Prepared for:
U.S. Army Corps of Engineers
New England District

FINAL FEASIBILITY STUDY
FORMER ATLAS SITE S-11
ELLENBURG, NEW YORK
FORMERLY USED DEFENSE SITE C02NY0216

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EXECUTIVE SUMMARY

The former Atlas S-11 Intercontinental Ballistic Missile (ICBM) site is in the hamlet of Ellenburg Depot, Town of Ellenburg, Clinton County, New York. The Department of Defense (DOD) acquired the property in 1960 for the ICBM site and deactivated the ICBM site in 1965. The property was conveyed to the Town of Ellenburg in1967. The DOD conducted a preliminary investigation of chemical contamination at the Atlas S-11 site in 1988. Trichloroethene (TCE) was detected in one groundwater sample at a concentration of 6 micrograms per liter (µg/L), which exceeds the drinking water maximum contaminant level (MCL) of 5 µg/L. TCE was also detected at concentrations below 5 µg/L in another monitoring well and in water collected from the missile silo. The Atlas S-11 property was placed in the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS).

In 1990, an investigation in the hamlet of Ellenburg Depot by the New York State Department of Environmental Conservation (NYSDEC) detected TCE at concentrations below MCLs in drinking water wells. The Site, for purposes of this Feasibility Study (FS), includes the former Atlas S-11 property (Property) and surrounding areas with groundwater impacted with contaminants originating from the former Atlas S-11 property. The NYSDEC has regulatory authority over the Site.

A Remedial Investigation (RI) was completed by Weston Solutions, Inc. in 2005 (Weston, 2005) and The Johnson Company, Inc., conducted additional groundwater monitoring from 2006 to 2008. The U.S. Army Corps of Engineers (USACE) New England District (NAE) conducted a Baseline Human Health Risk Assessment (HHRA) for the Site in 2009 (USACE, 2009). No discrete source for groundwater contamination has been found at the Site. This FS was performed under the DERP for FUDS**,** and was conducted in accordance with the Comprehensive Environmental Response Compliance and Liability Act (CERCLA) and National Contingency Plan (NCP), including United States Environmental Protection Agency (USEPA) RI/FS Guidance (USEPA, 1988a).

Detected concentrations of TCE and *cis*-1,2-dichloroethene (*cis*-1,2-DCE) in groundwater at the Site after 2000 have not exceeded MCLs and concentrations have been declining over time. The results from the HHRA indicate that human health risks at the Site are acceptable.

This FS evaluated four remedial alternatives: 1) No Action; 2) Institutional Controls; 3) Additional Long-term Groundwater Monitoring, and 4) Institutional Controls and Long-term Groundwater Monitoring. All four of these alternatives are protective of human health and the environment and comply with Applicable or Relevant and Appropriate Regulations (ARARs). Alternative 1 (No Action) is the recommended alternative for the Site.

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1.0 INTRODUCTION

The former Atlas S-11 property (the Property) is located on Bull Run Road, approximately 1/4 mile north of Route 11 (Figure 1-1), in the hamlet of Ellenburg Depot, Town of Ellenburg, Clinton County, New York, approximately 7 miles south of the Canadian – United States border. Previous investigations identified trichloroethene (TCE) and the associated biodegradation product *cis*-1,2-dichloroethene (*cis*-1,2-DCE) in groundwater on and off the Property.

This Feasibility Study (FS) is being performed under the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS). The Site, for the purposes of this FS, is defined as including the Property and the surrounding areas with groundwater impacted by contaminants originating from the Property, including a portion of the hamlet of Ellenburg Depot. A Remedial Investigation (RI) was completed by Weston Solutions, Inc. (Weston) in 2005 (Weston, 2005). The U.S. Army Corps of Engineers (USACE) New England District (NAE) conducted a Baseline Human Health Risk Assessment (HHRA) for the Site in 2009 (USACE, 2009). The purpose of this FS is to identify, screen, and evaluate potential remedial alternatives for the Site consistent with the Comprehensive Environmental Response Compliance and Liability Act (CERCLA), the National Contingency Plan (NCP), and USACE guidance and policy.

1.1 SITE HISTORY

The Department of Defense (DOD) acquired the Property in 1960 for an Atlas Intercontinental Ballistic Missile (ICBM) site. The Property was one of 12 in the region that formed the Plattsburg Atlas Missile Complex. Prior to this acquisition, the Property was used for agricultural purposes. This ICBM site was deactivated in 1965 and the Property was conveyed by the General Services Administration (GSA) to the Town of Ellenburg in 1967. The Town used the Property for recreation and the Quonset huts on the Property for vehicle storage (Figure 1-2). The current owner of the Property is Leonard Casey, and the Property is now used by a private business for storing architectural stone.

1.1.1 *Regulatory Background*

The DOD has the responsibility to remediate former DOD facilities under the DERP for FUDS, and therefore is responsible for remediation activities at the Site. The goal of the USACE is to achieve regulatory closure for the Site. FUDS program policy requires USACE to:

- Comply with the DERP and CERCLA, Executive Orders 12580 and 13016, the NCP, DERP guidance, and Army policies for the FUDS program;
- Coordinate with the lead regulator, which is the New York State Department of Environmental Conservation (NYSDEC);
- Conduct a remedial investigation with a baseline risk assessment to evaluate the need for remediation; and
- In a response action, attain standards, requirements, or criteria requested by the NYSDEC that are consistent with CERCLA and NCP processes and criteria.

Site investigation and remediation activities must meet federal regulations, policy and guidance. The NYSDEC was granted regulatory authority by the United States Environmental Protection Agency (USEPA) and therefore NYSDEC regulations are applicable or relevant and appropriate requirements (ARARs) to be included in the remedy selection process along with other applicable requirements for the Site. ARARs, such as New York State regulations, were identified and incorporated into the evaluation of alternatives in this FS. It is the policy of the USEPA and the Department of the Army to assure that activities conducted at the Site are protective of human health and the environment, and to meet the substantive provisions of permitting regulations that are ARARs.

This FS was conducted in accordance with the CERCLA and the NCP, including USEPA RI/FS Guidance (USEPA, 1988a) and pursuant to USACE ER 200-3-1 (USACE, 2004). Since the HHRA indicates that the Site poses little threat to human health (see Section 2.3 and Appendix A), this FS is scaled down in accordance with Section 3.4.2.2 of the USEPA RI/FS Guidance document (USEPA, 1988a), which states:

> "The results of the baseline risk assessment may indicate that the site poses little or no threat to human health or the environment. In such situations, the FS should be either scaled down as appropriate to that site and its potential hazard, or eliminated altogether. The results of the RI and the baseline risk assessment will therefore serve as the primary means of documenting a no-action decision".

Based on the results of the RI (see Section 1.1.2.2 and Weston, 2005) and the HHRA (USACE, 2009 included in Appendix A), and the guidance cited above, completing an FS for this Site is not necessarily required under CERCLA. However, the USACE elected to prepare this FS to provide additional documentation for the selection of an appropriate remedial alternative.

1.1.2 <u>Previous Site Investigations</u>

1.1.2.1 Preliminary Investigations

In 1988, the USACE contracted with Law Environmental, Inc. of Kennesaw, Georgia, to conduct a preliminary determination of the presence or absence of chemical contamination resulting from former DOD activities at the Site. Investigation activities included installing three groundwater monitoring wells and collecting samples from surface soil, groundwater, and missile silo water. The soil and water samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and metals. TCE was detected in one of the monitoring wells at a concentration of 6 micrograms per liter (µg/L), which exceeds the drinking water maximum contaminant level (MCL) of 5 µg/L. TCE was also detected at concentrations below 5 µg/L in another monitoring well and in water collected from the missile silo.

In August 1990, a subsurface investigation was conducted by TWM Northeast, Inc. in Ellenburg Depot for the NYSDEC. The subsurface investigation was conducted because chlorinated and aromatic hydrocarbons were detected in water supplies (drilled wells and springs) in Ellenburg Depot by the NYSDEC. Five overburden wells and one bedrock well were installed in Ellenburg Depot. The investigation did not detect VOCs in the overburden or bedrock monitoring wells. The source of the VOCs in the water supply wells and springs was not determined.

In April 1991, a second subsurface investigation was conducted by TWM Northeast, Inc. for the NYSDEC. The investigation focused on potential sources of VOCs, including Northland Hides Processing, Inc. (Northland Hides) and the Site. The data collected during this investigation indicated that Northland Hides did not appear to be the source of the VOCs detected in wells and springs in the project area. TCE and *cis*-1,2-DCE were detected in water samples collected from shallow bedrock monitoring wells and the missile silo at the Site.

1.1.2.2 Remedial Investigation

Weston conducted a RI from 1998 through 2003 and issued the final RI report in 2005 (Weston, 2005). The RI included the following activities:

- Records search and field reconnaissance;
- Water supply well sampling (60 to 64 wells each quarter for four quarters) (Figure 1-3);
- Geophysical investigation of the subsurface;
- Passive soil gas survey (176 sample points);
- Fracture trace analysis;
- Test pit investigation (20 test pits);
- Groundwater monitoring well installation (eight wells) (Figure 1-3);
- Groundwater monitoring well sampling (six sampling rounds);
- Silo water sampling (five discrete depth samples);
- Bedrock core sampling;
- Packer test and heat pulse flow meter (HPFM) investigation; and
- Surface water and sediment sampling in the Great Chazy River.

Following completion of RI activities, Weston presented the following conclusions in the RI report (Weston, 2005):

- Concentrations of VOCs detected in soil samples collected from the test pits did not exceed the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) criteria;
- Metals concentrations detected in soil samples collected from the test pits represent naturally occurring background levels;
- SVOCs detected at concentrations exceeding TAGM criteria in soil samples collected from test pit TP-1 are likely associated with asphalt present in the soil;
- Metals, tetrachlorethene (PCE), and petroleum-related compounds detected in groundwater are not likely the result of former DOD activities at the Site;
- Former DOD activities a the Site may be the source of TCE in groundwater, but no distinct point source remains at the Site;
- TCE was not detected in any groundwater samples collected from private water supply wells or monitoring wells at concentrations exceeding the MCL, except at MW-01 where TCE was detected in an initial groundwater sample at 5.7 μg/L in November 2000, slightly exceeding the MCL of 5 μg/L;
- TCE concentrations in subsequent groundwater samples collected from MW-01 did not exceed the MCL and decreased to 2.4 μg/L by September 2003;

- Based on the conceptual site model (CSM) and HPFM data, groundwater discharges into the Great Chazy River;
- Based on sediment and surface water sampling results, no impacts to the Great Chazy River from groundwater discharges were documented;
- The extent of TCE in groundwater does not extend to the southern side of the Great Chazy River;
- There is evidence that limited biodegradation of TCE is occurring in groundwater at the Site; and
- TCE concentrations in groundwater are being reduced by the physical processes of dilution and dispersion.

1.1.2.3 Long-term Groundwater Monitoring

Following completion of the RI, Weston and then The Johnson Company (JCO), implemented long-term groundwater monitoring at the Site. The long-term groundwater monitoring program consisted of six individual groundwater monitoring events completed from 2006 through 2008. The groundwater monitoring network included one of the groundwater monitoring wells installed during the RI (MW-3) and five potable wells in nearby Ellenburg Depot (PW-24, PW-35, PW-68, PW-80 and PW-118). Reported groundwater concentrations detected during the long-term groundwater monitoring program were all less than one-half of the applicable MCLs. The locations of the long-term groundwater monitoring wells are shown on Figure 1-4 and associated analytical results are summarized in Table 1-1.

1.2 SITE CHARACTERIZATION

1.2.1 Site Description

The Site includes approximately 15 acres of open land surrounded by woods and some agricultural fields (Figure 1-2). The Site contains a single former missile silo that is approximately 70 feet in diameter and 175 feet deep. The missile silo is covered by reinforced concrete doors that are flush with the ground surface. Other visible structures at the Site include two Quonset buildings (each approximately 40 by 100 feet), two smaller storage buildings, and a concrete entrance stairwell that was used for access to the underground missile control facilities. This stairwell is flooded to a depth of approximately 20 feet below ground surface (bgs). An inner 8-foot-high, chain-link fence and an outer 3-foot-high, barbed-wire fence surround the central area of the Site. A private business currently uses a portion of the Site as a storage area for pallets of architectural stone.

The hamlet of Ellenburg Depot is located along U.S. Route 11 and the Great Chazy River, and is southeast of the Site (See Figure 1-1). The area between the Site and Ellenburg Depot consists primarily of wooded areas, with some agricultural fields at the edge of Ellenburg Depot. The predominant soil type at the Site is Schroon fine sandy loam with 3 percent to 8 percent slopes. A review of the NYSDEC environmental resource information did not indicate any rare, threatened or endangered species, or significant natural areas in the vicinity of the Site.

1.2.2 Surface Water

The Site does not contain surface waters or wetlands. An unnamed stream occurs southeast of the Site and flows south through Ellenburg Depot into the Great Chazy River. Brandy Brook is located north of the Site. Significant wetlands mapped by the National Wetland Inventory (NWI) and State of New York occur north of the Site, contiguous with Brandy Brook. Three mapped wetlands also occur south and southeast of the Site, two of which appear to be contiguous with the unnamed stream mentioned above. The third wetland is contiguous with the Great Chazy River to the south of the Site. These mapped wetlands are classified as Class 2 by NYSDEC.

1.2.3 Geology and Hydrogeology

The geology of Ellenburg Depot and most of the surrounding area consists of early Pleistocene glacial till overburden, which is underlain by the early Paleozoic Potsdam Sandstone formation. The glacial till layer is typically 10 to 50 feet thick and is most likely the result of a ground moraine. It consists of variable-texture till with particle sizes ranging from silt to boulder and contains large amounts of Precambrian crystalline rock and Paleozoic sedimentary rock. A recessional moraine runs north by northwest and south by southeast through Ellenburg Depot and ranges from 5 to 100 feet thick (Weston, 2005).

TABLE 1-1 GROUNDWATER MONITORING DATA															
Sample Date	**MCL[1] (µg/L)**	**MW-3**		**PW-24[2]**		**PW-35**		**PW-68**		**PW-80**		**PW-118**		**MW-01[2]**	
		TCE	***cis*-1,2 DCE**	**TCE**	***cis*-1,2 DCE**	**TCE**	***cis*-1,2 DCE**	**TCE**	***cis*-1,2 DCE**	**TCE**	***cis*-1,2 DCE**	**TCE**	***cis*-1,2 DCE**	**TCE**	***cis*-1,2 DCE**
3/1/1999	5	NS	NS	1.2	NA	NA	NA	3.1	NA	3.4	NA	3.4	NA	NS	NS
6/1/1999	5	NS	NS	1.2	NA	2 J	NA	2.7	NA	3.3	NA	2.9 J	NA	NS	NS
9/1/1999	5	NS	NS	1.2	NA	NA	NA	3.2	NA	3.5	NA	1.2	NA	NS	NS
11/7/2000	5	2.6 J	4.3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**5.6 / 5.7**	4.3 / 4.5
4/17/2001	5	1.9 J	0.86 J	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.4 / 2.5	1.9 / 2.0
4/18/2001	5	3	0.82 J	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
12/4/2002	5	1.8	0.78	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	4.9	2.9
3/27/2003	5	1.6	0.72	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.6	1.1
6/11/2003	5	1.4	0.7	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	3	3.2
9/16/2003	5	1.4	0.63	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.4	1.7
7/27/2006	5	0.82	0.64	0.63 / 0.67	0.5 U / 0.5 U	1.1	0.5 U	2.1	0.5 U	1.9	0.41 J	0.69	0.5 U	NS	NS
1/10/2007	5	0.9	0.78	0.64 / 0.58	0.5 U / 0.5 U	0.5 U	0.5 U	2	0.5 U	2	0.4 J	0.89	0.22 J	NS	NS
6/25/2007	5	0.65	0.61	0.67 / 0.62	0.5 U / 0.5 U	0.84	0.5 U	1.7	0.5 U	2.1	0.27 J	1.7	0.21 J	NS	NS
10/8/2007	5	0.7	0.56	0.67 / NA	0.5 U / 0.5 U	0.98	0.5 U	1.8	0.5 U	1.9	0.35 J	1.6	0.35 J	NS	NS
2/12/2008	5	0.81	0.6	0.62 / 0.65	0.5 U / 0.5 U	0.5	0.5 U	1.9	0.5 U	2.1	0.24 J	1.8	0.28 J	NS	NS
8/14/2008	5	0.72	0.6	0.62 / 0.64	0.5 U / 0.5 U	0.77	0.5 U	1.6	0.5 U	1.9	0.25 J	1.2	0.5 U	NS	NS

Notes:

NA = Not Available

NS = No sample collected

U = Analyte was not detected above the method quantitation limit

µg/L = micrograms per liter or parts per billion

J = indicates the stated result is an estimated value

TCE = trichloroethene

cis-1,2-DCE = *cis*-1,2-dichloroethene

Table only includes DOD-related COPCs for groundwater monitoring wells sampled since 1999

TCE and *cis*-1,2-DCE concentrations shown on this Table are in µg/L

Results shown in bold exceed the MCL

[1] The MCLs for TCE and *cis*-1,2-DCE are the same

[2] Two concentrations are shown for TCE and *cis*-1,2-DCE when both a primary and duplicate sample were analyzed

Shaded data were used for baseline Human Health Risk Assessment

The Potsdam Sandstone formation typically consists of quartz sandstone, as well as arkose and shale. Drilling records reviewed by Weston during the RI indicated that Ellenburg Depot is underlain by white/gray sandstone, with some shale reported in the nearby hamlet of Ellenburg Center (Weston, 2005). Outcrops observed in the vicinity of the Site during the RI contained at least two sets of fractures trending in the northwest to southeast direction and perpendicular in the northeast to southeast direction.

In the RI, Weston reported that the groundwater flow direction is toward the south/southeast in the bedrock based on groundwater levels in groundwater monitoring wells at the Site (Weston, 2005). Well records obtained from the New York State Department of Health (NYSDOH) indicate that water supply wells in Ellenburg Depot range in depth from 16 to 232 feet bgs, with casing depths from 11 to 39 feet bgs. Based on 49 wells, the average well depth in Ellenburg Depot is approximately 75 feet bgs. Well yields reportedly range from 6 to 20 gallons per minute.

Fracture trace analysis completed by Weston indicates that a well-developed fracture system exists in the bedrock in the area (Weston, 2005). The principal fracture plane orientations are north-northwest to south-southeast, east-northeast to west-southwest and northwest to southeast. These fracture plane directions are also reflected in the course of the local streams and in the ground surface topography. A set of lineaments identified to the south and east of the Site are apparently topographic expressions of the bedrock fracture systems. These observed bedrock fracture systems likely affect the groundwater flow regime at the Site. While the north to south trending fractures represent the shortest and most direct pathway to the local discharge zone (Great Chazy River), the generally east to west trending fractures induce cross-gradient flow, resulting in an easterly displaced contaminant plume (Weston, 2005). This is generally consistent with the observed distribution of VOCs in groundwater at the Site and in Ellenburg Depot.

