Draft Focused
Corrective Measure Study for the State-Licensed Disposal Area at the Western New York Nuclear Service Center
West Valley, New York

May 2010

Prepared for:

NEW YORK STATE ENERGY RESEARCH AND DEVELOPMENT AUTHORITY

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List of Abbreviations and Acronyms

AGC	Annual-Average-Based Guideline Concentration
BOD	biological oxygen demand
BSWLF	Bulk Storage Warehouse Landfill
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CAO	corrective action objective
Ci	curies
COC	contaminant of concern
COD	chemical oxygen demand
cm/s	centimeters per second
CMS	Corrective Measure Study
DOE	United States Department of Energy
ECL	New York State Environmental Conservation Law
ECMP	Erosion Control and Maintenance Plan
EIS	Environmental Impact Statement
EMP	Erosion Monitoring Plan
EPA	United States Environmental Protection Agency
FEIS	Final Environmental Impact Statement
HLW	high-level waste
IC	institutional control
IERT	Independent Expert Review Team

List of Abbreviations and Acronyms (cont.)

LDR	land disposal restriction
µg/L	micrograms per liter
µCi/mL	microcuries per milliliter
m/yr	meters per year
mg/L	milligrams per liter
NEPA	National Environmental Policy Act
NDA	Nuclear Regulatory Commission Disposal Area
NFS	Nuclear Fuel Services, Inc.
NRC	(United States) Nuclear Regulatory Commission
NYCRR	New York Codes, Rules, and Regulations
NYSDOH	New York State Department of Health
NYSDOT	New York State Department of Transportation
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research and Development Authority
PCB	polychlorinated biphenyl
PRP	principal responsible party
QRA	quantitative risk assessment
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SDA	State-Licensed Disposal Area
SEQRA	New York State Environmental Quality Review Act
SMW	silt-trench monitoring well
SPDES	State Pollutant Discharge Elimination System
SWPPP	Storm Water Pollution Prevention Plan
SVOC	semivolatile organic compound
SWMU	solid waste management unit

List of Abbreviations and Acronyms (cont.)

TAGM	Technical Administrative Guidance Memorandum
TCL	target compound list
TOC	total organic carbon
TOGS	Technical and Operational Guidance Series
TOX	total organic halogen
TSS	total suspended solid
VLDPE	very low density polyethylene
VOC	volatile organic compound
WNYNSC	Western New York Nuclear Service Center
WVDP	West Valley Demonstration Project

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1 Introduction

Ecology and Environment, Inc., was contracted by the New York State Energy Research and Development Authority (NYSERDA) to prepare a Corrective Measure Study (CMS) for the State-Licensed Disposal Area (SDA) at the Western New York Nuclear Service Center (WNYNSC). The CMS has been prepared in accordance with the United States Environmental Protection Agency's (EPA's) Administrative Order on Consent. Docket No. II RCRA-3008(h)-92-0202 (EPA 1992). The CMS is intended to support or inform a remedial action decision for the SDA by evaluating the potential RCRA hazardous constituent hazards present at the facility. The CMS is not intended to replace or supersede the more comprehensive evaluations presented in the 2010 Final Environmental Impact Statement (FEIS), which was prepared by the United States Department of Energy (DOE) and NYSERDA (DOE and NYSERDA 2010). The following sections describe the site background and the purpose and scope of the CMS.

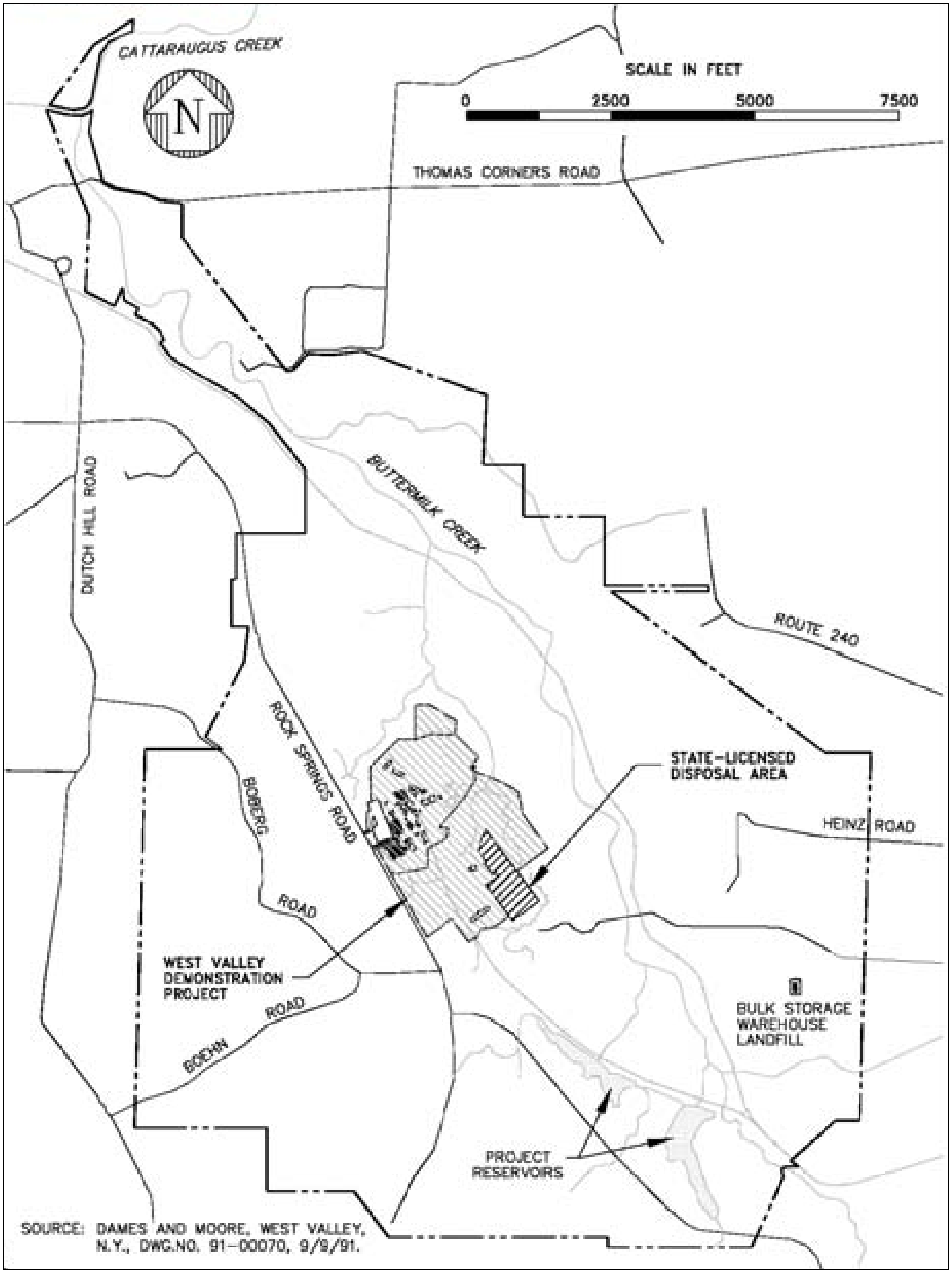
1.1 Site Background

NYSERDA maintains and monitors the SDA at the WNYNSC. The WNYNSC covers 3,338 acres and is located near West Valley, New York (see Figure 1-1). NYSERDA holds the title to the WNYNSC on behalf of the people of the state of New York.

The SDA, which occupies approximately 15 acres of the WNYNSC, was constructed and operated by Nuclear Fuel Services, Inc. (NFS) as a commercial radioactive waste disposal facility from 1963 to March 1975, at which time waste disposal operations at the SDA were terminated. NFS monitored and maintained the SDA until March of 1983, when management responsibility was transferred to NYSERDA.

1.1.1 Regulatory Context

In 1980, the West Valley Demonstration Project (WVDP) Act (Public Law 96-368) was enacted for the purpose of demonstrating high-level waste (HLW) solidification and then decontaminating and decommissioning of the facilities used in solidification. As required by the WVDP Act, NYSERDA and the DOE entered into a 1980 Cooperative Agreement (as amended in 1981) that, among other things, provided for the DOE to take exclusive possession and control of approximately 167 acres of the WNYNSC to conduct the WVDP. The DOE also uses and maintains certain additional facilities at the Center. Management responsibility for the remainder of the WNYNSC, including the SDA, was transferred from the NFS to NYSERDA in 1983.



SOURCE: DAMES AND MOORE, WEST VALLEY, N.Y., DWG.NO. 91-00070, 9/9/91.

Figure 1-1 Site Map, Western New York Nuclear Service Center (WNYNSC)

In 1986, New York State was authorized by the EPA to implement the Resource Conservation and Recovery Act (RCRA) Hazardous Waste Program. Effective May 1990, New York State was authorized to regulate the hazardous waste constituents of mixed radioactive and hazardous wastes. The DOE and NYSERDA submitted separate RCRA Part A Permit applications in June 1990 to the EPA and the New York State Department of Environmental Conservation (NYSDEC) to operate mixed waste management units at the WVDP and SDA, respectively, under interim status.

In March 1992, the EPA and NYSDEC entered into an Administrative Order on Consent Docket No. II RCRA-3008(h)-92-0202 (the Consent Order) with the DOE and NYSERDA that required the DOE and NYSERDA to conduct a RCRA Facility Investigation (RFI) and, where necessary, a CMS for the solid waste management units (SWMUs) at the WNYNSC. The RFI for NYSERDA-maintained SWMUs (see Section 1.1.2) was conducted in 1993. The Consent Order also indicated that the EPA and NYSDEC intended to accommodate the DOE and NYSERDA's desire to coordinate and integrate the requirements of the Consent Order with the development of the Environmental Impact Statement (EIS) to the extent that such coordination and integration did not delay the completion of the work required under the Order. However, by letter, dated November 2, 2005, NYSDEC and the EPA stated that the environment could be best served if the EIS and a separate CMS were prepared on two separate time tracks. By letter, dated January 20, 2006, NYSDEC and the EPA agreed that NYSERDA would prepare a separate CMS for the SDA SWMUs.

A separate FEIS has been prepared by DOE and NYSERDA (DOE and NYSERDA 2010), in accordance with the National Environmental Policy Act (NEPA) and the New York State Environmental Quality Review Act (SEQRA). The FEIS evaluates alternatives for integrated sitewide actions to complete the DOE decontamination and decommissioning activities and provide for NYSERDA's closure or long-term management of facilities at the WNYNSC. This joint FEIS supports the selection of the site management strategy and gives environmental input for NYSERDA and the DOE decisions for future site closure or management activities.

In November 2005, NYSERDA submitted a notification of claim for the 6 New York Codes, Rules, and Regulations (NYCRR) 374-1.9 storage and treatment conditional exemption for the low-level mixed waste in storage at the SDA Waste Storage Facility (SWMU SDA-5). Specifically, the low-level mixed waste in storage at the facility met the definition of "exempted waste" because it met the eligibility criteria of paragraph (b) (2) of § 374-1.9 and NYSERDA met all the conditions in paragraph (b) (3) of § 374-1.9. By letter dated February 26, 2006, NYSDEC acknowledged receipt of the notification.

In 2009, NYSERDA contracted to have all the low-level mixed waste stored at the SDA Waste Storage Facility removed, treated, and disposed of. This task will be completed in Spring 2010 and includes the removal of the Tank T-1 and

Trench 14 leachate treatment equipment. In addition to the removal of the low-level mixed waste, the Tank T-1 Building will be cleaned and closed in accordance with RCRA. Therefore, SWMU SDA-5 will soon be closed and no additional actions will be required.

1.1.2 NYSERDA-maintained SWMUs

The designated NYSERDA-maintained SWMUs include the following:

- **SWMU SDA-1.** 14 Inactive Radioactive Waste Disposal Trenches;
- **SWMU SDA-2.** Inactive Lagoon;
- **SWMU SDA-3.** Northern Filled Lagoon;
- **SWMU SDA-4.** Southern Filled Lagoon;
- **SWMU SDA-5.** SDA Waste Storage Facility, formerly known as the Trench 14 Leachate Treatment Facility, which has been closed in accordance with RCRA; and
- **SWMU 25.** Bulk Storage Warehouse Landfill (BSWLF).

Descriptions of these SWMUs and associated RFI activities are included in Section 2, Description of Current Conditions. However, as indicated in Section 1.1.1, SWMU SDA-5 will soon be closed in accordance with RCRA and will not be considered for further action.

1.1.3 Summary of Interim Control Measures

Several interim control measures were implemented at the SDA between 1992 and 1999 in an effort to minimize water infiltration and monitor groundwater elevations. These measures, which are more fully described in Section 2.1, included:

- Installation of a soil-bentonite subsurface barrier wall (slurry wall); and
- Placement of geomembrane covers over the 14 trenches and filled lagoons.

1.1.4 Summary of RFI Conclusions and Recommendations

For SWMU SDA-1 through SDA-4, the RFI concluded that the soil, surface water, groundwater, sediment, and air sampling data did not indicate the occurrence of past or present releases of RCRA-regulated hazardous constituents from the SDA disposal trenches or lagoons. The results of the air sampling study indicated that an air monitoring program at the SDA was not warranted.

For SWMU SDA-5, the RFI concluded that the facility was in compliance with applicable regulations and routine inspections documented that there had been no releases of leachate. No further action was recommended beyond the routine maintenance and inspections.

For SWMU 25, the RFI concluded that the landfill only contained decontaminated, empty containers that had been released by the United States Nuclear Regulatory Commission (NRC) for unrestricted use. In addition, records indicated that no RCRA-regulated or radioactive waste, or hazardous constituents had been disposed of at the landfill.

The RFI recommendations included:

- Continued sampling of well 1107A (see Section 2.1.3.1);
- Continued measurement of leachate and groundwater elevations;
- Development of action strategies for trench management to minimize the potential for release to the environment;
- Continued groundwater monitoring of the 1100 series wells and performance of intrawell and interwell comparisons; and
- Continued surface water monitoring in the vicinity of the SDA.

1.2 Purpose of the CMS

The purpose of the CMS for the SDA is to assess and update existing studies, data, and information regarding RCRA hazardous constituents at the SDA to:

1. Verify that historical and recently collected data continue to support the RFI conclusion that there is no evidence of a hazardous constituent release from the SDA;
2. Develop and evaluate corrective measure technologies and alternatives applicable to the control and containment of hazardous constituents so as to minimize the potential for a release of hazardous constituents from the SDA thereby protecting human health and the environment from these hazardous constituents; and
3. Recommend corrective measure technologies and alternatives appropriate to the containment of RCRA hazardous constituents.

The CMS is intended to support or inform a remedial action decision for the SDA by evaluating the potential RCRA hazardous constituent hazards present at the facility. The CMS is not intended to replace or supersede the more comprehensive evaluations presented in the 2010 FEIS. Final remedial or corrective action decisions for the SDA should not be made using this limited scope document. Such decisions must consider the primary hazard at the SDA (i.e., the radiological hazard). In addition, the CMS will review information to support no further action recommendations for SWMU 25, the BSWLF.

1.3 Scope of the CMS

This CMS evaluates containment, monitoring, and control technologies and alternatives applicable to RCRA hazardous constituent source areas of the SDA over a 30-year time period. The source areas of the SDA include:

- SWMU SDA-1: 14 Inactive Radioactive Waste Disposal Trenches;
- SWMU SDA-2: Inactive Lagoon;
- SWMU SDA-3: Northern Filled Lagoon; and
- SWMU SDA-4: Southern Filled Lagoon.

The 2010 FEIS preferred alternative for the site is the Phased Decision-making alternative. During Phase 1 (Ongoing Assessment Period), the anticipated management activities for the SDA are to monitor and maintain the facility in place and perform additional studies designed to improve NYSERDA's technical understanding of longer term management options. The studies will evaluate broader scope actions that could be implemented in the future, such as close-in-place and exhumation technologies. Studies conducted during the 10-year Ongoing Assessment Period could include long-term erosion controls, waste disposal availability, and field pilot studies. This information will be used to determine appropriate long-term management approaches to address the radiological hazards and will inform NYSERDA's Phase 2 decision on the SDA. The longer-term remedial approaches are primarily driven by the significant radiological hazard associated with the SDA as opposed to the RCRA hazardous constituents and are thus more appropriately evaluated in an EIS. Additional longer-term remedial action decisions for the SDA will be made within 10 years of the 2010 FEIS Record of Decision.

The information that has been gathered and assessed as part of the CMS is intended to supplement the radiological performance assessment information generated as part of the 2010 FEIS to support a complete (radiological and chemical) risk assessment. Final remedial action decisions for the SDA must be made in the context of a long-term radiological performance assessment and the 6 NYCRR Part 380 Radiation Control Permit for the SDA.

In support of the 2010 FEIS, NYSERDA completed a *Quantitative Risk Assessment of the State-Licensed Radioactive Waste Disposal Area* (QRA) to evaluate the risk from continued operation of the SDA for the next 30 years with its current physical and administrative controls. The scope of the QRA was limited to quantifying the radiation dose, though the mechanisms for contaminant release would be the same for a radiological or hazardous constituent. As such, the QRA provided valuable information for the CMS regarding the probabilities for a hazardous waste release from the SDA under certain man-induced and natural conditions. The potential conditions evaluated were:

- **Disruptive Events** - unexpected events that may cause an immediate change to the site (i.e., severe storms, tornadoes, earthquakes, fires, and airplane crashes).

- **Nominal Events and Processes -** expected events and processes that evolve continuously over the life of the facility (i.e., groundwater flows, slope subsidence, and the aging of engineered and natural systems).

The results of the QRA were factored into the CMS evaluation, as appropriate, providing valuable information on the probabilities of a hazardous constituent release from the SDA.

In addition to considering and acknowledging the importance of the 2010 FEIS in establishing the scope of this CMS, consideration was also given to the experience that EPA and NYSDEC have gained in assessing technologies and remedies most commonly applied to Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) municipal landfills (EPA 1995). From solely a RCRA hazardous constituent assessment perspective (i.e., excluding the radiological constituents), the waste in the SDA may be viewed as similar to CERCLA municipal landfill waste in that it is present as a heterogeneous mixture of municipal type waste combined with industrial and/or hazardous waste. The EPA and NYSDEC's experience with municipal landfills has shown that most of the technologies and alternatives other than containment often have been eliminated based on the heterogeneity of the waste, the large volume, the lack of reliable information concerning disposal history, and the problems with excavating through these wastes. Similar considerations apply to the hazardous waste constituents in the SDA. Accordingly, this CMS will focus on near-term containment technologies for the RCRA constituents at the SDA. As previously stated, longer-term remedial approaches, such as exhumation to address the radiological hazard, are evaluated in the broader-scope 2010 FEIS.

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Description of Current Conditions

2.1 SDA Disposal Trenches and Lagoons

2.1.1 Description

During its operational life (1963 to 1975), the SDA received approximately 2.4 million cubic feet of radioactive waste initially containing approximately 736,000 curies (Ci). It has been estimated that as of January 2000, approximately 129,000 Ci remain due to radioactive decay (Wild 2002). The waste was received from the NFS fuel reprocessing plant in addition to institutions, industries, government facilities, nuclear power plants, waste brokers, and decontamination facilities. The physical forms of the waste were diverse and included nuclear power plant processing wastes (e.g., resins, filters, evaporator bottoms), biological wastes, research wastes and absorbed liquids, sealed sources, and activated metals. This waste, in addition to the water that has accumulated in the trenches (trench leachate), constitute the sources of contamination at the SDA. Even though there are no records indicating that hazardous or mixed wastes were disposed of in the trenches, hazardous constituents have been detected in the trench leachate (see Section 2.1.3.1).

The SDA disposal trenches (SWMU SDA-1) are composed of 14 trenches arranged in two parallel sets, with the northern trenches numbered 1 through 7 and the southern trenches numbered 8 through 14 (see Figure 2-1). The trenches range from 450 to 650 feet in length and are approximately 20 feet deep. Each trench has a mounded cap of 8 to 10 feet of compacted clay with a drainage swale between adjacent trenches. During construction, the trench floors were sloped along their length to allow water to drain into a low point where a trench sump was located (see Figure 2-2). A vertical pipe extending from each sump to above the trench cap allows routine monitoring of trench leachate elevations. Trenches 6 and 7 were constructed to hold higher activity wastes and do not have sumps. Trench 6 is a series of auger holes storing irradiated reactor components. Trench 7 is a narrow, shallow trench in which waste containers were placed and then encased in concrete.

The inactive lagoon (SWMU SDA-2) was constructed in 1975 to contain water pumped from the grass-covered trenches that were accumulating water. This lagoon was unlined and had a capacity of 100,000 to 125,000 gallons. From 1975 until the spring of 1981, it was used as a leachate holding and pretreatment lagoon. Water within the lagoon was chlorinated to destroy biological hazards

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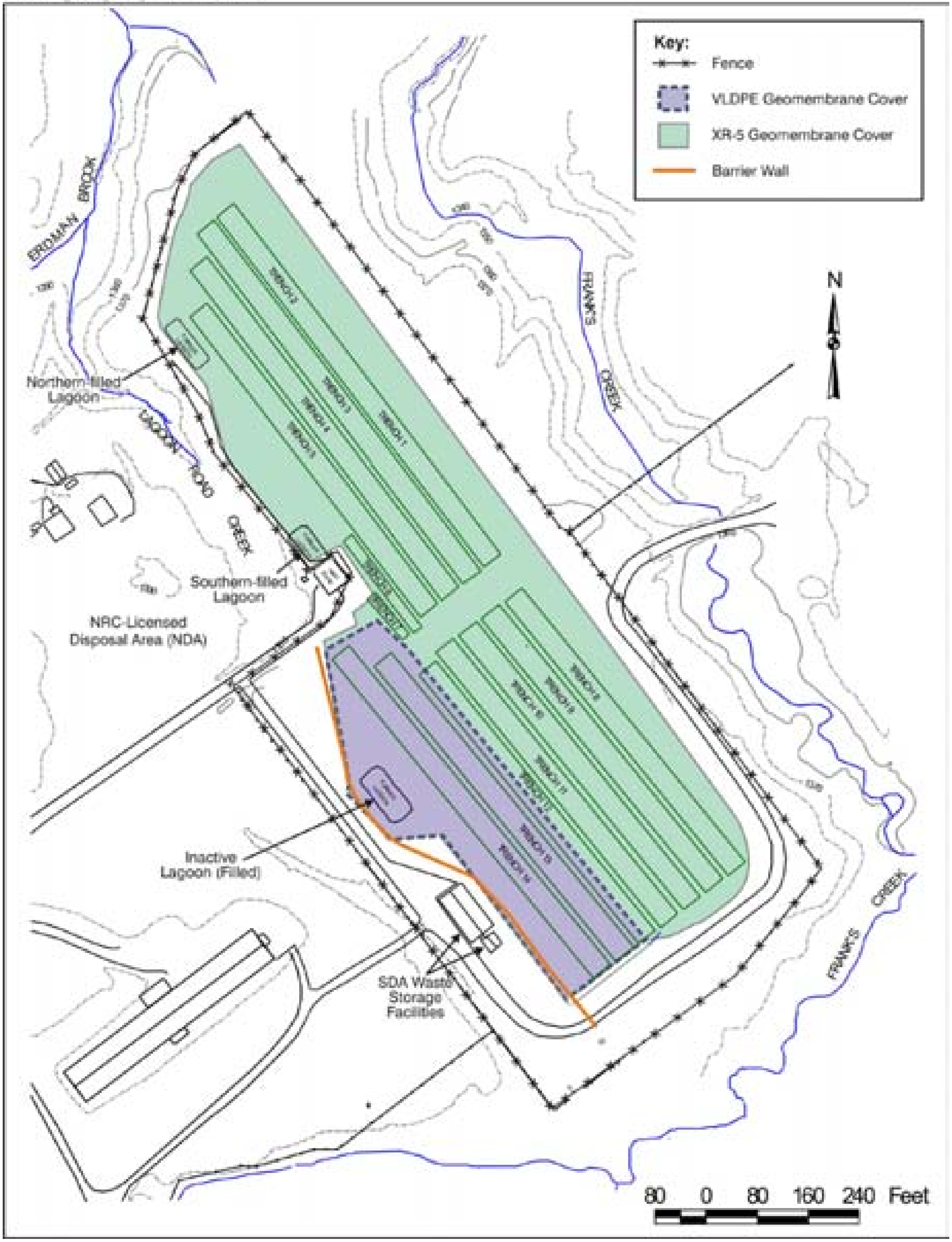

Figure 2-1 State-licensed Disposal Area (SDA)

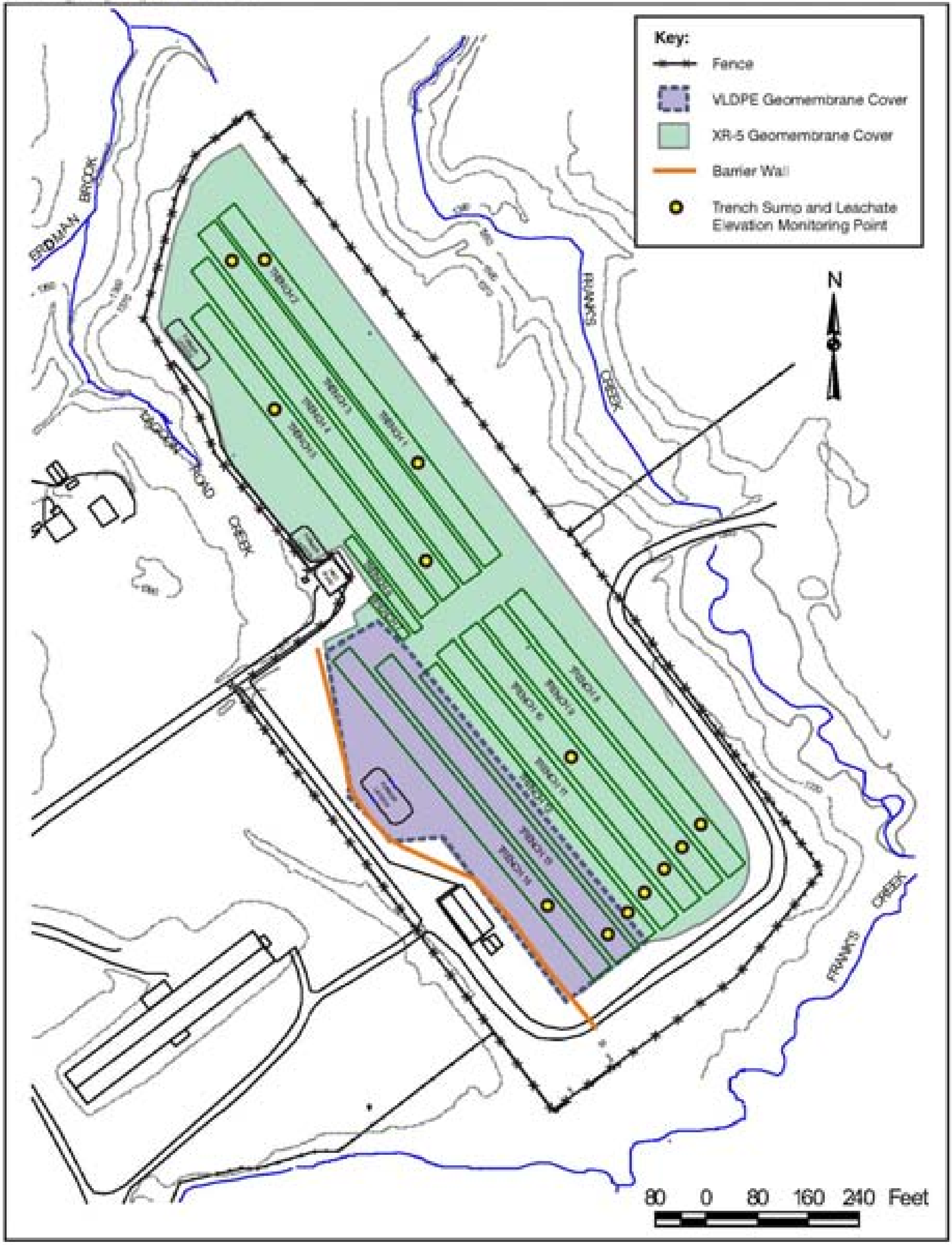

Figure 2-2 Trench Sump Locations

and then treated to reduce water hardness and coprecipitate some of the radionuclides. After the floc had settled, the water was transferred to the reprocessing plant's low-level liquid waste treatment facility. During 1991 and 1992, interim closure activities were conducted to isolate contaminated materials within the lagoon and determine the extent and magnitude of releases from the lagoon. These activities included the removal of accumulated precipitation, installation of a vinyl liner, filling of the lagoon with native till materials, and capping with clay till (E & E 1994).

The northern and southern filled lagoons (SWMUs SDA-3 and SDA-4) were unlined lagoons excavated adjacent to the northern trenches to hold water that was pumped from the open ends of the active trenches to create drier conditions. These lagoons also later received leachate that was pumped from the northern trenches after disposal operations were completed. These lagoons were closed in 1975 and 1977, respectively, by filling with absorbent material and compacted native soil (Anderson 1988).

In 1990, 21 groundwater monitoring wells (1100-series wells) were installed around the SDA as part of a facility-wide RCRA Groundwater Monitoring Program (see Figure 2-3). The well series is composed of 11 well clusters, with up to three wells per cluster, screened at shallow (A), medium (B), and/or deep (C) intervals. Well screen intervals generally correspond to the following three distinct geological layers: weathered Lavery Till, unweathered Lavery Till, and the Lacustrine (Kent Recessional) unit. The wells have been sampled and analyzed over the years for a variety of volatile organic compounds (VOCs), inorganic compounds, groundwater quality parameters, and radionuclides in varying regimes and schedules; and groundwater elevations in the wells have been routinely measured.

In 1991, a system of over 25 piezometers was installed primarily near Trench 14 to characterize and monitor subsurface hydrogeologic conditions in response to increases in leachate elevations at that time (see Figure 2-3). In 1992, nine slit-trench monitoring wells (SMWs) were installed in conjunction with the installation of the subsurface barrier wall (see Section 2.1.2) to characterize and monitor shallow-subsurface hydrologic conditions on the upgradient side of the wall (see Figure 2-3). The piezometers and SMWs have been occasionally sampled and analyzed for some radionuclides (and not for hazardous constituents), but their primary purpose has been for the routine measurement of groundwater elevations.

A storm water runoff collection system was installed for the SDA in conjunction with the installation of the geomembrane cover in 1995 (see Section 2.1.2). The system consists of drainage areas that direct runoff to detention basins and collection pipes and discharge it at surrounding outfalls. The system was designed to accommodate a 25-year, 24-hour storm event. One SDA drainage outfall (WO6) was eliminated in 2008 due to recent changes in the site topography at the adjacent NRC-Licensed Disposal Area (NDA). SDA surface water runoff that used to flow through WO6 has been redirected to WO5. Figure 2-5 shows the current

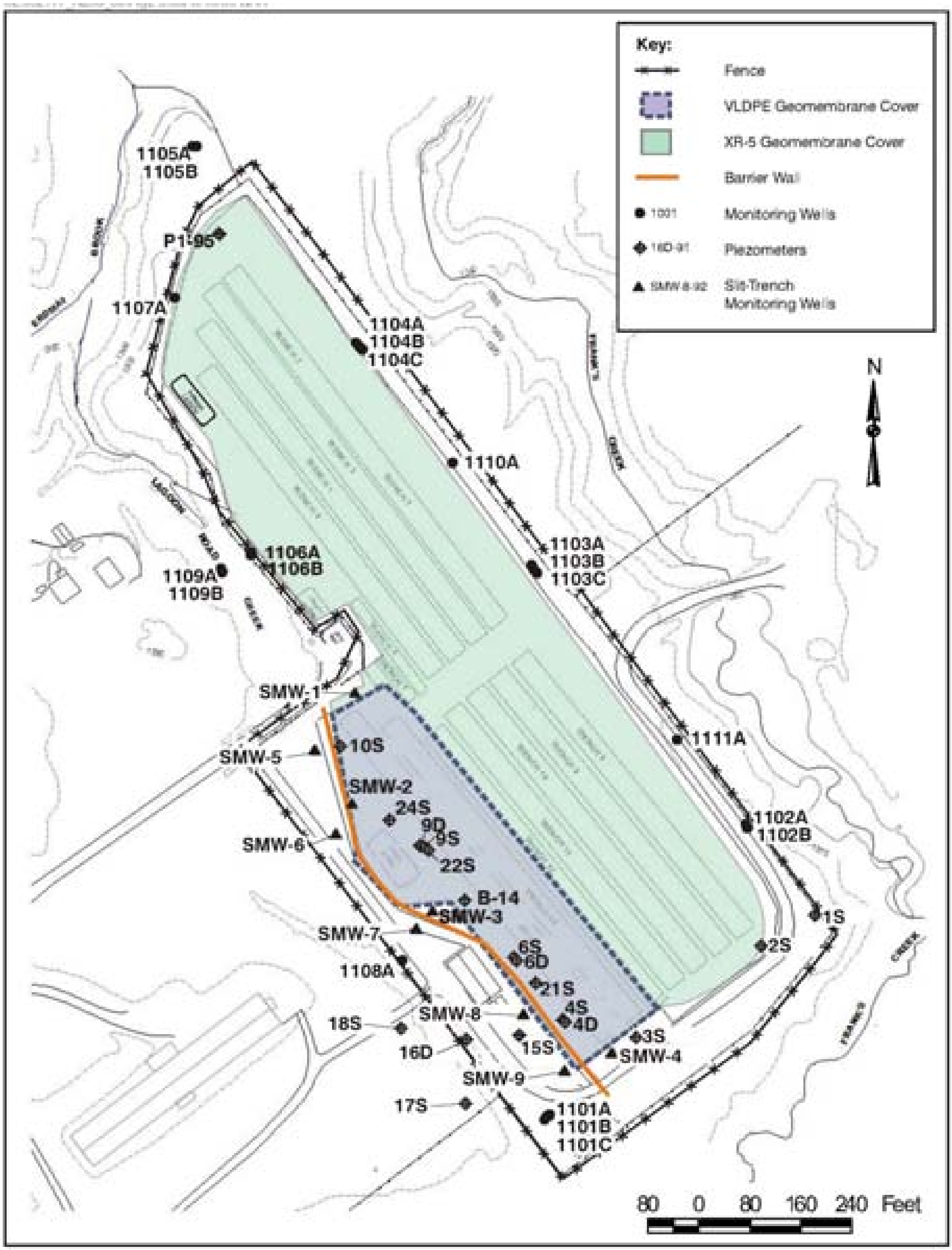

Figure 2-3 Groundwater Monitoring Well Locations

storm water runoff collection system, consisting of five drainage areas (01 through 05) and five outfalls (W01 through W05).

2.1.2 Trench Leachate Control Measures

Efforts to minimize erosion of the clay caps and infiltration of water into the SDA trenches began in the late 1970s and early 1980s. These efforts included rolling and reseeding the trench caps as well as several larger-scale regrading, recapping, and water infiltration control projects. In the early 1990s, rising water levels in Trenches 13 and 14 led NYSERDA to investigate more proactive water management measures. Trench leachate control projects consisted of the following (those after 1991 were performed as interim measures under the Consent Order):

- **1991.** Approximately 8,000 gallons of leachate from Trench 14 were pumped into an aboveground storage tank in the SDA Waste Storage Facility built at the SDA in 1990 (see Section 2.2). In addition, treatability studies were performed to determine feasible treatment and disposition options for trench leachate;

- **1992.** A soil-bentonite subsurface barrier wall (slurry wall) was installed along the western side of Trench 14 to prevent groundwater flow into the south trenches (see Figure 2-3).

- **1993.** A very low-density polyethylene geomembrane cover was installed from the centerline of Trench 12 and across Trenches 13 and 14, to just beyond the barrier wall.

- **1993.** A leachate treatment system was designed (the system was ultimately not constructed due to the success of the infiltration control measures).

- **1995 and 1996.** An exposed reinforced ethylene interpolymer alloy (XR-5) geomembrane cover was installed over Trenches 1 through 8 and 10 through 12. The storm water collection system (Section 2.1.1) for the landfill was installed at the same time.

- **1999.** A geomembrane cover was installed over Trench 9 to replace a previously installed pilot bioengineering management cover.

2.1.3 Nature and Extent of Contamination

2.1.3.1 Summary of the RFI and Other Preceding Investigations

Trench Leachate

Leachate was sampled and analyzed for Trenches 1 through 5 and 8 through 13 in 1987 and for Trench 14 in 1992 during performance of a leachate treatability study. Both studies indicated the presence of VOCs, semi-volatile organic compounds (SVOCs), and inorganic compounds in the leachate. Table 2-1 summarizes the results of these studies.

Table 2-1 Concentrations of Chemical Constituents in Trench Leachate

Chemical Constituent	Frequency of Detection[1]	Concentration Range (μg/L)[2]	Groundwater Standard (GA) (μg/L)[3]
Acetone	1/1	<50 - 7,700	50*
Acetonitrile	1/1	3,200	No standard exists
Benzene	10/13	<5 - 2,500	1
2-Butanone [Methyl ethyl ketone]	1/1	<100 -3,300	50*
Carbon disulfide	1/1	<5 - 680	60*
Chlorobenzene	3/13	<1 - 660	5
Chloroethane	5/13	3 - 900	5
Chloroform	10/13	5 - 1,000	7
2-Chlorophenol	3/13	<1 - 16,000	1 (in Total Phenols)
o-Cresol [2-Methylphenol]	12/13	<1 - 2,700	1 (in Total Phenols)
Cresol, m and p isomers [3- and 4-Methylphenol]	12/13	<1 - 5,400	1 (in Total Phenols)
1,1-Dichloroethane	10/13	<5 - 2,000	5
1,2-Dichloroethane	9/13	<5 - 630	0.6
trans-1,2-Dichloroethylene	6/13	<5 - 29	5
2,4-Dichlorophenol	1/13	<1 - 8,100	1 (in Total Phenols)
2,4-Dimethylphenol	12/13	<1 - 280	1 (in Total Phenols)
1,4-Dioxane	1/1	1,400,000	No standard exists
Ethylbenzene	10/13	<5 - 1,100	5
bis(2-Ethylhexyl)phthalate	11/13	<1 - 860	5
Methylene chloride	12/13	<5 - 18,000	5
4-Methyl-2-pentanone [Methyl isobutyl ketone]	1/1	<36 - 550	No standard exists
Naphthalene	12/13	14 - 680	10*
Pentachlorophenol	3/13	<2 - 1,000	1 (in Total Phenols)
Polychlorinated biphenyls	3/13	<0.5 - 82	0.09
Phenol	9/13	30 - 4,100	1 (in Total Phenols)
Styrene	1/1	<5 - 77	5
Tetrachloroethylene	4/13	<2 - 28	5
Toluene	11/13	256 - 98,000	5
1,1,1-Trichloroethane	3/13	<5 - 350	5
Trichloroethylene	9/13	<5 - 44	5
Trichlorofluoromethane	4/13	<1 - 3,100	5
2,4,6-Trichlorophenol	1/13	1 - 1,600	1 (in Total Phenols)
Vinyl acetate	1/1	<10 - 370	No standard exists
Xylenes (total)	1/1	40 - 20,000	5 each isomer

Note:

[1] No. of trenches in which constituent detected out of number of trenches sampled (1987 and 1992 sampling events).

[2] If a range is given for those constituents detected in only one trench, the constituent was analyzed for during both 1987 and 1992 sampling events.

[3] NYS Class GA Groundwater Standards or Criteria value; June 1998.

* Guidance value.

Soil

The results of the soil sampling program, including detailed data tables, are provided in the RFI report (E & E 1994). A summary of the investigation and results is provided below.

During the RFI, seven soil borings were drilled around the periphery of the SDA. Soil samples were analyzed for Target Compound List (TCL) organics, including VOCs, SVOCs, pesticides and polychlorinated biphenyls (PCBs), and RCRA metals. A surface soil sample was analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) due to the detection of these compounds at a low level in a nearby groundwater monitoring well. A background soil boring was drilled east of the SDA.

No VOCs were detected in the soil samples collected from the soil borings. No BTEX compounds were detected in the surface soil sample. The RCRA metals detected in the soil samples did not exceed background concentrations with the exception of thallium, which was not detected in the background sample. The concentrations of all metals were within the published common ranges of concentrations in soils in the eastern United States (E & E 1994).

During the RFI, sampling was conducted at the northern and southern filled lagoons. An evaluation of the inactive lagoon was based on three soil borings that were drilled in December 1991. Low levels of VOCs and SVOCs (below Technical Administrative Guidance Memorandum [TAGM] 4046 soil cleanup objectives) were detected in the sediments (soil) from all of the lagoons and in the fill materials for the northern and southern filled lagoons (assumed to be due to backfilling with soil contaminated by site operations). Low levels of toluene detected below the sediment in the northern and southern filled lagoons indicated some downward movement of this constituent (approximately 4.5 feet).

The RFI concluded that because the concentrations of hazardous constituents detected in lagoon sediments and fill were low, the lagoons were not considered to be significant source areas that would contribute to potential releases of RCRA-regulated constituents from the SDA.

Groundwater

During the RFI, groundwater well monitoring data collected from 1991 to 1993 were compared to the upgradient well (1101A, B, C) using statistical analyses. Parameters for which the statistical analyses were performed included iron, manganese, and total phenols; the indicator parameters of pH, specific conductance, total organic carbon (TOC), total organic halogens (TOX), sodium, and chloride; and gross alpha and gross beta radioactivity and tritium. Statistical analyses were not performed for VOCs during the RFI because they were not detected above quantitation limits. Based on the results of the statistical analyses, it did not appear that there had been any releases of hazardous constituents to the groundwater from the SDA (E & E 1994).

Well 1107A was identified as an area of interest in the RFI because the concentration of parameters, such as tritium, gross beta, chloride, manganese, iron, TOX, and TOC, were higher, while pH was lower, in this well than in other wells. The unique groundwater chemistry in well 1107A has been attributed to past practices and historical events in this area, including the pumping of water from the SDA trenches to the ground and a 1975 surface release of leachate from Trenches 4 and 5. Regardless of the source of the differences, RCRA hazardous constituents other than iron, which is a naturally occurring metal, were not detected in well 1107A.

Sediment and Surface Water Sampling

During the RFI, two sediment samples and one surface water sample were collected in the northern area of the SDA, in a surface water runoff collection area. No organic compounds were detected in the sediment samples and detected RCRA metals were all below background values and within the published common ranges for soils in the eastern United States. Toluene was detected at a low concentration in the surface water sample, but additional samples collected at a later date did not confirm its presence. The RCRA metals detected in the surface water were below NYSDEC Class D surface water standards, with the exception of iron. The RFI sediment and surface water samples did not indicate releases of RCRA-regulated hazardous constituents or hazardous wastes from the SDA trenches (E & E 1994).

Air

During the RFI, ambient air sampling was conducted at the SDA to assess the potential for off-site migration of VOCs from the trenches via the air pathway. The ambient concentrations of the detected compounds (carbon disulfide, xylene, and methylene chloride) in the downwind samples were below their corresponding Annual-Average-Based Guideline Concentrations (AGCs) (E & E 1994).

2.1.3.2 Environmental Monitoring Program Results

Leachate Elevations

Leachate elevations are currently measured quarterly in the 13 trench sump locations at the SDA to monitor water infiltration and assess the performance of the infiltration controls. Annual statistical assessments of trends in leachate elevation have been performed since 1996. Leachate elevations have been reported as statistically decreasing for most trenches in most of those assessments, demonstrating the overall effectiveness of the infiltration controls. The leachate elevation for Trench 1, which has typically been reported as decreasing in annual trend assessments, was reported in the last two assessments as increasing (when assessing data from 2000 through 2007 and 2000 through 2008, respectively). This represents a physical increase of about 2 inches since 2000 (E & E 2009 and prior annual statistical assessment reports). Based on well construction information, NYSERDA believes the leachate elevation is very near the bottom of Trench 1.

Groundwater Elevations

Groundwater elevations are currently measured quarterly in the 1100-series wells, select piezometers, a cased soil boring, and the slit-trench monitoring wells to monitor hydrology around the landfill. Quarterly groundwater elevation contour maps have consistently shown that the hydraulic gradient in the weathered Lavery Till in the vicinity of the disposal trenches continues to be inward and the direction of groundwater movement in the Kent Recessional Sequence continues to be northeasterly (NYSERDA 2009a), again demonstrating the effectiveness of the infiltration controls.

Annual statistical assessments of groundwater elevations show varying results and trends depending on the well, year, and range of data assessed. Recent assessments performed for data from 2000 on have repeatedly indicated an increase in groundwater elevations at particular locations on the east, south, and southwest of the landfill and little change in groundwater elevation at the majority of the locations (E & E 2009 and prior annual statistical assessment reports).

Groundwater Sampling

The 1100-series wells are currently monitored in accordance with the SDA Groundwater Monitoring Plan (NYSERDA 2008a). They are sampled annually for VOCs (56 RCRA Appendix IX compounds), gamma emitters, carbon-14, iodine-129, strontium-90, and technetium-99 and semiannually for gross alpha, gross beta, tritium, and water quality (pH, conductivity, temperature, and turbidity). With a few exceptions, background-level concentrations have been observed for the wells. The groundwater chemistry and content are notably different at well 1107A where, for example, the tritium and strontium-90 are elevated and the pH is lower compared to other 1100-series wells (E & E 2008). VOCs are not typically detected above NYSDEC groundwater standards at the wells; however, benzene has been detected twice at 24 micrograms per liter (µg/L) at upgradient well 1101C in 1994 and 1998. Tritium has been consistently detected above the program detection limit (1×10^{-7} microcuries per milliliter [µCi/mL]) at about half of the wells, but is currently present at levels below the NYSDEC 6 NYCRR 703.5 water quality standard (2×10^{-5} µCi/mL). Tritium concentrations in the groundwater samples have been decreasing at a rate that seems to be consistent with its half-life although that has not been formally verified.

Surface Water Sampling

Surface water samples are currently collected quarterly at four locations near the SDA (see Figure 2-4) and one background location. The samples are analyzed for gross alpha, gross beta, and tritium. Prior to June 2005, the samples were collected weekly at location WNERB53 and monthly at locations WNDCELD, WNFRC67, and WNNDADR. Beginning in June 2005, NYSERDA implemented a NYSDEC-approved quarterly surface water sampling and analysis program. Some surface water sample results are typically elevated above background concentrations (e.g., at WNNDADR) but results have consistently been below NYSDEC 6 NYCRR 703.5 Table 1 surface water quality standards (NYSERDA 2009a).

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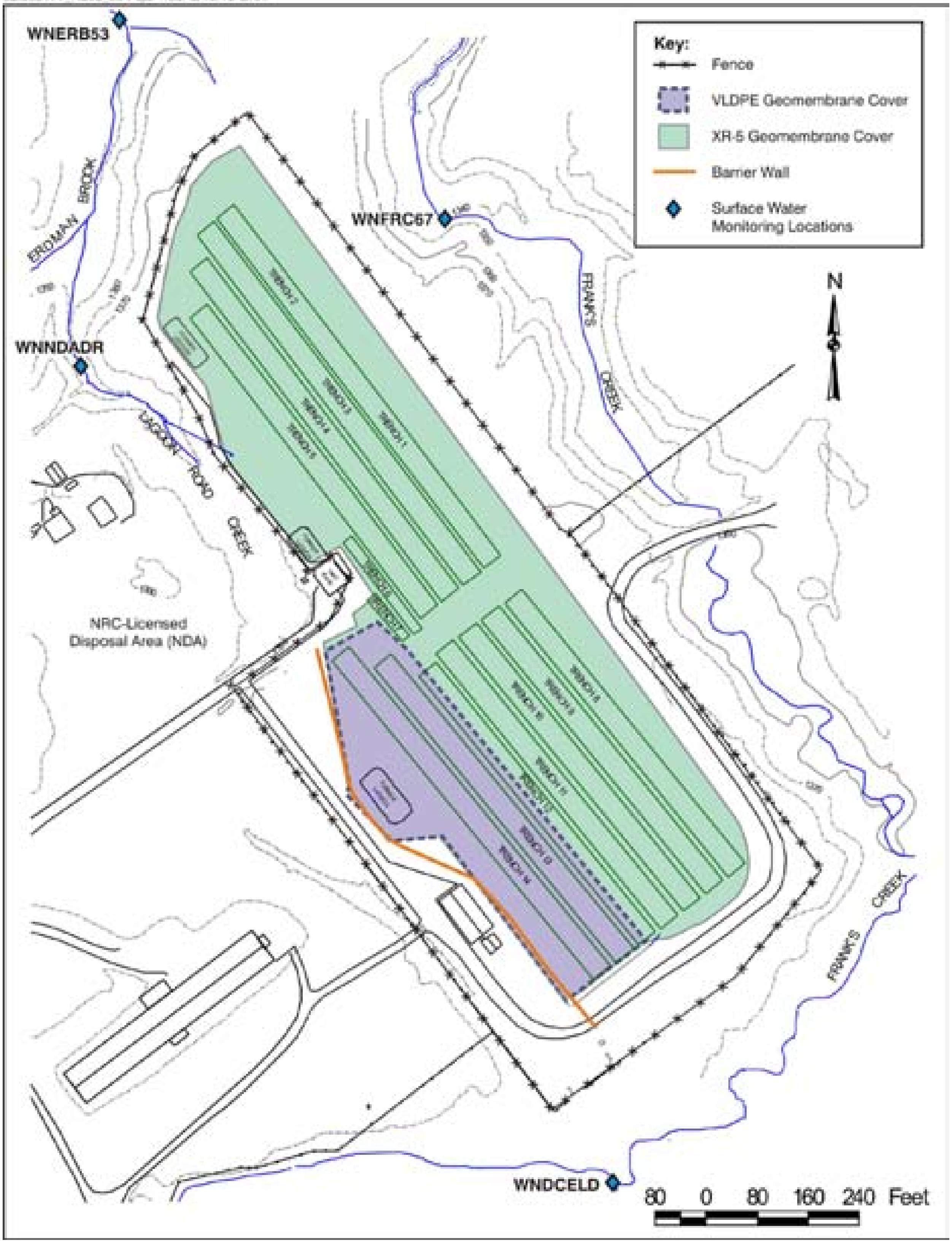

Figure 2-4 Surface Water Monitoring Locations

Storm Water Sampling

Storm water samples are currently collected semiannually at outfall W01 under NYSERDA's September 2005 State Pollutant Discharge Elimination System (SPDES) permit. Outfall W01, also known as location WNSTM1, is the preferred sampling point that is used to represent conditions for the five SDA outfalls (see Figure 2-5). The samples are analyzed for pH, oil and grease, biological oxygen demand (BOD), chemical oxygen demand (COD), total nitrogen, total phosphorus, total suspended solids (TSS), gross alpha, gross beta, tritium, and gamma emitters. Low levels of the chemical constituents and tritium at above background levels, are typically seen in the storm water samples, especially in the first flush grab component of the sample. The measured pH for the first flush grab component typically is slightly below the NYSDEC water quality standard range for pH (6.5 to 8.5 pH units for most water quality classifications). Oil and grease, which is the only constituent with a SPDES compliance limit (15 milligrams per liter [mg/L]), has not been detected above that limit under the current program.

From 1993 to 2005, storm water runoff from the Trench 13 and 14 geomembrane cover was sampled monthly at surface water location WNSDADR, which functioned as a collocated sample location for outfall W05 (also known as location WNSTM5; see Figure 2-5). The samples were analyzed for pH, TSS, and oil and grease (required as part of the 1992 infiltration controls project), as well as gross alpha, gross beta, tritium, and gamma emitters. The pH measurements were typically within the NYSDEC surface water quality standard range for pH (6.5 to 8.5 pH units for most surface water classifications). TSS results were varied over that period. With the exception of two samples, the oil and grease results were below the current SPDES permit limit. The radiological results were below NYSDEC surface water quality standards.

Environmental Radiation Monitoring

Ambient gamma exposure at the SDA landfill is measured using two methods. Since December 1995, environmental dosimeters have been used to measure cumulative quarterly exposure at four on-site locations — three around the SDA and one in the Tank T-1 building. An off-site background location has been monitored since 2006. A semiannual overland real-time survey of the gamma exposure rate has been performed since 1993 at assigned locations around the perimeter and across the trench caps of the SDA using a portable meter. The exposure for the eastern side and majority of the SDA has typically been similar to background. Since the removal of the radioactive waste in 2007 in the nearby Drum Cell, the exposure for the western boundary of the SDA is also typically similar to background.

The trench sump covers have been monitored semiannually for radioactive contamination. Several sump covers are typically contaminated with low levels of alpha and/or beta contamination above background, which are attributed to radon daughters and other particulate radiation released in gas from the sump pipes.

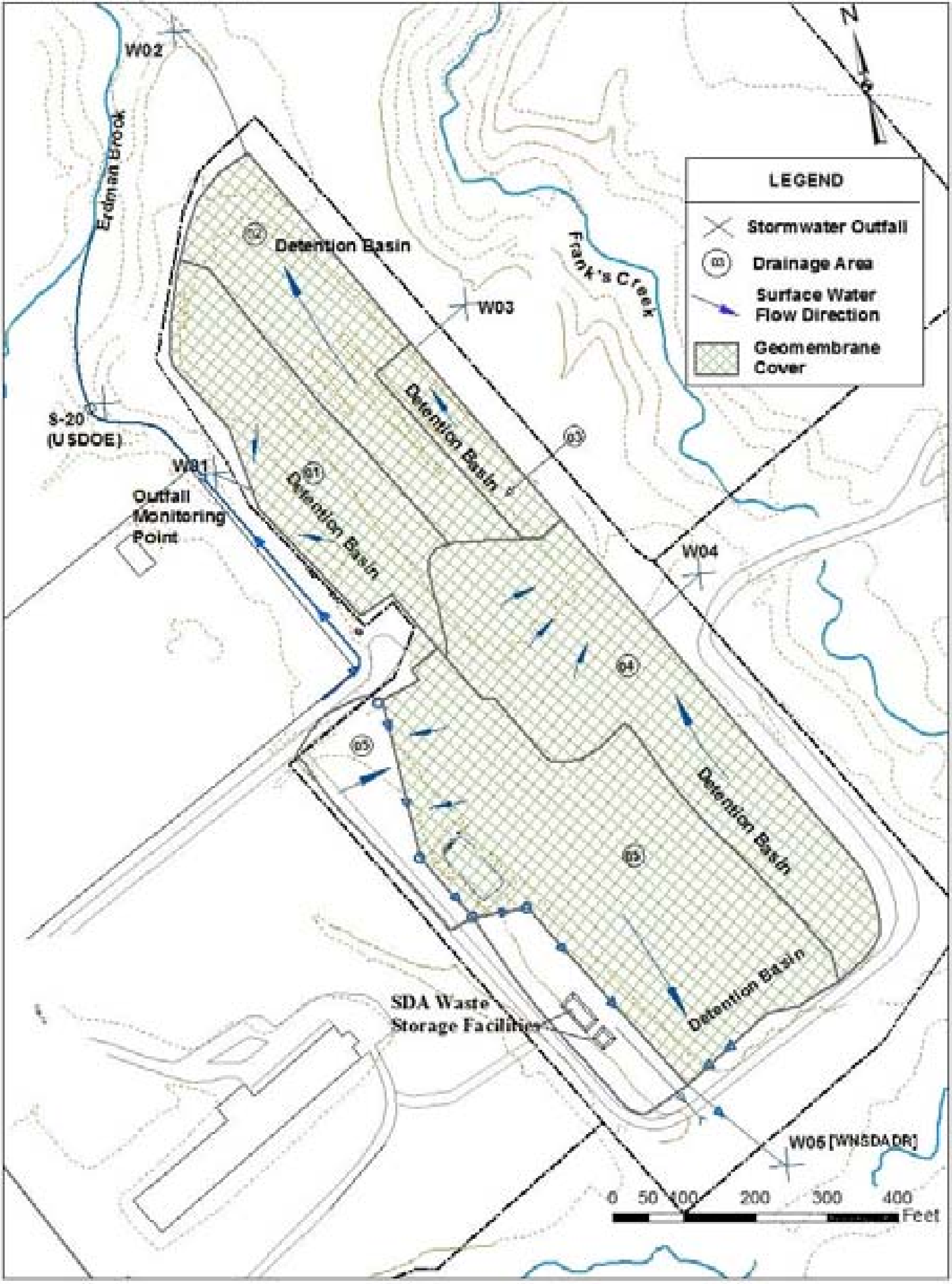

Figure 2-5 Storm Water Monitoring Locations

SDA Ground Surface Elevation Surveys

Annual surveys of ground surface elevation have been performed since 1991 for multiple points along each of the trench caps and the SDA North Slope to monitor and assess stability, settlement, and erosion. In general, there is little substantive vertical or horizontal change in the measurements between annual surveys, indicating overall stability of the trench caps.

2.1.4 Current Inspection and Maintenance Activities

NYSERDA performs a detailed annual inspection of the geomembrane cover including welds, boots, drainage systems and the safety walkway. The annual inspection identifies any repairs and maintenance required to keep the geomembrane cover performing as designed. Five walkover inspections of the SDA and the surrounding area, which includes the geomembrane cover, are conducted during the year to provide more frequent monitoring of conditions and performance. The very low density polyethylene (VLDPE) geomembrane is scheduled for replacement within the next year and the XR-5 geomembrane is scheduled for replacement within the next five to 10 years. Routine walkover inspections are performed within and immediately around the SDA to assess the condition of the trench caps, slopes, drainage areas, ridges, streams, and vegetation areas considered critical to the integrity of the SDA. NYSERDA also performs annual inspections and maintenance of the WNYNSC perimeter fence, and performs routine inspections of the SDA Waste Storage Facility. Observations and deficiencies are recorded and corrective actions are implemented.

