and document recommendations to address them.

The U.S. Environmental Protection Agency prepares FYRs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121 and the National Contingency Plan (NCP). CERCLA 121 states:

> *"If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews."*

EPA interpreted this requirement further in the NCP; 40 Code of Federal Regulations (CFR) Section 300.430(f)(4)(ii), which states:

> *"If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such actions no less often than every five years after the initiation of the selected remedial action."*

EPA conducted a FYR on the remedy implemented at the Silresim Superfund Site in the city of Lowell, Middlesex County, Massachusetts. EPA is the lead agency for developing and implementing the remedy for the Site. MassDEP has reviewed all supporting documentation and provided input to EPA during the FYR process.

This is the fourth FYR for the Silresim Superfund Site. The triggering action for this statutory review is the signature date of the previous FYR which was September 8, 2009. The FYR is required due to the fact that hazardous substances, pollutants, or contaminants remain at the Site above levels that allow for unlimited use and unrestricted exposure. The Site consists of two Operable Units, both of which are addressed in this FYR.

II. PROGRESS SINCE THE LAST REVIEW

The third Five-Year Review Report was signed on September 8, 2009. The 2009 review found that the OU1 remedy will be protective because the GWTP was active, an interim cover was in

place, and the majority of institutional controls were in effect. However, in order for the remedy to be protective in the long-term, the 2009 review found that additional groundwater monitoring is required. Tables 1 and 2 below present the protectiveness determination and recommendations from the 2009 FYR.

Table 1: Protectiveness Determinations/Statements from the 2009 FYR

OU #	Protectiveness Determination	Protectiveness Statement
1	Will be Protective	All immediate threats at and from the Site have been addressed. The remedy is expected to be protective of human health and the environment upon completion, and in the interim, exposure pathways that could result in unacceptable risks are being controlled. Long term protectiveness of the remedial action will be verified by continuing the ongoing groundwater monitoring program, and annual assessment of abutting property usage. Portions of the plume may have migrated beyond the extraction well array to the North Study area are being monitored. Current monitoring data indicate that the plume is contained in the other three study areas.

Table 2: Status of Recommendations from the 2009 FYR

Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Party	Original Milestone Date	New Milestone Date
The sewer line trench, which traverses the North Study Area, may serve as a pathway for the migration of contaminated groundwater.	Check on depth of trench and pipeline and compare to the groundwater contamination migrating from the Site.	MassDEP	EPA	Sep 2011	12/31/2015
Increasing contaminant trends in some monitoring wells in the North Study Area.	Increase frequency of data collection to verify results and evaluate the need for additional extraction and monitoring wells.	MassDEP	EPA	Sep 2011	12/31/2015
Institutional Controls need to be kept updated.	To ensure long-term protectiveness, the existing IC should be re-evaluated and amended as necessary.	MassDEP & EPA	EPA	Sep 2014	9/1/2019

Vapor intrusion is a potential concern in areas north of the site.	Continue periodic assessments of abutting property uses and groundwater monitoring data as they relate to the potential for vapor intrusion into indoor air.	MassDEP	EPA	Sep 2014	9/1/2019

Recommendation 1

This recommendation has not yet been implemented. This recommendation should be implemented when ambient (or near ambient) groundwater conditions have been reached. This is expected to occur before 12/31/2015, and ideally as part of the next comprehensive groundwater evaluation (planned for the Fall of 2014). The sewer line which traverses the North Study Area, down gradient of the northern-most extraction well, is reported to be an 84-inch diameter brick combined sanitary/storm water sewer. The sewer located to the West of the Site, along Tanner Street, is reported to be a 52-inch by 38-inch oval brick sewer. The size and invert elevations of these sewers should be confirmed and the unconsolidated material adjacent to the pipes evaluated to determine whether or not they are currently, or potentially, preferential migration pathways for contaminated groundwater.

Recommendation 2

This recommendation has not yet been implemented. The rate of cooling (post-ERH treatment) was substantially slower than anticipated; this resulted in groundwater conditions significantly above ambient temperatures within the ERH treatment area. Further, the ERH operation required some re-configuration of monitoring wells (MWs) and extraction wells (EWs). Thirty four new MWs were added (8 of which were replacements for existing MWs). Since the completion of the ERH remedial action in February 2012, and the removal of significant quantities of VOCs (~50,000 to ~90,000 pounds), the remaining residual groundwater contamination should be characterized. These data will allow MassDEP to assess if the existing extraction well array is ideally configured to capture and treat residual groundwater contamination.

Recommendation 3

This recommendation has not yet been implemented. Transfer of existing ICs (recorded on the abutting properties deeds) to the Commonwealth is currently under discussion. Currently there are no restrictions on the 4.5-acre Silresim property. This is due to the absence of a viable property owner to record a grant or easement against the deed. Since the completion of the Final Cover (August 2013), there may be renewed interest within the City of Lowell (or other third party) in acquiring a portion of the property. As a condition of any acquisition, the new owner will be required to record land use restrictions. Until such time as there is a new owner, EPA and MassDEP have unencumbered Site access and a regular presence on-Site (operating the GWTP) thus ensuring that activities that might otherwise be restricted are not occurring.

Recommendation 4

This recommendation is being implemented. The above-mentioned ICs (on abutting properties) do not contemplate potential risk from Vapor Intrusion; however they do require notice be provided to EPA of any new construction. Periodic (annual) assessments of abutting property uses has occurred and should be continued so as to insure no new development or change of use (e.g., residential) has occurred. Note the Silresim property and surrounding properties are zoned "industrial" precluding any residential development.

Remedy Implementation Activities

Significant Remedial Action activities have occurred since the previous five-year review. Specifically the following two activities were completed: 1) thermal remediation, via Electrical Resistive Heating, and 2) construction of the Final Cover over portions of the Silresim property. A Preliminary Closeout Report was signed in August 2011 (post-ERH system construction) documenting that no additional remedial construction activities are anticipated. Each of the recently completed Remedial Actions is described in more detail below.

Capping Remedial Activities - A 14-inch thick (interim) clay cap was originally constructed in 1984 and modified in successive years (e.g., from soil added during GWTP construction and off-property soils which were excavated as part of OU2). The resulting interim cap was not homogenous and consisted of six different cap cross-sections. As described in the 2008 ESD, a final cover system was selected consistent with the State's Guidance on *Construction and Design of Engineered Barriers* (MassDEP, 2002). Further, the extent of the cap improvements were limited based on input provided by the city of Lowell. The city of Lowell advocated for a uniform cap so as not to preclude future redevelopment at a portion of the Site. The final Cap Design included cap improvements to a 2-acre portion of the property behind the existing GWTP (refer to Figure 3). The remainder of the property is the location of the GWTP itself, paved roadways, or field office trailers. Given the anticipated duration of groundwater treatment (e.g., decades) thereby reducing any future reuse and the good condition of the interim cap in these areas, EPA and MassDEP accepted the existing (interim) cover as the final cover in these areas.

A Pre-Final Inspection of the final cover was completed in October 2010 (after construction and during operation of the ERH system). A Final Inspection was performed after the completion of Site restoration activities in July 2013. On August 5, 2013 MassDEP concurred that all punch list items had been completed and that the final cover was Operational and Functional thus beginning the Commonwealth's responsibility to perform routine O&M. MassDEP contractors perform monthly inspections of the cover and perimeter fence.

ERH Remediation – Thermally-enhanced SVE via ERH was identified as the preferred Source Control remedy in the 2008 ESD. This was based on the results of a prior ERH Pilot Study (Foster Wheeler, 2003) and the recommendation of MassDEP (MassDEP, 2007). The extent of the ERH treatment zone was based on an "ERH Treatment Zone Evaluation" (i.e.,

the Remedial Design) prepared by the U.S. Army Corps of Engineers (USACE, 2008). The system design focused on treating the highest concentrations of VOCs, notably TCE – the most wide-spread contaminant as well as a significant contributor to the overall site risks. Funding for the ERH Remedy was obtained via the American Recovery and Reinvestment Act (ARRA) of 2009. System construction began in 2010. Significant hurtles were identified during construction such as identifying a sufficient power source to operate the ERH system and obtaining access across railroad property right-of-way.

The ERH system consisted of installing 304 electrodes (within 138 soil borings) spread over 5 contiguous areas – each with varying total depth. Other penetration included 77 multiphase extraction wells, 50 shallow vapor extraction wells, and numerous temperature and pressure sensing wells. A thermal oxidizer was mobilized to the Site for contaminant destruction. The liquid effluent from the ERH treatment system was sent to the existing GWTP for "polishing" prior to discharge to the city of Lowell. Figure 4 depicts the areal extent of the ERH system inclusive of electrode and extraction well locations. The ERH system was operational on July 29, 2011. As expected, it took approximately 100 days to achieve treatment temperatures (i.e., boiling) notwithstanding power outages associated with Hurricane Irene and a rare October Nor'easter. Treatment temperatures were maintained until February 2012 at which time power to the electrodes was turned off. Vapor control was maintained for an additional 2 weeks during the initial stage of cooling and while significant vapors (i.e., steam) were still being generated.

The Draft Remedial Action Report (Nobis, 2013) estimated the ERH system removed approximately 23,773 kg (52,300 pounds) of total VOCs as measured by laboratory analysis (TO-15) and field measurements (PID/FID). Additionally, an estimated 3,480 pounds of non-aqueous phase liquid (NAPL) were removed for a total of 55,780 pounds of VOCs. Mass removal estimates based on caustic usage yield 87,600 pounds of VOCs removed. Thus, total mass removal is somewhere between 55,780 and 91,080 pounds.

Institutional Controls - Institutional Controls at the Site are in the form of easements obtained in 1995 by the PRPs from the abutting property owners. The easements grant EPA access in, over, under, across, upon and through areas designated as the "groundwater monitoring area," the "groundwater extraction area," the "soil vapor extraction area," and the "permanent cap area." The grantors (property owners) retain rights including access to, and use of, the surface and subsurface in any manner that does not prevent, disrupt or otherwise interfere with the activities described in the agreements. In general, for all the adjacent properties, the restrictions prohibit any groundwater withdrawal for drinking water purposes and require that prior to any new construction or activity, the property owner shall notify EPA. There are no property use restrictions (i.e., Environmental Easements) on the Silresim property specifically. This is due to its abandoned status and, thus, the lack of an owner to record any restrictions. Despite the lack of any recorded restrictions, EPA and MassDEP have a regular presence on the property due to the on-going operation of the GWTP; this mitigates the imminent need to record any property use restrictions.

System Operation/Operation and Maintenance Activities

O&M activities have continued during the past five years. Monthly GWTP influent and effluent sampling was reduced to bi-monthly sampling in July 2009 due to previously consistent results. Monthly thermal oxidation air testing was also reduced to bi-monthly sampling in July 2009. Semi-annual GWTP influent and effluent sampling is conducted to satisfy the LRWU discharge permit. In-plant sampling is also conducted to monitor the GWTP system. Beginning in December 2013, extraction well sampling is conducted quarterly.

During October 2010 eight extraction wells were taken off-line due to the construction and operation of the ERH system. During October 2011, an additional 14 extraction wells were taken off-line due to the construction and operation of the ERH system. Only extraction well EW-31 remained operational during ERH operations. Post ERH treatment (August 2012), extraction wells were reactivated, pending the installation of heat-tolerant pumps at some locations within the ERH treatment zone.

The GWTP continues to operate effectively relative to contaminant removal and runtime (i.e., 98.9 percent of available runtime reported in Status Report No. 37). A total of 2.5 million gallons of contaminated groundwater were pumped and treated through the system during the 2012 reporting period. It is estimated that the GWTP removed approximately 0.54 tons Total Toxic Organics from the Site during the 2012 reporting period. The total estimated mass removed by the GWTP up through 2012 is approximately 93.79 tons since it began operations in November 1995. The GWTP operated in compliance with all effluent discharge regulations and air emission guidelines throughout the 2012 operation's period.

III. FIVE-YEAR REVIEW PROCESS

Administrative Components

The Silresim Superfund Site Five-Year Review was led by Daniel Keefe of the U.S. EPA, Remedial Project Manager for the Site. Janet Waldron assisted in the review as the Project Manager for the MassDEP.

The review, which began on November 20, 2013, consisted of the following components:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection; and
- Five-Year Review Report Development and Review.

Community Notification and Involvement

EPA published a press release on February 13, 2014, stating that there was a five-year review and inviting the public to submit any comments to the U.S. EPA. The results of the review and

the report will be made available at the Site information repository located at Pollard Memorial Library, 401 Merrimack Street, Lowell, MA 01850 and at the OSRR Records and Information Center, 1st Floor, 5 Post Office Square, Suite 100 (HSC), Boston, MA 02109.

Document Review

This five-year review consisted of a review of relevant documents including O&M inspections, monitoring data, and completed Remedial Action reports. Applicable groundwater and soil cleanup standards, as listed in the September 1991 Record of Decision and as modified by the September 2003 and September 2008 Explanation of Significant Differences, were also reviewed.

Data Review

Available groundwater and soil data were reviewed. There is a brief discussion of surface water and indoor air in this section; however, there were no surface water or indoor air data collected during the review period.

Groundwater

In general, the groundwater monitoring program is designed to provide chemical and hydrogeological data necessary to evaluate the effectiveness of GTWP in containing the groundwater plume. A hiatus in annual monitoring data exists due to the implementation of the ERH remedy and corresponding slow rate of cooling (post treatment). Thus, the last annual round of samples collected by MassDEP to assess the GWTP performance was in 2012 (the result of which are reported in Status Report No. 37). This report details groundwater and extraction well data collected from multiple sampling events (August 2012 and December 2012). Other groundwater data were generated in 2012 to assess the ERH system performance during and immediately following ERH treatment. Quarterly sampling of extraction wells began in December 2013.

Specific objectives of the routine annual groundwater monitoring program include the following:

- Characterization of Site groundwater chemistry and contamination;
- Characterization and confirmation of Site hydrogeology including groundwater flow directions;
- Continued development of a hydrogeological and chemical database to support the on-going evaluation of changes in groundwater quality associated with extraction well pumping, GWTP operations, and the overall progress of efforts to manage and/or contain the migration of groundwater contaminants.

The Site has previously been divided into five study areas (North, South, East, West, and Central) to provide a more focused discussion of contaminant distribution and migration. The

effectiveness of the overall GWTP at managing the migration of contaminants is assessed based on hydrogeology (i.e., groundwater flow direction) and by groundwater chemistry (i.e., an evaluation of increasing/decreasing trends in contaminant concentrations). The conceptual model of the Site consists of six hydrostratigraphic layers numbered 1 through 6 from the surface downward. The cross section of the six layers are shown on Figure 5.

Groundwater levels are measured during the annual groundwater sampling events. Equipotential surfaces and contaminant plume contours from the 2012 report are depicted in Figure 6a – 6g. More infrequently, a comprehensive assessment of groundwater has occurred. From this, additional analyses can be performed such as Capture Zone Analysis (CZA). The last comprehensive round of groundwater sampling for which CZA was performed was in 2007. A capture zone is a three-dimensional region that is created by the pumping of an extraction well(s) such that groundwater within that zone is either stagnant, and referred to as the stagnation point, or is drawn towards the extraction well. The tentative date for the next comprehensive evaluation of groundwater, including CZA, is the fall of 2014

Table 3. Summary of Groundwater Samples during this Five-Year Review Period

Sample Dates within FYR period	Number of MWs Sampled	Number of EWs Sampled	Summarized in Status Report No.
August & December 2009	**12** (Aug), **36** (Dec)	**23** (Dec)	34 (Watermark, 2010)
December 2010	**34**	**15**	35 (Watermark, 2011)
December 2011	**35**	**9**	36 (Watermark, 2012)
August, September, December 2012	**21** (Aug), **11** (Dec)	**22** (Dec), **21** (Sep)	37 (Watermark, 2013)

Groundwater sampling results from the above-referenced Status Reports are summarized below (for a subset of contaminants detected):

Table 4. Summary of Select VOC Concentrations (µg/L) in Groundwater from selected wells during December 2009 to December 2012

Compound		Acetone		Benzene		Trichloroethene (TCE)		Tetrachloro-ethene (PCE)		1,1,1-Trichloroethane (TCA)	
Cleanup Goal		50000		480		1400		5000		50000	
Well Number	Study Area	Range	Most Recent	Range	Most Recent	Range	Most Recent	Range	Most Recent	Range	Most Recent
MW-315-A	North	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-501-B	North	10 UJ – 50 U	50 UJ	5 U – 1U	1 U	5 U – 4.1 J	4.8	9.3 J – 5.5	8.2	3.9 J – 4.2 J	3.4
MW-703-A	North	250 U - 38000 J	10 U	98 – 21000	15000	1 U - 2000 U	1 U	5 UJ - 2000 U	1 U	5 UJ - 2000 U	1 U
MW-803-1-90	North	2500 U – 3400 J	250 U	170 – 310	160	50 U - 100 U	5 U	50 U - 100 U	5 U	50 U - 100 U	5 U
EW-04-C	Central	4000 U - 5000 UJ	4000 U	1400 - 2400 J	1400	53000 - 76000	53000	6400 - 7100	6400	20000 - 62000	20000
EW-06-C	Central	500 UJ - 6800	6800	500 - 1400 J	500	38000 – 3800	3800	490 J - 5500	490 J	500 U - 42000	500 U
MW-101-A	Central	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-306-A	Central	540 J - 2000	1300 U	380 – 790	380	29 J - 490	490	50 U – 200 U	58	25 U – 200 U	25 U
MW-405-A	Central	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-701-B	Central	50 U – 220 J	5000 U	18 J – 100 U	100 U	16 J – 440	440	180 - 240	240	470 - 650	650
MW-702-B	Central	ND – 5000 U	50 UJ	ND – 840	560	2000 - 76000	6.9	490 - 9800	4.4 J	220 - 10000	3.8 J
MW-713-B	Central	10 UJ – 1300 U	1300 U	2.9 J – 1700	770	5 U – 50 U	25 U	5 U – 50 U	25 U	5 U – 50 U	25 U
MW-716-C	Central	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-402-B	South	10 U – 10 U	10 U	5 U – 5 U	5 U	5 U – 5U	5 U	5 U – 5 U	5 U	5 U – 5 U	5 U
MW-408-A	West	50 UJ – 500 U	200 UJ	100 - 630	72	10 U - 25 U	4 U	10 U - 25 U	4 U	10 U - 25 U	4 U

Note: Highlighted cells indicate exceedances of CUG.
Selected wells and COCs are the same as presented in the 2009 Five-Year Review Report.
Data are from Status Reports No. 34 – No. 37.
NS = Not sampled
J = Estimated value less than the laboratory's reporting limit or based on data evaluation of laboratory results.
U = Compound was not detected above the laboratory's reporting limit. Reporting limits may be elevated due to sample dilution.

Approximately 128 groundwater monitoring wells, and 23 extraction wells, were located across the Site prior to ERH remediation. As part of the ERH project, 34 new monitoring wells were installed in the fall of 2010. Eight of these MWs replaced existing wells within the ERH area due to incompatible well construction materials (i.e., those that would not survive the thermal treatment temperatures). These new wells were not sampled as part of the annual groundwater sampling by MassDEP, but were sampled by EPA as part of the ERH remedial action to establish baseline conditions and thereafter to monitor ERH remedy performance.