1.2.4 *Nature and Extent of Contamination*

Soil

Since 1988, several soil samples were collected from the Site and were analyzed for metals, VOCs, and SVOCs. The concentrations of VOCs detected in RI soil samples were relatively low and did not exceed NYSDEC TAGM criteria (Weston, 2005). The concentrations of SVOCs detected in soil samples collected from the Site were also relatively low and did not exceed NYSDEC TAGM criteria, with one exception. This exception was a soil sample collected from test pit TP-1 at a depth of 4.0 to 4.5 feet bgs, which contained elevated concentrations of SVOCs believed to be associated with asphalt present in the trench soil (Weston, 2005). The concentrations of metals detected in soil samples collected from the Site exceed the NYSDEC TAGM criteria; however, these concentrations represent naturally occurring background levels (Weston, 2005).

Sediment and Surface Water

Neither sediment nor surface water was identified as media of concern at the Site during previous investigations. However, sediment and surface water samples were collected from the Great Chazy River to the southeast of the Site and were analyzed for VOCs. VOCs were not detected in these sediment and surface water samples. Based on the relatively low concentrations of VOCs detected in groundwater samples collected from potable wells near the Great Chazy River and the absence of VOC detections in sediment and surface water samples collected from the Great Chazy River, Weston concluded that it is unlikely groundwater discharges are impacting the Great Chazy River (Weston, 2005).

Groundwater

Groundwater sampling was conducted at the Site from 1988 to 2008 and included analysis for VOCs, SVOCs, and metals. Thallium was detected at concentrations exceeding the MCL; however, Weston reported that this metal is naturally occurring in the bedrock at the Site. Iron and manganese, which do not have health-based MCLs, were detected at levels that exceed their secondary standards (aesthetic-based MCLs), but Weston concluded that these compounds are also naturally occurring in the bedrock at the Site. Sodium, which does not currently have a

MCL, was detected at apparently elevated concentrations in monitoring well samples, but Weston concluded that this is the result of road deicing (Weston, 2005). Although petroleum-related compounds (i.e., benzene), 1,2-dichloroethane (1,2-DCA), and PCE were detected in a few wells in Ellenburg Depot, these contaminants are not related to DOD activities at the Site (Weston, 2005).

TCE and the associated biodegradation product *cis*-1,2-DCE were detected in groundwater samples collected from shallow groundwater wells at the Site. However, the detected concentrations of TCE and *cis*-1,2-DCE were less than their respective MCLs, except TCE in the initial groundwater samples collected from MW-01. TCE (MCL of 5 µg/L) was detected at 5.6 and 5.7 µg/L in the primary and duplicate samples, respectively, collected from MW-01 in November 2000. Concentrations of TCE detected in all samples collected from MW-01 since these initial samples (2001 through 2003) were less than the MCL. Concentrations of TCE and *cis*-1,2-DCE detected in samples collected from wells at the Site (in Ellenburg Depot) were less than the MCLs. 1,2-DCA was detected at 9.5 µg/L (MCL of 5 µg/L) in a groundwater sample collected from PW-25 in December 1998; however, it was not detected above the MCL in subsequent samples. Weston concluded that 1,2-DCA at this location is not likely related to DOD activities at the Site (Weston, 2005).

1.3 CONCEPTUAL SITE MODEL (CSM)

1.3.1 Conceptual Model of Groundwater Flow

The RI report by Weston presented a CSM explaining groundwater flow directions in the bedrock aquifer based on three-dimensional groundwater data (see Figures 3-1 and 2-14 of the RI). Based on the results of the HPFM testing and down-hole temperature logs, Weston concluded there are two local groundwater flow regimes and a deeper regional groundwater flow regime in the vicinity of the Site (Weston, 2005). The topographic high area between the Site and the Brandy Brook generally coincides with the groundwater divide for the two local regimes and provides recharge for both Brandy Brook and the Great Chazy River. With the Site located on the south side of this divide, groundwater flow beneath the Site is generally to the south/southeast (towards the Great Chazy River) and groundwater flow on the north side of this divide is generally to the north (towards Brandy Brook) (Weston, 2005).

The CSM assumes that the regional groundwater flow regime occurs directly below the local system and discharges to the Great Chazy River. Based on data collected from MW-02, Weston concluded that the divide between the local and regional groundwater flow regimes is approximately 80 feet bgs at MW-02 (Weston, 2005). This regional regime is likely recharged at a regional divide located north of the Site. Based on the results presented in the RI, it is unlikely that the deeper groundwater flow regime is impacted by VOCs (Weston, 2005).

1.3.2 Contaminant Fate and Transport

One of the primary objectives of the RI was to identify a discrete source area for contaminants previously detected at the Site. To achieve this objective, the RI included: geophysical surveys to locate buried objects; test pits and soil sampling at 20 locations, including reported geophysical anomalies; passive soil gas sampling at 176 locations to identify VOCs present in soil; and additional sampling of six groundwater monitoring wells, 64 water supply wells, and standing water in the abandoned missile silo. Although relatively low concentrations of TCE were detected in samples collected from the soil and the missile silo, a discrete source area was not identified during the RI despite the extensive investigation. Weston concluded in the RI report that due to the length of time since DOD activities occurred on the Site and the highly fractured nature of the bedrock, it is likely that any contaminants released at the Site migrated downward into the bedrock several years ago (Weston, 2005). Although former DOD activities at the Site may be the source of VOCs detected in groundwater wells in the area, no distinct point source in the unconsolidated deposits remains at the Site (Weston, 2005).

The CSM assumes that TCE, which occurs as a dense non-aqueous phase liquid (DNAPL), migrated downward through the soil to the bedrock aquifer, where through slow dissolution, low-level concentrations of dissolved TCE were transported toward Ellenburg Depot and the Great Chazy River by the local groundwater flow regime. Based on vertical groundwater profiling and flow direction data from the RI, it is unlikely that TCE is migrating into the lower regional groundwater flow regime at the Site (Weston, 2005). As TCE dispersed in the local groundwater flow regime, concentrations likely decreased due to limited biodegradation; as demonstrated by the presence of *cis*-1,2-DCE. The concentrations of TCE and *cis*-1,2-DCE are likely further reduced by dilution and dispersion as the groundwater flows toward the Great Chazy River. Although TCE and *cis*-1,2-DCE were detected in groundwater samples collected from groundwater wells at the Site, concentrations decreased over time and the most recent concentrations are all less than one-half of the MCLs. Due to biodegradation, dilution, and dispersion, concentrations of TCE and *cis*-1,2-DCE in groundwater are expected to continue to decrease over time (Weston, 2005).

Although impacted groundwater may discharge into the Great Chazy River, VOCs were not detected in surface water or sediment samples (Weston, 2005). It is likely that the groundwater and river water are diluting VOCs to concentrations below laboratory detection limits when discharging into the Great Chazy River. Since TCE was not detected in groundwater wells on the south side of the Great Chazy River, it appears that TCE impacts are confined to the local groundwater flow regime, which likely discharges into the Great Chazy River (Weston, 2005).

2.0 DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES

The first step in the FS process presented in Section 300.430(e) of the NCP, is the development of remedial action objectives (RAOs). RAOs are developed based on the evaluation of contaminants of concern (COCs) for the protection of human health and contaminants of ecological concern (CECs) for the protection of ecological receptors, exposure routes, human and ecological receptors, and location-specific ARARs. The development of RAOs represents an essential element of the overall remedial alternatives development and evaluation process. The RAOs are required to clearly articulate the intent of remedial activities that are implemented at the Site to address risks to human health or ecological receptors.

RAOs specify the COCs and CECs, exposure pathways, and Preliminary Remediation Goals (PRGs). The PRGs are used to develop the remedial alternatives. The PRGs are developed based on ARARs and human health and ecological risk assessments.

2.1 IDENTIFICATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121 of CERCLA requires that the ARARs of federal and more stringent state laws must be attained by any remedial action selected, unless one of the specific ARAR waivers established in Section 121(d)(4) is invoked by the lead agency, in this case the USACE. The NCP, and relevant USEPA guidance, specify that ARARs may be chemical-specific, action-specific, or location-specific [see 40 CFR, Section 300.400(g)(1)]. ARARs were identified using *CERCLA Compliance with Other Laws Manual Parts I and II* (USEPA, 1988b), *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final* (USEPA, 1988a), and NYSDEC *Technical Guidance for Site Investigation and Remediation, Draft DER-10* (NYSDEC, 2009).

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or more stringent state laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the Site. Relevant and appropriate requirements are those requirements, criteria, or limitations that, while not "applicable," address problems or situations sufficiently similar to those encountered at the Site. Any requirement, or portion thereof, that is determined by the lead agency to be a relevant and appropriate requirement must be attained by a selected remedy to the same degree as if it were determined to be an applicable requirement.

In addition to ARARs, To Be Considered (TBC) criteria may be considered as part of the site-specific risk assessment and may be used in determining the necessary cleanup for the protection of human health or the environment. TBCs are defined as non-promulgated advisories or guidance issued by state or federal governments that are not legally binding and do not have the status of potential ARARs. TBCs are evaluated along with ARARs and are considered appropriate in the absence of a specific ARAR or where ARARs are not sufficiently protective in developing cleanup goals.

The table in Appendix B presents a listing of those chemical-specific, location-specific, and action-specific ARARs and TBCs, which provide the key requirements in remedial alternative evaluation and comparison.

2.1.1 Chemical-Specific ARARs and TBCs

MCLs are federal chemical-specific ARARs for potable groundwater. The federal Safe Drinking Water Act (SDWA) is an applicable ARAR for the Site. New York State has primacy under the Clean Water Act and has established standards and guidance values for groundwater (6 NYCRR Part 703.5), which are also considered chemical-specific ARARs. The relevant NYSDEC groundwater standards are those for "Class GA Fresh Groundwater," which is the groundwater classification in the vicinity of the Site. New York State has established soil clean-up objectives and guidance that are ARARs for the Site (NYSDEC, 1994). Other chemical-specific ARARs do not represent cleanup levels, but can trigger other action-specific ARARs.

2.1.2 Location-Specific ARARs and TBCs

State and federal regulations that apply to natural and cultural resources are potential location-specific ARARs for the Site. Examples are state and federal wetland regulations and state groundwater and surface water classifications. The historical uses and structures at the Site are sufficiently old that they may be considered eligible for state or federal listing as a historical site.

2.1.3 Action-Specific ARARs and TBCs

Action-specific ARARs and TBCs apply to the implementation of a remedy. The federal CERCLA regulations (40 CFR Part 300), Resource Conservation and Recovery Act (RCRA) regulations, and New York State environmental remediation program regulations (6 NYCRR Part 375) and the related guidance documents, are considered action-specific ARARs and establish the framework for evaluating remedial alternatives for the Site.

2.2 SUMMARY OF CONTAMINANTS OF POTENTIAL CONCERN

The contaminants of potential concern (COPCs) at the Site are TCE and the associated breakdown product *cis*-1,2-DCE. The detected concentrations of TCE in two groundwater samples collected at the Site more than nine years ago slightly exceeded the MCL; however, TCE in all other groundwater samples collected from the Site were less than the MCL. All detected concentrations of *cis*-1,2-DCE in groundwater samples collected from the Site were less than the MCL. The detection of relatively low concentrations of TCE and *cis*-1,2-DCE in soil gas samples and subsurface soil samples collected at the Site indicate that these contaminants were likely released at the Site, even though a discrete source was not identified. Table 1-1 summarizes key groundwater sampling results for DOD-related COPCs detected at the Site. A complete list of groundwater sampling results is presented in the RI report (Weston, 2005) and long-term groundwater monitoring reports (JCO, 2008a, 2008b, 2008c, and 2009).

2.3 SUMMARY OF BASELINE RISK ASSESSMENT

2.3.1 Human Health Risk Assessment

A HHRA was prepared to estimate the potential current and future risks to human health from exposure to COPCs associated with former DOD activities at the Site. Since COPC concentrations appear to have decreased over time in groundwater wells, only the most recent groundwater data (long-term groundwater monitoring data from 2006 through 2008) were used for the HHRA (see highlighted portion of Table 1-1). These most recent groundwater monitoring data were used because they are considered to be the most representative of current groundwater conditions at the Site. The HHRA estimated carcinogenic risk and non-carcinogenic hazards associated with potential exposure to COPCs in groundwater due to vapor intrusion and household use of groundwater. A copy of the HHRA is included as Appendix A.

The HHRA calculated the excess cancer risk and non-carcinogenic hazard quotient for vapor intrusion at the Site to be approximately $1x10^{-6}$ and 0.001, respectively. The HHRA estimated the total risk for exposure from household use of groundwater at the Site to be approximately:

- $7x10^{-7}$ for age-adjusted excess cancer risk;
- 0.02 non-carcinogenic hazard quotient for a child; and
- 0.008 non-carcinogenic hazard quotient for an adult.

The calculated excess cancer risks indicated above are less than or equal to the lower end of the USEPA target risk range of 10^{-4} to 10^{-6} (USEPA, 1991). Similarly, the calculated non-carcinogenic hazard quotients are significantly below the USEPA upper bound of 1 (USEPA, 1989). The NYSDEC Technical Guidance for Site Investigation and Remediation (NYSDEC, 2009) refers to CERCLA for guidance in performing a quantitative risk assessment, which incorporates the USEPA target risk numbers. Therefore, concentrations of COPCs in groundwater at the Site do not represent unacceptable risks to human health.

2.3.2 Ecological Risk Assessment

Based on the findings and conclusions presented in the RI report (Weston, 2005), an ecological risk assessment was not prepared for the Site. These key findings and conclusions include the following:

- Concentrations of VOCs, SVOCs, and metals detected in soil samples are lower than NYSDEC TAGM criteria or are not associated with former DOD activities at the Site;
- The only medium of concern that is impacted with DOD-related COPCs is groundwater, which generally occurs at depths beyond 5 feet bgs; and
- Sediments and surface water where impacted groundwater is likely discharging into the Great Chazy River did not have detectable concentrations of COPCs.

In general, either the potential exposure pathways are incomplete or the anticipated exposure point concentrations are lower than applicable screening criteria for ecological receptors at the Site. Therefore, an ecological risk assessment is not warranted for the Site.

2.4 REMEDIAL ACTION OBJECTIVES

RAOs were developed based on the evaluation of COPCs, media impacted, exposure routes, human and ecological receptors, and ARARs. The RAOs are required to clearly articulate the intent of remedial activities that are implemented at the Site to address risks to human health or ecological receptors. No COCs were identified for the Site.

Based on the results of the RI, the contaminated medium of concern is groundwater in the shallow bedrock aquifer. The CSM for the Site indicates that transport of the COPCs to the deeper bedrock aquifer is unlikely, and the slow dissolution and limited biodegradation processes are maintaining COPCs at low concentrations. Based on the results of the RI, the COPCs for the Site (TCE and the associated biodegradation product *cis*-1,2-DCE) do not present unacceptable risk to human health or the environment. The Site currently meets the ARARs as detailed in Section 2.1 and Appendix B. A discrete source for the COPCs in groundwater at the Site was not identified during the RI.

Screening groundwater RAOs for the Site were developed to evaluate remedial alternatives that:

- Prevent exposure (i.e., ingestion, inhalation, and direct contact) to site-specific COPCs (TCE and *cis*-DCE) in groundwater at levels that present an unacceptable risk to human health;
- Minimize COPC-related constraints that restrict land and/or groundwater use at the Site; and
- Meet federal and state ARARs and/or risk-based cleanup levels for groundwater.

3.0 IDENTIFICATION AND DEVELOPMENT OF ALTERNATIVES

3.1 GENERAL RESPONSE ACTIONS

General response actions (GRAs) that may be applicable at hazardous waste sites include:

- No Action;
- Limited Action;
- Containment;
- Removal; and
- Treatment.

The maximum concentration of TCE detected in groundwater samples collected during the RI and long-term groundwater monitoring was 5.7 µg/L (from MW-01 in 2000). This maximum was the only groundwater result that exceeded the MCL for TCE (5 µg/L) in any sample collected from groundwater wells to date. The TCE degradation product *cis*-1,2-DCE was detected in a few wells on the Site, but always at concentrations less than the MCL of 5 µg/L. More recent concentrations of VOCs detected in samples collected from groundwater wells at the Site were below MCLs and appear to decrease over time.

Despite a thorough RI, a discrete source for TCE contamination was not identified at the Site. The CSM suggests that TCE previously released at the Site has migrated downward into the shallow bedrock aquifer where it now acts as a continuing source of relatively low levels of TCE and *cis*-1,2-DCE in groundwater (Weston, 2005). The monitored natural attenuation (MNA) parameters measured at the Site indicate that limited biodegradation is likely occurring, but biodegradation is not likely the primary cause of declining COPC concentrations in groundwater. Dispersion and dilution are most likely the dominant processes causing reductions in COPCs at the Site (Weston, 2005).

A HHRA was completed using recent (2006 through 2008) groundwater monitoring data from drinking water wells at the Site. The excess cancer risks and hazard quotients (non-cancer risks) calculated in the HHRA are below USEPA target risk levels.

Based on the RI and HHRA results summarized above, GRAs selected to address the RAOs established in Section 2.4 are No Action and Limited Action. A No Action remedy involves no remedial activities. Limited Action may include assessment of conditions on a periodic basis through five-year reviews, engineering and/or institutional controls. A No Action GRA, required for consideration in an FS under CERCLA, can be used as a baseline against which other alternatives are compared.

3.2 IDENTIFICATION OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 Approach

In circumstances where there are risks to human health or ecological receptors, an FS should identify and screen remedial technologies and process options, then assemble those remaining into appropriate remedial alternatives that are further screened and analyzed in detail. Based on the HHRA, unacceptable human health risks are not present at the Site and ARARs are currently met. Under these conditions, a FS may be scaled down (or eliminated) under CERCLA guidance (see Section 1.1.1). Because unacceptable human health risks are not present at the Site, this FS evaluates only options that do not require active remediation. These options are No Action and Limited Action, which are described in the following sections.

3.2.2 No Action

As described above, No Action is a required remedial alternative under CERCLA, and provides a baseline against which other alternatives are compared. No Action would mean no further actions, testing, reporting, etc.

3.2.3 Limited Action

Limited Action may include engineering controls (e.g., fencing) and/or institutional controls (e.g., land use restrictions and public information programs) to mitigate potential exposure and to inform the community about the reduction of groundwater contamination over time. It may also include long-term groundwater monitoring.

3.2.3.1 Institutional Controls

Deed restrictions on the Site that prohibit the installation and use of potable water wells can be established, if needed, to eliminate potential exposure to COPCs in groundwater. Although a portion of the Site is currently fenced, the results of shallow soil sampling on the Site do not indicate a need for fencing to prevent exposure to COPCs in soil. Another potential institutional control includes communication of long-term groundwater monitoring results to the public.