2.2 SDA Waste Storage Facility

The SDA Waste Storage Facility, formerly known as the Trench 14 Leachate Treatment Facility (SWMU SDA-5), consists of a 9,200 gallon fiberglass-reinforced plastic storage tank (Tank T-1), two empty 21,000-gallon stainless steel frac tanks, secondary containments, and their weather enclosure buildings. Although a leachate treatment system was designed to treat the Trench 14 leachate as an interim measure under the Consent Order, NYSDEC and the EPA agreed that the system was no longer required due to the success of the SDA infiltration control measures (see Section 2.1.2).

In 2009, NYSERDA contracted to have all the low-level mixed waste stored at the SDA Waste Storage Facility removed, treated, and disposed of. This task will be completed in Spring 2010 and includes the removal of the Tank T-1 and Trench 14 leachate treatment equipment. In addition to the removal of the low-level mixed waste, the Tank T-1 Building will be cleaned and closed in accordance with RCRA. Therefore, SWMU SDA-5 will soon be closed and no additional actions will be required.

2.3 Bulk Storage Warehouse Landfill

The BSWLF (SWMU 25) is located in the southeastern corner of the WNYNSC (see Figure 1-1). During the RFI, records pertaining to the BSWLF were reviewed and it was determined that no radioactive waste, RCRA-regulated waste, or hazardous constituents had been disposed of in the BSWLF. Because there was no possibility of a release of hazardous waste or hazardous constituents, it was determined that no further action was required (E & E 1994).

2.4 Site Geology and Hydrology

The geology underlying the SDA site is composed of the approximately 90-foot thick Lavery Till, underlain by a 20- to 30-foot Lacustrine unit. The upper 15 feet of the Lavery till is weathered and cracked and is known as the weathered Lavery Till. Beneath the weathered Lavery Till is the unweathered Lavery Till, a highly impermeable layer, which presents a substantial barrier to downward migration of groundwater.

Groundwater in the weathered Lavery Till unit generally flows to the northeast across the South Plateau from higher elevations at Rock Springs Road toward lower elevations in the stream valleys of Erdman Brook and Frank's Creek. In the area of the SDA, the prevailing groundwater flowpath is interrupted by the trenches, drains, and engineered features of these facilities (WVNS 1993a). The groundwater flows both laterally and vertically within the weathered Lavery Till unit. Groundwater in the unweathered Lavery Till generally flows vertically downward toward the underlying Kent Recessional Sequence (Prudic 1986, WVNS and Dames and Moore 1997). This unit is perennially saturated and has relatively low hydraulic conductivity in the vertical and horizontal dimension and thus functions as an effective aquitard (WVNS and Dames and Moore 1997).

In the trenches, the primary direction of leachate flow in the unweathered Lavery Till is vertical (downward) as opposed to horizontal (Prudic 1986; Bergeron and Buliosi 1988). Leachate elevations in the trenches have been closely monitored for over a decade. Trend analysis of leachate elevations indicates that the leachate migration is downward and progresses at roughly 1 to 3 cm/yr, depending on the trench.

2.5 RFI Site Conceptual Model

A site conceptual model for the SDA was presented in the RFI report. This model illustrated potential migration pathways and associated potential exposure routes for the SDA because no specific releases had been conclusively identified. The potential migration pathways involved both atmospheric and groundwater pathways and included diffusion of gases through the soil cover or fill material into the atmosphere; migration with groundwater, dominantly downward, in the unweathered till; and migration with groundwater, laterally and downward, within the weathered till. The report discussed pathways as they related to potential future migration of contaminants in the SWMUs to environmental media and potential receptors. To date, no specific releases have been conclusively identified from the SDA, therefore, the RFI conceptual model still remains applicable to the site.

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3

Corrective Action Objectives

Site-specific corrective action objectives (CAOs) for the SDA were established in conjunction with NYSDEC through the review and revision of the CMS Work Plan. The CAOs that were established will protect human health and the environment and comply with, where practical and cost effective, the following NYSDEC guidance documents:

- TAGM HWR-94-4046, Determination of Soil Cleanup Objectives and Cleanup Levels (January 1994) or superseding cleanup guidance; and

- Division of Waters Technical and Operational Guidance Series (TOGS) 1.1.1, *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations* (June 1988/2004 addendum).

The potential SDA contaminants of concern (COCs) are defined as those hazardous constituents that have been detected in the SDA trench leachate at levels exceeding the TOGS 1.1.1, Class GA water quality standards. These COCs, along with the regulatory value listed in TOGS 1.1.1 for groundwater are identified in Table 2-1.

The RFI and current environmental monitoring data for the SDA indicate that these quantitative media clean-up standards are not currently relevant to the SDA, as there is no evidence of a release of hazardous constituents from the SDA (i.e., there is no groundwater plume or other contaminated environmental media outside of the SDA that needs to be remediated). The threat of a release of hazardous constituents is the issue of concern for the SDA. Thus, NYSERDA believes that the appropriate focus of the CMS for the SDA is the evaluation of technologies and alternatives for source control and containment of the leachate, as well as verification of this containment through monitoring and inspection.

NYSERDA proposes the following qualitative source containment CAOs against which the SDA corrective measure technologies and alternatives could be evaluated:

1. Prevent or minimize the generation of additional leachate;

2. Prevent or minimize the release of leachate to groundwater and surface water;

3. Prevent human exposure to leachate and disposed wastes; and
4. Provide detection and monitoring capabilities to demonstrate the first three objectives.

4 Identification, Screening, and Development of Corrective Measure Alternatives

4.1 Screening of Corrective Measure Technologies

Previous documents have been developed to screen and evaluate contaminant control technologies for the SDA (Provencher 1993; URS 2005). These documents evaluated a broad range of biological, chemical, thermal, and physical technologies to treat or contain, either in situ or ex situ, the wastes in the trenches and lagoons to reduce their toxicity, mobility, and/or volume. This focused CMS evaluated technologies designed to contain hazardous constituents over the next 30 years (see Section 1.3). Evaluation of containment technologies at the SDA as an interim measure is consistent with the Phased Decision-making Alternative in the 2010 FEIS. The information gathered from the analyses conducted as part of the CMS will be used in conjunction with the radiological performance assessment information that will be generated during the Phase 1 implementation of the EIS. This information will be used to determine the longer term remedial approaches to address the radiological hazards at the SDA during Phase 2.

4.1.1 Screening Criteria

This focused CMS only evaluates containment technologies, consistent with the selected alternative in the 2010 FEIS. Site-specific characteristics, leachate characteristics, and technology-specific information were used to screen out containment technologies that are not feasible or effective, or are not as feasible or as effective, as other technologies in achieving CAOs. In addition, technologies must comply with applicable environmental discharge limits and requirements.

4.1.1.1 Site-Specific Characteristics

The site-specific characteristics that will be used to screen out the technologies are identified below:

- **Low-permeability Soils of the South Plateau.** The unweathered Lavery Till clay layer has extremely low permeability and acts to retard contaminant migration.

- **South Plateau Stratigraphy.** The top-most weathered Lavery Till layer permits some lateral migration of groundwater when a lateral groundwater gradient is present, due to a higher lateral permeability than vertical permeability. The underlying unweathered Lavery Till has a significant vertical (downward) gradient. However, due to the 76 foot thickness of the unweathered Lavery Till, and its extremely low permeability, this layer presents a significant barrier to contaminant migration into the much deeper Lacustrine unit. The Lacustrine unit represents a lateral migration pathway.

- **Adjacent Creeks and Wetlands.** Erdman Brook, Frank's Creek, and Lagoon Road Creek, and their associated riparian wetlands, surround the northern, eastern/southern, and a portion (the northern third of Trench 5) of the western site boundaries, respectively. These creeks and wetlands have generated concerns regarding potential site erosion and stability because there is a drop in elevation from the SDA to these water bodies. In 2008, the DOE completed an extensive water infiltration controls project at the NDA, immediately adjacent to the SDA, which includes an upgradient subsurface barrier wall (to prevent groundwater inflow) and a geomembrane cover (to prevent infiltration of precipitation). Precipitation falling on the NDA geomembrane drains to a detention basin and is released downstream of the SDA Storm Water Outfall WO1 in Lagoon Road Creek.

4.1.1.2 Leachate Characteristics

The leachate characteristics that will be used to screen out the containment technologies are described below:

- **Radioactive constituents in the leachate.** Radionuclides in the leachate present concerns regarding treatability of the waste and the hazards they pose to personnel during treatment.

- **Hazardous constituents in the leachate.** Each constituent must be considered when evaluating leachate treatability, as must the potential risk each poses to human health if the leachate were to migrate off site.

- **Limited disposal history information.** The exact contents and depths of the trenches are unknown, which adds uncertainty to the cost and applicability of leachate treatment options and fate-and-transport analyses.

- **Large volume of leachate.** At approximately one million gallons, the total leachate volume would be difficult to store and/or transport for off-site treatment.

- **Heterogeneity of leachate from trench to trench.** Heterogeneity of the leachate affects the design of a system that is capable of treating all of the leachate.

4.1.1.3 Technology Limitations

The various factors that will be used to screen out the technologies not applicable or feasible at the site are discussed below:

- **Level of technology development.** The screening will be based on the degree to which the technologies have been proven, whether in the laboratory, by limited field studies, or through extensive testing at similar sites.

- **Performance record.** The performance records for the technology in general, as well as performance of the technology in previous applications at the SDA, will be considered.

- **Mixed waste applicability.** The heterogeneous nature of the SDA trench wastes (radiological and RCRA hazardous constituents) presents technological challenges and limited options for treatment and disposal in accordance with both sets of regulatory requirements (land disposal restrictions [LDR] treatment and disposal standards, and radioactive materials licensing and radiological discharge limitations).

- **Constructability.** Refers to whether the technology can be built as designed.

- **Operation and maintenance issues.** For example, technologies may be overly complex, become unreliable after implementation, or require frequent/ routine inspections, repairs, or replacements (e.g., exchange of treatment resins due to dose rate issues).

The technologies that passed this screening, either individually, or in combination with complimentary technologies, are discussed in general in Section 4.2 of this report. Detailed evaluations of the selected alternatives are presented in Sections 4.3 through 4.4. A No Action alternative has been included for comparison purposes.

The containment technologies considered in this section are separated into the following five categories. Each category includes several technologies that are evaluated for applicability to the site and leachate characteristics.

- Infiltration controls;

- Site stability controls;

- Leachate management, treatment, and disposal;

- Institutional controls; and

- Monitoring and inspections.

4.1.2 No Action

Implementation of No Action would result in the SDA left in its current condition and would require elimination of all current maintenance and monitoring practices. Therefore, No Action is not considered a viable technology and will only be used for comparison purposes in the following discussions.

4.1.3 Infiltration Controls

Infiltration controls are designed to limit exposure of the waste material to infiltrating precipitation and laterally migrating groundwater, thus reducing or eliminating the generation of contaminated leachate.

4.1.3.1 Caps

Capping reduces the potential for contaminants to come into contact with surface water runoff and limits infiltration of precipitation into groundwater, thus limiting potential contaminant exposure and mobility. Capping systems use materials such as soil, clay, asphalt, synthetic membranes, concrete, and chemical sealants to cover the landfill. The use of capping technology at the SDA would involve replacement of the existing geomembrane cover or an addition to that cover.

Capping is generally performed when subsurface contamination at a site precludes excavation and removal because of potential hazards and/or prohibitive costs. Disadvantages of capping include uncertain design life and the need for long-term maintenance and monitoring.

Clay Cap

Caps consisting of low permeability soils are effective in reducing the amount of water that infiltrates to the underground waste material, and thus, the amount of leachate generated in the trenches. They also reduce human exposures by acting as a barrier between the waste and the surface. The caps do not reduce the toxicity or volume of the wastes. Clay caps must be maintained, and periodic reworking and re-compaction of the cap may be required to address the effects of natural weathering and settlement.

Each trench at the SDA has 8 to 10 feet of mounded, compacted clay soil between the waste material and the existing geomembrane cover. Similarly, clay caps were placed over the lagoons after disposal activities ceased. Prior to installation of the geomembrane cover (when only the clay cap existed over the SDA), leachate levels in the trenches rose in response to additions from precipitation, indicating that infiltration was occurring through the cap. As described in Section 2, the existing geomembrane covers installed in the 1990s have proven to be effective in significantly reducing water infiltration into the SDA trenches and lagoons and are, therefore, a more effective cap than a clay cap alone. Therefore, clay caps will not be retained for further evaluation.

Vegetated (Bioengineering) Cap

For the purposes of this report, a vegetated cap is assumed to be a layer of topsoil covered by native grasses or plants that is placed over the existing clay cap or the existing combined clay cap and geomembrane liner. The vegetative cover reduces moisture levels in the soil via plant uptake and evapotranspiration and also helps to limit soil erosion. While a vegetated cap does not reduce toxicity or volume of wastes, it does reduce human exposure by acting as a barrier between the waste and the surface (when combined with a clay cap). In addition, this cap enhancement must be maintained by mowing and repaired by seeding/planting if soil areas are exposed.

Additionally, a five-year bioengineering pilot study of a vegetated cap was performed on Trench 9 between 1994 and 1999. Shallow-rooted junipers were planted in narrow gaps between impermeable panels mounted on wooden frames over the trench cap. During this pilot study, the amount of water entering the trenches was observed to be greater when compared to other SDA trenches that had a geomembrane cover. The study was discontinued because the vegetated cap was a monoculture that was susceptible to disease and rodents, and this type of cap presented regulatory challenges associated with permitting and monitoring.

Because the vegetated clay cap and bioengineered vegetated cap were proven to not be as effective as other infiltration controls used at the SDA, this technology will not be retained for further evaluation.

Exposed Geomembrane Cap

Exposed geomembrane caps typically consist of a base layer of compacted, fine soil covered by an exposed impermeable synthetic cover. Geomembrane caps are designed to minimize or prevent contaminant mobility by preventing infiltration by surface water. They are less difficult to construct than multi-layer caps. While geomembrane caps do not reduce the toxicity or volume of wastes, they do reduce human exposure to hazardous constituents by acting as a barrier between the waste and the surface. Radiation exposure is reduced as well when used in combination with a soil or clay cap. Geomembrane caps must be maintained and periodic replacement may be required.

The compacted soil and exposed geomembrane caps currently covering the SDA have been determined to be effective in significantly reducing infiltration to the trenches and lagoons, thereby reducing leachate generation. In addition, exposed geomembrane covers have been used at other hazardous and radioactive waste disposal sites as a precipitation infiltration barrier. Therefore, this technology can be effectively applied at the SDA and will be retained for further evaluation.

Multi-layer Engineered Cap

A multi-layer engineered cap typically consists of a base layer of compacted, fine soil covered by an impermeable synthetic cover. This cover is overlain by a collection system, a burrow barrier, and a vegetative layer. There are multiple impermeable covers in some caps. Multi-layer caps are designed to minimize or prevent contaminant mobility by preventing infiltration of surface water. While multi-layer caps do not reduce the toxicity or volume of wastes, they do reduce human exposures by acting as a barrier between the waste and the surface. Due to the additional weight from additional soil and synthetic layers and the force of compaction during soil layer installation, cap design would consider the potential impacts from increased pressure, such as trench waste subsidence and impacts on leachate migration. Multi-layer caps must be maintained, and periodic replacement may be required. Two types of multi-layer caps, a 6 NYCRR Part 373 (RCRA) cap and a 6NYCRR Part 383 (LLRW Disposal) cap, would potentially fulfill the land burial requirements for hazardous and radioactive waste at the SDA.

Multi-layer caps have been used as a long-term permanent solution at hazardous and radioactive waste disposal sites as intruder and precipitation infiltration barriers. However, since the existing compacted soil and exposed geomembrane cover over the SDA has proven to be effective in reducing infiltration into the trenches at the SDA, and because this CMS is focused on containment technologies that will be in place for the next 30 years, the multi-layer cap will not be retained for further consideration.

4.1.3.2 Upgradient Barrier Walls/Drains

Upgradient barrier walls and drains are designed to prevent groundwater from laterally infiltrating the waste site. Barrier walls act to limit groundwater movement, while drains redirect the flow in another direction.

Slurry Wall

Slurry walls are constructed by excavating a trench in native soils, mixing the native soils with water and bentonite, and pumping the mixture back into the trench in a continuous operation. The slurry wall then acts as a barrier to horizontal groundwater flow, thus reducing contaminant mobility and migration potential (contaminant toxicity and volume will not be reduced). Slurry walls may be installed in combination with a liner over the waste material to further reduce groundwater flow. The limitations of this technology include: slurry walls cannot be installed in consolidated materials, such as solid rock or cemented sands; wall depth is limited to the reach of surface equipment; and the bottom of the wall must be keyed into an impermeable layer to function as a flow barrier.

A slurry wall has been installed at the SDA. Constructed of a soil/bentonite clay mixture, it is 890 feet long, 2.5 feet wide, and 30 feet deep and spans the upgradient side of the southern trenches. The slurry wall has an in situ hydraulic conductivity of 2.5 x 10^{-8} centimeters per second (cm/s; J & L Testing Company, Inc. 1992) and, in conjunction with the geomembrane cover over the SDA, has proven effective in reducing infiltration and groundwater flow to the southern trenches. Evaluation of long-term leachate elevations indicate that a decreasing trend occurs in the northern and southern trenches. In addition, there appears to be less variability in the leachate elevations since the infiltration controls were installed at the SDA. It is possible, however, that there is some lateral groundwater migration toward the SDA trenches in an area between the northern and southern trenches just north of the slurry wall as indicated by the quarterly contour measurements of groundwater elevation.

For the purposes of this report, installation of a slurry wall refers to the extension of the existing wall along the northern trenches, not replacement of the existing slurry wall. Given the infiltration controls projects that were recently completed at the NDA and the changes in site topography between the NDA and SDA, additional data collection would be required to evaluate the necessity of installing another subsurface barrier wall along the northern SDA trenches.

Due to the effectiveness of the existing slurry wall (in conjunction with the geomembrane cover) in reducing infiltration, this technology has proven that it can be effectively applied at the SDA and will be retained for further evaluation.

French Drain

French drains are used to intercept and convey storm water and shallow groundwater. They typically consist of shallow to deep trenches filled with gravel and covered with topsoil and grass. The trench wall may be lined with a porous filter fabric and a pipe may be placed in the trench bottom to aid drainage. French drains do not affect waste toxicity or volume, but they can help reduce migration potential by reducing infiltration through capture and redirection of surface and groundwater flows. At the SDA, it is expected that French drains would effectively capture shallow groundwater flow upgradient of the trenches and direct it away from the SDA. Therefore, French drains would serve to reduce contaminant mobility by limiting the amount of groundwater and surface water that could potentially affect the waste.

French drains are used extensively to divert groundwater flow and are effective at reducing head buildup upgradient of vertical barrier walls. At the SDA, French drains could be constructed behind the slurry wall to capture and reduce the buildup of groundwater. Therefore, French drains will be retained for further evaluation in conjunction with other technologies.

Sheet Pile

Sheet piles are steel or reinforced plastic panels that are driven into soil to form a barrier to groundwater flow or provide structural stability. Sheet piles can function similarly to a slurry wall and can be readily installed in sands and clays. Over time, steel piles may corrode in groundwater or in certain soils. Because piles are constructed of separate sheets, the joints between sheets must be sealed to prevent water from flowing through. It is difficult, however, to ensure a complete seal throughout the depth of the joints. This technology does not reduce waste toxicity or volume, but it can reduce mobility, migration potential, and inflow of groundwater.

Sheet piles have been used to provide hydraulic isolation and can be used in soils and weathered tills. While sheet piles are effective in redirecting groundwater flow, they are more effectively used in short-term applications (on the order of months rather than years) such as excavations. Long-term use of sheet piles as a groundwater barrier would need to consider corrosion of metal piles or degradation of plastic piles, and effectiveness of the watertight seals at the joints, which cannot easily be tested in situ. In addition, because sheet piles function similarly to slurry walls, and a slurry wall has already been successfully installed at the site, sheet piles will not be retained for further evaluation.

4.1.3.3 Downgradient Barrier Walls and Drains

Downgradient barrier walls and drains (e.g., slurry walls, sheet piling, French drains, as described above) are designed to prevent lateral (horizontal) movement of site groundwater away from the site and/or to capture site groundwater for treatment or disposal. Based on historical analytical data (see Section 2.1.3), hazardous constituents from trench leachate have not been detected in groundwater from downgradient wells at levels above background concentrations. Currently, leachate is confined within the unweathered Lavery Till layer where the primary direction of leachate flow is vertical (downward; Prudic 1986; Bergeron and Buliosi 1988). Downgradient barriers would be of minimal effectiveness in reducing contaminants from migrating off-SDA, because they would provide a barrier only to horizontal flow. Because a decreasing trend in leachate elevations has been observed in the trenches following the installation of the infiltration controls, it is unlikely that leachate levels would rise significantly to reach the unweathered/ weathered Lavery Till interface and migrate horizontally through the weathered Lavery Till. Therefore, downgradient barrier technologies will not be retained for further evaluation.

Another type of downgradient barrier is a permeable treatment wall, which typically uses a metal (e.g., granulated zero-valent iron), activated carbon, or an organic material (e.g., peat) to either chemically convert contaminants to less harmful forms or adsorb them for later removal and disposal. Permeable treatment walls have been shown to be effective for VOCs, SVOCs, and metals in groundwater plumes. In practice, the reactive material is placed in a trench so that groundwater flow passes through it, either naturally or by funneling between slurry or sheet pile walls. Typically, groundwater flow and reaction times are slow enough that the reactive material can last many years before replacement is necessary. This technology requires a low permeability soil layer under the aquifer to prevent downward flow of groundwater. The material used in the wall must be sufficiently reactive to handle contaminants at the flow rates expected at the application site, and it must be periodically replaced. Biologic reactions within the wall may enhance toxicity reduction, but this also may reduce permeability over time. In the case of the SDA, because contaminants would be expected to migrate off-SDA only from the Kent Recessional aquifer, approximately 90 feet below the site, construction of an on-SDA permeable treatment wall would be infeasible due to the depth required.

4.1.4 Site Stability Controls

Site stability controls are designed to limit erosion on and near the SDA that could impact the integrity of the SDA and/or facilitate off-site migration of contaminants. These controls could be applied off-SDA (e.g., detention basins in an upstream portion of the West Valley site), on-SDA in drainage channels that direct surface water runoff to streams, in adjacent streams (e.g., stream channel armoring), and/or on land sloping away from the SDA trenches (slope stabilization).

4.1.4.1 Detention Basins

Detention basins are used to temporarily detain (control) runoff for a defined amount of time. Basins vary in size depending on the drainage area and can be designed to completely drain (dry basin) or consistently retain water (wet basin). They are not designed to provide water quality treatment. Erosion of soils within or adjacent to the site is a concern at the SDA. Eroding drainage channels and stream banks could negatively impact the site by destabilizing the side slopes of the SDA.

On-SDA detention basins are currently used to manage surface water flows and velocities in on-SDA drainage channels, thus reducing the potential for erosion. As described in the Storm Water Pollution Prevention Plan (SWPPP) for the SDA (NYSERDA 2009b), five detention basins are located within the extent of the existing geomembrane. These detention basins were designed to discharge peak flows at rates less than pre-existing conditions (if the SDA were completely grass covered) (NYSERDA 2004). With the exception of W05, each of the detention basin outfalls discharges to stone fill prior to draining to an adjacent creek. Outfall W05 discharges directly to the freshwater wetlands composing part of Frank’s Creek on the southern boundary of the SDA. These basins manage nearly 90% of the SDA’s runoff, thus additional basins do not appear to be necessary based on the existing conditions at the site. However, if a technology implemented at the site would result in a change in existing drainage patterns, on-SDA basins should be considered in the future.

The watersheds of the three creeks that pass adjacent to the SDA (Lagoon Road Creek, Erdman Brook, and Frank’s Creek) are all contained within the current WNYNSC property boundaries (WVNS 1993b; EEEPC 1994). Frank’s Creek and Erdman Brook both drain significant areas upstream of the SDA. Development of the WNYNSC, which increased the amount of impervious surface, has increased surface water discharge in these streams to above pre-development levels. Off-SDA detention basins could be designed for upstream areas to slow the flows in Erdman Brook and Frank’s Creek to pre-development rates, which would reduce the potential for in-stream erosion and improve site stability.

Because this technology could potentially manage on-SDA and off-SDA stream flows adjacent to the site, and thus increase site stability, this technology will be retained for further evaluation.

4.1.4.2 Drainage Channel Armoring

Armoring channel beds or side slopes can help stabilize the channel and reduce erosion. Armoring of drainage channels can be accomplished with a variety of methods/materials, including concrete, riprap, fiber rolls and/or plantings (bioengineering), and reinforcement matting. The method/material selected is based primarily on velocities and shear stresses imposed on the drainage channel by storm water flow. This section will focus on armoring of drainage channels that are on-SDA or just outside the SDA fence line; waterways located off-SDA will be addressed in the next section.

As mentioned above in Section 4.1.4.1, there are two drainage channels on or near the site—one at the downstream end of Lagoon Road Creek and the other in the southwest corner of the SDA. The drainage channel in the southwest corner of the site is fully stabilized with vegetation, and armoring is not currently necessary. Similarly, the downstream end of the Lagoon Road Creek culvert appears to be adequately armored with riprap and vegetation.

A study of erosion near the SDA in the early 1990s identified several gullies along the sides of the SDA. The incision of these gullies (at estimated rates of 0.3 to 0.6 meters per year [m/yr]) was identified as the greatest threat to site stability (WVNS 1993a). To mitigate this gully and drainage erosion, an on-going monitoring and maintenance program for drainage channels and gullies was initiated. Additionally, beginning in 1993, control of on-SDA storm water runoff became considerably more sophisticated through use of a geomembrane cover and a number of storm water detention basins (designed to slow runoff rates to below the natural rate) with culverted outlets (NYSERDA 2004). The geomembrane covers approximately 13 of the 15 acres of the SDA, including the trenches, filled lagoons, and storm water detention basins. With the presence of the storm water collection and detention system and the existing drainage and gully armoring, only minor modifications to gully and culvert outlet armoring, routine maintenance, and repair of small gullies are likely necessary.

Erosion is an ongoing and long-term process and additional drainage channel armoring could be required in the future. As such, drainage channel armoring will be retained for further evaluation.

4.1.4.3 Stream Channel Flow Controls and Armoring

Stream channel flow controls can be used to reduce stream erosion and thus increase stability of the SDA site. By slowing stream flow and reducing the amount of sediment that can be transported downstream, bank erosion is reduced to a minimum, thus maintaining a stable landscape. The velocity and erosive energy of a stream can be reduced through channel reconstruction or by flow obstructions. Flow velocity decreases with increased channel roughness, increased channel width, and decreased channel slope so channels can be reconstructed to reduce the velocity of flow. Channel roughness can be increased through the placement of stone or riprap. Channels can be widened or regraded to decrease slope in the vicinity of the SDA. Such channel reconstruction efforts could be performed such that stream sedimentation is in equilibrium, with equal amounts of sediment entering and exiting the stream segment, minimizing stream downcutting, and associated slope instability. Stream energy can also be dissipated with concrete baffles or stilling basins. Stilling basins are typically constructed as excavated pools lined with riprap, and can also include blocks and baffles to create addition flow eddies and turbulence to reduce stream energy.

Stream channel armoring involves the use of riprap, concrete, gabions, and other techniques to armor stream channels and stream banks and dissipate flow energy. Riparian vegetation, including fast-growing vegetation such as Root Propagation Method (RPM) plants and trees, can be planted to stabilize stream banks. Other biological techniques include the use of root wads (i.e., the root mass or root ball of a tree) to armor stream banks. Riprap or interlocking concrete jacks can be used to armor the toe of stream banks and gabion baskets or log-crib walls (vertical posts holding up a wall of horizontal logs) can be installed along stream banks to prevent bank down-cutting (North Carolina Stream Restoration Institute).

NYSERDA recently completed an erosion control project that incorporated stream channel flow controls and armoring to assure slope stability around the SDA. During the past several years, the flow of Lagoon Road Creek and Erdman Brook has been approaching the toe of the North Slope of the SDA. A significant knickpoint within Erdman Brook also migrated very close to the base of the North Slope, with both conditions potentially threatening the integrity of the SDA. NYSERDA redirected the flow away from the North Slope by installing new stream channels lined with geotextile separation fabric and armored with a two-foot-thick layer of New York State Department of Transportation (NYSDOT) Medium Stone Fill. Two stone check dams were installed downstream of the newly armored stream channels to slow the stream velocity and promote sedimentation. NYSERDA is planning to complete similar stream channel armoring within Frank's Creek during 2010; therefore, stream channel flow controls and stream channel armoring will be retained for further evaluation.

4.1.4.4 Slope Stabilization

Slope stabilization measures may entail either placement of some form of reinforcement material (e.g., matting and/or vegetation) on slopes prone to erosion to immobilize loose soils, the addition of soil to reduce slopes or construction of drains to lower groundwater levels.

Erosion control matting, which is available in single or multi-layer netting that can also be 100% biodegradable, can provide up to 36 months of protection while vegetation becomes established. Once established, the vegetation's extensive root systems would continue to provide slope stabilization.

The North Slope has numerous small hummocks, and thus might appear to be eroding. Site records indicate that during clearing of the north area and excavation of the first few northern trenches, soils were pushed over the side of the North Slope (E & E 1994; DOE 1979). A 1992 slope stability evaluation performed on the North Slope concluded that the irregular surface condition was likely due to shallow instability of loose soil rather than deep-seated failure (Aloysious et al. 1992). The evaluation credited runoff, poor drainage control, and limited vegetative cover as the cause for the instability.

An evaluation of the North Slope settlement point data is presented in Appendix A. A review of survey elevations collected annually for the past 25 years illustrates that the majority of elevation differences at many of the survey locations occurred prior to 1995, which was when infiltration control measures were installed at the SDA. The construction of on-SDA detention basins in 1995/1996, which were designed to control runoff drainage to the north slope, appears to have also contributed to the mitigation of the erosion process on the North Slope (most likely due to decreased surface water runoff). The survey elevation data along the North Slope spanning from 1982 through 2008 indicate that the elevation decrease was less than 1.5 inches at all but one survey location after the detention basins were installed and survey locations do not appear to moving down slope (except as noted below). The one survey location where there was greater elevation loss, is located at the northernmost point adjacent to Erdman Brook (Point 6; see Appendix A).

Another slope stability evaluation was performed by an Independent Expert Review Team (IERT) in 2008 as part of the Quantitative Risk Assessment (QRA) completed for the SDA (Garrick et al. 2009). The purpose of the QRA was to assess the radiation risk to the public by means of probabilistic analyses. Analyses were conducted to evaluate the stability of the slopes during seismic and non-seismic events that might result in release of contaminants. A review of the slope stability analysis conducted at the SDA is presented in Appendix B. For seismic events, the evaluation considered accelerations ranging from 0.25 g (acceleration due to gravity) to 1.0 g. Accelerations below 0.25 g were shown through a preliminary analysis to have a low likelihood of significant slope failure and were not modeled. The greatest horizontal seismic acceleration with 0.2-second duration and a 2 % probability of occurrence in 50 years, as presented in the Interactive National Seismic Hazard Maps on seismic hazards in the West Valley Area (USGS 2008), is 0.12 g which is less than the lowest acceleration (0.25 g) considered in the QRA to possibly cause slope failure. Hence, the likelihood of slope failure due to seismic events at the SDA is low. For non-seismic events, the evaluation estimated a factor of safety of 2 for the north and east slopes of the SDA under nominal site conditions. This suggests that under the soil conditions typically observed at the SDA, the slopes as they were analyzed are stable.

Tension cracks on the North Slope and knickpoints within Erdman Brook and Franks Creek migrating upstream have been observed around the SDA. These indicators of potential instability could indicate the presence of conditions that could compromise the integrity of the SDA, therefore slope stabilization activities are currently being undertaken. Mitigation of the primary Erdman Brook knickpoint was completed in the fall of 2009. Efforts were undertaken to realign Erdman Brook away from the toe of the North Slope and reduce stream velocity by adding such control structures as rip-rap and check dams.

While additional slope stabilization controls may not be necessary, the erosion potential of slopes around the SDA should continue to be monitored and, therefore, this technology has been retained for further evaluation.

4.1.5 Leachate Management, Treatment and Disposal

These technologies are designed to prevent trench leachate from migrating off-SDA. These technologies are applicable to the trenches only; the three lagoons addressed in this CMS do not contain waste material that could generate leachate.

4.1.5.1 Leachate Left in Place with Gradual Migration into the Soil Column beneath the SDA

Trench leachate is currently slowly migrating downward through the approximate 90-foot-thick Lavery Till clay layer while the tritium decays and other contaminants degrade. As the leachate migrates, its concentration decreases due to natural attenuation. Natural attenuation processes, such as dispersion, dilution, sorption, volatilization, radioactive decay, and chemical or biological stabilization act to reduce mass, toxicity, mobility, volume, or concentrations of contaminants (EPA 1999). Site controls, such as fencing and a barrier over trenches and lagoons, would be required to protect human exposure to site contaminants as natural attenuation occurs.

Previous hydrogeologic investigations have identified the probable leachate contaminant transport pathway from trenches to the SDA boundary. The primary direction of leachate flow in the unweathered Lavery Till is vertical (downward) as opposed to horizontal (Prudic 1986; Bergeron and Buliosi 1988). Leachate elevations have been closely monitored for over a decade. Trend analysis of leachate elevations indicates that downward leachate migration progresses at roughly 1 to 3 cm/yr, depending on the trench. Given that the trenches have been in existence for over 40 years, the total distance of leachate migration is about 80 cm (or 2.6 feet). At this rate, the leachate will take hundreds of years to progress through the 90-foot-thick Lavery Till layer. Once the leachate reaches the Kent Recessional aquifer, transport through groundwater will be lateral to Buttermilk Creek.

A fate and transport analysis is presented in Appendix C. This analysis indicates that the combination of slow groundwater movement, retardation of contaminant migration (due to adsorption), and decay are expected to substantially reduce contaminant levels during their extended migration to the vertical boundaries of the site. Adsorption of contaminants to subsurface soils will result in retardation of contaminant migration; therefore, with the exception of tritium, the chemical and radiological contaminants in the leachate will travel slower than the groundwater. Migration of radionuclides, including strontium-90 (Sr-90) and carbon-14 (C-14) was simulated by Prudic (1986). Sr-90 was predicted to migrate a distance of no more than 6 meters in 500 years while C-14 was predicted to take up to 20,000 years to migrate to the Lacustrine unit. The transport velocities of organic compounds are expected to be retarded relative to groundwater flow. Radionuclide and chemical contaminants also will undergo substantial radioactive decay and biological degradation, respectively, as they are transported through the subsurface.

Key results of the fate and transport model include:

- With biodegradation occurring at conservative (low) rates, no site contaminants are expected to reach the bottom of the till layer at measurable concentrations at any time, and
- Without biodegradation, concentrations of many site contaminants would be expected to exceed allowable concentrations, but not for hundreds of years.

However, trench leachate bacterial enumeration (E & E 1995), and background groundwater monitoring data, indicate that conditions are conducive to biodegradation both in the SDA trenches as well as in the underlying groundwater. There is significant evidence that the current infiltration controls are effective; thus, once all the leachate has drained from the trench bottoms, a minimal amount of additional leachate should be generated. As a result, it is expected that contaminant concentrations are likely to never reach maximum allowable concentrations at the site boundary (SDA fenceline) due to downward migration of trench leachate. Therefore, there is a low potential for human exposure to contaminants at concentrations that pose a risk.

Appendix D presents graphs illustrating leachate levels for 10 years for most trenches, a comparison of paired groundwater monitoring wells upgradient and downgradient of the existing slurry wall, and a statistical analysis of the potential seasonality of leachate levels over a 10-year period.

Based on the results of the detailed fate-and-transport study, this analysis of leachate levels will be retained in the future.

4.1.5.2 Leachate Removal, Treatment, and Discharge

Leachate removal, treatment, and discharge to further reduce contaminant toxicity, mobility, and volume will not be addressed in this CMS. As discussed in Section 4.1.5.1, leaving the leachate in place is protective of human health on- and off-SDA for the next 30 years and beyond. Removal of the leachate at this time is possible; however, the occupational health risks associated with the removal and/ or treatment of leachate, the complexities involved with implementation of a mixed waste leachate treatment program, and the costs associated with implementation of these types of technologies outweigh their benefits for purposes of this CMS. The leachate collected in 1987 and 1992 (see Section 2.1.3.1) indicated the presence of VOCs, SVOCs, and inorganic compounds in the leachate, in addition to radionuclides. In particular, the presence of benzene, which is a known carcinogen, would pose an occupational hazard to the workers. Because of the heterogeneous nature of the leachate, there also are limited treatment and disposal options. Presently, the only two approved LDR treatment paths for mixed waste are thermal treatment and chemical oxidation. It is, however, recommended that these technologies be revisited in future efforts to evaluate comprehensive remedial actions at the WNYNSC.

4.1.6 Institutional Controls

Institutional controls (ICs) are administrative or legal controls meant to minimize the potential for human exposure to site contaminants. Because No Action is not an option at the SDA, ICs would be implemented in conjunction with other technologies. The EPA (2000) categorizes ICs into four major groups:

- Government controls;
- Enforcement and permit tools;
- Informational devices; and
- Proprietary controls.

Because the SDA is currently owned and operated by a state authority (NYSERDA), which limits site access, proprietary controls will not be retained for further evaluation.

4.1.6.1 Government Controls

Government controls include a wide variety of controls typically issued by local governments to restrict use of a site or establish additional requirements for future owners of the site. Government controls include:

- Ordinances;
- Zoning restrictions;
- Environmental easements;
- Groundwater use restrictions;
- Statutes; and
- Condemnation of property.

The following discussion presents short descriptions of each type of government control, a discussion of whether the control is relevant and/or applicable for the SDA, and indicates whether it should be screened out and not retained for further evaluation.

Ordinances

Ordinances, or laws or rules enacted by local governments, can be used to outline specific requirements before an activity is authorized. For example, an ordinance may require that anyone seeking a building permit in a particular area be notified of contamination in that area (NYSDEC 2009).

For the SDA, a local ordinance is not required because the state holds title to the land and no other entity will be allowed access over the next 30 years. Therefore, this IC will not be retained for further evaluation.

Zoning Restrictions

Zoning restrictions can be used by local governments to specify land use for certain areas. For example, a local government could prohibit residential development in an area of contamination or limit gardening in certain areas (NYSDEC 2009).

As with ordinances, this option does not apply to the SDA. Therefore, this IC will not be retained for further evaluation.

Environmental Easements

Environmental easements in New York State are granted by the property owner to the state, via written instrument recorded in the county recording office. Environmental easements establish use restrictions and/or insure that engineering controls remain in place and are maintained in an effective state. Environmental easements are binding upon all subsequent owners and occupants of the property. The state then retains the sole right to extinguish or amend the easement. Property deeds must contain prominent notices that they are subject to an environmental easement. The municipality must notify NYSDEC when a building permit is requested for NYSDEC to determine whether the construction or land use is consistent with the terms of the easement (NYSDEC 2009).

An environmental easement could potentially be placed on Center properties located adjacent to and upstream from the SDA where future development could increase peak storm water flows, during site construction or operation, which could affect the stability of the SDA. Because site control measures are not expected to protect all potential land uses, and because long-term maintenance of engineering controls are likely, environmental easements are relevant, and will be retained for consideration as an IC at the SDA.

Groundwater Use Restrictions

Groundwater use restrictions are government controls, generally at the local or county level, directed at limiting or prohibiting certain uses of groundwater (e.g., using it as potable water [NYSDEC 2009]).

The groundwater flow direction at the SDA is vertically downward through the Lavery Till to the Kent Recessional Aquifer, and then horizontally towards Buttermilk Creek. Based on the fate and transport analysis discussed in Appendix C, site contaminants are not expected to migrate off the SDA. Additionally, the area between the SDA and Buttermilk Creek is owned by NYSERDA. However, in order to provide an additional layer of protection, in the event that a downgradient portion of the WNYNSC property is sold, this IC will be retained for further evaluation.

Statutes

State and federal statutes can be used to control potential exposure at a contaminated site. Because NYSERDA is responsible for the maintenance and monitoring of the SDA and holds several permits that act to control potential exposures, this IC is not retained for further evaluation.

Condemnation of Property

State and local governments can exercise eminent domain to condemn a property in order to take over title (NYSDEC 2009). NYSERDA currently holds title to the 3,300-acre West Valley site and is responsible for maintenance and operation of the SDA. Thus, this approach need not be retained for further evaluation.

State Ownership

The primary government control of the SDA is based on state ownership of the site through NYSERDA. The state maintains a continued presence on site, and has full authority over site operations, consistent with federal, local, and state laws. This overriding IC will be retained for further consideration.

4.1.6.2 Enforcement and Permit Tools

Enforcement Tools

The EPA can issue Administrative Orders on Consent (Consent Orders) under RCRA sections 3004(a), 3004(u), and (v), 3008(h), or 7003. A Consent Order is a legal document signed by NYSDEC or the EPA and the principal responsible party (PRP) that formalizes the agreement under which the PRP will conduct remedial activities, including implementation and maintenance of institutional controls, and can be used to compel land owners to limit certain site activities. Consent Orders usually contain provisions to transfer responsibilities to a new landowner in case of property ownership transfer (EPA 2000).

NYSERDA and the DOE are currently operating under Consent Order Docket No. II RCRA-3008(h)-92-0202, which was issued by NYSDEC on March 9, 1992, under the authority of Section 71-2727 of the New York State Environmental Conservation Law (ECL). The current Consent Order specifies that no change in ownership of the facility shall change the respondent’s responsibilities under the Consent Order (EPA 1992).

In addition, the Consent Order does not address corrective measure implementation. A Corrective Action Permit is being developed to establish the provisions for implementation of actions resulting from the CMS. It is not known if the current Consent Order will remain in effect, but all actions resulting from the CMS will be conducted in accordance with the Corrective Action Permit. Therefore, this IC will be retained for further evaluation.

Permit Tools

A number of permit tools are currently in effect at the SDA. Permits typically have an operation and maintenance requirement and monitoring requirements.

Current Permit tools:

- New York State Department of Health Radioactive Materials License (NYSDOH RML No. C-0382);
- SDA Monitoring and Maintenance Permit (RCP No. 137-6, NYSDEC Permit No. 9-0422-00011/00011); and
- SPDES Permit (NY-0269271, NYSDEC Permit No. 9-0422-00011/02001).

Future Permit Tools:

- Corrective Action Permit.

All of the above permit tools are considered relevant for future maintenance of the site. It is anticipated that the above regulatory agencies will have a continued interest in the site and in their involvement as permitting authorities.

These permits are expected to remain in effect and additional permits may be required if the leachate is removed from the trenches. Therefore, this IC will be retained for further evaluation.

4.1.6.3 Informational Devices

Informational devices, which are considered a secondary layer of institutional controls, help ensure overall reliability of ICs. The EPA considers state registries of contaminated properties, deed notices, and advisories to be typical informational devices (EPA 2000).

Deed Notice

A deed notice is a non-enforceable, purely informational document filed in public land records that alerts anyone searching the records to important information about the property (NYSDEC 2009). Sale of the SDA parcel is a topic of interest with the public. Identification of an area around the site boundary as a “buffer zone” may be considered under this type of IC primarily to ensure long-term access for the purpose of monitoring. As discussed above, any existing environmental easements should be noticed prominently in the deed for the affected property. Therefore, this IC will be retained for further evaluation.

Public Health Advisories

Public health advisories are warnings, usually issued by federal, state, or local public health agencies that provide notice to potential users of land, surface water, groundwater, or other natural resources of some existing or impending risk associated with their use. Advisories would only be considered if contaminants were released to the environment from the landfill at levels exceeding the CAOs. Because groundwater and air monitoring on site have consistently shown no release of site contaminants, there is no current need for a public health advisory. In addition, groundwater fate and transport modeling demonstrates that no chemical contaminant release, beyond the SDA boundary, is expected at any time. As a result, this IC will not be retained for further evaluation.

Site Security

Site security institutional controls are non-engineering measures, such as security guards. Access to the site is currently restricted; the SDA is a *restricted* or *controlled area* as defined in 6 NYCRR Part 380, 12 NYCRR Part 38, and the Security Plan for the WVSMP (NYSERDA 2008b). All visitors must watch a short video on emergency procedures at the site and they must pass through a guard station. Site surveillance is provided by DOE personnel already providing surveillance at the adjacent WVDP site. Routine security patrols are conducted every 2 hours (12 vehicle patrols per day), covering the WVDP and the SDA. Breaches to the security fence are to be reported immediately to the WVDP Security Manager. Security violations or potential security breaches are to be reported to the NYSERDA West Valley Site Management Program Emergency Coordinator. Access to the site is limited to those individuals who have completed all required health and safety training or are escorted by NYSERDA personnel. It is anticipated that site security will continue through the next 30 years, so this IC will be retained for further evaluation.

Fencing

NYSDEC formally categorizes fencing as an engineering control rather than an IC (NYSDEC 2009), and the EPA considers fencing as a physical barrier rather than an IC (EPA 2000). The SDA is currently surrounded by an 8-foot high, chain-link fence with several padlock gates. In addition, signs are posted on each entrance gate indicating the area contains radioactive material, specifically stating:

- "Controlled Area--Training or Escort Required for Entry;"
- "Danger--Unauthorized Personnel Keep Out;" and
- "Underground Radioactive Materials."

It is anticipated that the fencing will continue through the next 30 years, so this IC will be retained for further evaluation.

4.1.7 Monitoring and Inspections

4.1.7.1 Groundwater Monitoring

Groundwater monitoring is a means of identifying whether hazardous constituents have migrated from the site. Water level data is used to identify hydrologic conditions (including groundwater flow direction) in the vicinity of the trenches. The groundwater monitoring program at the SDA (see Section 2.1.3.2) would be a key element of all the near-term containment technologies and, as such, will be retained for further evaluation.

4.1.7.2 Storm Water Monitoring

Typically, storm water monitoring provides information on the pollutants present in runoff (e.g., oil, pesticides, sediment, and bacteria) that are picked up from streets, parking lots, and lawns and carried into the storm drain system. These pollutants then flow to downstream water bodies, potentially impacting their water quality.

Storm water monitoring at the SDA is currently performed as required by the SDA SPDES permit and Storm Water Pollution Prevention Plan (NYSERDA 2009b). Due to the existing drainage patterns at the SDA, approximately 90% of the site runoff flows across the geomembrane cover that overlies the trenches (NYSERDA 2004). There is little potential for groundwater contaminants of concern from the trenches to contaminate storm water (NYSERDA 2009b). However, it is expected that the permit will remain in place for the next 30 years; therefore, it will be retained for further evaluation.

4.1.7.3 Leachate Level Monitoring

Leachate level monitoring is critical to determining leachate migration rates and the effectiveness of infiltration controls.

Measurement of leachate levels at the SDA (see Section 2.1.3.2) would be a key element of all the near-term containment technologies and as such will be retained for further evaluation.

4.1.7.4 Surface Water Monitoring

Surface water monitoring provides information on pollutants present in surface water bodies. Pollutant concentrations detected in surface water samples must take into consideration potential upstream sources in addition to on-SDA sources.

Although the RFI did not indicate releases of RCRA-regulated hazardous constituents or hazardous wastes from the SDA, surface water samples are collected and analyzed for select radionuclides (see Section 2.1.3.2). Although surface water monitoring would seem unwarranted, an exposure pathway from groundwater to adjacent water bodies does exist. Therefore, surface water monitoring will be retained for further evaluation.

4.1.7.5 Inspection of Site Stability Controls

Site stability controls are defined as existing or new structural features, such as detention basins, drainage channel armoring, stream channel armoring, and stream channel flow and grade controls. Inspection points and frequency will vary based on the type of control. It is important to routinely inspect these controls to ensure they are functioning as designed.

With respect to site stability controls, NYSERDA currently maintains and inspects the trench caps, geomembrane covers, five on-SDA detention basins, the five storm water outfalls, and drainage channel armoring. Effective operation of these features helps to reduce downstream erosion of channel beds and side slopes. Inspection and maintenance of these and any new controls installed at the site will be retained for future evaluation.

4.1.7.6 Inspection of Infiltration Controls

Existing infiltration controls at the site include the geomembrane covers and the slurry wall extending along the western edge of the southern trenches. The geomembrane covers are routinely inspected visually and periodically tested. Effectiveness of these controls is critical in reducing infiltration of precipitation to the trenches and thereby reducing leachate levels. Inspection and maintenance of existing infiltration controls will be retained for further evaluation.

4.1.7.7 Air Monitoring

Gases can be generated in the trenches by volatilization, biological activity, and chemical reactions. Gases can diffuse and/or be advected via pressure gradients through the soil and into the atmosphere. Several site investigators found that SDA trenches emitted measurable amounts of radioactive and other gases related to decomposition of organic matter (Envirosphere 1985). Once in the atmosphere, the gases can mix with air passing over the site and may be carried to on-SDA and off-SDA receptors.

The analytical results for RFI air samples collected in August 1993 indicated that there were no significant releases of VOCs from the SDA trenches and that off-site migration was, therefore, not a concern (E & E 1994). These air samples were collected three months after the first geomembrane cover over Trench 13/14 was installed. Since then, gas buildup has not been observed beneath the geomembrane liner and, therefore, installation of gas vents has not been considered (NYSERDA 2007).

Ambient air sampling was repeated at the SDA on October 21 and 22, 2009 to reassess the potential for off-site migration of VOCs. Since 1999, geomembrane covers have been installed over all of the trenches (see Section 2.1.2). The purpose of the 2009 sampling was to update the information regarding VOC concentrations in ambient air above and around the SDA for comparison to the 1993 data.

Sample locations and sampling procedures were kept as similar as possible to the previous 1993 sampling. In comparison to the 1993 results, the 2009 VOC sample results yielded concentrations that were lower than the 1993 detection limits (overall, the 2009 detection limits were lower than those used in 1993). Appendix E includes a full discussion of the methodology and the results of the 2009 air sampling study. Based on the results, additional routine air monitoring is not recommended at the SDA.

4.1.7.8 Erosion Monitoring

As described in NYSERDA's Walkover Inspection of the SDA procedure (NYSERDA 2009c), NYSERDA staff conduct routine visual inspections of the SDA perimeter, adjacent slopes, SDA detention basin discharge points, and drainage channels a total of five times per year. Additional walkover inspections are performed following abnormally large precipitation events or extended periods of precipitation.

As described in NYSERDA's Ground Surface and Monitoring Well Elevation Surveys at the SDA plan (NYSERDA 2006), NYSERDA performs annual surveys of the established survey points on the North Slope of the SDA to monitor for possible vertical or downslope movement of the slope surface.

As part of the NYSDEC SDA Monitoring and Maintenance Permit (RCP No. 137-6), NYSERDA is required to perform additional erosion monitoring activities at the SDA. The activities described in the permit include:

- Verbally reporting any significant erosional impacts to the SDA, surrounding slopes or the adjacent streams to the NYSDEC within one business day.
- Performing five walkover visual inspections of the SDA within one year including the site perimeter, adjacent slopes, SDA detention basin discharge points and drainage channels.
- Performing the annual elevation survey of the established survey points on the North Slope of the SDA.
- Collecting routine quantitative measurements, using direct or remote methods, of the growth or progression of erosion features near the SDA.
- Obtaining photographs of the side slopes of the SDA, for the purpose of documenting the condition of slopes and any changes occurring due to erosion or mass-wasting process (e.g., slumping, gullying).
- Performing detailed topographic mapping of the land surface of the SDA, and adjacent slopes and stream channels, at least once every 10 years. These maps

will allow quantitative measurements of erosion rates, growth and progression of erosion features, and movement of slopes at the SDA.

4.1.7.9 Trench Settlement Monitoring

Monitoring of trench settlement assists in the determination of compression of the waste material over time. After a cap has been placed over waste material, the typical means of quantifying settlement is through elevation surveys. Significant changes in elevations can indicate the material is biodegrading and/or chemically decomposing and provide information on the fate and transport of the material and leachate and the potential for gas generation.

At the SDA, trench cap elevation survey data have been collected annually over the past 16 years. Appendix F lists the elevation data for each trench from 1991 to 2008. The data collected over that time period indicate that the majority of the trenches have settled less than 0.5 feet in 15 years. Elevation differences greater than 0.5 feet occurred in Trenches 12, 13, and 14, however, the bulk of the elevation difference was a result of top soil removal in 1992 prior to installation of the geomembrane over these trenches (compare elevation data for 1991 and 1993 for these trenches, see Appendix F).

Trench settlement monitoring is considered to be a key element of the near-term containment technologies and as such will be retained for further evaluation.

4.1.7.10 Summary of Technology Screening

Table 4-1 contains a summary of the results of the technology screening.

Table 4-1 Summary of Containment Technologies

Section Reference	Technology	Achieve CAOs?*	Further Considered
4.1.2	No Action (for comparison purposes only)	No	Yes
Infiltration Controls			
4.1.3.1	Clay Cap	Yes (1,2,3)	No
4.1.3.1	Vegetated Cap	Yes (1,2,3)	No
4.1.3.1	Exposed Geomembrane Cap	Yes (1,2,3)	Yes
4.1.3.1	**Multi-layer Engineered Cap**		
	Part 373 (RCRA) Cap	Yes (1,2,3)	No
	Part 383 (LLRW Disposal) Cap	Yes (1,2,3)	No
Upgradient Barrier Walls/Drains			
4.1.3.2	Slurry Wall	Yes (1,2,3)	Yes
4.1.3.2	French Drain	Yes (1,2,3)	Yes
4.1.3.2	Sheet Piling	Yes (1,2,3)	No
Downgradient Barrier Walls/Drains			
4.1.3.3	Slurry Wall, French Drain, Sheet Piling	Yes (2,3)	No
4.1.3.3	Permeable Treatment Barrier	Yes (2,3)	No
Site Stability Controls			
4.1.4.1	**Drainage Basin**		

Table 4-1 Summary of Containment Technologies

Section Reference	Technology	Achieve CAOs?*	Further Considered
	On-SDA	Yes (2,3)	Yes
	Off-SDA	Yes (2,3)	Yes
4.1.4.2	Drainage Channel Armoring	Yes (2,3)	Yes
4.1.4.3	Stream Channel Flow Control and Armoring	Yes (2,3)	Yes
4.1.4.4	Slope Stabilization	Yes (2,3)	Yes
Leachate Management, Treatment and Disposal			
4.1.5.1	Leachate Left in Place with Gradual Migration into Soil Column under the SDA	Yes (3)	Yes
4.1.5.2	Leachate Removal, Treatment and Discharge	Yes (1,2)	No
Institutional Controls			
4.1.6.1	Government Controls (environmental easements, groundwater use restrictions, state ownership)	Yes (3)	Yes
4.1.6.2	Enforcement and Permit Tools	Yes (3)	Yes
4.1.6.3	Informational Devices (deed notice, site security, fencing)	Yes (3)	Yes
Monitoring and Inspections			
4.1.7.1	Groundwater Monitoring	Yes (4)	Yes
4.1.7.2	Storm Water Monitoring	Yes (4)	Yes[1]
4.1.7.3	Leachate Level Monitoring	Yes (4)	Yes
4.1.7.4	Surface Water Monitoring	Yes (4)	Yes[1]
4.1.7.5	Inspection of Site Stability Controls	Yes (4)	Yes
4.1.7.6	Inspection of Infiltration Controls	Yes (4)	Yes
4.1.7.7	Air Monitoring	Yes (4)	Yes[2]
4.1.7.8	Erosion Monitoring	Yes (4)	Yes
4.1.7.9	Trench Settlement Monitoring	Yes (4)	Yes

Notes:

* "Yes" indicates the technology is expected to achieve a minimum of one qualitative CAO; the numbers in parenthesis correspond to the CAO described in Section 2. "No" indicates none of the CAOs are expected to be achieved.

[1] Part of current monitoring program for radioactive contaminants, but not needed as corrective measure for site chemical contaminants.

[2] Additional Air monitoring to be considered based on results of planned SDA air sampling.

Key:

CAO = Corrective action objective.
LLRW = Low–level radioactive waste
RCRA = Resource Conservation and Recovery Act.
SDA = State-licensed disposal area.

4.2 Identification of Alternatives

Corrective measure alternatives are identified based upon the technologies that passed the screening in Section 4.1. This section identifies corrective measure alternatives using individual technologies or various combinations of technologies developed to address the CAOs at the SDA.

4.2.1 Development of Alternatives

The technologies presented in Table 4-1 were systematically considered in developing alternatives for the SDA. The No Action alternative has been retained for baseline and comparative purposes. Key considerations in the development of alternatives for the SDA are discussed below.

- Corrective measure alternatives are preventative in nature rather than remedial. Ongoing groundwater monitoring indicates that site contaminants have not migrated beyond the SDA site boundary. With the exception of benzene, VOCs (assumed to be the hazardous constituent primary indicator) have not been detected in site groundwater monitoring wells above NYSDEC groundwater standards. Benzene has been detected twice at 24 µg/L at upgradient well 1101C in 1994 and 1998. Because this well is upgradient of the site, it is unlikely that these concentrations were a result of contaminants from the SDA.

- Corrective measure alternatives should prevent off-site migration of site contaminants over the next 30 years.

- Corrective measure alternatives should consider the proven effectiveness of interim control measures that have been installed to reduce precipitation and groundwater infiltration to the trenches. Interim control measures consist of an upgradient groundwater cutoff wall to impede lateral groundwater flow and a geomembrane cover over the SDA trenches and lagoons to prevent vertical percolation into the trenches. Groundwater elevation data from paired monitoring wells immediately upgradient and downgradient of the slurry wall indicate lateral flow is effectively restricted. At some locations, the downgradient wells were dry (see Appendix D). Evidence of the infiltration control effectiveness is also shown in monthly and seasonal leachate elevation data which has been continuously decreasing since the control measures were installed. Finally, while groundwater monitoring wells show a clear and significant seasonal fluctuation in elevation, leachate levels in all trenches with the exception of Trench 1 have shown a steady decline, suggesting that there is no direct influence of the surrounding groundwater on the trench leachate levels. A statistical analysis, presented in Appendix D, confirms the finding that the slight fluctuations in trench leachate elevations are not seasonal.