Table 5. Summary of Groundwater Samples associated with ERH Remedial Action

Sample Dates within FYR period	Number of MWs Sampled	Summarized in Groundwater Sampling Technical Memorandum
November 2010	32	Baseline (Nobis, 2010)
October 2011	31	Round 1 (Nobis, 2011)
December 2011	36	Round 2 (Nobis, 2011)
January 2012	37	Round 3 (Nobis, 2012)
February 2012	36	Round 4 (Nobis, 2012)
March 2012	34	Round 5 (Nobis, 2012)
May 2012	34	Round 6 (Nobis, 2012)
August 2012	34	Round 7 (Nobis, 2012)

The ERH Remedial Action resulted in a significant number of decreases in contaminant concentrations (within the ERH treatment zone). ERH Performance Goals (PGs) were created for "8 key indicator" compounds (based on their frequency of detection, their toxicity, and/or their level of contamination). Groundwater PGs are identical to the groundwater clean-up goals (CUGs) memorialized in the 2008 ESD. Soil PGs were calculated so as not to leach into groundwater and result in a GW PG exceedance.

- During the ERH monitoring period, 1,1,1-TCA concentrations decreased from 10 exceedances of the ERH Performance Goal (PG) to no exceedances in the final sampling round;

- During the ERH monitoring period, Chlorobenzene concentrations decreased from 14 exceedances of the ERH PG to 11 in the final sampling round;

- During the ERH monitoring period, Ethylbenzene concentrations decreased from 6 exceedances of the ERH PG to 0 exceedances in the final sampling round;

- During the ERH monitoring period, PCE concentrations decreased from 14 exceedances of the ERH PG to 7 exceedances in the final sampling round; and

- During the ERH monitoring period, TCE concentrations decreased from 19 exceedances to 11 exceedances in the final sampling round.

Soil

In 2004, as part of the OU2 remedial action, excavation and disposal of contaminated soil from off-property locations was completed. Contaminated soil was excavated, consolidated, and placed under a geosynthetic clay liner on the Silresim property. A vegetative (grass) cover was established in May, 2005. The volume of off-Silresim property soil excavated was 1,983 cubic yards. The excavation depth ranged from one to six feet below ground surface.

Subsurface soil contamination was evaluated as part of the ERH Treatment Zone Evaluation (USACE, 2009). The revised soil CUGs in the 2008 ESD are protective against direct contact, but do not consider groundwater impacts (leaching of contaminated soil). However, the ERH Performance Goals developed for the ERH remedial action were selected so that they would not be a continuing source of groundwater contamination. Soil PGs were calculated using the empirical relationship observed between site soil and groundwater (K_d). The soil PGs were calculated to leave soil sufficiently low levels of contamination that such soil will not lead to exceeding a groundwater PG.

A baseline soil sampling evaluation was conducted prior to the ERH remedial action (Nobis, 2013). Thirteen soil sample locations were selected based on lateral and vertical placement relative to the estimated contaminant mass. A total of 26 samples from 13 borings were analyzed. Post thermal treatment, confirmation soil samples were collected. A total of 91 confirmation samples were collected from 47 locations. The 47 locations included 12 of the original 13 baseline locations and 35 additional locations. Based upon the pre- and post-ERH soil sampling, TCE mass in the soil was estimated to have decreased between 87% and 99% in the 25 months between July/August 2010 and September 2012 at those 12 locations whee both pre- and post-ERH samples were collected.

The prior excavation of off-property soil contamination (OU2) coupled with the final cover construction (in 2013) and recent grading/re-grading activities on the Lowell Iron and Steel property (associated with the ERH remedial action) eliminate incidental exposure to any contaminated surface soils.

Surface Water

The historically low levels of contamination in wells near East Pond strongly suggest that the Site contamination poses very little threat to East Pond. It is worth noting that East Pond is devoid of water through most of the year.

The historically low contaminant concentrations in the region of River Meadow Brook strongly suggest that an insignificant quantity of contamination (levels below site CUGs) is reaching River Meadow Brook (if at all). No surface water samples were collected within the five-year review period.

Indoor Air

A Vapor Intrusion evaluation were completed at LIS and B&L Used Auto Parts. The LIS facility was evaluated first since it was located directly downgradient of the contaminated groundwater plume. The results of this evaluation are documented in the "Final Indoor Air/Vapor Intrusion Assessment for Silresim Superfund Site, Lowell, Massachusetts", December 2004 (TtEC, 2004c). An evaluation of the B&L Used Auto Parts property is documented in a December 3, 2007 Memorandum.

In March 2007, EPA's Office of Site Remediation and Restoration (OSRR) developed a framework to assist in the evaluation of potential vapor intrusion issues at Superfund sites. The framework closely follows the EPA 2002 Draft Vapor Intrusion Guidance. Based on both the regional vapor intrusion approach and the existing national vapor intrusion tools, EPA concluded that further assessment of the LIS and B&L Used Auto Parts buildings to assess the potential for unacceptable indoor air concentrations as a result of contamination from the Silresim Site is not warranted at this time. This conclusion was based on the following:

- The only buildings located within 100 feet of the Silresim VOC contaminated groundwater plume are the LI&S and B&L Used Auto Parts buildings;
- Indoor air sampling performed in the LI&S building concluded that detected concentrations of VOCs in indoor air appear to be at least partially attributable to commercial/industrial activities rather than solely to intrusion of vapors from contamination originating from the Site. This information is summarized in the report prepared by Jacobs-Tetra Tech FW, "Indoor Air/Vapor Intrusion Assessment for the Silresim Superfund Site," October 2004; and
- An inspection performed on the B&L Used Auto Parts building and surrounding property concludes that automobile storage and service activities would impede the ability to collect representative soil gas and indoor air data. It was estimated that approximately 70-80% of the basement floor space was occupied by various stored automobile parts. Staining of the dirt and concrete floor was also observed and a strong petroleum odor was present.

Further assessment of the vapor intrusion (VI) pathway was not recommended unless:

1. Concentrations and/or known toxicity of VOCs in shallow groundwater increase, or the shallow groundwater plume expands beyond the current extent;
2. New buildings are constructed over the plume, or within 100 ft of the plume; and/or
3. Future uses of the LIS or B&L Used Auto Parts properties change to include non-industrial uses, particularly for residential purposes (which are prohibited based on zoning and land use restrictions applicable to a portion of the adjacent properties).

A property use assessment at LIS was documented by EPA in a memo dated April 14, 2008. This assessment was a follow-up to the 2007 Memorandum and the resulting conclusions listed above. The property use assessment concluded that based on the continued lack of utilization of basements as well as the various industrial operations conducted, there is no complete vapor intrusion exposure pathway at any of the LIS properties. An assessment of the LI&S property is conducted annually and the findings reported in annual Groundwater Status Reports.

Site Inspection

A Site Inspection was conducted on November 20, 2013. In attendance were Daniel Keefe, U.S. EPA; Janet Waldron, Mass DEP; Stephen Lefebvre, USACE; Cynthia Colquitt, USACE; and Jonathan Kullberg, USACE. The purpose of the inspection was to observe the various remedy components (notably the GWTP and the Final Cap). The cap was inspected by walking over the surface and perimeter and inspecting its features. Features of the cap included: the cover itself, drainage swales, fences, and access roads. Observations were made regarding the vegetative cover, erosion, settlement, and general condition of the various features.

The Cap surface is in good condition and all slopes appear stable. The areas with vegetated surfaces appeared healthy and dense with full coverage. A stock pile was noted at the southern corner of the property. It measures about 10 feet wide by 30 feet long, 4 feet high, and is covered in vegetation. Also, the project manager for the Site indicated that animal burrows have been observed on the landfill cap in the past. Animal burrows should be filled as necessary as part of normal maintenance.

There is a passive gas vent system in place consisting of 4-inch diameter PVC candy cane vents. The vents were in good condition. The existing gas vent layer, located beneath the clay barrier layer, is vented via horizontal perforated piping that runs to vents that penetrate the existing cap. The final design report for the cap stated: "These vents will be retained/extended in the new cap to continue to vent the cap. No further vapor control was deemed necessary for the Site in this area." The Operation and Maintenance Plan, dated June 2013, does not require monitoring of the passive gas collection system. During the inspection, there was no visible or olfactory evidence of landfill gas emergence at the gas vents.

The drainage system swales are in good condition. The western swale along the treatment plant had some puncture marks (marked with orange paint) where the clay cap had reportedly been punctured by wooden stakes. The holes that were made allowed precipitation to seep down saturating the soil and allowing it to "slump". The puncture locations should be repaired by filling with additional material conforming to the project design specifications for the clay cap material. Additionally, there is a drainage pipe with riprap that has been eroded adjacent to the treatment plant. The riprap should be repaired/replaced.

The access roads were noted to be in good condition. The landfill cap, drainage swales, and access roads are stable and in good repair.

Interviews

During the FYR process, interviews were conducted with parties impacted by the Site, including the local wastewater utility and MassDEP. The purpose of the interviews was to document any perceived problems or successes with the remedy. Interviews are summarized below and complete interviews are included in Appendix D.

An interview was conducted with Janet Waldron, Project Manager from MassDEP on March 7, 2014 via interview questionnaire. An interview was conducted with Mark Young, Manager from the Lowell Regional Wastewater Utility on March 7, 2014 via telephone. Finally, an interview was also conducted with Watermark Environmental, operators of the GWTP.

Ms. Waldron stated that while the ERH did not completely achieve cleanup goals, most locations sampled achieved PRGs for both soil and groundwater, although she believes there is still significant contaminant mass in the deeper portions of the aquifer and other areas where ERH was not implemented. Ms. Waldron stated that it appears that it will require hundreds of years to reach Site cleanup goals throughout the entire plume.

Generally, based on the results of the interviews conducted, implementation of the selected remedy has proceeded without significant issues or concerns.

IV. TECHNICAL ASSESSMENT

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

Yes.

The GWTP continues to operate at a high level of efficiency relative to contaminant removal and runtime (98.9 percent of available runtime during the 2012 reporting period). A total of 2.5 million gallons of contaminated groundwater were pumped and treated through the system during the 2012 reporting period. It is estimated that the GWTP removed approximately 0.54 tons Total Toxic Organics (TTO) (0.73 tons Total Volatile Organics (TVO)) from the Site during the 2012 reporting period. The total estimated mass removed by the GWTP to date (through 2012) is 93.79 tons TTO (113.6 tons TVO) since it began operation in 1995.

The GWTP operated in compliance with all effluent discharge regulations and air emission guidelines throughout the 2012 operations period. Previous review periods within the last five years also show a similarly high percentage rate for runtime. The influent and effluent water is sampled semi-annually to test for discharge permit compliance. The GWTP influent contaminant conditions are a function of the extraction wells that are in operation at the time of sampling. The system effectively removed VOCs from the influent during the five-year review period. Acetone continues to be present in the influent in high concentrations. Given that acetone is a biodegradable compound, the LRWU has accepted acetone in the GWTP discharge. Other samples are collected within the plant to assess treatment equipment performance. These include metals, pH, total dissolved solids (TDS), and total suspended solids (TSS). In addition the Thermal Oxidizer (TOX) emissions are sampled quarterly.

Review of Status Reports and other Site documents indicates that the remedy components that have been completed are functioning as intended by the ROD and the ESDs. The GWTP continues to remove significant quantities of VOCs. Despite the mass removed via pump and treat technology, the plume remains relatively widespread. The most recent CZA (2007) showed incomplete capture from the Central to the North Area in some hydrogeological layers. There may also be an increasing trend in contamination in groundwater in some wells in the North Study Area. A recommendation of this Five Year Review is to conduct comprehensive monitoring with added focus on groundwater conditions in the North Study Area.

During the review period, a more aggressive source control remedy was implemented, specifically ERH remedial action. A primary goal of the ERH RA was to remove as much as possible of the high concentrations of VOCs from the source area, thus shortening the length of time needed to reach groundwater CUGs. Complete clean-up of the entire Site was not envisioned, and it is understood that residual contamination would remain after ERH treatment. Since the completion of the ERH RA, the extraction well network should be re-evaluated in order to optimize capture of the remaining plume (this is a recommendation of this Five Year Review).

The other components of the remedy, institutional controls and the soil cap, are functioning as originally intended. However institutional controls on the Silresim property itself are needed as soon as a viable property owner (possibly the City of Lowell) acquires the now abandoned parcel.

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

No.

Some of the exposure assumptions, toxicity data, and/or cleanup levels in place at the time of the original remedy selection are no longer valid; however, they have been evaluated and updated through one technical evaluation and two ESDs. The RAOs remain valid.

The current CUGs were calculated in the Supplemental Clean-up Goal Evaluation Technical Memo dated May 2008 (TtEC, 2008). These CUGs were memorialized in the September 2008 ESD (USEPA, 2008) and are presented in Tables 1 through 3 in Appendix B. The 2008 revised CUGs presented in Appendix B are protective of utility workers, construction workers, industrial/commercial workers, and trespassers. Prior to the 2008 ESD, a 2003 ESD updated ROD CUGs based on changes in chemical toxicity information as well as a Groundwater Use & Value determination prepared by the MassDEP.

Since the ROD was signed, three exposure pathways have changed. First, the City of Lowell is no longer considering recreational reuse for this property, so this exposure pathway was eliminated during the 2008 CUG recalculations. Second, CUGs in the ROD included a potential railroad worker's exposure, but this exposure scenario was eliminated as it is similar to exposure of a construction or utility worker. Last, based on indoor air sampling at an abutting property as well as observations as part of the Site Inspection for this Five Year Review and annual Status Reports, the indoor air migration pathway is currently considered incomplete, but will continue to be monitored.

Since the ROD was signed, and based on the 2008 Supplemental Clean-up Goal Evaluation, one new contaminant along with its CUGs for surface soil, subsurface soil, and groundwater was added to the list of monitored contaminants (1,4-dioxane). This contaminant was added through the 2008 ESD.

Some toxicity factors for COCs have changed since the ROD was signed. The current toxicity factors for COCs are presented in Appendix B. Toxicity factors which have changed since the last Five Year Review are presented in Table 6. The medium for which each substance has a CUG is also listed in Table 6. In particular, on September 28, 2011, EPA finalized the revised toxicity assessment for TCE with new toxicity values. Based on the new assessment, TCE is more toxic for both cancer and non-cancer health effects. In November 2010 and September 2013, EPA finalized the cancer and non-cancer toxicity assessment for 1,4-dioxane, showing 1,4-dioxane to be more toxic for both cancer and non-cancer effects. EPA's dioxin reassessment has been developed and undergone review for many years, with participation of scientific experts in 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, EPA released the final human health non-cancer dioxin reassessment, publishing an oral non-cancer toxicity value, or reference dose (RfD), of $7x10^{-10}$ mg/kg-day for 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in EPA's Integrated Risk Information System (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. These particular changes to the toxicity values of TCE, 1,4-dioxane, and 2,3,7,8-TCDD would result in an increase of estimated Site risks. On February 10, 2012, EPA also finalized the revised toxicity assessment for PCE. Based on the new assessment, PCE is more toxic for cancer effects but less toxic for non-cancer health effects. In 2014, EPA finalized a Directive to update standard default exposure factors and frequently asked questions associated with these updates. Many of these exposure factors

differ from those used in the risk assessment for the 1991 ROD. These changes, in general, would result in a slight decrease of the risk estimates for most chemicals. Although calculated risks from potential exposure pathways at the Site may differ from those previously estimated, higher for some contaminants and lower for a few others, the revised methodologies themselves are not expected to affect the protectiveness of the remedy.

The toxicity changes for TCE, 1,4-dioxane, PCE, and 2,3,7,8-TCDD and the updated standard default exposure factors are considered in reviewing the soil and groundwater CUGs for these contaminants presented in the 2008 ESD to ensure that the revised CUGs are still protective of human health. The toxicity changes for a few other contaminants are not significant to affect the estimated risks and CUGs.

Review of 2008 soil CUGs:
Using the new TCE oral cancer slope factor value of 4.6E-02 $(mg/kg\text{-}day)^{-1}$ and the reference dose value of 5.0E-04 mg/kg-day with the updated standard default exposure factors for workers, a TCE soil level of 6 mg/kg is associated with a 1E-06 cancer risk level and a soil level of 18.7 mg/kg is associated with a hazard index (HI) level of 1. Using the ratio approach, the TCE soil CUG of 81 mg/kg would result in a cancer risk level of 1E-05 and an HI of 4, which exceeds the acceptable HI level of 1. However, TCE (among other contaminants) from off-property locations were excavated as part of the OU2 remedy and the soil relocated onto the Silresim property. This contaminated soil has since been included under the recently constructed Final Cover. Further inhibiting potential exposure are the Institutional Controls (ICs) which have been recorded against each of the abutting property deeds. These ICs require notice be given to EPA prior to any new construction activities. Future construction on the Silresim property is unlikely (due to the GWTP and elements of the final cover). However, if any construction were planned, it would be subject to yet to be recorded property use restrictions (ICs) that would preserve the protectiveness of the Final Cover.

Using the new 1,4-dioxane oral cancer slope factor value of 1.0E-01 $(mg/kg\text{-}day)^{-1}$ and the reference dose value of 3.0E-02 mg/kg-day with the updated standard default exposure factors for workers, a 1,4-dioxane soil level of 23 mg/kg is associated with a 1E-06 cancer risk level and a soil level of 2.47E+04 mg/kg is associated with an HI of 1. Using the ratio approach, the 1,4-dioxane soil CUG of 260 mg/kg would result in a cancer risk level of 1E-05 and an HI of less than 1, which is acceptable and protective of human health.

Using the new PCE oral cancer slope factor value of 2.1E-03 $(mg/kg\text{-}day)^{-1}$ and the reference dose value of 6.0E-03 mg/kg-day with the updated standard default exposure factors for workers, a PCE soil level of 103 mg/kg is associated with a 1E-06 cancer risk level and a soil level of 388 mg/kg is associated with an HI of 1. Using the ratio approach, the PCE soil CUG of 210 mg/kg would result in a cancer risk level of 2E-06 and an HI of less than 1, which is acceptable and protective of human health.

The soil 2,3,7,8-TCDD CUG of 0.003 mg/kg (3 ppb) was developed based on cancer effects, using the CalEPA oral cancer slope factor value. With the 2012 non-cancer reference dose value of 7.0E-10 mg/kg-day (0.7 pg/kg-day) and the updated standard default exposure factors for workers, a soil level of 0.000727 mg/kg (727 ppt) is developed. This level is associated with an HI level of 1 and a cancer risk level of 3E-05, which is acceptable to EPA. Using the ratio approach, the 2,3,7,8-TCDD CUG of 3 ppb would result in an HI of 4 and a cancer risk level of 1E-4. It is not protective of non-cancer health effects since the HI exceeds the acceptable HI level of 1. However, 2,3,7,8-TCDD (among other contaminants) from off-property locations were excavated as part of OU2 remedy and the soil relocated onto the Silresim property. This contaminated soil has since been included under the recently

constructed Final Cover. Further inhibiting potential exposure are the Institutional Controls (ICs) which have been recorded against each of the abutting property deeds. These ICs require notice be given to EPA prior to any new construction activities. Future construction on the Silresim property is unlikely (due to the GWTP and elements of the final cover). However, if any construction were planned, it would be subject to yet to be recorded property use restrictions (ICs) that would preserve the protectiveness of the Final Cover.