3.2.3.2 Additional Long-term Groundwater Monitoring

Additional long-term groundwater monitoring would include annual sampling of groundwater wells MW-01, MW-03, PW-24, PW-35, PW-68, PW-80, and PW-118 (Figure 3-1). The collected groundwater samples would be analyzed for VOCs by USEPA Method 524.2. Additional long-term groundwater monitoring would continue until detected concentrations of VOCs remain below MCLs for a minimum of 5 years.

3.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

3.3.1 Alternative 1: No Action

The No Action alternative would include no remedial activities. Since very low level contamination would remain at the Site, five-year reviews might be appropriate for some period of time to confirm the on-going protection of human health and the environment, and to demonstrate that conditions have not worsened. According to USEPA Guidance, five-year reviews are not required if the remaining contamination is below levels that allow for unlimited use and unrestricted exposure (USEPA, 2001). There is no distinct source of contamination left on the Site; therefore, a Five Year review is not required.

3.3.2 Alternative 2: Institutional Controls

Alternative 2 would include placing a deed restriction on the Site that would prevent the installation and use of potable groundwater wells. Although the deed restriction would limit the land use for the Site, protectiveness does not rely on this institutional control. Therefore, five-year reviews are not required under USEPA guidance (USEPA, 2001). To ensure this alternative is protective over time, a five-year review is included in this alternative. The five-year review for this alternative would be made available to the public through posting on the USACE NAE website, and by placing a hard copy of the report in the local public information repository.

3.3.3 Alternative 3: Additional Long-term Groundwater Monitoring

Alternative 3 would include annual sampling of groundwater wells MW-01, MW-03, PW-24, PW-35, PW-68, PW-80, and PW-118 for VOCs (Figure 3-1). The results of the annual groundwater sampling would be posted on the USACE NAE website; and a link would be provided from the Town of Ellenburg website. Hard copies of the monitoring reports would also be provided in the local public information repository. Additional groundwater monitoring data would provide greater confidence that residual VOCs in groundwater remain below MCLs and that applicable risk thresholds are not exceeded over time. If future groundwater monitoring results indicate that VOC concentrations in groundwater wells have risen above MCLs, or are trending upward, additional activities may be required at the Site. Additional groundwater monitoring would continue annually until detected concentrations of VOCs remain below MCLs for a minimum of 5 years. Although not required by USEPA guidance, a five-year review is included as part of this alternative as described above for Alternative 2.

3.3.4 Alternative 4: Institutional Controls and Additional Long-term Groundwater Monitoring

Alternative 4 includes the remedial activities described above for Alternatives 2 and 3.

4.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section documents the detailed analysis of remedial alternatives for the Site. The purpose of the detailed analysis is to provide information to decision-makers that allows them to compare alternatives and select an appropriate remedy for the Site. The NCP requires that the detailed analysis of remedial alternatives is conducted using evaluation criteria. A description of the evaluation criteria is provided below in this section, followed by a detailed analysis of each remedial alternative.

4.1 EVALUATION CRITERIA

The NCP requires that the detailed analysis of remedial alternatives is conducted using nine criteria (NCP 300.430; 55FR 8849). The nine criteria, which encompasses statutory requirements and technical, cost and institutional considerations, are divided into three categories: 1) threshold criteria; 2) balancing criteria; and 3) modifying criteria.

The first two criteria are the threshold criteria. Any alternative that does not satisfy both of these criteria is dropped from further consideration in the detailed analysis, unless the requisite basis for a waiver of an ARAR exists pursuant to CERCLA Section 121(d)(4). These two criteria are:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

Five primary balancing criteria are used to make comparisons between the remedial alternatives. Alternatives that satisfy the two threshold criteria are evaluated further using the following balancing criteria:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, and/or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

The remaining two criteria, State of New York acceptance and community acceptance, are modifying criteria. State acceptance and community acceptance will be evaluated after receipt of public comments on the USACE NAE Proposed Plan, which will identify the remedial alternative preferred by USACE NAE.

A discussion of the seven evaluation criteria (the threshold and balancing criteria) used in the detailed analysis of remedial alternatives in this FS is presented below.

Overall Protection of Human Health and the Environment

This threshold evaluation criterion provides an overall assessment of protection based on a composite of short-term and long-term effectiveness factors. Evaluation of overall protection addresses:

- How well a specific remedial action achieves protection over time;
- How well risks are reduced; and
- How each source of contamination is to be eliminated, reduced, or controlled for each remedial alternative.

Compliance with ARARs

This second threshold evaluation criterion is used to determine how each remedial alternative complies with federal and state ARARs as defined in CERCLA Section 121. Each alternative is evaluated in detail for compliance with:

- Chemical-specific ARARs;
- Action-specific ARARs;
- Location-specific ARARs; and
- Other appropriate criteria, advisories, and guidance (i.e., TBCs).

The potential ARARs and TBCs for the Site are discussed in Section 2.2.1 and are summarized in Appendix B.

Long-term Effectiveness

This evaluation criterion addresses the effectiveness of the remedial alternatives in terms of reducing risk. The components of this criterion include the following:

- Magnitude of the remaining risks measured by numerical standards such as cancer risk levels;
- Adequacy and suitability of physical controls for managing residuals or untreated wastes; and

- Long-term reliability of management controls for providing continued protection from residuals (i.e., the assessment of potential failure of the technical components).

Since physical management controls are not necessary at the Site to address risk, the long-term effectiveness evaluation focuses on residual risk.

Reduction of Toxicity, Mobility, and/or Volume through Treatment

This evaluation criterion addresses the statutory preference that treatment at the Site result in reduction of the total mass of contaminants, irreversible reduction in contaminant mobility, and/or reduction of the total volume of contaminated media. Factors usually evaluated under this criterion include the following:

- Treatment process employed;
- Amount of hazardous material destroyed or treated;
- Degree of reduction in toxicity, mobility, and/or volume expected; and
- Type and quantity of treatment residuals.

Since active treatment is not a reasonable option for the Site due to the absence of a discrete source to be treated and the limited risks posed by the COPCs, the focus of this criterion evaluation is on reduction of toxicity, mobility, and/or volume through non-treatment means.

Short-Term Effectiveness

This evaluation criterion addresses the impacts of the remedial action during the construction and implementation phases, which precede the attainment of the RAOs. Factors to be evaluated include the following:

- Protection of workers and neighboring communities during the remedial actions;
- Environmental impacts resulting from the implementation of the remedial actions; and
- Time required for achieving protection.

Implementability

This criterion addresses the technical and administrative feasibility of implementing a remedial action and the availability of various services and materials required during remedial action implementation.

Technical feasibility factors may include:

- Construction and operation difficulties;
- Reliability of the technology;
- Ease of undertaking additional remedial actions, if necessary; and
- Ability to monitor the effectiveness of the remedy.

Since active remedial technologies are not a reasonable option for the Site due to the absence of a discrete source to be treated and the limited risk posed by the COPCs, the evaluation of this criterion will focus on the last two factors.

The administrative feasibility factors include:

- Ability and time required to coordinate with other agencies;
- Availability of services and materials including availability of treatment, storage, and disposal services with required capacities;
- Availability of equipment and specialists; and
- Availability of prospective technologies for competitive bidding.

Cost

This criterion addresses: capital costs; operation and maintenance (O&M) costs; present worth of capital and O&M costs; and potential future remedial action costs, if necessary. Present worth analysis allows remedial alternatives to be compared on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, is sufficient to cover all costs associated with the remedial alternative over the entire project cycle. A required operating performance period is assumed for present worth, which is a function of the discount rate and time. A discount rate of 7 percent is assumed for the base calculation. The "study estimate" costs provided for the remedial actions are intended to reflect actual costs with an accuracy of -30 to +50 percent, as stated in the RI/FS Guidance document (USEPA, 1988a).

4.2 ALTERNATIVE 1: NO ACTION

4.2.1 Threshold Criteria

Protection of human health and the environment

There were two reported COPC results that exceeded the MCL: 6 µg/L TCE in a sample collected from one monitoring well at the Site in 1988; and 5.7 µg/L TCE in a sample collected from monitoring well MW-01 at the Site in 2000. No COPCs were detected at concentrations that exceed MCLs in subsequent samples collected from wells at the Site between 2001 and 2008. Also, excess cancer risks and hazard quotients (non-cancer risks) calculated in a recently completed HHRA (see Appendix A) for COPCs reported during recent (2006 through 2008) groundwater monitoring events were all below USEPA and NYSDEC target risk levels. Therefore, it appears that even if groundwater at the Site is used for drinking water in the future, this alternative would be protective of human health.

Compliance with ARARs

Federal drinking water MCLs and NYSDEC groundwater standards for "Class GA Fresh Groundwater," which are the same for TCE and *cis*-1,2-DCE (5 µg/L), are chemical-specific ARARs. Recent concentrations of COPCs detected during groundwater monitoring at the Site were less than MCLs. Therefore, the No Action alternative satisfies these chemical-specific ARARs.

4.2.2 *Balancing Criteria*

Long-term Effectiveness

With the No Action alternative, remedial actions would not be implemented at the Site. Given the apparent decreasing trend for COPCs in groundwater samples and the acceptable human health risks associated with exposure to recent groundwater sample concentrations, it is anticipated that future human health risks associated with COPCs in groundwater will continue to be at acceptable levels and likely will decrease over time. Therefore, this alternative is expected to be effective at maintaining RAOs in the long-term.

Reduction of Toxicity, Mobility, and/or Volume

The No Action alternative would not result in a reduction of toxicity, mobility, or volume of contaminants due to the remedy itself; however, toxicity is being naturally reduced as a result of decreasing concentrations of COPCs through attenuation processes (dilution and dispersion) and some COPC mass is being eliminated over time as a result of limited biodegradation.

Short-Term Effectiveness

Since remedial activities would not be performed with this alternative, there would be no increased risks to workers or the public as a result of remedial activities.

Implementability

There are no technical feasibility issues for the No Action alternative.

Cost

There are no capital costs for the No Action alternative.

4.3 ALTERNATIVE 2: INSTITUTIONAL CONTROLS

4.3.1 Threshold Criteria

Protection of human health and the environment

As described under Alternative 1, there are currently no unacceptable risks associated with exposure to Site-related COPCs. At the Site, there were no exceedances of MCLs or NYSDEC groundwater standards during the most recent groundwater monitoring events (2006 through 2008). It is expected that groundwater concentrations of COPCs at the Site have decreased over time (due to dilution, dispersion, and limited biodegradation); however, with limited recent groundwater monitoring data, the establishment of deed restrictions that prohibit installation and use of drinking water wells at the Site may be a conservative measure.

Compliance with ARARs

As with Alternative 1, ARAR compliance would be satisfied with this alternative.

4.3.2 Balancing Criteria

Long-term Effectiveness

With Alternative 2, the deed restriction preventing the installation and use of potable water wells at the Site would be effective in the long-term, because the deed restriction would be passed on to subsequent property owners.

Reduction of Toxicity, Mobility, and/or Volume

This alternative would not result in a reduction of toxicity, mobility, or volume of contaminants due to the remedy itself; however, as with Alternative 1, toxicity and COPC mass are being naturally reduced through attenuation processes (dilution and dispersion) and limited biodegradation.

Short-Term Effectiveness

Since no remedial activities would be performed with this alternative, there would be no increased risks to workers or the public as a result of remedial activities.

Implementability

There are no technical feasibility issues for this alternative. In terms of administrative feasibility, legal expertise would be required to draft the deed restriction. In addition, coordination with regulatory agencies would be required for five-year reviews. Legal services for the deed restriction and consulting services for five-year reviews are readily available, and the regulatory coordination would be easy to manage.

Cost

There are no capital costs for Alternative 2. The costs associated with this alternative would be the legal services and recording fees for the deed restriction, costs for a round of groundwater monitoring for the five-year review, and costs for the five-year review report. The legal and recording costs would be an initial one-time cost estimated at $42,000. The five-year review cost is estimated at $34,000, including a round of groundwater sampling. The present worth cost for this alternative is approximately $66,000, assuming five years and a 7 percent discount rate. Details for these cost estimates are provided in Appendix C.

4.4 ALTERNATIVE 3: ADDITIONAL LONG-TERM GROUNDWATER MONITORING

4.4.1 Threshold Criteria

Protection of human health and the environment

As with Alternatives 1 and 2, there are currently no unacceptable risks associated with exposure to Site-related COPCs. It also does not appear that there would be unacceptable risks if drinking water wells were installed and used at the Site; however, there is limited recent groundwater data from the Site. Additional long-term groundwater monitoring at the Site would provide current data regarding groundwater conditions, which would not be provided in Alternative 1 (which only includes existing groundwater data) and Alternative 2 (which includes existing data and new data collected with the five-year review).

Compliance with ARARs

As with Alternatives 1 and 2, ARAR compliance would be satisfied with this alternative. However, unlike Alternatives 1 and 2, Alternative 3 would provide redundant annual groundwater data to further demonstrate on-going compliance with groundwater ARARs.

4.4.2 Balancing Criteria

Long-term Effectiveness

With this alternative, remedial actions would not be implemented at the Site. Given the apparent decreasing trend for COPC concentrations in groundwater samples and the acceptable human health risks associated with exposure to recent groundwater sample concentrations, it is anticipated that future human health risks associated with COPCs in groundwater will continue to be at acceptable levels and likely will decrease over time. Therefore, this alternative is expected to be effective at maintaining RAOs in the long-term.

Reduction of Toxicity, Mobility, and/or Volume

This alternative would not result in a reduction of toxicity, mobility or volume of contaminants due to the remedy itself; however, toxicity and COPC mass is being reduced naturally through attenuation processes (dilution and dispersion) and limited biodegradation. The additional long-term groundwater monitoring data is expected to further confirm these reductions over time.

Short-Term Effectiveness

Since no remedial activities would be performed with this alternative, there would be no increased risks to workers or the public as a result of remedial activities.

Implementability

There are no technical feasibility issues for this alternative. In terms of administrative feasibility, coordination with regulatory agencies would be required for the annual groundwater monitoring events and a five-year review. Consulting services for the annual groundwater monitoring events and five-year reviews are readily available, and regulatory coordination would be relatively easy to manage.

Cost

There are no capital costs for Alternative 3. The costs associated with this alternative would include costs for the annual groundwater monitoring events and costs for a five-year review. Setting up the procedures for reporting the additional long-term groundwater monitoring results to the public would have an initial cost, plus small annual costs in subsequent years. These costs are included with the annual groundwater monitoring and reporting costs. The annual monitoring cost would be approximately $24,000 (including a groundwater monitoring round for the five-year review), and the five-year review report cost would be approximately $10,000. The present worth cost for this alternative is approximately $106,000, assuming five years and a 7 percent discount rate. Details for these cost estimates are provided in Appendix C.

4.5 ALTERNATIVE 4: INSTITUTIONAL CONTROLS AND ADDITIONAL LONG-TERM GROUNDWATER MONITORING

4.5.1 Threshold Criteria

Protection of human health and the environment

As with the other alternatives, there are currently no unacceptable risks at the Site and the most recent groundwater data (from 2006 through 2008) from the Site indicate COPC concentrations are less than MCLs. Establishing deed restrictions for the Site combined with annual groundwater monitoring would be an increasingly conservative approach (compared to Alternatives 1, 2, and 3) for ensuring the protection of human health.

Compliance with ARARs and TBCs

As with the other alternatives, ARAR compliance would be satisfied with this alternative. Annual groundwater data would provide on-going confirmation of compliance with groundwater ARARs.

4.5.2 Balancing Criteria

Long-term Effectiveness

The deed restriction preventing the installation and use of potable water wells at the Site would be effective in the long-term because the deed restriction would be passed on to subsequent property owners. Given the apparent decreasing trend for COPCs in groundwater samples and the acceptable human health risks associated with exposure to recent groundwater sample concentrations, it is anticipated that future human health risks will continue to be at acceptable levels and likely will decrease over time. Therefore, this alternative is expected to be effective at maintaining RAOs in the long-term.

Reduction of Toxicity, Mobility, and/or Volume

This alternative would not result in a reduction of toxicity, mobility or volume of contaminants due to the remedy itself; however, toxicity and COPC mass is being reduced naturally through attenuation processes (dilution and dispersion) and limited biodegradation. The additional groundwater monitoring data is expected to further confirm these reductions.

Short-Term Effectiveness

Since remedial activities would not be performed under this alternative, there would be no increased risks to workers or the public as a result of remedial activities.

Implementability

There are no technical feasibility issues for this alternative. In terms of administrative feasibility, legal expertise would be required to draft the deed restriction. In addition, coordination with regulatory agencies would be required for the annual groundwater monitoring events and a five-year review. Legal services for the deed restriction and consulting services for the five-year review are readily available, and regulatory coordination would be relatively easy to manage.

Cost

There are no capital costs for Alternative 4. The costs associated with this alternative would be the legal services and recording fees for the deed restriction, costs for annual groundwater monitoring, and costs for the five-year review. The legal and recording costs would involve an initial one-time cost estimated at $42,000. Setting up the procedures for reporting groundwater monitoring results to the public would have an initial cost, plus small annual costs in subsequent years. The initial cost is included with the legal costs and the annual reporting costs are included with the long-term groundwater monitoring costs. The annual groundwater monitoring events would cost approximately $24,000 (including a groundwater monitoring round for the five-year review) and the five-year review report would cost approximately $10,000. The present worth cost for this alternative is approximately $148,000, assuming five years and a 7 percent discount rate. Details for these cost estimates are provided in Appendix C.

5.0 COMPARATIVE ANALYSIS

This section documents the comparative analysis of remedial alternatives for the Site. This analysis evaluates the relative performance of each of the remedial alternatives analyzed in detail (Section 4.0) relative to the same specific evaluation criterion. This provides decision-makers with another tool for selection of an appropriate remedy.

5.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

There are currently no unacceptable risks at the Site and the most recent groundwater data (from 2006 to 2008) from the Site indicate COPC concentrations are less than MCLs, suggesting that future use of groundwater at the Site would be protective of human health. Alternative 1 (No Action) is therefore protective of human health. Alternatives 2 and 4 include deed restrictions to prohibit future use of groundwater at the Site as a conservative measure to ensure future protection of human health. Alternative 3 does not include deed restrictions, but includes annual groundwater monitoring to provide current groundwater data at the Site to confirm that COPC concentrations are below MCLs and remain below risk thresholds. Alternative 4 combines the deed restriction with annual groundwater monitoring and is the most conservative approach for ensuring protection of human health.

5.2 COMPLIANCE WITH ARARS

The most recent groundwater data indicate compliance with groundwater ARARs, which is the case for all four alternatives, including No Action. The annual groundwater monitoring included in Alternatives 3 and 4 provides redundant confirmation that groundwater ARARs are satisfied. Alternative 1 will rely on existing groundwater data and Alternative 2 will rely on existing data and new data collected in support of the five-year review.

5.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

All four of the alternatives are expected to be effective and permanent, unless future groundwater monitoring data indicate future COPC concentrations exceed MCLs or risk thresholds (a low-probability risk that is the same for all alternatives). Future MCL exceedances are not expected, but they would likely be detected by future groundwater monitoring events (five-year frequency for Alternative 2, and annually for Alternatives 3 and 4).