- Corrective measure alternatives should consider the expected fate and transport of site contaminants, given the interim control measures. A screening-level groundwater contaminant fate and transport model evaluated migration of chemical contaminants vertically downward from the trench bottoms through the 75 -foot thick unweathered Lavery Till to the Lacustrine unit. Contaminant concentrations will be attenuated with distance below the trenches by the low permeability of soils beneath the trenches, adsorption to those soils, and biodegradation. The model demonstrated that chemical contaminants in trench leachate are not expected to migrate off-site for hundreds of years and if site contaminants biodegrade as expected, organic contaminants and tritium will never reach the site boundary at measurable concentrations (see Appendix C).

The following sections focus on the development and evaluation of corrective measure alternatives that will address the CAOs at the SDA. The identified alternatives are described briefly in the following subsections. A more detailed description and evaluation of the alternatives is provided in the later sections of this report.

4.2.2 Alternative 1 – No Action

The No Action alternative includes no remedial actions or institutional controls. This alternative has been developed to provide a baseline with which to compare other corrective measure alternatives.

4.2.3 Alternative 2a – Containment by Exposed Geomembrane Cover and Existing Slurry Wall with Institutional Controls, Long-term Monitoring, and Site Stability Controls

This alternative includes continued use of the exposed geomembrane covers over the SDA to reduce infiltration of precipitation into the trenches and lagoons. Over time, the geomembrane covers will degrade due to exposure to sunlight and require replacement. According to the manufacturer, the current SDA XR-5 geomembrane cover will likely need to be replaced in the next 10-15 years, and the VLDPE is being replaced in 2010.

Implementation of site stability controls, as well as institutional controls, monitoring, inspections, and maintenance as described in Section 4.2.1 are also included in this alternative to maintain the integrity of the cap system and other features at the SDA.

4.2.4 Alternative 2b – Containment by Exposed Geomembrane Cover and Extension of Slurry Wall with Institutional Controls, Long-term Monitoring, and Site Stability Controls

This alternative includes continued use of the exposed geomembrane covers over the SDA to reduce infiltration of precipitation into the trenches and lagoons. Over time, the geomembrane covers will degrade due to exposure to sunlight and require replacement. According to the manufacturer, the current SDA XR-5 geomembrane cover will likely need to be replaced in the next 5 to10 years, and the VLDPE will need to be replaced within 1 to 2 years. This alternative also includes the extension of the slurry wall, starting from the existing slurry wall, and extending along the northern trenches.

Implementation of site stability controls, as well as institutional controls, monitoring, inspections, and maintenance as described in Section 4.2.1 are also included in this alternative to maintain the integrity of the cap system and other features at the SDA.

4.3 Description and Evaluation of Alternatives

The alternatives identified above will be evaluated based on technical, environmental, human health and institutional criteria. This approach is intended to provide the information necessary to compare the merits of each alternative and select an appropriate remedy that satisfies the CAOs for the site.

4.3.1 Evaluation Criteria

This section presents a summary of the various criteria that were used to evaluate the alternatives.

4.3.1.1 Technical Criteria

The technical aspects of the alternative were evaluated based on performance, reliability, implementability, and safety.

Performance

This criterion evaluates the performance based on the effectiveness and useful life of the alternative. The effectiveness was evaluated based on the alternative's ability to perform the intended function, such as containment. Any specific waste or site characteristics that could potentially impede effectiveness of the alternative were also considered.

The useful life of an alternative is defined as the length of time the level of effectiveness can be maintained. Most technologies deteriorate with time and often deterioration can be maintained through proper maintenance and eventual replacement. The useful life was evaluated in terms of the projected service lives of its component technologies.

Reliability

This criterion evaluates the reliability of the alternative based on its operation and maintenance requirements and its demonstrated reliability. Operation and maintenance requirements include the frequency and complexity of the required maintenance. Technologies that require frequent or complex operation and maintenance are considered to be less reliable than technologies requiring minimal maintenance.

Demonstrated reliability is a way of measuring the risk and effect of failure. Factors to be evaluated include whether the technologies have been used under similar conditions; whether the combinations of technologies have been used together effectively; whether the failure of any technology has an immediate impact on receptors; and whether the alternative has the flexibility to deal with uncontrollable changes at the site.

Implementability

This criterion addresses the implementability based on the constructability and the time required to achieve the required level of response. Constructability refers to the ability to construct and operate under the specific conditions at the site, the availability of necessary equipment and technical specialists. Other factors that affect implementability include compliance with applicable rules, regulations, and statutes and the ability to obtain permits or approvals from government agencies or offices. The time it takes to implement the alternative and the time it takes to see beneficial results is also taken into account.

Safety

This criterion evaluates the alternative with regard to threats to the safety of near-by communities and environments as well as to workers during implementation of the alternative. Factors to be considered are fire, explosion, and exposure to hazardous substances.

4.3.1.2 Environmental Criteria

This assessment focuses on the facility conditions and pathways of contamination to the environment. Factors to be considered are the short and long term beneficial and adverse effects of the alternative; any adverse effects on environmentally sensitive areas; and an analysis of measures to mitigate adverse effects.

4.3.1.3 Human Health Criteria

This criterion provides an overall assessment of the protection of human health both during and after implementation of the alternative. The assessment describes the levels and characterizations of contaminants on site, potential exposure routes, and potentially affected populations.

4.3.1.4 Institutional Criteria

This criterion is used to evaluate the relevant institutional needs of an alternative, and specifically addresses the effects of Federal, State and local environmental and public health standards, regulations, guidance, advisories, ordinances, or community relations on the design and operation of the alternative.

4.3.1.5 Cost Estimate

The estimated capital costs, long-term O&M costs, and environmental monitoring costs of the alternative are evaluated. The estimates included herein (unless otherwise noted) assumed that engineering and administrative costs would equal 10% of the total costs and contingency costs would equal 15% of the total costs. A present-worth analysis was completed to compare the remedial alternatives on the basis of a single dollar amount for the base year. For the present-worth analysis, the annual real interest rates were obtained from the Office of Management and Budget (OMB 2009).

4.3.2 Alternative 1 – No Action

Description

The No Action alternative would eliminate current monitoring and maintenance activities at the SDA, including inspections of the geomembrane covers and soil erosion controls, environmental monitoring, and routine maintenance activities. This alternative has only been developed as a baseline to compare other alternatives.

4.3.2.1 Technical Criteria

Performance

The performance of Alternative 1 is dependent on the effectiveness and useful life of the existing infiltration and site stability controls, (e.g., geomembrane cover, slurry wall). Even though the site stability controls are currently working effectively, the useful life of the existing infiltration and site stability controls is limited and these technologies need to be maintained regularly. For example, testing results indicate that the VLDPE geomembrane cover on Trenches 13 and 14 be replaced within the next year and the XR-5 cover on the remaining trenches be replaced within the next 5 to 10 years.

Because this alternative does not include any maintenance activities, this alternative is not expected to continue performing effectively during the 30-year performance period of this interim CMS.

Reliability

Under Alternative 1, the current maintenance activities for the geomembrane cover would cease, the erosion controls would be eliminated and the monitoring activities at the site would stop. Therefore, this alternative is not reliable in the long term because the geomembrane covers will eventually degrade and the slopes could erode and potentially expose the contaminants to the environment. In addition, due to the absence of periodic monitoring, this alternative does not provide the flexibility to deal with uncontrollable changes at the site.

Implementability

There are no actions to implement under Alternative 1.

Safety

Because the current maintenance activities will not continue for Alternative 1, the failure of one or more of the infiltration and site stability controls could increase the potential for exposure to hazardous substances at the site.

4.3.2.2 Environmental Criteria

There are no anticipated short-term or long-term environmental benefits from Alternative 1. Maintenance and monitoring of site stability controls is integral to the prevention of contaminant migration and the lack of these controls could potentially cause adverse effects to the environment. For example, NYSERDA recently mitigated knickpoint erosion within the Erdman Brook stream channel to divert water flow away from the North Slope of the SDA. Lack of maintenance and monitoring could have left these conditions unaddressed, which may have resulted in slope instability.

4.3.2.3 Human Health Criteria

The potential exposure routes at the SDA include the air and groundwater pathways (E & E 1994). In the air pathway, the gases generated in a trench by volatilization, biological activity, or chemical reaction may diffuse through the soil cover into the atmosphere where they would be carried to on-site or off-site receptors. The potential route of exposure would be inhalation. Potential migration of hazardous constituents from the trenches via the groundwater pathway involves the formation of leachate within the trenches and then the downward or lateral flow of the leachate with the groundwater. There are no on-site receptors because surface water and groundwater are not used for drinking or process purposes at the WNYNSC. Off-site receptors would include any direct or indirect uses of surface water downstream of the WNYNSC. The potential for any releases to reach groundwater users are small (see Appendix C).

Alternative 1 could pose a risk to human health in the long term because site stability and infiltration controls would not be maintained. The degradation of the exposed geomembrane cover could allow trench gases to diffuse through the soil cover or allow infiltration of rain water and generation of additional leachate, thus creating a potential for contaminants to migrate into the surface water. In addition, slope erosion may compromise the integrity of the trenches and lagoons and create a health risk via surface water and/or air pathways.

4.3.2.4 Institutional Criteria

Alternative 1 does not involve the use of institutional controls.

4.3.2.5 Cost Estimate

There are no costs associated with Alternative 1.

4.3.3 Alternative 2a – Containment by Exposed Geomembrane Cover and Existing Slurry Wall with Institutional Controls, Long-term Monitoring, and Site Stability Controls

Description

This alternative involves retaining the existing exposed geomembrane cover and slurry wall to limit the movement of contamination at the site. It is also assumed that the exposed geomembrane cover will be replaced during the 30-year span of this interim CMS. The VDLPE cover over Trenches 13 and 14 is expected to be replaced with an XR-5 cover within the next year while the XR-5 cover over the remaining trenches of the SDA is expected to be replaced within 5 to 10 years. The existing slurry wall along the upgradient side of the southern trenches has, in conjunction with the geomembrane cover, proven to be effective in reducing infiltration and groundwater flow through the trenches.

The ICs at the site will include environmental easements, groundwater use restrictions, continuation of permits, deed notices, site security, and fencing around the

SDA. Implementation of existing institutional controls is expected to continue over the next 30 years. In addition, a buffer zone around the perimeter of the SDA will be maintained to ensure long-term access for the purpose of monitoring and to control activities on the slopes and in streams adjacent to the SDA to minimize erosion. Currently, access to the site is restricted and site surveillance is conducted by the DOE in conjunction with surveillance for the adjacent WVDP site. Under Alternative 2a, site security will continue at the SDA.

The maintenance and inspection of the existing site stability controls, namely, the non-SDA detention basins, drainage channels, and stream channel flow controls will continue at the site. To reduce the potential for slope failures, efforts to address the potential impacts of stream channel down-cutting and knickpoint migration on Frank's Creek, Lagoon Road Creek, and Erdman Brook will continue.

The following monitoring activities are included in Alternative 2a:

- Groundwater sampling of the 21 1100-series wells, in accordance with the SDA Groundwater Monitoring Plan (NYSERDA 2008a), will be performed to detect the releases of any hazardous constituents to the groundwater from the SDA.

- Quarterly groundwater elevation measurements from the 1100-series wells, select piezometers, and slit-trench monitoring wells will be performed to monitor the hydrology around the landfill.

- Semiannual sampling of storm water from one of the five SDA storm water outfalls (see Figure 2-5; WO1 is preferential sampling point) will be performed as required by the SDA SPDES permit and the SWPPP.

- Quarterly leachate elevation measurements will be collected from the 13 trench sumps at the SDA. The collected information will be used to monitor water infiltration and to evaluate the effectiveness of the infiltration controls. Annual statistical assessments of the trends in leachate elevation also will be performed;

- Quarterly sampling of surface water at some locations near the SDA (see Figure 2-4) will be conducted to collect information on pollutants present in surface water bodies;

- Maintenance and inspection of the five SDA detention basins, SDA storm water outfall WO1, and the drainage channel armoring on the downstream end of the outfall will be performed. In addition, stream channel flow controls and armoring will be inspected regularly to ensure that they are functioning properly;

- The existing infiltration controls will be inspected and tested regularly to evaluate their remaining life expectancy and effectiveness in preventing water from getting into the trenches;
- Erosion monitoring will be performed and erosion controls implemented, as needed;
- Trench settlement monitoring has been conducted annually from 1991 to 2008 to determine any significant changes in the trench cap elevation. This monitoring will continue at the site; and
- Annual radiation exposure monitoring including the environmental TLD monitoring and overall gamma radiation surveys will be performed.

4.3.3.1 Technical Criteria

Performance

The performance of Alternative 2a is dependent on the effectiveness and useful life of the existing and any future infiltration and site stability controls at the site. The existing geomembrane cover, slurry wall, and detention basins have performed effectively in preventing the migration of contaminants off site. Continued maintenance and monitoring of these controls will ensure optimum performance. The useful life of the controls will be extended through repair and replacement, as necessary. For example, testing results indicate that the VLDPE geomembrane cover on Trenches 13 and 14 be replaced within the next year and the XR-5 cover on the remaining trenches be replaced within the next 5 to 10 years. Additional replacements would be made, as needed, to maintain effectiveness of the cover system and other infiltration and stability controls. This alternative is, therefore, expected to continue performing effectively during the 30-year span of this interim CMS.

Reliability

Alternative 2a is considered to be reliable in the long term since the technologies included in this alternative have been proven to work effectively in containing the contaminants at the SDA. This alternative includes regular monitoring and maintenance of the various technologies, which will provide early identification and mitigation of any potential problems.

Implementability

Alternative 2a can be readily implemented using standard construction means and methods. All of the site stability and infiltration controls except for the geomembrane cover replacement have already been implemented at the site. Replacement of the geomembrane covers would be performed by technical specialists in these areas In addition, there are established environmental monitoring and inspection programs that have proven to be effective.

Safety

Alternative 2a, which includes monitoring and maintenance activities, minimizes the threat to the safety of the nearby communities and the environment. However, there may be potential short-term impacts to the safety of the workers during the replacement of the geomembrane cover at the SDA. To minimize these potential short-term impacts, health and safety measures and environmental monitoring commensurate with the hazards would be employed to protect the workers and surrounding community.

4.3.3.2 Environmental Criteria

The existing site stability and infiltration controls, and maintenance and monitoring of those controls, have had a beneficial effect on the environment by preventing the release of contaminants to the environmental media surrounding the SDA. These controls in addition to the existing environmental monitoring program will continue during implementation of Alternative 2a. In addition, the continued monitoring and inspection programs will serve to identify any potentially adverse effects so that mitigation measures can be implemented in a timely manner.

4.3.3.3 Human Health Criteria

The potential exposure routes at the SDA, i.e., the air and groundwater pathways, and potential receptors are discussed in Section 4.3.2.3. The existing geomembrane covers, which will be retained in Alternative 2a, prevent the release of gases from the trenches, and are protective of human health from the air pathway.

The existing site stability and infiltration controls, and maintenance and monitoring of those controls, have been effective in reducing the generation of leachate in the trenches. Because these controls will be retained in Alternative 2a, the potential for human health impacts over the 30-year performance period are small.

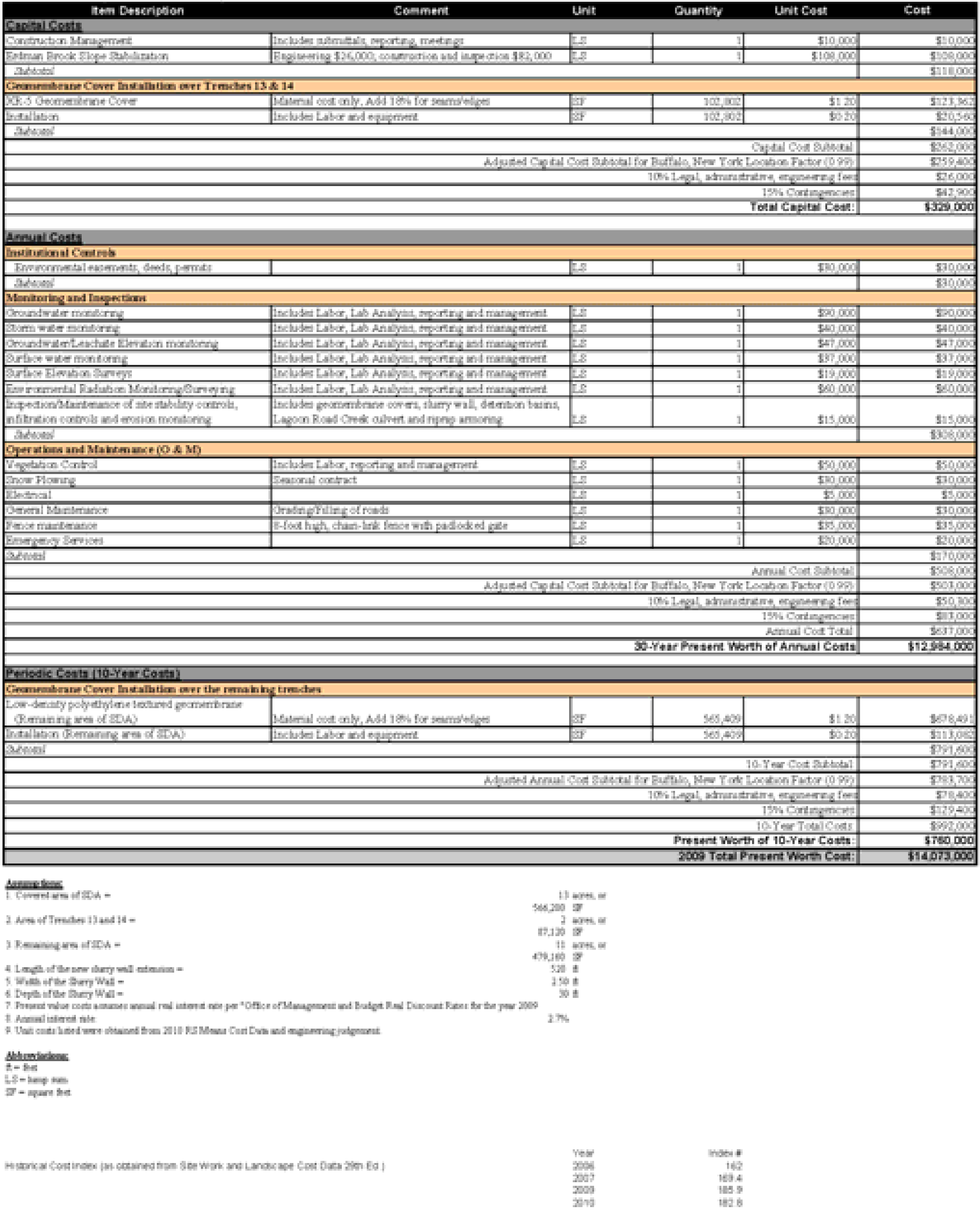
4.3.3.4 Institutional Criteria

The existing institutional controls would remain in effect under Alternative 2a. Site security will continue to be enforced, and the current chain-link fencing will remain in place and be maintained throughout the 30-year period of performance.

4.3.3.5 Cost Estimate

The 2009 total present-worth cost of this alternative based on a 30-year period is $14,073,000. Table 4-2 presents the quantities, unit costs, and subtotal costs for the work items in this alternative. Cost estimating information was obtained from RS Means Cost Data series, engineering judgment, and vendor estimates

Table 4-2 Cost Estimate for Alternative 2a – Containment by Exposed Geomembrane Cover and Slurry Wall with Institutional Controls, Long-term Monitoring, and Site Stability Controls, State-Licensed Disposal Area, West Valley, New York



Item Description	Comment	Unit	Quantity	Unit Cost	Cost
Capital Costs					
Construction Management	Includes submittals, reporting, meetings	LS	1	$10,000	$10,000
Erdman Brook Slope Stabilization	Engineering $26,000, construction and inspection $82,000	LS	1	$108,000	$108,000
Subtotal					$118,000
Geomembrane Cover Installation over Trenches 13 & 14					
XR-5 Geomembrane Cover	Material cost only, Add 18% for seams/edges	SF	102,802	$1.20	$123,362
Installation	Includes Labor and equipment	SF	102,802	$0.20	$20,560
Subtotal					$144,000
				Capital Cost Subtotal	$262,000
				Adjusted Capital Cost Subtotal for Buffalo, New York Location Factor (0.99)	$259,400
				10% Legal, administrative, engineering fees	$26,000
				15% Contingencies	$42,900
				Total Capital Cost:	**$329,000**
Annual Costs					
Institutional Controls					
Environmental easements, deeds, permits		LS	1	$30,000	$30,000
Subtotal					$30,000
Monitoring and Inspections					
Groundwater monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$90,000	$90,000
Storm water monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$40,000	$40,000
Groundwater/Leachate Elevation monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$47,000	$47,000
Surface water monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$37,000	$37,000
Surface Elevation Surveys	Includes Labor, Lab Analysis, reporting and management	LS	1	$19,000	$19,000
Environmental Radiation Monitoring/Surveying	Includes Labor, Lab Analysis, reporting and management	LS	1	$60,000	$60,000
Inspection/Maintenance of site stability controls, infiltration controls and erosion monitoring	Includes geomembrane covers, slurry wall, detention basins, Lagoon Road Creek culvert and riprap armoring	LS	1	$15,000	$15,000
Subtotal					$308,000
Operations and Maintenance (O & M)					
Vegetation Control	Includes Labor, reporting and management	LS	1	$50,000	$50,000
Snow Plowing	Seasonal contract	LS	1	$30,000	$30,000
Electrical		LS	1	$5,000	$5,000
General Maintenance	Grading/Filling of roads	LS	1	$30,000	$30,000
Fence maintenance	8-foot high, chain-link fence with padlocked gate	LS	1	$35,000	$35,000
Emergency Services		LS	1	$20,000	$20,000
Subtotal					$170,000
				Annual Cost Subtotal	$508,000
				Adjusted Capital Cost Subtotal for Buffalo, New York Location Factor (0.99)	$503,000
				10% Legal, administrative, engineering fees	$50,300
				15% Contingencies	$83,000
				Annual Cost Total	$637,000
				30-Year Present Worth of Annual Costs	**$12,984,000**
Periodic Costs (10-Year Costs)					
Geomembrane Cover Installation over the remaining trenches					
Low-density polyethylene textured geomembrane (Remaining area of SDA)	Material cost only, Add 18% for seams/edges	SF	565,409	$1.20	$678,491
Installation (Remaining area of SDA)	Includes Labor and equipment	SF	565,409	$0.20	$113,082
Subtotal					$791,600
				10-Year Cost Subtotal	$791,600
				Adjusted Annual Cost Subtotal for Buffalo, New York Location Factor (0.99)	$783,700
				10% Legal, administrative, engineering fees	$78,400
				15% Contingencies	$129,400
				10-Year Total Costs	$992,000
				Present Worth of 10-Year Costs:	**$760,000**
				2009 Total Present Worth Cost:	**$14,073,000**

Assumptions:

1. Covered area of SDA =	13	acres, or
	566,280	SF
2. Area of Trenches 13 and 14 =	2	acres, or
	87,120	SF
3. Remaining area of SDA =	11	acres, or
	479,160	SF
4. Length of the new slurry wall extension =	520	ft
5. Width of the Slurry Wall =	2.50	ft
6. Depth of the Slurry Wall =	30	ft
7. Present value costs assumes annual real interest rate per "Office of Management and Budget Real Discount Rates for the year 2009		
8. Annual interest rate:	2.7%	
9. Unit costs listed were obtained from 2010 RS Means Cost Data and engineering judgement.		

Abbreviations:

ft = feet
LS = lump sum
SF = square feet

	Year	Index #
Historical Cost Index (as obtained from Site Work and Landscape Cost Data 29th Ed.)	2006	162
	2007	169.4
	2009	185.9
	2010	182.8

4.3.4 Alternative 2b – Containment by Exposed Geomembrane Cover and Extension of Slurry Wall with Institutional Controls, Long-term Monitoring, and Site Stability Controls

Description

This alternative involves retaining the existing exposed geomembrane cover and extending the existing slurry wall to limit the movement of contamination at the site. It is also assumed that the exposed geomembrane cover will be replaced during the 30-year span of this interim CMS. The VDLPE cover over Trenches 13 and 14 is expected to be replaced with an XR-5 cover within the next year while the XR-5 cover over the remaining trenches of the SDA is expected to be replaced within 5 to 10 years.

The existing slurry wall along the upgradient side of the southern trenches has in conjunction with the geomembrane cover proven to be effective in reducing infiltration and groundwater flow through the trenches. A new slurry wall, starting from the existing slurry wall, and extending along the northern trenches will be constructed to minimize the movement of groundwater. The slurry wall is expected to be constructed of a soil/bentonite clay mixture and is expected to be at least 520 feet long, 2.5 feet wide, and 30 feet deep. The slurry wall is expected to have an in-situ hydraulic conductivity of 2.5×10^{-8} centimeters per second (cm/s). A French drain system will be installed on the upgradient side of the slurry wall with VLDPE geomembrane cover wrapped over the top of the slurry wall and tucked into the stone bed. On the bottom of the stone bed, a perforated HDPE pipe will be installed and connected to the existing HDPE pipe for the southern trenches that is part of the storm water conveyance system. Figure 4-1 shows the proposed location of the slurry wall at the SDA.

Considering the infiltration projects that have been recently completed at the NRC-Licensed Disposal Area and the changes in the topography between the NDA and SDA, it is anticipated that prior to construction, additional data collection activities will be required to evaluate the necessity of installing a new wall, and to identify the technology and location of the slurry wall extension. However, for the purposes of this alternative, it is assumed that the slurry wall and French drain will be constructed.

The ICs at the site will include environmental easements, groundwater use restrictions, continuation of permits, deed notices, site security, and fencing around the SDA. Implementation of existing institutional controls is expected to continue over the next 30 years. In addition, a buffer zone around the perimeter of the SDA will be maintained to ensure long-term access for the purpose of monitoring and to control activities on the slopes and in streams adjacent to the SDA to minimize erosion. Currently, access to the site is restricted and site surveillance is conducted by the DOE in conjunction with surveillance for the adjacent WVDP site. Under Alternative 2b, site security will continue at the SDA.

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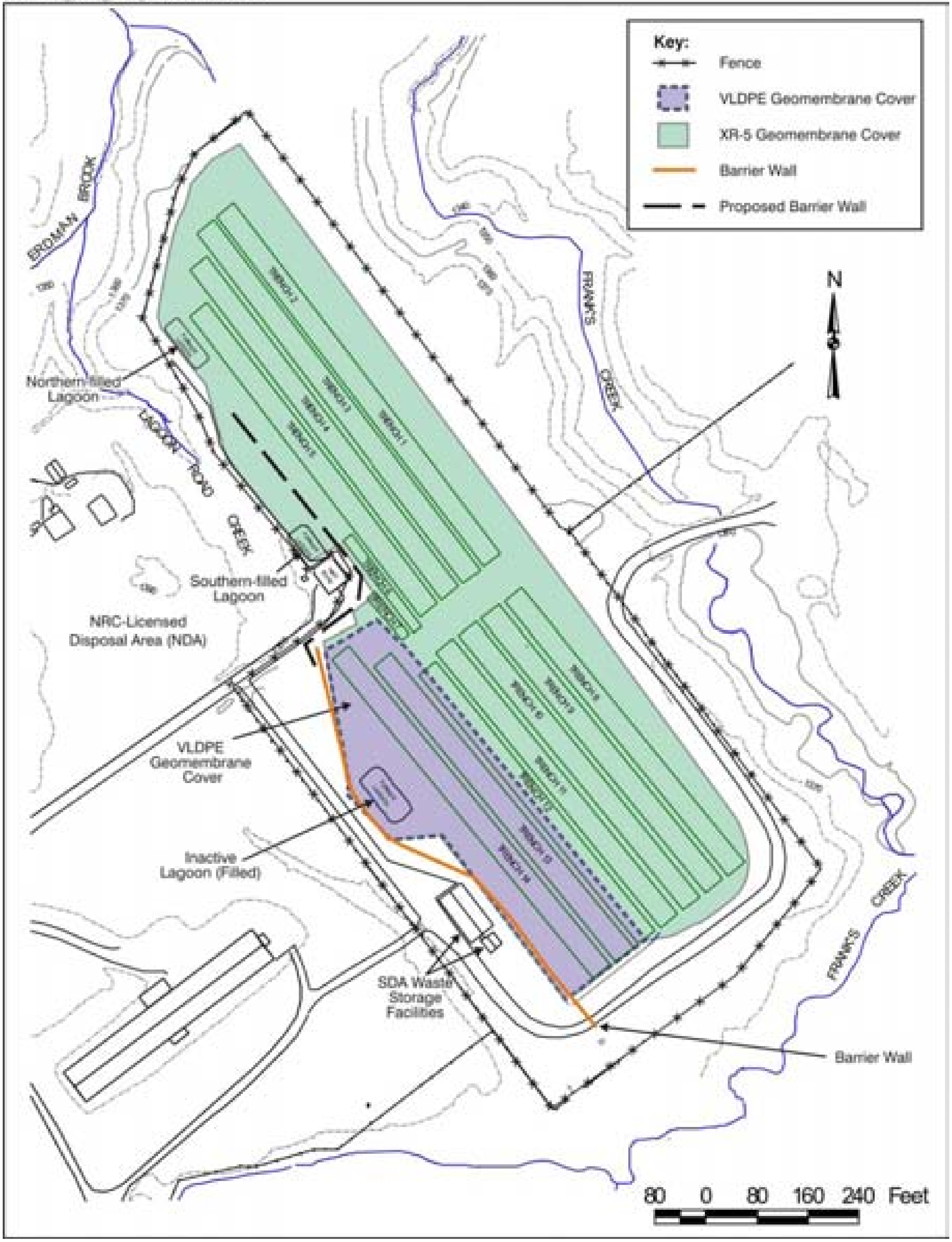

Figure 4-1 Proposed Barrier Wall Extension State-licensed Disposal Area (SDA)

The maintenance and inspection of the existing site stability controls, namely, the non-SDA detention basins, drainage channels, and stream channel flow controls will continue at the site. To reduce the potential for slope failures, efforts to address the potential impacts of stream channel down-cutting and knickpoint migration on Frank's Creek, Lagoon Road Creek, and Erdman Brook will continue.

The following monitoring activities are included in Alternative 2b:

- Groundwater sampling of the 21 1100-series wells in accordance with the SDA Groundwater Monitoring Plan (NYSERDA 2008a) will be performed to detect the releases of any hazardous constituents to the groundwater from the SDA.
- Quarterly groundwater elevation measurements from the 1100-series wells, select piezometers and slit-trench monitoring wells will be performed to monitor the hydrology around the landfill.
- Semiannual sampling of storm water from one of the five SDA storm water outfalls (see Figure 2-5; WO1 is preferential sampling point) will be performed as required by the SDA SPDES permit and the SWPPP.
- Quarterly leachate elevation measurements will be collected from the 13 trench sumps at the SDA. The collected information will be used to monitor water infiltration and to evaluate the effectiveness of the infiltration controls. Annual statistical assessments of the trends in leachate elevation will also be performed;
- Quarterly sampling of surface water at some locations near the SDA (see Figure 2-4) will be conducted to collect information on pollutants present in surface water bodies;
- Maintenance and inspection of the five SDA detention basins, SDA storm water outfall WO1, and the drainage channel (riprap) armoring on the downstream end of the outfall will be performed. In addition, stream channel armoring and stream channel flow controls (check dams) will be inspected regularly to ensure that they are functioning properly;
- The existing infiltration controls will be inspected and tested regularly to evaluate their remaining life expectancy and effectiveness in preventing water from getting into the trenches;
- Erosion monitoring will be performed and erosion controls implemented, as needed;

- Trench settlement monitoring has been conducted annually from 1991 to 2008 to determine any significant changes in the trench cap elevation. This monitoring will continue at the site; and

- Annual radiation exposure monitoring including the environmental TLD monitoring and overall gamma radiation surveys will be performed.

4.3.4.1 Technical Criteria

Performance

The performance of Alternative 2b is dependent on the effectiveness and useful life of the existing and any future infiltration and site stability controls at the site. The existing geomembrane cover, slurry wall, and detention basins have performed effectively in preventing the migration of contaminants off site. Continued maintenance and monitoring of these controls will ensure optimum performance. The useful life of the controls will be extended through repair and replacement, as necessary. For example, the testing results indicate that the VLDPE geomembrane cover on Trenches 13 and 14 be replaced within the next year and the XR-5 cover on the remaining trenches be replaced within the next 5 to 10 years. Additional replacements would be made, as needed, to maintain effectiveness of the cover system and other infiltration and stability controls. The installation of an extension of the existing slurry wall and upgradient French drain system along the northern trenches would potentially improve performance. This alternative is, therefore, expected to continue performing effectively during the 30-year span of this interim CMS.

Reliability

Alternative 2b is considered to be reliable in the long term since the technologies included in this alternative have been proven to work effectively in containing the contaminants at the SDA. It is anticipated that the slurry wall extension will perform reliably in minimizing the migration of contaminants in the long term. This alternative includes regular monitoring and maintenance of the various technologies, including the slurry wall extension, which will provide early identification and mitigation of any potential problems.

Implementability

Alternative 2b can be readily implemented using standard construction means and methods. All of the site stability and infiltration controls except for the slurry wall extension and the geomembrane cover replacement have already been implemented at the site. Extension of the slurry wall and replacement of the geomembrane covers would be performed by technical specialists in these areas. In addition, there are established environmental monitoring and inspection programs that have proven to be effective.

Safety

Alternative 2b, which includes monitoring and maintenance activities, minimizes the threat to the safety of the nearby communities and the environment. However, there may be potential short-term impacts to the safety of the workers during the construction of the slurry wall and replacement of the geomembrane cover at the SDA. To minimize these potential short-term impacts, health and safety measures and environmental monitoring commensurate with the hazards would be employed to protect the workers and surrounding community.

4.3.4.2 Environmental Criteria

The existing site stability and infiltration controls, and maintenance and monitoring of those controls, have had a beneficial effect on the environment by preventing the release of contaminants to the environmental media surrounding the SDA. These controls in addition to the existing environmental monitoring program will continue during implementation of Alternative 2b. In addition, the continued monitoring and inspection programs will serve to identify any potentially adverse effects so that mitigation measures can be implemented in a timely manner.

4.3.4.3 Human Health Criteria

The potential exposure routes at the SDA, i.e., the air and groundwater pathways, and potential receptors are discussed in Section 4.3.2.3. The existing geomembrane covers, which will be retained in Alternative 2b, prevent the release of gases from the trenches, and are protective of human health from the air pathway.

The existing site stability and infiltration controls, and maintenance and monitoring of those controls, have been effective in reducing the generation of leachate in the trenches. Because these controls will be retained in Alternative 2b, the potential for human health impacts over the 30-year performance period are small.

4.3.4.4 Institutional Criteria

The existing institutional controls would remain in effect under Alternative 2b. Site security will continue to be enforced, and the current chain-link fencing will remain in place and be maintained throughout the 30-year period of performance.

4.3.4.5 Cost Estimate

The 2009 total present-worth cost of this alternative based on a 30-year period is $14,808,000. Table 4-3 presents the quantities, unit costs, and subtotal costs for the work items in this alternative. Cost estimating information was obtained from RS Means Cost Data series, engineering judgment, and vendor estimates.

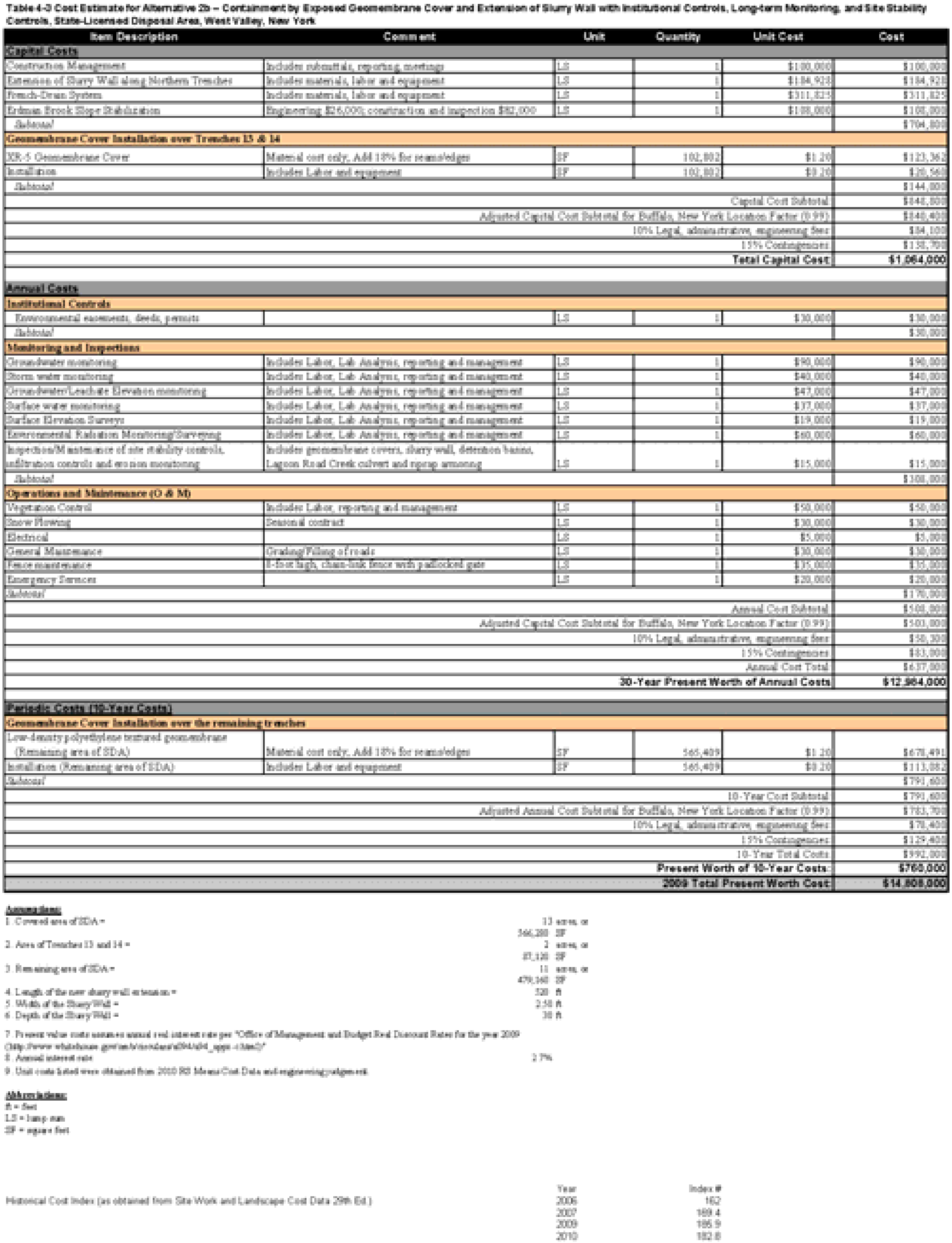

Table 4-3 Cost Estimate for Alternative 2b – Containment by Exposed Geomembrane Cover and Extension of Slurry Wall with Institutional Controls, Long-term Monitoring, and Site Stability Controls, State-Licensed Disposal Area, West Valley, New York

Item Description	Comment	Unit	Quantity	Unit Cost	Cost
Capital Costs					
Construction Management	Includes submittals, reporting, meetings	LS	1	$100,000	$100,000
Extension of Slurry Wall along Northern Trenches	Includes materials, labor and equipment	LS	1	$184,928	$184,928
French-Drain System	Includes materials, labor and equipment	LS	1	$311,825	$311,825
Erdman Brook Slope Stabilization	Engineering $26,000; construction and inspection $82,000	LS	1	$108,000	$108,000
Subtotal					$704,800
Geomembrane Cover Installation over Trenches 13 & 14					
XR-5 Geomembrane Cover	Material cost only. Add 18% for seams/edges	SF	102,802	$1.20	$123,362
Installation	Includes Labor and equipment	SF	102,802	$0.20	$20,560
Subtotal					$144,000
				Capital Cost Subtotal	$848,800
				Adjusted Capital Cost Subtotal for Buffalo, New York Location Factor (0.99)	$840,400
				10% Legal, administrative, engineering fees	$84,100
				15% Contingencies	$138,700
				Total Capital Cost	**$1,064,000**
Annual Costs					
Institutional Controls					
Environmental easements, deeds, permits		LS	1	$30,000	$30,000
Subtotal					$30,000
Monitoring and Inspections					
Groundwater monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$90,000	$90,000
Storm water monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$40,000	$40,000
Groundwater/Leachate Elevation monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$47,000	$47,000
Surface water monitoring	Includes Labor, Lab Analysis, reporting and management	LS	1	$37,000	$37,000
Surface Elevation Surveys	Includes Labor, Lab Analysis, reporting and management	LS	1	$19,000	$19,000
Environmental Radiation Monitoring/Surveying	Includes Labor, Lab Analysis, reporting and management	LS	1	$60,000	$60,000
Inspection/Maintenance of site stability controls, infiltration controls and erosion monitoring	Includes geomembrane covers, slurry wall, detention basins, Lagoon Road Creek culvert and riprap armoring	LS	1	$15,000	$15,000
Subtotal					$308,000
Operations and Maintenance (O & M)					
Vegetation Control	Includes Labor, reporting and management	LS	1	$50,000	$50,000
Snow Plowing	Seasonal contract	LS	1	$30,000	$30,000
Electrical		LS	1	$5,000	$5,000
General Maintenance	Grading/Filling of roads	LS	1	$30,000	$30,000
Fence maintenance	8-foot high, chain-link fence with padlocked gate	LS	1	$35,000	$35,000
Emergency Services		LS	1	$20,000	$20,000
Subtotal					$170,000
				Annual Cost Subtotal	$508,000
				Adjusted Capital Cost Subtotal for Buffalo, New York Location Factor (0.99)	$503,000
				10% Legal, administrative, engineering fees	$50,300
				15% Contingencies	$83,000
				Annual Cost Total	$637,000
				30-Year Present Worth of Annual Costs	**$12,984,000**
Periodic Costs (10-Year Costs)					
Geomembrane Cover Installation over the remaining trenches					
Low-density polyethylene textured geomembrane (Remaining area of SDA)	Material cost only. Add 18% for seams/edges	SF	565,409	$1.20	$678,491
Installation (Remaining area of SDA)	Includes Labor and equipment	SF	565,409	$0.20	$113,082
Subtotal					$791,600
				10-Year Cost Subtotal	$791,600
				Adjusted Annual Cost Subtotal for Buffalo, New York Location Factor (0.99)	$783,700
				10% Legal, administrative, engineering fees	$78,400
				15% Contingencies	$129,400
				10-Year Total Costs	$992,000
				Present Worth of 10-Year Costs:	**$760,000**
				2009 Total Present Worth Cost:	**$14,808,000**

Assumptions:

1. Covered area of SDA =	13	acres, or
	566,280	SF
2. Area of Trenches 13 and 14 =	2	acres, or
	87,120	SF
3. Remaining area of SDA =	11	acres, or
	479,160	SF
4. Length of the new slurry wall extension =	520	ft
5. Width of the Slurry Wall =	2.50	ft
6. Depth of the Slurry Wall =	30	ft

7. Present value costs assumes annual real interest rate per "Office of Management and Budget Real Discount Rates for the year 2009 (http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html)"

8. Annual interest rate 2.7%

9. Unit costs listed were obtained from 2010 RS Means Cost Data and engineering judgement.

Abbreviations:

ft = feet
LS = lump sum
SF = square feet

Historical Cost Index (as obtained from Site Work and Landscape Cost Data 29th Ed.)	Year	Index #
	2006	162
	2007	169.4
	2009	185.9
	2010	182.8

5 Corrective Measure Recommendations

5.1 Comparison of Alternatives

This section compares the impacts of the alternatives in a concise form to help select an alternative that would be suitable for implementation at the SDA. The results will be used to justify and recommend a corrective measure alternative or alternatives for the hazards associated with constituents at the SDA.

5.1.1 Technical Criteria

5.1.1.1 Performance

The long-term performance of Alternatives 1, 2a, and 2b is dependent upon the effectiveness and useful life of the existing infiltration and site stability controls at the site. Even though the site stability controls are currently working effectively, these technologies are expected to deteriorate over time and require regular maintenance to ensure continued effectiveness. Erosion monitoring activities near the SDA will continue to be performed through NYSERDA's Erosion Monitoring Plan (EMP). Data will be collected and reported in accordance with NYSERDA's New York State radiation control permit. Erosion control measures and drainage maintenance activities near the SDA will be performed as established in the Erosion Control and Maintenance Plan (ECMP). The EMP and ECMP are expected to maintain the long-term performance of the infiltration and site stability controls at the SDA. Alternatives 2a and 2b, which include these maintenance activities, are expected to provide a higher level of effectiveness when compared to Alternative 1. In addition, Alternatives 2a and 2b ensure that the performance is maintained over the 30-year performance period of this interim CMS.

5.1.1.2 Reliability

Alternative 1 is not reliable in the long term because the geomembrane covers would degrade, erosion controls would be eliminated, and monitoring would cease. Because Alternatives 2a and 2b employ technologies that have been proven to work effectively at the SDA, these alternatives are considered to be reliable in the long term. In addition, Alternatives 2a and 2b include regular monitoring activities, which will provide early identification and mitigation of any potential problems.

5.1.1.3 Implementability

There are no actions to implement for Alternative 1. Alternatives 2a and 2b can be readily implemented using standard construction means and methods and established monitoring and inspection programs.

5.1.1.4 Safety

Because the current maintenance activities will not continue under Alternative 1, the failure of one or more of the infiltration and site stability controls could increase the potential for exposure to hazardous substances and pose a safety threat to the nearby residents and the environment. Through the monitoring and maintenance activities, Alternatives 2a and 2b minimize the safety threat to the nearby communities and the environment. Construction activities required as part of Alternative 2b may result in some short-term impacts to the safety of the workers, which would be minimized through implementation of health and safety measures and environmental monitoring.

5.1.2 Environmental Criteria

Maintenance and monitoring of site stability controls is integral in preventing the migration of contaminants off site and the lack of these activities in Alternative 1 might result in adverse effects to the environment in the long term. Alternative 2a, which includes existing site stability and infiltration control and maintenance and monitoring of those controls, will help prevent the release of contaminants to the environment. Alternative 2b will provide increased protection by minimizing the migration of contaminants off-site along the northern trenches.

5.1.3 Human Health Criteria

Alternative 1 could pose a risk to human health in the long term because the degradation of the exposed geomembrane cover or slope erosion may create migration pathways for the contaminants currently stored at the site. Alternatives 2a and 2b are protective of human health both during and after the implementation of the alternative and are consistent with the CAOs. The existing infiltration controls have been effective in preventing the diffusion of trench gas and reducing the generation of leachate, which has prevented the migration of leachate to surface water and groundwater

5.2 Recommendation and Justification

Alternative 2a has been selected as the preferred alternative for implementation at the SDA. The infiltration and site stability controls included in this alternative have been implemented at the site and have been shown to work effectively in containing the existing contamination at the SDA. Future activities such as the replacement of the geomembrane covers will aid in maintaining the effectiveness of these controls.

Alternative 2a is expected to actively manage, monitor, and maintain the SDA for the next 30 years. The information that will be collected as part of this CMS is intended to supplement the radiological performance assessment information being generated as part of the EIS to support a complete radiological and chemical risk assessment for the SDA.

5.3 EIS/Radiological Performance Assessment Considerations

The 2010 FEIS preferred alternative for the SDA is to monitor and manage the SDA in place and perform additional studies and activities during an Ongoing Assessment Period. This Ongoing Assessment Period focuses on broader scope, longer-term remedial actions for the SDA, such as close-in-place and exhumation options. Studies conducted during the Ongoing Assessment Period could include long-term erosion controls, waste disposal availability, and field pilot studies. The longer-term remedial approaches are primarily driven by the significant radiological hazard associated with the SDA as opposed to the RCRA hazardous constituents and are thus more appropriately evaluated in an EIS. Additional longer-term remedial action decisions for the SDA will be made during the separate EIS process.

Final remedial action decisions for the SDA must be made in the context of a long-term radiological performance assessment and the 6 NYCRR Part 380 Radiation Control Permit for the SDA.

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Public Participation Plan

Public participation is a key phase in the CMS process.. The goal of the public participation process is to obtain input from citizens in order to build a mutual consensus. The following activities will be performed as part of the public participation process:

- The availability of the Draft Focused CMS for stakeholder and public review will be published in the Buffalo News, Springville Journal, and the Olean Times-Herald on June 3, 2010. The release of the Draft Focused CMS will initiate the public comment period from June 4, 2010, to July 6, 2010.
- During the public comment period, a public meeting will be held on Tuesday, June 8, 2010, at 6:30 pm at the Ashford Office complex, 9030 Route 219, West Valley, NY 14171.
- This CMS will then be revised based on public input. The Final Focused CMS will summarize and provide responses to the written comments received at the public meeting and during the public comment period.

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7

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A Evaluation of Historical North Slope Survey Data

A.1 Background

The stability of the slope between the northern trenches and Erdman Brook was evaluated in *Stability Evaluations of Slopes Adjoining the New York State-Licensed Disposal Area (SDA)* (Aloysious et al. 1992). This work focused on the North Slope and concluded that the irregular surface condition is likely due to instability of loose soil rather than a deep-seated failure. The report attributes the irregular surface condition to the past burial activities at the site when a portion of the native soil excavated for the north SDA trench construction was relocated onto the slope. The evaluation credited runoff, poor drainage control, and limited vegetative cover as the cause for the instability.

Since the publication of the evaluation (Aloysious et al. 1992), on-SDA detention basins were constructed helping to limit surface water runoff on the North Slope. Ground surface elevation measurements have been collected annually on the North Slope. The change in site conditions to improve on-SDA drainage and additional elevation data provided information to re-evaluate the stability of the North Slope at the SDA.

A.2 Evaluation

Figure A-1 shows each of the surveyed points on the North Slope in relation to the SDA (Letter Report by Ecology and Environment, Inc. [E & E] for the New York State Energy Research and Development Authority [NYSERDA] dated December 15, 2008, Re: Support Services for West Valley Site Management Program (WVSMP), Agreement No. 9017; Task Order 003, Environmental Monitoring Support Services; Subtask 6, Ground Surface Elevation Survey). Table A-1 presents the survey data collected at the SDA from 1982 through 2008.

Several events of note have occurred through the years that impact the evaluation:

- **1993.** Geomembrane covers were installed (over Trench 13 and 14).
- **1995/96.** Geomembrane covers were installed (over remaining trenches, except Trench 9) in late 1995 through early 1996. Detention basins were also constructed during this timeframe. Prior to this time, storm water discharged over the northern slope as sheet flow.

- **2000.** Survey procedure changed to survey from the upgradient side of the monitoring stake rather than the downgradient side.

