CPS
COMPLIANCE PLUS SERVICES

August 8, 2008

Mr. Raphael J. Cody
U.S. Environmental Protection Agency
Corrective Action Section
1 Congress Street, Suite 1100-HBT
Boston, MA 02114-2023

Re: Corrective Measures Study Evaluation of Landfill Treatment Residue; Envirite Corporation Facility, Thomaston, CT EPA ID No. CTD 093 616 613 RCRA Docket I-90-1032;

Dear Mr. Cody,

On behalf of Envirite Corporation, Compliance Plus Services, Inc. ("CPS") in conjunction with Michael Marley of XDD, LLC is pleased to provide this letter, which presents an analysis supporting the hypothesis that the landfill treatment residue ("LTR") in naturally-capped Cells 1, 2 and 3 at Envirite's Thomaston, CT property does not, and will not over the long-term, adversely impact the underlying aquifer. The term "naturally-capped" refers to the fact that the cap is constructed of natural soil and a vegetative (grass) cover, rather than a synthetic membrane covered by soil and vegetation. The analysis was performed in accordance with the proposed scope of work that EPA approved per correspondence dated February 26, 2008 to Geoffrey Stengel of Envirite Corporation. (See Appendix A.)

Constructed in 1975, Envirite's Thomaston facility accepted only inorganic liquid wastes, primarily from the metal finishing industry. No organic wastes were accepted. Envirite treated the inorganic wastes in a batch process designed to significantly reduce the toxicity of such materials, and beginning in the 1980's, the treatment process met standards set forth in new federal and state regulations for waste material to no longer be considered hazardous. Envirite's treatment process utilized cyanide oxidation, chromium reduction, lime neutralization and metals precipitation. Hydrated lime and sodium sulfide were used as metals precipitants. Following treatment, batches were filtered. The filtration process produced filtrate (i.e. wastewater) and non-hazardous residual solids. The residual solids were principally comprised of metal hydroxides. The solids were placed in an onsite monofill which commenced with Cells 1, 2 and 3 in the 1970's. These first three cells were capped and closed in 1980 when they had reached their capacity. Residual solids were placed in the three cells in compliance with permits issued by the Connecticut Department of Environmental Protection. Copies of the permits and related correspondence are provided in Appendix B.

Envirite ceased all operations in 1990 when its entire onsite landfill capacity had been attained.

RDMS DocID 107204

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In draft comments submitted in connection with Envirite's RCRA Facility Investigation, Phase 1, Interim Report, the federal Environmental Protection Agency ("EPA"), inquired as to the LTR's capacity to buffer the effect of acid rainfall over the long term, thereby precluding the transfer of metals to the groundwater.

To address this question, CPS, in conjunction with XDD, LLC ("XDD"), prepared this engineering analysis which takes into consideration the following four key factors:

1) the quantity and pH of regional precipitation;
2) the degree of precipitation infiltration through the natural cap;
3) the permeability of the LTR; and
4) the amount of hydroxide that would be required to buffer acid rainfall over a period of time.

The analysis shows that in the largest of the three cells (Cell 3), only 0.002 lb. of hydroxide is needed to offset the acidity of annual precipitation that would infiltrate the LTR. This value calculates to a total of 2 pounds of hydroxides being needed to buffer the volume of acid rain that could infiltrate the LTR for 1,000 years. Two pounds is a factor of 0.0000004 ($4x10^{-7}$) of the estimated 5,000,000 pounds of lime that were used to produce the LTR in Cell 3. Expressed as a ratio, the pounds of lime used in the treatment process (5,000,000), as compared to the pounds of hydroxide required to neutralize 1,000 years of acid rain infiltration (2) is a ratio of 2,500,000 to 1.

Historical site-specific information presented in this document is sourced from the report provided by Envirite Corporation to EPA entitled "Final Report on LTR Study Work Plan, dated December 21, 1998 ("1998 LTR Study"), unless otherwise specified.