5.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

None of the four alternatives include active remedial treatment. However, there would be on-going reductions in toxicity as COPC concentrations continue to decrease over time due to dilution, dispersion, and limited biodegradation. These reductions in COPC concentrations are a result of natural processes and would be the same for all four alternatives.

5.5 SHORT-TERM EFFECTIVENESS

None of the four alternatives involve active remediation; therefore, none of them will create increased risks to workers or the public as a result of remedial activities.

5.6 IMPLEMENTABILITY

Since none of the four alternatives involve active remediation, there are no technical feasibility issues associated with remedy implementation. The groundwater monitoring tasks associated with the five-year review for Alternatives 2, 3, and 4, and additional long-term monitoring included in Alternatives 3 and 4 are easily implementable. In terms of administrative feasibility, three of the alternatives involve a five-year review, which will require coordination with regulatory agencies and communication with the public, but will be relatively easy to manage. Legal services, which are readily available, will be required to establish the deed restrictions for Alternatives 2 and 4. Consulting services required to perform the tasks in all but the No Action Alternative are readily available.

5.7 COST

The estimated present worth costs for the four alternatives range from a low of $0 for Alternative 1 (No Action), $66,000 for Alternative 2 (Institutional Controls), $106,000 for Alternative 3 (Additional Long-term Groundwater Monitoring), and a high of $148,000 for Alternative 4 (Institutional Controls and Additional Long-term Groundwater Monitoring). Details for these cost estimates are provided in Appendix C.

5.8 SUMMARY

A summary of the comparative analysis of alternatives is provided in Table 5-1. All four of the alternatives compare favorably and fairly similarly against the seven evaluation criteria. Minor differences between the alternatives are noted for the criterion Overall Protection of Human Health and Compliance with ARARs. There most significant differences are found under the Cost criterion. These differences are summarized below.

The protection of human health and compliance with ARARs at the Site for Alternatives 1 and 3 rely on groundwater sampling results from the Site since 2001. The CSM suggests groundwater concentrations of COPCs will decrease over time (a trend generally observed in sampling data from Site wells); however, there is limited recent groundwater data from the Site. This less recent groundwater monitoring data from the Site reduces the certainty of compliance with groundwater ARARs and protectiveness of human health if future drinking water wells are installed and used at the Site. Alternative 3 includes annual groundwater monitoring to provide more current groundwater monitoring data from the Site to confirm the protection of human health and compliance with ARARs. Alternatives 2 and 4 include institutional controls (deed restrictions) that would serve to prevent future use of groundwater at the Site as a drinking water source, thereby providing additional confidence that human health is protected at the Site in the future.

The evaluation criterion for which there is a significant difference between alternatives is Cost. Alternative 1 has no cost, Alternative 2 is more costly (approximately $66,000), and Alternatives 3 and 4 have slightly higher costs (approximately $106,000 and $148,000, respectively) due to the inclusion of annual groundwater monitoring. Costs for Alternatives 2 and 4 include the cost for obtaining and preparing institutional controls. The cost estimates for Alternatives 2, 3, and 4 assume one-time groundwater with the single five-year review.

TABLE 5-1 **COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES**							
Remedial Alternatives	**Evaluation Criteria**						
	Threshold Criteria		**Balancing Criteria**				
	Overall Protection of Human Health and the Environment	**Compliance with ARARs**	**Long-term Effectiveness**	**Reduction of Toxicity, Mobility and/or Volume**	**Short-Term Effectiveness**	**Implementability**	**Cost (Present Worth)**
Alternative 1: No Action	Protective[1]	Compliant[1]	Effective	Reduction Limited to Natural Attenuation Processes	Effective	Easily Implementable	Very Low ($0)
Alternative 2: Institutional Controls	Protective	Compliant[1]	Effective	Reduction Limited to Natural Attenuation Processes	Effective	Reasonably Implementable	Low ($66,000)
Alternative 3: Additional Long-term Groundwater Monitoring	Protective[2]	Compliant[2]	Effective	Reduction Limited to Natural Attenuation Processes	Effective	Reasonably Implementable	Moderate ($106,000)
Alternative 4: Institutional Controls and Additional Long-term Groundwater Monitoring	Protective[2]	Compliant[2]	Effective	Reduction Limited to Natural Attenuation Processes	Effective	Reasonably Implementable	Moderate ($148,000)

[1] These determinations are based on limited recent groundwater data from the Site

[2] As with Alternative 1, these determinations are based on limited recent groundwater data from the Site; however, these alternatives include collection of redundant annual groundwater data from the Site to confirm conditions

6.0 RECOMMENDED ALTERNATIVE

Alternative 1, No Action is the recommended alternative for the Site. The continued groundwater monitoring at the Site over the last decade has confirmed the CSM, which suggested that dispersion, dilution, and limited degradation will lower contaminant concentrations. All current results (from 2003 through 2008) indicated that COPC concentrations in groundwater are less than half of their threshold criteria (MCLs). Therefore, concentrations of COPCs in groundwater at the Site pose no unacceptable risks to human health (see Appendix A).

7.0 REFERENCES

JCO, 2008a. *Final Long-term Groundwater Sampling Event #9, Former Atlas Site S-11, Ellenburg, New York.* The Johnson Company, Inc. for U.S. Army Corps of Engineers, New England District, April 2008.

JCO, 2008b. *Final Long-term Groundwater Sampling Event #10, Former Atlas Site S-11, Ellenburg, New York.* The Johnson Company, Inc. for U.S. Army Corps of Engineers, New England District, April 2008.

JCO, 2008c. *Final Long-term Groundwater Sampling Event #11, Former Atlas Site S-11, Ellenburg, New York.* The Johnson Company, Inc. for U.S. Army Corps of Engineers, New England District, August 2008.

JCO, 2009. *Final Long-term Groundwater Sampling Event #12, Former Atlas Site S-11, Ellenburg, New York.* The Johnson Company, Inc. for U.S. Army Corps of Engineers, New England District, January, 2009.

NYSDEC, 1994. *Division Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels (TAGM 4046).* New York State Department of Environmental Conservation, January 24, 1994.

NYSDEC, 2009. *Draft DER-10 Technical Guidance for Site Investigation and Remediation, Division of Environmental Remediation*. New York State Department of Environmental Conservation, November 4, 2009.

USACE, 2004. *Environmental Quality, Formerly Used Defense Sites (FUDS) Program Policy*. Department of the Army, U.S. Army Corps of Engineers, May 10, 2004.

USACE NAE, 2009. *Baseline Human Health Risk Assessment, Former Atlas Site S-11, Ellenburg, New York.* U.S. Army Corps of Engineers, New England District, May 2009.

USEPA, 1988a. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA Interim Final.* U.S. Environmental Protection Agency, OSWER Directive 9355.3-01, October 1988. EPA/540/G-89/004.

USEPA, 1988b. *CERCLA Compliance With Other Laws Manual Interim Final.* U.S. Environmental Protection Agency, August 1988. EPA/540/G-89/006.

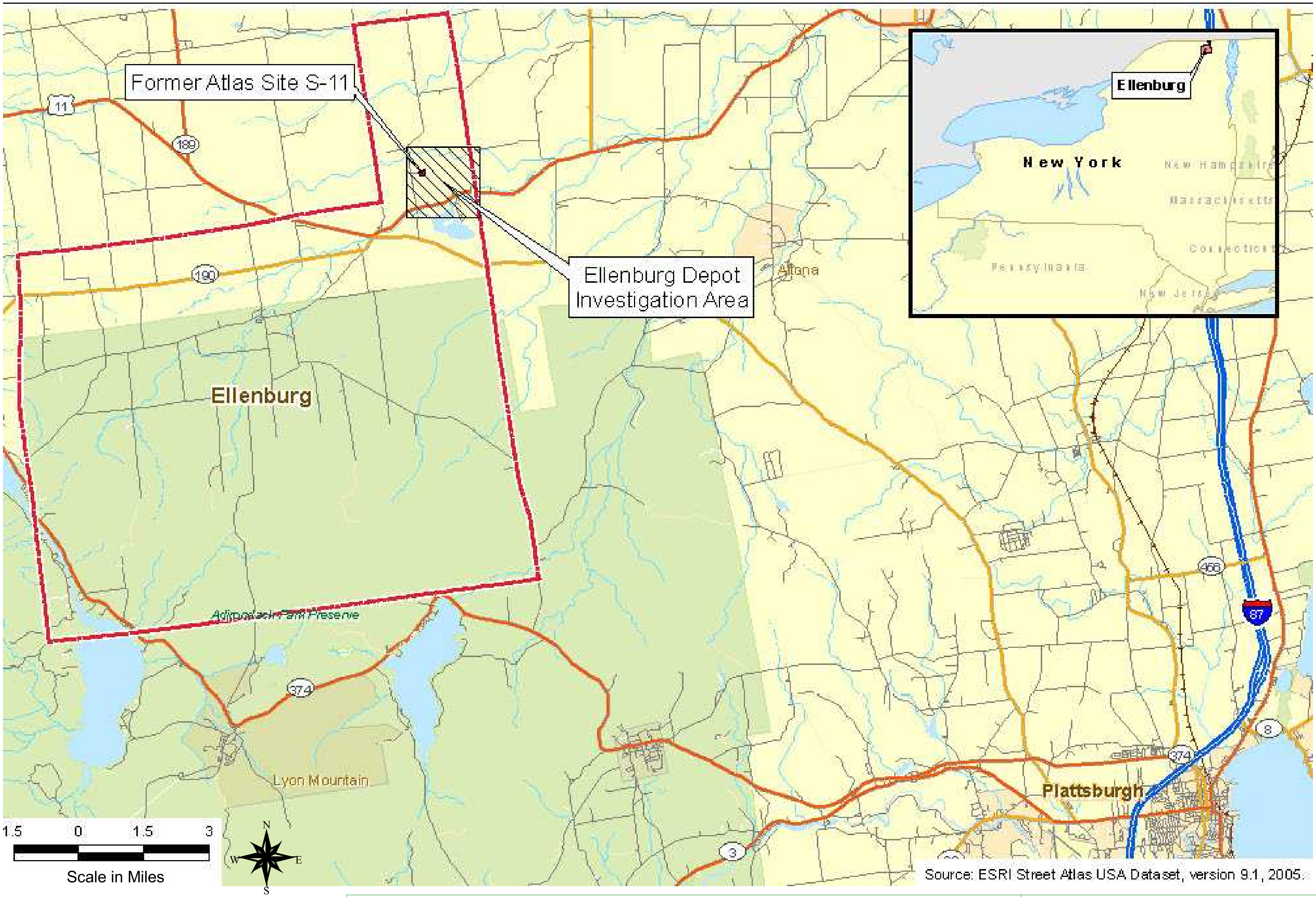
USEPA, 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A).* U.S. Environmental Protection Agency, December 1989. EPA/540/1-89-002.

USEPA, 1991. *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decision.* OSWER Directive #9355.0-30, April.

USEPA, 2001. *Comprehensive Five-Year Review Guidance.* U.S. Environmental Protection Agency, Office of Emergency and Remedial Response (5204 G), June 2001. OSWER 9355.7-03B-P.

Weston Solutions, Inc. (Weston), 2005. *Final Remedial Investigation Report DCN: AMS2-120401-AAEL. Former Atlas Site S-11, Ellenburg, New York.* Weston Solutions, Inc. for U.S. Army Corps of Engineers, New England District, October 2005.

FIGURES



SOURCE: SITE LOCATION MAP BY WESTON SOLUTIONS, OCTOBER 2007.

GIS\WestLocMap.apr

FIGURE 1-1: SITE LOCATION MAP
FORMER ATLAS SITE S-11
ELLENBURG, NEW YORK

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 11/03/10 PROJECT: 1-2128-5
DRAWN BY: TJK SCALE: AS SHOWN

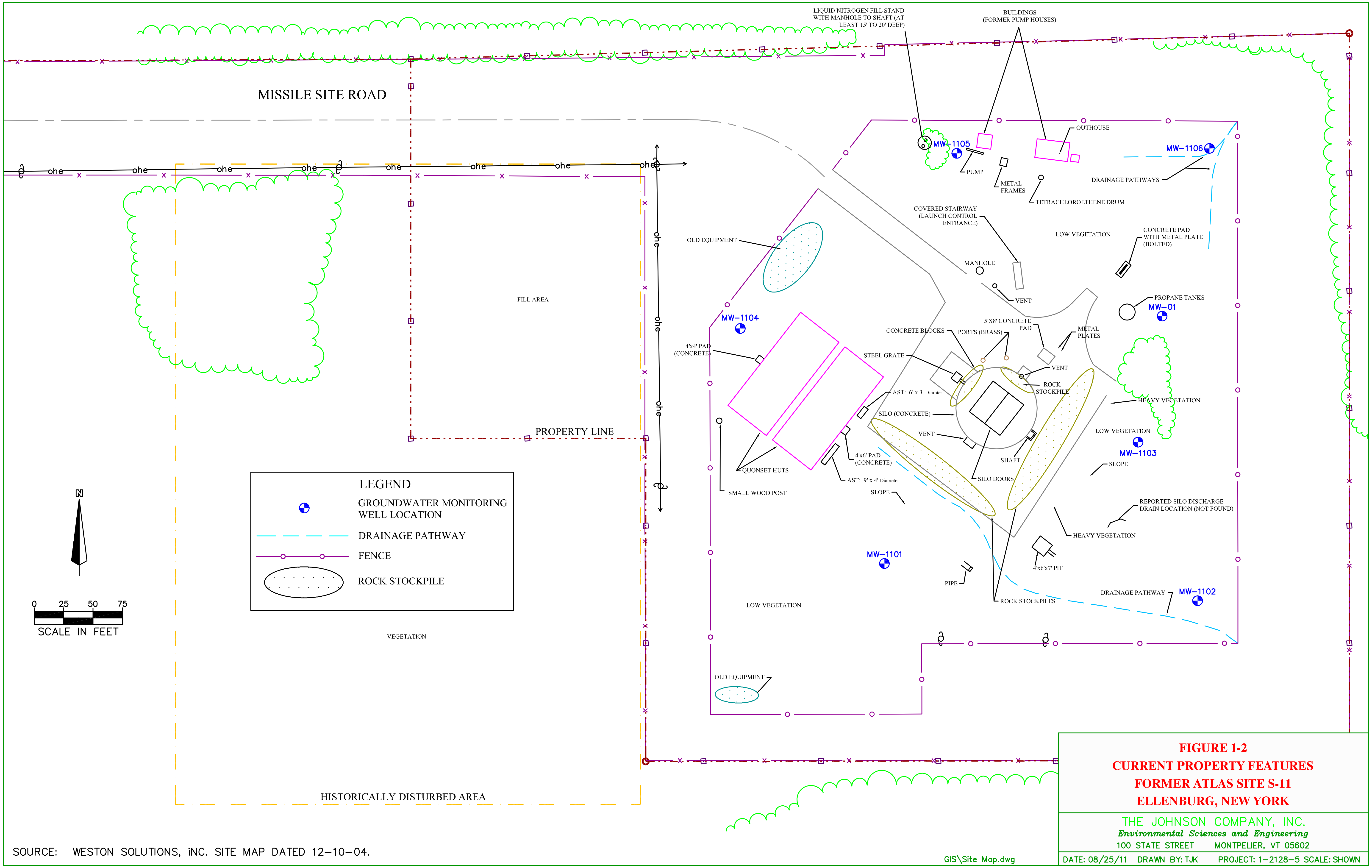


FIGURE 1-2
CURRENT PROPERTY FEATURES
FORMER ATLAS SITE S-11
ELLENBURG, NEW YORK

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 08/25/11 DRAWN BY: TJK PROJECT: 1-2128-5 SCALE: SHOWN

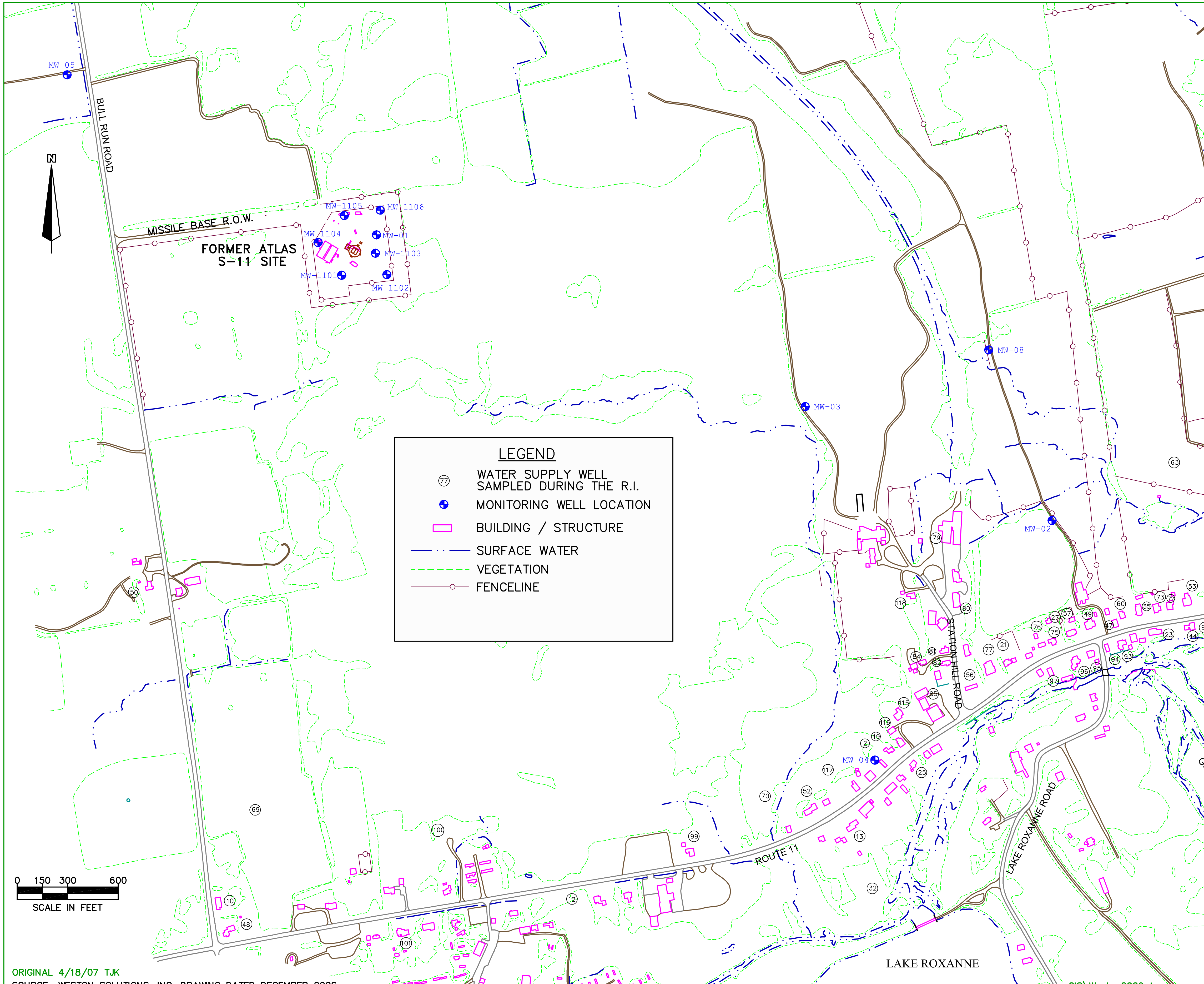


FIGURE 1-3: HISTORICAL GROUNDWATER MONITORING LOCATIONS
FORMER ATLAS S-11 SITE
ELLENBURG, NEW YORK

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 11/03/10 DRAWN BY: TJK PROJECT: 1–2128–5 SCALE: SHOWN