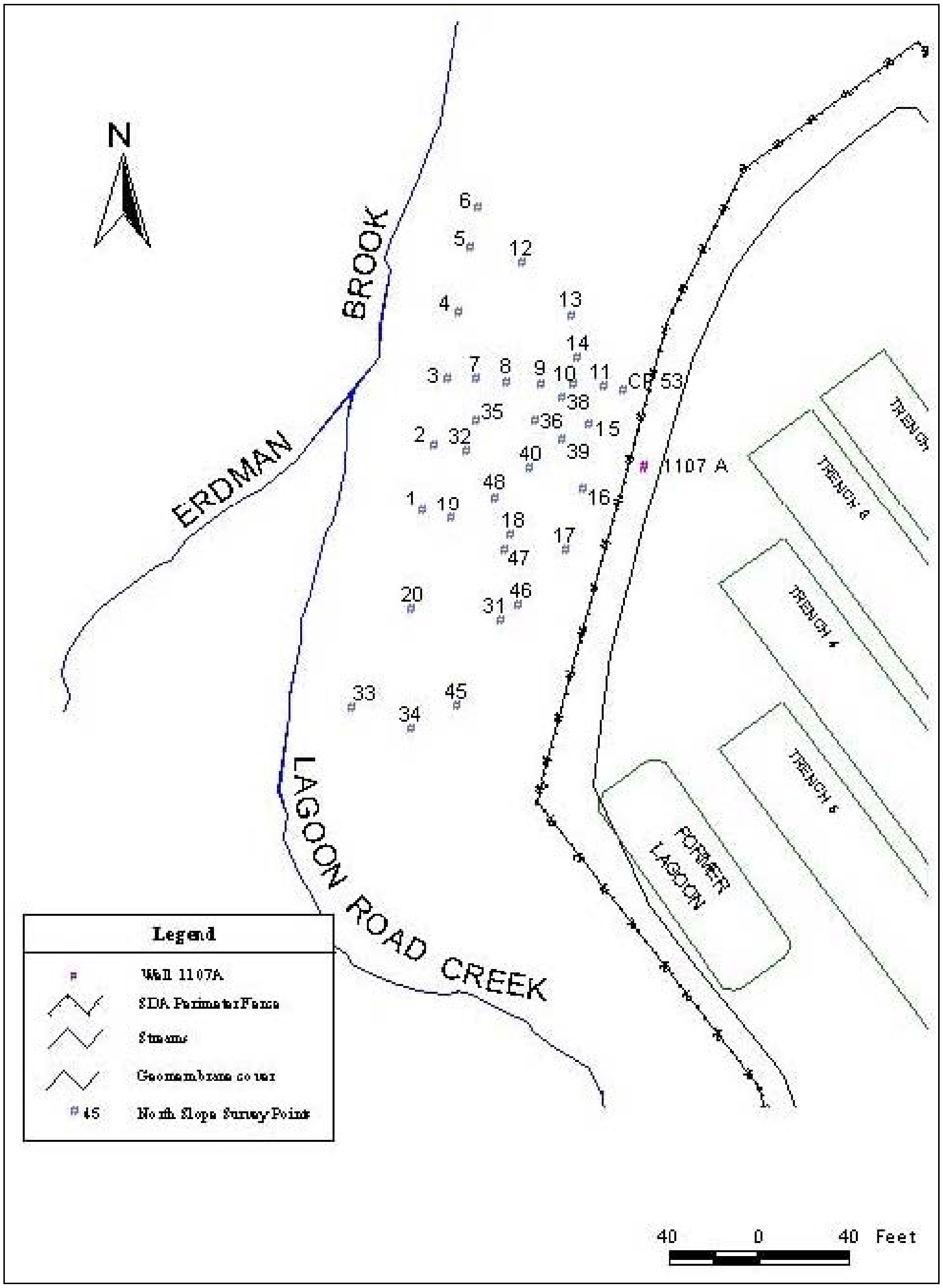


Figure A-1 North Slope Survey Locations

Table A-1 North Slope Coordinates at the SDA (1982 - 2008)

	2008				2007				2006				2005			
Pt. No.	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)
1	892311.71	481796.95	1345.82	77.96	892311.68	481796.87	1345.75	77.89	892311.67	481796.73	1345.79	77.93	892311.71	481796.75	1345.77	77.91
2	892341.07	481802.16	1345.15	77.29	892341.19	481802.17	1345.07	77.21	892341.20	481802.07	1345.17	77.31	892341.08	481802.08	1345.15	77.29
3	892370.76	481807.93	1343.44	75.58	892370.60	481807.50	1343.38	75.52	892370.66	481807.63	1343.36	75.50	892370.49	481807.75	1343.41	75.55
4	892400.19	481813.60	1345.28	77.42	892400.35	481813.44	1345.25	77.39	892400.25	481813.33	1345.21	77.35	892400.30	481813.38	1345.23	77.37
5	892429.11	481818.88	1349.85	81.99	892429.24	481818.98	1349.66	81.80	892428.73	481818.33	1349.80	81.94	892429.15	481818.89	1349.86	82.00
6	892446.39	481821.68	1355.99	88.13	892446.28	481821.73	1355.84	87.98	892446.06	481821.72	1356.00	88.14	892446.04	481821.55	1355.95	88.09
7	892370.03	481820.60	1348.30	80.44	892370.19	481820.45	1348.23	80.37	892370.09	481820.37	1348.33	80.47	892370.21	481820.41	1348.34	80.48
8	892369.04	481834.08	1356.59	88.73	892369.07	481834.12	1356.45	88.59	892369.17	481833.95	1356.58	88.72	892369.10	481834.01	1356.55	88.69
9	892368.34	481849.57	1363.08	95.22	892368.28	481849.52	1362.98	95.12	892368.45	481849.36	1363.07	95.21	892368.32	481849.37	1363.05	95.19
10	892367.67	481863.97	1368.72	100.86	892367.74	481863.89	1368.55	100.69	892367.72	481863.75	1368.70	100.84	892367.65	481863.78	1368.64	100.78
11	892367.16	481877.39	1375.61	107.75	892367.13	481877.04	1375.54	107.68	892367.16	481876.98	1375.57	107.71	892367.15	481877.11	1375.61	107.75
12	892422.18	481841.15	1358.85	90.99	892422.36	481841.22	1358.81	90.95	892422.33	481841.04	1358.88	91.02	892422.30	481841.03	1358.84	90.98
13	892399.10	481863.10	1367.66	99.80	892399.08	481862.87	1367.54	99.68	892399.07	481862.92	1367.71	99.85	892399.17	481862.95	1367.63	99.77
14	892379.80	481866.12	1371.50	103.64	892379.78	481866.08	1371.47	103.61	892379.83	481865.93	1371.58	103.72	892379.83	481865.97	1371.47	103.61
15	892350.65	481870.96	1373.58	105.72	892350.71	481870.92	1373.56	105.70	892350.68	481870.82	1373.63	105.77	892350.70	481870.82	1373.53	105.67
16	892322.10	481868.09	1371.13	103.27	892322.03	481868.10	1371.20	103.34	892322.08	481867.92	1371.24	103.38	892322.13	481867.99	1371.21	103.35
17	892293.50	481860.62	1370.59	102.73	892293.45	481860.60	1370.56	102.70	892293.40	481860.63	1370.66	102.80	892293.54	481860.46	1370.66	102.80
18	892300.26	481836.13	1357.43	89.57	892300.26	481836.09	1357.35	89.49	892300.43	481835.93	1357.42	89.56	892300.26	481835.93	1357.32	89.46
19	892307.63	481809.41	1349.44	81.58	892307.65	481809.44	1349.31	81.45	892307.73	481809.31	1349.40	81.54	892307.74	481809.27	1349.31	81.45
20	892267.47	481792.59	1348.83	80.97	892267.34	481792.64	1348.92	81.06	892267.51	481792.48	1348.91	81.05	892267.49	481792.49	1348.91	81.05
31	892261.71	481831.51	1363.83	95.97	892261.73	481831.26	1363.80	95.94	892261.66	481831.31	1363.89	96.03	892261.67	481831.33	1363.80	95.94
32	892337.92	481817.04	1350.91	83.05	892337.86	481817.13	1350.86	83.00	892337.86	481816.96	1350.98	83.12	892337.92	481816.98	1350.94	83.08
33	892222.92	481766.10	1351.71	83.85	892222.81	481766.11	1351.72	83.86	892223.00	481765.95	1351.72	83.86	892222.91	481765.97	1351.74	83.88
34	892213.43	481792.59	1363.05	95.19	892213.40	481792.61	1362.86	95.00	892213.33	481792.54	1363.03	95.17	892213.36	481792.54	1362.95	95.09
35	892352.57	481820.54	1350.79	82.93	892352.64	481820.43	1350.73	82.87	892352.65	481820.27	1350.74	82.88	892352.62	481820.40	1350.89	83.03
36	892352.17	481847.03	1362.97	95.11	892352.03	481846.96	1362.89	95.03	892352.01	481846.76	1362.98	95.12	892352.03	481846.80	1362.94	95.08
37																
38	892362.49	481858.88	1364.48	96.62	892362.43	481858.74	1364.43	96.57	892362.59	481858.63	1364.51	96.65	892362.49	481858.70	1364.50	96.64
39	892343.07	481859.03	1365.17	97.31	892343.28	481858.93	1365.24	97.38	892343.29	481858.83	1365.18	97.32	892343.33	481858.94	1365.24	97.38
40	892330.67	481844.97	1361.40	93.54	892330.82	481844.99	1361.39	93.53	892330.88	481844.80	1361.48	93.62	892330.81	481844.84	1361.45	93.59
45	892223.91	481812.60	1363.32	95.46	892223.90	481812.49	1363.28	95.42	892223.98	481812.33	1363.30	95.44	892223.97	481812.33	1363.22	95.36
46	892268.65	481838.74	1364.74	96.88	892268.78	481838.82	1364.61	96.75	892268.75	481838.68	1364.68	96.82	892268.74	481838.66	1364.64	96.78
47	892293.24	481833.12	1357.93	90.07	892293.23	481833.03	1357.75	89.89	892293.30	481832.89	1357.87	90.01	892293.26	481832.97	1357.80	89.94
48	892317.53	481829.36	1355.31	87.45	892317.50	481829.19	1355.18	87.32	892317.58	481829.12	1355.24	87.38	892317.76	481829.26	1355.23	87.37
CP53	892365.38	481885.41	1375.69	107.83	892365.41	481885.53	1375.64	107.78	892365.45	481885.29	1375.65	107.79	892365.44	481885.34	1375.68	107.82

Table A-1 North Slope Coordinates at the SDA (1982 - 2008)

	2004				2003				2002				2001			2000		
Pt. No.	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)	Northing	Easting	Elevation (ft AMSL)	Adjusted Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)
1	892311.65	481796.76	1345.79	77.93	892311.49	481796.67	1345.68	77.82	892000.00	481000.00	1345.69	77.90	950.00	909.32	77.86	949.94	909.16	77.87
2	892341.03	481802.04	1345.13	77.27	892341.02	481802.17	1345.03	77.17	892000.00	481000.00	1344.99	77.20	979.14	915.90	77.22	979.11	915.88	77.25
3	892370.38	481807.54	1343.56	75.70	892370.35	481807.62	1343.37	75.51	892000.00	481000.00	1343.14	75.35	1008.36	922.80	75.36	1008.22	922.71	75.43
4	892400.18	481813.33	1345.24	77.38	892400.12	481813.42	1345.16	77.30	892000.00	481000.00	1345.16	77.37	1037.75	929.75	77.32	1037.67	929.64	77.36
5	892429.20	481818.82	1349.81	81.95	892429.13	481818.85	1349.84	81.98	892000.00	481000.00	1349.66	81.87	1066.44	936.38	81.94	1066.42	936.27	81.96
6	892446.27	481821.97	1356.01	88.15	892445.86	481821.76	1355.99	88.13	892000.00	481000.00	1355.87	88.08	1083.10	939.91	88.21	1083.10	939.58	88.26
7	892370.09	481820.41	1348.35	80.49	892370.12	481820.49	1348.16	80.30	892000.00	481000.00	1348.26	80.47	1007.32	935.57	80.49	1007.39	935.53	80.50
8	892369.10	481834.11	1356.62	88.76	892369.02	481834.18	1356.53	88.67	892000.00	481000.00	1356.58	88.79	1005.82	949.15	88.79	1005.76	949.10	88.73
9	892368.44	481849.38	1363.11	95.25	892368.20	481849.52	1363.05	95.19	892000.00	481000.00	1363.05	95.26	1004.46	964.36	95.20	1004.39	964.32	95.23
10	892367.71	481863.77	1368.67	100.81	892367.55	481863.85	1368.59	100.73	892000.00	481000.00	1368.65	100.86	1003.21	978.65	100.83	1003.26	978.68	100.81
11	892367.12	481877.23	1375.62	107.76	892366.91	481877.17	1375.44	107.58	892000.00	481000.00	1375.53	107.74	1002.01	991.80	107.71	1002.04	991.93	107.65
12	892422.26	481841.04	1358.87	91.01	892422.31	481841.10	1358.92	91.06	892000.00	481000.00	1359.07	91.28	1058.70	958.24	91.05	1058.66	958.15	91.07
13	892399.08	481862.96	1367.62	99.76	892398.94	481862.97	1367.54	99.68	892000.00	481000.00	1367.49	99.70	1034.55	979.08	99.84	1034.57	979.10	99.82
14	892379.72	481866.03	1371.61	103.75	892379.70	481866.02	1371.43	103.57	892000.00	481000.00	1371.64	103.85	1015.12	981.37	103.83	1015.13	981.43	103.84
15	892350.68	481870.81	1373.55	105.69	892350.52	481870.92	1373.52	105.66	892000.00	481000.00	1373.25	105.46	985.90	985.01	105.74	985.86	985.03	105.71
16	892321.97	481868.19	1371.35	103.49	892321.89	481868.14	1371.19	103.33	892000.00	481000.00	1371.22	103.43	957.37	981.10	103.43	957.31	981.06	103.39
17	892293.49	481860.65	1370.66	102.80	892293.30	481860.66	1370.56	102.70	892000.00	481000.00	1370.53	102.74	929.22	972.41	102.82	929.15	972.40	102.73
18	892300.23	481836.00	1357.48	89.62	892300.05	481835.94	1357.32	89.46	892000.00	481000.00	1357.36	89.57	936.89	948.03	89.55	936.94	948.08	89.56
19	892307.72	481809.39	1349.44	81.58	892307.75	481809.31	1349.34	81.48	892000.00	481000.00	1349.27	81.48	945.52	921.79	81.48	945.48	921.72	81.49
20	892267.46	481792.57	1349.03	81.17	892267.42	481792.54	1348.67	80.81	892000.00	481000.00	1348.88	81.09	906.11	903.32	81.09	905.92	903.14	80.87
31	892261.61	481831.44	1363.88	96.02	892261.55	481831.40	1363.73	95.87	892000.00	481000.00	1363.77	95.98	898.63	941.86	95.97	898.54	941.85	95.92
32	892338.04	481816.86	1350.95	83.09	892337.88	481817.11	1350.94	83.08	892000.00	481000.00	1351.01	83.22	975.28	930.79	83.12	975.21	930.72	83.08
33	892222.90	481765.93	1351.70	83.84	892222.97	481765.98	1351.60	83.74	892000.00	481000.00	1351.60	83.81	862.68	874.88	83.88	862.58	874.86	83.84
34	892213.41	481792.50	1363.00	95.14	892213.15	481792.61	1362.96	95.10	892000.00	481000.00	1362.86	95.07	851.99	901.11	95.13	851.88	901.14	95.04
35	892352.20	481820.48	1351.02	83.16	892352.35	481820.49	1350.94	83.08	892000.00	481000.00	1350.83	83.04	989.80	934.78	83.00	989.76	934.78	82.99
36	892352.03	481846.94	1363.02	95.16	892351.88	481846.93	1362.93	95.07	892000.00	481000.00	1363.05	95.26	988.24	961.12	95.17	988.25	961.08	95.14
37																	NOT FOUND	
38	892362.45	481858.69	1364.51	96.65	892362.35	481858.75	1364.45	96.59	892000.00	481000.00	1364.53	96.74	998.08	973.31	96.63	998.10	973.34	96.66
39	892343.41	481858.89	1365.28	97.42	892342.94	481858.90	1365.08	97.22	892000.00	481000.00	1365.10	97.31	978.96	972.78	97.34	978.97	972.71	97.27
40	892330.81	481844.82	1361.43	93.57	892330.66	481844.69	1361.42	93.56	892000.00	481000.00	1361.35	93.56	967.12	959.39	93.64	966.99	959.27	93.50
45	892223.99	481812.37	1363.26	95.40	892223.88	481812.36	1363.19	95.33	892000.00	481000.00	1363.24	95.45	861.80	921.22	95.44	861.67	921.30	95.34
46	892268.75	481838.68	1364.67	96.81	892268.59	481838.66	1364.63	96.77	892000.00	481000.00	1364.60	96.81	905.46	949.43	96.86	905.25	949.43	96.84
47	892293.29	481833.08	1357.89	90.03	892293.18	481833.21	1357.78	89.92	892000.00	481000.00	1357.80	90.01	930.14	944.86	90.05	930.05	944.81	89.99
48	892317.55	481829.27	1355.29	87.43	892317.44	481829.28	1355.22	87.36	892000.00	481000.00	1355.20	87.41	954.53	942.14	87.40	954.49	942.05	87.42
CP53	892365.43	481885.31	1375.67	107.81	892365.29	481885.38	1375.67	107.81			1375.66	107.87						

Table A-1 North Slope Coordinates at the SDA (1982 - 2008)

	1999			1998			1997			1996			1995			1994		
Pt. No.	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)
1	949.91	909.18	77.79	949.95	909.22	77.73	949.90	909.19	77.86	949.89	909.18	77.87	949.93	908.95	77.65	949.89	909.14	77.67
2	979.07	915.94	77.22	979.01	915.64	77.08	979.10	915.82	77.13	979.09	915.89	77.20	979.05	915.59	76.96	979.11	915.73	76.85
3	1008.28	922.87	75.23	1008.30	922.75	75.42	1008.34	922.55	75.41	1008.28	922.53	75.42	1008.64	922.60	75.33	1008.29	922.53	75.24
4	1037.60	929.64	77.32	1037.89	929.46	77.26	1037.69	929.58	77.27	1037.64	929.54	77.31	1037.74	929.22	77.19	1037.81	929.41	77.09
5	1066.50	936.16	81.86	1066.45	936.30	81.91	1066.49	936.25	81.98	1066.43	936.24	82.01	1066.31	935.79	81.80	1066.41	936.09	81.71
6	1083.06	939.93	88.15	1083.13	939.88	88.14	1083.10	939.85	88.22	1083.00	939.84	88.24	1083.17	939.75	88.51	1083.13	939.72	88.08
7	1007.32	935.63	80.44	1007.34	935.61	80.45	1007.38	935.45	80.46	1007.35	935.55	80.50	1007.50	935.73	80.31	1007.37	935.29	80.24
8	1005.63	949.04	88.60	1005.64	949.11	88.63	1005.73	949.15	88.71	1005.76	949.15	88.73	1005.51	948.73	88.60	1005.77	949.02	88.57
9	1004.49	964.29	95.13	1004.44	964.43	95.13	1004.49	964.18	95.16	1004.51	964.22	95.17	1004.63	964.19	95.14	1004.52	964.28	95.07
10	1003.18	977.97	100.70	1002.97	978.57	100.75	1003.14	978.66	100.78	1003.14	978.49	100.65	1003.00	978.29	100.80	1003.14	978.52	100.53
11	1001.99	991.66	107.56	1002.03	991.86	107.61	1002.03	991.81	107.71	1002.02	991.85	107.64	1002.20	991.78	107.55	1002.06	991.67	107.51
12	1058.58	958.18	91.04	1058.61	958.10	90.90	1058.64	958.18	91.08	1058.60	958.16	91.03	1058.66	957.99	91.08	1058.72	958.01	90.93
13	1034.65	979.02	99.61	1034.43	978.85	99.57	1034.58	979.05	99.79	1034.54	979.08	99.72	1034.65	978.75	99.67	1034.51	978.94	99.55
14	1014.92	980.76	103.66	1015.14	981.16	103.65	1015.10	981.40	103.77	1015.12	981.45	103.82	1015.00	981.10	103.41	1015.12	981.36	103.22
15	986.03	985.00	105.49	986.16	984.61	105.50	985.77	985.02	105.67	985.83	985.05	105.72	985.71	984.83	105.30	985.76	984.95	105.15
16	957.16	980.88	103.45	957.03	981.17	103.46	957.06	981.23	103.51	957.08	981.21	103.54	957.15	981.14	103.28	957.04	981.06	102.95
17	929.15	972.43	102.73	928.96	972.46	102.63	929.02	972.48	102.73	929.04	972.52	102.73	929.05	972.22	102.59	929.11	972.39	102.48
18	936.83	948.08	89.40	936.79	947.95	89.35	936.92	947.91	89.34	936.92	947.90	89.40	937.03	947.55	89.31	936.95	947.88	89.30
19	945.50	921.75	81.39	945.58	921.85	81.36	945.40	921.65	81.39	945.44	921.71	81.47	945.48	921.48	81.22	945.56	921.52	81.18
20	906.07	903.43	80.99	905.94	903.23	80.88	906.04	903.08	80.74	906.04	903.08	80.80	906.02	903.10	80.65	906.05	903.15	80.64
31	898.38	941.96	95.85	898.39	941.96	95.85	898.50	941.69	95.87	898.50	941.72	95.91	898.50	941.50	95.85	898.52	941.76	95.61
32	975.21	930.78	82.87	975.11	930.10	82.91	975.17	930.71	82.94	975.22	930.80	83.11	975.21	930.48	82.91	975.18	930.72	82.77
33	862.57	874.92	83.76	862.50	874.84	83.82	862.60	874.71	83.35	862.61	874.71	83.36	862.63	874.76	83.25	862.66	874.73	83.08
34	851.69	901.03	94.92	851.64	900.99	94.98	851.79	901.10	95.03	851.77	901.11	95.08	851.90	900.93	94.88	851.87	900.96	94.72
35	989.98	934.90	82.95	989.69	934.47	82.91	989.73	934.78	82.97	989.77	934.75	83.04	989.66	934.66	82.93	989.81	934.75	82.84
36	988.10	960.98	95.02	988.21	961.03	95.06	988.13	961.04	95.13	988.18	961.04	95.16	987.97	960.90	95.08	988.27	960.95	94.97
37		NOT FOUND		NOT FOUND			949.63	872.27	77.26	949.57	872.26	77.34	949.58	872.39	77.09	949.72	872.20	76.95
38	998.14	973.28	96.53	998.09	973.37	96.61	998.07	973.14	96.56	998.10	973.11	96.55	998.01	973.16	96.48	998.05	973.18	96.41
39	978.99	972.76	97.19	979.05	972.66	97.33	979.02	972.58	97.09	979.01	972.58	97.13	978.84	972.69	97.07	979.01	972.56	97.06
40	967.05	957.93	93.42	967.13	958.27	93.47	967.00	958.27	93.53	966.97	958.29	93.58	966.92	958.02	93.43	967.03	958.17	93.36
45	881.71	921.33	95.25	881.60	921.45	95.22	881.63	921.31	95.31	881.62	921.30	95.33	881.87	920.96	95.31	881.64	921.18	95.03
46	905.32	949.48	96.72	905.34	949.38	96.68	905.31	949.41	96.77	905.28	949.46	96.81	905.54	948.98	96.70	905.41	949.05	96.58
47	930.06	944.98	89.91	930.28	944.83	89.87	930.04	944.77	89.94	930.03	944.85	89.95	930.17	944.59	89.87	930.23	944.56	89.84
48	954.59	942.17	87.32	954.75	942.00	87.35	954.48	942.08	87.36	954.43	942.07	87.39	954.72	941.63	87.30	954.60	941.97	87.24
CP53																		

Table A-1 North Slope Coordinates at the SDA (1982 - 2008)

	1993			1992			1991			1983			June 1982			April 1982		
Pt. No.	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)	Northing	Easting	Elevation (ft)
1	949.87	909.20	77.80	949.91	909.21	77.82	949.85	909.19	77.83	949.83	909.18	77.90	949.90	909.38	77.87	949.86	909.05	77.85
2	979.15	915.86	76.96	979.13	915.84	77.12	979.19	915.90	77.08	979.96	915.86	76.91	979.08	916.21	76.95	979.18	916.12	76.93
3	1008.28	922.65	75.37	1008.30	922.67	75.34	1008.28	922.68	75.44	1008.24	922.60	75.27	1008.13	922.88	75.28	1008.21	922.88	75.51
4	1037.68	929.61	77.13	1037.69	929.62	77.31	1037.64	929.67	77.37	1037.67	929.61	77.58	1037.47	929.82	77.41	1037.65	929.82	77.37
5	1066.43	936.32	81.93	1066.44	936.34	82.00	1066.48	936.36	82.03	1066.23	936.57	82.07	1066.25	936.44	82.14	1066.34	936.48	82.11
6	1082.95	939.95	88.33	1082.95	939.98	88.37	1082.89	939.98	88.38	1082.74	940.24	88.84	1082.65	940.29	88.81	1082.67	940.37	88.91
7	1007.32	935.59	80.43	1007.30	935.62	80.48	1007.33	935.70	80.45	1007.14	936.53	81.03	1007.09	937.12	81.22	1007.09	937.08	81.27
8	1005.83	949.24	88.74	1005.73	949.30	88.74	1005.74	949.35	88.83	1005.70	950.13	89.43	1005.67	950.79	89.56	1005.71	950.74	89.55
9	1004.47	964.30	95.14	1004.46	964.46	95.13	1004.55	964.39	95.23	1004.39	964.50	95.55	1004.32	964.97	95.71	1004.35	964.90	95.76
10	1003.16	978.70	100.72	1003.17	978.72	100.76	1003.22	978.79	100.84	1003.09	978.96	100.98	1003.24	979.44	101.48	1003.27	979.38	101.56
11	1002.10	991.82	107.64	1002.06	991.81	107.62	1002.09	991.72	107.63	1002.01	991.90	107.73	1002.09	991.80	107.75	1002.03	991.83	107.72
12	1058.64	958.19	91.03	1058.66	958.19	91.05	1058.62	958.23	91.10	1058.59	958.21	91.26	1058.58	958.32	91.25	1058.52	958.33	91.31
13	1034.48	979.14	99.76	1034.52	979.19	99.74	1034.43	979.17	99.81	1034.51	979.27	100.11	1034.24	979.36	100.19	1034.30	979.29	100.22
14	1015.13	981.59	103.88	1015.08	981.54	103.89	1015.08	981.61	103.98	1015.06	981.97	104.53	1014.99	982.07	104.49	1014.99	982.05	104.65
15	985.80	985.14	105.75	985.87	985.14	105.79	985.89	985.17	105.84	985.78	985.53	106.39	985.68	985.62	106.37	985.84	985.72	106.56
16	957.00	981.32	103.51	957.07	981.19	103.54	957.06	981.29	103.59	956.99	981.28	103.68	957.06	981.46	103.60	957.07	981.31	103.69
17	929.03	972.55	102.70	929.01	972.55	102.80	929.07	972.64	102.80	929.03	972.60	102.84	928.99	972.72	102.88	929.05	972.57	103.21
18	936.87	947.98	89.32	936.79	948.06	89.53	936.78	948.20	89.52	936.75	948.01	89.43	936.92	948.03	89.26	936.67	947.99	89.50
19	945.45	921.73	81.38	945.48	921.75	81.41	945.44	921.72	81.39	945.48	921.61	81.54	945.54	921.67	81.40	945.40	921.35	81.44
20	906.04	903.16	80.89	905.99	903.27	80.91	905.88	903.21	80.88	906.10	903.23	80.69	906.04	903.21	80.70	905.95	903.12	80.80
31	898.50	941.80	95.84	898.41	941.89	95.87	898.38	941.94	95.91	898.38	941.89	96.14	898.44	941.91	95.78	898.37	941.95	96.24
32	975.14	930.92	83.06	975.16	930.86	83.07	975.23	930.88	83.04	975.19	931.10	83.52	975.22	931.67	83.58	975.22	931.57	83.67
33	982.60	874.76	83.32	982.47	874.81	83.71	982.51	874.92	83.73	982.37	874.98	83.27	982.54	874.70	83.35	982.49	874.72	83.45
34	851.75	901.10	94.99	851.76	901.06	95.00	851.73	901.04	95.01	851.69	901.17	95.09	851.61	901.10	95.12	851.64	901.09	95.16
35	989.72	934.83	82.95	989.75	934.88	83.01	989.74	934.99	83.00	898.73	935.70	83.37	989.66	936.29	83.44	989.70	936.26	83.61
36	988.32	961.16	95.17	988.21	961.15	95.14	988.18	961.22	95.22	988.23	961.36	95.59	988.17	961.66	95.68	988.26	961.81	95.84
37	949.68	872.11	77.09	949.72	872.35	77.16	949.66	872.33	77.17	949.00	872.59	75.59	949.11	872.73	75.29	949.29	872.93	75.42
38	998.09	973.19	96.50	998.07	973.34	96.64	998.10	973.27	96.51	998.00	973.27	96.72	998.01	973.79	96.99	997.94	973.74	97.09
39	979.02	972.61	97.12	978.95	972.71	97.25	978.87	972.76	97.29	978.90	972.73	97.27	978.96	973.06	97.43	978.80	973.01	97.57
40	966.96	958.40	93.49	966.99	958.42	93.52	967.05	958.51	93.57	966.91	958.72	93.78	966.86	959.06	93.70	966.86	958.96	93.90
45	861.54	921.34	95.34	861.52	921.33	95.38	861.50	921.38	95.43									
46	905.25	949.46	96.75	905.28	949.44	96.75	905.29	949.52	96.85									
47	930.06	944.83	89.89	930.07	944.82	89.87	930.03	944.92	89.89									
48	954.48	942.16	87.34	954.50	942.15	87.32	954.43	942.20	87.38									
CP53																		

Notes:

1. Data obtained from NYSERDA in March 2007 and February 2010.
2. Elevation adjustment factor for change in survey benchmark for comparison to pre-2002 data:
   for 2002 = 1267.79 ft, for 2003 - 2008 = 1267.86 ft.
3. Geomembrane covers installed in 1993 (over Trench 13 and 14) and 1995 (remaining trenches, except Trench 9). Detention basins were constructed in fall 1995.
   Prior to this time, stormwater discharged over the northern slope as sheet flow.
4. Survey procedures changed in 2000 to survey from the upgradient side of the monitoring stake rather than the downgradient side.
5. Data rounded to two decimal places for consistency.

Table A-2 compares the elevation data for select years, prior to or after the events listed above. Northing and easting coordinates were plotted for four locations (Points 6, 7, 8 and 36) out of the seven locations where the total elevation difference over the 24-year period was greater than about 0.8 feet. Point 1, which had essentially no elevation change over the 24-year period, was also plotted for comparison purposes. Northing and easting coordinates were plotted against each other to evaluate whether the location of the survey point exhibited a trend. A decrease in the easting and an increase in the northing coordinates over time would be an indication that the survey point is moving downslope (northwest) toward Erdman Brook.

A.4 Results

As shown in Table A-2, the majority of elevation decrease occurred between 1982 and 1995 at each survey point, except for Point 6, which is the northernmost point located adjacent to Erdman Brook. This timeframe represents the period prior to construction of the detention basins. The maximum observed elevation loss during this timeframe was at Point 15 located at the top of the slope which had an elevation decrease of 1.26 feet. Elevation differences during this timeframe are generally consistent with an estimated rate of retreat for the North Slope of 0.06 feet per year (Aloysious et al. 1992).

Following the construction of detention basins (1995 through 2008), the maximum observed decrease in elevation was only about 0.12 feet or about 1.5 inches, except at Point 6 where a decrease of 0.5 feet in elevation was observed. Point 6 was also the only point observed to be moving downgradient towards Erdman Brook, likely a result of knickpoint migration near the toe of the North Slope.

A.5 Conclusion

The apparent causes of instability, runoff drainage control, and limited vegetative cover, discussed in the 1992 report, appear to have been addressed, for the most part, with the installation of the geomembrane covers and on-SDA detention basins in 1995/1996. Survey elevation data collected for the North Slope also supports this conclusion as an elevation decrease of less than 1 inch was observed at all but one survey location, following the construction of the detention basins. Furthermore, except for Point 6, all of the other survey locations did not appear to move down the slope.

Point 6 is the northernmost point located adjacent to Erdman Brook. This point showed a greater elevation loss than the other surveyed points since the construction of the detention basins. In addition, the analysis of the survey data shows that the survey point is moving down the slope towards Erdman Brook, and is very near the location of the Erdman Brook knickpoint that was recently mitigated. Hence, monitoring of the North Slope should continue in the future.

References

Aloysious et al. 1992, Stability *Evaluations of Slopes Adjoining the New York State-Licensed Disposal Area (SDA)*

Table A-2 Survey Elevation Data for North Slope, 1982 through 2008 (select years are presented)

	Elevation (ft)					Elevation Difference (ft)			
						Pre-Infiltration Controls (Note 3)	Infiltration Controls Constructed (Note 3)	Survey Rationale Modified (Note 4)	Total
Point	1982	1995	1999	2000	2008	1995 - 1982	1999 - 1995	2008 - 2000	1982 - 2008
1	77.85	77.65	77.79	77.87	77.96	**-0.20**	0.14	0.09	0.03
2	76.93	76.96	77.22	77.25	77.29	0.03	0.26	0.04	0.33
3	75.51	75.33	75.23	75.43	75.58	**-0.18**	**-0.10**	0.15	**-0.12**
4	77.37	77.19	77.32	77.36	77.42	**-0.18**	0.13	0.06	0.01
5	82.11	81.80	81.86	81.96	81.99	**-0.31**	0.06	0.03	**-0.22**
6	88.91	88.51	88.15	88.26	88.13	**-0.40**	**-0.36**	**-0.14**	**-0.90**
7	81.27	80.31	80.44	80.50	80.44	**-0.96**	0.13	**-0.06**	**-0.89**
8	89.55	88.60	88.60	88.73	88.73	**-0.95**	**0.00**	0.00	**-0.95**
9	95.76	95.14	95.13	95.23	95.22	**-0.62**	**-0.01**	**-0.01**	**-0.64**
10	101.56	100.60	100.70	100.81	100.86	**-0.96**	0.10	0.05	**-0.81**
11	107.72	107.55	107.56	107.65	107.75	**-0.17**	0.01	0.09	**-0.06**
12	91.31	91.08	91.04	91.07	90.99	**-0.23**	**-0.04**	**-0.08**	**-0.34**
13	100.22	99.67	99.61	99.82	99.80	**-0.55**	**-0.06**	**-0.02**	**-0.63**
14	104.65	103.41	103.66	103.84	103.64	**-1.24**	0.25	**-0.20**	**-1.19**
15	106.56	105.30	105.49	105.71	105.72	**-1.26**	0.19	0.01	**-1.06**
16	103.89	103.28	103.45	103.39	103.27	**-0.61**	0.17	**-0.12**	**-0.56**
17	103.21	102.59	102.73	102.73	102.73	**-0.62**	0.14	0.00	**-0.48**
18	89.50	89.31	89.40	89.56	89.57	**-0.19**	0.09	0.01	**-0.10**
19	81.44	81.22	81.39	81.49	81.58	**-0.22**	0.17	0.09	0.04
20	80.80	80.65	80.99	80.87	80.97	**-0.15**	0.34	0.10	0.29
31	96.24	95.85	95.85	95.92	95.97	**-0.39**	0.00	0.05	**-0.34**
32	83.67	82.91	82.87	83.08	83.05	**-0.76**	**-0.04**	**-0.03**	**-0.83**
33	83.45	83.25	83.76	83.84	83.85	**-0.20**	0.51	0.01	0.32
34	95.16	94.88	94.92	95.04	95.19	**-0.28**	0.04	0.15	**-0.09**
35	83.61	82.93	82.95	82.99	82.93	**-0.68**	0.02	**-0.06**	**-0.72**
36	95.84	95.08	95.02	95.14	95.11	**-0.76**	**-0.06**	**-0.03**	**-0.86**
37	75.42	77.09				1.67	-	-	1.67
38	97.09	96.48	96.53	96.66	96.62	**-0.61**	0.05	**-0.04**	**-0.59**
39	97.57	97.07	97.19	97.27	97.31	**-0.50**	0.12	0.04	**-0.34**
40	93.90	93.43	93.42	93.50	93.54	**-0.47**	**-0.01**	0.04	**-0.43**
45		95.31	95.25	95.34	95.46	-	**-0.06**	0.12	0.07
46		96.70	96.72	96.84	96.88	-	0.02	0.04	0.06
47		89.87	89.91	89.99	90.07	-	0.04	0.08	0.11
48		87.30	87.32	87.42	87.45	-	0.02	0.03	0.05
CP53					107.83	-	-	-	-

Notes:

1. Bolded values indicate a loss in elevation data between time period.
2. Shaded values indicate elevation loss greater than 0.85 feet, which is -1 standard deviation from the mean of the total elevation difference.

Mean =	-0.42	feet
Standard Deviation =	0.43	feet

3. Geomembrane covers installed in 1993 (over Trench 13 and 14) and 1995 (remaining trenches, except Trench 9). Detention basins were constructed in fall 1995. Prior to this time, storm water discharged over the northern slope as sheet flow.
4. Survey procedures changed in 2000 to survey from the upgradient side of the monitoring stake rather than the downgradient side.
5. Blank cells indicate a measurement was not collected for this location.

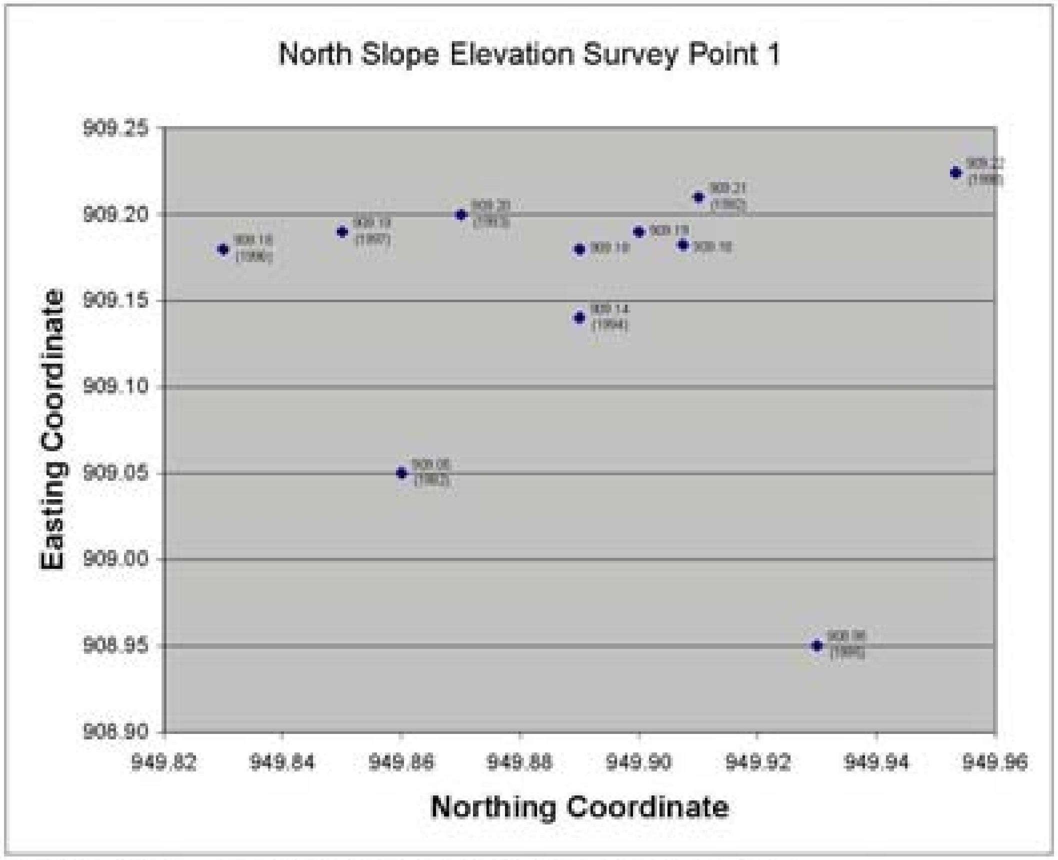
Table A-3 Evaluation of Survey Coordinate Data for Select Survey Point Locations Along the North Slope, 1982 through 1999

North Slope Elevation Survey Point 1

Point	Year	Northing	Easting	Elevation (ft AMSL)	'95 - '82 Elev Diff	'95 - '99 Elev Diff
1	Survey procedures modified starting in 2000. In addition, survey data was collected inconsistently between the years 2000 to 2008. Therefore this data is not included in this evaluation					
	1999	949.91	909.18	77.79		0.14
	1998	949.95	909.22	77.73		
	1997	949.90	909.19	77.86		
	1996	949.89	909.18	77.87		
	1995	949.93	908.96	77.65	-0.20	
	1994	949.89	909.14	77.67		
	1993	949.87	909.20	77.80		
	1992	949.91	909.21	77.82		
	1991	949.85	909.19	77.83		
	1983	949.83	909.18	77.90		
	1982	949.86	909.05	77.85		

Note:

1. Bold line indicates completed installation of geomembrane covers (on all trenches, except Trench 9) and detention basins.



Point 1 Observation: Appears to be random scatter; no significant change in elevation noted

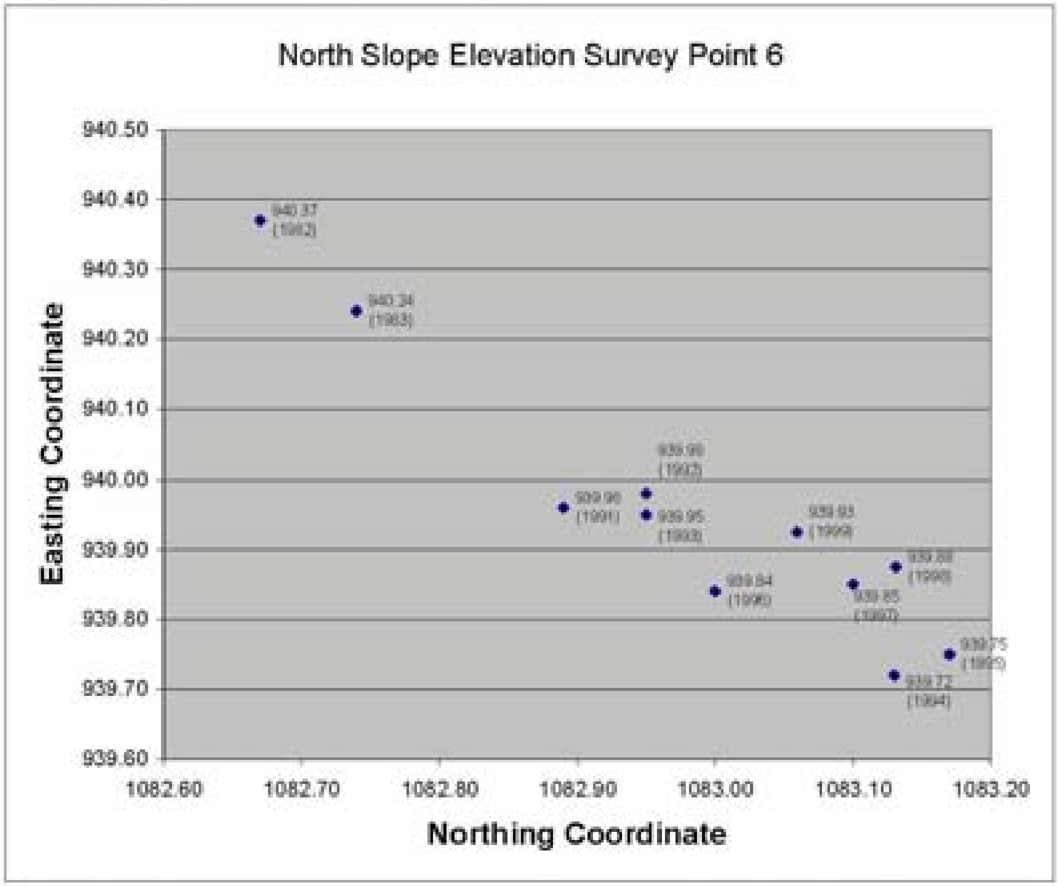
Table A-3 Evaluation of Survey Coordinate Data for Select Survey Point Locations Along the North Slope, 1982 through 1999

North Slope Elevation Survey Point 6

Point	Year	Northing	Easting	Elevation (ft AMSL)	'95 - '82 Elev Diff	'95 - '99 Elev Diff
6	Survey procedures modified starting in 2000. In addition, survey data was collected inconsistently between the years 2000 to 2008. Therefore this data is not included in this evaluation					
	1999	1083.06	939.93	88.15		-0.36
	1998	1083.13	939.88	88.14		
	1997	1083.10	939.85	88.22		
	1996	1083.00	939.84	88.24		
	1995	1083.17	939.75	88.51	-0.40	
	1994	1083.13	939.72	88.06		
	1993	1082.95	939.95	88.33		
	1992	1082.95	939.98	88.37		
	1991	1082.89	939.96	88.36		
	1983	1082.74	940.24	88.84		
	1982	1082.67	940.37	88.91		

Note:

1. Bold line indicates completed installation of geomembrane covers (on all trenches, except Trench 9) and detention basins.



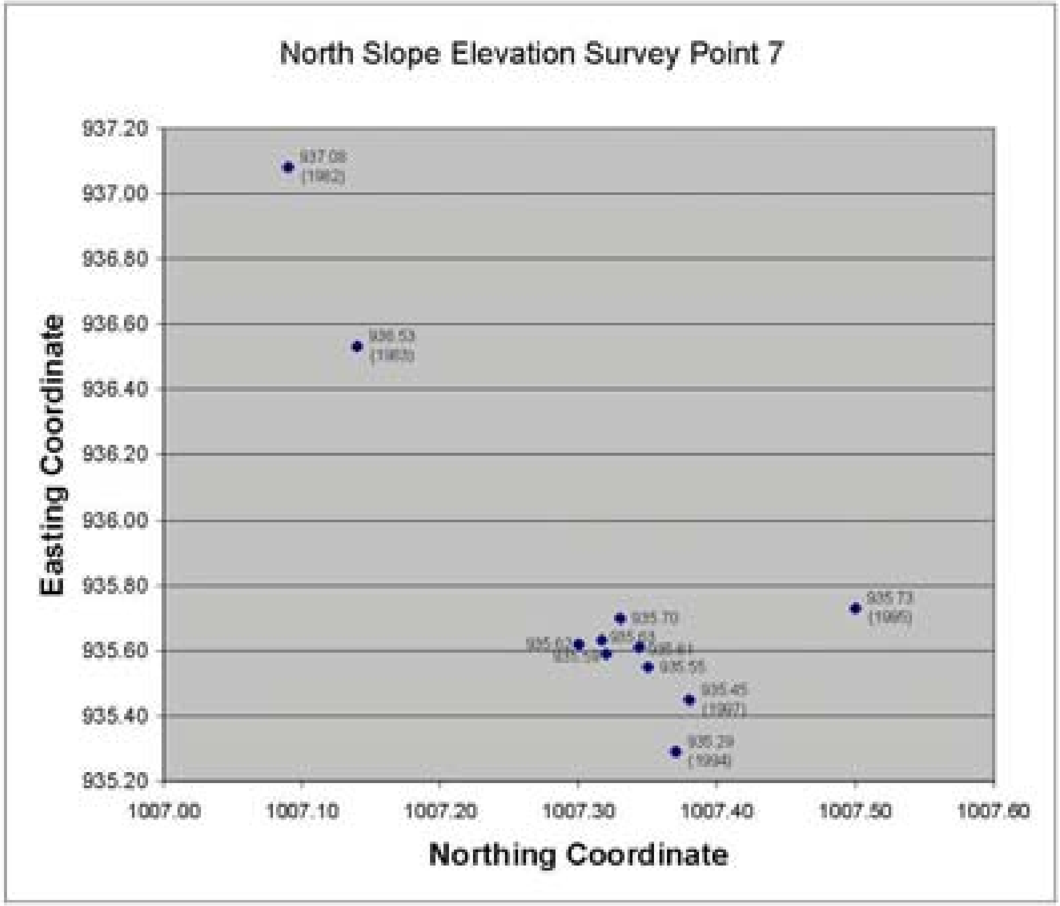
Point 6 Observation: Appears both northing and easting coordinates decreasing as time goes on indicating the monitoring point is moving down slope.

North Slope Elevation Survey Point 7

Point	Year	Northing	Easting	Elevation (ft AMSL)	'95 - '82 Elev Diff	'95 - '99 Elev Diff
7	Survey procedures modified starting in 2000. In addition, survey data was collected inconsistently between the years 2000 to 2008. Therefore this data is not included in this evaluation					
	1999	1007.32	935.63	80.44		0.13
	1998	1007.34	935.61	80.45		
	1997	1007.38	935.45	80.46		
	1996	1007.36	935.55	80.50		
	1995	1007.50	935.73	80.31	-0.96	
	1994	1007.37	935.29	80.24		
	1993	1007.32	935.59	80.43		
	1992	1007.30	935.62	80.48		
	1991	1007.33	935.70	80.45		
	1983	1007.14	936.53	81.03		
	1982	1007.09	937.08	81.27		

Note:

1. Bold line indicates completed installation of geomembrane covers (on all trenches, except Trench 9) and detention basins.



Point 7 Observation:	Appears both northing and easting coordinates decreasing as time goes on indicating the monitoring point is moving down slope. However, appears to have subsided in recent years.

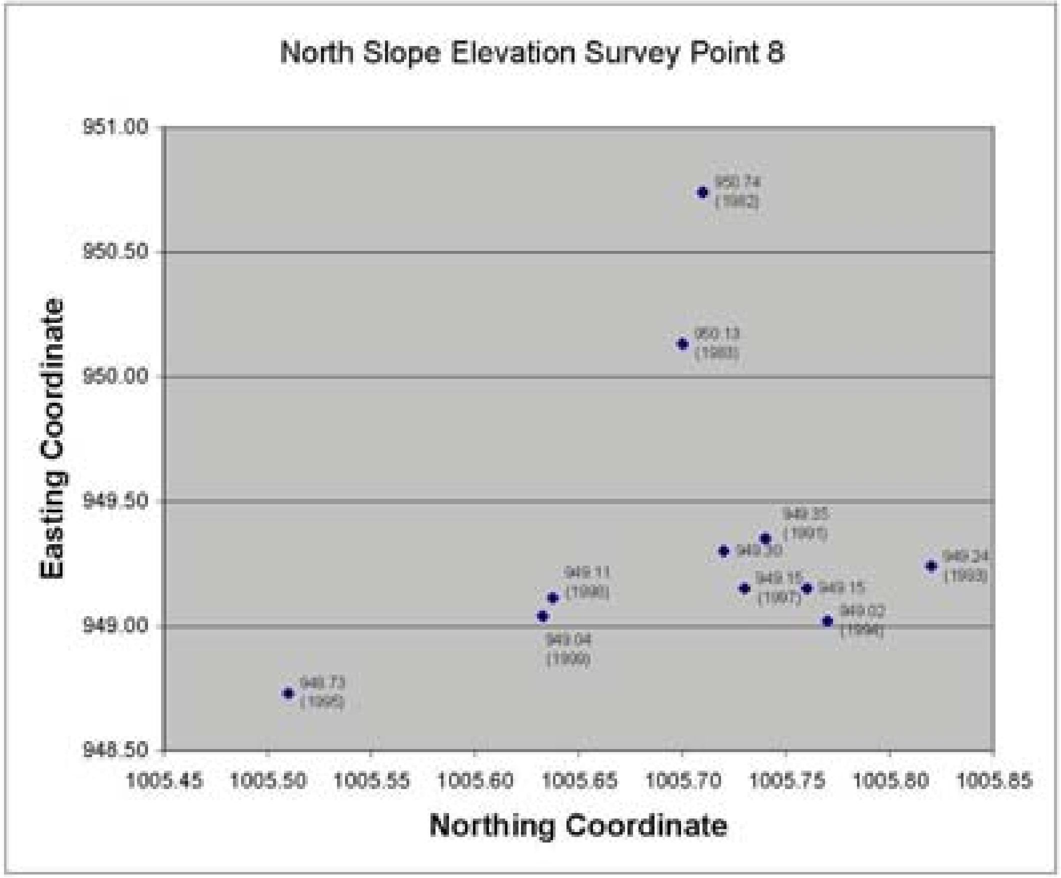
Table A-3 Evaluation of Survey Coordinate Data for Select Survey Point Locations Along the North Slope, 1982 through 1999

North Slope Elevation Survey Point 8

Point	Year	Northing	Easting	Elevation (ft AMSL)	'95 - '82 Elev Diff	'95 - '99 Elev Diff
8	Survey procedures modified starting in 2000. In addition, survey data was collected inconsistently between the years 2000 to 2008. Therefore this data is not included in this evaluation					
	1999	1005.63	949.04	88.60		0.00
	1998	1005.64	949.11	88.63		
	1997	1005.73	949.15	88.71		
	1996	1005.76	949.15	88.73		
	1995	1005.51	948.73	88.60	-0.95	
	1994	1005.77	949.02	88.57		
	1993	1005.82	949.24	88.74		
	1992	1005.72	949.30	88.74		
	1991	1005.74	949.35	88.83		
	1983	1005.70	950.13	89.43		
	1982	1005.71	950.74	89.55		

Note:

1. Bold line indicates completed installation of geomembrane covers (on all trenches, except Trench 9) and detention basins.



Point 8 Observation: Appears both northing and easting coordinates decreasing between 1982 and 1991indicating the monitoring point is moving down slope. However, since 1991 the randomness of the data indicates this downslope movement has subsided.

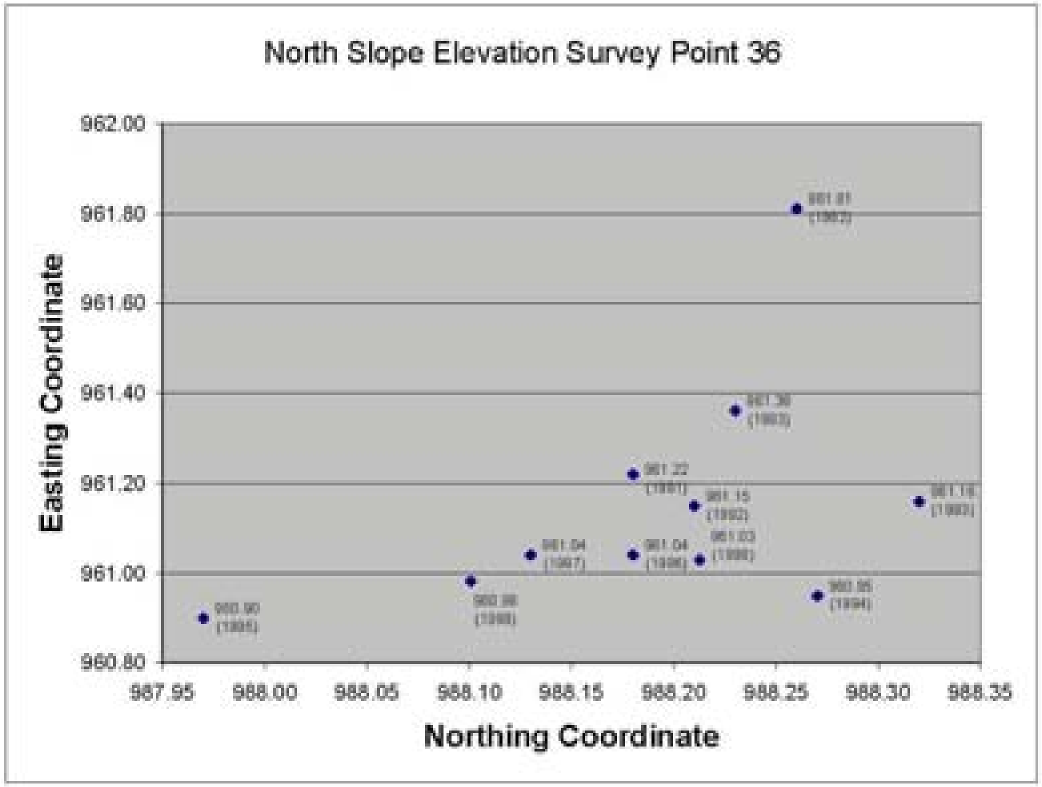
Table A-3 Evaluation of Survey Coordinate Data for Select Survey Point Locations Along the North Slope, 1982 through 1999

North Slope Elevation Survey Point 36

Point	Year	Northing	Easting	Elevation (ft AMSL)	'95 - '82 Elev Diff	'95 - '99 Elev Diff
36	Survey procedures modified starting in 2000. In addition, survey data was collected inconsistently between the years 2000 to 2008. Therefore this data is not included in this evaluation					
	1999	988.10	960.98	95.02		-0.06
	1998	988.21	961.03	95.06		
	1997	988.13	961.04	95.13		
	1996	988.18	961.04	95.16		
	1995	987.97	960.90	95.08	-0.76	
	1994	988.27	960.95	94.97		
	1993	988.32	961.16	95.17		
	1992	988.21	961.15	95.14		
	1991	988.18	961.22	95.22		
	1983	988.23	961.36	95.59		
	1982	988.26	961.81	95.84		

Note:

1. Bold line indicates completed installation of geomembrane covers (on all trenches, except Trench 9) and detention basins.



Point 36 Observation: Appears to be random scatter. However, data pattern is more similar to points with greater elevation loss, such as Point 8, rather than those with no significant elevation change such as Point 1.

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B Evaluation of Slope Stability Analysis at the SDA

The company AquAeTer conducted the modeling and an Independent Expert Review Team (IERT) performed an evaluation of the slope stability at the SDA as part of the Quantitative Risk Assessment (QRA) on the State-Licensed Radioactive Waste Disposal Area (Garrick et al., 2009). The purpose of the QRA was to assess the radiation risk to the public by means of probabilistic analyses. Analyses were conducted to evaluate the stability of the slopes at the North End of the SDA site along Erdman Brook and at the East side of the site along Frank's Creek. The scope of the analyses included potential slope failures that may be caused by seismic events and potential landslides that may occur due to other natural processes.

The modeling results for the best estimate of site conditions were considered by the IERT sufficient for the purpose of evaluating the slopes. The IERT stated that they "expect values measured in the past decades to be about the same in the next 30 years for geometry of slopes, geologic layers, unit weights, friction angles, cohesion, pore pressure and water levels. The exceptions are human or gully modification of slopes, seismic additions of forces, and effects of soil-fracture growth from dewatering" (6-57 QRA).

B.1 Slope Stability Model

The North Slope, the North End of the East Slope and the South End of the East Slope was modeled with the computer program WinSTABL, version 2.4. WinSTABL is a graphical user interface for the STABL slope stability program. STABL uses the method of slices and an adaption of the simplified Bishop Method to find the factor of safety against slope failure. A factor of safety less than one indicates the slope is unstable, while a factor of safety equal to or greater than one indicates stability.

The soil was divided into different layers, including cover soil, weathered till, waste, and unweathered till, and assigned probabilities that would represent the site characteristics for that level. Probabilities were assigned for high, nominal, and low soil strength conditions and high, middle, and low groundwater levels. Groundwater levels correlated to trench water levels. For each of the three slopes, WinSTABL evaluated 200 "code generated" surfaces as potential slip surfaces. WinSTABL identified the ten most limiting critical potential slip surfaces and computed their corresponding factors of safety (FS) to evaluate whether they would fail under the nine probabilistically weighted site conditions (combinations of soil strength and groundwater level) summarized in the QRA (Garrick et al 2009).

B.2 Non-Seismic Induced Slope Failures

The FS for nominal soil strength conditions, with no seismic accelerations, are above 2.00, which indicate slope stability. Additionally, no slip-circles generated intersected with the trenches.

The nominal soil strength parameters were based on those used in a previous slope stability evaluation (Aloysius et al 1992) for the SDA, which stated that a "friction angle of 27° with a cohesion intercept of 500 pounds per square foot (psf) are conservative engineering soil property values for the slope subsoils at the site". The nominal cohesive strength for weathered till in the QRA was estimated more conservatively at 250 lb/ft2.

The modeling results found FS for low soil strength conditions to be greater than 1.00 and have no intersection with the trenches. The lowest FS occurred in conditions of high groundwater level and had values of 1.19 for the North Slope, 1.03 for the North End of the East Slope, and 1.18 for the South End of the East Slope. For the low soil strength parameters in the QRA, the weathered till was assigned a friction angle of 20° and a cohesive strength of 100 lb/ft2. The low cohesive strength values assigned in the QRA could be considered low for any soil and are considered so as to determine the likelihood of slope failure under even unlikely conditions. There are no soil measurements that indicate that these values have been observed on the site.

B.3 Seismic Induced Slope Failures

In the case of a slope failure due to seismic causes, five different horizontal peak ground accelerations were considered as seismic load input ranging from 0.25 g to 1.0 g. Accelerations below 0.25 g were shown through a preliminary analysis to have a low likelihood of significant slope failure and were not modeled. The mean fraction of damaging slope failures increases significantly from 0.35 g to 0.50 g, while it increases at a decreasing rate from 0.50 g to 1.0 g. From this it was inferred that the extent of damage for accelerations above 1.0 g would not increase significantly.

The slope stability analysis made no attempt to analyze the likelihood of seismic hazards. The Interactive National Seismic Hazard Maps on seismic hazards in the West Valley Area (USGS 2008) suggests that the peak horizontal accelerations with a 10% and 2% probability of occurrence in 50 years are 0.02 g and 0.06 g, respectively. The horizontal accelerations with 1-second and 0.2-second durations and a 2% probability of occurrence in 50 years are 0.04 g and 0.12 g, respectively. The horizontal seismic acceleration presented here with the shortest duration, least likelihood and greatest magnitude of 0.12 g, was still less than the 0.25 g acceleration first considered in the QRA to possibly cause slope failure.

B.4 References

Aloysius, D. L. and A. J. Nello, "Stability Evaluations of Slopes Adjoining the New York State-Licensed Disposal Area (SDA) Western New York Nuclear Service Center (WNYNSC) West Valley, New York," Document #SLK0215:SEA-178, 1992.

Garrick, J. B., Stetkar, J. W., Dykes, A. A., Potter, T.E., and Wampler, S. L., 2009. Quantitative Risk Assessment of the State-Licensed Radioactive Waste Disposal Area. Prepared for New York State Energy Research and Development Authority.

United States Geological Survey (USGS). 2008 United States National Seismic Hazard Maps. Last modified May 13, 2008. http://gldims.cr.usgs.gov/nshmp2008/viewer.htm

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C Model of Trench Leachate Contaminant Fate and Transport

C.1 Introduction

In support of the CMS, E & E developed a one-dimensional leachate contaminant fate and transport model to evaluate whether the chemical contaminants in trench leachate would ever be transported to groundwater at the SDA site boundary at concentrations exceeding groundwater standards.

The geology underlying the SDA site is composed of the approximately 90-foot thick Lavery Till, underlain by a 20- to 30-foot Lacustrine unit. The upper 15 feet of the Lavery till is weathered and cracked and is known as the weathered Lavery Till. Beneath the weathered Lavery Till is the unweathered Lavery Till, a highly impermeable layer, which presents a substantial barrier to downward migration of groundwater.

Because the leachate levels in the SDA trenches are all well below the weathered/ unweathered Lavery Till interface and are generally 10 feet below groundwater levels surrounding the SDA, lateral flow through the weathered till is no longer a concern. The installation and maintenance of infiltration controls has prevented leachate levels from rising, and are successfully preventing the lateral migration of leachate from the trenches.

With effective infiltration controls in place, the slow vertical migration of leachate through the bottom of the trenches into the unweathered Lavery Till is the primary groundwater contamination pathway. The site conceptual model indicates that groundwater flow beneath the SDA is directly downward through the highly impermeable unweathered Lavery Till, and horizontally through the underlying, more permeable Lacustrine unit (WVNS 1993a).