On December 31, 2012, EPA finalized the OSWER Directive Compilation and Review of Data on Relative Bioavailability of Arsenic in Soil and Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil Documents. Based on this Directive, arsenic was found to be less bioavailable via soil ingestion relative to other analytes. A default relative bioavailability factor of 60% is now applied for soil and sediment ingestion risk calculation and developing cleanup levels. Since Silresim has surface soil arsenic cleanup level based on risk, this level (if revised) would be less stringent than the 2008 CUG.

Review of 2008 groundwater CUGs:
Groundwater is not used for drinking at the Site under current and future scenarios. The MassDEP has classified the underlying aquifer as a Non-Potential Drinking Water Source Area due to its concentrated industrial development. Further, classification of the majority of the area is low yield non-drinking water. Construction workers and utility workers can be exposed to groundwater incidentally in trench or during open excavation via dermal absorption and inhalation of volatiles in groundwater. Since the groundwater exposures to these workers during their activities at the Site are incidental and minimal, it is likely that the changes in dermal and inhalation toxicity values as well as the updated standard default exposure factors for workers scenario will not make any difference to the 2008 groundwater CUGs. The groundwater CUGs are still protective of construction workers and utility workers.

As discussed in Section III/Data Review, the progress towards meeting the RAOs was not well documented during this five year review period due, in part, to the multi-year implementation for the combined ERH and Capping Remedial Action (2010 – 2013). However, based on the recent ERH project completion, final cap completion, and continued GWTP operation, and ongoing operation and maintenance, the remedy remains currently protective of human health and the environment.

Table 6
Summary of Toxicity Factor Changes
Between 2009 and 2014 Five Year Reviews

Substance	Potential Exposure Medium	Date	RfD_{oral} (mg/kg -day)	RfC ($\mu g/m^3$)	CSF_{oral} $(mg/kg\text{-}day)^{-1}$	Unit Risk $(\mu g/m^3)^{-1}$
*cis*1,2-Dichloroethene	Groundwater	9/30/10(2)	2.0E-03(2)			
1,4-Dioxane	Groundwater, surface & subsurface soil	8/11/10(2),9/20/13(2),9/20/13(2)	3.0E-02(2)	3.0E+01(2)	1.0E-01(2)	5.0E-06(2)
Hexachlorobutadiene	Groundwater	7/3/10 (1)	1.0E-03(1)			
Methylene Chloride	Groundwater, subsurface soil	11/18/11(2)	6.0E-03(2)	6.0E+02(2)	2.0E-03(2)	1.0E-08(2)
2,3,7,8-TCDD	Surface soil	2/17/12(2)	7.0E-10(2)			
1,2,4-Trichlorobenzene	Groundwater, subsurface soil	6/16/09(1)		2.0E+00(1)	2.9E-02(1)	
1,1,2,2-Tetrachloroethane	Groundwater	9/30/10(2)	2.0E-02(2)		2.0E-01(2)	
Trichloroethene	Groundwater, surface & subsurface soil	9/28/11(2)	5.0E-04(2)	2.0E+00(2)	5.0E-02(2)	4.0E-06(2)

Notes:

RfD_{oral} - Reference Dose for chronic exposure used to estimate noncancer adverse health effects resulting from oral exposure.
RfC - Reference Concentration for chronic inhalation exposure used to estimate noncancer adverse health effects resulting from inhalation exposure.
CSF_{oral} - Cancer Slope factor used to estimate cancer health effects resulting from oral exposure.
Unit Risk – Inhalation Unit Risk used to estimate cancer health effects resulting from inhalation exposure.

(1) PPRTV – Provisional Peer Reviewed Toxicity Values (USEPA)
(2) IRIS – Integrated Risk Information System

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

No.

Technical Assessment Summary

Review of Status Reports and other Site documents and the groundwater monitoring data, indicate that the remedy components are functioning as intended by the ROD (1991) as amended by two ESDs (2003 and 2008). However, the groundwater portion of the remedy will not meet the RAOs within a reasonable time (i.e., is greater than 30 years) based on prior flushing model projections (2009). Based on absence of recent monitoring well data (post ERH treatment) it is difficult to assess the effectiveness of the existing extraction well network and recent mass removal rates. The most recent capture zone analysis (CZA) in 2007 showed incomplete capture from the Central Study Area to the North Study Area. This area needs to be monitored more closely as recommended in this FYR. The other components of the remedy (namely Institutional Controls and the final cover), are functioning as originally intended. However, updated institutional controls may need to be implemented to reflect current land use and ownership. No Institutional Controls have been recorded with regard to the Silresim property itself; however, continued occupation of the Site by the GWTP and regular personnel visits (by GWTP staff and/or MasssDEP) ensures against inappropriate property use or unintended development.

V. ISSUES/RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Table 7: Issues and Recommendations/Follow-up Actions

OU #	Issue	Recommendations/ Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness? (Y/N)	
						Current	Future
1	Unconsolidated soil adjacent to sewer lines in the North Study Area may serve as a preferential pathway for contaminated groundwater.	Check on depth of trench and/or pipe and compare to elevation of groundwater contamination migrating from the Site. Collect samples from adjacent to pipe(s).	State	EPA	12/31/2015	No	Yes
1	Increasing contaminant trends in some monitoring wells in the North Study Area.	Increase frequency of data collection to verify recent results and evaluate the need for additional extraction and monitoring wells. Update Capture Zone Analysis.	State	EPA	12/31/2015	No	Yes
1	Institutional Controls needed for Silresim Property.	ICs should be recorded against the Silresim property deed as soon as a viable owner takes title to the property.	EPA/State	EPA	9/1/2019	No	Yes
1	Vapor intrusion is a potential concern in areas north of the site.	Continue periodic assessments of abutting property uses, zoning, and groundwater monitoring data as they relate to the potential for vapor intrusion into indoor air.	MassDEP	EPA	9/1/2019	No	Yes

VI. PROTECTIVENESS STATEMENT

Protectiveness Statement(s)		
Operable Unit: 1	*Protectiveness Determination:* Short-term Protective	*Addendum Due Date (if applicable):*
The remedy at OU1 is currently protective of human health and the environment because the Groundwater Pump and Treat (GWPT) system continues to collect and treat groundwater, institutional controls for the majority of the Site remain in place, and periodic assessments of abutting properties are conducted to evaluate potential indoor air receptors for vapor intrusion. However, in order for the remedy to be protective in the long-term, the following actions need to be taken to ensure protectiveness: further evaluation of contamination in vicinity of sewer pipeline; additional data collection and evaluation of capture and extraction well network; completion of Institutional Controls on the Silresim property; and, continued periodic assessments of abutting property uses and groundwater monitoring data as they relate to the potential for vapor intrusion into indoor air.		

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date (if applicable):*
2	Protective	
The remedy at OU2 is protective of human health and the environment because all construction activities for the Off-Property Soil Excavation were completed in May 2005. Excavated soil has been moved onto the Site and covered by the newly constructed clay cap.		

Site-wide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):*
Short-term protectiveness has been achieved through the operation of the Groundwater Pump and Treat system; the construction of a the final cover; the adoption of institutional controls; and periodic assessment of abutting properties for potential vapor intrusion. However, because the remedial action at OU1 is not yet protective in the long-term, the Site is not protective of human health and the environment in the long-term until follow-up actions noted above for OU1 are completed.	

VII. NEXT REVIEW

The next five-year review report for the Silresim Superfund Site is required five years from the completion date of this review.

References

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APPENDIX A – EXISTING SITE INFORMATION

A. SITE CHRONOLOGY

Table 1: Site Chronology

Event	Date
Facility used as oil and fuel storage depot.	1916-1971
Facility used for chemical waste reclamation and later for hazardous waste collection and treatment by Silresim Chemical Corporation.	1971-1977
Silresim bankrupt, facility abandoned.	1978
Over 30,000 drums were removed from the Site.	1981-1982
Facility listed on National Priorities List by USEPA.	1983
Site structures removed, security fence extended, and clay cap installed.	1984
Remedial Investigation/Feasibility Study (RI/FS) process initiated by 185 PRPs (Silresim Site Trust).	1985
RI/FS and Risk Assessment completed.	1990
Record of Decision (ROD) issued by USEPA.	1991
Construction of Groundwater Treatment Facility begins.	1994
Groundwater Treatment Facility begins continuous operation.	1995
Soil Vapor Extraction Pilot Test completed.	1996
Cap upgrade and drainage improvements completed.	1998
State determination that the groundwater is not suitable as a drinking water source.	1998
Phase I Soil Vapor Extraction Operations completed.	1999
First Five-Year Review completed	1999
ERH Pilot Test completed.	2003
Explanation of Significant Differences (ESD) completed (amending clean-up goals and creating OU No. 2 for off-property soil contamination).	2003
Groundwater Flushing model completed.	2004
Second Five-Year Review completed.	2004
Off-site surface soil contamination relocated and disposed of on the Silresim Property.	2004
GWTP Operation and Maintenance (O&M) transferred from USEPA to the Commonwealth of Massachusetts.	2007
ESD completed identifying ERH as the preferred Source Control Remedy.	2008
Final Cap Design completed.	2008
Final ERH Treatment Zone Evaluation (i.e. Remedial Design) completed.	2009
Third Five-Year Review Completed.	2009
ERH Remedial Action implemented.	2010-2013
Capping Remedial Action implemented.	2010-2013
Fourth Five-Year Review completed (this report).	2014

B. BACKGROUND

This section includes the Site's physical characteristics and resources potentially affected by the Site as well as contamination history. The initial response discussing the sequence of events leading to the NPL listing of the Site and the ROD are also discussed in this section. The final sub-section lists the chemicals in each media which required remediation.

Physical Characteristics

The Site (inclusive of the extent of groundwater contamination) is comprised of approximately 16 acres in an industrial area of Lowell, Massachusetts (Figure 1). The 4.5-acre Silresim property, outlined by the fence line in Figure 2, was formerly owned and operated by the Silresim Chemical Corporation (Silresim) at 86 Tanner Street, and groundwater and soil contamination extend to other adjacent properties. The property is bordered by the Lowell Iron & Steel (LIS) Company to the north, the Boston and Maine (B&M) railroad yard and tracks to the east/northeast, an automobile salvage yard to the south and Tanner Street to the west. Residential areas are located south, east, and northeast of the Silresim property, with the closest residences located on Canada, Main, and Maple Streets, roughly 300 to 500 feet from the Silresim property. River Meadow Brook is located approximately 400 feet west of the Silresim property and flows northeast and discharges into the Concord River. East Pond, a small, surface water body, is located about 300 feet to the east of the Silresim property.

An 84-inch diameter interceptor sanitary sewer is located north of the Site. The interceptor sewer is brick-lined, has an invert elevation of approximately 76.6-feet msl and trends approximately east-west. A smaller 52-inch by 38-inch oval brick sanitary sewer is located west of the Site. The smaller sewer is located beneath Tanner Street, has an invert elevation of approximately 91-feet msl, and trends northeast-southwest.

An 8-foot high chain link fence surrounds the Silresim property. Most of the land surface within the fence is covered with a clay cap. Crushed stone has been placed on runoff areas along the northern and southern perimeter of the Silresim property to prevent direct contact with dioxin contaminated soils. The groundwater treatment plant (GWTP) required by the 1991 Record of Decision (ROD) occupies the central portion of the property and began operations in 1995. The 10-year long-term remedial action (LTRA) period expired on September 24, 2007 and operation of the treatment plant has since been transferred to the Commonwealth of Massachusetts acting through the Massachusetts Department of Environmental Protection (MassDEP).

Hydrology

Geology consists of alternating layers of sandy silt and silt with thin clay layers (varves), overlying till, over bedrock. Bedrock is on the order of 100 feet (ft) below ground surface (bgs) under most of the Site, but rises to shallower depths north of the Site. The Site is located over the buried pre-glacial Merrimack River bedrock valley, which passes from west to east in this area.

The conceptual model of the Site consists of six hydrostratigraphic layers numbered 1 through 6 from the surface downward. The cross section of the six layers are shown on Figure 5. The six layers are based on the Site's sediment textures, stratigraphy and depth to bedrock. The following are descriptions of the layers:

Layer 1 is the uppermost layer (10 – 15 feet bgs), terminating at a lower elevation of 95 feet NGVD (where NGVD stands for the National Geodetic Vertical Datum). This layer is primarily fine sand or fill.

Layer 2 extends from elevation 95 feet NGVD downward to 75 feet NGVD. Layer 2 is characterized by varved clayey lacustrine silt deposited in a glacial lake quiet water environment. In general, this layer is characterized by low hydraulic conductivities and high anisotropy ratios meaning the vertical hydraulic conductivity is much lower than the horizontal hydraulic conductivity. The clay varves (layers) are absent north of the site, representing either a slightly different depositional environment lacking a cyclical deposition of finer-grained material, or possibly some degree of later reworking of material in this area by glacial meltwater stream flows.

Layer 3 extends from 75 feet NGVD downward to 50 feet NGVD. This layer is primarily silty fine sand in the southern and central portions of the Site and fine sand in the northern portion of the Site. This layer has the highest hydraulic conductivities at the Site.

Layer 4 extends from 50 feet NGVD downward to 20 feet NGVD and consists of varved clayey lacustrine silt similar to Layer 2. This layer has a low hydraulic conductivity and high anisotropy ratios.

Layer 5 is a layer of till, typically on the order of 15 feet thick, lying below Layer 4 on top of the bedrock surface, from elevation 20 feet NGVD to 5 feet NGVD.

Layer 6 is defined by the bedrock underlying the entire Site below 5 feet NGVD.

Land and Resource Use

The City of Lowell considered the future use of the Silresim property and determined it is most-likely to be commercial/industrial as are the properties which abut the site. This was memorialized in a letter to EPA from the City Manager dated June 2007. Accordingly, recreational use of the site is no longer being considered. The commercial/industrial properties surrounding the Silresim property also are expected to continue to be used for similar purposes in the future; however, future redevelopment of these properties is possible, including the construction of new buildings. Groundwater is assumed to remain unused for consumptive and non-consumptive purposes. In regard to abutting properties, institutional controls (ICs) were obtained in the form of property restrictions contained in easements obtained by the PRPs in 1995. In general, for all the adjacent properties, the restrictions prohibit any groundwater withdrawal for drinking water purposes and require that prior to any construction activities or activity that would withdraw groundwater, the property owner shall notify EPA.

Shallow groundwater flows radially from a mound typically located near the northeast corner of the fenced area of the Site. At depth, the predominant groundwater flow direction at the Site is to the north and northwest. River Meadow Brook is the most-likely surface water discharge point for site groundwater. There are no known public or private wells in the surrounding area. MassDEP completed a groundwater use and value determination consistent with the EPA's 1996 Final Groundwater Use and Value Determination Guidance. The MassDEP determined a "low" use and value for the groundwater beneath the Site.

There has been a change in property ownership since the last review. The owner of Lowell Iron and Steel now also owns the Boston and Maine Railroad property.

Infrastructure improvements along Tanner Street have been evaluated. One such project was the Innovative Storm Water Project (Watermark, 2007). The object of the design was to improve the storm water drainage system in the Tanner Street area. Three different methods of final cap construction are described in the Final Cap Evaluation Report and reflect input from the city of Lowell regarding possible future land use (TtEC, 2007). The Miserlis family (the original owners of the Silresim property) still owns the entire Silresim property and is delinquent in payment of real estate taxes.

History of Contamination

The Site and its surrounding areas have been used for industrial activities since the early 1900s. From 1916 to 1971, several petroleum companies used the property as an oil and fuel storage depot. Adjacent parcels have contained oil storage terminals, a foundry, steel fabrication equipment, a sales facility for used auto parts, coal storage facilities and railroad operations. From 1971 through 1977, Silresim operated its chemical waste reclamation facility. The facility's primary operations included recycling and reclaiming various chemicals and consolidating wastes for off-site disposal. The Massachusetts Division of Water Pollution Control (DWPC) granted the facility a hazardous waste collection and disposal permit in 1973. Wastes were accepted at the facility in drums, tank trucks, railroad tanker cars, and other containers. These substances included halogenated solvents, oily wastes, alcohols, plating wastes, metal sludge, and pesticide wastes. Although exact figures do not exist, it is estimated that the facility handled approximately 3 million gallons of waste per year.

Silresim filed for bankruptcy in late 1977 and abandoned the facility in January 1978, leaving behind approximately one million gallons of hazardous materials in drums and bulk tanks, including almost 30,000 decaying drums covering virtually all open areas of the 4.5-acre Silresim property.

Typically, the highest levels of contamination are concentrated in a thin layer (typically 2-ft thick) just at the water table, sorbed to the fine-grained material at the top of a varved clay layer. The water table typically occurs at a depth of about 10 ft bgs. An area north of the existing groundwater treatment plant has been characterized as having deeper migration of contaminants (to depths of at least 50 feet). Groundwater flow is radial in the shallow zone, from a high located in the northeast corner of the site, and then at greater depth joins regional flow patterns from south to north. Free product (non-aqueous phase liquid or "NAPL") has been reported in several Site wells.

Initial Response

From 1978 to 1982, DWPC erected a fence around the Site, hired a 24-hour guard, removed liquid wastes in drums and aboveground tanks, constructed berms and absorbent-filled trenches to reduce the spread of waste through surface runoff, and conducted a series of studies of Site soils and groundwater.

In 1982, EPA proposed the Site for inclusion on the National Priorities List (NPL) and the Site was subsequently listed on the NPL in 1983. In 1983, EPA sampled air, soils and groundwater and found contamination both on and off the Silresim property. In 1984, EPA raised the height of the fence and covered the Silresim property with 9 inches of crushed gravel and a clay cap. Subsequent sampling revealed an additional area of soil contamination that was secured by extending the fence to prevent exposure. In 1986, EPA identified dioxin and the fence was reconstructed to prevent access by the public, and a gravel cover was placed over the dioxin-contaminated soil to prevent exposure by direct contact.

Between 1985 and 1990, Remedial Investigation (RI) and Feasibility Study (FS) activities were conducted to further characterize the Site. The RI assessed the type and extent of contaminants present

and included human health and ecological risk assessments. Field activities conducted as part of the RI included monitoring well installation and the collection and analysis of groundwater, soil, sediment, surface water, and air samples. Volatile organic compounds were the primary contaminant type identified. Other contaminants which were identified included: semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, herbicides, pesticides and dioxin. Subsequent risk assessments were completed which evaluated the potential impacts from Site contaminants to human health and the environment.

In September 1991, EPA issued the ROD for the Site. The comprehensive remedy selected in the ROD called for in-situ soil-vapor extraction (SVE). Soils with residual contamination would be consolidated, stabilized, and capped on-site. Contaminated groundwater would be extracted and treated by metals removal, air stripping, and vapor treatment prior to discharge to the City sewer system. In early 1993, a Consent Decree between EPA and a group of potentially responsible parties (PRPs) was executed. Under this Consent Decree, the PRPs provided approximately $41 million in clean-up funding for the Site of which approximately $28 million was identified for Remedial Action and $13 million was given to the Commonwealth for long-term operation and maintenance (O&M) of the GWTP and cap.

Construction of the GWTP began in 1994 and groundwater extraction and treatment has been underway since November 1995. Initial response actions, including the installation of fencing and covering areas of contamination, have reduced the potential for accidental exposure and further migration of contaminated soils. Approximately 2,000 cubic yards of surface soil contamination at off-property locations was consolidated onto the Silresim property and placed under an interim cap; this work was completed in 2005.