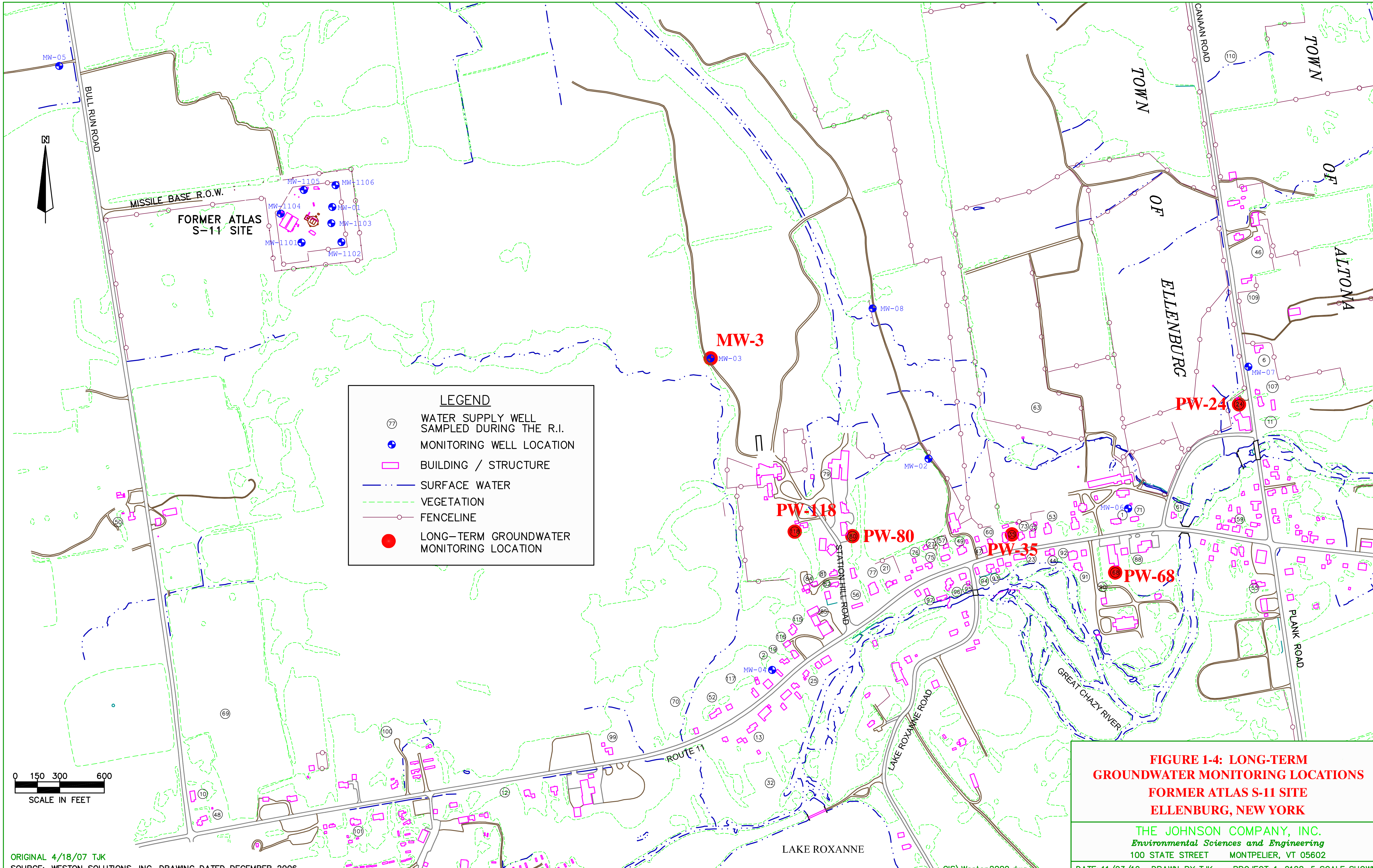


FIGURE 1-4: LONG-TERM GROUNDWATER MONITORING LOCATIONS
FORMER ATLAS S-11 SITE
ELLENBURG, NEW YORK

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 11/03/10 DRAWN BY: TJK PROJECT: 1-2128-5 SCALE: SHOWN

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ORIGINAL 4/18/07 TJK
SOURCE: WESTON SOLUTIONS, INC. DRAWING DATED DECEMBER 2006.

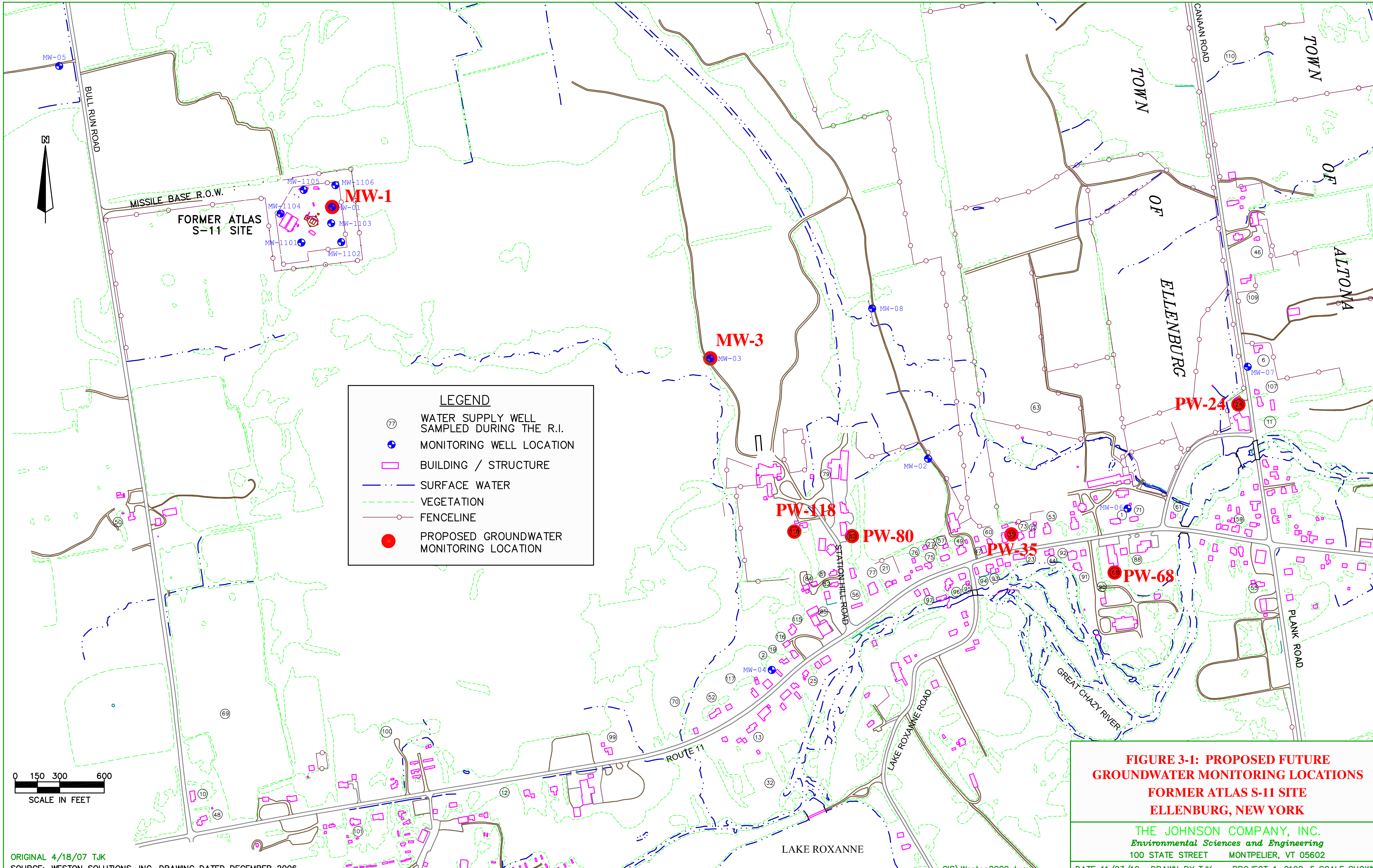

FIGURE 3-1: PROPOSED FUTURE GROUNDWATER MONITORING LOCATIONS
FORMER ATLAS S-11 SITE
ELLENBURG, NEW YORK

THE JOHNSON COMPANY, INC.
Environmental Sciences and Engineering
100 STATE STREET MONTPELIER, VT 05602

DATE: 11/03/10 DRAWN BY: TJK PROJECT: 1-2128-5 SCALE: SHOWN

ORIGINAL 4/18/07 TJK
SOURCE: WESTON SOLUTIONS, INC. DRAWING DATED DECEMBER 2006.

APPENDIX A

BASELINE HUMAN HEALTH RISK ASSESSMENT

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

AAF	Absorption Adjustment Factor
ADD	Average Daily Dose
AF	Adherence Factor
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
BW	Body Weight
COC	Contaminant of Concern
COPC	Compounds of Potential Concern
CF	Conversion Factor
CSF	Cancer Slope Factor
CSM	Conceptual Site Model
ED	Exposure Duration
EF	Exposure Frequency
ELCR	Excess Lifetime Cancer Risk
EPC	Exposure Point Concentration
FS	Feasibility Study
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LOAEL	Lowest Observable Adverse Effect Level
NAS	National Academy of Sciences
NCEA	National Center for Environmental Assessment
ND	Not Detected
NOAEL	No Observed Adverse Effect Level
RAGS	Risk Assessment Guidance for Superfund
RfC	Reference Concentration
RfD	Reference Dose
UR	Unit Risk
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WOE	Weight of Evidence

1.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

The following section is the baseline risk assessment. It is conducted under the Formerly Utilized Defense Sites (FUDS) program using federal methods for risk assessment as specified by the Defense Environmental Restoration Program (DERP). As required by the DERP, the technical methods used at FUDS are those developed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. CERCLA was amended by the Superfund Amendments and Reauthorization Act (SARA) on October 17, 1986. The National Contingency Plan (NCP) was concurrently revised to provide the guidelines and procedures for responses to releases and threatened releases of hazardous substances, pollutants, or contaminants.

The purpose of the risk assessment is to determine the need for remediation. Where remediation is required, USACE is required to conduct Feasibility Studies (FS), Remedial Designs and Remedial Actions (RA) for Contaminants of Concern (COCs) identified during the remedial investigation (RI) process. In such cases risk assessment typically is used to determine health-protective interim remediation goals, and to determine that a selected remediation has attained final cleanup goals.

The risk assessment estimates potential current and future risks to human health from exposures to VOCs released from the site. The risk assessment follows federal human health risk assessment guidance as provided in USEPA's *Guidance for Data Usability in Risk Assessment* (USEPA 1992), *Risk Assessment Guidance for Superfund* (RAGS Part A through F, USEPA 1989, 1996, 1997, 2001, 2004a, 2009c). The four-step risk assessment process defined by the National Academy of Sciences (NAS, 1983) and U.S. EPA (USEPA, 1989) is:

Hazard Identification	Discusses analytical data, data quality and usability, and constituents of potential concern (COPC). COPCs are a subset of the target analytes that are carried through the quantitative risk assessment.
Toxicity Assessment	Summarizes the toxicological data for COPCs.
Exposure Assessment	Identifies potential human receptors, real or potential transport pathways (the exposure pathways) in environmental media, the real or hypothetical places where exposures may occur (the exposure point), and quantifies the frequency and intensity of the exposure to COPCs.
Risk Characterization	Combines exposure and toxicity information to estimate the magnitude or likelihood of adverse health effects from potential exposures.

The following additional step often is included:

Uncertainty Analysis	Provides further considerations that may bear on the risk estimates, in order to support site management decisions.

The FUDS is located in Ellenburg Depot, New York. Atlas intercontinental ballistic missiles were placed in the FUDS, which was one of the numerous launching facilities known as the Plattsburgh Complex between the years 1960 and 1965. This was the only ICBM complex within the continental United States located east of the Mississippi River. No missiles were fired from the FUDS.

1.1 Conceptual Site Model

The focus of the investigation is on groundwater, based on many years of investigation at this FUDS. The conceptual site model (CSM) of the investigation is used to focus the investigation on complete (or potentially complete) exposures. The CSM is composed of the following three elements:

- *Source*—chlorinated solvents (i.e., volatile organic compounds, or VOCs) were commonly used at the facility as degreasers and cleaners at the time the former FUDS was operational. Those material were primarily released to the subsurface soil via spills, leaks, or disposals to the soil surface or other appurtenances such as drains, tanks, or dry wells. Secondary sources may exist in soil or bedrock as residual pools that are heavier than water. These pools may then slowly dissolve into nearby groundwater. There are no known identifiable sources of FUDS-eligible constituents (i.e., those related to the former military mission) remaining in the accessible soils within the FUDS, only residuals are identified.
- *Pathway*—dissolved chlorinated solvents in the groundwater at Ellenburg Depot have been observed to be migrating in the direction of the groundwater flow from the launch area. There are no known springs or other areas where direct contact with contaminated groundwater may occur. In the past, concentration of VOCs detected in several monitoring wells occasionally have exceeded drinking water standards, but not in any of the sampled potable water wells in the community. More recent results from the potable wells indicate gradual decreases in concentration.
- *Receptor*—the people of Ellenburg Depot use the groundwater. No target analytes were found in the surface water and sediment of the North Branch Chazy River. At locations other than the households using groundwater at Ellenburg Depot other VOCs from the FUDS are not believed to reach human and ecological receptors and as such no other receptors are undergoing exposure.

Although monitoring of the groundwater has been underway for some time, the baseline risk assessment represents conditions based on recent sample data. The recent data have been collected from six potable well locations that continue to serve as a monitoring network[1].

1.2 HAZARD IDENTIFICATION

Hazard identification evaluates the inherent toxicity of a substance involved in a complete exposure. The constituents of potential concern (COPC) have been identified for the FUDS as volatile organic compounds (VOCs) based on years of investigation and monitoring what is detected in the groundwater. The following are the VOCs that have been detected during recent groundwater sampling events:

- Chloroform
- 1,2-Cis-dichloroethylene
- Trichloroethylene

[1] The Clinton County

- Toluene
- Xylene

The subject of this RI report is focused on the health effects related to residual contamination of the groundwater as it currently exists.

1.2.1 Groundwater Detections of Target Analytes

Groundwater data available for use in the HHRA extends back to 1999, with the most recent data gathered in 2008. Recently gathered data are used in the risk assessment since they best represent current conditions. Table 1 lists the sample well designation, the location of the well where VOC analytes were detected, the date of the sample, and the VOC detected at each location.

Table 1. Recent Groundwater Monitoring Results

Well	Setting	Date and Analyte Detected					
PW-24	Hardware Store	7/27/2006 o TCE	1/10/2007 o TCE	6/25/2007 o TCE	10/08/2007 o TCE	02/12/2008 o TCE	8/14/2008 o TCE
PW-35	Residence	7/27/2006 o TCE	1/10/2007 o CHCl3	7/5/2007 o TCE o CHCl3	10/08/2007 o TCE o CHCl3	02/12/2008 o TCE o CHCl3	8/14/2008 o TCE o CHCl3
PW-68	Market	7/27/2006 o TCE	1/10/2007 o TCE o CHCl3	6/25/2007 o TCE o CHCl3	10/08/2007 o TCE	02/12/2008 o TCE	8/14/2008 o TCE
PW-80	Business	7/27/2006 o c12DCE o TCE	1/10/2007 o c12DCE o TCE	6/25/2007 o c12DCE o TCE	10/16/2007 o c12DCE o TCE	02/12/2008 o c12DCE o TCE	8/14/2008 o c12DCE o TCE
PW-118	Residence	7/27/2006 o TCE	1/10/2007 o c12DCE o TCE	6/25/2007 o c12DCE o TCE	10/08/2007 o c12DCE o TCE	02/12/2008 o c12DCE o TCE	8/14/2008 o TCE
MW-3	Private Property	7/27/2006 o c12DCE o TCE	1/10/2007 o c12DCE o TCE	6/25/2007 o c12DCE o Xylene o TCE	10/08/2007 o c12DCE o Toluene o TCE	02/12/2008 o c12DCE o TCE	8/14/2008 o c12DCE o TCE

PW – Private Well
MW – Monitoring Well
TCE – Trichloroethylene
CHCl3 – Chloroform
C12DCE – cis-1,2-Dichloroethlyene

All data were validated for quality and subsequent usability, and all data are validated, qualified, and are acceptable for use. Reporting limits were appropriate with respect to being able to detect significant risk-based concentrations. During data validation, only one data qualifier was needed:

U The analyte was not detected at the specific detection limit.

Consideration was given to target analytes that were not detected in any sample. There are no suspected instances in which undetected substances *should* have been detected, based on long-term monitoring of the groundwater.

1.2.2 Health Effects Associated with Detected Substances in Groundwater

The following briefly summarizes the health effects for the detected substances at the certain concentrations in potable domestic water. The purpose of the risk assessment is to evaluate whether concentrations and exposures that may occur at the site are sufficiently elevated to be associated with these health effects. Exposures occurring at higher concentrations, such as in the workplace or during an emergency are often quite distinct from those at lower exposure levels. For example, high levels of exposure to VOCs may result in intoxication, with symptoms such as confusion or stupor. Those exposures or symptoms would not be expected at the low concentrations found in the groundwater at Ellenburg Depot. The following are the critical health effects underlying toxicity values discussed in Section 1.4.

> *Chloroform*—Oral and dermal exposures can result in noncancer effects to the liver such as formation of fatty cysts in dogs. Inhalation exposures are evaluated for the occurrence of cancer effects.
>
> *1,2-Cis-dichloroethylene*—Oral and dermal exposures is associated with noncancer effects to the blood that includes decreased hematocrit (e.g., the proportion of blood volume that is occupied by red blood cells) as seen in rats. Inhalation exposures are not evaluated for either cancer or noncancer effects.
>
> *Trichloroethylene*—Oral and dermal exposures may result in cancer effects. Although oral exposures are expected to result in noncancer effects, existing information is inadequate for quantitative evaluation. Inhalation exposures are evaluated for cancer effects, and for the occurrence of noncancer effects that may affect the liver, kidney, and developing fetus.
>
> *Toluene*—Oral and dermal exposures may result in noncancer effects such as increased kidney weight as observed in rats. Inhalation exposures are evaluated for the occurrence of neurological noncancer effects as observed in humans.
>
> *Xylene*—Oral and dermal exposures may result in noncancer effects such as decreased body weight as seen in rats. Inhalation exposures are evaluated for the occurrence of neurological noncancer effects such as impaired motor skills as observed in rats.