Organic contaminants are known to attenuate with distance from a source as a result of natural processes. Natural attenuation processes include biodegradation of contaminants by native bacteria, and adsorption of contaminants to subsurface soils. Adsorption to soils slows or retards the rate at which contaminants migrate. Biodegradation and this retardation effect of adsorption function together to reduce the mass and concentration of contaminants with increased distance from the source. Because the SDA trenches are underlain by a 75-to-100-foot-thick low permeability clay till layer, groundwater percolates downward very slowly at a rate of several centimeters per year (WVNS 1993a), thus providing additional time for contaminant concentrations to be reduced through biodegradation and radioactive decay.

This groundwater fate and transport model was used to:

- Provide a conservative estimate of the expected peak concentrations at the bottom of the clay layer (Lavery Till);
- Determine the time at which peak concentrations are expected to arrive at the bottom of the clay layer; and
- Predict peak contaminant concentrations in the deeper Lacustrine unit.

C.2 Evaluation Criteria

Using the above approach, predicted peak groundwater concentrations were evaluated by comparison with New York State (NYS) Class GA Groundwater Standards (June 1998). Comparisons were performed at two locations:

- At the base of the unweathered Lavery Till, directly underneath the trenches.
- In the Lacustrine unit, directly underneath the trenches, assuming mixing throughout its depth (i.e., as if in a well screened throughout the depth of the Lacustrine unit).

Model results were also evaluated based on the time at which contaminant concentrations would reach their peak, or contaminant concentrations would exceed groundwater standards. Arrival times were determined to be useful in evaluating the need for leachate removal and treatment, as well as monitoring, on an immediate or long-term basis.

C.3 Modeling Approach

Due to the strong groundwater flow gradient in the vertical direction through the unweathered Lavery Till, a model of contaminant fate and transport in a uniform unidirectional flow field was used (Codell and Schreiber 1977). The model is based on a single equation describing advection, dispersion, biodegradation/radioactive decay, and adsorption. Codell and Schreiber (1977) present an analytical solution to the equation for the case for a finite contaminant source spread over a rectangular area perpendicular to the groundwater flow direction (see Figure C-1 for schematic representation):

$$C_i = \frac{1}{n_e a} X_1(x,t) \cdot Y_2(x,t) \cdot Z_2$$

where:

C_i = the concentration at a point (x,y,z) in space for an instantaneous release of one unit of mass or radioactivity
n_e = soil effective porosity

a = retardation factor
x = distance from center of contaminant source, in direction of groundwater flow
y = distance from center of contaminant source, in direction perpendicular to groundwater flow

and:

$$X_1 = \frac{1}{\sqrt{4\pi \frac{D_x t}{a}}} \exp\left(-\frac{(x - \frac{ut}{a})^2}{4D_x \frac{t}{a}} - \lambda t\right)$$

$$Y_2 = \frac{1}{2b}\left(erf\frac{(\frac{b}{2} + y)}{\sqrt{4D_y \frac{t}{a}}} + erf\frac{(\frac{b}{2} - y)}{\sqrt{4D_y \frac{t}{a}}}\right)$$

$$Z_2 = \frac{1}{h}$$

where:
D_x = dispersion coefficient, in direction of groundwater flow
D_y = dispersion coefficient, in direction perpendicular to groundwater flow
t = time
u = groundwater velocity
λ = biodegradation rate constant or radioactive decay constant
b = length of source perpendicular to groundwater flow direction
h = width of source perpendicular to groundwater flow direction
erf = error function

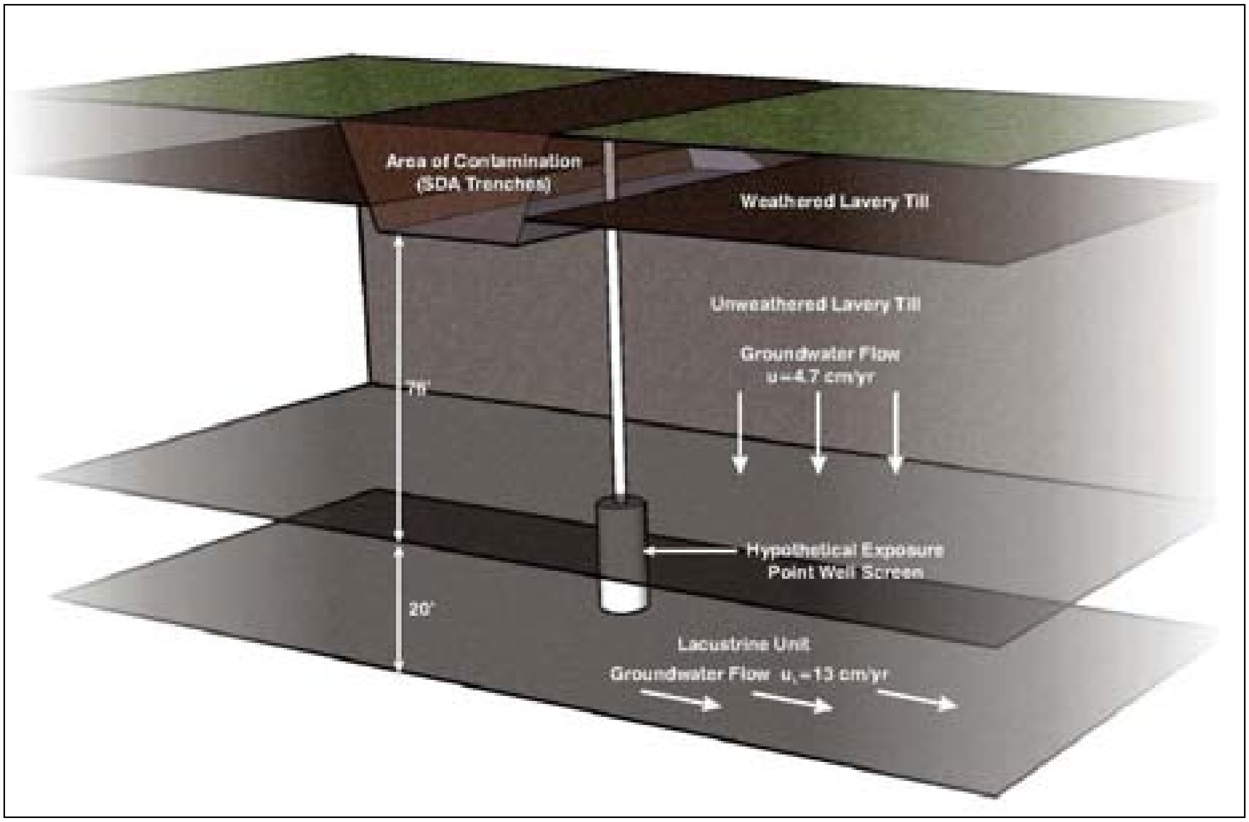

Figure C-1 Schematic Representation of Groundwater Modeling Scenario

The retardation factor (a) is calculated as follows:

$$a = 1 + \frac{p_b}{n} K_d$$

where:

p_b = soil bulk density
n = soil total porosity
K_d = soil/water partitioning coefficient

Diffusion coefficients are calculated as follows:

$$D_x = \alpha_x u$$

$$D_y = \alpha_y u$$

where:

α_x dispersivity in the x direction
α_y dispersivity in the y direction

Groundwater velocity was determined from the following relationship:

$$u = \frac{k_x i}{n_e}$$

where:

k_x hydraulic conductivity in the direction of groundwater flow
i hydraulic gradient

For this modeling study, K_d was determined from the following two equations presented by Piwoni and Keeley (1990).

$$K_d = foc \cdot K_{oc}$$

where:

K_{oc} organic carbon/water partitioning coefficient
foc soil fraction organic carbon

A screening level estimate of K_{oc} can be found through the following equation.

$$Log(K_{oc}) = 0.69 Log(K_{ow}) + 0.22$$

where:

K_{ow} octanol-water partitioning coefficient

The initial mass of each contaminant is calculated through the following equation:

$$M = C_l \cdot V_l + C_l \cdot \frac{V_l}{n_{trench}} \cdot \rho_b \cdot K_d$$

Where:

C_l initial concentration of contaminant in leachate
V_l initial volume of trench leachate
n_{trench} porosity of trench contents

The above model was used to simulate the trench leachate chemical contaminants, as listed in the CMS work plan (E & E 2006), for which partitioning coefficient and biodegradation rate data were readily available. Tritium was added to the contaminant list as it is the most abundant and mobile of the radioactive constituents. Fate and transport of tritium and other radioactive contaminants at the SDA have previously been modeled (Prudic 1986). Potential impacts from longer-lived radionuclides at the SDA will be addressed in future environmental assessment and/or radiological performance assessment analyses for the SDA. The model was used to predict contaminant concentrations at the bottom of the Lavery Till layer (directly underneath the center of the source) over time.

A conservative estimate of peak contaminant concentrations in the Lacustrine unit was developed using the following methodology. The mass flux of contaminants entering the Lacustrine unit from the Lavery Till is conservatively estimated as the peak concentration at the base of the Lavery Till (directly beneath the center of the trench bottom) times the trench bottom area and the vertical groundwater flow rate. Using a simple mass balance equation, this mass is diluted with additional clean water flowing through the Lacustrine unit. The result is predicted peak contaminant concentrations, as if measured in a well placed directly beneath the trenches, and screened throughout the Lacustrine unit.

$$C_L = C_T\left(\frac{Q_T}{Q_T + Q_L}\right)$$

Where:
CL = concentration in the Lacustrine unit
CT = concentration at the base of the Lavery Till
QT = groundwater flow rate exiting the bottom of the Lavery Till through an area equivalent to and directly beneath the trenches
QL = groundwater flow rate in the Lacustrine unit through a cross-section defined by the trench width lateral to flow, times the depth of the Lacustrine unit

Groundwater flow rates are calculated with the following equations:

$$Q_T = b \cdot h \cdot u$$
$$Q_L = d_{L.} \cdot b_L \cdot u_L$$

where:
dL = depth of flow in the Lacustrine unit
bL = width of source area lateral to groundwater flow in the Lacustrine unit
uL = velocity of groundwater in the Lacustrine unit

The model was implemented in a spreadsheet such that a set of ten time periods could be simulated at once. Different sets of time periods were simulated in an iterative fashion until a peak concentration for each contaminant was identified.

Model input parameter values were derived from reports and scientific articles regarding the SDA and the WNYNSC area, as well as the general scientific literature. The following parameters could be estimated based on SDA-specific literature:

- Fraction organic carbon;
- Soil bulk density;
- Soil total porosity;
- Soil effective porosity;
- Hydraulic conductivity;
- Hydraulic gradient, vertical; and
- Diffusivities and dispersion coefficients.

Ranges of biodegradation rates for anaerobic degradation, which would be more conservative than aerobic degradation rates, and log Octanol-water partitioning coefficients, were taken from the general scientific literature. Table C-1 includes all contaminant compounds listed in the CMS work plan, as well as the concentrations, biodegradation rates, and partitioning coefficients used in the model. The radioactive decay rate of tritium is readily available in the scientific literature.

The model was run with model parameter values derived as described above and as shown in Table C-2. The model was not calibrated due to the lack of data on contaminant concentrations below the trench bottoms.

The following conservative assumptions were used for the modeling input parameters:

- Leachate contaminant concentrations were selected from the maximum of the range of concentrations for all trenches reported in site documentation, including the CMS work plan (E & E 2006).
- Initial trench leachate volume was estimated as the current leachate volume as estimated for fourth quarter 2005 (Attridge 2007) plus an estimate of the volume of leachate that has percolated through trench bottoms since initial waste burial. The volume of historical leachate percolation was calculated as the average leachate loss rate, times the number of years since waste placement, times the average leachate generation rate (based on leachate elevation and pumping data as presented in Pacific Nuclear 1992).
- Biodegradation rates were estimated using the low end of the range (high end of half-life range) reported in the literature (Howard et al. 1991). The range of rates typically includes both aerobic as well as anaerobic degradation, where anaerobic rates are typically significantly lower. Dissolved oxygen (DO) sampled between May 2007 and December 2008 in both shallow and intermediate wells, show a range of concentrations of 0.7 to 9.1 milligrams per liter (mg/L) and mean of 3.0 mg/L. Thus, DO levels consistently indicate the presence of oxygen and generally indicate conditions supportive of aerobic biodegradation. Because the groundwater fate and transport modeling assumes the low end of the range of biodegradation rates, and those typically associated with anaerobic conditions, the presence of aerobic conditions indicates the modeling analysis is conservative. That is, actual biodegradation rates would be expected to be initially higher than those modeled. Once the available oxygen was depleted, additional biodegradation could occur under anaerobic conditions. Evidence that biodegradation is actively occurring in the trench leachate was provided in the *West Valley Trench Gas Evaluation Final Report* (E & E 1995) as follows:
- Significant quantities of bacteria (aerobes, anaerobes, denitrifiers, sulfate-reducers, and methanogens) were numerated in leachate samples collected in both 1978 and 1989. Bacteria were numerated through both direct counts and plate count assays.

- Bacteria isolated from LLRW trench leachate have shown resistance to radioactivity up to 2.7E07 picocuries per liter (pCi/L) due to ^{60}Co, ^{85}Sr, and ^{134,137}Cs (Francis et al. 1980) while SDA trench leachate have a much lower total radioactivity due to these compounds of less than 1E04 pCi/L (E & E 1994).

- Water quality parameters measured in SDA groundwater monitoring wells (1100 series) indicate water quality that would be supportive of biodegradation. The pH has been measured in surrounding groundwater in the 6.5 to 7.8 range, which is similar to the range conducive to biodegradation and similar to the pH of trench leachate (7.2 to 7.6 in E & E 1995). Sulfate has been detected in surrounding groundwater, which would support the growth of sulfate reducing bacteria found in significant quantities in trench leachate.

- Oxidation-reduction potential (ORP) data collected in SDA monitoring wells provides additional insight into the biodegradation potential of site groundwater. ORP data for both shallow and intermediate wells, collected between May 2007 and December 2008, show a mean of 152 mV and a range of -3 mV to 285 mV, well within the general range of groundwater ORP values of -400 to +800 mV (Wiedemeier et al. 1999). ORP is defined as the electric potential required to transfer electrons from an electron donor compound to an electron acceptor compound. Microorganisms, such as bacteria, obtain energy for growth by transferring electrons from an electron donor to an electron acceptor (NAVFAC 2009). As electron acceptors and nutrients are depleted by microbial activity during biodegradation of contaminants, the ORP of groundwater decreases. This results in a succession of bacterial consortia adapted to specific oxidation-reduction regimes and electron acceptors. As each geochemical species that can be used to oxidize chemical contaminants is exhausted, the micro-organisms are forced to use electron acceptors with a lower oxidizing capacity (Wiedemeier et al. 1999). Some biodegradation reactions occur preferentially at various ORP levels. For example, reductive dechlorination tends to be more efficient in a more reducing environment, i.e. at lower ORP levels (Nielsen 2005). Thus, as groundwater ORP levels beneath the SDA are reduced in response to intrusion of trench leachate, and degradation of leachate compounds, a range of ORP values will result along the leachate plume creating conditions to degrade a range of various site contaminants.

- Soil partitioning coefficients (K_d) were estimated using octanol-water partitioning coefficients (K_{ow}) from the literature (Dragun 1998). K_{ow} values were not available for all contaminants listed in the CMS. However, a wide range of K_{ow} values are represented by those with known values, from a minimum of 0.38 milliliters per gram for 1, 4 dioxane (highly mobile) to 100,000 mL/g for pentachlorophenol (highly immobile).

- Hydraulic conductivity was estimated at the high end of the range of reported values from the site literature (Prudic 1986). This is a conservative assumption because higher hydraulic conductivity means a higher groundwater velocity, and thus quicker arrival of contaminants.

- Dispersivity was estimated such that the dispersion coefficient (equal to dispersivity times groundwater velocity) was equal to the diffusion coefficient for tritium as reported in the literature (Prudic 1986). At low velocities, such as those seen at the SDA, the primary component of dispersion is diffusion. Also, because dispersion is the sum of mechanical dispersion and molecular diffusion, and dispersion spreads out contaminants as they migrate thus reducing their maximum concentrations, use of a low dispersion coefficient is a conservative assumption.

- Location of predicted contaminant concentrations was selected as the bottom of the clay layer, directly underneath the center of the contaminant source. This will result in the maximum contaminant concentration beneath the source, and thus is conservative, because contaminant concentrations will decrease with distance from the source center.

C.4 Modeling Results

Model predictions for contaminant concentrations at the bottom of the clay layer show the highest peak concentration was for chloroform at 5.4E-26 micrograms per liter (µg/L), occurring at 260 years from the start of trench leachate percolation. The lowest peak concentration is for 2-butanone at 4.3E-218 µg/L occurring at 14 years from the start of trench leachate percolation. Model results for the full contaminant list from the CMS work plan are presented in Table C-3. These concentrations are many orders of magnitude lower than current detection limits, which are on the order of 1.0E-03 µg/L or part per trillion (ppt) levels, and represent contaminant concentrations of essentially zero. Predicted peak concentration arrival times range from 13 years for acetone to 500 years for 2, 4, 6-trichlorophenol.

A bounding test was performed to evaluate the influence of biodegradation on peak concentrations and arrival times at the bottom of the Lavery Till. The same model was run, as described above but with biodegradation rates of zero replacing the original literature-reported low biodegradation rates. To determine the amount of time it would take to reach groundwater standards, different sets of time periods were simulated in an iterative fashion until the model results showed concentrations at the groundwater standards. Model results indicated that the highest peak concentration would be for 1, 4 dioxane at 6.4E04 µg/L occurring roughly 500 years from initiation of trench leachate migration. The lowest predicted peak concentration was for tetrachloroethylene at 1.8 µg/L occurring roughly 5,000 years after initial leachate migration. Thus, if biodegradation did not occur, the resulting peak concentrations would exceed allowable groundwater standards for most site contaminants. With no biodegradation, concentrations would not exceed allowable groundwater standards for a minimum of 250 years from today for acetone (290 years from initial trench leachate migration), and up to thousands of years for other compounds.

It should be noted that the model calculates the concentration of contaminants as they enter the more permeable Lacustrine unit underlying the Lavery Till layer, rather than the concentrations that would be seen in groundwater pumped from the Lacustrine unit. The actual groundwater concentrations would be somewhat lower because since the Lacustrine unit contributes upgradient groundwater flow. Thus a groundwater well screened over the depth of the Lacustrine unit would intercept clean water traveling horizontally from upgradient as well as contaminated water percolating downward. This dilution factor is estimated to cause only a slight reduction in concentrations to approximately 99% of the percolating concentrations presented above.

C.5 Conclusions

A groundwater contaminant fate and transport modeling study was performed to evaluate whether the existing pattern of slow trench leachate percolation is expected to result in an eventual exceedance of regulatory groundwater standards at the site boundary.

Key results of this fate and transport model include:

- With biodegradation occurring at conservative (low) rates, no site contaminants are expected to reach the bottom of the clay layer at measurable concentrations at any time.
- Without biodegradation, and/or chemical decomposition, concentrations of many site contaminants would be expected to exceed allowable concentrations, but not for hundreds of years (which is well beyond the 30-year evaluation period of this study).

Trench leachate bacterial enumeration, and background groundwater monitoring data, indicates that conditions are conducive to biodegradation both in the SDA trenches as well as in the underlying groundwater.

Table C-1 Trench Leachate Contaminants: Concentrations, Partitioning Coefficients, and Biodegradation Rates

Chemical Constituent	Concentration Range (µg/L)	Maximum Concentration (µg/L)	Log Octanol-Water Partitioning Coefficient Log(mL/g)	Biodegradation Rate Constant or Radioactive Decay Constant (λ) (yr^{-1})
Acetone	<50 - 7,700	7,700	-0.24	1.81E+01
Acetonitrile	3200	3,200	-0.34	7.03E-01
Benzene	<5 - 2,500	2,500	2.13	3.51E-01
2-Butanone [Methyl ethyl ketone]	<100 -3,300	3,300	0.69	1.81E+01
Carbon disulfide	<5 - 680	680	NA	NA
Chlorobenzene	<1 - 660	660	2.81	8.43E-01
Chloroethane	3 - 900	900	1.54	4.52E+00
Chloroform	5 - 1,000	1,000	1.97	1.41E-01
2-Chlorophenol [o-Chlorophenol]	<1 - 16,000	16,000	2.15	NA
o-Cresol [2-Methylphenol; o-Methylphenol]	<1 - 2,700	2,700	1.95	1.81E+01
Cresol, m and p isomers [3- and 4-Methylphenol]	<1 - 5,400	5,400	1.96	5.16E+00
1,1-Dichloroethane	<5 - 2,000	2,000	1.79	7.03E-01
1,2-Dichloroethane	<5 - 630	630	1.48	7.03E-01
trans-1,2-Dichloroethylene	<5 - 29	29	NA	8.80E-02
2,4-Dichlorophenol	<1 - 8,100	8,100	NA	5.88E+00
2,4-Dimethylphenol	<1 - 280	280	2.34	1.81E+01
1,4-Dioxane	1400000	1,400,000	-0.42	7.03E-01
Ethylbenzene	<5 - 1,100	1,100	3.15	1.11E+00
bis(2-Ethylhexyl)phthalate	<1 - 860	860	NA	6.50E-01
Methylene chloride [dichloromethane]	<5 - 18,000	18,000	1.25	4.52E+00
4-Methyl-2-pentanone [Methyl isobutyl ketone]	<36 - 550	550	NA	1.81E+01
Naphthalene	14 - 680	680	3.01	9.81E-01
Pentachlorophenol	<2 - 1,000	1,000	5.01	2.51E+01
Polychlorinated biphenyls	<0.5 - 82	82	NA	NA
Phenol	30 - 4,100	4,100	1.46	3.61E+01
Styrene	<5 - 77	77	NA	1.20E+00
Tetrachloroethylene	<2 - 28	28	2.88	3.51E-01
Toluene	256 - 98,000	98,000	2.69	9.04E+00
1,1,1-Trichloroethane	<5 - 350	350	NA	4.63E-01
Trichloroethylene	<5 - 44	44	2.29	1.53E-01
Trichlorofluoromethane	<1 - 3,100	3,100	2.53	3.51E-01
2,4,6-Trichlorophenol	1 - 1,600	1,600	3.62	1.39E-01
Vinyl acetate	<10 - 370	370	NA	NA
Xylenes (total)	40 – 20,000	20,000	3.20	7.03E-01
Tritium (pCi/L)	2.11 E05 – 1E10	NA	-999.00	5.64E -02

Key:
µg/L = Micrograms per liter.
NA = Not applicable.
yr = Year.
pCi/L = Picocuries per liter.
(λ) (yr^{-1}) = degradation rate (1/year)

Table C-2 Derivation of Model Input Parameter Values

Model Parameter	Value	Rationale and Source
Fraction organic carbon (foc) (unitless)	0.017	Average of values reported in Table 5-2, (WVNS 1993b)
Soil bulk density (p_b) (g/ cm^3)	1.59	From soil specific gravity (p_s) of 2.74 g/cm^3 from WVNS, 1993a Table 4-1; and equation $p_b = p_s(1-n)$
Total porosity (n) (unitless)	0.42	From Table 4-1, WVNS 1993a
Effective porosity (n_e) (unitless)	0.399	95% of total porosity (Lindeburg 2003)
Dispersivity, in flow direction (α_x) (cm)	100.2	Calculated such that dispersion coefficient matches typical diffusion coefficient, because diffusion dominates dispersion at the SDA site (Prudic 1986)
Dispersivity, lateral to flow (α_y) (cm)	100.2	Calculated such that dispersion coefficient matches typical diffusion coefficient, because diffusion dominates dispersion at the SDA site (Prudic 1986)
Hydraulic conductivity (k_x) (cm/s)	6.0E-08	High end of hydraulic conductivity range reported for unweathered till by Prudic (1986)
Hydraulic gradient (i) (ft/ft)	1.0	Vertical hydraulic gradient, reported in Dames and Moore 1995
Groundwater velocity (u) (cm/yr)	4.74	Calculated as $(k_x * i)/n_e$
Dispersion coefficient (D_x) (cm^2/yr)	475	Calculated as $\alpha_x * u$ (Freeze and Cherry 1979)
Dispersion coefficient (D_y) (cm^2/yr)	475	Calculated as $\alpha_y * u$ (Freeze and Cherry 1979)
Distance from source (x) (cm)	2316	Distance to top of lacustrine unit (aquifer) - 76 feet below bottom of trenches (E & E 1994) (x points in downward direction)
Lateral distance from source center (trench length direction) (y) (cm)	0	Center of source
Length of source (b) (cm)	40,200	1,320 feet - approximate length of SDA trench area (NYSERDA, 2006)
Width of source (h) (cm)	8,380	275 feet - approximate width of SDA trench area (NYSERDA, 2006)
Initial trench leachate volume (L)	1.0E+07	Estimated as current leachate volume (4.07E6, Attridge 2007) plus vertical gw velocity x time buried x leachate generation rate.
Time from waste placement to present (yr)	44	Wastes buried in trenches from November 1963 to March 1974 (E & E 1994), using 2007-1963 = 44 yrs.
Leachate generation rate (L/ cm)	28,800	Using average of leachate generation rates from Pacific Nuclear (1992), assuming Trench 1 same as Trench 2.
Porosity of trench contents (unitless)	0.28	Estimated from specific yield calculated from trench pumpout data, from Dames & Moore (1993) as reported in Dames & Moore (1995).
Depth of flow in Lacustrine unit (cm)	30	1 foot - average difference between monitored groundwater elevations (NYSERDA 2006) and lacustrine unit bottom elevations from well boring logs (Dames and Moore 1990).
Lateral extent of trenches perpendicular to groundwater flow (cm)	40,200	1,320 feet – determined using groundwater contours in Appendix B of NYSERDA (2006)
Groundwater velocity in Lacustrine unit (cm/yr)	13.1	Estimated in WVNS (1993a)

Table C-3 Model Predicted Peak Concentration and Arrival Times

	With Biodegradation/Decay			Without Biodegradation/Decay				
Chemical Constituent	Max Conc. at Till Base (µg/L)	Time[1] to Max Conc. at Till Base (yr)	Max. Conc. w/ Lacustrine Unit Dilution (µg/L)	Max Conc. at Till Base (µg/L)	Time[1] to Max Conc. at Till Base (yr)	Time[1] to GW Std. at Till Base (yr)	Max. Conc. w/ Lacustrine Unit Dilution (µg/L)	Groundwater Standard[2] (µg/L)
Acetone	1.3E-195	13	1.2E-195	3.5E+02	480	290	3.5E+02	50*
Acetonitrile	2.8E-33	64	2.8E-33	1.5E+02	480	No standard exists	1.4E+02	No standard exists
Benzene	6.7E-49	181	6.6E-49	1.5E+02	2,000	790	1.5E+02	1
2-Butanone [Methyl ethyl ketone]	4.3E-218	14	4.3E-218	1.6E+02	610	390	1.6E+02	50*
Carbon disulfide								60*
Chlorobenzene	3.6E-129	185	3.6E-129	4.2E+01	4,800	2,700	4.2E+01	5
Chloroethane	7.5E-140	37	7.4E-140	5.0E+01	1,000	560	5.0E+01	5
Chloroform	5.4E-26	260	5.4E-26	6.0E+01	1,600	890	5.9E+01	7
2-Chlorophenol [o-Chlorophenol]				9.8E+02	2,000	710	9.7E+02	1 (in Total Phenols)[3]
o-Cresol [2-Methylphenol; o-Methylphenol]	0.0E+00	NA	0.0E+00	1.6E+02	1,600	640	1.6E+02	1 (in Total Phenols)[3]
Cresol, m and p isomers [3- and 4-Methylphenol]	9.0E-186	43	8.9E-186	3.2E+02	1,600	620	3.2E+02	1 (in Total Phenols)[3]
1,1-Dichloroethane	2.1E-58	110	2.1E-58	1.2E+02	1,300	650	1.2E+02	5
1,2-Dichloroethane	3.6E-50	91	3.6E-50	3.5E+01	990	440	3.5E+01	0.6
trans-1,2-Dichloroethylene								5
2,4-Dichlorophenol								1 (in Total Phenols)[3]
2,4-Dimethylphenol	0.0E+00	NA	0.0E+00	1.7E+01	2,500	1,300	1.7E+01	1 (in Total Phenols)[3]
1,4-Dioxane	1.7E-30	64	1.7E-30	6.4E+04	500	No standard exists	6.3E+04	No standard exists
Ethylbenzene	7.0E-193	210	6.9E-193	7.2E+01	7,900	4,100	7.1E+01	5
bis(2-Ethylhexyl) phthalate								5

Table C-3 Model Predicted Peak Concentration and Arrival Times

	With Biodegradation/Decay			Without Biodegradation/Decay				
Chemical Constituent	Max Conc. at Till Base (µg/L)	Time[1] to Max Conc. at Till Base (yr)	Max. Conc. w/ Lacustrine Unit Dilution (µg/L)	Max Conc. at Till Base (µg/L)	Time[1] to Max Conc. at Till Base (yr)	Time[1] to GW Std. at Till Base (yr)	Max. Conc. w/ Lacustrine Unit Dilution (µg/L)	Groundwater Standard[2] (µg/L)
Methylene chloride [dichloromethane]	7.6E-123	33	7.6E-123	9.7E+02	830	340	9.6E+02	5
4-Methyl-2-pentanone [Methyl isobutyl ketone]								No standard exists
Naphthalene	1.3E-162	200	1.3E-162	4.4E+01	6,400	3,900	4.4E+01	10*
Pentachlorophenol	0.0E+00	NA	0.0E+00	6.6E+01	140,000	63,000	6.6E+01	1 (in Total Phenols)[3]
Polychlorinated biphenyls								0.09
Phenol	0.0E+00	NA	0.0E+00	2.3E+02	960	390	2.3E+02	1 (in Total Phenols)[3]
Styrene								5
Tetrachloroethylene	4.3E-87	300	4.3E-87	1.8E+00	5,300	Standard not exceeded	1.8E+00	5
Toluene	0.0E+00	NA	0.0E+00	6.2E+03	3,900	1,700	6.2E+03	5
1,1,1-Trichloroethane								5
Trichloroethylene	1.1E-35	300	1.0E-35	2.7E+00	2,400	Standard not exceeded	2.7E+00	5
Trichlorofluoromethane	4.8E-65	230	4.7E-65	2.0E+02	3,200	1,500	1.9E+02	5
2,4,6-Trichlorophenol	3.1E-94	840	3.1E-94	1.1E+02	16,000	6,800	1.0E+02	1 (in Total Phenols)[3]
Vinyl acetate								No standard exists
Xylenes (total)	6.2E-157	270	6.1E-157	1.3E+03	8,200	3,400	1.3E+03	5 each isomer[3]
Tritium (pCi/L)	6.4E+01	200	6.3E+01					20,000

Notes:

1 Time from 1963 (earliest date of waste placement).
2 NYS Class GA Groundwater Standards or Criteria value; June 1998.
3 Time to concentration of 1 µg/L for phenols; time to concentration of 5 µg/L for total xylenes.
* Guidance value

Key:

µg/L = Micrograms per liter.
NA = Not applicable.
yr = Year.
pCi/L = Picocuries per liter.

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D Summary of Statistical Analysis of Trench Data for Time Series Effects

D.1 Background

Based on a review of groundwater elevation data and corresponding groundwater contours at the State-Licensed Disposal Area (SDA), there might be a pathway for groundwater to enter the trenches around the sides of the existing slurry wall. In addition, historical leachate elevations appeared to fluctuate in certain trench sumps potentially due to seasonal groundwater elevations.

An evaluation was performed to determine what seasonality effects were present in historical trench leachate data, if any, and observe if the leachate levels indicated increasing or decreasing elevations.

D.2 Evaluation Methodology

To evaluate whether trench leachate elevations exhibited seasonality effects, a select number of trench sumps were included in the analysis. The trenches included 1, 2, 4, 5, 8, 10N, and 14. Trenches 1, 2, 5, 8, and 14 were selected due to their location around the perimeter of the SDA. These trenches could potentially receive groundwater laterally from the north and south edges of the SDA. Trenches 4 and 10N were also selected, as their sumps were located towards the center of the SDA in what appeared to be a potential groundwater migration pathway around the slurry cutoff wall.

Historical leachate elevation data for the above-mentioned trenches were obtained from a database comprised of data from New York State Information Management System (NYSIMS) and data collected by Ecology and Environment, Inc. (E & E). Thirteen years of data (1995 through 2008) were considered a representative dataset for purposes of this evaluation. Weekly, biweekly, or monthly readings were collected from 1995 to 2002, while quarterly readings were collected from 2003 to 2008.

Statistical Package for the Social Sciences (SPSS) version 14.0, 2006, is a statistical software package used to evaluate data for seasonality affects using time series analysis. To run this type of analysis, the data set must be regularly spaced throughout the study period. Raw data were averaged into quarterly values so that the time series was regularly spaced for the analysis, where necessary. These quarterly datasets were imported from a Microsoft Excel spreadsheet into SPSS.

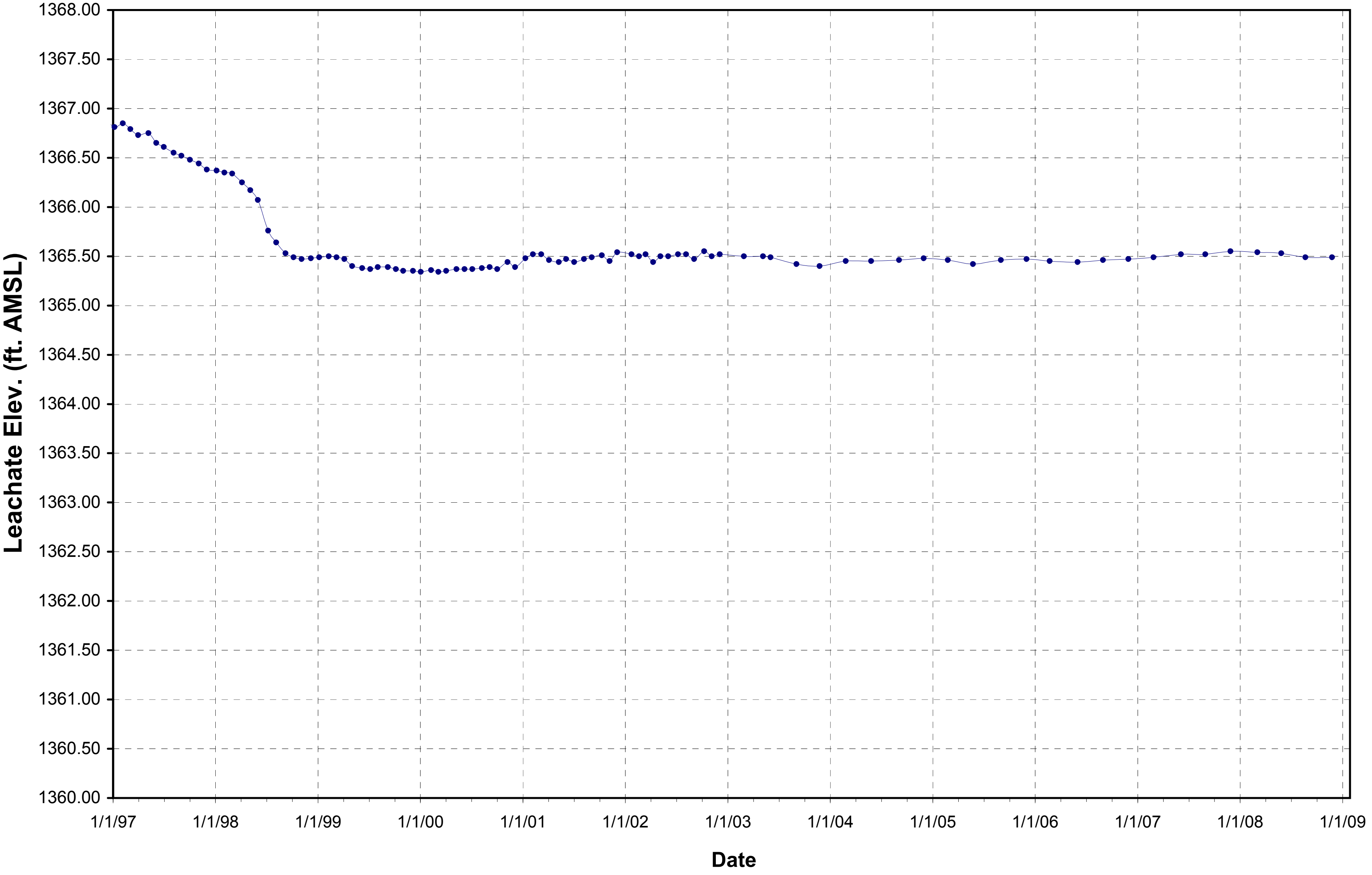
The quarterly data for the selected trenches were analyzed using the time series graphic analysis in SPSS, with both autocorrelations and partial autocorrelations being examined. Statistical significance was detected using an alpha level of 0.05. Trench data were also modeled using linear regression analysis, with time as the independent variable. The residuals from these models were examined visually for randomness and seasonality effects. Output files from the linear regression analysis are presented in this appendix.

D.3 Results

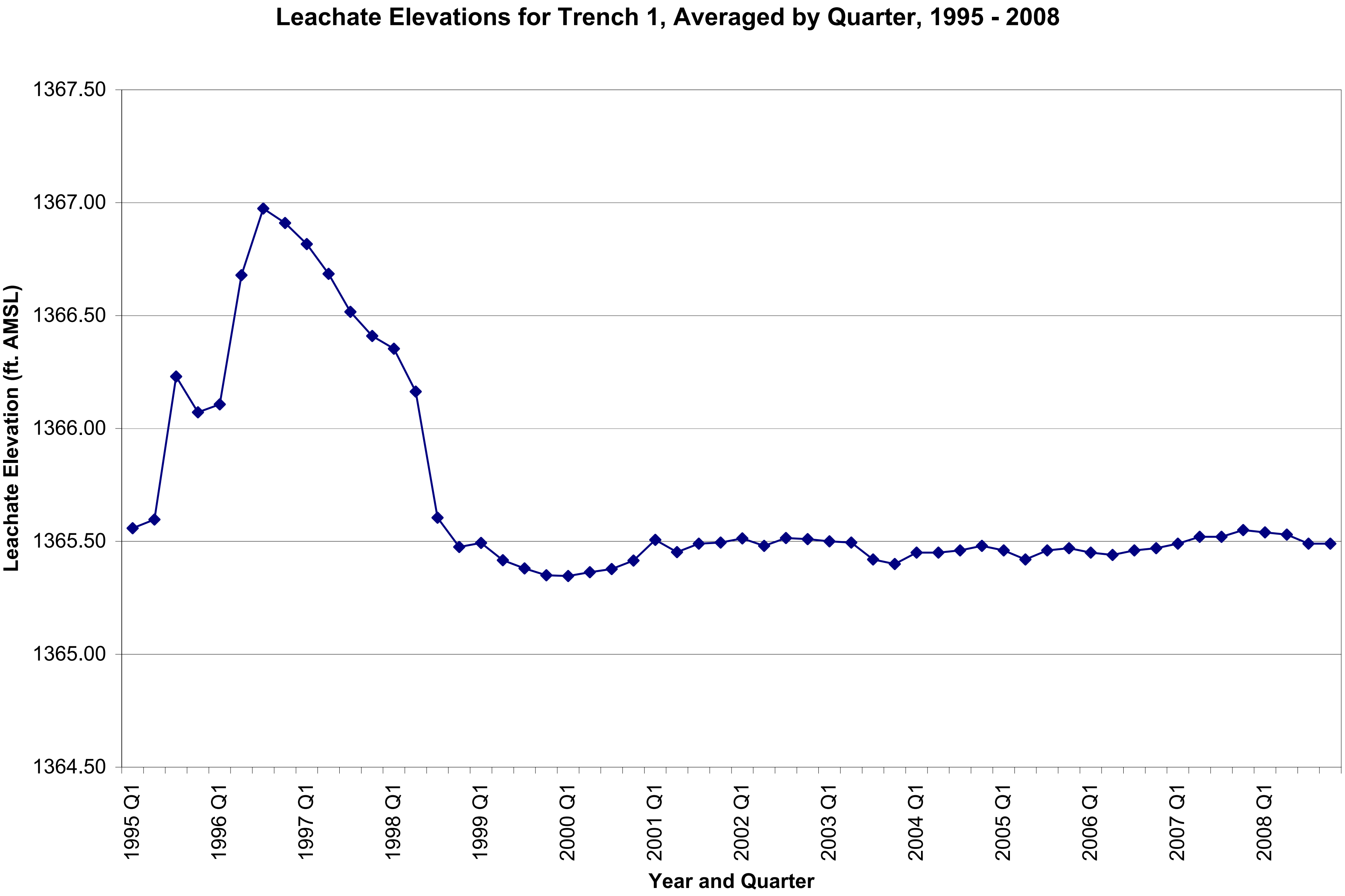
Significant linear decreasing trends were detected in data from trenches 2, 4, 5, 8 10N, and 14. Trench 1 data had an abrupt decline in elevation until 1999; from 1999 to 2008, the data did not substantially fluctuate and an increasing trend was identified. No significant seasonality effects were detected in the quarterly time series data or in the residuals from the linear regression models for any trench examined.

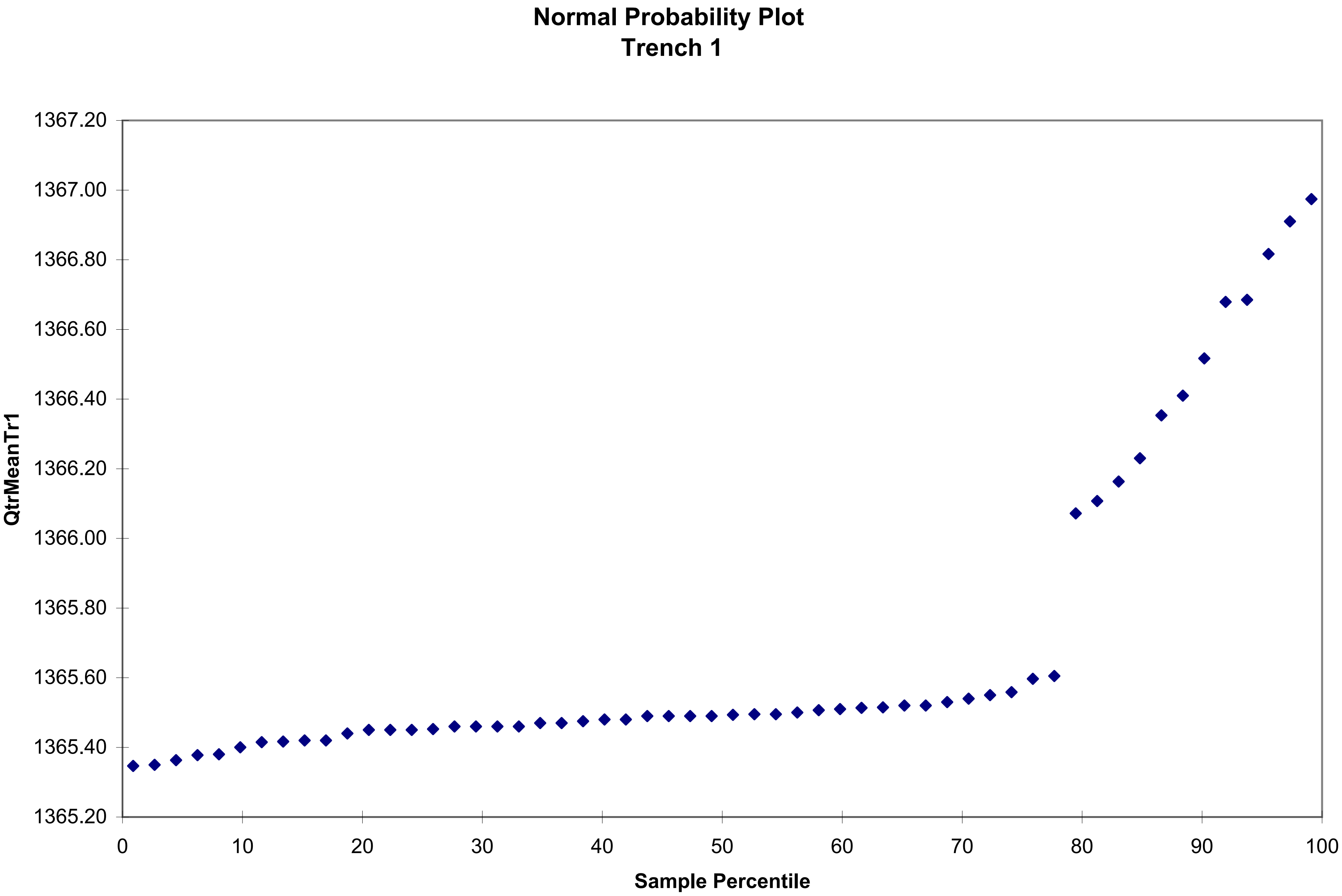
D.4 Conclusions

These calculations indicate there was no seasonality effect present in the quarterly leachate elevations from the trenches included in this study. Trench leachate elevations decreased over time for all but one of the trenches evaluated.

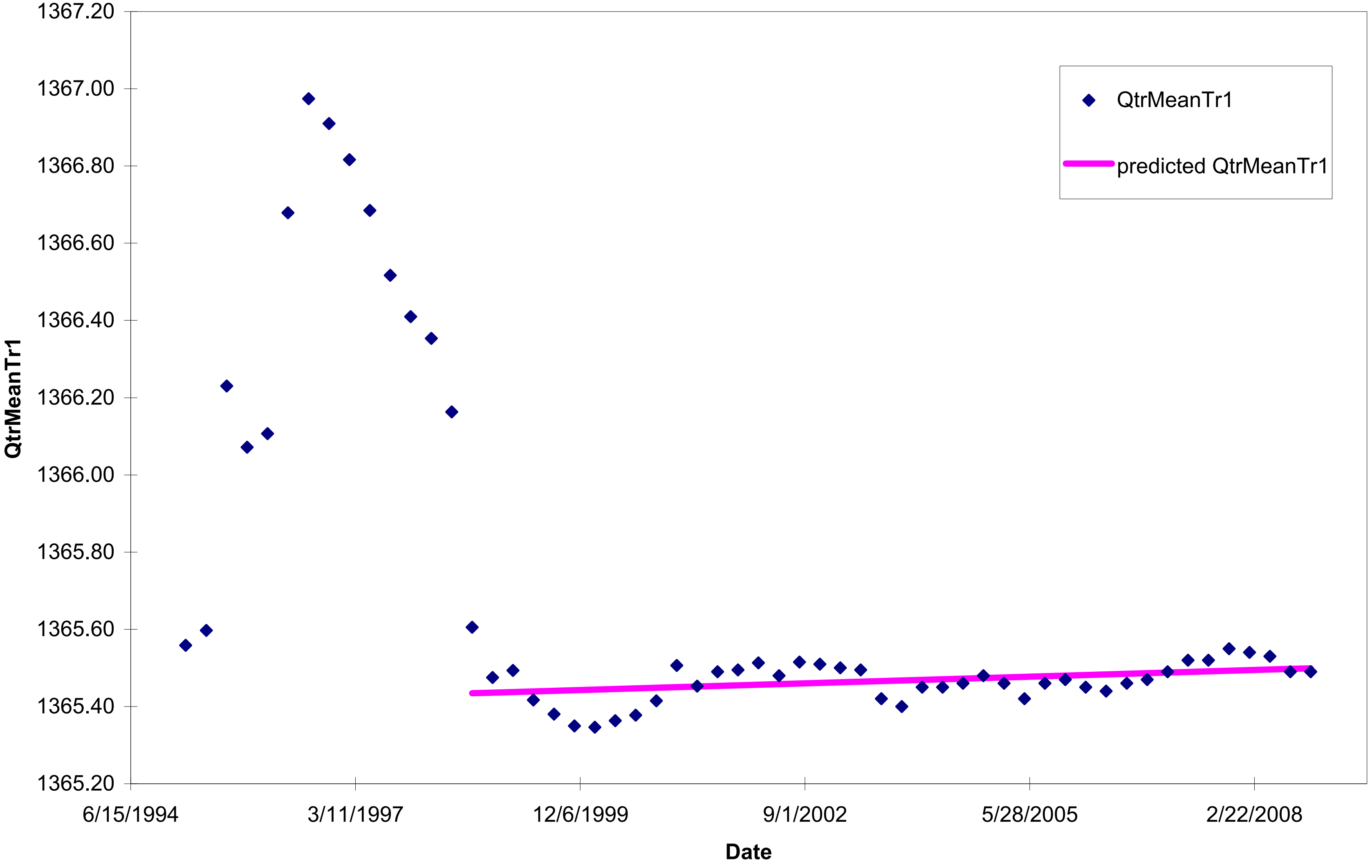


Leachate Elevation for Trench 1, 1997 to 2008

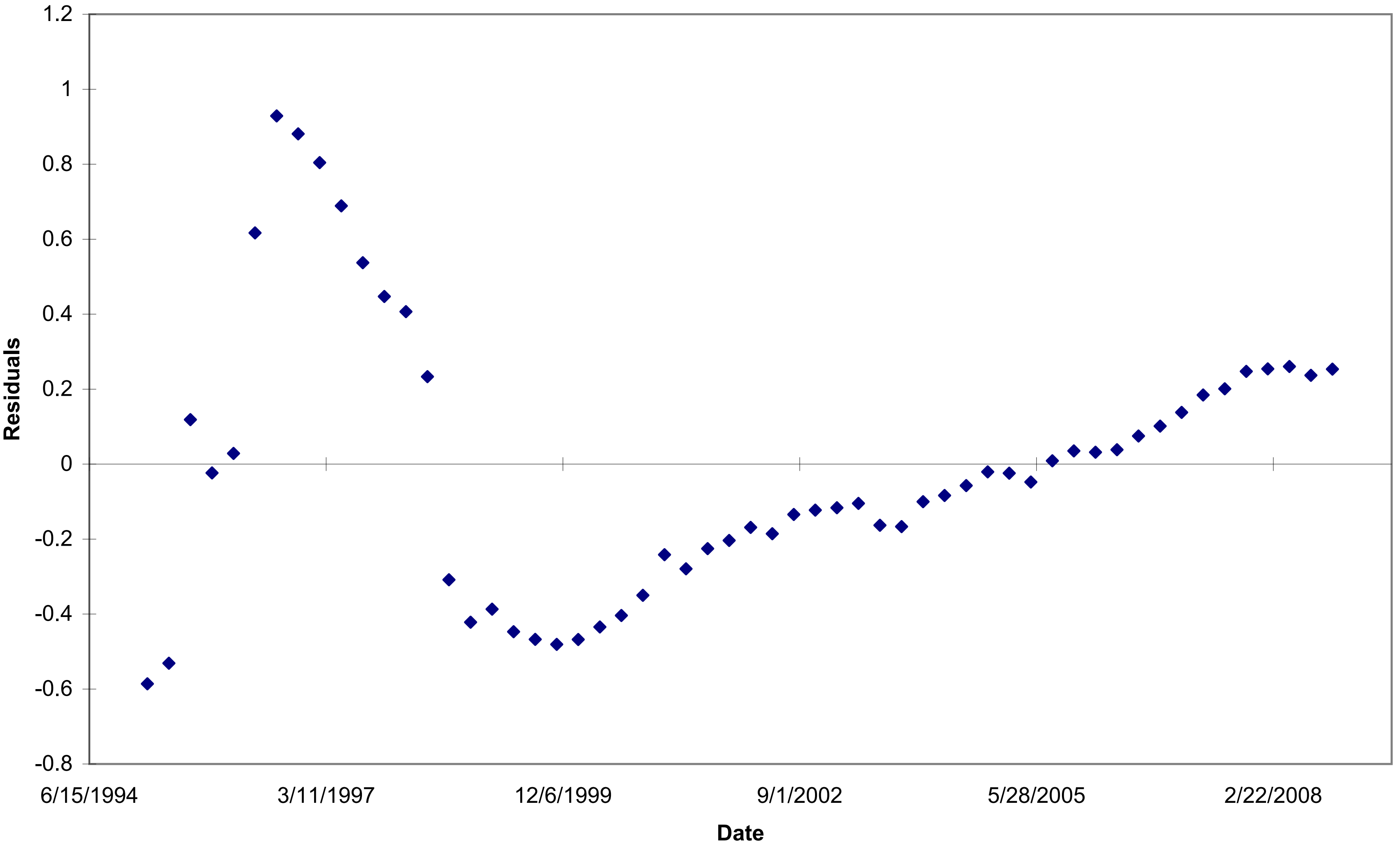

Leachate Elevations for Trench 1, Averaged by Quarter, 1995 - 2008
Leachate Elevation (ft. AMSL)
1367.50
1367.00
1366.50
1366.00
1365.50
1365.00
1364.50
1995 Q1
1996 Q1
1997 Q1
1998 Q1
1999 Q1
2000 Q1
2001 Q1
2002 Q1
2003 Q1
2004 Q1
2005 Q1
2006 Q1
2007 Q1
2008 Q1
Year and Quarter

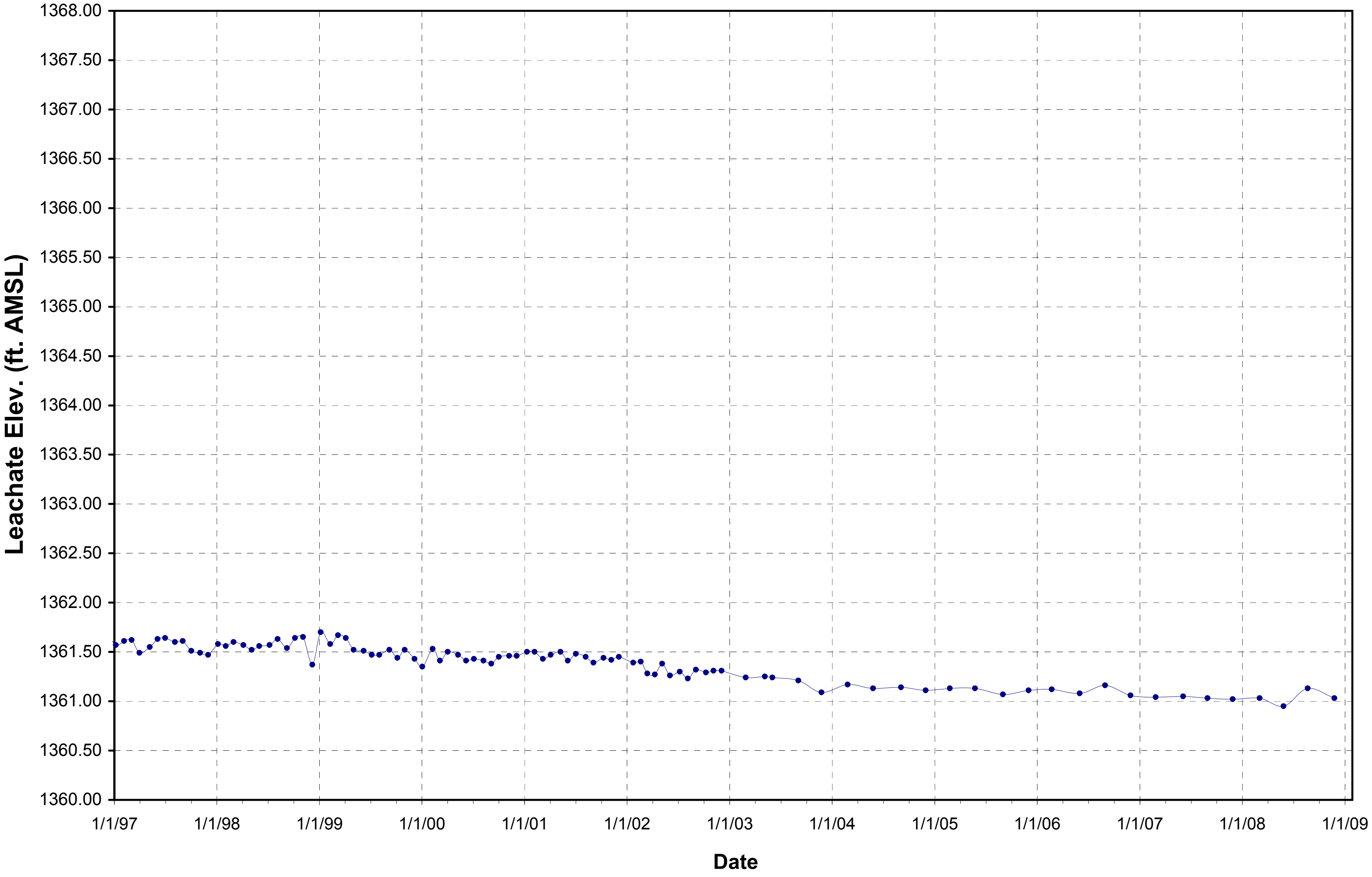

Normal Probability Plot
Trench 1
QtrMeanTr1
1367.20
1367.00
1366.80
1366.60
1366.40
1366.20
1366.00
1365.80
1365.60
1365.40
1365.20
0
10
20
30
40
50
60
70
80
90
100
Sample Percentile