Basis for Taking Action

Hazardous substances that have been released at the Site in each media include:

Surface Soil	Subsurface Soil	Groundwater
1,1,2,2-Tetrachloroethane	Benzene	Vinyl Chloride
Trichloroethene	Chlorobenzene	Acetone
1,2,4-Trimethylbenzene	Chloroform	1,1-Dichloroethene
1,3,5-Trimethylbenzene	1,2-Dichloroethane	Methylene Chloride
Benzo(a)anthracene	1,1-Dichloroethene	1,2-Dichloroethene (total)
Benzo(a)pyrene	Ethylbenzene	cis-1,2-Dichloroethene
Benzo(b)fluoranthene	Methylene Chloride	Chloroform
Dibenz(a,h)anthracene	Styrene	1,1,1-Trichloroethane
Hexachlorobenzene	1,1,2,2-Tetrachloroethane	1,2-Dichloroethane
1,2,4-Trichlorobenzene	Tetrachloroethene	Benzene
2,3,7,8-Tetrachloro-dibenzo-	Toluene	Trichloroethene
pdioxin equivalents	1,1,1-Trichloroethene	1,1,2-Trichloroethane
PCBs (Aroclors 1242 & 1254)	1,1,2-Trichloroethane	Tetrachloroethene
Arsenic	Trichloroethene	Chlorobenzene
Lead	Vinyl Chloride	Ethylbenzene
Mercury	1,2-Dichlorobenzene	1,1,2,2-Tetrachloroethane
	Hexachlorobenzene	Naphthalene
	Naphthalene	1,2,4-Trichlorobenzene
	2,3,7,8-Tetrachloro-dibenzo-	Arsenic
	pdioxin equivalents	Cadmium

	PCBs (Aroclor 1242) 1,2,4-Trichlorobezene Lead Mercury	Lead Nickel

C. REMEDIAL ACTIONS

Remedy Selection

The original remedy in the ROD is comprehensive consisting of both SC and MOM components. Each is discussed in more detail below. There are phases of remedial action that have been completed. To address the surficial soils off-property containing VOCs and non-VOC contaminants above cleanup levels, excavation of off-site soils was completed in the Fall of 2004. Surficial soils contaminated with VOCs were excavated to a depth of one foot. Soils contaminated with non-VOCs above MassDEP Upper Concentration Limits were excavated from several "hot spot" areas from depths greater than 1 foot. This activity was designated as OU2 in the 2003 Explanation of Significant Differences (ESD). The excavation and management of off-site contaminated soil is documented in a September 29, 2005 letter and a report attached to that letter entitled "Interim Remedial Action Report Source Removal OU2 Surficial Soils" (USEPA, 2005).

Source Control

Source control activities specified in the ROD included the construction, start-up, and operation of a Soil Vapor Extraction (SVE) system to remove VOCs from unsaturated zone soils. Air permeability and SVE pilot tests were conducted at the Site from July 1995 to December 1996. SVE pilot tests were conducted using three techniques: conventional SVE, heated air injection, and high vacuum or multiphase SVE. In general, extracted vapor flow rates for the extraction wells (< 9 standard cubic feet per minute) and radii of influence (< 2-3 feet at some locations) were less than expected. A Phase I SVE program focusing on maximizing the removal of VOC mass was implemented from October 1998 through December 1999. This resulted in the removal of an estimated 12 tons of VOCs from the subsurface. However, the effectiveness of the SVE system was limited because the Site was not sufficiently de-watered, soil moisture content was high, and low permeability soils were encountered. It was subsequently concluded that conventional SVE would be unable to significantly reduce groundwater clean-up time frames. Accordingly, operation of the SVE system was terminated.

The 1991 ROD also specified that the final cap would be constructed using a design consistent with State and Federal closure requirements for a RCRA facility. As discussed in the Final Cap Design report dated September 2008 (TtEC, 2008), protection of human health and the environment can be achieved by substantively meeting the performance requirements of an Engineered Barrier (a man-made structure that typically includes an earthen cover and that is intended to meet the performance objectives) as defined by 310 Code of Massachusetts Regulations (CMR) 40.996(4)(c).

An Engineered Barrier that is protective of human health and the environment was constructed on the Silresim property. As defined in 310 CMR 40.996(4)(c), an Engineered Barrier means a permanent cap with or without a liner that is designed, constructed, and maintained in accordance with scientific and engineering standards to achieve a level of no significant risk for any foreseeable period of time. The final cover remediation project was constructed beginning 2011 and was substantially complete in 2012. The Final Inspection occurred in 2013 thus beginning O&M requirements for MassDEP.

Management of Migration

The ROD outlined the following objectives for the GWTP to extract and treat the contaminated groundwater:

- Manage the migration of contaminated groundwater toward downgradient receptors of local building basements, River Meadow Brook, and East Pond;
- Capture as much of the contaminated plume as possible; and
- Drawdown the groundwater across the Site to support the Source Control (SC) remedy. (The drawdown of groundwater across the Site was ineffective and consequently the original SVE SC remedy was ruled out.)

Remedy Implementation

Source Control

To address the lack of effectiveness of the selected SC remedy and the long timeframe of pump and treat remediation required, an evaluation of alternative methods of treatment was performed. Several technologies were considered. However, only Electrical Resistance Heating (ERH) was considered as a viable option for a pilot test. ERH is a thermally-enhanced application of SVE that employs electrical current to heat both the underlying soil and groundwater. This heating of the contaminated media liberates substantially more contamination which can then be captured, treated, and/or destroyed.

ERH was pilot tested from October 2002 to January 2003. The results of the pilot test concluded that, while it may be a substantially long time (> 100 years) to meet groundwater clean-up goals for all contaminants in all layers beneath the Site, a significant reduction for the majority of contaminants can be achieved for most substances in the most-contaminated layers. Based upon the evaluation, the first significant change memorialized by the 2008 ESD was the substitution of thermally-enhanced SVE such as ERH to replace traditional SVE as the cleanup technology for soil.

A pilot test of ERH conducted on LI&S for 90 days removed 1,500 pounds of VOCs and reduced shallow groundwater VOC contamination by greater than 99%. The additional source removal might also help achieve cleanup goals in areas of the site that are downgradient from the most-contaminated areas of the Site, and more easily ensure that the plume is contained on the Silresim property itself.

A Final ERH evaluation and remedial design for this technology was completed by the U.S. Army Corps of Engineers (USACE). This evaluation included an assessment of the cost-benefit of various ERH implementation scenarios. The benefit is quantified both in terms of cost per pound [of VOC] removed, as well as the potential anticipated savings associated with a reduced timeframe in which the GWTP will need to operate. The complete ERH evaluation is in the "Final Technical Memorandum Treatment Zone Evaluation for Silresim Superfund Site, Lowell, Massachusetts" dated April 19, 2009.

The Electrical Resistance Heating (ERH) remediation project was from July 2010 to June 2013. The ERH remedy consisted of subsurface heating through electrodes, vapor extraction, and groundwater extraction and removed an estimated 55,880 to 91,080 pounds of VOCs.

Another change documented in the 2008 ESD with respect to SC is the ROD's provision for the stabilization/solidification of up to 18,000 cubic yards of soil. As part of the recent evaluation of the design for the final cap at the site, EPA determined that the anticipated cap design is sufficient to reduce

contaminant mobility and comply with applicable and/or relevant and appropriate requirements and that the additional reduction to contaminant mobility afforded by stabilization is not required.

Management of Migration

The groundwater extraction system has been unable to achieve the original drawdown objective across the Site (as contemplated in the ROD). However, the GWTP continues to operate and remove significant quantities of VOCs. Based on the most recent comprehensive groundwater sampling report, Draft Status Report 37 (Watermark, 2013), approximately 1,460 pounds of total volatile organics were removed during the period from February 6, 2012 to February 5, 2013; the total quantity of volatiles removed since the plant's construction is 113.5 tons. The National Priorities List (NPL) geographically defines the Silresim Site as the extent of contamination that includes approximately 16 acres containing groundwater contamination (USEPA, 1991). Despite mass removal via pump and treat technology and ERH, the plume remains relatively widespread and includes both on- and off-property locations.

Status Report 37 summarizes the current MOM trends (Watermark, 2013). Overall, the contaminant concentrations observed in the monitoring wells located in the surrounding study areas appear to be primarily stable or decreasing with the exception of one well (MW-803-2-80) in the North Study Area. The contaminant concentrations (mainly acetone) in MW-803-2-80 appear to increase during winter months or oscillate between lower summer values and higher winter values. Concentrations in excess of the Site's CUGs were measured in three of the five wells sampled in the North Study Area during the December 2012 sampling event.

Continued treatment via groundwater pump and treat is required. Based on a report entitled Evaluation of Future Groundwater Flushing (March 2004), it was anticipated that in the absence of any additional Source Control remedy, attainment of groundwater clean-up goals utilizing Pump and Treat (P&T) technology alone may take several hundred years. Estimated timeframes to reach cleanup goals for certain contaminants was dramatically reduced as reported in the ERH Final Treatment Zone Evaluation.

System Operation/Operation and Maintenance

The primary goal of the GWTP is to manage the migration of contaminated groundwater as required in the ROD. This includes maintaining a constant hydraulic gradient in the direction of the extraction wells in order to reduce the migration of the contaminant plume from the Site.

The GWTP continues to be effective in the removal of contaminants from the waste stream and continues to meet all water and air discharge requirements. The water is discharged to the Lowell Regional Wastewater Utility (LRWU). The VOC discharge concentrations are based on a monthly limit of 2.13 ppm total volatile organics (TVO).

Regular O&M of the GWTP has allowed operational runtime to be maximized. Major O&M changes implemented during this five-year period include:

- Monthly GWTP influent and effluent sampling was reduced to bi-monthly sampling in July 2009 due to previous consistent results.
- Monthly thermal oxidation air testing was also reduced to bi-monthly sampling in July 2009 due to previous consistent results.
- During October 2010 eight extraction wells were taken off-line due to the construction and operation of the ERH system. During October 2011 an additional 14 extraction wells were taken

off-line due to the construction and operation of the ERH system. Only extraction well EW-31 remained operational during ERH operations. During August 2012 eight extraction wells were reactivated following completion of ERH operations. The eight extraction wells are: EW-2, EW-3, EW-8, EW-12, EW-13, EW-20, EW-21 and EW-26.

- Extraction well EW-17 remains inactive due to a damaged well screen.

A Capture Zone Analysis (CZA) has not been conducted for this 5-year period and was scheduled for late 2013 or early 2014. The most recent CZA was included in Status Report 26 (Watermark Environmental, 2005 (August 6, 2004 – February 5, 2005) and Status Report 30 (Watermark Environmental, 2007a (August 6, 2006 – February 5, 2007). In both reports, the CZA indicated there was "incomplete capture from the Central to the North Area in layers 1, 2 and 3". In regard to the West Area, Status Report 26 indicated there was "incomplete capture from the Central to the West Area in layers 1, 2 and 3," however; the more recent CZA done for Status Report 30 indicated that "capture is present in all layers located in this area". In both reports complete capture was demonstrated from the Central to the South Area and from the Central to the East Area.

Table 2. Annual system operations/O&M Costs.

Dates		Total Estimated Cost
From	**To**	
July 2009	June 2010	$924,000
July 2010	June 2011	$883,000
July 2011	June 2012	$800,000
July 2012	June 2013	$1,100,000
July 2013	January 31, 2014	$493,000*

- Costs are not inclusive of DEP staff costs.

* Partial year only.

APPENDIX B – ADDITIONAL TABLES

TABLE 1
REVISED CLEAN-UP GOALS FOR SURFACE SOIL
SILRESIM SUPERFUND SITE, LOWELL, MASSACHUSETTS

Chemicals of Potential Concern	Current Silresim CUG from 2003 ESD (1) (mg/kg)	Risk-Based CUG for Surface Soil (2) (mg/kg)	MassDEP Method 3 Upper Concentration Limits (3) (mg/kg)	**Revised Site-Specific Surface Soil CUG (4) (mg/kg)**	Basis for Value
1,1,2,2-Tetrachloroethane	20	23	400	**23**	Risk-Based
Trichloroethene (5)	190	81	10,000	**81**	Risk-Based
1,2,4-Trimethylbenzene	73	73	-	**73**	Risk-Based
1,3,5-Trimethylbenzene	17	18	-	**18**	Risk-Based
Benzo(a)anthracene	50	50	3,000	**50**	Risk-Based
Benzo(a)pyrene	5	5.0	300	**5.0**	Risk-Based
Benzo(b)fluoranthene	50	50	3,000	**50**	Risk-Based
Dibenz(a,h)anthracene	5	5.0	300	**5.0**	Risk-Based
1,4-Dioxane	-	260	-	**260**	Risk-Based
Hexachlorobenzene	15	15	300	**15**	Risk-Based
1,2,4-Trichlorobenzene	18	150	9,000	**150**	Risk-Based
Arsenic	30	30	200	**30**	Risk-Based
Lead (6)	448	232	3,000	**380**	BKGD
Mercury	0.8	0.80	300	**0.80**	Risk-Based
2,3,7,8-TCDD (7)	0.0002	0.00034	0.003	**0.003**	MCP-UCL
Aroclor 1248	13	13	100	**13**	Risk-Based
Aroclor 1254	13	13	100	**13**	Risk-Based

NOTES AND ABBREVIATIONS:

- = No Value Identified
CUG = Clean-up Goals
BKGD = Background Concentration
MCP-UCL = Massachusetts Contingency Plan - Upper Concentration Limits
(1) Current Silresim CUGs from the Explanation of Significant Differences, 2003.
(2) Risk-based CUGs assume a target risk goal of 1E-5 and target hazard index of 1 for each chemical.
(3) UCLs taken from MassDEP's MCP Numerical Standards Spreadsheets - January 2008 http://www.mass.gov/dep/service/compliance/riskasmt.htm
(4) The most stringent of the risk-based CUG or the UCL was taken as the recommended CUG for each chemical.
(5) Trichloroethylene CUG based on CalEPA toxicity value (2007)
(6) Value resulting from the application of the Adult Lead Model (ALM) used per correspondance with Region 1 Risk Assessor (6/11/07)
(7) Current toxicological carcinogenic slope factor for dioxin published in CalEPA

(USEPA, 2008)

TABLE 2
REVISED CLEAN-UP GOALS FOR SUBSURFACE SOIL
SILRESIM SUPERFUND SITE, LOWELL, MASSACHUSETTS

Chemicals of Potential Concern	Current Silresim CUG from 2003 ESD (1) (mg/kg)	Risk-Based CUGs for Subsurface Soil (2) (mg/kg)	MassDEP Method 3 Upper Concentration Limits (3) (mg/kg)	**Revised Site-Specific Subsurface Soil CUG (4) (mg/kg)**	Basis for Value
Benzene	0.04	68	9,000	**68**	Risk-based
Chlorobenzene	1.2	270	10,000	**270**	Risk-based
Chloroform	0.015	69	5,000	**69**	Risk-based
1,2-Dichloroethane	0.031	440	6,000	**440**	Risk-based
1,1-Dichloroethene	0.005	220	10,000	**220**	Risk-based
Ethylbenzene	1.2	4,500	10,000	**4,500**	Risk-based
Methylene Chloride	0.58	2,100	10,000	**2,100**	Risk-based
Styrene	290	11,000	10,000	**10,000**	MCP-UCL
1,1,2,2-Tetrachloroethane	0.16	140	400	**140**	Risk-based
Tetrachloroethene	0.85	210	10,000	**210**	Risk-based
Toluene	11	14,000	10,000	**10,000**	MCP-UCL
1,1,1-Trichloroethane	13	4,000	10,000	**4,000**	Risk-based
1,1,2-Trichloroethane	0.12	240	2,000	**240**	Risk-based
Trichloroethene (5)	0.25	81	10,000	**81**	Risk-based
Vinyl Chloride	0.0062	110	300	**110**	Risk-based
1,2-Dichlorobenzene	75	2,500	10,000	**2,500**	Risk-based
1,4-Dioxane	-	1,600	-	**1,600**	Risk-based
Hexachlorobenzene	6	140	300	**140**	Risk-based
Naphthalene	16	140	10,000	**140**	Risk-based
1,2,4-Trichlorobenzene	1	150	9,000	**150**	Risk-based
Lead (6)	448	232	3,000	**380**	Risk-based
Mercury	0.77	0.80	300	**0.80**	Risk-based
2,3,7,8-TCDD (7)	0.0002	0.0048	0.003	**0.003**	MCP-UCL
Aroclor 1242	13	13	100	**13**	Risk-based

NOTES AND ABBREVIATIONS:

- = No Value Identified
CUG = Clean-up Goals
MCP-UCL = Massachusetts Contingency Plan - Upper Concentration Limits
(1) Current Silresim CUGs from the Explanation of Significant Differences, 2003.
(2) Risk-based CUGs assume a target risk goal of 1E-5 and target hazard index of 1 for each chemical.
(3) MADEP UCLs taken from MCP Numerical Standards Spreadsheets - January 2008 http://www.mass.gov/dep/service/compliance/riskasmt.htm
(4) The most stringent of the risk-based CUG or the UCL was taken as the recommended CUG for each chemical.
(5) Trichloroethylene CUG based on CalEPA toxicity value.(2007)
(6) Value resulting from the application of the Adult Lead Model (ALM) used per correspondance with Region 1 Risk Assessor (6/11/07)
(7) Current toxicological carcinogenic slope factor for dioxin published in CalEPA.