The lack of health effects information needed to identify hazards does not necessarily mean that there are no health effects due to exposures. Rather, this may simply mean that the health-based information is limited. For example, although cis-1,2-dichloroethylene is associated with noncancer effects, it is not evaluated for cancer effects. In this case, the lack of cancer-based information does not mean there are no effects. Further, although chloroform is not evaluated for noncancer effects via inhalation, there should be a noncancer effect if exposure is high enough. In general, the available information has been accumulated over time, and although incomplete and subject to change, it is believed to provide an adequate basis for supporting decisions relating to health effects.

The following section (toxicity assessment) provides further information needed to quantify the risk estimates.

1.3 EXPOSURE ASSESSMENT

The exposure assessment considers residential uses of the groundwater affected by migration of toxic constituents in groundwater. Exposure assessment defines the intensity of contact between an exposed receptor and a constituent. First and foremost, contact must occur in order for an exposure to be estimated. With no exposure, there is no possibility for encountering an adverse effect. The exposure assessment considers whether current (these are most likely) and foreseeable (these are reasonably hypothetical) conditions should be distinguished at the affected downgradient properties. At Ellenburg Depot, residential land use is considered to be likely currently and in the future, so such a distinction is unnecessary.

1.3.1 Potential Receptors and Exposure Pathways

Ellenburg Depot is a developed area with mixed commercial and residential land uses. It is located downgradient of the former missile silo where the observed VOCs in the groundwater are believed to have originated. Other than water wells in the community, human or ecological receptors are not likely to be exposed to VOCs coming from the FUDS. Depth to groundwater in water supply wells ranges from 16 to 232 feet below land surface with an average of 75 feet. The remedial investigation report concluded that the groundwater discharges into the North Branch Chazy River with no adverse effect.

Exposure parameters for resident:

- Exposure frequency 350 days/year
- Exposure duration 30 years (6 as child, 24 as adult)
- Body weight 15 kg (child), 70 kg (adult)
- Averaging time 30 years for noncarcinogenic effects
    - 2,190 as child and 8,760 as adult
- Averaging time 70 years for carcinogenic effects is 25,550 days

Noncancer exposures are evaluated by considering the child separately from the adult. Carcinogenic exposures are evaluated by considering the age-weighted exposures (see Table 2), from child to adulthood, occurring over an entire lifetime of exposure.

The exposure parameters are intended to cover residential household use of the groundwater. Additional parameters are shown in Table 2.

1.3.1.1 Vapor Intrusion

The previously noted guidance memorandum *Interim Recommended Trichloroethylene (TCE) Toxicity Values to Assess Human Health Risk and Recommendations for the Vapor Intrusion Pathway Analysis* addressed the vapor intrusion pathway and recommended the use of multiple lines of evidence approach to assess sites for vapor intrusion. USEPA expects to issue a separate document that will address the multiple lines of evidence approach as it relates to the vapor intrusion pathway. Existing methods are used in the interim.

As a matter of Army policy, the vapor intrusion exposure pathway should be evaluated if volatile chemicals in groundwater are due to DoD release at a FUDS, if volatile chemicals could migrate from groundwater into existing buildings, and if those building are occupied. The initial evaluation is, in this case, conducted using the Johnson & Ettinger model[2] provided by USEPA.

If the modeling results exceed the screening levels, then a recommendation may be made to gather sample data and determine the potential for fate and transport of volatile chemicals exists.

The screening version of the model was used since it contains generic parameters such as building dimensions that are generally applicable to Ellensburg Depot. A typical structure was

[2] Provided online by USEPA in the form of an Excel spreadsheet.

assumed to have a basement approximately 200 centimeters above the saturated zone containing VOCs. The model uses the following standard default exposure parameters for a resident adult (i.e., no child included):

- Exposure frequency 350 days/year
- Exposure duration 30 years
- Averaging time 30 years for noncarcinogenic effects
- Averaging time 70 years for carcinogenic effects

Other than varying the constituent and concentration, all other input parameters with the model were used as provided. These input parameters appear to be sufficiently representative of the various sampling locations at Ellenburg Depot.

Table 2. Ingestion and Dermal Intakes for Resident Exposures to Drinking Water

Ingestion	Noncancer		Cancer			Note
Age	**1 through 6**	**7 through 30**	**0 through 6**	**7 through 30**	**Age-weighted**	
IR	1	2	1	2	--	Intake rate (L/day)
EF	350	350	--	--	350	Exposure frequency (days/year)
ED	6	24	6	24	--	Exposure duration (years)
BW	15	70	15	70	--	Body weight (kg)
AT	2,190	8,760	--	--	25,550	Averaging time (days)
Dermal	**Noncancer**		**Cancer**			**Note**
Age	**1 through 6**	**7 through 30**	**0 through 6**	**7 through 30**	**Age-weighted**	
SA	6,600	18,000	6,600	18,000	--	Surface area of exposed skin (cm^2)
EV	1	1	1	1	--	Exposure event rate (events/day)
EF	350	350	--	--	350	Exposure frequency (days/year)
ED	6	24	6	24	30	Exposure duration (years)
DAevent	Chemical-specific	Chemical-specific	Chemical-specific	Chemical-specific	--	Dermal contact rate for exposure to groundwater (mg/cm^2-event)
BW	15	70	15	70	--	Body weight (kg)
AT	2,190	8,760	--	--	25,550	Averaging time (days)
Inhalation (Water Use)	**Noncancer**		**Cancer**			**Note**
Age	**1 through 6**	**6 through 30**	**0 through 6**	**6 through 30**	**Age-weighted**	
EF1	1	0.58	1	0.58	--	Hours/day
CF	0.0417	0.0417	0.0417	0.0417	--	Day/hours
EF2	350	350	--	--	350	Days/year
ED	6	24	6	24	--	Years
AT	2,190	8,760	--	--	25,550	Days

Groundwater ingestion exposure, age-weighted 0 to 6 yrs @ 1 L/d, 15 kg and 6 to 30 yrs @ 2 L/day, 70 kg for 6+24=30 yrs
Groundwater bathing exposure age-weighted 0 to 6 yrs @ 1 hr/d, 15 kg and 6 to 30 yrs @ 0.58 hr/day, 70 kg for 6+24=30 yrs
Groundwater bathing dermal exposure age-weighted 0 to 6 yrs @ 6,600cm2 and 6 to 30 yrs @ 18,000 cm2
Inhalation exposures in this table are for use of household water.
-- Not applicable

1.3.2 Quantifying Exposure Point Concentrations (EPC)

The groundwater data used to derive the EPC are based on six sampling events occurring from July 2006 through August 2008. As such, the data represent seasonal and temporal variations over several years. The EPC is the concentration used to derive the risk estimate. Although the EPC is typically an estimate of the average concentration (i.e., to represent average exposures over time), in this case the maximum detected concentrations were used for the risk estimates, regardless of the actual well location. This means that the maximum detected concentration of a given constituent from each well was simply compiled into a hypothetical location. Although this is not realistic (since such a place is unlikely to exist), it is a useful way to simplify the assessment. If risks for the hypothetical location are acceptable, then the risks for any of the individual wells also should be acceptable. Further, if risks are acceptable at maximum concentrations, then risks at average concentrations also should be acceptable. Because groundwater has been monitored over time, it is likely that the sample maximums are reasonable representatives of the actual (i.e., population) maximums. Once again, the risk estimates based on maximums may be expected to overstate the risks to some degree. Since the sample data are not spatially averaged, samples taken as duplicates for data quality purposes are simply treated as an additional available samples.

Table 3 presents the sample date and reported concentration[3] for each well location in the upper portion of the table. In the lower portion of the table are the maximum detected concentrations of each constituent for each well sampled over time; these are temporal maximums. On the right side of the table is the greatest temporal maximum concentration for each constituent at any well. The rightmost column is the exposure point concentration (EPC) that is used in the risk estimates.

[3] USACE NAE. *Final Long Term Groundwater Monitoring Report #12*, Atlas S-11 Site, Ellenburg, New York. January 2009.

Table 3. Groundwater Sample Data Used in the Risk Assessment

Sample Date and Concentration	Concentration (µg/L)														mg/L
	CL4 PW-35	CL4 PW-68	C12DCE PW-80	C12DCE PW-118	C12DCE MW-3	TCE PW-24	TCE PW-35	TCE PW-68	TCE PW-80	TCE PW-118	TCE MW-3	TOL MW-3	MPXYL MW-3	Maximum at Any Well Over Time	Exposure Point Concentration
Jul-06	0.50	0.50	0.41	0.50	0.64	0.63	1.10	2.1	1.9	0.69	0.82	0.50	0.50	NA	NA
Jan-07	1.10	0.61	0.40	0.22	0.78	0.64	0.50	2.0	2.0	0.89	0.90	0.50	0.50	NA	NA
Jun-07	0.63B	0.35	0.27	0.21	0.61	0.67	0.84	1.7	2.1	1.7	0.65	0.29	0.26	NA	NA
Oct-07	0.76	0.50	0.35	0.35	0.56	0.67	0.98	1.8	1.9	1.6	0.70	0.50	0.50	NA	NA
Feb-08	0.72	0.50	0.24	0.28	0.60	0.62	0.50	1.9	2.1	1.8	0.81	0.50	0.50	NA	NA
Aug-08	0.54	0.50	0.25	0.50	0.60	0.62	0.77	1.6	1.9	1.2	0.72	0.50	0.50	NA	NA
Maximum Concentration Over Time															
Chloroform (maximum)	1.10	0.61												1.10	**0.00110**
Dichloroethylene, 1,2-cis- (maximum)			0.41	0.50	0.78									0.78	**0.00078**
Trichloroethylene (maximum)						0.67	1.10	2.10	2.10	1.80	0.90			2.10	**0.00210**
Toluene (maximum)												0.50		0.50	**0.00050**
Xylene, Mixture (maximum)													0.50	0.50	**0.00050**

Temporal maximum is the highest concentration at a single well over time.
Greatest temporal maximum is the highest concentration at any well over time.
EPC for a given constituent is taken from the well with the highest UCL, regardless of location.
CCL4 – Chloroform
C12DCE – cis-1,2-Dichloroethene
TCE – Trichloroethylene
TOL – Toluene
MPXYL - Xylenes
NA - Not Applicable

The following several sections present the equations used to determine intakes for exposures to groundwater.

1.3.2.1 Ingestion of Noncarcinogens in Household Water

$$ADD = \frac{EPC \times IR \times EF \times ED}{BW \times ATnc}$$

Where:

ADD	=	Average Daily Dose for ingestion of tap water (mg/kg-day)
EPC	=	Exposure Point Concentration in tap water (mg/L)
IR	=	Ingestion Rate of tap water (1 liter/day—child, 2 liters/day—adult)
EF	=	Exposure Frequency (350 days/year)
ED	=	Exposure Duration (6 years—child, 24 years—adult)
BW	=	Body Weight (15 kg—child, 70 kg—adult)
ATnc	=	Averaging Time (2,190 days—child, 8,760—adult)

1.3.2.2 Ingestion of Carcinogens in Household Water

$$ADD = \frac{\left[\left(\left(IRc \times EDc\right)/BWc\right) + \left(\left(IRa \times EDa\right)/BWa\right)\right] \times EPC \times EF}{ATca}$$

Where:

ADD	=	Average Daily Dose for ingestion of tap water (mg/kg-day)
IRc	=	Ingestion Rate of tap water for child (1 liter/day)
IRa	=	Ingestion Rate of tap water for adult (2 liters/day)
EPC	=	Exposure Point Concentration in tap water (mg/L)
EF	=	Exposure Frequency (350 days/year)
EDc	=	Exposure Duration for child (6 years)
EDa	=	Exposure Duration for adult (24 years)
BWc	=	Body Weight for child (15 kg)
BWa	=	Body Weight for adult (70 kg)
ATca	=	Averaging Time (25,550 days)

1.3.2.3 Dermal Contact with Noncarcinogens in Household Water

$$ADD = \frac{EPC \times SA \times EV \times EF \times ED \times DA_{event}}{BW \times ATnc}$$

Where:

ADD	=	Average Daily Dose Due to Dermal Contact (mg/kg-day)
EPC	=	Exposure Point Concentration (mg/L)

SA = Skin Surface Area Exposed (6,600 cm^2—child, 18,000cm^2—adult)
EV = Event Frequency (1 event/day)
EF = Exposure Frequency (350 days/year)
ED = Exposure Duration (6 years—child, 24 years—adult)
DA_{event} = Absorbed Dermal Dose per Event (mg/cm^2-event; chemical-specific)
BW = Body Weight (15 kg—child, 70 kg—adult)
ATnc = Averaging Time (2,190 days—child, 8,760—adult)

1.3.2.4 Dermal Contact with Carcinogens in Household Water

$$ADD = \frac{\left[\left(\left(SAc \times EVc \times EDc \times DA_{event}\right) / BWc\right) + \left(\left(SAa \times EVa \times EDa \times DA_{event}\right) / BWa\right)\right] EPC \times EF}{ATca}$$

Where:

ADD = Average Daily Dose Due to Dermal Contact (mg/kg-day)
SA = Skin Surface Area Exposed (6,600 cm^2—child, 18,000cm^2—adult)
EPC = Exposure Point Concentration (mg/L)
EV = Event Frequency (1 event/day)
EF = Exposure Frequency (350 days/year)
ED = Exposure Duration (6 years—child, 24 years—adult)
DA_{event} = Absorbed Dermal Dose per Event (mg/cm^2-event; chemical-specific)
BW = Body Weight (15 kg—child, 70 kg—adult)
ATca = Averaging Time (2,190 days—child, 8,760—adult)

In RAGS Part E (dermal exposure assessment guidance) USEPA recommends evaluating the dermal route only when it contributes to at least 10% of the exposure from the oral pathway. Table 4 indicates the chemicals that qualify for further evaluation of the dermal exposure pathway, as well as the chemical-specific DA_{event} term.

Table 4. Estimation of DA_{event} (Dermal Contact Rate) for Dermal Exposures

Organics	EPC as C_w (mg/L)	EPC as C_w (mg/cm^3)	FA (unitless)	K_p (cm/hr)	B (unitless)	tau_{event} (hr/event)	t* (hr)	$t_{event-ch}$ (hr/event)	$DA_{event-ch}$ (mg/cm2-event)	$t_{event-ad}$ (hours)	$DA_{event-ad}$ (mg/cm^2-event)	Evaluate per RAGS E Screening?
Chloroform	1.10E-03	1.10E-06	1.0	8.92E-03	3.74E-02	4.87E-01	1.17E+00	1	NA	0.58	NA	No
Dichloroethylene, 1,2-cis-	7.80E-04	7.80E-07	1.0	1.49E-02	5.64E-02	3.66E-01	8.79E-01	1	NA	0.58	NA	No
Trichloroethylene	2.10E-03	2.10E-06	1.0	1.57E-02	6.91E-02	5.69E-01	1.36E+00	1	6.87E-08	0.58	5.23E-08	Yes
Toluene	5.00E-04	5.00E-07	1.0	4.53E-02	1.67E-01	3.44E-01	8.26E-01	1	7.21E-08	0.58	2.80E-08	Yes
Xylene, Mixture	5.00E-04	5.00E-07	1.0	7.04E-02	2.79E-01	4.12E-01	9.89E-01	1	1.17E-07	0.58	4.76E-08	Yes

DA_{event} - Dermal contact rate for constituents in groundwater.
For organics, if t_{event} <= 2.4*tau_{event}, then DA_{event} = 2FA*Kp*Cw*((6*tau_{event}*t_{event})/pi)^0.5
For organics, if t_{event} > 2.4*tau_{event}, then DA_{event} = FA*Kp*Cw*((t_{event}/1+B)+(2*tau_{event} (1+3*B+3*B^2)/(1+B)^2))
Evaluate per RAGS E Screening? - Per RAGS E Exhibit B-3 dermal dose <10% of the associated oral dose, so the chemical is not prone to significant dermal penetration.
K_p's provided by the Oak Ridge National Laboratory's online Risk Assessment Information System
t_{event} in this context is as recommended by EPA; 1 hour for an adult, 0.58 hours for an adult.
NA - Not applicable
Default value for FA is 1.

1.3.2.5 Inhalation of Vapors in Household Water

Inhalation exposures for volatile organic chemicals released during household use of groundwater was evaluated by estimating the exposure to the child and the adult. The EPC was calculated by estimating a concentration in air using the following formula:

$$C_{AIR} = C_W \times VF$$

Where:

C_{AIR} = Concentration of volatiles in air (mg/m^3, chemical-specific)
C_W = Concentration of volatiles in water (mg/L, chemical-specific)
VF = Volatilization factor[4] (0.5 liter/m^3)

The resulting C_{AIR} was then combined with exposure parameters (see intakes in Table 2) for the child or the adult to derive an EPC in units of mg/m^3.

$$EPC_{AIR} = C_{AIR} \times IF$$

Where:

EPC_{AIR} = Exposure Point Concentration of volatiles in air (mg/m^3, chemical-specific)
C_{AIR} = Concentration of volatiles in air (mg/m^3, chemical-specific)
IF = Intake factor for child or adult, noncancer or cancer effects (unitless)

4 *Andelman* as cited in EPA RAGS Part B. This applies only to volatile organic chemicals with a Henry's law constant greater than 1 x 10-5 atm-m3/mole and a molecular weight of less than 200 grams per mole.

For noncancer effects, the intake factor for child exposures are evaluated separately from adult exposures:

$$IF_{NC} = (EF1 \times CF \times EF2 \times ED) / AT$$

Where:

IF_{NC}	=	Intake Factor for noncarcinogenic effects (unitless)
EF1	=	Hourly Exposure Frequency (hours/day)
CF	=	Conversion Factor (day/hours)
EF2	=	Annual Exposure Frequency (days/year)
ED	=	Exposure Duration (years)
AT	=	Averaging Time (days)

For carcinogenic effects, a weighted average is used in the intake factor:

$$IF_{CA} = [(EF1_C \times ED_C) + (EF1_A \times ED_A)] \times CF \times EF2 / AT$$

Where:

IF_{CA}	=	Age-Weighted Intake Factor for noncarcinogenic effects (unitless)
$EF1_C$	=	Hourly Exposure Frequency for child (hours/day)
$EF1_A$	=	Hourly Exposure Frequency for adult (hours/day)
ED_C	=	Exposure Duration for child (years)
ED_A	=	Exposure Duration for adult (years)
CF	=	Conversion Factor (day/hours)
EF2	=	Annual Exposure Frequency (days/year)
AT	=	Averaging Time (days)

1.4 TOXICITY ASSESSMENT

The toxicity assessment defines dose—response relationships; the exposure of COPC to a receptor and the response of adverse health effects. Carcinogenic health effects are believed to be cumulative, without a lower limit or threshold of effect over a lifetime of exposure. Noncarcinogenic health effects are believed to be effective over the duration of exposure, with a lower limit or threshold below which the adverse effect is not expressed. Toxicity values are combined with the intake parameters to quantify potential risks.