Predicted line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date Trench 1

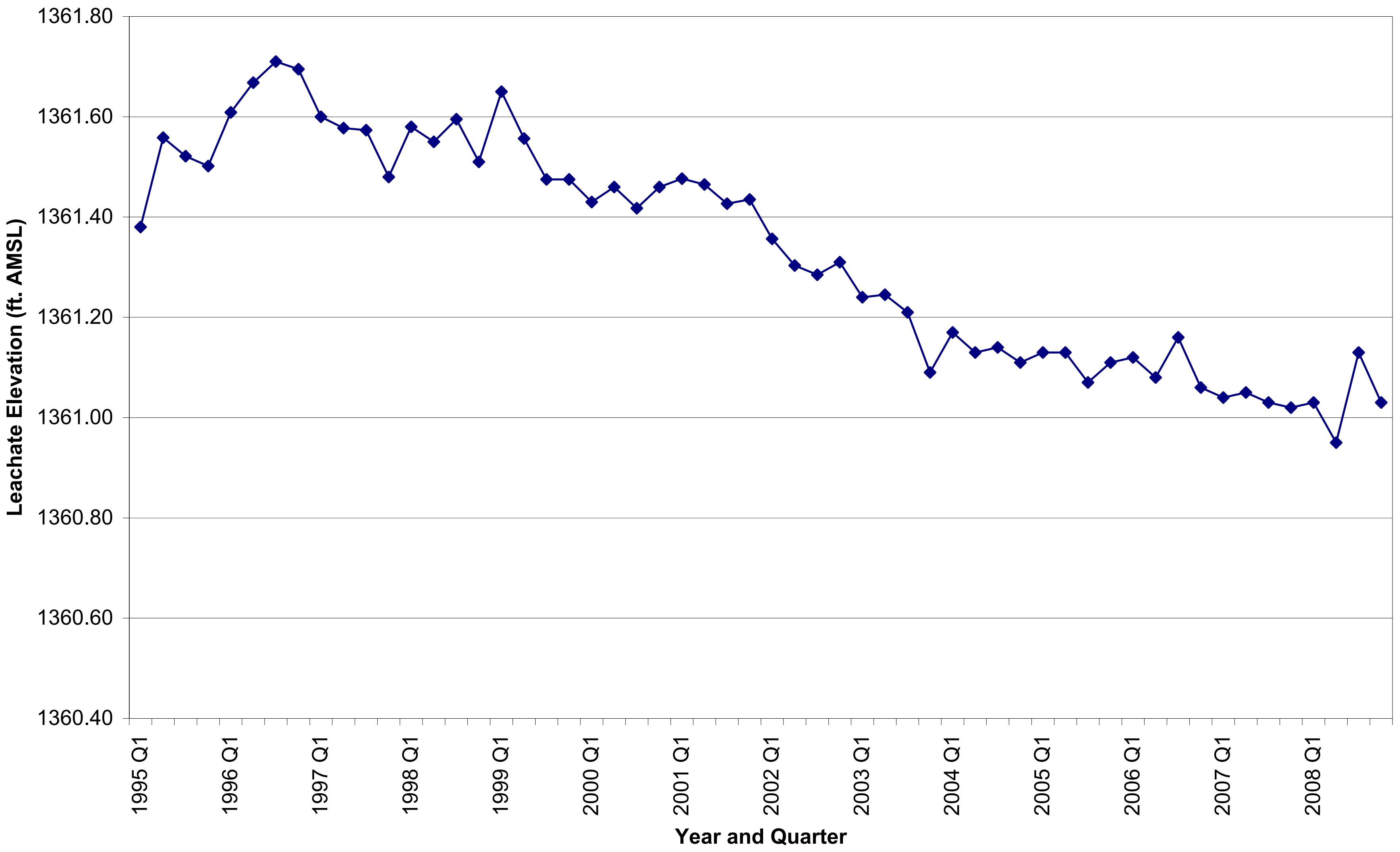


Model Residuals vs Date - not random, but no seasonality identified
Trench 1

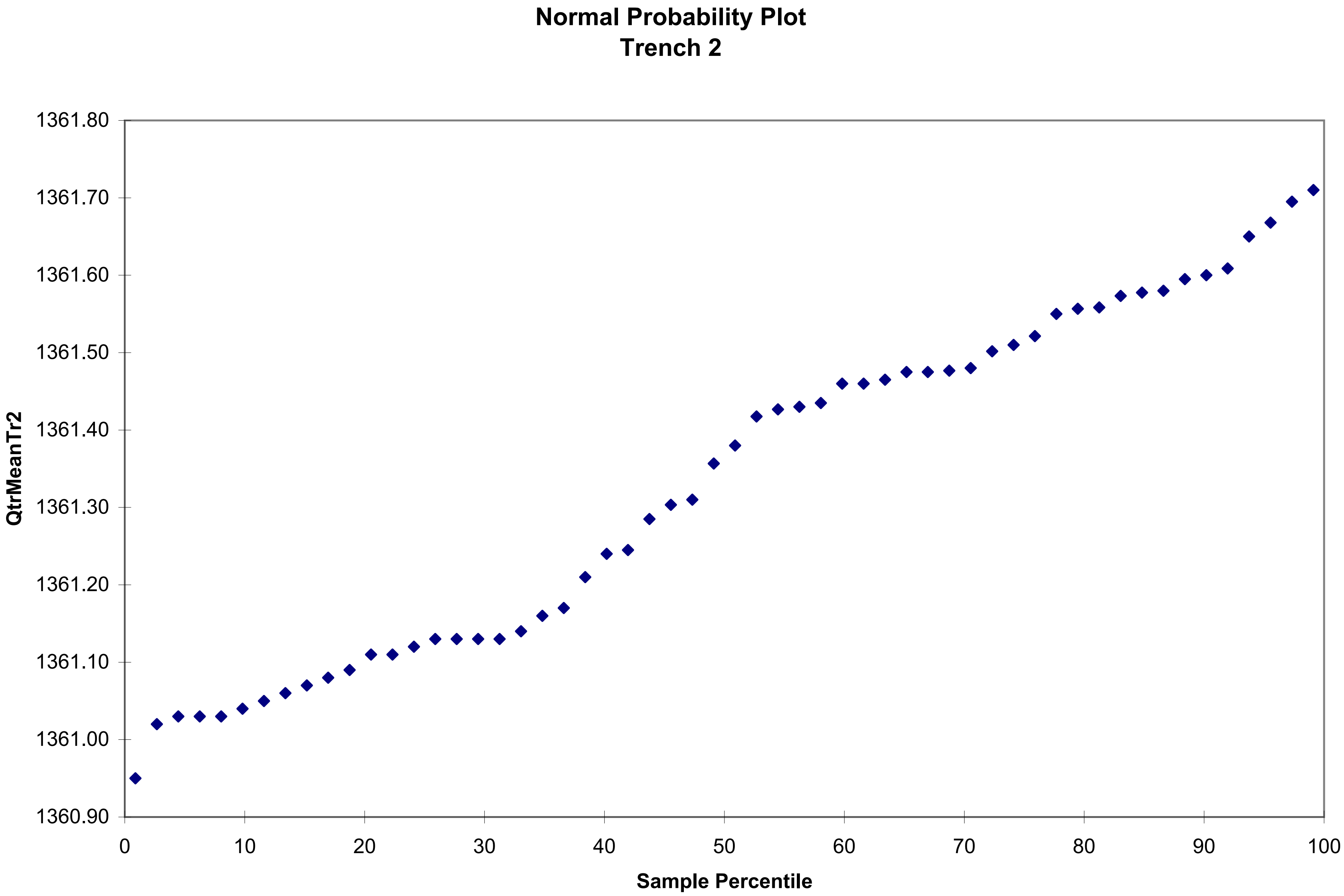




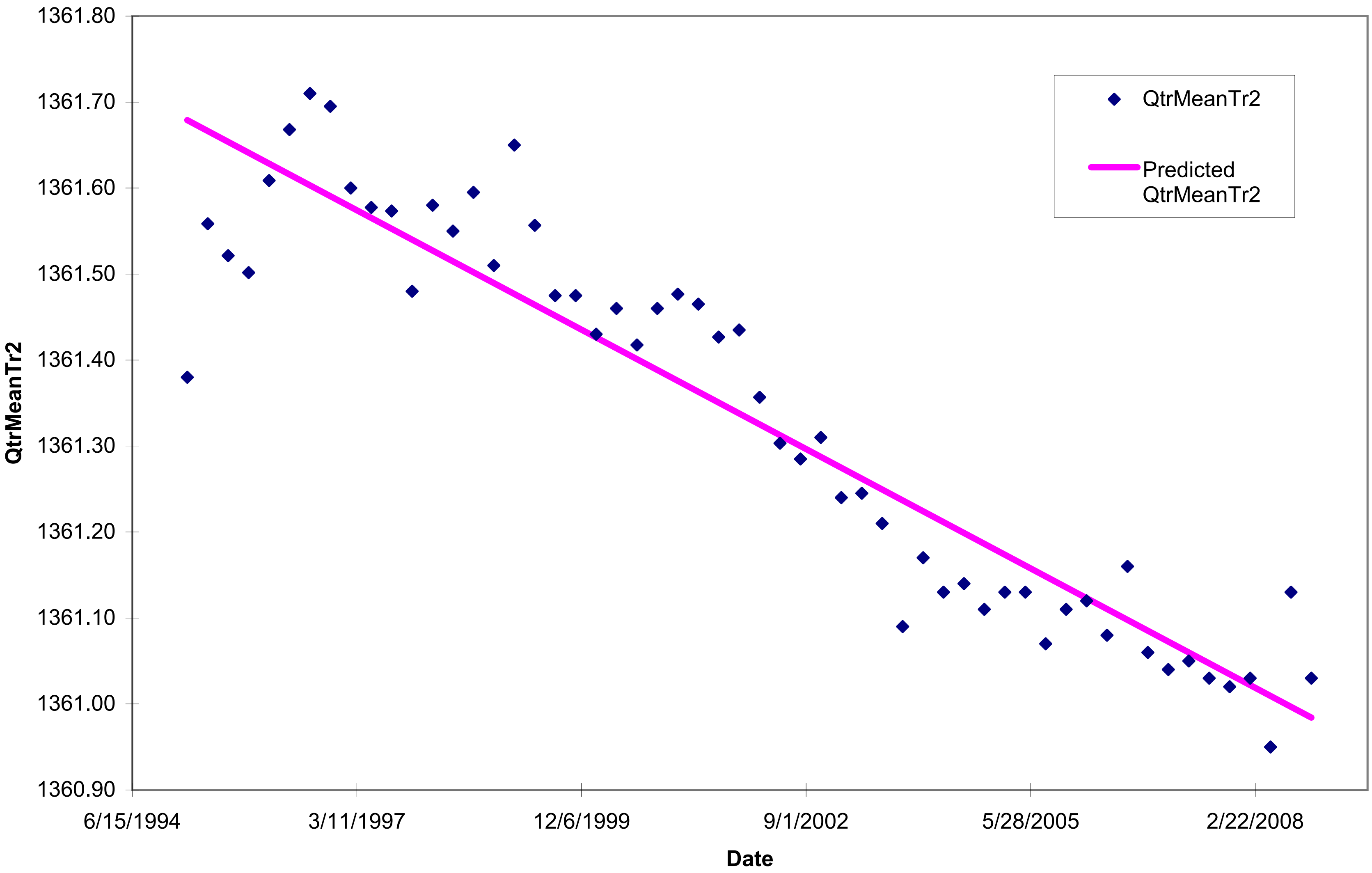
Leachate Elevation for Trench 2, 1997 to 2008



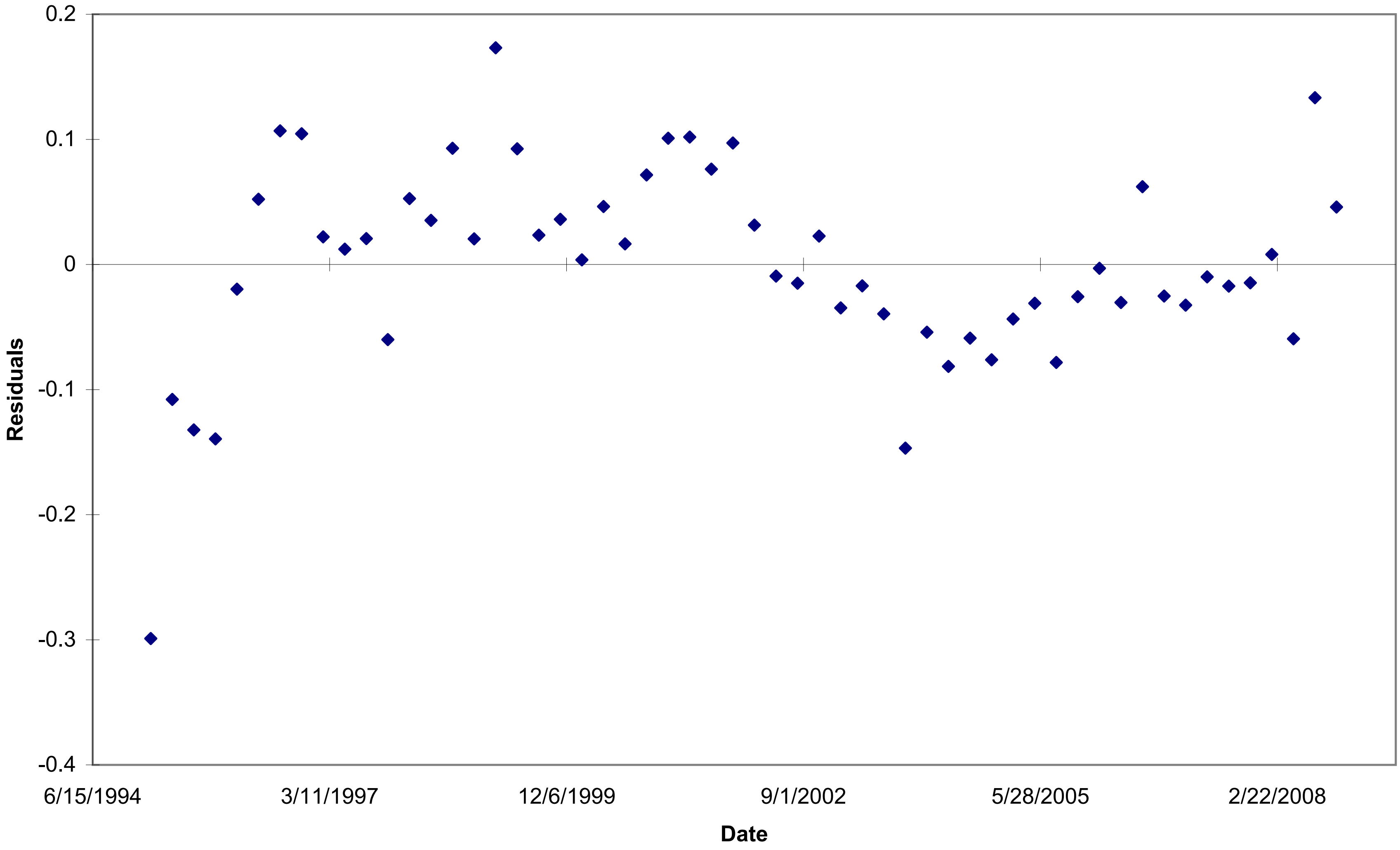
Leachate Elevations for Trench 2, Averaged by Quarter, 1995 - 2008

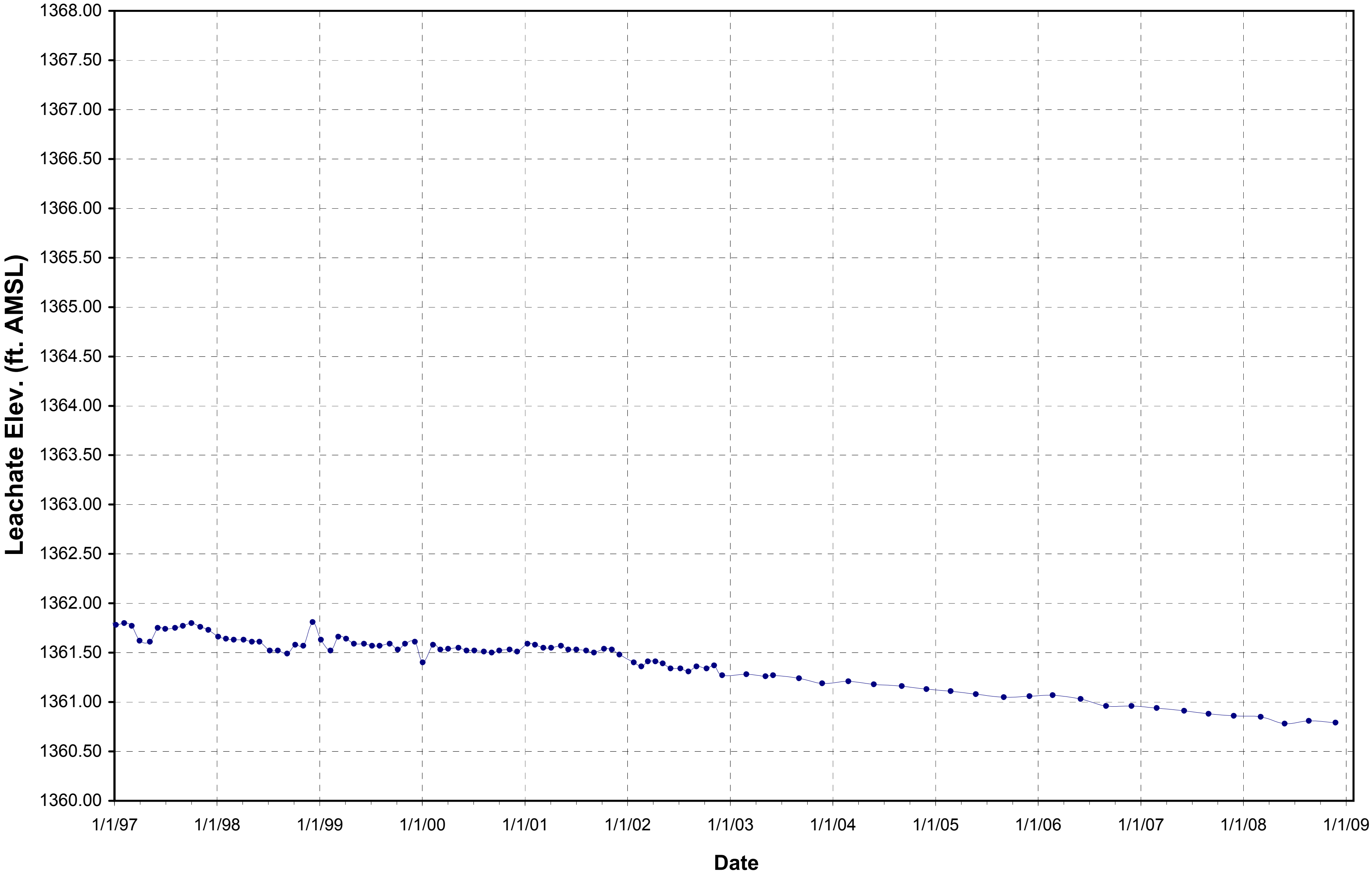

Normal Probability Plot
Trench 2
QtrMeanTr2
1361.80
1361.70
1361.60
1361.50
1361.40
1361.30
1361.20
1361.10
1361.00
1360.90
0
10
20
30
40
50
60
70
80
90
100
Sample Percentile

Predicted Line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date
Trench 2

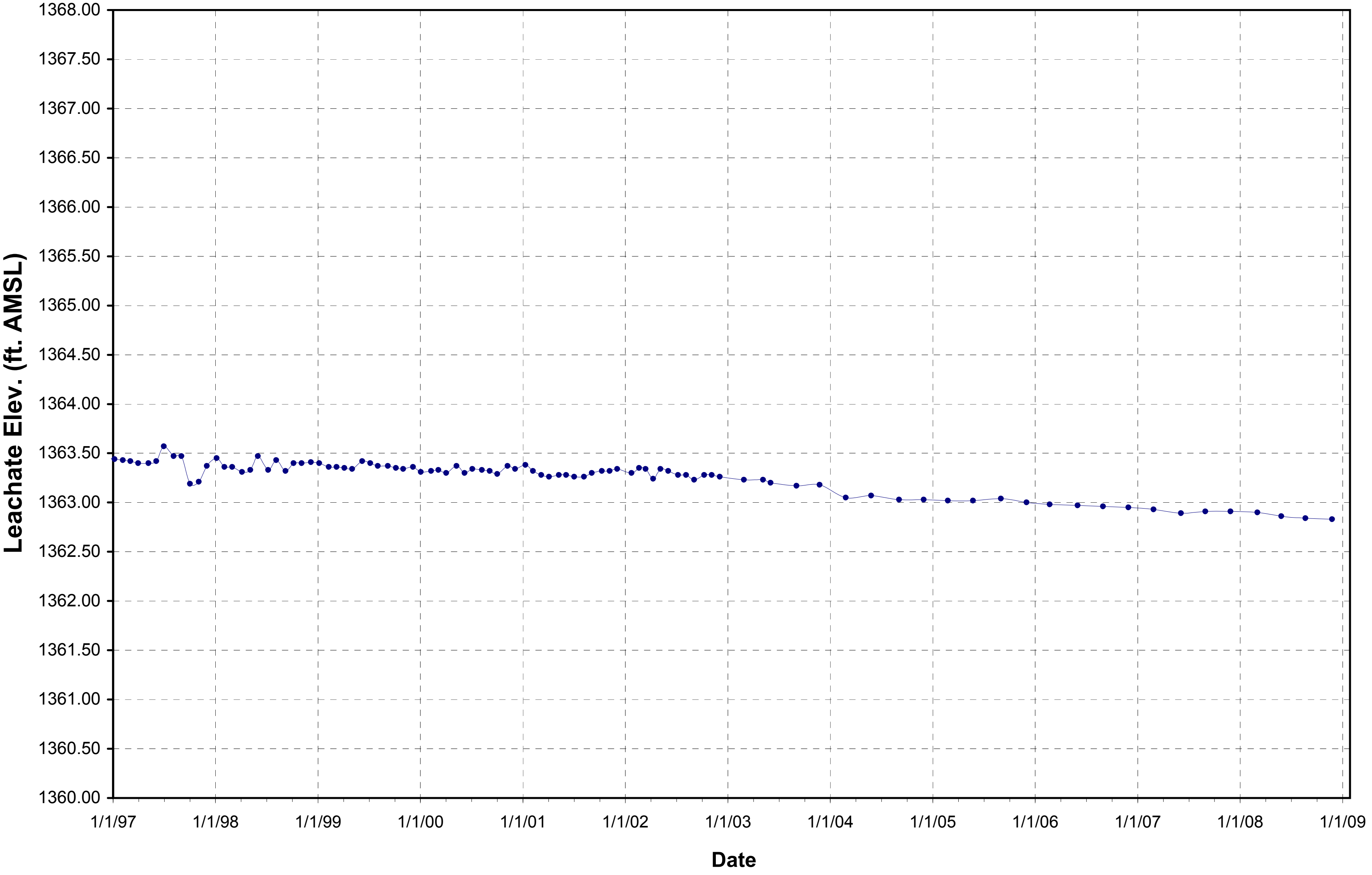


Model Residuals vs Date - random, no seasonality identified
Trench 2



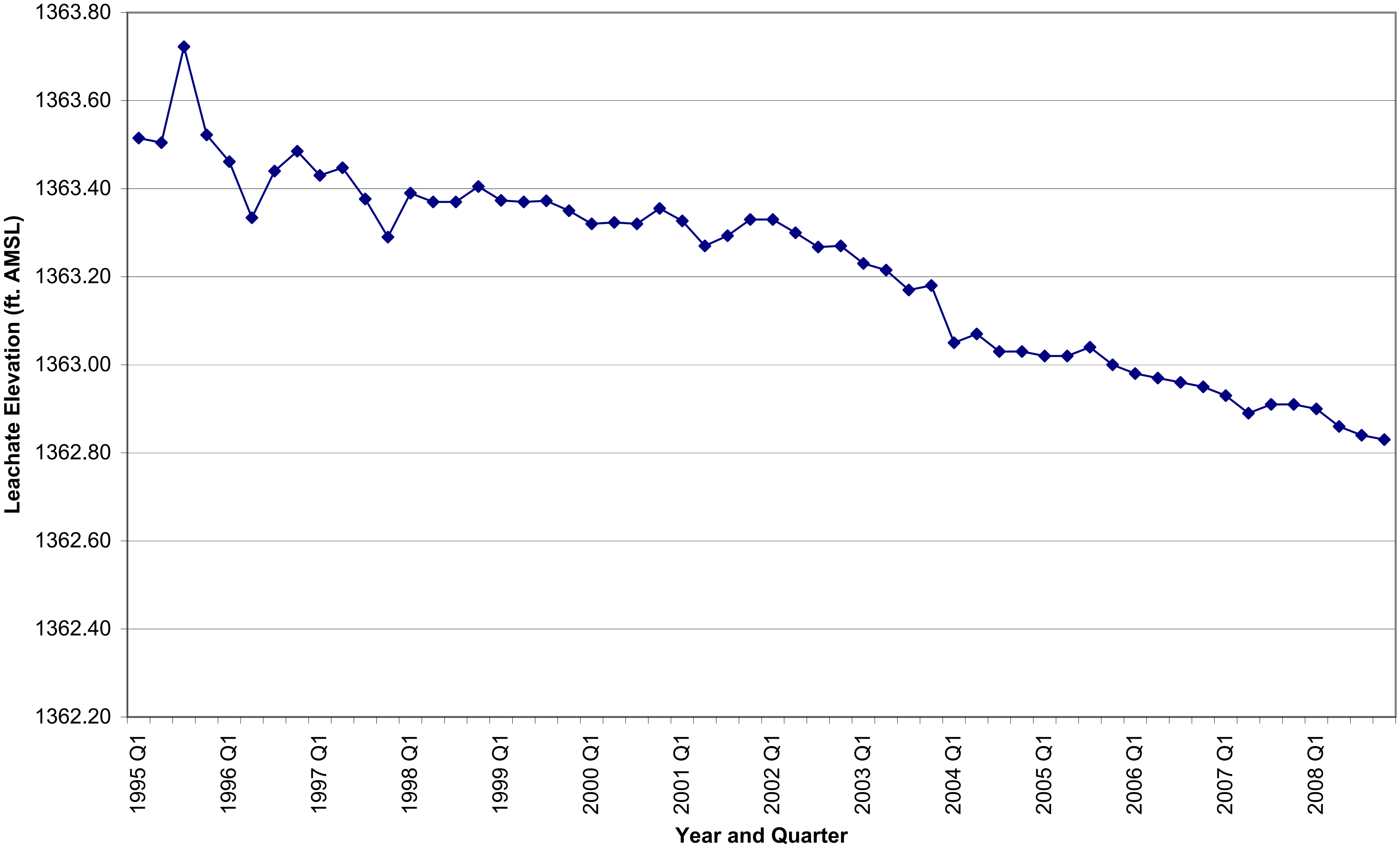


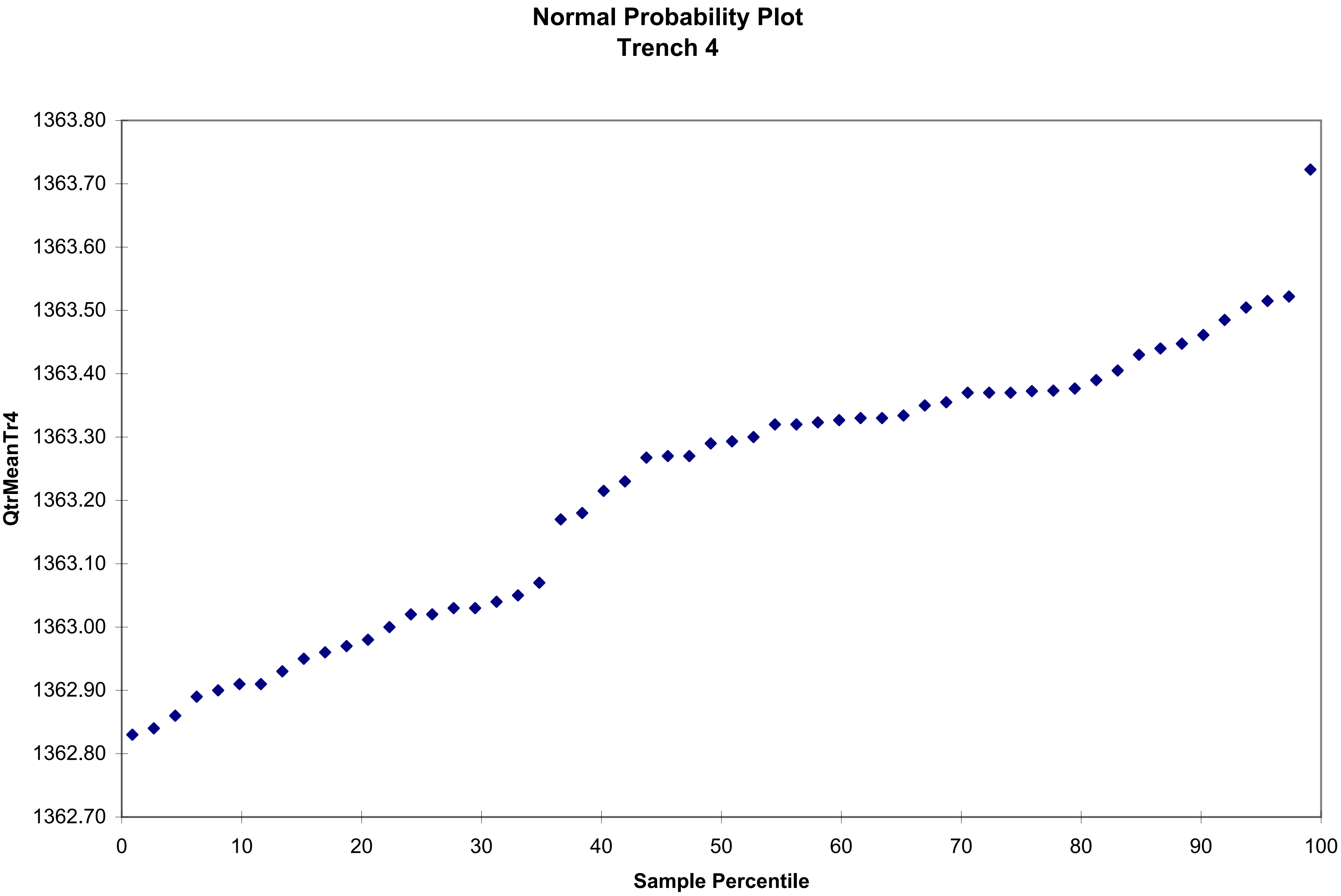
Leachate Elevation for Trench 3, 1997 to 2008



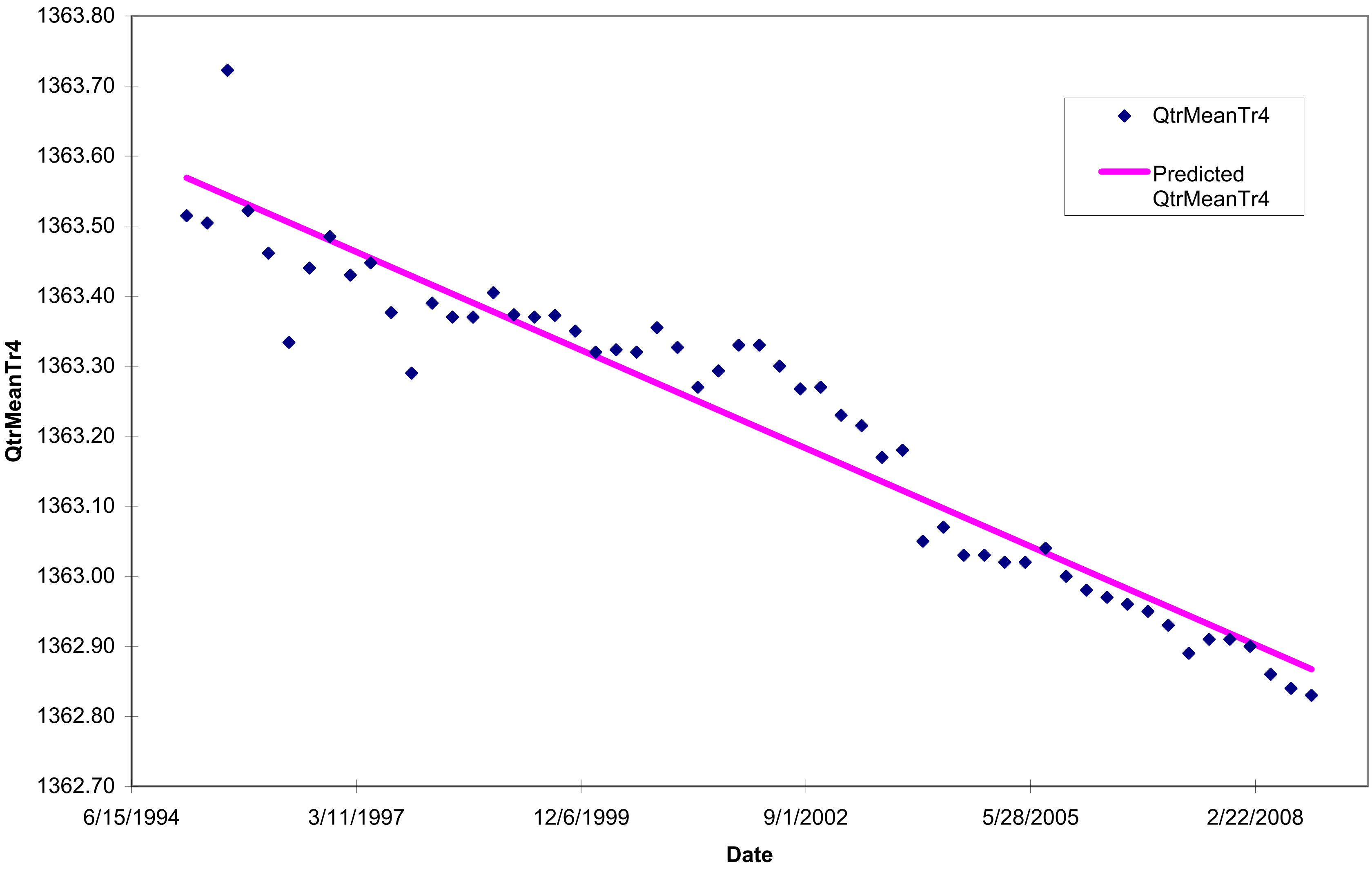
Leachate Elevation for Trench 4, 1997 to 2008

Leachate Elevations for Trench 4, Averaged by Quarter, 1995 - 2008

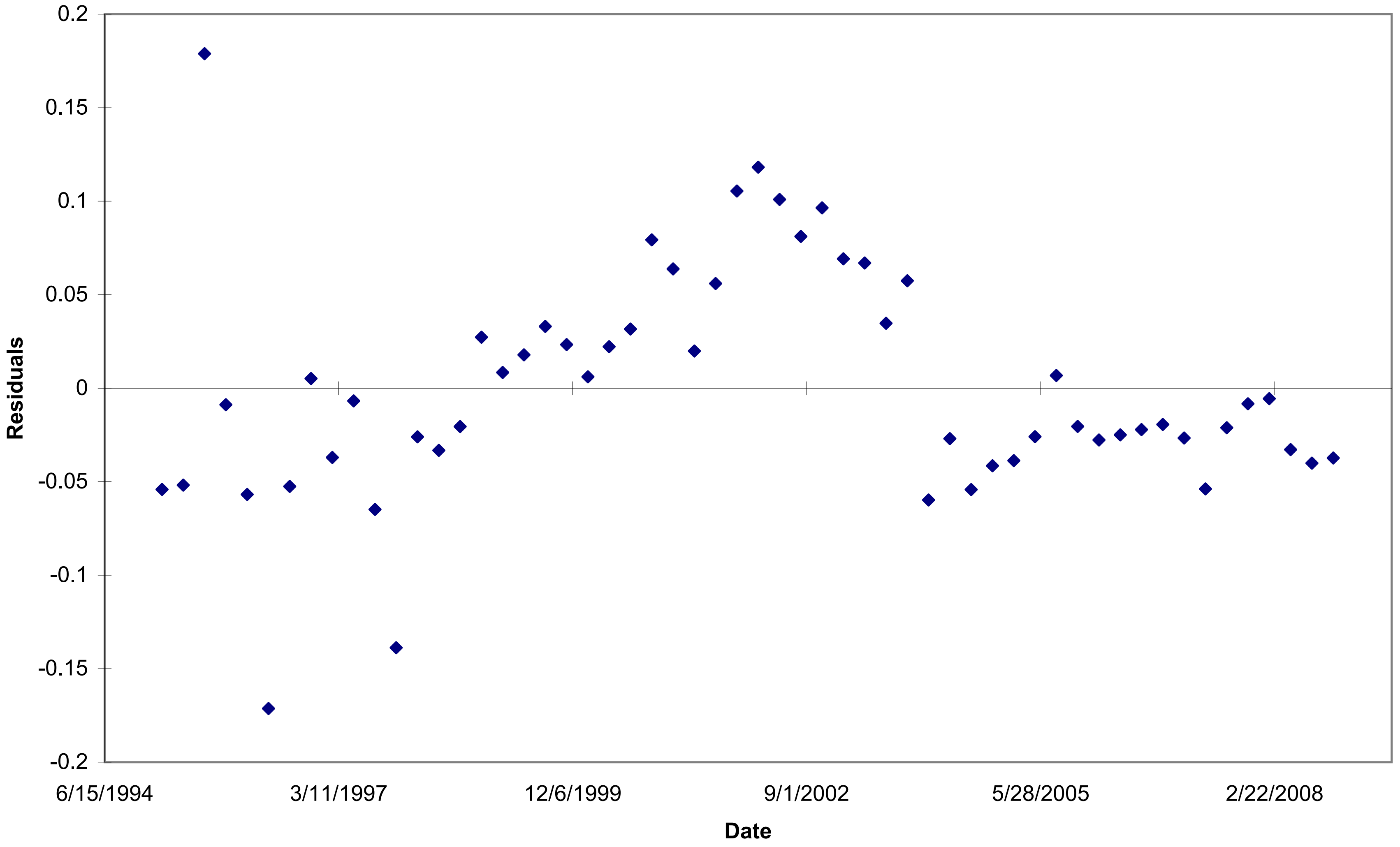


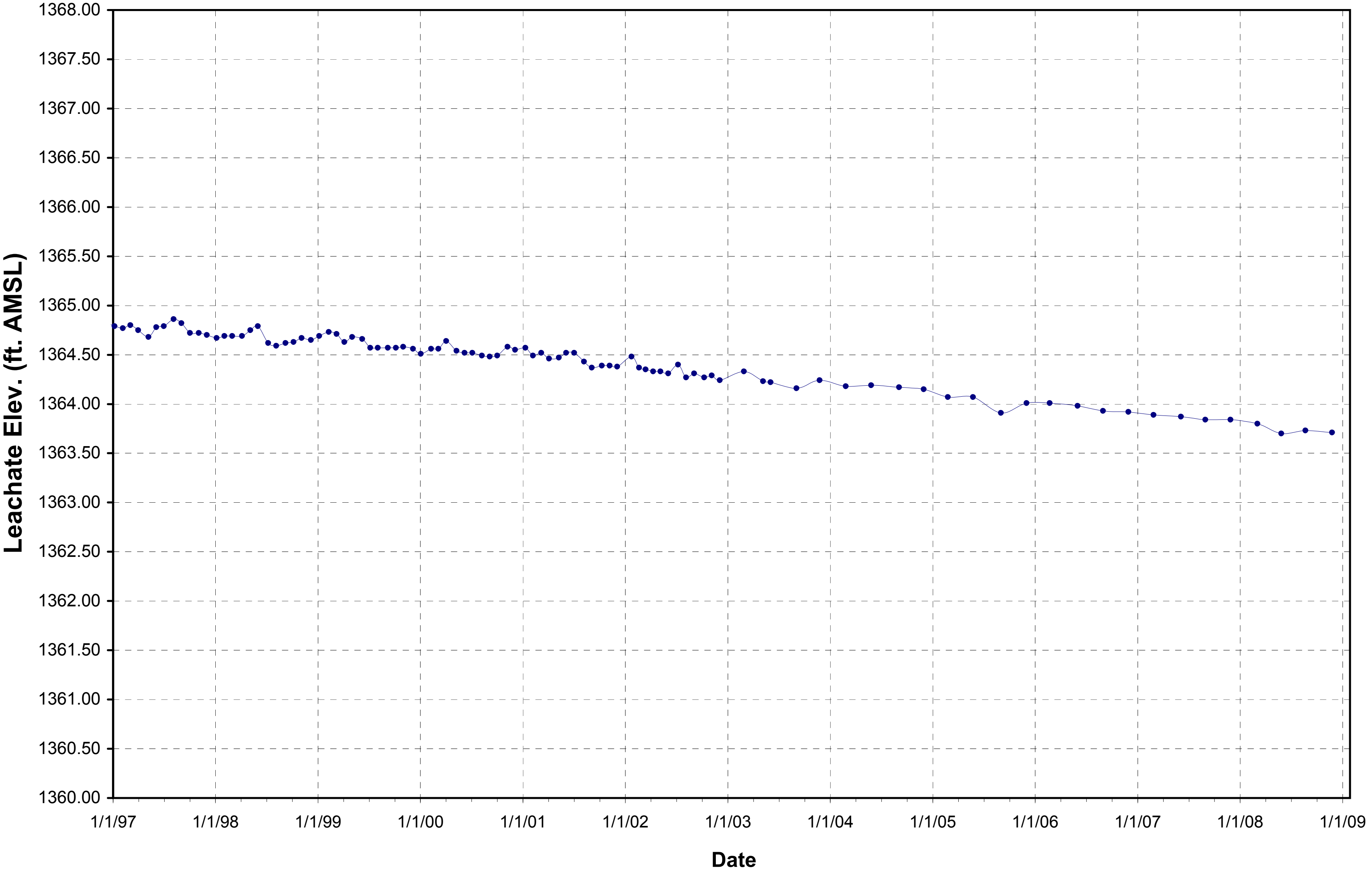

Normal Probability Plot
Trench 4
QtrMeanTr4
1363.80
1363.70
1363.60
1363.50
1363.40
1363.30
1363.20
1363.10
1363.00
1362.90
1362.80
1362.70
0
10
20
30
40
50
60
70
80
90
100
Sample Percentile

Predicted Line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date
Trench 4



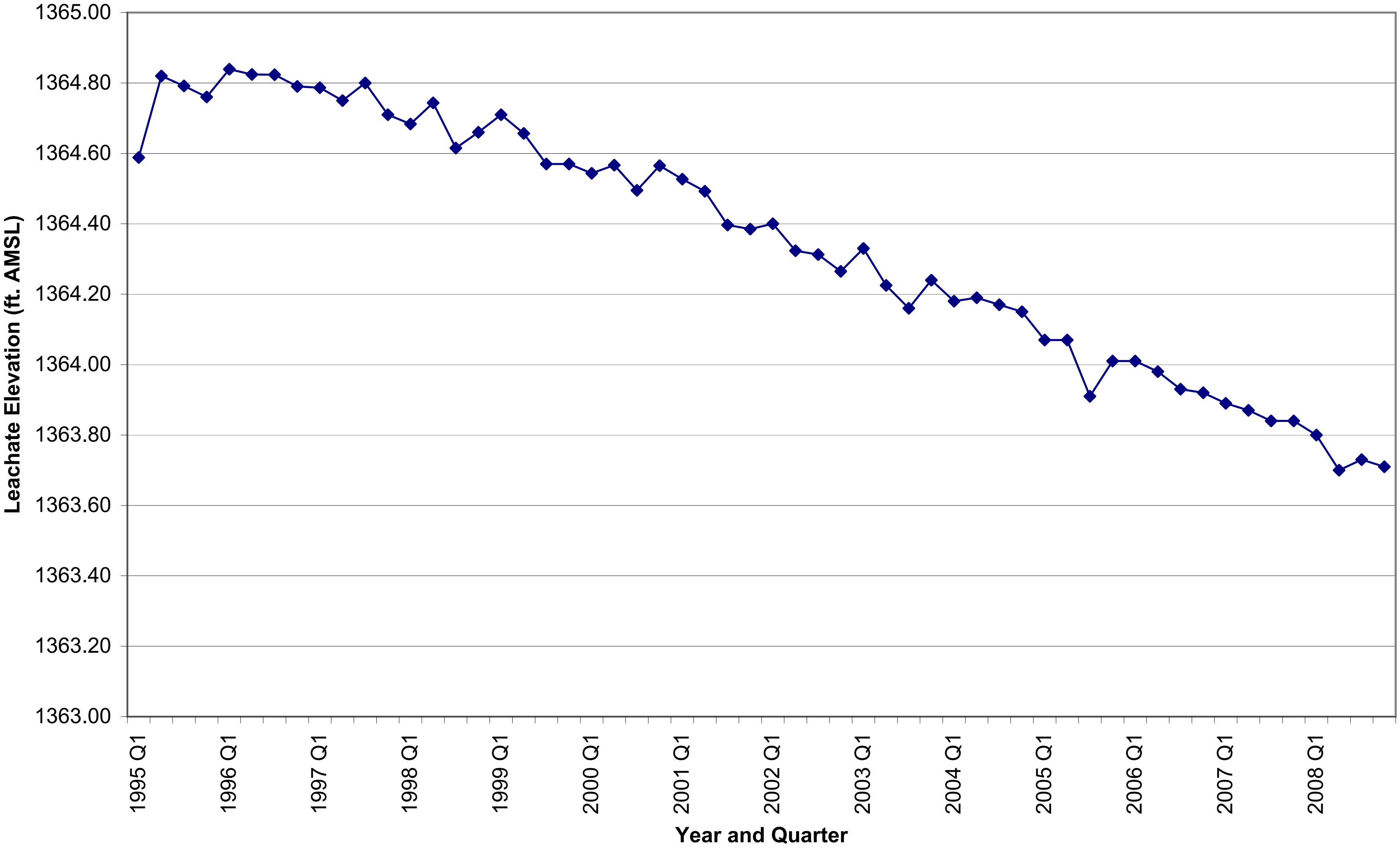
Model Residuals vs Date - not random, but no seasonality identified
Trench 4

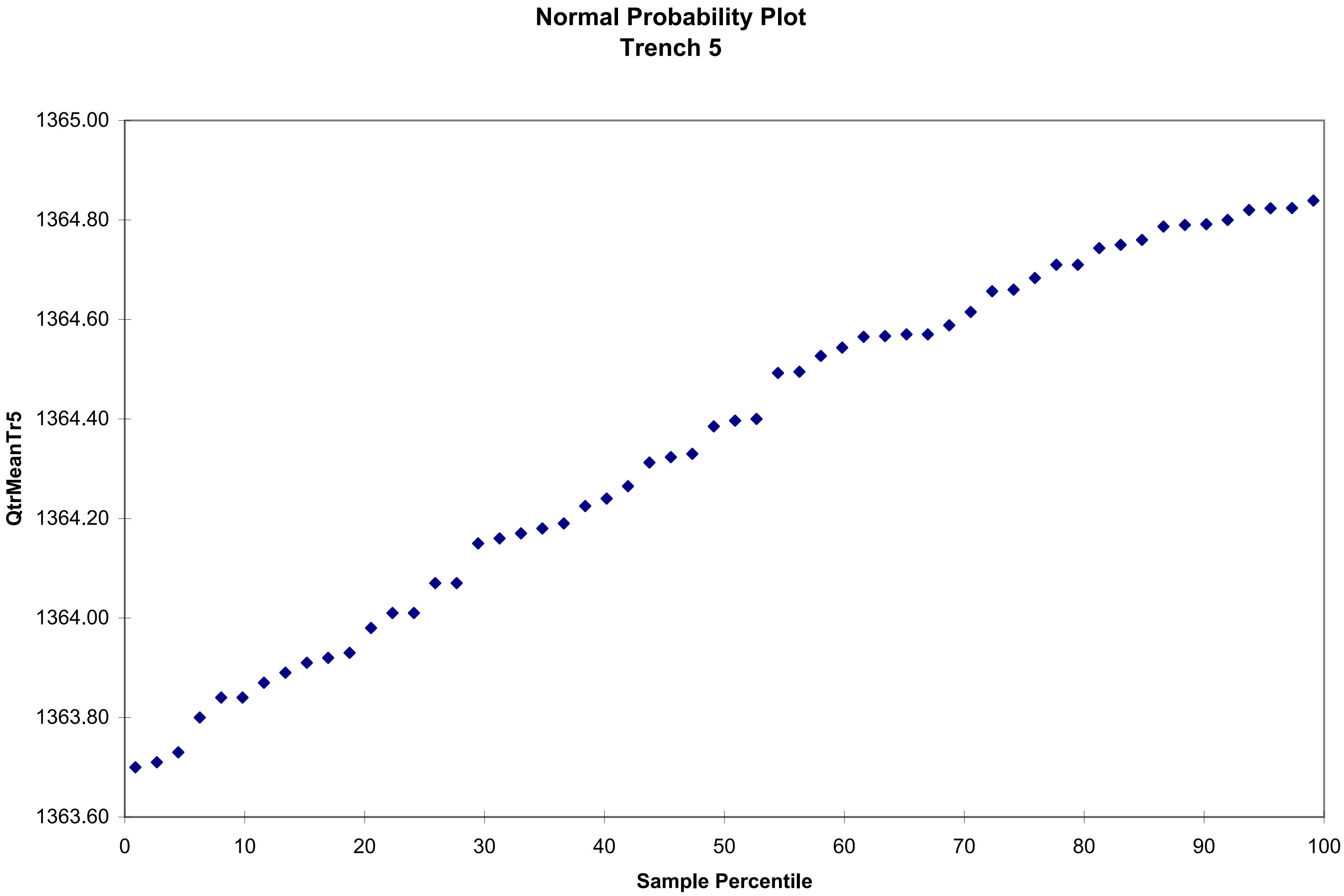




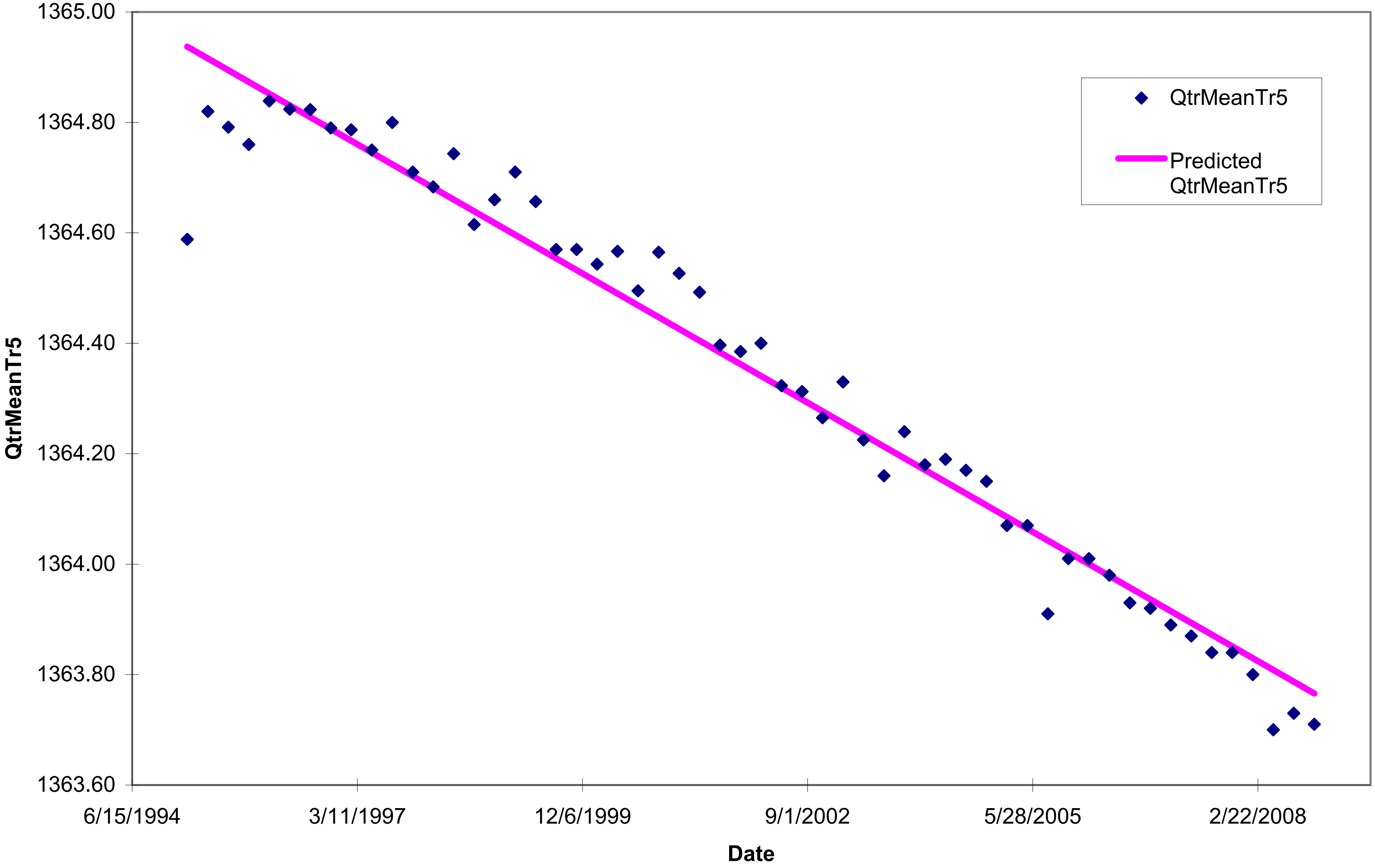
Leachate Elevation for Trench 5, 1997 to 2008

Leachate Elevations for Trench 5, Averaged by Quarter, 1995 - 2008

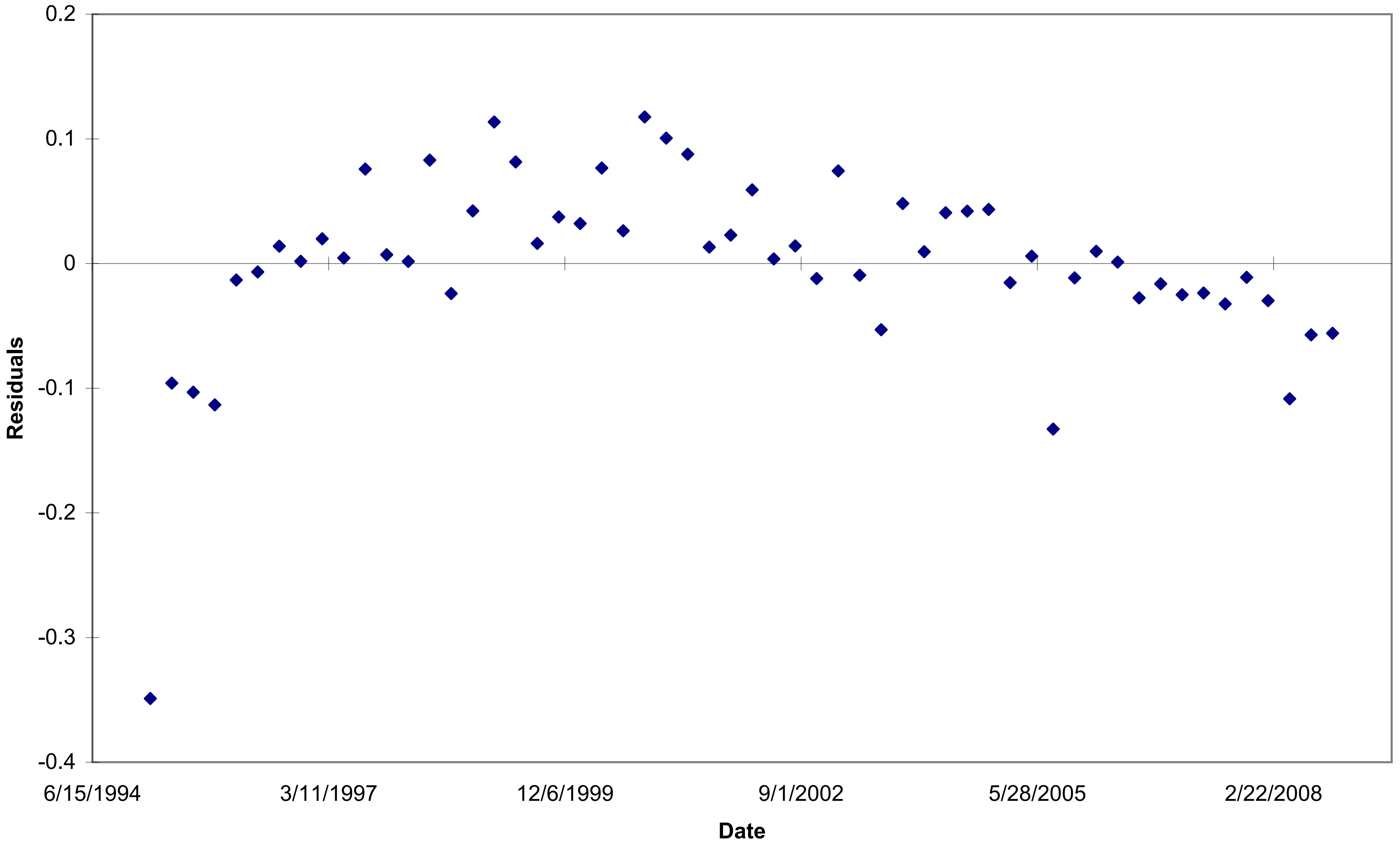


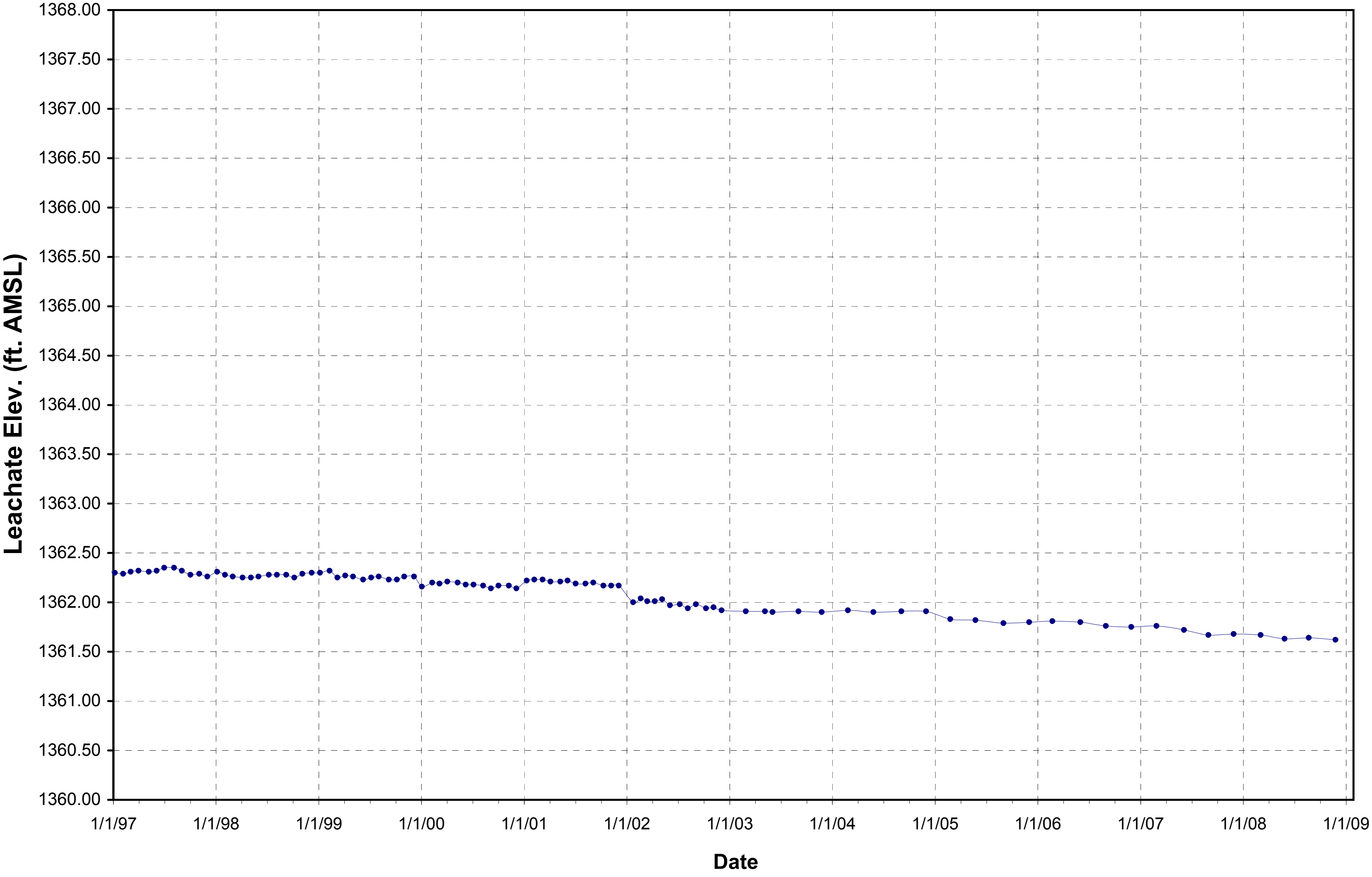

Normal Probability Plot
Trench 5
QtrMeanTr5
1365.00
1364.80
1364.60
1364.40
1364.20
1364.00
1363.80
1363.60
0
10
20
30
40
50
60
70
80
90
100
Sample Percentile