(USEPA, 2008)

TABLE 3
REVISED CLEAN-UP GOALS FOR GROUNDWATER
SILRESIM SUPERFUND SITE, LOWELL, MASSACHUSETTS

Chemicals of Potential Concern	Current Silresim CUG from 2003 ESD (1) (mg/L)	Risk-Based Clean-up Goal for Groundwater (2) (mg/L)	MassDEP Method 1 GW-3 Standard (3) (mg/L)	MassDEP Method 3 Upper Concentration Limits (3) (mg/L)	**Revised Site-Specific Groundwater CUG (4) (mg/L)**	Basis for Value
Acetone	50	4,100	50	100	**50**	MCP GW-3
Benzene	0.48	5.6	10	100	**5.6**	Risk-based
Chlorobenzene	0.5	14	1	10	**1**	MCP GW-3
Chloroform	0.2	9.3	10	100	**9.3**	Risk-based
1,2-Dichloroethane	0.5	7.7	20	100	**7.7**	Risk-based
1,1-Dichloroethene	0.015	47	30	100	**30**	MCP GW-3
1,2-Dichloroethene (total)	120	58	-	100	**58**	Risk-based
cis-1,2-Dichloroethane	50	3,500	50	100	**50**	MCP GW-3
Ethylbenzene	3.4	67	4	100	**4**	MCP GW-3
Hexachlorobutadiene	0.041	0.041	3	30	**0.041**	Risk-based
Methylene Chloride	14	240	-	100	**100**	MCP-UCL
1,1,2,2-Tetrachloroethane	0.61	3.0	50	100	**3.0**	Risk-based
Tetrachloroethene	5	1.1	30	100	**1.1**	Risk-based
1,2,3-Trichlorobenzene	3.8	1.0	-	-	**1.0**	Risk-based
1,1,1-Trichloroethane	50	620	20	100	**20**	MCP GW-3
1,1,2-Trichloroethane	1.1	11	50	100	**11**	Risk-based
Trichloroethene (5)	1.4	0.87	5	50	**0.87**	Risk-based
Vinyl Chloride	0.13	7.9	50	100	**7.9**	Risk-based
1,4-Dioxane	-	37	-	-	**37**	Risk-based
Naphthalene	0.89	0.89	20	100	**0.89**	Risk-based
1,2,4-Trichlorobenzene	0.15	1.0	50	100	**1.0**	Risk-based
Arsenic	0.4	31	0.9	9	**0.90**	MCP GW-3
Cadmium (water)	0.01	2.6	0.004	0.05	**0.004**	MCP GW-3
Lead	0.03	-	0.01	0.15	**0.01**	MCP GW-3
Nickel	0.08	410	0.2	2	**0.2**	MCP GW-3

NOTES AND ABBREVIATIONS:
- = No Value Identified
CUG = Clean-Up Goal
MCP GW-3 = Established to be the Massachusetts Contingency Plan Groundwater 3 Standard for the protection of ecological resources.
MCP UCL= Established to be the Massachusetts Contingency Plan Upper Concentration Limit.
(1) Current Silresim CUGs from the Explanation of Significant Differences, 2003.
(2) Risk-based CUGs assume a target risk goal of 1E-5 and target hazard index of 1 for each chemical.
(3) MassDEP GW-3 Standards (310 CMR40.0974(2) Table 1) and UCLs (310 CMR 40.0996(7) Table 6) were included as possible ARAR for the site.
(4) The most stringent of the risk-based CUG, the GW-3 value, or the UCL was taken as the recommended CUG for each chemical.
(5) Trichloroethylene CUG based on CalEPA toxicity value (2007).

(USEPA, 2008)

Table 4
Summary of 2008 ESD Toxicity Values, Clean-up Goals (CUGs) & Changes Between 2009 and 2014 Five Year Reviews

Substance	Date of Change	RfD_{oral} (mg/kg -day)	RfC (µg/m^3)	CSF_{oral} (mg/kg-day)$^{-1}$	Unit Risk (µg/m^3)$^{-1}$
		2009/Current**	2009/Current**	2009/Current**	2009/Current**
Acetone	12/21/07[7]	9E-01	3.1E+04[7]	- -	- -
Benzene	4/17/03[2], 4/17/03[2], 1/9/00[2]	4.0E-03[2]	3.0E+01[2]	5.5E-02[2]	7.8E-06
Bis(2-ehtylhexyl) phthalate	NA[3]	- -	- -	- -	NA[3]
Chlorobenzene	07/01/1993[2], 10/12/06[1]	7.0 E-02[1]/2.0E-02[2]	5.0 E+01[1]	- -	- -
Chloroform	12/21/07[7]	- -	9.8E+01[7]	- -	- -
1,2,-Dichlorobenzene	7/13/07[1]	--/ 9.0E-02[2]			
1,2-Dicholorethane	12/21/07[7]	- -	7.0E-03[1]	- -/9.1E-02[2]	- -
1,1-Dichlorethene	NA[3], 8/13/02[2]	- -/5.0E-02[2]	- -/2.0E+02[2]	- -	NA
*cis*1,2-dichloroethene	9/30/10[2]	2.0E-03[2]			
*trans*1,2-dichloroethene	9/17/07[1]	2.0E-02[2]		- -	- -
1,4-Dioxane	8/11/10[2],9/20/13[2],9/20/10[2]	3.0E-02[2]	3.0E+01[2]	1.0E-01[2]	5.0E-06[2]
Ethylbenzene	6/01/91[2], 3/01/91[2], 8/1/91[2]	1.0E-01[2]	1.0E+03[2]	--	
4,4'-DDE	12/17/07[4]	- -	- -	- -	9.7E-05[4]
Hexachlorobenzene	4/1/91[2],3/1/91[2],11/1/96[2]	8.0E-04[2]		1.6E+00[2]	
Hexachlorobutadiene	7/3/10 [1], 9/23/05[2]	--/1.0E-03[1]		7.8E-02 [2]	2.2E-05[2]
Toluene	9/23/05[2]	8.0E-02[2]	5.0E+03[2]	- -	- -
1,1,1-trichloroethane	9/28/07 [2], 4/23/08[5]	2.0E+00[2]	- -/5.0E+03 [2]	- -	- -
1,1,2-trichloroethane	2/1/94[2], 4/23/08[1]	4.0E-03[2]	- -	- -/5.7E-02[2]	- -/1.6E-05[2]
Lindane (gamma BHC)	3/1/88[2], NA[3]	3.0E-04[2]	- -	- -	NA[3]
Naphthalene	9/17/98[2]	2.0E-02[2]	3.0E+00[2]		
Methylene Chloride	12/21/07[7], 11/18/11[2]	- -/6.0E-03[2]	1.1E+03/6.0E+02[2]	- -/2.0E-03[2]	- -/1.0E-08[2]
n-Propylbenzene	5/12/05	NA[2, 3,11]		- -	- -
Styrene	9/1/90[2], 7/1/93[2]	2.0E-01[2]	1.1E+03[2]		
2,3,7,8-TCDD[4, 6,10]	9/19/07 --12/21/07-- 2/17/12[2]	- -/7.0E-10[2]	- -	1.3E+05[4]	3.3E-05[10]/3.8E+01[4]
1,2,3-Trichlorobenzene	10/01/07[8]	- -	4.0E+00[8]	- -	- -
1,2,4-Trichlorobenzene	10/01/07[1], 6/16/09[1]	- -	2.0E+00[1]	- -/2.9E-02[1]	- -
1,3,5-Trichlorobenzene					
1,1,2,2-Tetrachloroethane	9/30/10	--/2.0E-02[2]		0.2[2]	
Tetrachloroethene	12/21/07[4]	- -/6.0E-03[2]	2.76E+02[4]/4.0E+01[2]	- -/2.1E-03[2]	- -/2.6E-07[2]
Trichloroethene	9/28/11[2], 12/17/07[1]	- -/5.0E-04[2]	- -/2.0E+00[2]	- -/4.6E-02[2]	2.0E-06[4,5]/4.1E-06[2]
Vinyl Chloride	8/7/07[2]	3.0E-03[2]	1.0E+02 [2]	7.2E-01[2]	4.4E-06[2]
Benzo(a)anthracene	3/1/94[2]*	- -	- -	- -	- -
Benzo(a) pyrene	11/1/94[2]*			7.3E+00[2]*	
Benzo(b)fluoranthene	*			*	
$C_5 - C_8$Aromatics	11/03[9]	- -	2.0E+01[9]	- -	- -
$C_9 - C_{18}$Aromatics	11/03[9]	- -	- -	- -	- -
$C_9 - C_{18}$Aromatics	11/03[9]	- -	5.0E+01[9]	- -	- -
Aroclor 1242					
Aroclor 1248					
Aroclor 1254					
Aluminum	9/17/07[1]	1.0E+00[1]	5.0E+00[1]	- -	- -
Arsenic	2/1/91[2] , 4/10/98[2]	3.0E-04[2]		1.5E+00[2]	
Barium	9/18/07[2,10], 12/21/07[2,10]	2.0E-01[2,10]	5.0E-01[10]	- -	- -
Cadmium	2/1/94[2] , 9/18/07[2,3], 6/1/92[2]	- -/5.0E-04[2]	- -	NA[2,3]	- -/1.8E-03[2]

Lead					
Nickel	2/1/96(2) , 12/18/07(2)	2.0E-02(2)	- -	- -	2.4E-04(2)
Mercury	6/1/95(2)		3.0E-01(2)		

Notes:

This table is based on information presented in tables from 2008 ESD (Chemicals with clean-up Goals) and 2009 Five Year Review (Toxicity factors updated since 2008 ESD). Toxicity factors available on IRIS in March 2014 are included in this table.

Exposure routes included in the remedy are ingestion, inhalation and dermal contact.

RfD_{oral} - Reference Dose for chronic exposure used to estimate noncancer adverse health effects resulting from oral exposure.
RfC - Reference Concentration for chronic inhalation exposure used to estimate noncancer adverse health effects resulting from inhalation exposure.
CSF_{oral} - Cancer Slope factor used to estimate cancer health effects resulting from oral exposure.
Unit Risk – Inhalation Unit Risk used to estimate cancer health effects resulting from inhalation exposure.

- - no toxicity value
NA - not applicable – see other notes

1- PPTRV – Provisional Peer Reviewed Toxicity Values (USEPA)
2 – IRIS – Integrated Risk Information System
3 -now unquantified - no value supported
4 – CalEPA – State of California Environmental Protection Agency
5- USEPA
6- Dioxin Reassessment
7-ATSDR – Agency for Toxic Substances and Disease Registry
8-NCEA – National Center for Environmental Assessment
9 –MassDEP 2002. Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of MADEP VPH/EPH Approach. October 31, 2002 cited in the 2008 Supplemental CUG had only a background estimate for $C_9 – C_{18}$Aromatics. However, the Final Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology, MassDEP, November 2003 had toxicity values for the various aromatic carbons which are cited in this Five Year Review
10 –HEAST – Health Effects Assessment Summary (USEPA, 1997)
11- EPA Superfund Technical Support Center
*Benzo(a)pyrene Toxic Equivalent evaluation method (USEPA)
** If there was a change between 2009 and 2014, then the two values are listed chronologically in the same cell

APPENDIX C – SITE INSPECTION CHECKLIST

Five-Year Review Site Inspection Checklist
Silresim Superfund Site, Lowell, Massachusetts

("N/A" refers to "not applicable")

I. SITE INFORMATION	
TASK 1 - Site name: Silresim Superfund Site	**TASK 2 - Date of inspection:** 20 November 2013
TASK 3 - Location and Region: Lowell, Massachusetts, USEPA Region I	**TASK 4 - EPA ID:** MAD000192393
TASK 5 - Agency, office, or company leading the five-year review: United States Army Corps of Engineers New England District	**TASK 6 - Weather/temperature:** Cool, Sunny, 40°F, Breezy

Remedy Includes: (Check all that apply)

- ■ Landfill cover/containment
- ■ Access controls
- ■ Institutional controls
- ■ Ground water pump and treatment
- ☐ Surface water collection and treatment
- ☐ Other _____
- ☐ Monitored natural attenuation
- ☐ Ground water containment
- ☐ Vertical barrier walls

Attachments: ■ Inspection team roster attached (in report) ■ Site map attached (in report)

II. INTERVIEWS (Check all that apply)

1. **O&M site manager** John Haley Watermark Project Manager
   Name Title Date
   Interviewed ☐ at site ☐ at office ■ by phone Phone no. 978-452-9696
   Problems, suggestions: See Attached Report

2. **O&M staff**
   Name Title Date
   Interviewed ☐ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☐Report attached _____

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency MassDEP
Contact Janet Waldron | Project Manager | 03-07-14 | 617-556-1156
Name | Title | Date | Phone no.
Problems; suggestions; ■ Report attached

Agency USEPA, Region 1
Contact Dan Keefe | Remedial Project Manager | 617-918-1327
Name | Title | Date | Phone no.
Problems; suggestions; □ Report attached

Agency Lowell Regional Wastewater Utility
Contact Mike Stuer | Manager | 978-970-4248 Ext. 1606
Name | Title | Date Phone no.
Problems; suggestions ; ■ Report attached

Agency
Contact WaterMark Environmental (John Haley)
Name | Title | Date Phone no.
Problems; suggestions; ■ Report attached

4. **Other interviews** (optional) □Reports attached.

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. **O&M Documents**

■ O&M manual	■ Readily available	■ Up to date	□ N/A
■ As-built drawings	■ Readily available	■ Up to date	□ N/A
■ Maintenance logs	■ Readily available	■ Up to date	□ N/A

Remarks

2. **Site-Specific Health and Safety Plan**
Contingency plan/emergency response plan ■ Readily available ■ Up to date □ N/A
Remarks

3. **O&M and OSHA Training Records** ■ Readily available ■ Up to date □ N/A
Remarks

4. **Permits and Service Agreements**

■ Air discharge permit	■ Readily available	■ Up to date	□ N/A
■ Effluent discharge	■ Readily available	■ Up to date	□ N/A
■ Waste disposal, POTW	■ Readily available	■ Up to date	□ N/A
■ Other permits Dumpster for the City	■ Readily available	■ Up to date	□ N/A

Remarks

5.	**Gas Generation Records**	☐ Readily available	☐ Up to date	■ N/A
	Remarks			
6.	**Settlement Monument Records**	■ Readily available	■ Up to date	☐ N/A
	Remarks			
7.	**Ground water Monitoring Records**	■ Readily available	■ Up to date	☐ N/A
	Remarks Available in Status Reports			
8.	**Leachate Extraction Records**	☐ Readily available	☐ Up to date	■ N/A
	Remarks			
9.	**Discharge Compliance Records**			
	■ Air	■ Readily available	■ Up to date	☐ N/A
	■ Water (effluent)	■ Readily available	■ Up to date	☐ N/A
	Remarks Air discharge memo			
10.	**Daily Access/Security Logs**	■ Readily available	■ Up to date	☐N/A
	Remarks			

IV. O&M COSTS

1. **O&M Organization**

☐ State in-house ■ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☐ Other_____

2. **O&M Cost Records**

■ Readily available ■ Up to date
■ Funding mechanism/agreement in place
Original O&M cost estimate_____ ■ Breakdown attached

Total annual cost by year for review period if available is in text of the FYR

3. **Unanticipated or Unusually High O&M Costs During Review Period**

V. ACCESS AND INSTITUTIONAL CONTROLS ■ Applicable ☐ N/A

A. Fencing

1. **Fencing** ■ Location shown on site map ■ Gates secured ☐ N/A
Remarks Fence surrounding Silresim Site is in good condition, 8' tall.

B. Other Access Restrictions

1. **Signs and other security measures** ■ Location shown on site map ☐N/A
Remarks. Signs in good condition

C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ■ No ☐ N/A
Site conditions imply ICs not being fully enforced ☐ Yes ■ No ☐ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): Daily visits by MassDEP GWTP staff
Frequency Institutional Controls exist in the form Easements on abutting properties
Responsible party/agency EPA and MassDEP
Contact _____
Name Title Date Phone no.

Reporting is up-to-date ■ Yes ☐ No ☐ N/A
Reports are verified by the lead agency ■ Yes ☐ No ☐ N/A

Specific requirements in deed or decision documents have been met ■ Yes ■ No ☐ N/A
Violations have been reported ■ Yes ■ No ☐ N/A
Other problems or suggestions: ■ Report attached
Institutional Controls are in place in the form of Easements in documents titles "Grant of Easements and Restrictions Agreement" dated 1993-1994.

2. **Adequacy** ■ ICs are adequate ☐ ICs are inadequate ☐N/A
Remarks ICs may need to be updated to reflect current land owners of abutting properties

D. General

1. **Vandalism/trespassing** ☐ Location shown on site map ■ No vandalism evident
Remarks _____

2. **Land use changes on site** ■ N/A
Remarks _____

3. **Land use changes off site** ☐ N/A
Remarks There may be a new power plant going in adjacent to the Site to the northeast

VI. GENERAL SITE CONDITIONS

A. Roads ■ Applicable ☐ N/A

1. **Roads damaged** ■ Location shown on site map ■ Roads adequate ☐N/A
Remarks: None

B. Other Site Conditions

Remarks _____

VII. LANDFILL COVERS ■ Applicable ☐N/A

A. Landfill Surface

1. **Settlement** (Low spots) ☐ Location shown on site map ■ Settlement not evident
   Areal extent_____ Depth_____
   Remarks_____

2. **Cracks** ☐ Location shown on site map ■ Cracking not evident
   Lengths_____ Widths_____ Depths_____
   Remarks_____

3. **Erosion** ☐ Location shown on site map ■ Erosion not evident
   Areal extent_____ Depth_____
   Remarks_____

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
   Areal extent_____ Depth_____
   Remarks Few animal burrows noted

5. **Vegetative Cover** ■ Grass ■ Cover properly established ■ No signs of stress
   ☐ Trees/Shrubs (indicate size and locations on a diagram)
   Remarks_____

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
   Remarks asphalt, gravel

7. **Bulges** ☐ Location shown on site map ■ Bulges not evident
   Areal extent_____ Height_____
   Remarks_____

8. **Wet Areas/Water Damage** ■ Wet areas/water damage not evident
   ☐ Wet areas ☐ Location shown on site map Areal extent_____
   ☐ Ponding ☐ Location shown on site map Areal extent_____
   ☐ Seeps ☐ Location shown on site map Areal extent_____
   ☐ Soft subgrade ☐ Location shown on site map Areal extent_____
   Remarks_____

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ■ No evidence of slope instability
Areal extent_____
Remarks_____

B. Benches ☐ Applicable ■ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ■ N/A or okay
Remarks_____

2. **Bench Breached** ☐ Location shown on site map ■ N/A or okay
Remarks_____

3. **Bench Overtopped** ☐ Location shown on site map ■ N/A or okay
Remarks_____

C. Letdown Channels ☐ Applicable ■ N/A
(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Areal extent_____ Depth_____
Remarks_____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type_____ Areal extent_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent_____ Depth_____
Remarks_____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent_____ Depth_____
Remarks_____

5. **Obstructions** Type_____ ☐ No obstructions
☐ Location shown on site map Areal extent_____
Size_____
Remarks_____

6. **Excessive Vegetative Growth** Type_____
☐ No evidence of excessive growth
☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent_____
Remarks_____

D. Cover Penetrations ■ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ■ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ■ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
   Remarks

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ■ N/A
   Remarks

3. **Monitoring Wells** (within surface area of landfill)
   ■ Properly secured/locked ☐ Functioning ■ Routinely sampled ■ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
   Remarks Wells inside Site – are unlocked, wells outside – are locked

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ■ N/A
   Remarks

5. **Settlement Monuments** ☐ Located ☐ Routinely surveyed ■ N/A
   Remarks

E. Gas Collection and Treatment ☐ Applicable ■ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks_____

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks_____

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs Maintenance ☐ N/A
   Remarks_____

F. Cover Drainage Layer ☐ Applicable ■ N/A

1. **Outlet Pipes Inspected** ☐ Functioning ☐ N/A
   Remarks_____

2. **Outlet Rock Inspected** ☐ Functioning ☐ N/A
   Remarks_____

G. Detention/Sedimentation Ponds ☐ Applicable ■ N/A

1. **Siltation** Areal extent_____ Depth_____ ☐☐N/A
   ☐ Siltation not evident
   Remarks_____

2. **Erosion** Areal extent_____ Depth_____
   ☐ Erosion not evident
   Remarks_____

3. **Outlet Works** ☐ Functioning ☐ N/A
   Remarks_____

4. **Dam** ☐ Functioning ☐ N/A
   Remarks_____

H. Retaining Walls ☐ Applicable ■ N/A

1. **Deformations** ☐ Location shown on site map ☐Deformation not evident
Horizontal displacement_____ Vertical displacement_____
Rotational displacement_____
Remarks_____

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
Remarks_____

I. Perimeter Ditches/Off-Site Discharge ■ Applicable ☐ N/A

1. **Siltation** ☐ Location shown on site map☐ Siltation not evident
Areal extent_____ Depth_____

Remarks: Three puncture holes were noted along the groundwater treatment plant, on the west side swale. It was reported by the project manager that the holes were from wooden stakes holding hay bales in place used for erosion control, and that they had penetrated the clay layer. The clay layer should be repaired with material consistent with the requirements of the project specifications. Additionally in this area, there is a discharge pipe from the gutter system from the GWTP that discharges into a riprap apron. The riprap has been eroded and should be replaced/supplemented with material conforming to the project specifications.