Dose-response information used in this risk assessment was obtained from the following sources, in order of priority in accordance with EPA guidance (USEPA, 2003):

- EPA's Integrated Risk Information System (IRIS) (USEPA, 2009)
- EPA’s Provisional Peer Reviewed Toxicity Values (PPRTVs)
- Other sources, such as New York State Department of Environmental Conservation (NYSDEC), California EPA (CalEPA), Agency for Toxic Substances and Disease Registry (ATSDR), EPA's Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997a).

The respective oral, dermal, and inhalation toxicity information for the constituents evaluated in this report are presented with the associated risk estimates in Tables 6 through 8.

1.4.1 Non-Carcinogenic Toxicity

Substances with known or potential noncarcinogenic effects are believed to have a dose below which an adverse effect does not occur and above which the effect is seen. This *threshold* dose is known as the *No Observed Adverse Effect Level* (NOAEL). The lowest dose at which an adverse effect is seen is the *Lowest Observed Adverse Effect Level* (LOAEL). In an ideal case toxicity information will define the *highest* possible NOAEL along with the *lowest* possible LOAEL, and those two levels will be close to one another. However, there is often some difference in the lowest observed and no effects dose, which leads to uncertainty. Using factors to account for this and other types of uncertainty, the USEPA has developed Reference Doses (RfDs) and Reference Concentrations (RfCs) for chronic and subchronic exposures for noncarcinogens. Provisional (i.e., temporary) RfD values are developed by the National Center for Environmental Assessment (NCEA) (2001).

Uncertainty factors are used to produce more stringent toxicity values due to lack of knowledge associated with the toxicity value, such as:

- Using an animal study to derive a human toxicity value.
- Extrapolating from high experimental doses to low environmental doses.
- Accounting for sensitive human subpopulations.

The RfD is intended to provide a reasonable estimate of the threshold at which human health effects are expected to occur over time, up to a lifetime of exposure. RfDs are doses, expressed in milligrams of COPC per kilogram of body weight per day (mg/kg-day). Inhalation of vapor (from household water) is considered for COPC that are sufficiently volatile (i.e., Henry's Law constants >$1x10^{-5}$ atm-m^3/mol and molecular weight <200 grams per mole (USEPA, 2001c)). Inhalation RfCs are expressed in units of exposed concentration (mg/m^3).

1.4.2 Carcinogenic Toxicity

Unlike noncancer effects, a working assumption for potential carcinogenic effects is that no threshold dose exists and that some degree of risk is associated with any dose. In March 2005, USEPA issued new cancer guidelines (USEPA, 2005) to guide the assessment of cancer risks when deriving toxicity values. The data for many of the potentially carcinogenic constituents have not been updated, so the cancer toxicity information currently presented in the EPA's IRIS database remains unchanged. Only a limited number of substances have been evaluated under the newer guidance.

The first step in the updated approach is to assign a new weight-of-evidence (WOE) classification to the constituent. Under USEPA's 1986 risk assessment guidelines, the WOE was described by categories "Group A" through "Group E", with Group A category reserved for known human carcinogens, and Group E category at the other end of the spectrum for evidence of non-carcinogenicity. The newer WOE provides for a more complex narrative approach to summarizing the evidence of human carcinogenicity. Five standard WOE descriptors are currently used as part of the narrative, including:

- Carcinogenic to Humans
- Likely to be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential
- Inadequate Information to Assess Carcinogenic Potential
- Not Likely to be Carcinogenic to Humans

In the updated guidance, the USEPA emphasizes the value of understanding the biological changes that the agent of interest can cause (e.g., mode of action) and how these changes might lead to the development of cancer. The agent's human carcinogenic potential is summarized by USEPA's scientists considering the full range of available evidence and any conclusions about an agent's hazard potential, such as which populations or life stages may be particularly susceptible.

The second step is the calculation of a quantitative estimate of carcinogenic potency. The USEPA has developed computer models to relate the observed responses to more intense shorter-term doses used in animal studies to the predicted responses in humans at the less intense longer-term doses expected in the environment. The models developed by the USEPA assume no threshold and usually consider animal (and sometimes human) data. The USEPA assumes that carcinogenic dose-response is linear at low doses, and the numerical estimate for oral exposures is referred to as the cancer slope factor (CSF). The CSF is an estimate of the upper-bound excess lifetime cancer risk daily from exposure to an agent at a unit dose of one mg/kg-day. For inhalation exposures, the numerical estimate is expressed as the unit risk (UR), expressed as cancer risk per microgram of agent per cubic meter of air [$(ug/m^3)^{-1}$]; this is an upper-bound excess lifetime cancer risk estimate for continuous exposure at a concentration of 1 $\mu g/m^3$ in air (USEPA, 2005).

1.4.3 Absorption Adjustment Factors

The CSFs and RfDs used in quantitative risk assessment often are based on applied rather than absorbed doses. The efficiency of absorption for a COPC via a particular route (e.g., ingestion) and from a particular matrix (e.g., soil) may, however, differ from the absorption efficiency for the exposure route and matrix used in the experimental study. An absorption adjustment factor (AAF) may then be used to adjust an oral toxicity if the amount absorbed in the gastrointestinal tract is very small (less than 1%; e.g., arsenic, cadmium, and vanadium per USEPA 2004a). This simply changes the toxicity value from one based on the amount administered to one based on the amount absorbed.

AAFs often are based upon USEPA recommended or default values, as compiled by the *Risk Assessment Information System* (RAIS) online website (ORNL, 2009). Default values may be used when chemical-specific absorption efficiencies are scarce or based on limited information. In this risk assessment, the reference doses and oral CSFs were not adjusted for dermal exposures because the published gastrointestinal absorption factors are all equal to 1.

1.4.4 Trichloroethylene

On January 15, 2009, the USEPA issued a guidance memorandum entitled *Interim Recommended Trichloroethylene (TCE) Toxicity Values to Assess Human Health Risk and Recommendations for the Vapor Intrusion Pathway Analysis*. The Agency withdrew that guidance on April 9, 2009 to further evaluate the noncancer TCE toxicity value for inhalation exposures. In the interim, the existing hierarchy of toxicity values for TCE is used as previously described in this section. In particular, the source of the oral RfD is from USEPA (Nation Center for Environmental Assessment), the inhalation RfC is from New York State Department of Environmental Conservation, the oral and inhalation cancer slope factors are from California EPA.

1.5 HUMAN HEALTH RISK CHARACTERIZATION

The Human Health Risk Characterization step combines the information from the exposure and toxicity assessments to derive quantitative estimates of the magnitude or likelihood of adverse health effects from exposure to COPC.

1.5.1 Carcinogenic Risk

Excess lifetime carcinogenic risk (ELCR) is calculated as follows:

$$ELCR = LADD \text{ x } CSF$$

Where:

ELCR = Excess Lifetime Cancer Risk (unitless);
LADD = Lifetime Average Daily Dose (mg/kg-day); and
CSF = Cancer Slope Factor $(mg/kg\text{-}day)^{-1}$.

For inhalation exposures, the cancer risk is calculated as follows:

$$ELCR = EPC_V \times UR_{INH}$$

Where:

ELCR = Excess Lifetime Cancer Risk (unitless);
EPC_V = Exposure Point Concentration for vapors (mg/m^3); and
UR_{INH} = Unit Risk for inhalation exposures $(mg/m^3)^{-1}$.

The ELCR for the ingestion, dermal, and inhalation pathways were calculated by summing the ELCRs for each carcinogenic COPC. A cumulative ELCR for a receptor was then calculated by summing the pathway ELCRs. Risk managers may then compare the ELCR to a range defined by the federal program of $1x10^{-4}$ (one in ten thousand) to $1x10^{-6}$ (one in one million) (NCP 1968, 1972, 1980, 1994). In terms of significance, cancer risks falling below $1x10^{-6}$ may be determined to be *de minimus* (minimal). The need for further evaluation may be considered for cancer risks falling between $1x10^{-6}$ and $1x10^{-4}$. The need for a response action becomes *de manifestis* (increasingly apparent) as cancer risks exceed $1x10^{-4}$. Any response actions undertaken to mitigate risk must consider risk-based cleanup goals set at $1x10^{-6}$ for individual constituents, and any more stringent substantive cleanup goals (i.e., promulgated numeric values) that are determined to be applicable, relevant, and appropriate requirements.

The total site ELCR for the resident reaches $5x10^{-7}$, which falls below the lower end of the range of cancer risks noted previously. The total site risk estimate includes all constituents and all exposure pathways for each receptor.

1.5.2 Non-Carcinogenic Hazards

The non-carcinogenic hazard quotient is calculated as follows:

$$HQ = \frac{ADD}{RfDo,i}$$

Where:

HQ = Hazard Quotient (unitless);
ADD = Average Daily Dose (mg/kg-day); and
RfDo,i = Oral or Inhalation Reference Dose (mg/kg-day).

For inhalation exposures, the hazard quotient is calculated as follows:

$$HQ = \frac{EPCv}{RfC}$$

Where:

HQ = Hazard Quotient (unitless);
EPCv = Exposure Point Concentration for vapors (mg/m^3); and
RfC = Reference Concentration for inhalation exposures (mg/m^3).

HQs for each COPC are summed for each receptor to generate a hazard index (HI). An HQ or total HI for a constituent that does not exceed 1 for a given receptor indicates that significant adverse noncarcinogenic health effects are not expected for that receptor's potential exposure to COPC.

The HIs for each receptor do not distinguish the critical toxic effect for multiple toxins, and in many cases the noncancer hazards are not alike. When HIs are found to exceed 1, the critical toxic effect of the primary contributors should be considered and appropriately segregated. In such a case more than one HI might result, each focused on distinct toxic effects. This is not the case for this FUDS, since the HQs and HIs for current or future residential use of the groundwater coming from the FUDS do not exceed 1.

1.5.3 Results

Risk estimates are summarized in Table 5 (combined exposures), Table 6 (ingestion exposures), Table 7 (dermal exposures), Table 8 (vapor exposures while bathing), and Table 9 (vapor intrusion exposures).

Table 5. Total Site Risk Estimates for Groundwater Exposures, Ellenburg Depot, NY

Target Organ - Critical Effect	Exposure Route	Noncancer HQ				Cancer Risk	
		Child	% of HI	Adult	% of HI	Age-adjusted	% of Risk
Chloroform	Ingestion	7.03E-03	40%	3.01E-03	38%	NA	NA
	Dermal	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	1.44E-07	0.00003%
Dichloroethylene, 1,2-cis-	Ingestion	4.99E-03	28%	2.14E-03	27%	NA	NA
	Dermal	NA	NA	NA	NA	NA	NA
	Inhalation	NA	NA	NA	NA	NA	NA
Trichloroethylene	Ingestion	NA	NA	NA	NA	4.06E-07	82%
	Dermal	NA	NA	NA	NA	8.98E-08	18.1%
	Inhalation	4.20E-03	24%	2.43E-03	30%	2.39E-08	0.000005%
Toluene	Ingestion	4.00E-04	2%	1.71E-04	2%	NA	NA
	Dermal	3.80E-04	2%	8.62E-05	1%	NA	NA
	Inhalation	2.00E-06	0%	1.16E-06	0%	NA	NA
Xylene, Mixture	Ingestion	1.60E-04	1%	6.85E-05	1%	NA	NA
	Dermal	2.46E-04	1%	5.86E-05	1%	NA	NA
	Inhalation	9.99E-05	1%	5.79E-05	1%	NA	NA
Sum by Cumulative Effects		0.02	100%	0.008	100%	7E-07	100%

Percent cancer risk is the portion of the total cancer risk for the adjacent cancer risk estimate.
Cancer risk does not exceed remediation trigger at site-wide maximum concentrations (see text).
NA - Not available or not applicable

Table 6. Risk Estimates for Groundwater Ingestion Exposures, Ellenburg Depot, NY

Chemical Parameters				Child - Noncancer			Adult - Noncancer			Age-Adjusted - Cancer		
Substance	**EPC_{Max} (mg/l)**	**RfD_{oral} (mg/kg-day)**	**CSF_{oral} (mg/kg-day)$^{-1}$**	**Dose (mg/kg/day)**	**HQ**	**% of HQ**	**Dose (mg/kg/day)**	**HQ**	**% of HQ**	**Dose (mg/kg-day)**	**Risk**	**% of Risk**
Chloroform	1.10E-03	1.00E-02 (d)	NA	7.03E-05	7.03E-03	56%	3.01E-05	3.01E-03	56%	1.64E-05	NA	NA
Dichloroethylene, 1,2-cis-	7.80E-04	1.00E-02 (e)	NA	4.99E-05	4.99E-03	40%	2.14E-05	2.14E-03	40%	1.16E-05	NA	NA
Trichloroethylene	2.10E-03	3.00E-04 (a)	1.30E-02 (b)	1.34E-04	NA	NA	5.75E-05	NA	NA	3.12E-05	4.06E-07	100%
Toluene	5.00E-04	8.00E-02 (d)	NA	3.20E-05	4.00E-04	3%	1.37E-05	1.71E-04	3%	7.44E-06	NA	NA
Xylene, Mixture	5.00E-04	2.00E-01(d)	NA	3.20E-05	1.60E-04	1%	1.37E-05	6.85E-05	1%	7.44E-06	NA	NA
Sum					0.0126	100%		0.00539	100%		4.06E-07	100%

NA - Not available or not applicable
(a) USEPA National Center for Environmental Assessment
(b) California EPA
(d) USEPA IRIS Database
(e) USEPA Provisional

Table 7. Risk Estimates for Dermal Exposures to Groundwater While Bathing, Ellenburg Depot, NY

Chemical Parameters				Child - Noncancer				Adult - Noncancer				Age-Adjusted - Cancer		
Substance	**EPC_{Max} (mg/l)**	**RfD_{ORAL} (mg/kg-day)**	**CSF_{ORAL} (mg/kg-day)$^{-1}$**	**DA_{EVENT} (mg/cm^2-event)**	**Dose (mg/kg-day)**	**HQ**	**% of HQ**	**DA_{event}**	**Dose (mg/kg-day)**	**HQ**	**% of HQ**	**Dose (mg/kg-day)**	**Risk**	**% of Risk**
Chloroform	1.10E-03	1.00E-02 (d)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichloroethylene, 1,2-cis-	7.80E-04	1.00E-02 (e)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Trichloroethylene	2.10E-03	3.00E-04 (a)	1.30E-02 (b)	6.87E-08	2.90E-05	NA	NA	5.23E-08	1.29E-05	NA	NA	6.91E-06	8.98E-08	100%
Toluene	5.00E-04	8.00E-02 (d)	NA	7.21E-08	3.04E-05	3.80E-04	61%	2.80E-08	6.90E-06	8.62E-05	60%	4.97E-06	NA	NA
Xylene, Mixture	5.00E-04	2.00E-01 (d)	NA	1.17E-07	4.92E-05	2.46E-04	39%	4.76E-08	1.17E-05	5.86E-05	40%	8.24E-06	NA	NA
Sum						0.000626	100%			0.000145	100%		8.98E-08	100%

NA - Not available or not applicable
(a) USEPA National Center for Environmental Assessment
(b) California EPA
(d) USEPA IRIS Database
(e) USEPA Provisional

Table 8. Inhalation Risk Estimates for Household Bathing Exposures, Ellenburg Depot, NY

Constituent	C_{water} (mg/l)	VF (l/m^3)	C_{air} (mg/m^3)	RfC Chronic (mg/m^3)	Unit Risk (mg/m^3)$^{-1}$	Child – Noncancer Exposure (mg/m^3)	Child – Noncancer HQ	Child – Noncancer % of HQ	Adult - Noncancer Exposure (mg/m^3)	Adult - Noncancer HQ	Adult - Noncancer % of HQ	Age-Adjusted - Cancer Exposure (mg/m^3)	Age-Adjusted - Cancer Risk	Age-Adjusted - Cancer % of Risk
Chloroform	0.00110	0.5	5.50E-04	NA	2.30E-02 (d)	2.20E-05	NA	NA	1.27E-05	NA	NA	6.25E-06	1.44E-07	85.8
Dichloroethylene, 1,2-cis-	0.00078	0.5	3.90E-04	NA	NA	1.56E-05	NA	NA	9.04E-06	NA	NA	4.43E-06	NA	NA
Trichloroethylene	0.00210	0.5	1.05E-03	1.00E-02 (c)	2.00E-03 (b)	4.20E-05	4.20E-03	98	2.43E-05	2.43E-03	98	1.19E-05	2.39E-08	14.2
Toluene	0.00050	0.5	2.50E-04	5.00E+00 (d)	NA	9.99E-06	2.00E-06	0.05	5.79E-06	1.16E-06	0.05	2.84E-06	NA	NA
Xylene, Mixture	0.00050	0.5	2.50E-04	1.00E-01 (d)	NA	9.99E-06	9.99E-05	2	5.79E-06	5.79E-05	2	2.84E-06	NA	NA
Sum							0.00430	100		0.00249	100		1.68E-07	100

NA - Not available or not applicable
(b) California EPA
(c) New York State Department of Environmental Conservation
(d) USEPA IRIS Database

1.5.4 Vapor Intrusion

Noncarcinogenic and carcinogenic risk estimates for the vapor intrusion pathway are presented together in Table 9.

Table 9. Risk Estimates for Vapor Intrusion Screen for Two Types of Soil

Constituent	EPC_{Max}		Sandy Clay		Sand	
	mg/l	µg/l	Cancer Risk	Hazard Quotient	Cancer Risk	Hazard Quotient
Chloroform	0.00110	1.10	1.02E-06	NA	5.90E-08	NA
Dichloroethylene, 1,2-cis-	0.00078	0.78	NA	NA	NA	NA
Trichloroethylene	0.00210	2.10	1.12E-08	0.00131	3.62E-07	0.0423
Toluene	0.00050	0.50	NA	0.000000527	NA	0.0000132
Xylene, Mixture	0.00050	0.50	NA	0.0000116	NA	0.000284
Sum			1E-06	0.001	4E-07	0.04

Risk estimates are provided for two soil types.
Risk estimates were calculated per USEPA 2004b.
The risk estimates do not approach HQ =1 or Cancer Risk = $1x10^{-4}$

The summed noncancer HQs or cancer risk estimates for the vapor intrusion pathway fall below the respective limits.