Predicted Line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date
Trench 5

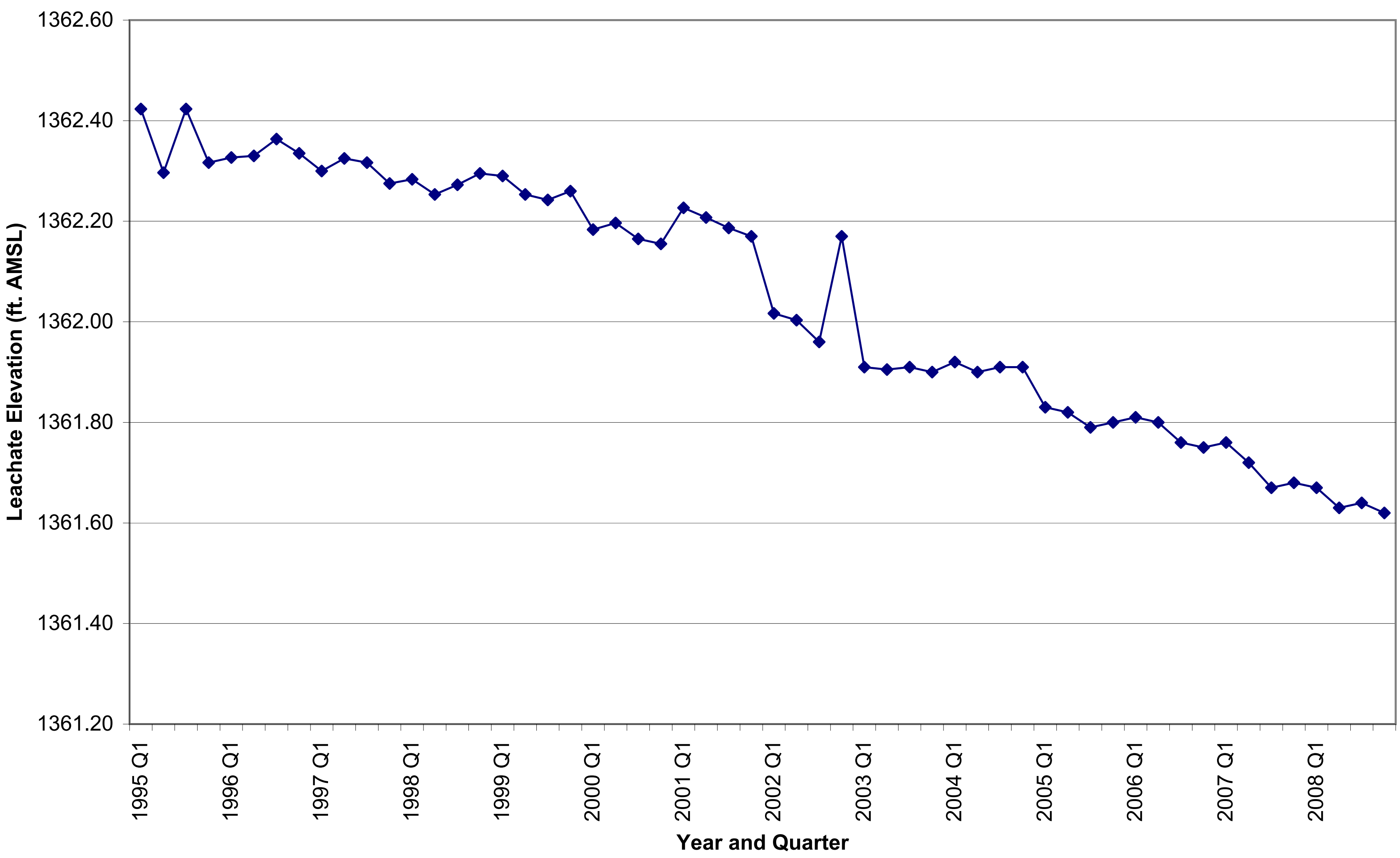


Model Residuals vs Date - not random, but no seasonality identified
Trench 5

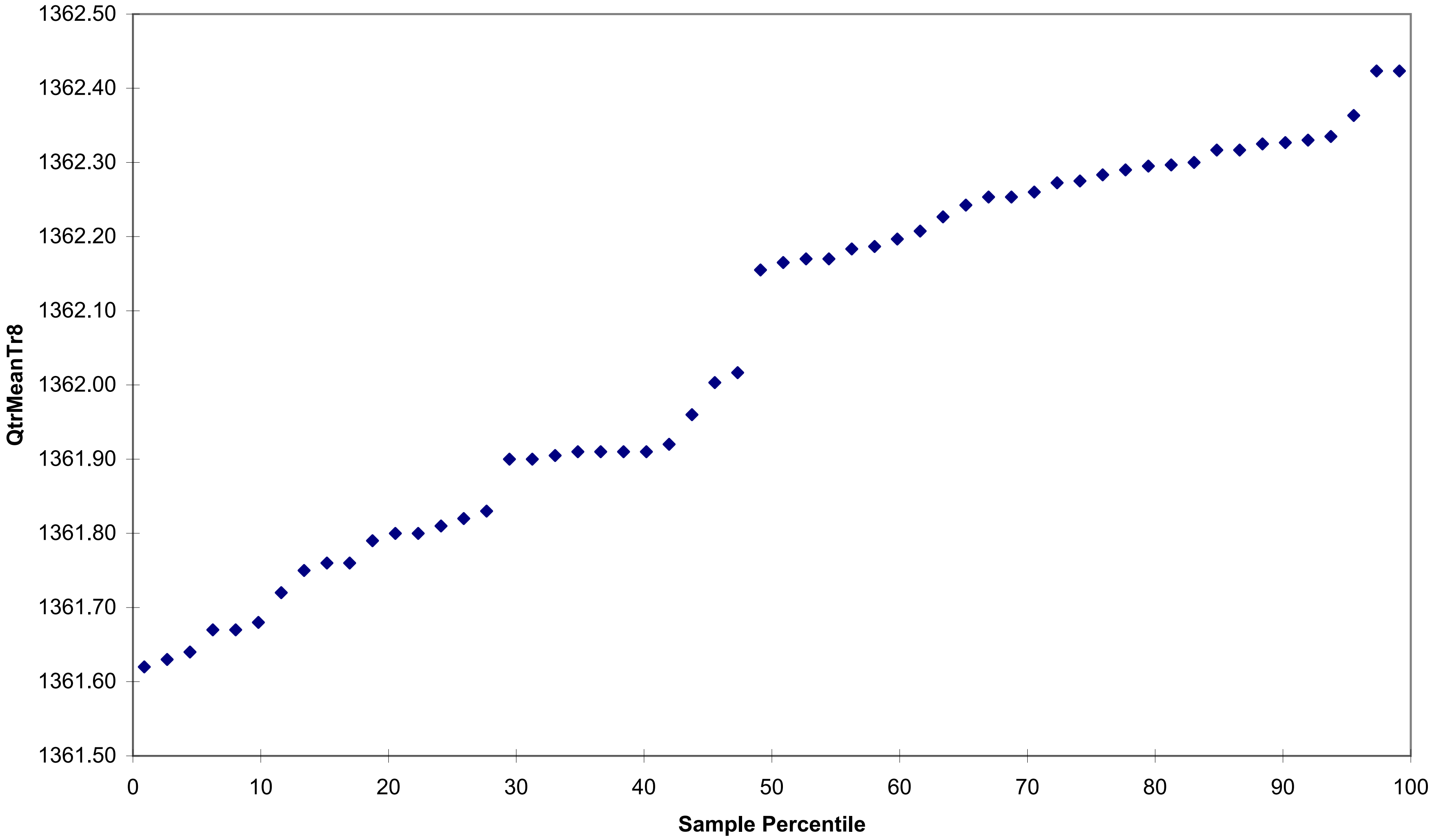




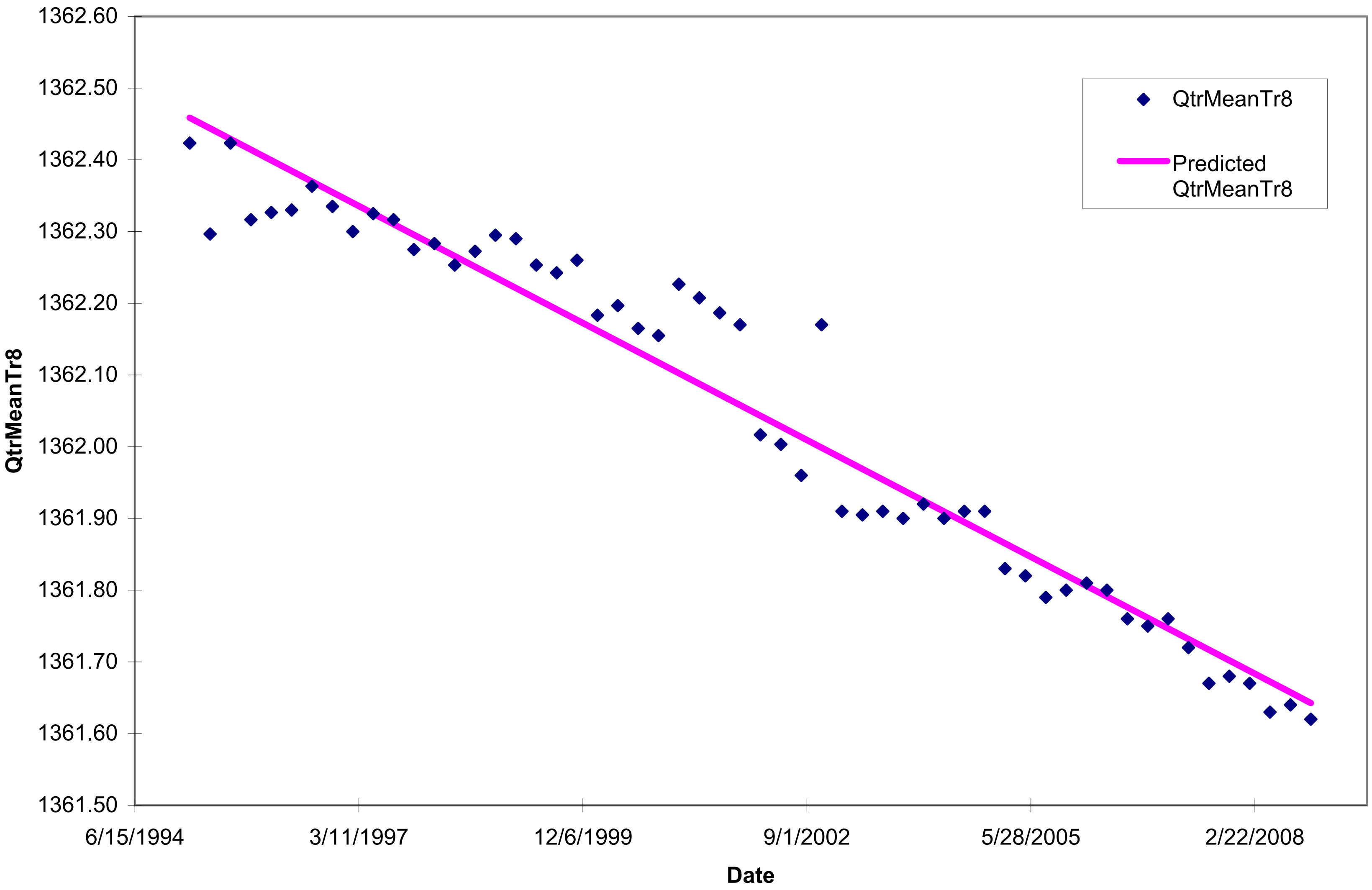
Leachate Elevation for Trench 8, 1997 to 2008


Leachate Elevations for Trench 8, Averaged by Quarter, 1995 - 2008

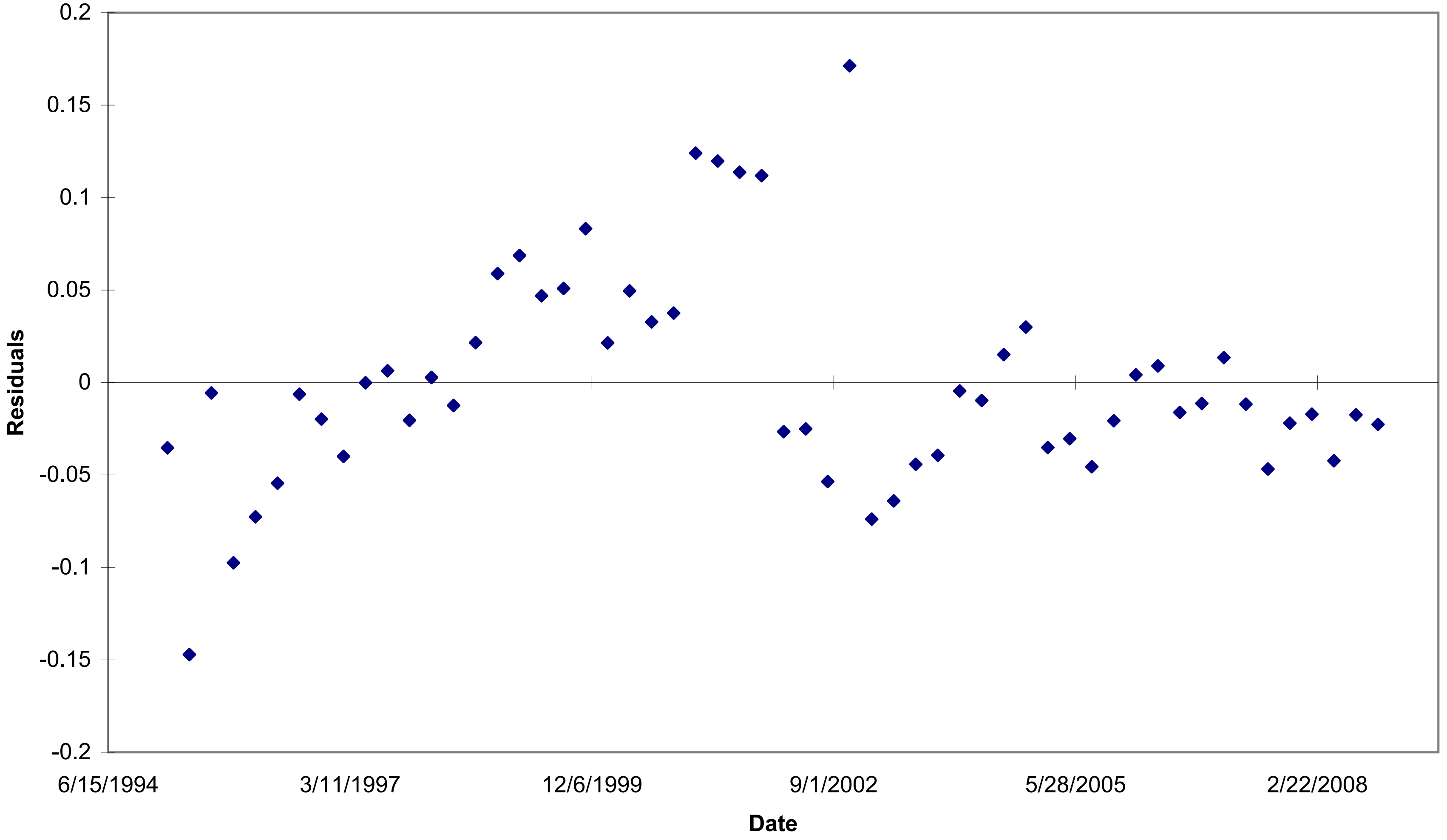
Normal Probability Plot
Trench 8

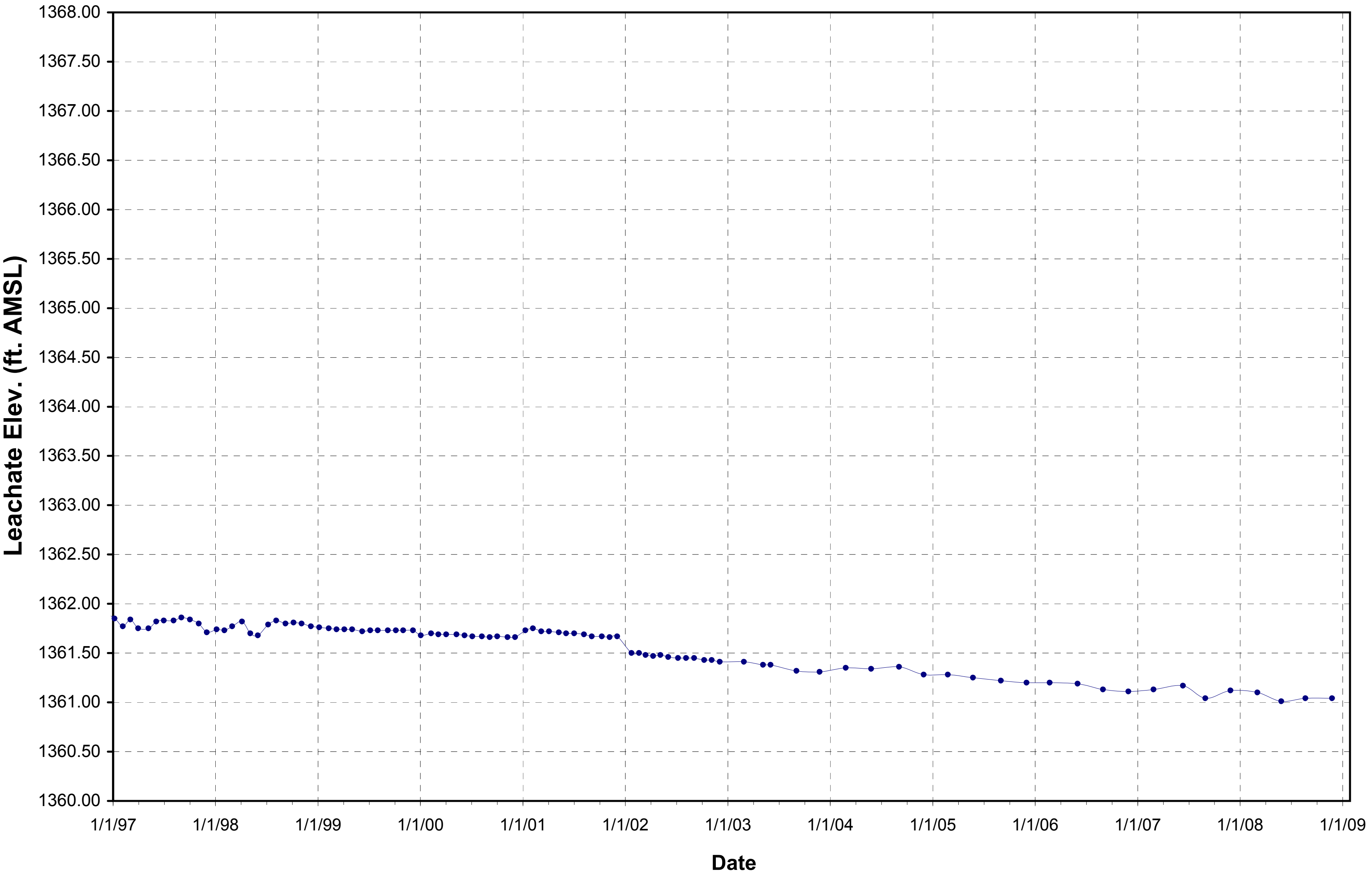


Predicted Line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date
Trench 8

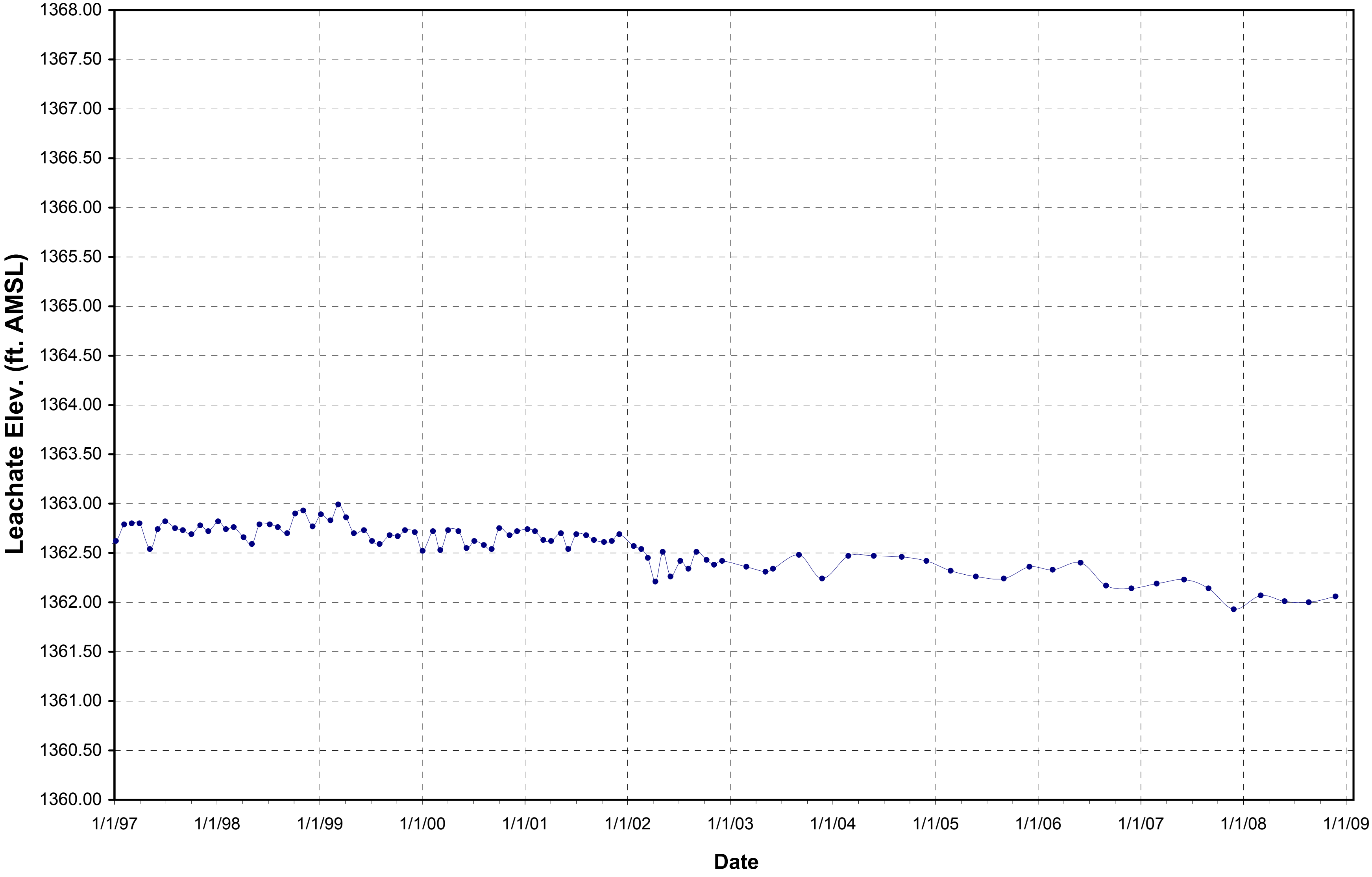


Model Residuals vs Date - not random until 2004, and random thereafter,
no seasonality identified
Trench 8



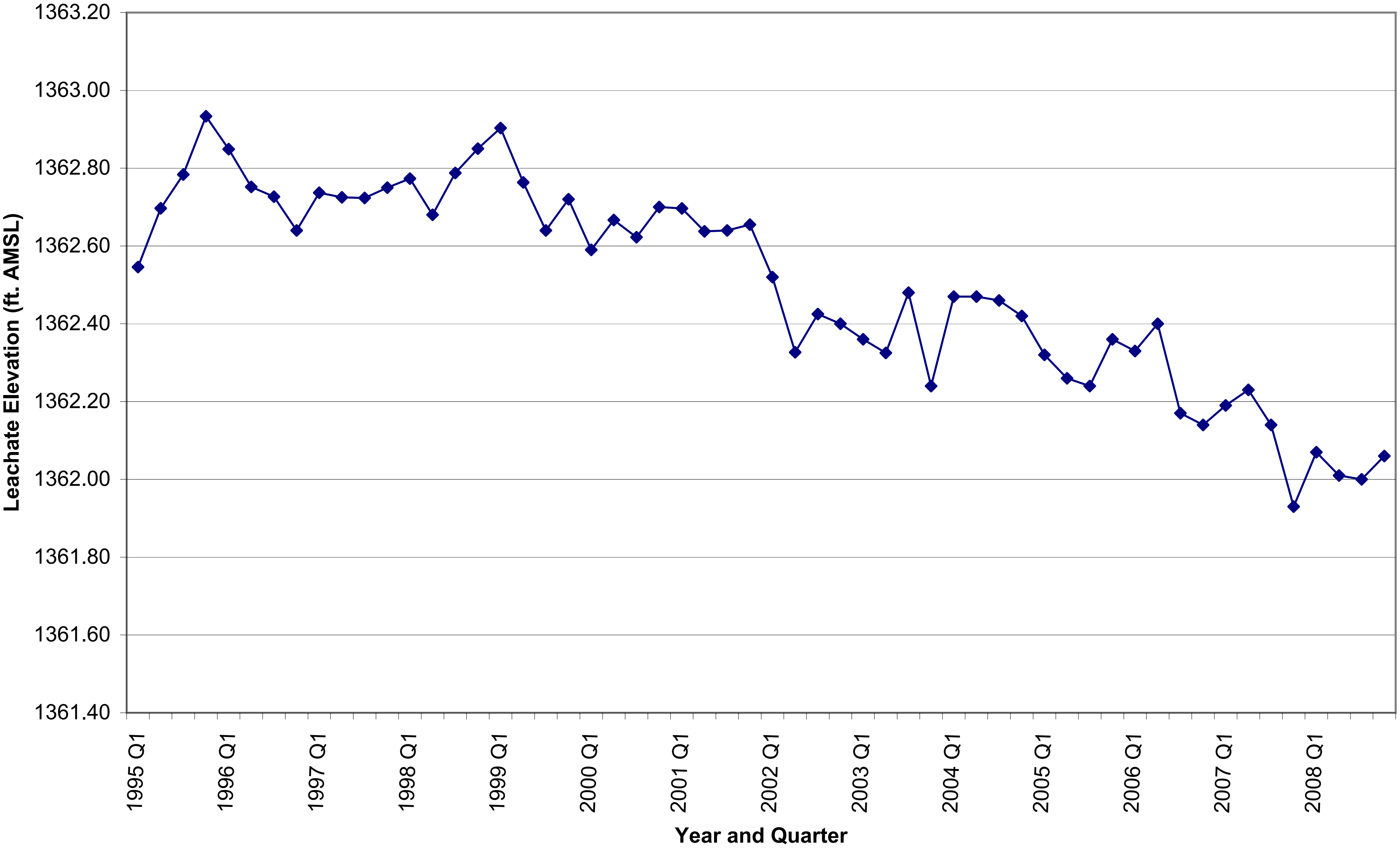


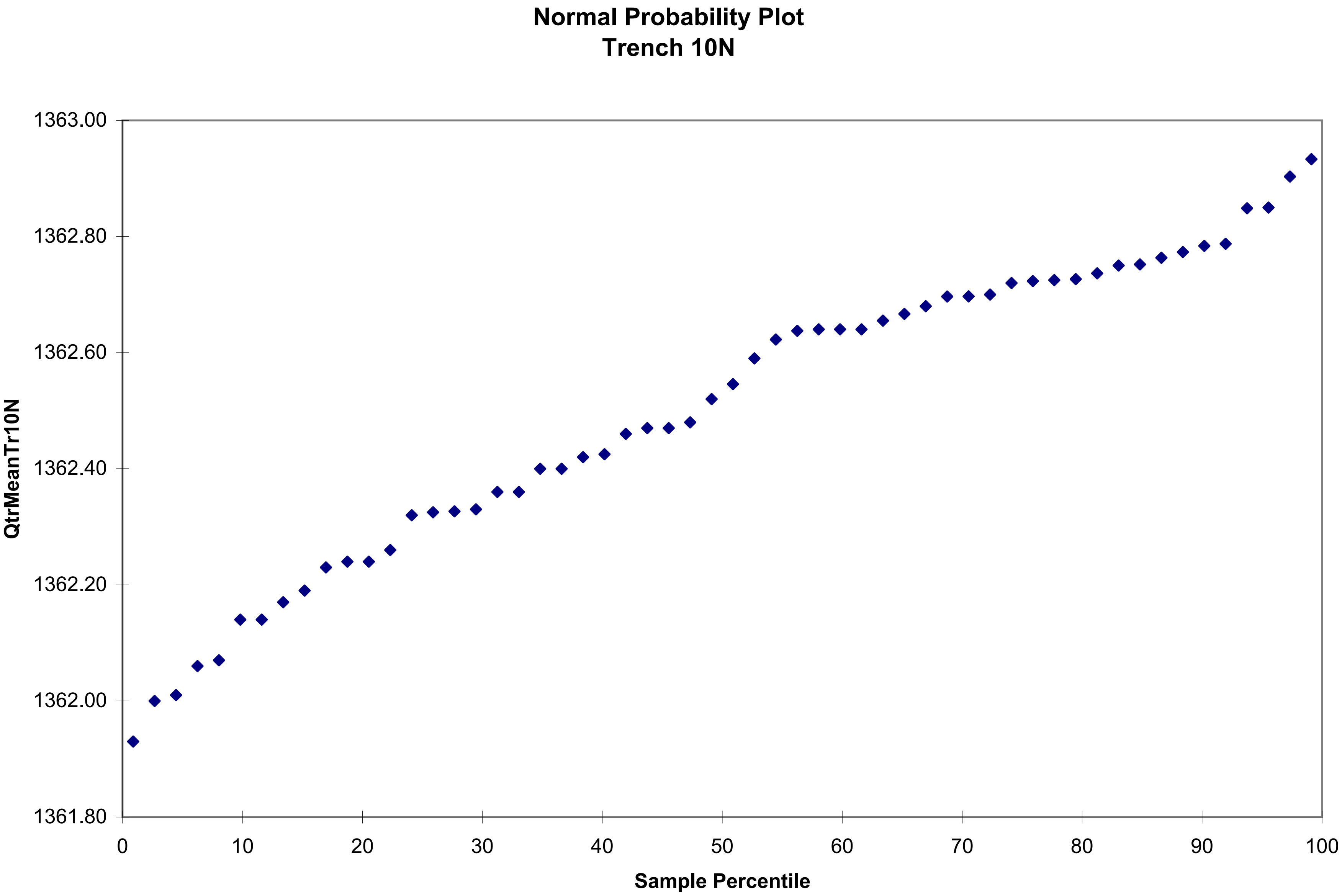
Leachate Elevation for Trench 9, 1997 to 2008



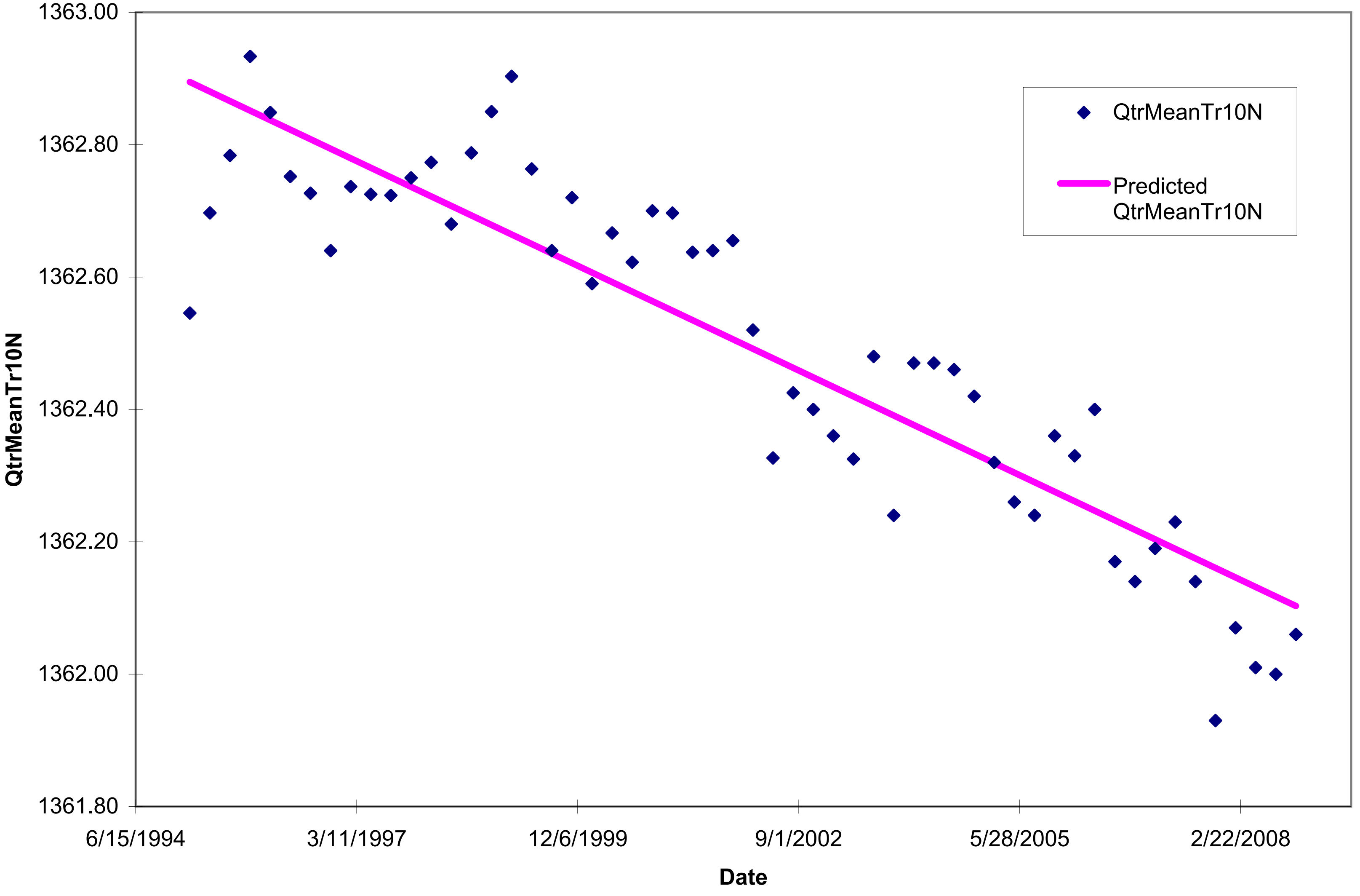
Leachate Elevation for Trench 10N, 1997 to 2008

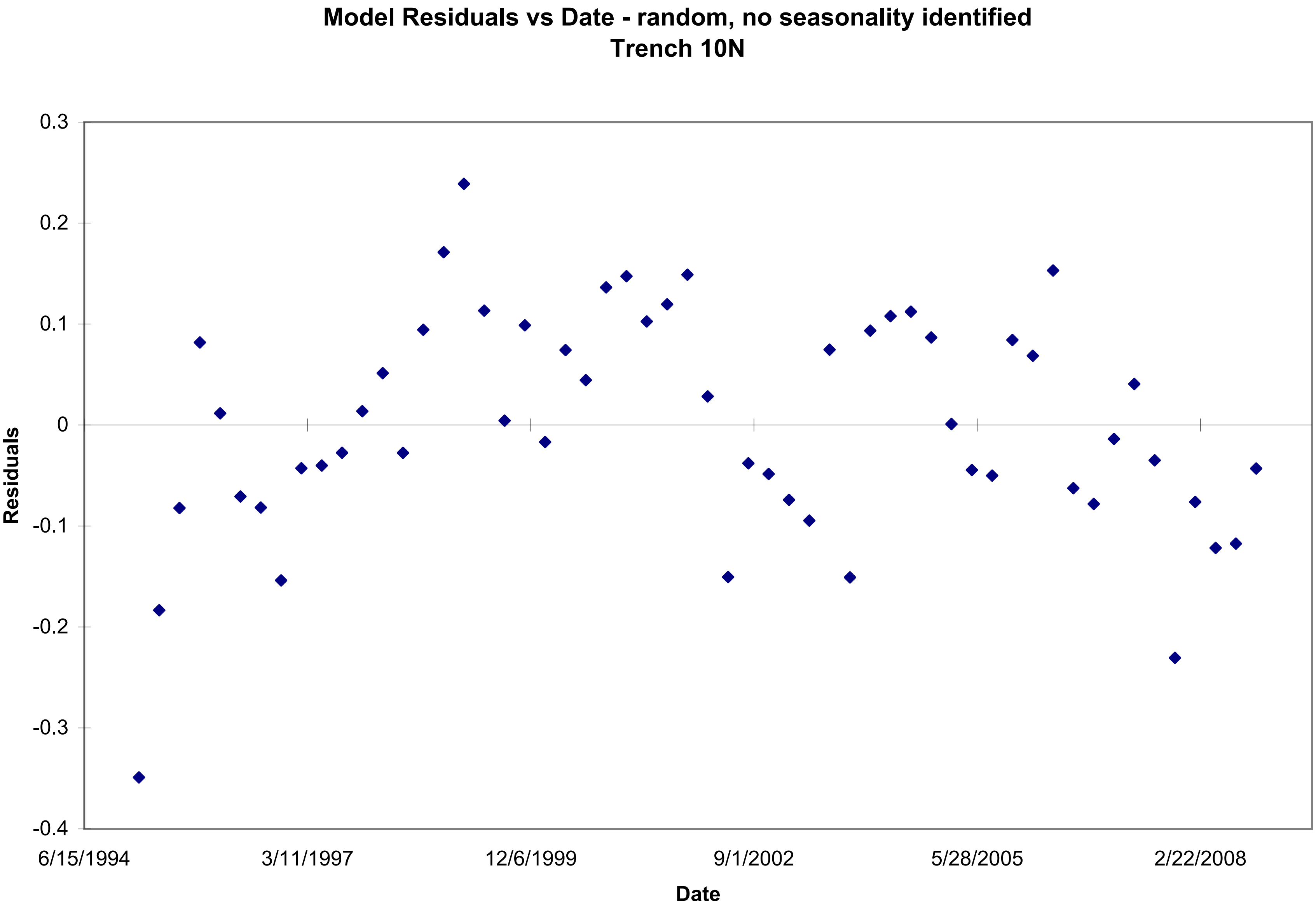
Leachate Elevations for Trench 10N, Averaged by Quarter, 1995 - 2008

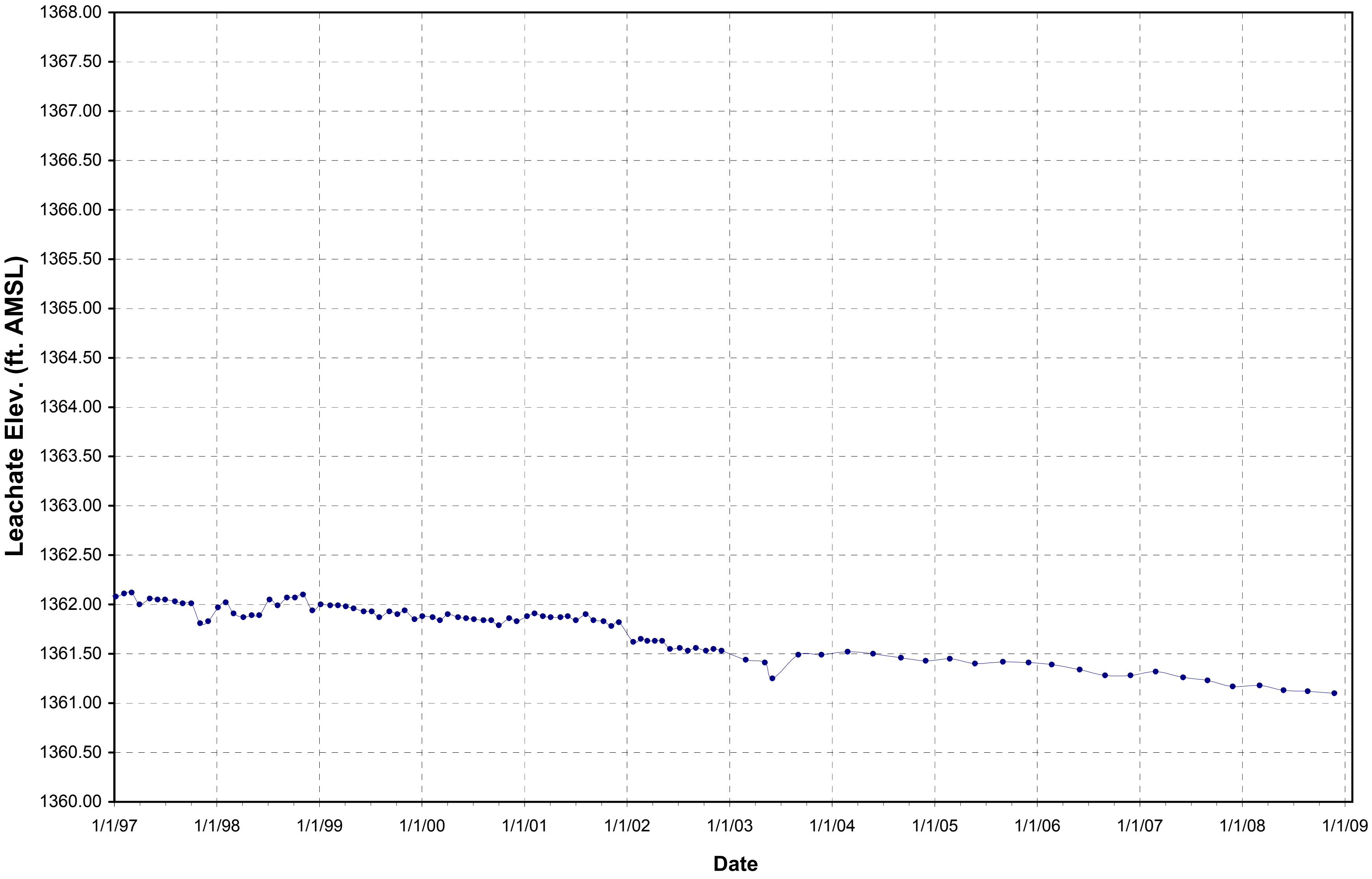



Normal Probability Plot
Trench 10N
QtrMeanTr10N
1363.00
1362.80
1362.60
1362.40
1362.20
1362.00
1361.80
0
10
20
30
40
50
60
70
80
90
100
Sample Percentile

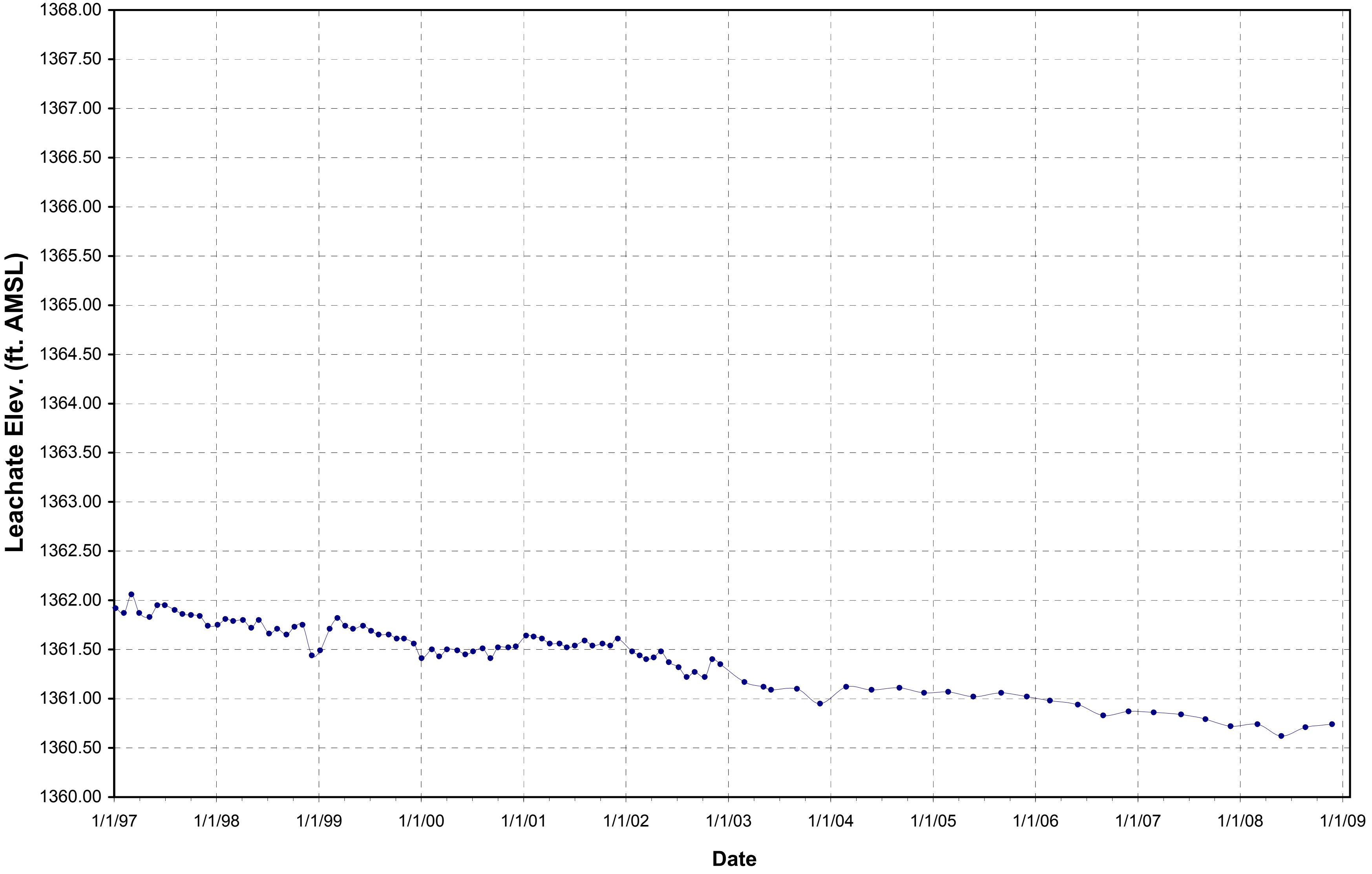
Predicted Line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date
Trench 10N



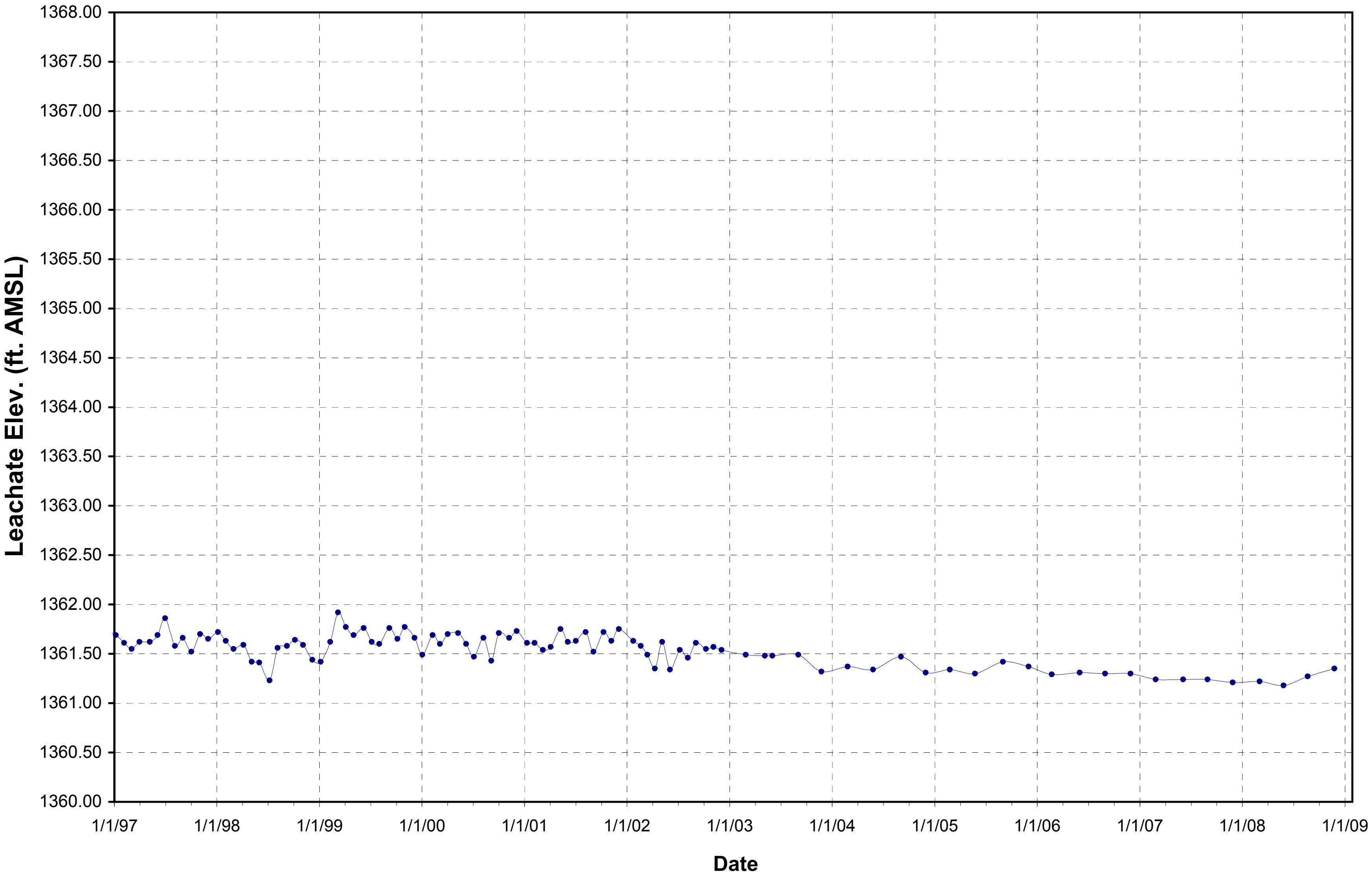

Model Residuals vs Date - random, no seasonality identified
Trench 10N
Residuals
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
6/15/1994
3/11/1997
12/6/1999
9/1/2002
5/28/2005
2/22/2008
Date



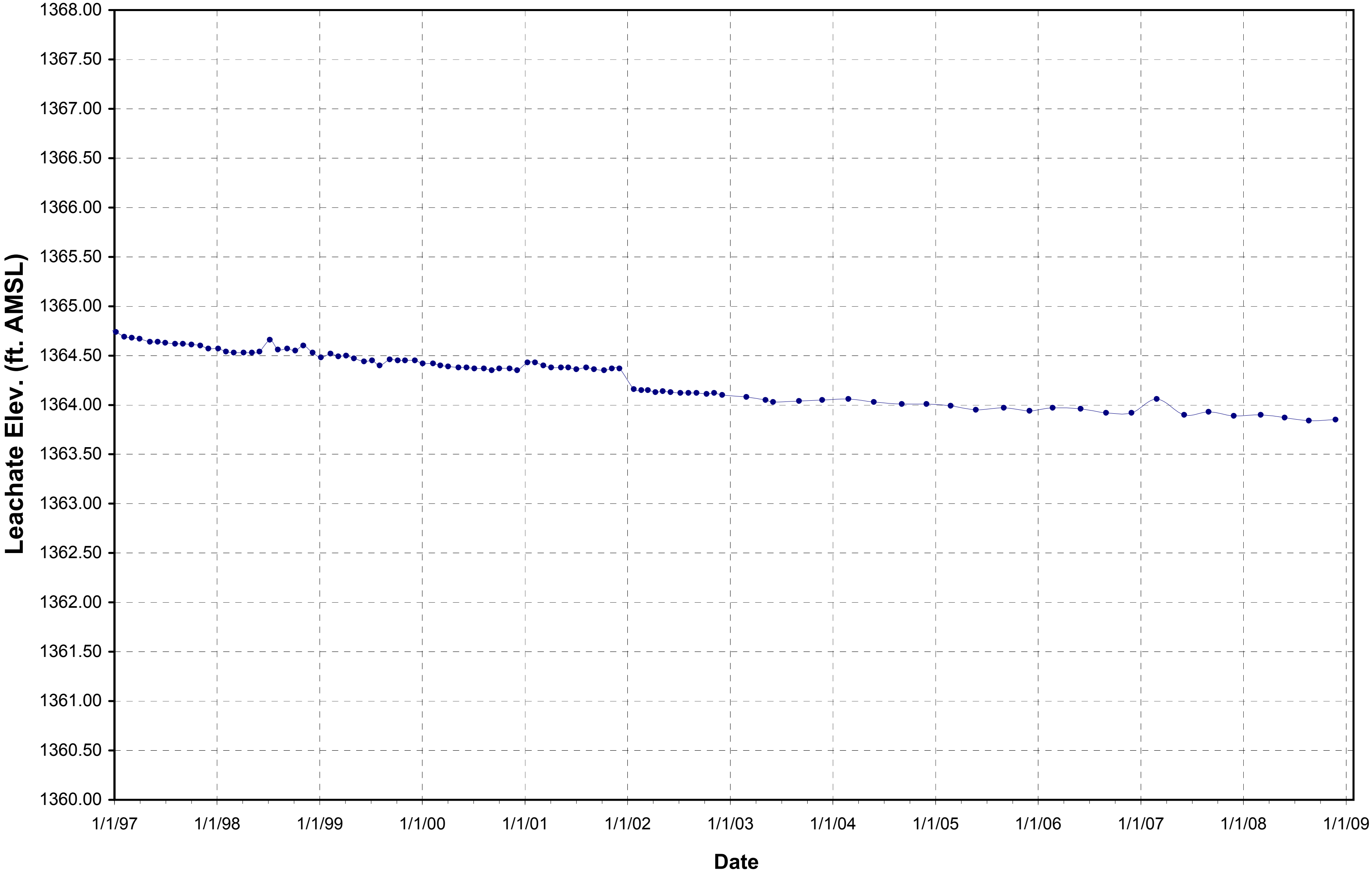
Leachate Elevation for Trench 10S, 1997 to 2008