Swales – Surface water discharge to River Meadow Brook

2. **Vegetative Growth** ☐ Location shown on site map ☐ N/A
■ Vegetation does not impede flow
Areal extent_____ Type_____
Remarks_____

3. **Erosion** ☐ Location shown on site map ■ Erosion not evident
Areal extent_____ Depth_____
Remarks_____

4. **Discharge Structure** ■ Functioning ☐ N/A
Remarks Head wall at River Meadow Brook

VIII. VERTICAL BARRIER WALLS ☐ Applicable ■ N/A

1. **Settlement** ☐ Location shown on site map ☐ Settlement not evident
Areal extent_____ Depth_____
Remarks_____

2. **Performance Monitoring** Type of monitoring_____
☐ Performance not monitored
Frequency_____ ☐ Evidence of breaching
Head differential_____
Remarks_____

IX. GROUND WATER/SURFACE WATER REMEDIES ■ Applicable ☐N/A

A. Ground water Extraction Wells, Pumps, and Pipelines ■Applicable ☐N/A

1. **Pumps, Wellhead Plumbing, and Electrical**
   ■ Good condition ■ All required wells properly operating ☐ Needs Maintenance ☐ N/A
   Remarks Well sampling scheduled for 2014.

2. **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ■ Good condition ☐ Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   ☐ Readily available ■ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks Parts for potential optimization, many spare parts available. Preventative maintenance is performed.

B. Surface Water Collection Structures, Pumps, and Pipelines ☐ Applicable ■ N/A

1. **Collection Structures, Pumps, and Electrical**
   ☐ Good condition ☐ Needs Maintenance
   Remarks

2. **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**
   ☐ Good condition ☐ Needs Maintenance
   Remarks

3. **Spare Parts and Equipment**
   ☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided
   Remarks

C. Treatment System ■ Applicable ☐ N/A

1. **Treatment Train** (Check components that apply)
   - ■ Metals removal ☐ Oil/water separation: not in use ☐ Bioremediation
   - ■ Air stripping ■ Carbon adsorbers: not in use
   - ■ Filters pressure filters
   - ■ Additive (*e.g.*, chelation agent, flocculent) NaOH, NaOCl, polymer
   - ■ Others anti-foam (Foamtrol)
   - ■ Good condition ☐ Needs Maintenance
   - ■ Sampling ports properly marked and functional
   - ■ Sampling/maintenance log displayed and up to date
   - ■ Equipment properly identified

   Quantity of ground water treated annually Approximately 9.3 million gallons *
   Quantity of surface water treated annually N/A
   Remarks * Information from Status Report No. 32

2. **Electrical Enclosures and Panels** (properly rated and functional)
   ☐ N/A ■ Good condition ☐ Needs Maintenance
   Remarks

3. **Tanks, Vaults, Storage Vessels**
   ☐ N/A ■ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
   Remarks

4. **Discharge Structure and Appurtenances**
   ☐ N/A ■ Good condition ☐ Needs Maintenance
   Remarks

5. **Treatment Building(s)**
   ☐ N/A ■ Good condition ☐ Needs repair
   ■ Chemicals and equipment properly stored
   Remarks Miscellaneous (nuisance) odor associated with GWTP operation and groundwater treatment.

6. **Monitoring Wells** (pump and treatment remedy)
   ■ Properly secured/locked ■ Functioning ■ Routinely sampled ■ Good condition
   ■ All required wells located ☐ Needs Maintenance ☐ N/A
   Remarks

D. Monitoring Data

a. 1. Monitoring Data
   ■ Is routinely submitted on time ■ Is of acceptable quality

b. 2. Monitoring data suggests:

c. Contaminated ground water is not adequately contained in the north area of the Site. Some contaminant concentrations are declining and others are increasing

d.
   ☐ Ground water plume is effectively contained ☐ Contaminant concentrations are declining

D. Monitored Natural Attenuation

1. **Monitoring Wells** (natural attenuation remedy)

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs Maintenance ■ N/A
Remarks _____

X. OTHER REMEDIES

If there are remedies applied at the site which are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The GWTP, ERH, and clay cap remedies are effective and functioning as designed. The GWTP removes mass and contains the groundwater contamination plume. The ERH treatment removed a significant amount of soil and groundwater contamination and the clay cap isolates contaminated soil.

B. Adequacy of O&M

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

O&M procedures are adequate for continuing operation of the GWTP and clay cap.

C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

No early indicators of potential remedy problems have been noted.

D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.
The location of potential additional extraction wells could be optimized based upon investigation of remaining VOC contamination. Shallow monitoring wells on the Lowell Iron & Steel property near the border with Silresim can be evaluated and possibly abandoned. The use of a tray stripper could be evaluated to determine whether the installation of a second air stripper could alleviate the need to pre-heat the water and reduce the use of natural gas. The benefit of a heat pump system at the GWTP could be investigated. Waste heat may also be captured from the thermal oxidizer and re-used

APPENDIX D – INTERVIEW DOCUMENTATION

INTERVIEW RECORD

Site Name: Silresim Superfund Site		**EPA ID No.:** MAD000192393
Subject: Fourth Five-Year Review		**Time:** 1222 **Date:** 7 March 2014
Type: Telephone Visit X Other: email		☐☐ Incoming Outgoing
CONTACT MADE BY		
Name: Stephen Lefebvre	**Title:** Technical Lead	**Organization:** USACE
INDIVIDUAL CONTACTED:		
Name: Janet Waldron	**Title:** Project Manager	**Organization:** MassDEP
Telephone No: 617-556-1156 **E-Mail Address:** Janet.Waldron@state.ma.us	**Street Address:** One Winter Street City, State, Zip: Boston, MA 02108	

SUMMARY OF CONVERSATION

Q1: What is your overall impression of the project and site?

A1: DEP continues to implement O&M (GWTP and site cap) and there are no immediate concerns for potential exposures to contaminated groundwater or soil at the Site. There is a concern that the plume may not be completely contained (elevated concentrations of VOCs in monitoring wells downgradient of the extraction well array), however, potential targets (basements) are monitored for use on a yearly basis by DEP (to make sure the use has not changed creating a new exposure pathway).

More information is needed as to the remaining groundwater contamination at the Site (see No. 7 below).

Q2: Is the remedy functioning as expected? Charring

A2: The groundwater treatment portion of the remedy continues to function as expected from previous years. It appears that it will still take hundreds of years to reach site cleanup goals throughout the entire plume. The best that can be done (without implementing other remedial measures) is to contain the plume.

There is a concern with one of the swales on the southern side of the site. The swale appears to have been compromised during the ERH RA by hay bale stakes being driven through the site cap. Holes were created which have caused erosion and slumping of soil within the swale resulting in poor drainage (low spots with standing water, and blocked flow from the excess soil in the swale).

Q3: How effective do you think the ERH treatment process was in obtaining its objective?

A3: The ERH was quite successful in achieving significant mass reduction in the areas where it was implemented. While it did not completely achieve cleanup goals (primarily on the Silresim property), most locations sampled did achieve PRGs for both soil and groundwater.

Although contaminants in groundwater have been reduced significantly in portions of the shallow aquifer (down to about 30 – 40 feet deep in the areas treated by ERH), there is still significant mass in the deeper portions of the aquifer (40 to 60 feet deep) and other areas where the ERH was not implemented.

Q4: Are you aware of any issues the five-year review should focus on?

A4: Institutional Controls for the Silresim property need to be created and implemented.

Q5: Who should USACE speak to in the community to solicit local input?

A5: Sarah Brown with the City of Lowell Department of Planning & Development (978-674-4252 x1446).

Carol McCarthy, Ayer's City Neighborhood Group (Dan may have a phone #)

Q6: Have there been any changes in the site or surrounding property in the last 5 years, or are changes planned?

A6: Some of the properties have changed owners (Scannell-owned property across Tanner Street). Some of the current owners of properties in the vicinity may wish to sell property if someone offers the right price. There has also been discussion of redevelopment of the Ayer's City Industrial Park (in which Silresim is located) for manufacturing (see information from the Massachusetts Manufacturing Community Roundtable workshop, which Dan Keefe may have provided).

Q7: What improvements/adjustments (if any) do you feel can be made to the GW Treatment Plant operation?

A7: Once the groundwater temperatures have returned to ambient, an investigation of where the remaining VOC contamination exists and how it is migrating should be conducted. Optimizing the locations of potential additional extraction wells based on the investigation (and possibly abandoning some in shallow levels on the Lowell Iron & Steel property near the border with Silresim) should be implemented.

The use of the tray stripper should be evaluated once temperatures in groundwater have returned to ambient conditions to determine whether the installation of this second stripper could alleviate the need to pre-heat the flow through the plant, thus saving money spent on natural gas to pre-heat the water.

The benefit of a heat pump system at the plant should also be investigated, plus determining if the heated water from the thermal oxidizer (or waste heat?) could be utilized in any way to save the cost of pre-heating water.

INTERVIEW RECORD

Site Name: Silresim Superfund Site		**EPA ID No.:** MAD000192393
Subject: Fourth Five-Year Review		**Time:** 1400 **Date:** 7 March 2014
Type: X Telephone Visit Other Location of Visit:		Incoming X Outgoing
CONTACT MADE BY		
Name: Stephen Lefebvre	**Title:** Technical Lead	**Organization:** USACE
INDIVIDUAL CONTACTED:		
Name: Mike Stuer	**Title:** Manager	**Organization:** Lowell Regional Wastewater Utility
Telephone No: 978-970-4248 x1606	**Street Address:** 815 Pawtucket Blvd City, State, Zip: Lowell, MA 01854	

SUMMARY OF CONVERSATION

Q1: What is your overall impression of the project and site?

A1: He is very happy with the site and wishes everyone else would do as good a job reporting their discharges. He stated that he thought that we spent a lot of money to conduct the ERH.

Q2: Do you have any comments, suggestions, or recommendations regarding the Site's management?

A2: He is very pleased with Watermark and the operation. He stated that they have been excellent.

Q3: Has the Site been in compliance with the permitting and reporting requirements (TTO of 2.13 ppm)?

A3: He stated that the site is always in compliance. They are really only concerned with metals and the site does not have high concentrations of metals. They are not really concerned with organics.

Q4: Are you aware of any issues the five-year review should focus on?

A4: No issues or comments

Q5: Have there been any changes in the site or surrounding property in the last 5 years, or are aware of any planned changes?

A5: He stated that he has heard some talk about an initiative to possibly redevelop the area but didn't know any details.

INTERVIEW RECORD

Site Name: Silresim Superfund Site		**EPA ID No.:** MAD000192393	
Subject: Fourth Five-Year Review		Time:	Date:
Type: Telephone ☐ Visit ☐ Other Location of Visit:		Incoming ☐ Outgoing	

CONTACT MADE BY

Name: Stephen Lefebvre	Title: Technical Lead	Organization: USACE

INDIVIDUAL CONTACTED:

Name: John Haley	Title: Project Manager	Organization: Watermark Environmental, Inc.

Telephone No: 978-452-9696 Fax No: 978-453-9988 E-Mail Address: johnh@watermarkenv.com	Street Address: 175 Cabot Street City, State, Zip: Lowell, MA 01854

SUMMARY OF CONVERSATION

Q1: What is your overall impression of the project and site?

A1:

Q2: What (if any) are the major O&M changes implemented during the past 5 year period?

A2:

Q3: When was the new control system installed?

A3:

Q4: Are you aware of any issues the five-year review should focus on?

A4:

Q5: Have there been any changes in the site or surrounding property in the last 5 years, or are changes planned?

A5:

Q6: What improvements/adjustments (if any) do you feel can be made to the GW Treatment Plant operation?

A6:

SILRESIM SUPERFUND FIVE-YEAR REVIEW QUESTIONNAIRE

Watermark

1. What is your overall impression of the project site?
I think the overall site operates well. The treatment system is in good condition. I don't think the distribution of contamination or deep contamination is well understood. With better understanding the extraction well system may be able to be modified to increase mass removal, while still providing containment.

2. What (if any) are the major O&M changes implemented during the past 5 year period?
The major change to the GWTP system was the replacement of the control system.

3. When was the new control system installed?
The control system was completed in October 2013. It was started in September 2013 and punch-list items were completed in the month long start-up.

4. Are you aware of any issues the five-year review should focus on?

As stated in question 1, I think the distribution of contaminant mass and expanding the extraction well array to improve mass removal should be the focus.

5. Have there been any changes in the site or surrounding property in the last 5 years, or are aware of any planned changes?

I am not aware of any changes and there have been no major changes. Minor changes, such as property owners, have occurred.

6. What improvements/adjustments (if any) do you feel can be made to the GW Treatment Plant operation?

I believe the GWTP has been fairly well optimized. MassDEP is looking at installing an additional tray air stripper to allow for the process boiler to be shutdown We are also looking at testing the vapor stream to see if VGAC is a viable alternative to the TOX.

APPENDIX E – FIGURES

NORTH

USGS TOPOGRAPHIC MAP

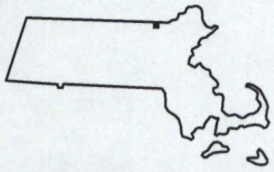
LOWELL, MASSACHUSETTS

1987

APPROXIMATE SCALE
1 INCH = 2,000 FEET

Nobis

Nobis Engineering, Inc.
585 Middlesex Street
Lowell, MA 01851
Tel (978) 683-0891
Fax (978) 683-0966
www.nobisengineering.com



QUADRANGLE LOCATION

FIGURE 1

LOCUS PLAN

SILRESIM CHEMICAL CORPORATION SITE
(RECOVERY)
LOWELL, MASSACHUSETTS

PROJECT: 80045.03

APRIL 2010

R:\80000 Task Orders\80045 Silresim Chemical Corp (RECOVERY)\Technical Data\CAD\dwg\80045.03-LOCUS.dwg

LEGEND

Basemap Features

- Roads
- Former Railroad
- Former Structures
- Treatment Plant
- Lowell Iron
- Tree Line
- Water/Wetland
- Fence
- Water Line
- Sewer Line

LOCATION MAP

0 100 Feet

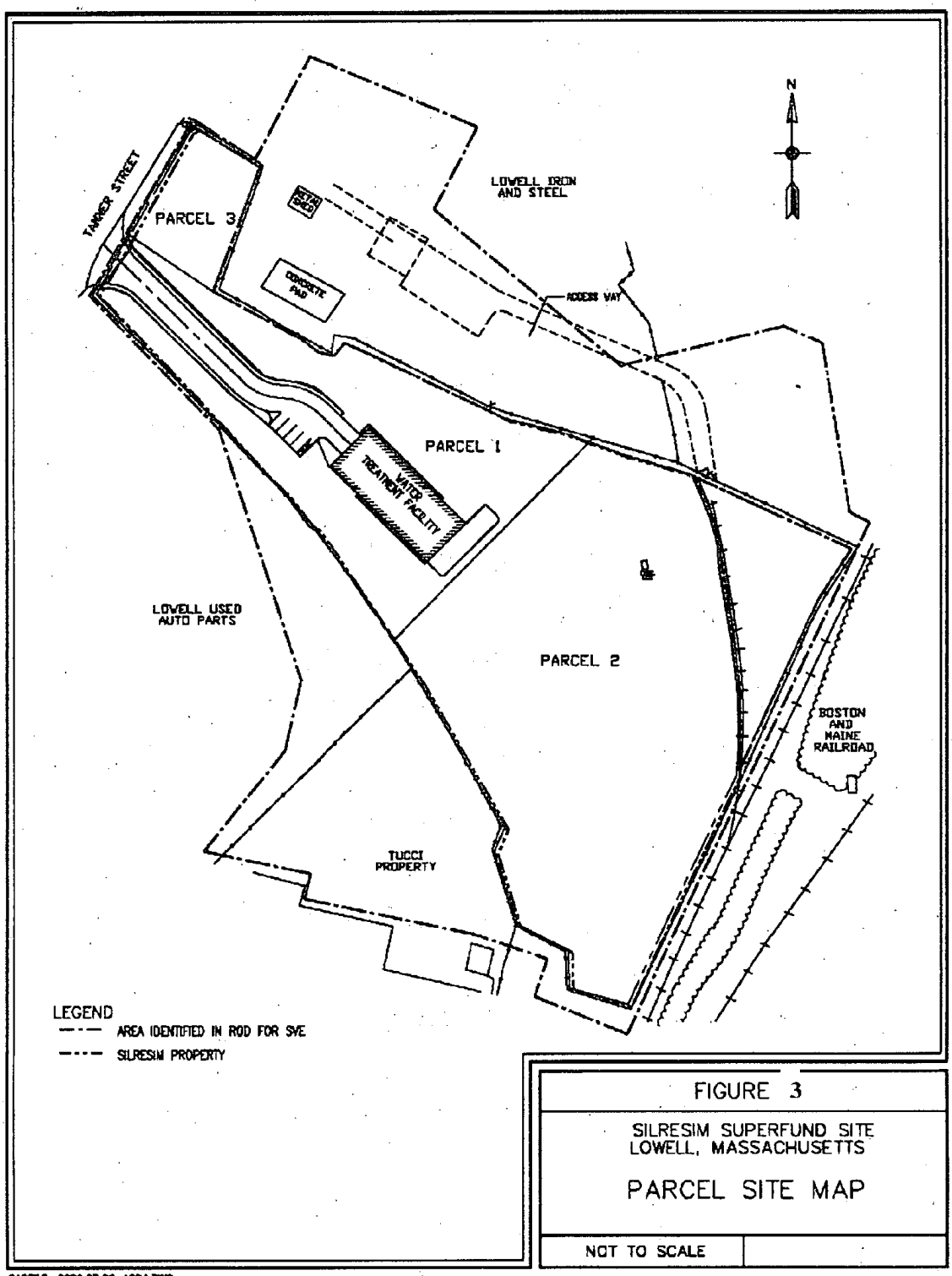
NOTES & SOURCES
Map Coordinates:
Horizontal - MA Stateplane NAD27 Feet

US Army Corps of Engineers
New England District

M:\Projects\Superfund\Silresim\Figures\Fig2-SiteDiagram_102408.pdf
M:\Projects\Superfund\Silresim\MXDs\Fig2-SiteDiagram_102308.mxd
October 24, 2008 DWN: MTW CHKD: RAS