1.6 UNCERTAINTY ANALYSIS

Uncertainty is inherent in all risk estimates. This is due to the combined effect of uncertainties introduced by field sample efforts, laboratory measurements, toxicity studies (typically conducted with animals), derivation of toxicity values for humans, and assumptions made in the exposure assessment. In the case of Ellenburg Depot, the primary concern with respect to uncertainty is the magnitude of the risk estimates for the community. In this risk assessment, an effort was made to provide risk estimates that over-predict actual exposures. As a worst-case approach, the uncertainties are such that the actual risk estimates are believed to actually be lower than those presented. The intent was to increase confidence in risk management decisions about determining the need for a response action.

1.7 SUMMARY OF POTENTIAL HUMAN HEALTH RISKS

Volatile organic compounds persist in slowly decreasing quantities in the groundwater at Ellenburg Depot that likely originated at the nearby Atlas S-11 FUDS. Petroleum contamination exists in some portions of the groundwater at Ellenburg Depot, but it was not included in this risk assessment since the source of the petroleum does not involve the FUDS, and since that problem is being addressed under another response action lead by the State of New York. The remedial investigation report concluded that environmental pathways for FUDS constituents are not discharging to surface water in detectable quantities or otherwise affecting non-human ecological resources. Human health risk estimates were prepared for household use of groundwater at Ellenburg Depot. This included ingestion, dermal contact while bathing, inhalation of vapors, and vapor intrusion from the subsurface into living spaces. An effort was made to over-estimate exposures as a worst-case scenario. Under that scenario, none of the summed noncancer hazard quotients or cancer risk estimates approached the respective limits that might warrant a response action as defined by the federal government of the United States.

REFERENCES

NAS 1983. Risk Assessment in the Federal Government. Managing the Process. Prepared by National Academy of Sciences. National Academy Press, Washington, D.C. March.

Oak Ridge National Laboratory (ORNL). 2009. Risk Assessment Information System (RAIS), http://rais.ornl.gov.

USEPA 2009a. Integrated Risk Information System (IRIS). www.epa.gov/iris

USEPA 2009b. Interim Recommended Trichloroethylene (TCE) Toxicity Values to Assess Human Health Risk and Recommendations for the Vapor Intrusion Pathway Analysis, January 15,2009, and subsequent memorandum withdrawing the same guidance entitled Interim Recommended Trichloroethylene (TCE) Toxicity Values to Assess Human Health Risk and Recommendations for the Vapor Intrusion Pathway Analysis, April 9, 2009.

USEPA 2009c. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final, EPA-540-R-070-002, OSWER 9285.7-82, January 2009.

USEPA 2005. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F. March.

USEPA. 2004a. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). Final. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

USEPA 2004b. Spreadsheet GW-SCREEN-Feb04.xls

USEPA 2003. Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53. December.

USEPA 2001. Risk Assessment Guidance for Superfund, Volume I: Human Health Environmental Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments). Final. EPA Publication 9285.7-47. December.

USEPA 1997. Exposure Factors Handbook Volumes I –III. Office of Research and Development. EPA/600/P-95/002F. August.

USEPA 1996. Soil Screening Guidance: Technical Background Document. Office of Solid Waste and Emergency Response. EPA/540/R95/128. May.

USEPA 1992. Guidance for Data Useability in Risk Assessment. Final. Office of Emergency and Remedial Response. 9285.7-09A. April.

USEPA 1989. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1-89-002. December.

NCP 1968, 1972, 1980, 1994. National Contingency Plan, 400 CFR Part 300. National Oil and Hazardous Substances Pollution Contingency Plan.

APPENDIX B

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

BRIEF DESCRIPTION	CITATION	REQUIREMENT	COMMENTS
CHEMICAL SPECIFIC FEDERAL			
Safe Drinking Water Act Regulations	40 CFR 141	Drinking water standards which apply to specific contaminants, and which have been determined to have an adverse impact on human health	Potential ARAR for groundwater and/or surface water remediation
Region III Risk Based Screening Levels	Guidance Criteria	Guidelines established for soil and tapwater to protect human health	Potential ARAR for site remediation
EPA Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments	Guidance Criteria Guidelines for Ecological Risk Assessment EPA/630/R-95/002F, April 1998	Provides guidance in preparing Environmental Risk Assessments	Potential ARAR for site remediation
National Ambient Air Quality Standards	40 CFR 50	Sets national standards for levels of air quality deemed necessary for protection of public health	Potential ARAR for on-site activities that would generate particulates
Ambient Water Quality Criteria	Guidance Criteria	Guidelines established for the protection of human health and/or aquatic organisms	Potential ARAR for surface water potentially impacted by site contaminants
EPA Region III BTAG Freshwater Sediment Benchmarks	Guidance Criteria Freshwater Sediment Screening Benchmarks	Guidelines for screening contaminants in freshwater sediments, including consideration of total organic carbon content	TBC for sediment remediation
EPA Region III BTAG Freshwater Benchmarks	Guidance Criteria Freshwater Screening Benchmarks	Guidelines for screening contaminants in freshwater	TBC for surface water remediation
EPA Ecological Soil Screening Guidance	Guidance Criteria Guidance for Developing Ecological Soil Screening Levels *et al.* OSWER 92857-55	Establishes ecological soil screening levels (SSLs) for specific contaminants and receptors	TBC for soil remediation
CHEMICAL SPECIFIC NEW YORK STATE STANDARDS, CRITERIA AND GUIDANCE (SCGs)			
New York Water Quality Standards	6 NYCRR Parts 700-706	Sets out water quality standards and criteria	Potential ARAR for surface water and groundwater
Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations	NYSDEC TOGOS 1.1.1	Provides tables and application guidance for ambient surface water standards, ambient groundwater quality, and groundwater effluent standards	Potential ARAR for surface water and groundwater

BRIEF DESCRIPTION	CITATION	REQUIREMENT	COMMENTS
Soil Vapor Intrusion Guidance – Appendix D	NYSDOH CEH BEEI October 2006	Development of criteria for TCE	Potential ARAR for indoor air
Determination of Soil Cleanup Objectives and Cleanup Levels	NYSDEC TAGM 4046	Provides recommended soil cleanup levels	Potential ARAR for soil
LOCATION SPECIFIC FEDERAL			
Protection of Wetlands Order	40 CFR Part 6, Appendix A, Executive Order No. 11990 Section 404(b)(1), 33 USC 1344(b)(1)	Requires consideration of impacts to wetlands in order to minimize their destruction, loss or degradation and to preserve/enhance wetland values	Potentially applicable to activities which would impact wetlands, applicable to FKP and WCRN AOCs.
Rivers and Harbors Act, Section 10 Regulations	33 CFR 320-330	Requirements for evaluating the placement of structures and/or excavation activities within navigable waters	Potential ARAR for site remediation involving the management of contaminated sediments, therefore applicable to only WCRN AOC.
Emergency Wetlands Resources Act of 1986	16 USC 3901	Requires Secretary to establish a national wetlands priority conservation plan and authorizes wetland acquisitions	Potential ARAR for site remediation activities affecting refuge wetlands included in conservation plans or purchased pursuant to the Act
Endangered Species Act	16 USC 1531	Establishes requirements for the protection of federally listed threatened and endangered species and their habitat	Potential ARAR for site remediation involving activities that could affect threatened or endangered species or their habitat
National Historic Preservation Act	16 USC 470	Establishes requirements for the identification and preservation of historic and cultural resources	Potential ARAR for site remediation that result in disturbance activities that could impact historic and cultural resources
Archeological Resources Protection Act	16 USC 470	Provides for the protection of archeological resources located on public lands	Potential ARAR for site remediation that results in the discovery of archeological resources
Archaeological and Historic Preservation Act	16 USC 469 et seq. 40 CFR 6.301(c)	Provides for the protection and preservation of archeological and historical resources that may be destroyed through the alteration of terrain as a result of federal construction projects	Potential ARAR for site remediation that results in the discovery of archeological resources

BRIEF DESCRIPTION	CITATION	REQUIREMENT	COMMENTS
Clean Water Act, Section 404(b)(1) Guidelines	40 CFR 230.10	Establishes criteria for evaluating impacts to waters of the US (including wetlands) and sets forth factors for considering mitigation measures	Potential ARAR for site remediation involving the placement of fill or dredge material into on-site wetlands and waterways
Historic Sites, Buildings, and Antiquities Act	16 USC 461 et seq. 40 CFR 6.310(a)	Requires the consideration of the existence and location of historic and prehistoric sites, buildings, objects, and properties of historical and archaeological significance when evaluating remedial alternatives	Potential ARAR for site remediation involving disturbance activities that could impact areas of historical or archaeological significance
LOCATION SPECIFIC NEW YORK STATE STANDARDS, CRITERIA AND GUIDANCE (SCGs)			
Classification of Surface Waters and Groundwaters	10 NYCRR Part 701	Establishes groundwater classification	TBC for groundwater remediation
New York Historic Preservation Act	Act of 1980, Sec. 14.09	Establishes requirements for protection of state identified historic resources	Potential ARAR for site remediation involving disturbance activities that could impact areas of historical or archaeological significance
State List of Rare, Threatened and Endangered Species	ECL Section 11-0535 6 NYCCR Part 182	Establishes requirements for the protection of state listed threatened and endangered species and their habitat	TBC for site remediation
New York Freshwater Wetlands Act	Article 24 and Article 71 Title 23	Establishes state responsibility to protect freshwater wetlands	Potential ARAR for site remediation involving freshwater wetlands
Wetland Classification and Mapping	6 NYCCR Part 664	Classification of freshwater wetlands and mapping of wetlands and their adjacent areas	Potential ARAR for site remediation involving freshwater wetlands
ACTION SPECIFIC FEDERAL			
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	42 U.S.C. § 9601 *et seq.*	Creates Superfund remediation program	Potential ARAR for site activities
National Contingency Plan (NCP)	40 CFR Part 300	Sets for the rules for hazardous waste site remediation	Potential ARAR for site activities
Guidance for Conducting Remedial Investigations and Feasibility Studies	OSWER 9355.3-01	Provides process for conducting Feasibility Studies	Potential TBC for Feasibility Study
Hazardous Waste Generation	40 CFR 262	Specifies requirements for hazardous waste packaging, labeling, manifesting, and storage	Potential ARAR for off-site transportation of hazardous waste generated during investigation or active remediation

BRIEF DESCRIPTION	CITATION	REQUIREMENT	COMMENTS
Transportation of Hazardous Waste	40 CFR 263	Specifies requirements for transporters of hazardous waste to obtain a USEPA identification number, compliance with manifest procedures and spill response	Potential ARAR for transportation and off-site disposal of hazardous waste generated during investigation or active remediation
Treatment, Storage, and Disposal of Hazardous Waste	40 CFR 264	Specifies requirements for the operation of hazardous waste treatment, storage, and disposal facilities	Potential ARAR for on-site hazardous waste storage activities
Land Disposal Restrictions	40 CFR 268	Sets out prohibitions and establishes standards for the land disposal of hazardous wastes	Potential ARAR for off-site hazardous waste disposal activities
National Ambient Air Quality Standards- Particulates	40 CFR 50	Establishes maximum concentrations for particulates and fugitive dust emissions	Potential ARAR for on-site activities that generate particulate emissions
Clean Water Act Effluent Guidelines and Standards	40 CFR 401	Provides requirements for point source discharges of pollutants	Potential ARAR for discharges of wastewaters to surface water bodies
Clean Water Act Stormwater Program	40 CFR 122	Regulates the discharge of stormwater from industrial and construction activities	Potential ARAR for point source discharges of stormwater to surface waters
USDOT Hazardous Materials Transportation Regulations	49 CFR 171-180	Establishes classification, packaging and labeling requirements for shipments of hazardous materials	Potential ARAR for off-site transportation of hazardous materials generated on-site
USEPA Test Methods for Evaluation of Solid Waste	SW-846	Establishes analytical requirements for testing and evaluating solid and/or hazardous wastes	Potential ARAR for testing waste samples
USDOT Hazardous Materials Transportation Regulations	49 CFR 171-180	Establishes classification, packaging and labeling requirements for shipments of hazardous materials	Potential ARAR for off-site transportation of hazardous materials generated on-site
Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites	OSWER Directive 9283.1-2	Provides guidance for addressing contaminated groundwater from investigation through remediation	Potential TBC for remedy selection

BRIEF DESCRIPTION	CITATION	REQUIREMENT	COMMENTS
Monitored Natural Attenuation	OSWER Directive 9200.4-17	Provides guidance on the use of monitored natural attenuation at superfund, RCRA Corrective Action, and Underground Storage Tank sites.	Potential TBC for remedy selection
Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration	OSWER Directive 9234.2-25	Provides guidance for determining when groundwater restoration is technically impracticable.	Potential TBC for remedy selection
ACTION SPECIFIC NEW YORK STATE STANDARDS, CRITERIA AND GUIDANCE (SCGs)			
Environmental Remediation Programs	6 NYCRR Part 375	Regulations for the development of remedial programs for inactive hazardous waste sites including NPL sites and sites being addressed by the Department of Defense	Potential ARAR for Feasibility Study development
Technical Guidance for Site Investigation and Remediation	NYSDEC Draft DER-10	Guidance for the site investigation and remediation for inactive hazardous waste sites under state standards, criteria, and guidance	Potential TBC for Feasibility Study development, remedy selection, and remediation
Strategy for Evaluating Soil Vapor Intrusion at Hazardous Waste Sites in New York	NYSDEC DER-13	Documents the requirement for vapor intrusion evaluation at chlorinated solvent contaminated sites.	Potential ARAR for HHRA and Feasibility Study
Soil Vapor Intrusion Guidance	NYSDOH CEH BEEI October 2006	Guidance for evaluation of soil vapor intrusion	Potential ARAR for HHRA and Feasibility Study
Individual Water Supplies – Activated Carbon	NYSDOH CSFP-530	Guidance for treatment of individual water supplies	Potential ARAR for Feasibility Study
Determination of Soil Cleanup Objectives and Cleanup Levels	NYSDEC TAGM 4046	Guidance for development of soil cleanup objectives	Potential TBC for Feasibility Study
Assistance for Contaminated Water Supplies	NYSDEC DER-24	Guidance for assistance for contaminated drinking water wells	TBC for drinking water wells
Hazardous Waste Manifest System	6 NYCRR Part 372	Requirements for shipment of hazardous waste	Potential ARAR for remedial action
Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites	NYSDEC TAGM 4031	Guidance for management and monitoring of fugitive dust	Potential ARAR for remedial action
Disposal of Drill Cuttings	NYSDEC TAGM 4032	Guidance for disposal of soil material from well installation	Potential ARAR for remedial action
Underground Injection/Recirculation (UIR) at Groundwater Remediation Sites	NYSDEC TOGS 2.1.2	Operational guidance for UIR systems	Potential ARAR for remedial action

BRIEF DESCRIPTION	CITATION	REQUIREMENT	COMMENTS
Citizen Participation	6 NYCRR Part 375 Voluntary Cleanup Program Internal Procedures Guide	Requirements for citizen participation activities for inactive hazardous waste sites	TBC for Feasibility Study and remedial action
Special Licenses and Permits – Definitions and Uniform Practices	6 NYCRR Part 175	Defines NYSDEC requirements for special permits applicable to takings of fish and wildlife for purposes other than hunting and fishing, and takings of rare, threatened or endangered species	TBC for remedial action
Freshwater Wetlands Permit Requirements	6 NYCCR Part 663	Establishes permit requirements for activities in wetlands	Potential ARAR for remediation activities such as well drilling
Local Assumption of Regulatory Authority over Freshwater Wetlands	6 NYCCR Part 665	Gives local government the option to assume regulatory authority over freshwater wetlands	Potential ARAR for remediation activities

APPENDIX C

REMEDIAL ALTERNATIVE COST ESTIMATE TABLES

ALTERNATIVE 1: NO ACTION

<u>Estimating Assumptions:</u>

* There are no one-time costs, long-term monitoring costs, five-year review costs, or public outreach costs associated with the No Action alternative

Line Item		*Total Costs*
Initial Implementation Cost		
Institutional Controls		$0
	Contingency at 20%	$0
	Total Initial Implementation One-Time Cost	$0
Long-Term Monitoring Cost		
Annual Sampling and Reporting		$0
	Contingency at 20%	$0
	Long-Term Monitoring Annual Cost	$0
Five Year Review		
Five-Year Review Sampling and Report		$0
Public Outreach		$0
	Five-Year Review Costs	$0
	Present Worth of Future Costs (20-years, 7%)	$0
	Total Present Worth	**$0**

ALTERNATIVE 2: INSTITUTIONAL CONTROLS

Estimating Assumptions:

* One time cost for institutional controls - legal
* Assumes one groundwater monitoring event associated with the Five-Year Review
* Five-Year Review includes cost for public outreach

Line Item		***Total Costs***
Initial Implementation Cost		
Institutional Controls		$35,000
	Contingency at 20%	$7,000
	Total Initial Implementation One-Time Cost	$42,000
Long-Term Monitoring Cost		
Annual Sampling and Reporting		$0
	Contingency at 20%	$0
	Long-Term Monitoring Annual Cost	$0
Five Year Review		
Five-Year Review Sampling and Report		$30,000
Public Outreach		$4,000
	Five-Year Review Costs	$34,000
	Present Worth of Future Costs (5-years, 7%)	$24,242
	Total Present Worth	**$66,242**

ALTERNATIVE 3: ADDITIONAL LONG-TERM GROUNDWATER MONITORING

Estimating Assumptions:

* Five-Year Review includes cost for public outreach
* Five-Year Review report relies on Long-term monitoring results and associated reporting
* Long-term groundwater monitoring for volatile organic compounds (five years assumed)

Line Item		***Total Costs***
Initial Implementation Cost		
Institutional Controls		$0
	Contingency at 20%	$0
	Total Initial Implementation One-Time Cost	$0
Long-Term Monitoring Cost		
Annual Sampling and Reporting		$20,000
	Contingency at 20%	$4,000
	Long-Term Monitoring Annual Cost	$24,000
Five Year Review		
Five Year Review Report		$6,000
Plus Public Outreach		$4,000
	Five-Year Review Costs	$10,000
	Present Worth of Future Costs (5-years, 7%)	$105,535
	Total Present Worth	**$105,535**

ALTERNATIVE 4: INSTITUTIONAL CONTROLS AND ADDITIONAL LONG-TERM GROUNDWATER MONITORING

Estimating Assumptions:

* One time cost for institutional controls - legal
* Five-Year Review includes cost for public outreach
* Five-Year Review report relies on Long-term monitoring results and associated reporting
* Long-term groundwater monitoring for volatile organic compounds (five years assumed)

Line Item		***Total Costs***
Initial Implementation Cost		
Institutional Controls		$35,000
	Contingency at 20%	$7,000
	Total Initial Implementation One-Time Cost	$42,000
Long-Term Monitoring Cost		
Annual Sampling and Reporting		$20,000
	Contingency at 20%	$4,000
	Long-Term Monitoring Annual Cost	$24,000
Five Year Review		
Five Year Review Report		$6,000
Plus Public Outreach		$4,000
	Five-Year Review Costs	$10,000
	Present Worth of Future Costs (5-years, 7%)	$105,535
	Total Present Worth	**$147,535**