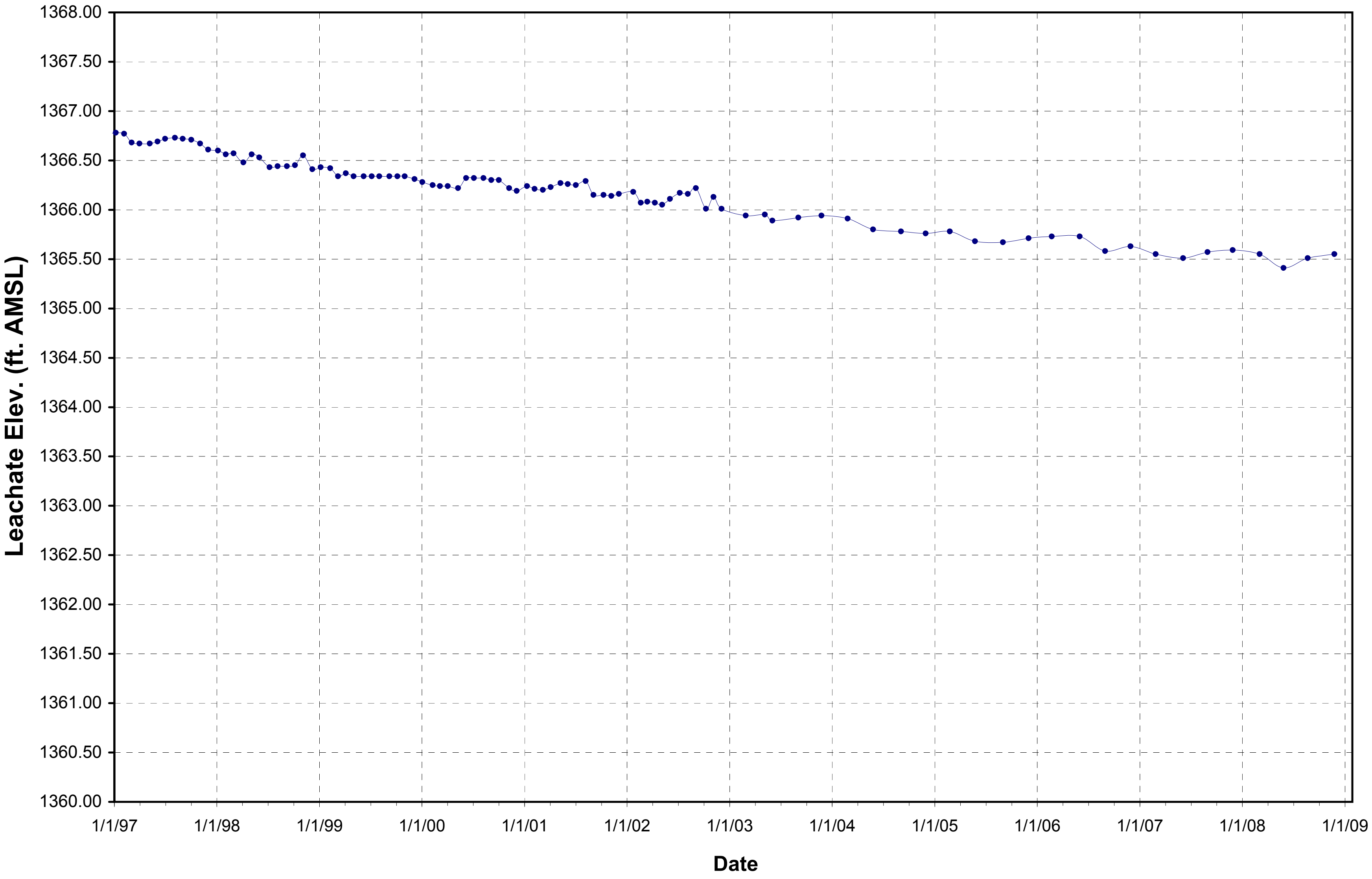
Leachate Elevation for Trench 11, 1997 to 2008



Leachate Elevation for Trench 12, 1997 to 2008

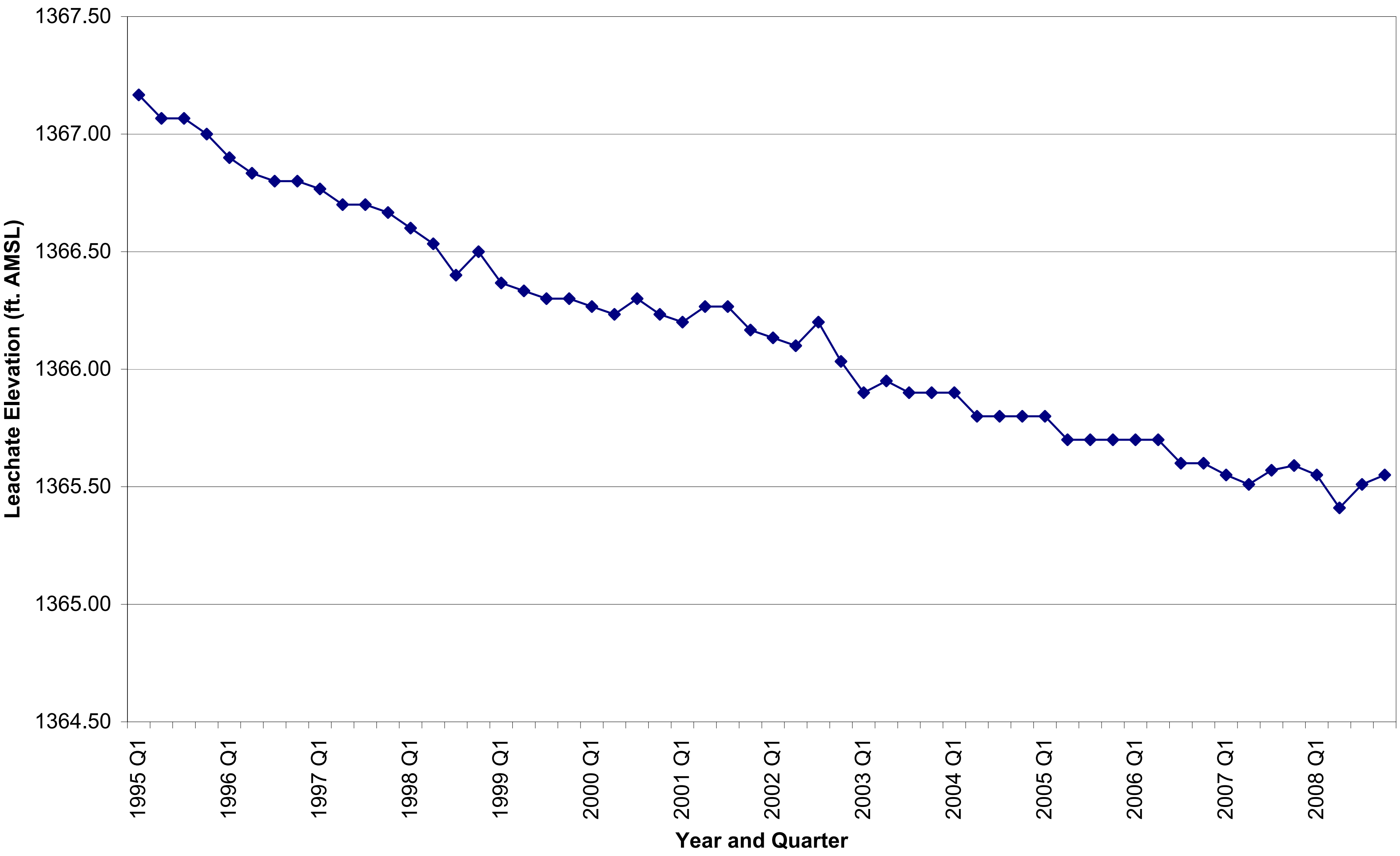


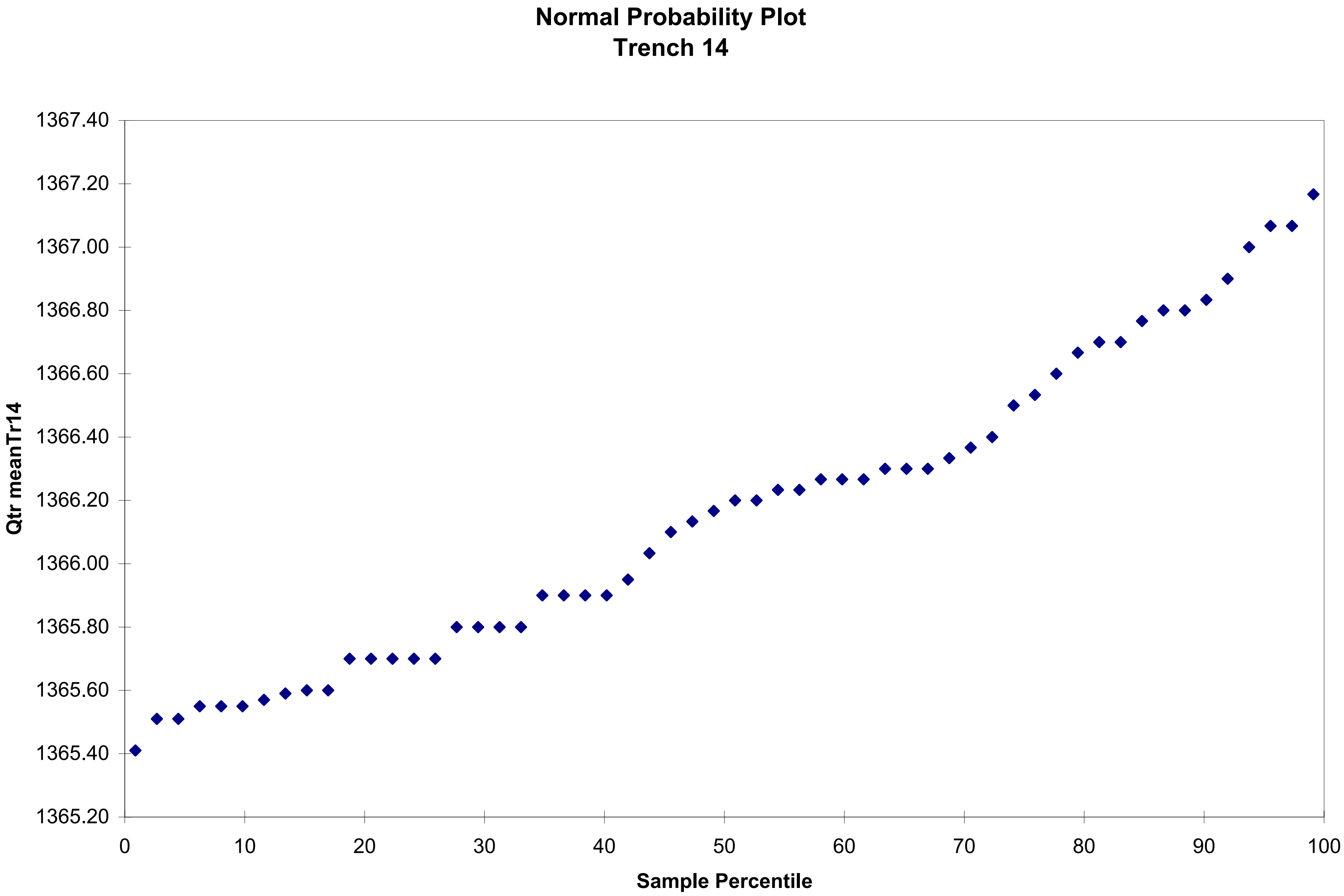
Leachate Elevation for Trench 13, 1997 to 2008



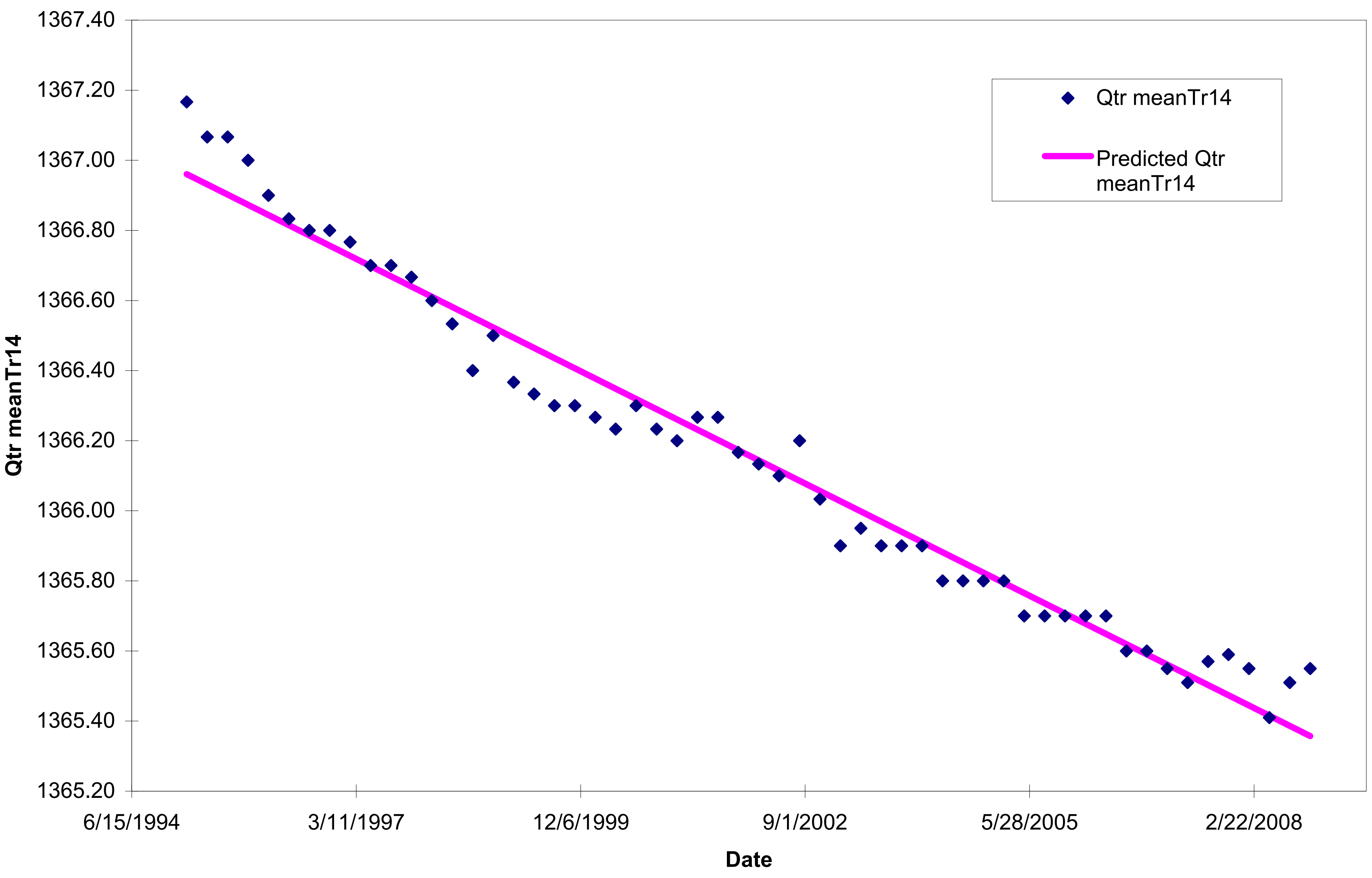
Leachate Elevation for Trench 14, 1997 to 2008

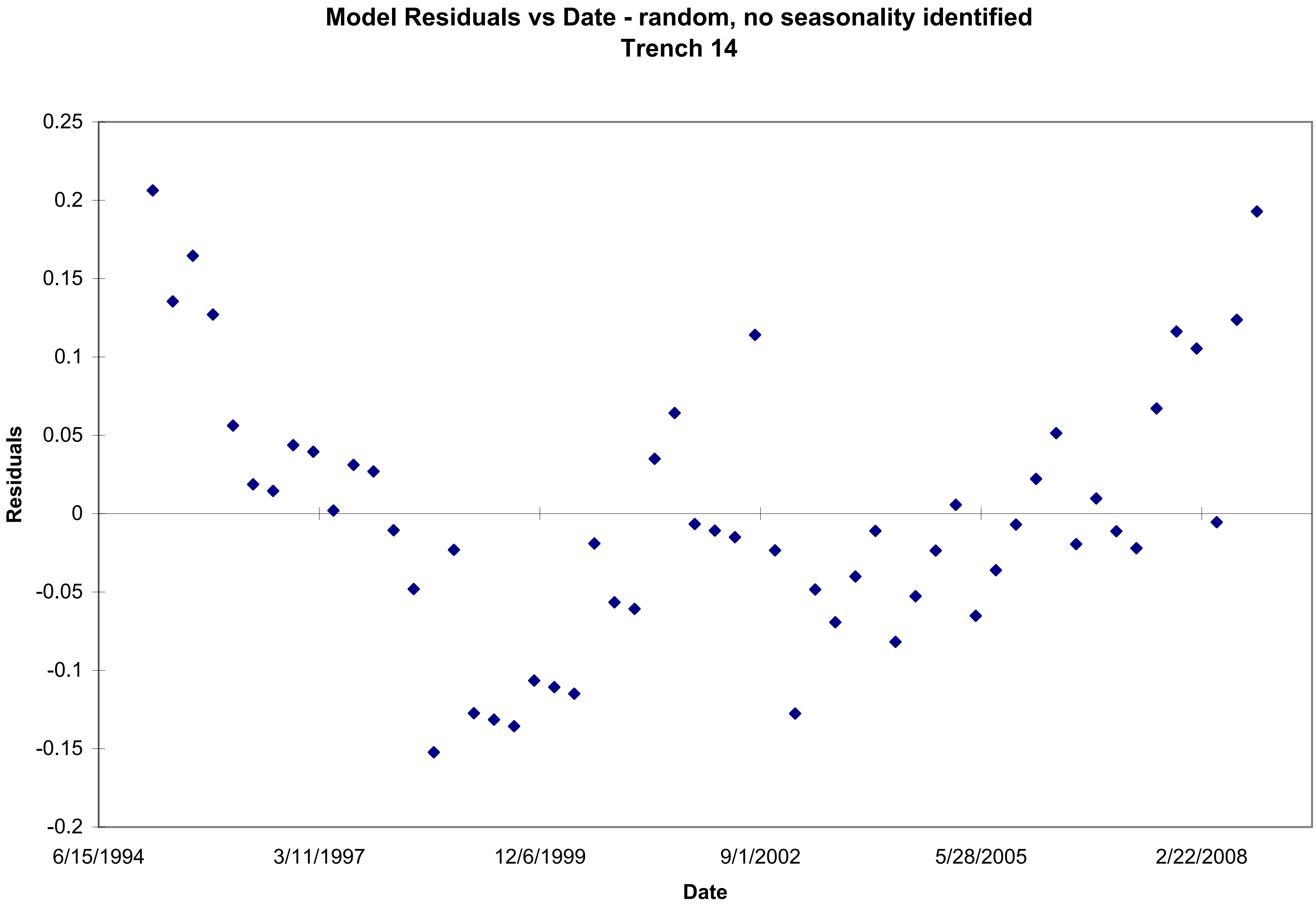
Leachate Elevations for Trench 14, Averaged by Quarter, 1995 - 2008




Normal Probability Plot
Trench 14
Qtr meanTr14
1367.40
1367.20
1367.00
1366.80
1366.60
1366.40
1366.20
1366.00
1365.80
1365.60
1365.40
1365.20
0
10
20
30
40
50
60
70
80
90
100
Sample Percentile

Predicted Line vs Actual Data Plot, Linear Regression of Leachate Elevations vs Date
Trench 14




Model Residuals vs Date - random, no seasonality identified
Trench 14
Residuals
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
6/15/1994
3/11/1997
12/6/1999
9/1/2002
5/28/2005
2/22/2008
Date

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E

Ambient Air Sampling at the SDA

Ambient air sampling was conducted at the State-Licensed Disposal Area (SDA) on October 21 and 22, 2009. Ambient air sampling for assessing the potential for off-site migration of volatile organic compounds (VOCs) at the SDA was last performed in 1993. At that time, the geomembrane cover had not been fully installed over all trenches. The purpose of the current sampling is to update the information regarding VOC concentrations in ambient air at the SDA for comparison to the 1993 data.

Sample locations and sampling procedures were kept as similar as possible to the previous 1993 sampling study. It should be noted that analytical procedures, particularly with respect to detection limits, have been refined since the 1993 study and detection limits are lower today than were possible in 1993. Thus, some of the VOCs detected in the current sampling event also may have been present in 1993 below the detection limits in place at the time.

Meteorological Conditions

On-site meteorological conditions were documented with data provided from the WVDP 10-meter meteorological tower near the SDA. The data were used to document the conditions under which the samples were collected. Wind speed and direction were of primary importance for the study; temperature, precipitation and barometric pressure also were monitored.

Sampling was performed for a 24-hour period beginning at approximately 10 a.m. on October 21 and ending at approximately 10 a.m. on October 22, 2009. During this period, 16.7% of the time the winds were calm and 83.3% of the time the wind speeds ranged from 1 mile per hour (mph) to 14 mph. Wind direction was generally from the south-southeast and no precipitation occurred during the sampling period. Ambient air temperature ranged from 51°F to 59°F during the sampling period. A wind rose for the sampling period is shown as Figure E-1.

Sampling Methodology

The air sampling was conducted in accordance with a work plan developed specifically for this study. Sampling and analysis were conducted following the EPA’s Compendium Method TO-15. Sample canisters and flow control devices were obtained from the analytical laboratory that performed the air analyses (Test

America Incorporated, Knoxville, Tennessee). The air samples were analyzed for 113 target VOCs.

Sample Site Selection

Sample locations for this study were selected to match as closely as possible the location of air samples collected in the 1993 study. Forecasted wind direction and wind direction on the day of canister deployment were used to place the canisters such that there was at least one upwind site and several downwind sites. Based on the wind direction during sampling shown in Figure E-1, the canisters were placed at the following sample locations:

- Upwind site – SDA1-A06;
- Downwind sites – SDA1-A05, SDA1-A04, SDA1-A02/03 (sample field duplicate site), SDA1-A8201 (sample field blank site).

Figure E-2 shows the sample locations. The site is free of significant microscale obstructions to air flow. The trench area is slightly elevated above the surrounding ground area; however, the slope of the trench area is gentle and does not significantly disturb air flow. The general site location is in an area of moderate terrain consisting of hills and valleys, thus wind tends to vary significantly in direction during periods of low wind speed.

Each sample canister was set on a base which was placed on top of the geomembrane cover. An air inlet tube extended approximately 18 inches above the sample canister; therefore, the air inlet height was approximately 4.5 feet above the ground surface.

Sample flow during the 24-hour sampling period was controlled by a mass flow controller on each sample canister. The initial vacuum in each canister was in the range of 28.5 to 29.5 inches mercury (Hg). The vacuum in each canister was in the range of 4.5 to 6.0 inches Hg at the completion of sampling.

Sampling Results

The analytical data provided by the laboratory were reviewed by a data validation chemist for precision, accuracy, and completeness following NYSDEC Division of Environmental Remediation (DER) Guidance for the Development of Data Usability Summary Reports (DUSRs), June 1999. The data were evaluated using method-specific checklists that included, but were not limited to, parameters such as holding times, laboratory blanks, field blanks, duplicate samples, comparison of sample results to previous sampling results, etc.

The data validation completeness review noted that the field blank (an evacuated air sample canister not used to collect an air sample but subject to the same handling as other air sample canisters) was reanalyzed after VOCs were detected in the field blank at levels higher than in the actual air samples. Based on the reanalysis, the laboratory determined that contamination from laboratory air resulted in the presence of 2-methylbutane, n-butane, and n-hexane in the field blank; the sample results for these compounds are therefore suspect and are not included in the tables below.

Table E-1 presents the results of the October 21 and 22, 2009, air sampling study compared to the results of the 1993 sampling study as reported in the 1994 RFI report (E & E 1994). The compounds listed are those VOCs that were detected at the SDA during the 1993 study. The ambient air concentrations in 2009 were either lower than the 1993 concentrations or reported as values below the 1993 detection limits.

Table E-1 VOCs Detected in 1993 and 2009 Sampling Studies (ppbv)

Location Identification (Year)	Benzene	Carbon Disulfide	Xylenes (Total)	Methylene Chloride
SDA1-A01 (1993)	2.3	<1.0	<1.0	<1.0
SDA1-A06 (2009)[1]	0.18	<0.2	<0.19	0.44
SDA1-A02/03 (1993)	<1.0	<1.0	<1.0	<1.0
SDA1-A02/03 (2009)[2]	0.18	<0.2	<0.19	0.44
SDA1-A04 (1993)	<1.0	1.7	3.9	1.0
SDA1-A04 (2009)	0.18	<0.2	<0.19	0.24
SDA1-A05 (1993)	<1.0	1.1	<1.0	<1.0
SDA1-A05 (2009)	0.18	<0.2	<0.19	0.30

Note 1: Location SDA1-A06 in the 2009 study approximated the location of SDA1-A01 in the 1993 study. All other sample locations used matched the locations from the 1993 study.

Note 2: Location SDA1-A02 result reported; SDA1-A03 is the field duplicate sampling location co-located with SDA1-A02.

Additional VOCs that were detected in 2009 are shown in Table E-2. All of the concentrations were below the 1993 detection limits for compounds that were analyzed in both studies. As shown, various alcohols (1-butanol, ethanol, methanol, and isopropyl alcohol) and acetone were detected at low levels near the quantifiable limits in ambient air in 2009. These compounds had not been analyzed for in 1993. The detected levels were nearly identical in the upwind (SDA1-A06) and downwind samples (SDA1-A02/03, SDA1-A04, and SDA1-A05), suggesting that the source of these compounds was outside of the SDA. The detected concentrations were far below the NYSDEC short-term and annual guideline concentrations (SGCs and AGCs). Acetone, 1-butanol, methanol, ethanol, and isopropyl alcohol are produced naturally by plants (primarily evergreens), molds, fungi, compost, and soil-dwelling microbes at low levels. Methanol is a component (up to 10%) of gasoline; alcohols and acetone are emitted by gasoline combustion engines (which may also contribute to the concentration of alcohols and acetone found in the samples). Additional sampling to further define the source of alcohols and acetone is not recommended due to the low levels detected and the similar values found in upwind and downwind locations. Based on the results of the

1993 and 2009 air sampling studies, continued routine air monitoring at the SDA is not recommended.

Table E-2 Additional VOCs Detected in 2009 Air Sampling Study (ppbv)

	Sample Location/Year/Quantity Detected							
	SDA1 A06[1]		SDA1 A02/03[2]		SDA1 A04		SDA1 A05	
VOC	2009	1993	2009	1993	2009	1993	2009	1993
1,1,2-Trichlorotrifluoroethane	<0.08	<1.0	<0.08	<1.0	<0.08	<1.0	0.081	<1.0
1-Butanol	<0.8	na	<0.8	na	0.94	na	<0.8	na
2-Butanone	0.71	na	1.2	na	0.55	na	0.52	na
4-Isopropyltoluene	0.085	na	<0.08	na	<0.08	na	<0.08	na
Acetone	7.0	na	11	na	6.4	na	5.4	na
Acrolein	<0.32	na	0.38	na	<0.32	na	<0.32	na
Carbon tetrachloride	0.086	<1.0	0.098	<1.0	0.083	<1.0	0.092	<1.0
Chlorodifluoromethane	0.32	<2.0	0.28	<2.0	0.33	<2.0	0.28	<2.0
Chloromethane	0.63	<2.0	0.75	<2.0	0.60	<2.0	0.64	<2.0
Dichlorodifluoromethane	0.59	<1.0	0.54	<1.0	0.60	<1.0	0.59	<1.0
Ethanol	5.7	na	5.4	na	5.6	na	5.3	na
Isopropyl alcohol	3.3	na	2.5	na	7.6	na	3.2	na
Methanol	14	na	14	na	13	na	13	na
Toluene	0.27	<1.0	0.26	<1.0	0.27	<1.0	0.32	<1.0
Trichlorofluoromethane	0.26	<1.0	0.25	<1.0	0.26	<1.0	0.25	<1.0

Notes

na = not analyzed

[1] Location SDA1-A06 in the 2009 study approximated the location of SDA1-A01 in the 1993 study.

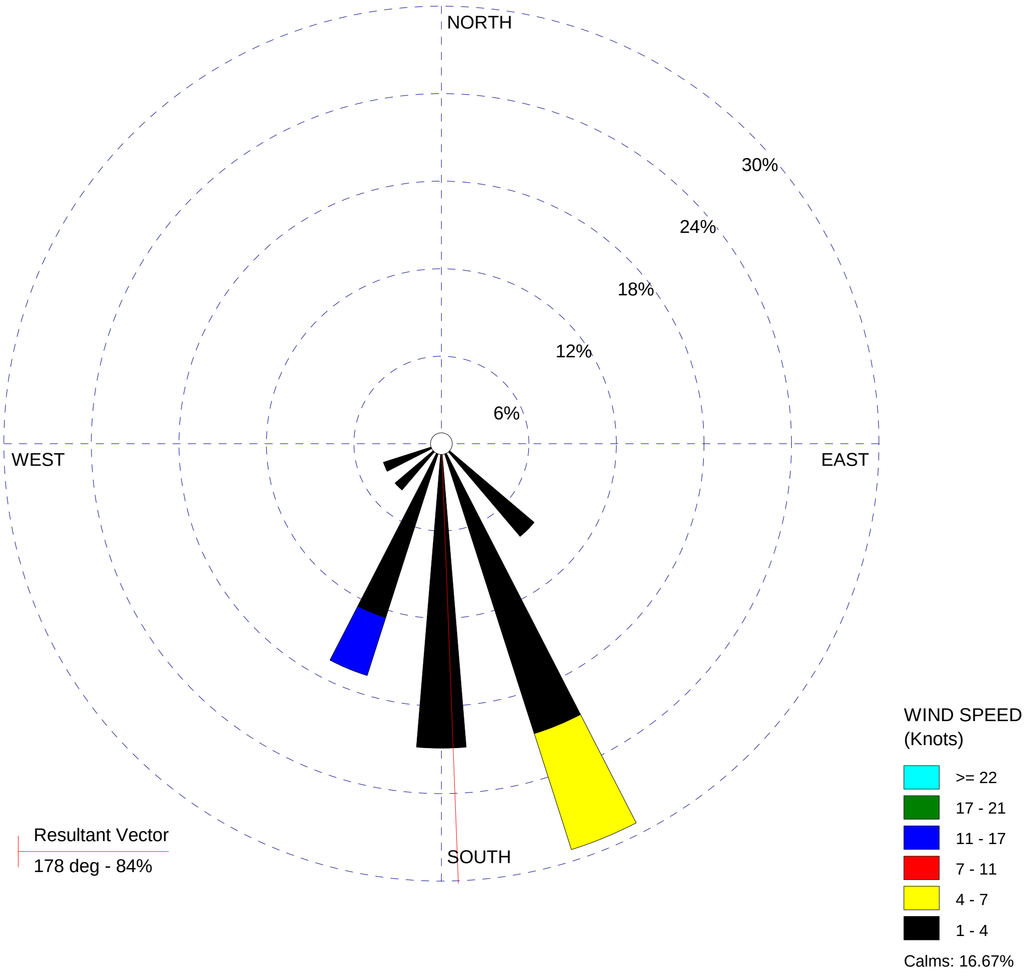
[2] Location SDA1-A02 result reported; SDA1-A03 is the field duplicate sampling location co-located with SDA1-A02.

WIND ROSE PLOT:

West Valley Oct 21 to 22, 2009
For 24 hours beginning 10am Oct 21, 2009 and ending 10am Oct 22, 2009

DISPLAY:

Wind Speed
Direction (blowing from)



COMMENTS:

From on-site met station

COMPANY NAME:

MODELER:

CALM WINDS:

16.67%

TOTAL COUNT:

24 hrs.

AVG. WIND SPEED:

2.67 Knots

DATE:

1/21/2010

PROJECT NO.:

NZ05

WRPLOT View - Lakes Environmental Software

Figure E-1 Wind Rose for Sampling Period, October 21/22, 2009

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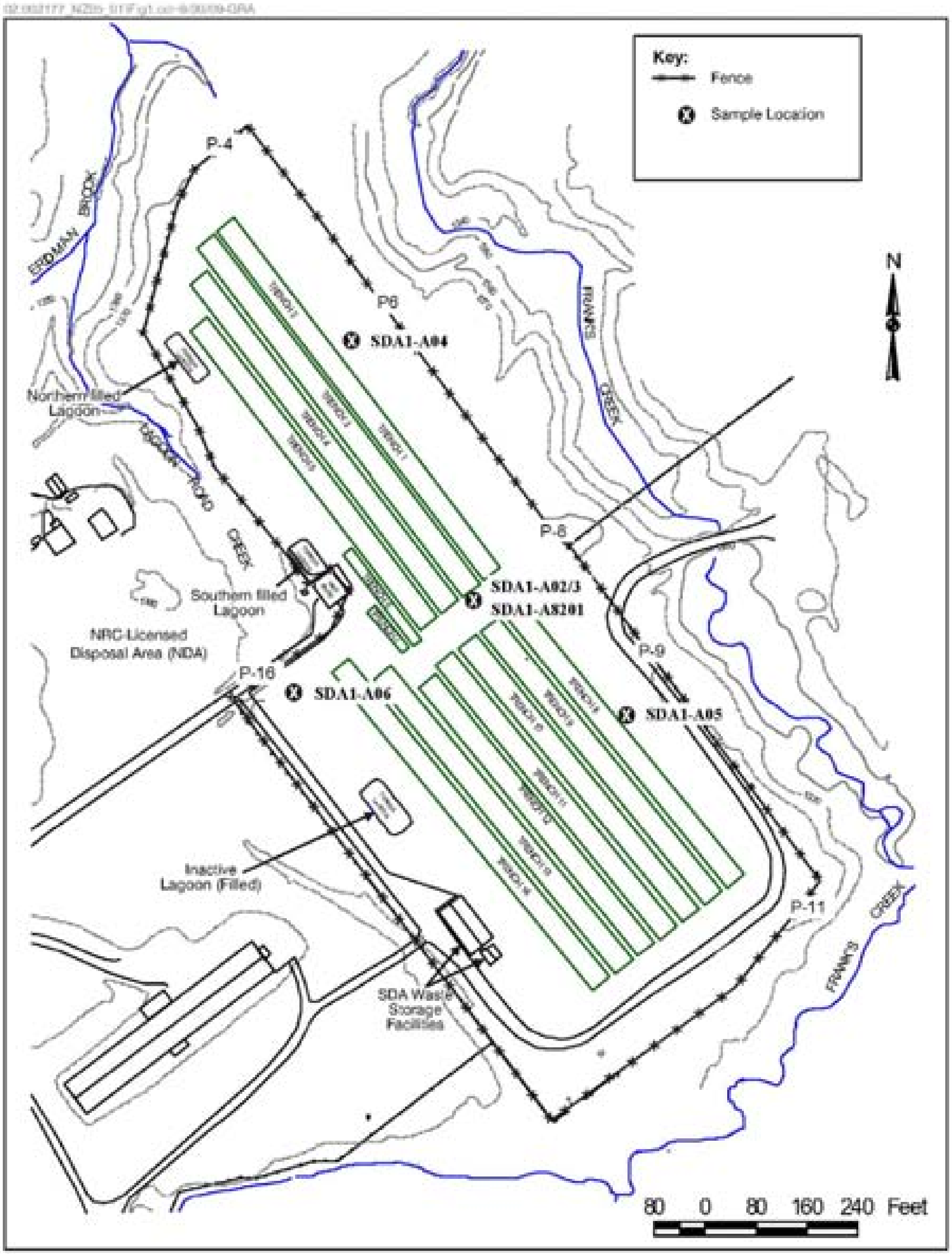

Figure E-2 Ambient Air VOC Sample Locations at the SDA - October 2009

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F

Trench Elevation Data at the SDA (1991-2008)

Table F-1 Trench Elevation Data at the SDA (1991 - 2008)

Trench No	Station	1991	1992	1993	1994	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Elevation Difference (ft) 2008 - 1991 (17 yrs)
1/2	0+0	1390.90	1391.00	1391.00	1391.50	1391.10	1391.10	1391.10	1391.10	1391.10	1391.10	1391.15	1391.14	1391.29	1391.19	1391.33	No Data	No Data	--
	1+0	1392.60	1392.60	1392.60	1393.00	1392.60	1392.60	1392.60	1392.60	1392.60	1392.70	1392.66	1392.65	1392.77	1392.70	1392.84	1392.74	1392.56	-0.04
	2+0	1391.70	1391.70	1391.80	1392.30	1391.60	1391.60	1391.70	1391.60	1391.60	1391.70	1391.72	1391.72	1391.83	1391.75	1391.86	1391.78	1391.62	-0.08
	3+0	1391.40	1391.30	1391.50	1391.70	1391.20	1391.20	1391.30	1391.10	1391.30	1391.30	1391.35	1391.32	1391.45	1391.40	1391.46	1391.40	1391.24	-0.16
	4+0	1390.90	1390.90	1391.00	1391.30	1390.70	1390.70	1390.70	1390.60	1390.70	1390.80	1390.79	1390.74	1390.88	1390.85	1391.03	1390.83	1390.72	-0.18
	5+0	1389.70	1389.60	1389.70	1390.10	1389.60	1389.60	1389.60	1389.40	1389.60	1389.60	1389.67	1389.63	1389.79	1389.75	1389.85	1389.72	1389.61	-0.09
	6+0	1386.90	1386.90	1386.90	1387.30	1386.70	1386.70	1386.80	1386.60	1386.80	1386.90	1386.86	1386.86	1386.99	1386.94	1387.02	1386.92	1386.79	-0.11
	7+0	1382.00	1382.10	1382.10	1382.60	1382.00	1382.00	1382.10	1381.90	1382.10	1382.20	1382.2	1382.19	1382.31	1382.25	1382.31	No Data	No Data	--
	7+10	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1380.29	1380.36	1380.33	1380.46	1380.47	1380.39	1380.33	--
	7+20	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1378.16	1378.21	1378.23	1378.29	1378.32	1378.20	1378.17	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1384.64	1384.59	1384.57	1384.47	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1393.67	1393.57	1393.41	--
3	0+0	1391.00	1391.00	1391.00	1391.60	1391.20	1391.20	1391.20	1391.20	1391.20	1391.30	1391.29	1391.32	1391.39	1391.34	1391.46	No Data	No Data	--
	1+0	1392.90	1392.90	1393.00	1393.40	1393.00	1393.00	1393.10	1393.00	1393.00	1393.10	1393.16	1393.20	1393.26	1393.22	1393.29	1393.21	1393.13	0.23
	2+0	1392.90	1392.90	1393.00	1393.40	1393.00	1393.00	1393.00	1392.90	1393.00	1393.10	1393.09	1393.10	1393.16	1393.15	1393.15	1393.13	1393.03	0.13
	3+0	1391.90	1391.80	1391.90	1392.30	1391.80	1391.80	1391.80	1391.70	1391.80	1391.90	1391.87	1391.86	1391.93	1391.91	1392.06	1391.90	1391.83	-0.07
	4+0	1391.50	1391.40	1391.40	1391.90	1391.30	1391.30	1391.30	1391.10	1391.30	1391.40	1391.39	1391.38	1391.49	1391.45	1391.61	1391.46	1391.39	-0.11
	5+0	1389.90	1389.90	1390.00	1390.40	1389.80	1389.80	1389.90	1389.70	1389.90	1390.00	1389.93	1389.86	1390.00	1390.01	1390.09	1389.97	1389.88	-0.02
	6+0	1387.10	1387.00	1387.20	1387.50	1387.10	1387.00	1387.10	1386.90	1387.10	1387.20	1387.15	1387.14	1387.27	1387.27	1387.29	1387.20	1387.30	0.20
	7+0	1382.60	1382.70	1382.70	1383.10	1382.60	1382.60	1382.70	1382.50	1382.80	1382.80	1382.79	1382.82	1382.91	1382.94	1382.88	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1385.01	1385.00	1384.88	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1393.83	1393.73	1393.62	--
4	0+0	1391.40	1391.40	1391.30	1391.90	1391.40	1391.40	1391.40	1391.50	1391.40	1391.50	1391.5	1391.52	1391.62	1391.55	1391.71	No Data	No Data	--
	1+0	1392.60	1392.50	1392.60	1393.00	1392.40	1392.40	1392.40	1392.40	1392.30	1392.40	1392.39	1392.39	1392.48	1392.39	1392.49	1392.38	1392.21	-0.39
	2+0	1392.90	1392.90	1392.90	1393.40	1392.90	1392.80	1392.90	1392.90	1392.80	1392.90	1392.96	1392.93	1393.06	1393.03	1393.07	1393.03	1392.94	0.04
	3+0	1392.40	1392.40	1392.50	1392.90	1392.30	1392.30	1392.30	1392.30	1392.30	1392.30	1392.39	1392.36	1392.48	1392.43	1392.46	1392.46	1392.31	-0.09
	4+0	1392.20	1392.00	1392.20	1392.70	1392.10	1392.10	1392.10	1392.10	1392.10	1392.20	1392.2	1392.18	1392.31	1392.28	1392.41	1392.25	1392.16	-0.04
	5+0	1390.40	1390.30	1390.40	1390.90	1390.30	1390.30	1390.30	1390.20	1390.30	1390.30	1390.37	1390.35	1390.47	1390.43	1390.50	1390.39	1390.30	-0.10
	6+0	1388.10	1388.00	1388.20	1388.60	1388.00	1388.00	1388.00	1387.90	1388.00	1388.00	1388.08	1388.04	1388.18	1388.18	1388.14	1388.12	1387.97	-0.13
	6+57	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1385.61	1385.62	1385.76	1385.76	1385.70	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1388.00	1388.00	1387.84	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1394.22	1394.12	1394.02	--
5	0+0	1391.50	1391.50	1391.60	1392.00	1391.10	1391.50	1391.50	1391.50	1391.40	1391.50	1391.57	1391.52	1391.66	1391.65	1391.74	No Data	No Data	--
	1+0	1392.20	1392.20	1392.30	1392.60	1392.30	1392.30	1392.40	1392.30	1392.30	1392.30	1392.42	1392.38	1392.51	1392.51	1392.58	1392.46	1392.37	0.17
	2+0	1391.90	1391.90	1392.00	1392.20	1391.90	1391.90	1391.90	1391.90	1391.80	1391.90	1391.96	1391.93	1392.02	1392.01	1392.06	1391.91	1391.88	-0.02
	3+0	1391.30	1391.20	1391.30	1391.40	1391.00	1391.00	1391.10	1391.00	1391.00	1391.00	1391.09	1391.06	1391.17	1391.14	1391.23	1391.06	1390.97	-0.33
	4+0	1390.70	1390.40	1390.80	1390.80	1390.40	1390.30	1390.40	1390.30	1390.40	1390.30	1390.42	1390.39	1390.50	1390.49	1390.57	1390.43	1390.30	-0.40
	5+0	1390.40	1390.40	1389.90	1390.90	1390.30	1390.30	1390.30	1390.30	1390.40	1390.30	1390.43	1390.41	1390.55	1390.54	1390.55	1390.45	1390.38	-0.02
	6+0	1387.40	1387.30	1387.40	1387.90	1387.40	1387.40	1387.40	1387.40	1387.40	1387.40	1387.50	1387.50	1387.64	1387.66	1387.62	1387.52	1387.44	0.04
	6+1	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1300.00	No Data	No Data	1387.50	1387.50	1387.61	1387.62	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1389.21	1389.14	1389.05	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1394.70	1394.60	1394.56	--
6	0+0	1385.40	1385.40	1385.40	1385.80	1385.50	1385.50	1385.50	1385.50	1385.50	1385.60	1385.64	1385.64	1385.72	1385.70	1385.77	No Data	No Data	--
	1+0	1388.60	1388.50	1388.50	1389.00	1388.80	1388.80	1388.80	1388.80	1388.80	1388.90	1388.93	1388.96	1389.06	1389.05	1389.10	1389.02	1388.90	0.30
	1+81.5	1388.80	1388.80	1388.80	1389.30	1389.10	1389.00	1389.10	1389.10	1389.10	1388.90	1389.19	1389.17	1389.26	1389.23	1389.28	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1391.45	1391.43	1391.36	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1386.71	1386.62	1386.52	--

Table F-1 Trench Elevation Data at the SDA (1991 - 2008)

Trench No	Station	1991	1992	1993	1994	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Elevation Difference (ft) 2008 - 1991 (17 yrs)
7	0+0	1384.90	1384.90	1385.60	1386.00	1385.60	1385.60	1385.60	1385.60	1385.60	1385.60	1385.71	1385.67	1385.91	1385.79	1385.96	No Data	No Data	--
	0+42.25	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1385.69	1385.67	1385.79	1385.78	1385.84	1385.76	1385.70	--
	0+50	1385.00	1384.80	1385.30	1385.70	1385.60	1385.50	1385.60	1385.60	1385.60	1385.60	No Data	No Data	No Data	No Data	No Data	No Data	No Data	--
	0+84.5	No Data	No Data	No Data	No Data	No Data	1384.30	1384.30	1384.30	1384.30	1384.30	1384.41	1384.39	1384.53	1384.49	1384.55	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1385.60	1385.54	1385.45	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1386.73	1386.65	1386.59	--
8	0+0	1388.90	1388.50	1388.90	1389.20	1388.60	1388.60	1388.60	1388.60	1388.60	1388.70	1388.65	1388.75	1388.85	1388.70	1388.84	No Data	No Data	--
	1+0	1388.40	1388.40	1388.50	1388.90	1388.30	1388.20	1388.20	1388.10	1388.40	1388.20	1388.21	1388.25	1388.33	1388.16	1388.24	1388.18	1388.10	-0.30
	2+0	1388.60	1388.70	1388.80	1389.20	1388.60	1388.60	1388.60	1388.60	1388.70	1388.60	1388.66	1388.69	1388.78	1388.68	1388.74	1388.69	1388.58	-0.02
	3+0	1388.60	1388.40	1388.60	1389.10	1388.50	1388.40	1388.50	1388.50	1388.50	1388.40	1388.48	1388.50	1388.56	1388.47	1388.50	1388.50	1388.40	-0.20
	4+0	1388.40	1388.30	1388.50	1388.90	1388.30	1388.30	1388.30	1388.20	1388.30	1388.30	1388.32	1388.32	1388.42	1388.33	1388.36	1388.35	1388.25	-0.15
	5+0	1388.40	1388.40	1388.40	1388.80	1388.30	1388.30	1388.30	1388.30	1388.30	1388.30	1388.26	1388.36	1388.45	1388.39	1388.41	1388.37	1388.25	-0.15
	5+62	1387.50	1387.60	1387.50	1387.70	1387.20	1387.30	1387.30	1387.30	1387.30	1387.40	1387.44	1387.42	1387.53	1387.49	1387.58	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1389.84	1389.86	1389.76	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1391.01	1390.99	1390.90	--
9	0+0	1386.50	1386.30	1386.90	1387.30	1386.90	1386.80	1386.90	1386.50	1386.80	1386.60	1386.91	1386.86	1386.94	1386.80	1386.90	No Data	No Data	--
	1+0	1386.30	1387.40	1387.20	1387.70	1387.20	1387.10	1387.10	1386.90	1387.10	1387.00	1387.03	1387.15	1387.21	1387.09	1387.15	1387.11	1387.05	0.75
	2+0	1387.40	1387.40	1387.90	1388.50	1387.90	1387.90	1387.70	1387.60	1387.70	1387.70	1387.76	1387.88	1387.92	1387.82	1387.88	1387.83	1387.86	0.46
	3+0	1387.70	1387.80	1388.40	1388.90	1388.30	1388.30	1388.30	1388.10	1388.10	1388.10	1388.18	1388.28	1388.32	1388.24	1388.28	1388.26	1388.19	0.49
	4+0	1387.90	1387.90	1389.00	1389.50	1389.00	1389.00	1388.70	1388.70	1388.80	1388.80	1388.84	1388.93	1388.98	1388.89	1388.94	1388.92	1388.82	0.92
	5+0	1388.20	1388.30	1389.40	1389.80	1389.20	1389.20	1389.30	1389.10	1389.10	1389.20	1389.21	1389.25	1389.31	1389.26	1389.30	1389.26	1389.18	0.98
	5+62	1388.20	1388.20	1389.20	1388.80	1388.60	1388.70	1388.70	1388.70	1387.70	1387.80	1387.91	1387.90	1388.01	1387.96	1388.05	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1390.60	1390.63	1390.50	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1389.24	1389.22	1389.18	--
10	0+0	1384.90	1384.90	1384.90	1385.50	1385.00	1385.00	1384.90	1384.90	1385.10	1385.00	1385.09	1385.23	1385.34	1385.48	1385.24	No Data	No Data	--
	1+0	1386.30	1386.40	1386.30	1386.70	1386.20	1386.20	1386.20	1386.10	1386.30	1386.20	1386.17	1386.26	1386.34	1386.20	1386.25	1386.18	1386.13	-0.17
	2+0	1387.20	1387.20	1387.20	1387.40	1387.10	1387.10	1387.20	1387.10	1387.20	1387.20	1387.22	1387.21	1387.38	1387.25	1387.29	1387.26	1387.28	0.08
	3+0	1387.80	1388.00	1388.00	1388.10	1387.70	1387.70	1387.70	1387.70	1387.80	1387.80	1387.81	1387.25	1387.94	1387.81	1387.87	1387.86	1387.78	-0.02
	4+0	1388.40	1388.40	1388.40	1388.90	1388.30	1388.30	1388.30	1388.30	1388.40	1388.30	1388.41	1388.45	1388.52	1388.43	1388.46	1388.44	1388.36	-0.04
	5+0	1388.60	1388.60	1388.60	1389.10	1388.40	1388.50	1388.50	1388.50	1388.50	1388.50	1388.53	1388.58	1388.66	1388.57	1388.60	1388.60	1388.52	-0.08
	5+62	1388.00	1388.00	1387.90	1387.50	1387.60	1387.60	1387.60	1387.60	1387.60	1387.60	1387.68	1387.7	1387.82	1387.73	1387.84	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1390.23	1390.24	1390.20	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1387.36	1387.32	1387.28	--
11	0+0	1384.30	1384.40	1384.30	1384.80	1384.30	1384.30	1384.40	1384.30	1384.40	1384.30	1384.34	1384.43	1384.58	1384.58	1384.50	No Data	No Data	--
	1+0	1385.10	1385.10	1385.10	1385.40	1385.10	1385.10	1385.10	1385.10	1385.20	1385.10	1385.16	1385.18	1385.32	1385.20	1385.26	1385.19	1385.14	0.04
	2+0	1386.30	1386.30	1386.30	1386.80	1386.20	1386.20	1386.20	1386.20	1386.30	1386.20	1386.29	1386.33	1386.47	1386.35	1386.39	1386.35	1386.28	-0.02
	3+0	1387.20	1387.20	1387.20	1387.70	1387.20	1387.10	1387.20	1387.20	1387.20	1387.20	1387.26	1387.27	1387.41	1387.28	1387.32	1387.32	1387.23	0.03
	4+0	1387.80	1387.70	1387.80	1388.10	1387.60	1387.60	1387.60	1387.60	1387.70	1387.70	1387.71	1387.70	1387.84	1387.74	1387.76	1387.75	1387.66	-0.14
	5+0	1388.00	1388.00	1387.90	1388.30	1387.90	1387.90	1387.90	1387.90	1387.90	1387.90	1387.97	1387.94	1388.07	1388.01	1388.03	1388.01	1387.88	-0.12
	5+62	1387.40	1387.40	1387.40	1387.90	1387.00	1387.00	1387.00	1387.00	1387.10	1387.10	1387.22	1387.13	1387.29	1387.22	1387.31	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1389.35	1389.37	1389.25	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1386.16	1386.09	1386.08	--
12	0+0	1384.20	No Data	1384.00	1384.40	1383.20	1383.30	1383.40	1383.30	1383.50	1383.20	1383.46	1383.39	1383.65	1383.48	1383.60	No Data	No Data	--
	1+0	1385.10	No Data	1384.60	1385.10	1384.50	1384.50	1384.50	1384.50	1384.50	1384.50	1384.51	1384.54	1384.63	1384.56	1384.61	1384.49	1384.53	-0.57
	2+0	1386.20	No Data	1385.70	1386.30	1385.60	1385.60	1385.60	1385.60	1385.70	1385.60	1385.67	1385.70	1385.81	1385.74	1385.75	1385.71	1385.70	-0.50
	3+0	1387.30	No Data	1386.70	1387.20	1386.60	1386.60	1386.60	1386.60	1386.70	1386.70	1386.72	1386.76	1386.85	1386.78	1386.81	1386.82	1386.73	-0.57
	4+0	1388.00	No Data	1387.40	1387.90	1387.30	1387.30	1387.30	1387.30	1387.40	1387.40	1387.44	1387.43	1387.53	1387.50	1387.54	1387.52	1387.41	-0.59
	5+0	1387.80	No Data	1387.40	1387.90	1387.30	1387.30	1387.30	1387.30	1387.30	1387.40	1387.42	1387.40	1387.5	1387.44	1387.47	1387.45	1387.35	-0.45
	5+52	1387.70	No Data	1387.70	1388.10	1387.60	1387.60	1387.50	1387.60	1387.60	1387.80	1387.73	1387.68	1387.79	1387.76	1387.85	No Data	No Data	--
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1390.29	1390.29	1390.22	--
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1386.13	1386.09	1386.00	--

Table F-1 Trench Elevation Data at the SDA (1991 - 2008)

Trench No	Station	1991	1992	1993	1994	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Elevation Difference (ft) 2008 - 1991 (17 yrs)
13	0+0	1383.50	No Data	1383.20	1383.50	1383.20	1383.20	1383.20	1383.10	1383.30	1383.20	1383.23	1383.27	1383.36	1383.26	1383.34	No Data	No Data	–
	1+0	1384.50	No Data	1383.80	1384.30	1383.40	1383.70	1383.70	1383.70	1383.70	1383.60	1383.59	1383.60	1383.70	1383.55	1383.53	1383.45	1383.30	-1.20
	2+0	1385.60	No Data	1385.30	1385.80	1385.30	1385.30	1385.30	1385.30	1385.40	1385.20	1385.35	1385.37	1385.50	1385.41	1385.43	1385.43	1385.33	-0.27
	3+0	1386.60	No Data	1386.10	1386.60	1386.10	1386.10	1386.10	1386.10	1386.20	1386.10	1386.19	1386.21	1386.36	1386.27	1386.32	1386.30	1386.21	-0.39
	4+0	1387.10	No Data	1386.80	1387.30	1386.80	1386.80	1386.80	1386.80	1386.80	1386.80	1386.89	1386.90	1387.01	1386.97	1386.98	1386.97	1386.92	-0.18
	5+0	1387.60	No Data	1387.10	1387.60	1387.10	1387.10	1387.10	1387.10	1387.20	1387.10	1387.21	1387.22	1387.33	1387.25	1387.28	1387.25	1387.17	-0.43
	6+0	1386.20	No Data	1385.80	1386.30	1385.80	1385.80	1385.80	1385.80	1385.80	1385.80	1385.91	1385.92	1386.02	1385.96	1386.06	1385.97	1385.89	-0.31
	6+6	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1385.95	1385.95	1386.07	1385.98	1386.11	No Data	No Data	–
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1388.67	1388.70	1388.58	–
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1386.00	1385.98	1385.94	–
14	0+0	1383.90	No Data	1382.70	1383.10	1382.70	1382.70	1382.70	1382.70	1382.80	1382.60	1382.69	1382.78	1382.89	1382.80	1382.88	No Data	No Data	–
	1+0	1384.60	No Data	1383.80	1384.30	1383.80	1383.80	1383.80	1383.80	1383.90	1383.80	1383.87	1383.94	1383.99	1383.91	1383.96	1383.93	1383.83	-0.77
	2+0	1385.40	No Data	1384.70	1385.20	1384.70	1384.70	1384.70	1384.70	1384.70	1384.60	1384.72	1384.75	1384.81	1384.70	1384.75	1384.71	1384.60	-0.80
	3+0	1386.70	No Data	1385.70	1386.10	1385.60	1385.70	1385.70	1385.60	1385.70	1385.70	1385.73	1385.74	1385.84	1385.76	1385.78	1385.77	1385.67	-1.03
	4+0	1386.90	No Data	1386.20	1386.70	1386.20	1386.20	1386.20	1386.20	1386.20	1386.20	1386.23	1386.23	1386.33	1386.26	1386.28	1386.28	1386.15	-0.75
	5+0	1386.70	No Data	1386.00	1386.40	1385.90	1385.90	1385.90	1385.80	1385.80	1385.80	1385.84	1385.82	1385.93	1385.83	1385.84	1385.80	1385.68	-1.02
	6+0	1386.00	No Data	1385.00	1385.70	1385.10	1385.10	1385.10	1385.10	1385.10	1385.00	1385.15	1385.11	1385.23	1385.19	1385.31	1385.18	1385.08	-0.92
	6+54	1383.60	No Data	1382.50	1383.50	1382.60	1382.60	1382.60	1382.60	1382.70	1382.60	1382.68	1382.67	1382.77	1382.72	1382.86	No Data	No Data	–
	N-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1385.37	1385.40	1385.28	–
	S-M	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	1386.10	1386.06	1385.99	–

Notes:

1. Elevations are rounded to the nearest 0.01 ft.
2. Trenches 12, 13, and 14 were not surveyed in 1992 due to topsoil being stripped in preparation for installation of the geomembrane cover.
3. A different control point was used in 1994 with an elevation difference +0.51 feet higher than preceding years.
4. 1995 elevations are not included in this comparison because the grass cap stations did not correspond to the new geomembrane stations established in 1996.
5. Stations 7+10 and 7+20 were added in 2000 to monitor possible slumping north of the Trench 2 monument.
6. A different control point was used in 2003 with an elevation difference +0.07 feet higher than preceding years.
7. From 1991 to 2006, the 0+00 point was taken at the base of the monument. Due to the possibility that the tension of the geomembrane at the base could affect the measurement, the trench start and end points were changed to the centerline mark on the plaque of the monument (points N-M and S-M).
8. Entry of "–" in the elevation difference column indicates that the elevation at the station was not measured over the entire 17-year period.
9. The data from 2002-2008 underwent a thorough review and QA check for entry into the NYSERDA NYSIMS database in 2009.