Site Diagram
Figure 2
Silresim Superfund Site
Lowell, MA

Figure 3 Silresim Site Parcel Map



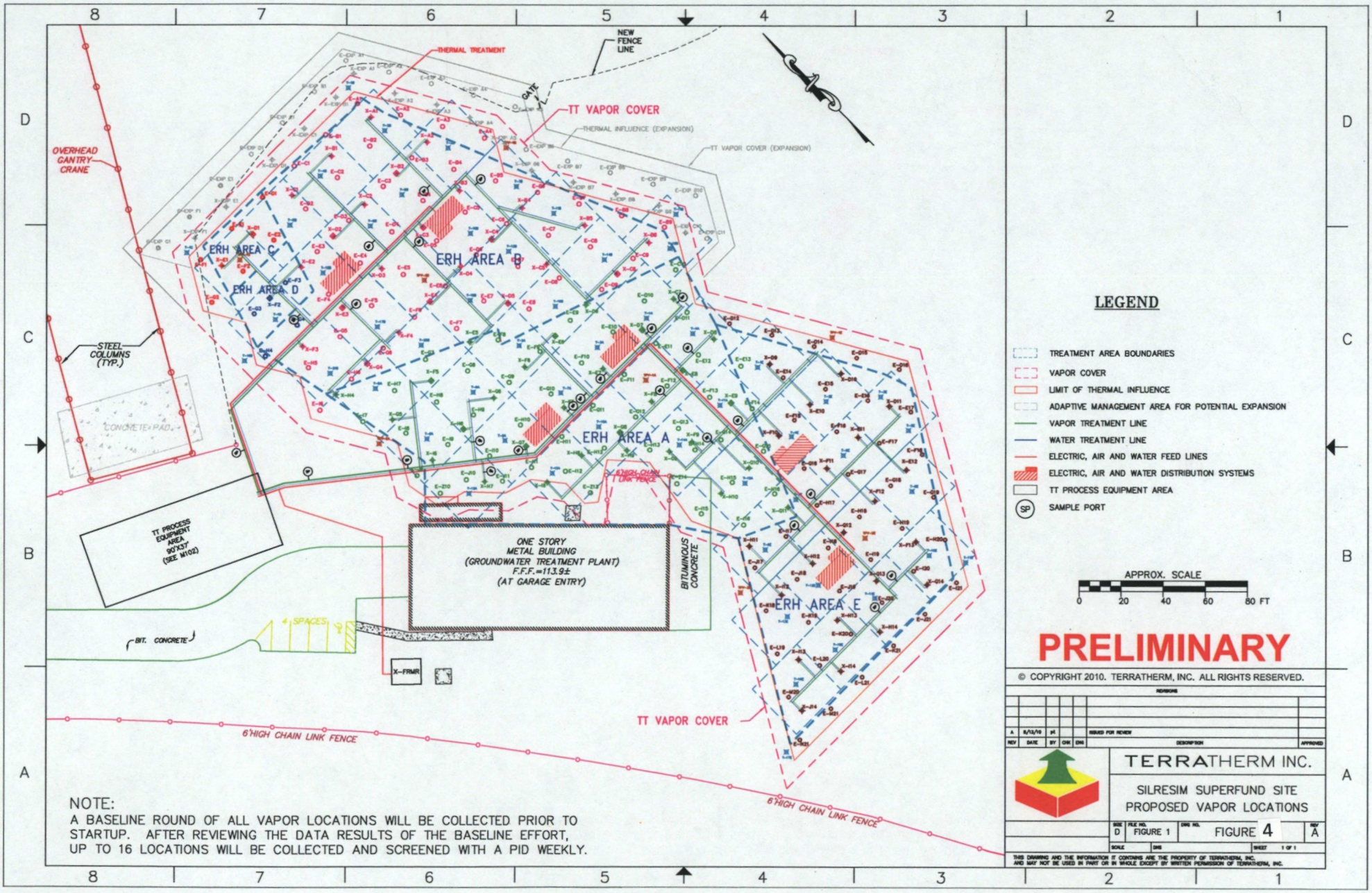
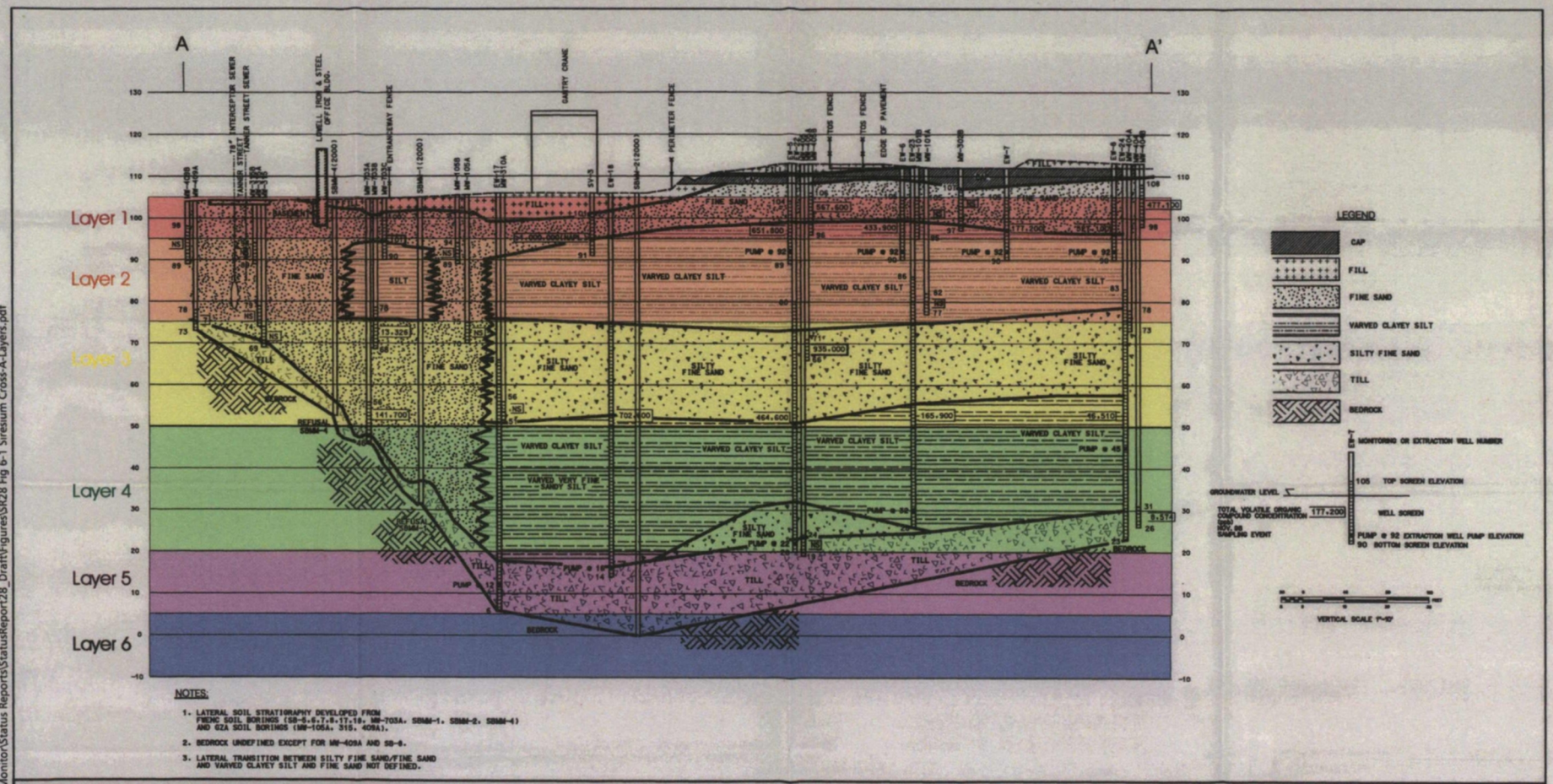

THERMAL TREATMENT
NEW FENCE LINE
GATE
TT VAPOR COVER
THERMAL INFLUENCE (EXPANSION)
TT VAPOR COVER (EXPANSION)
OVERHEAD GANTRY CRANE
STEEL COLUMNS (TYP.)
CONCRETE PAD
ERH AREA C
ERH AREA D
ERH AREA B
ERH AREA A
ERH AREA E
TT PROCESS EQUIPMENT AREA 90'X37' (SEE M102)
ONE STORY METAL BUILDING (GROUNDWATER TREATMENT PLANT) F.F.F.=113.9± (AT GARAGE ENTRY)
BITUMINOUS CONCRETE
6'HIGH CHAIN LINK FENCE
BIT. CONCRETE
4 SPACES
X-FRMR
TT VAPOR COVER
6'HIGH CHAIN LINK FENCE
LEGEND
TREATMENT AREA BOUNDARIES
VAPOR COVER
LIMIT OF THERMAL INFLUENCE
ADAPTIVE MANAGEMENT AREA FOR POTENTIAL EXPANSION
VAPOR TREATMENT LINE
WATER TREATMENT LINE
ELECTRIC, AIR AND WATER FEED LINES
ELECTRIC, AIR AND WATER DISTRIBUTION SYSTEMS
TT PROCESS EQUIPMENT AREA
SP SAMPLE PORT
APPROX. SCALE
0 20 40 60 80 FT
PRELIMINARY
© COPYRIGHT 2010. TERRATHERM, INC. ALL RIGHTS RESERVED.
TERRATHERM INC.
SILRESIM SUPERFUND SITE
PROPOSED VAPOR LOCATIONS
FIGURE 1
FIGURE 4
NOTE:
A BASELINE ROUND OF ALL VAPOR LOCATIONS WILL BE COLLECTED PRIOR TO STARTUP. AFTER REVIEWING THE DATA RESULTS OF THE BASELINE EFFORT, UP TO 16 LOCATIONS WILL BE COLLECTED AND SCREENED WITH A PID WEEKLY.

Figure 4



NOTES:

1. LATERAL SOIL STRATIGRAPHY DEVELOPED FROM FRENC SOIL BORINGS (SB-5,6,7,8,17,18, MW-203A, SBMW-1, SBMW-2, SBMW-4) AND GZA SOIL BORINGS (MW-105A, 315, 409A).
2. BEDROCK UNDEFINED EXCEPT FOR MW-409A AND SB-6.
3. LATERAL TRANSITION BETWEEN SILTY FINE SAND/FINE SAND AND VARVED CLAYEY SILT AND FINE SAND NOT DEFINED.

FIGURE 5 SIX-LAYER CONCEPTUAL MODEL, CROSS SECTION A-A'
Silresim Superfund Site, Lowell, Massachusetts

Source: Foster Wheeler

WATERMARK ENVIRONMENTAL
STONE ENVIRONMENTAL INC

O:\PROJ-01\1234-R-SilresimMonitor\Status Reports\StatusReport28_Draft\Figures\SR28 Fig 6-1 Siresium Cross-A-Layers.pdf

Figure 5

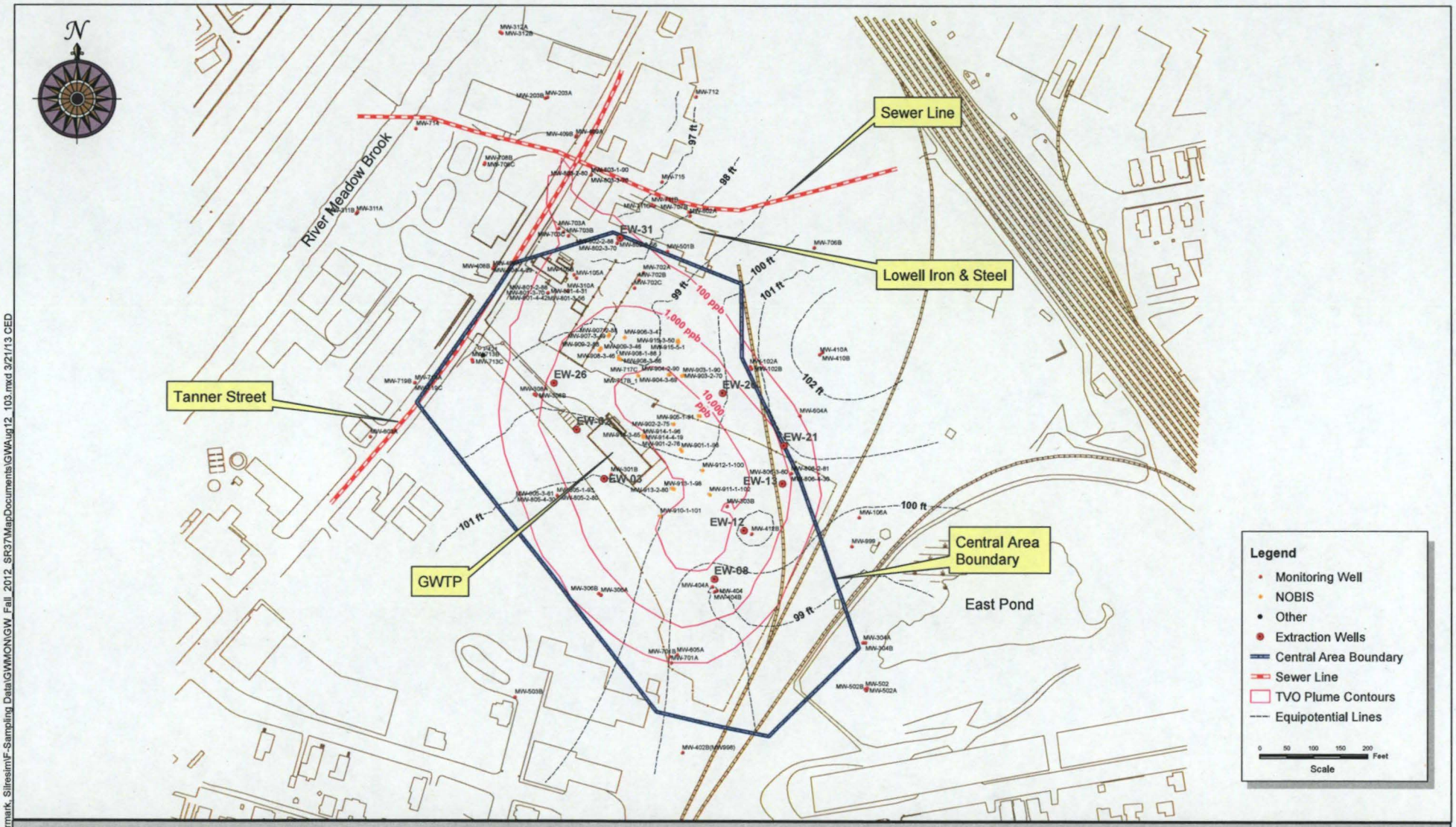


FIGURE 6-2a: EQUIPOTENTIAL SURFACE FOR LAYER 1, AUGUST, 2012
Slice Elevation at 103 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Watermark
STONE ENVIRONMENTAL INC

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, August, 2012 Levels.

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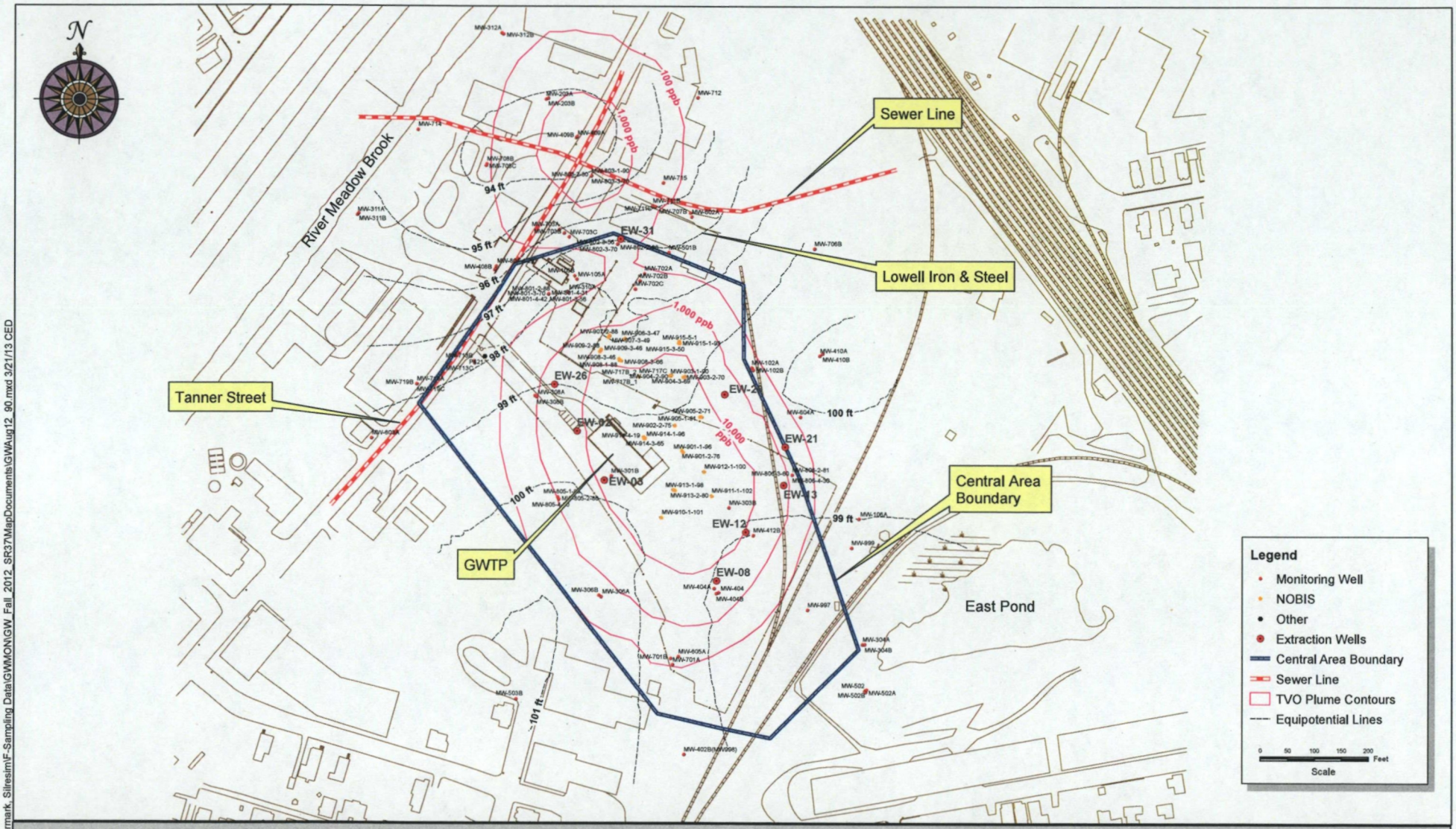

FIGURE 6-2b: EQUIPOTENTIAL SURFACE FOR LAYER 2, AUGUST 2012
Slice Elevation at 90 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, August, 2012 Levels.

Watermark
STONE ENVIRONMENTAL INC

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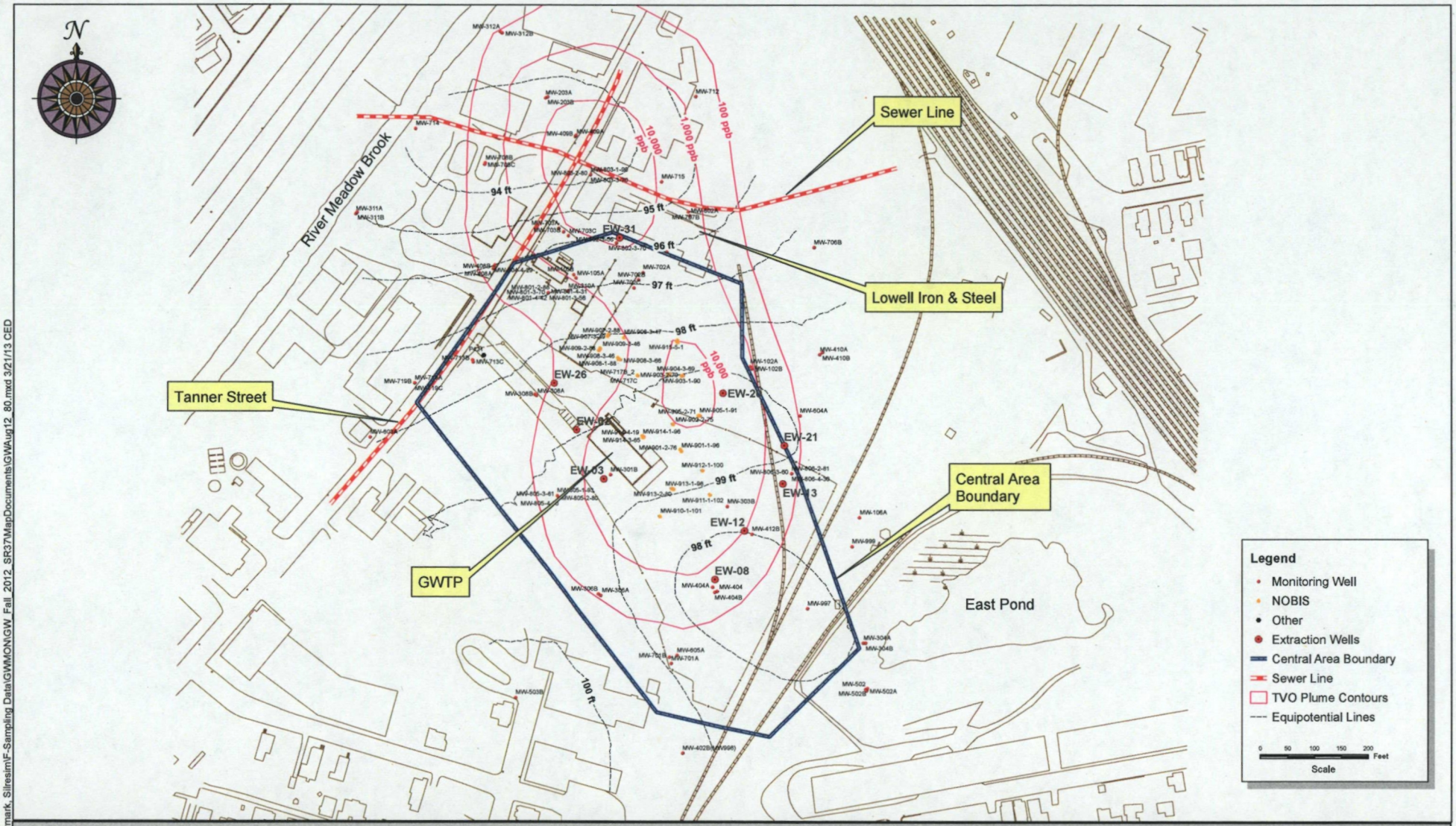

FIGURE 6-2c: EQUIPOTENTIAL SURFACE FOR LAYER 2, AUGUST 2012
Slice Elevation at 80 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, August, 2012 Levels.

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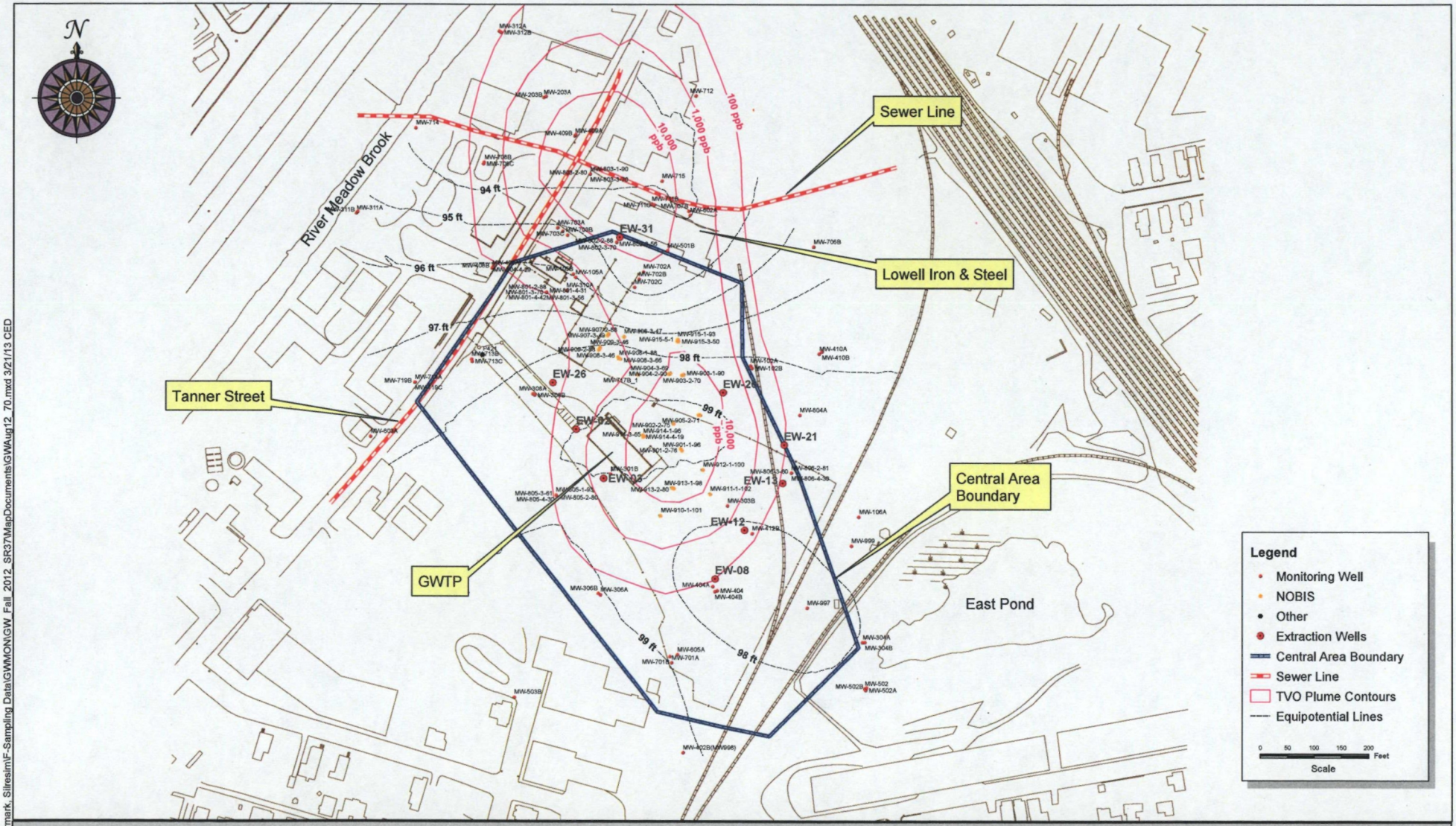

FIGURE 6-2d: EQUIPOTENTIAL SURFACE FOR LAYER 3, AUGUST 2012
Slice Elevation at 70 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Watermark
STONE ENVIRONMENTAL INC

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, August, 2012 Levels.

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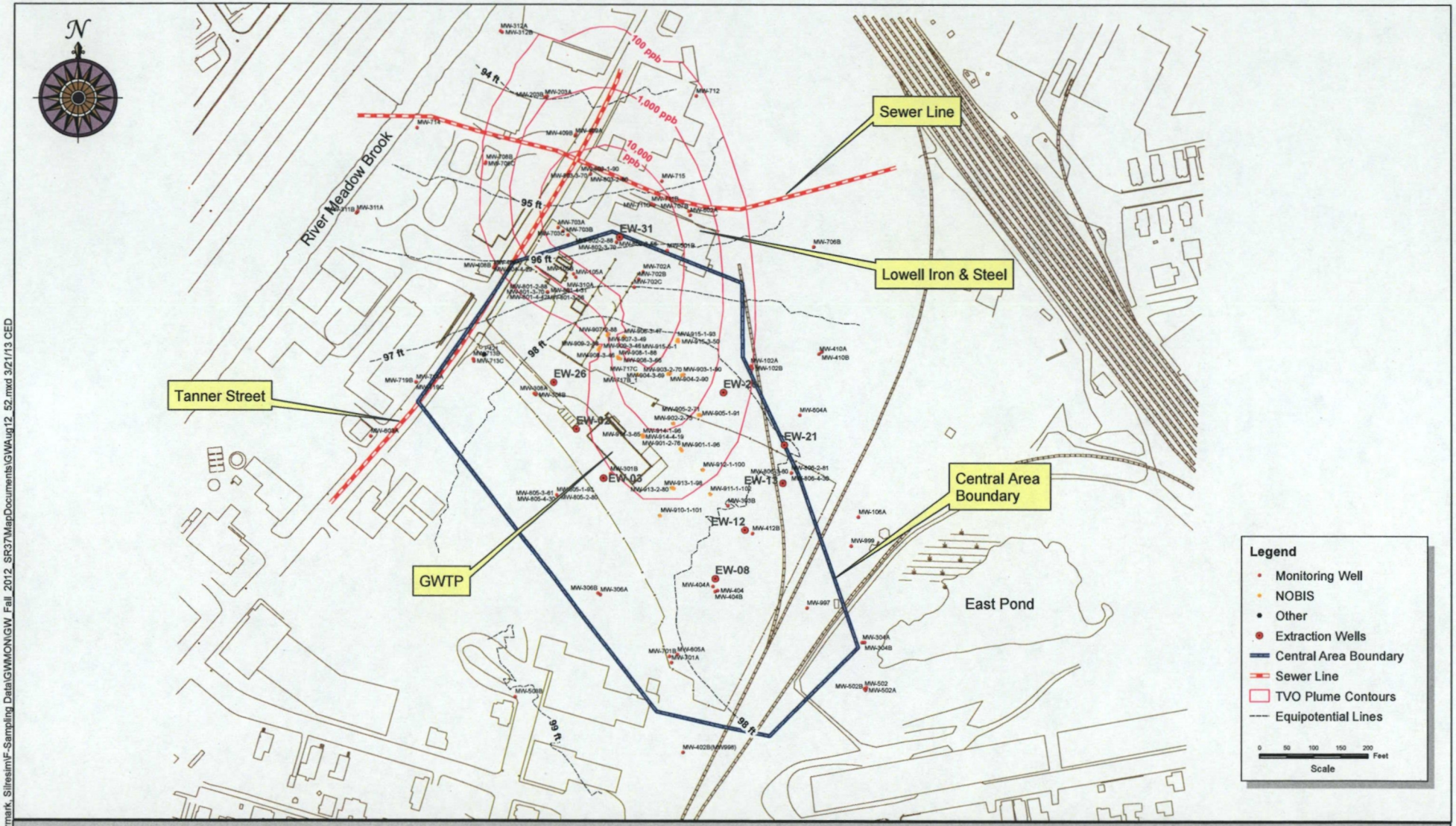

FIGURE 6-2e: EQUIPOTENTIAL SURFACE FOR LAYER 3, AUGUST 2012
Slice Elevation at 52 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Watermark
STONE ENVIRONMENTAL INC

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, August, 2012 Levels.

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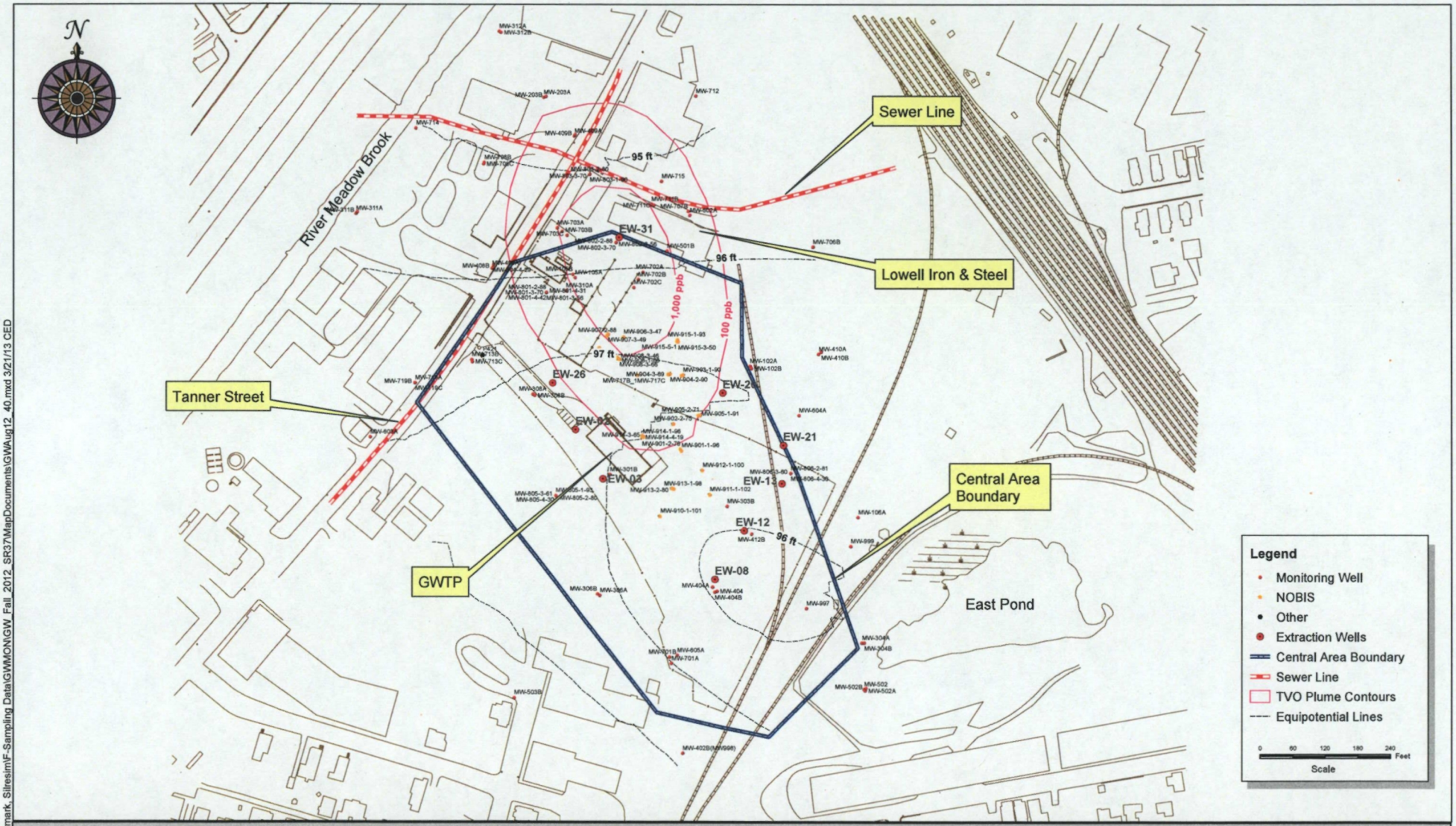

FIGURE 6-2f: EQUIPOTENTIAL SURFACE FOR LAYER 4, AUGUST 2012
Slice Elevation at 40 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Watermark
STONE ENVIRONMENTAL INC

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, August, 2012 Levels.

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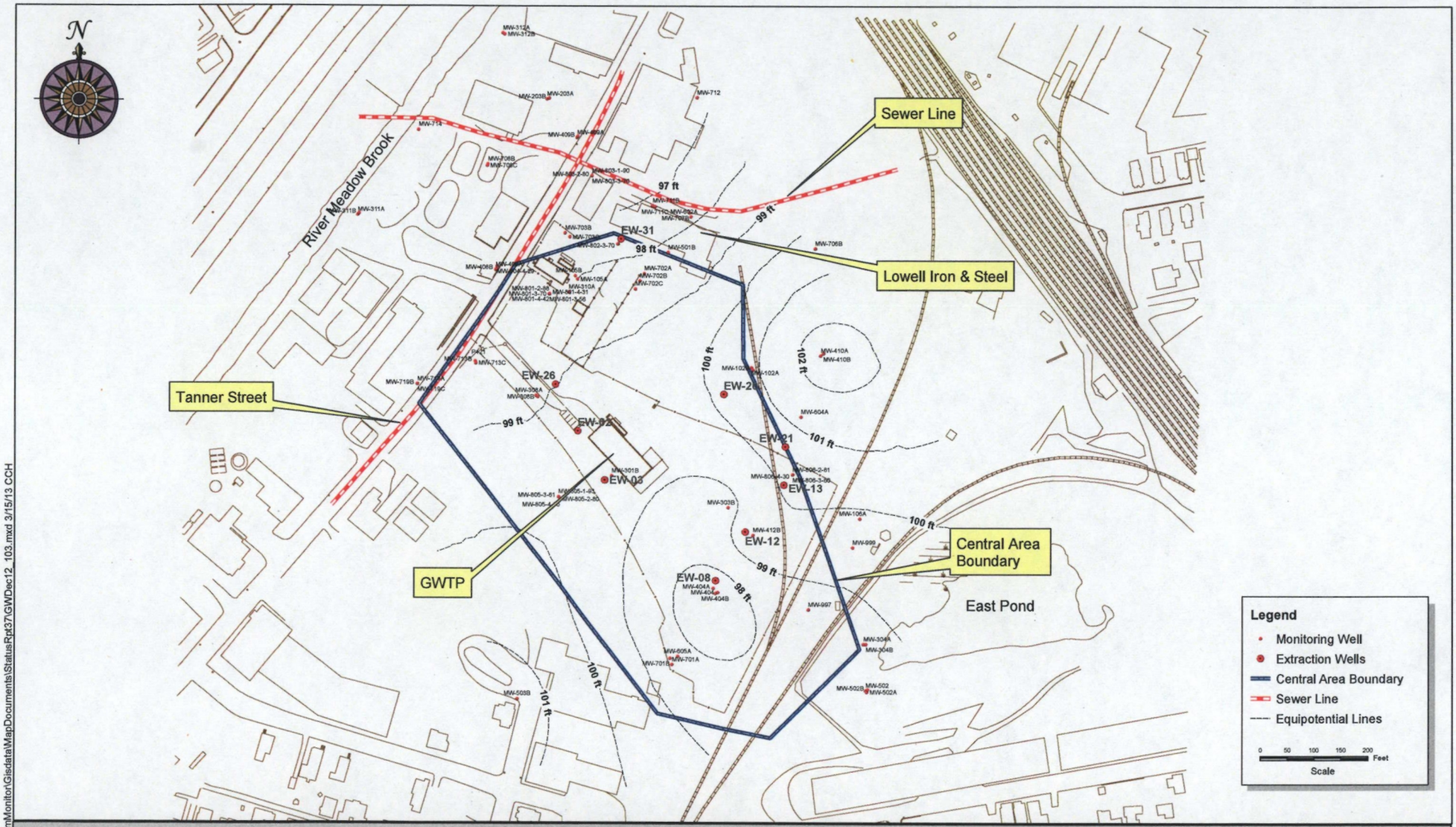

FIGURE 6-2g: EQUIPOTENTIAL SURFACE FOR LAYER 1, DECEMBER 2012
Slice Elevation at 103 ft msl
Silresim Superfund Site, Lowell, Massachusetts

Watermark
STONE ENVIRONMENTAL INC

Sources: Well Locations and Site Plan, Watermark Environmental, Inc.; Hydraulic Head Distribution, December, 2012 Levels.

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