1. Precipitation Infiltration into the Natural Cap and LTR

The particles comprising the LTR are similar in size to clay particles. The grain size analysis presented in Table 3.2.5-1 of the 1998 LTR Study supports this characterization of the waste material as primarily clay-like with some silt.[1] Clay and silt soils typically have hydraulic conductivities of 9×10^{-8} cm/s (3×10^{-4} ft/d) and 3×10^{-5} cm/s (0.08 ft/d), respectively. These hydraulic conductivities are the arithmetic mean average hydraulic conductivity for each soil type, as presented in Batu (1998).[2] The native material surrounding the LTR cells is comprised of various grained sands with some silt, and likely has a hydraulic conductivity ranging from 5×10^{-2} cm/s (150 ft/d) to 2.3×10^{-3} (0.08 ft/d). Precipitation will infiltrate preferentially through the more permeable soils – in this case, the native material surrounding the LTR.

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1 The sample is identified as sample number UC2-1E-M18.

2 Batu. V., Table 2-2, Aquifer Hydraulics: A Comprehensive Guide to Hydrogeologic Data Analysis, John Wiley & Sons, 1998.

For any given unit of time, the quantity of precipitation that infiltrates the LTR would be significantly less than the amount of precipitation that infiltrates the native soil surrounding the LTR, based on the relative permeability of these materials. For the purposes of this assessment, it is assumed that 0.1 % ($F_I = 0.001$ in Equation 2) of precipitation infiltrates the LTR (using the difference between the maximum representative hydraulic conductivities of 5×10^{-2} cm/s [native soil] and 3×10^{-5} cm/s [LTR]).

Additionally, sand layers occur throughout the LTR, as a result of the landfilling process. Sand typically has a hydraulic conductivity of approximately 5×10^{-2} cm/s (150 ft/d). Therefore, these sand layers create preferential pathways for water movement around the LTR, and thus limit the duration of infiltrating precipitation's contact with the LTR.

Also, a review of applicable regulations indicates that the LTR's hydraulic conductivity may be similar to that of an engineered cap. In fact, the State of Connecticut's Remediation Standards Regulations (RSRs) defines an engineered cap as having a permeability of less than 10^{-6} cm/s. [*See* RSRs, 22a-133k-2(f)(2)(B)(i)(bb).] As presented above, the LTR material can be characterized as having a permeability/hydraulic conductivity of 3×10^{-5} to 9.0×10^{-8} cm/s.

2. Buffering Requirement for Acid Rain

The treatment of liquid metal-bearing wastes disposed as LTR included principally the addition of pressure-hydrated dolomitic lime to stabilize metals in the form of metal hydroxides. The manufacture of lime converts calcium and magnesium carbonate (limestone) to calcium oxide and magnesium oxide (CaO and MgO, respectively.) During the slaking process, CaO and MgO react with water to form calcium hydroxide and magnesium hydroxide (CaOH and MgOH, respectively). Pressure-hydrated dolomitic lime has almost all (more than 92%) of the oxides hydrated, whereas lime prepared in other types of processes has considerably less hydroxide content.

Based on a sampling of available records, it can be estimated that approximately 5,000,000 lbs of lime as (CaOH or MgOH) were added as part of the treatment of the metals waste in the LTR in Cell #3.[3] On a proportionate basis the lime-to-waste ratio of the LTR is similar throughout Cells # 1, 2, and 3. Also, it is noted that Envirite included in the treatment process a minimum of 0.02 lb of sodium sulfide for every gallon of raw waste. Like lime, sodium sulfide was used to

3 An estimated mass of LTR material in Cell #3 was calculated using boring logs presented in Appendix D of the 1998 LTR Study report. An average thickness of sludge material in Cell #3 was estimated to be 23.8 ft based on boring logs for L-03, L-04 and L-06. The footprint of 125 ft x 130 ft and a thickness of 23.8 ft results in an approximate mass of 36,000,000 lbs of LTR material in Cell #3, using a representative dry bulk density of 1.5 g/cm^3 for Cell #3 sludge material (Table 3.2.5-2, LTR Study Work Plan). From a selection of available facility records (summarized in the table in Appendix C, attached hereto) it is shown that Envirite used 43,736 lbs to lime treat 31,650 gallons of raw waste. Also, an average specific gravity of 1.20 for the raw waste was determined. With this data, it can be estimated that each gallon of waste weighed 10 lb/gallon, and 0.138 lbs of lime was used to treat 1 pound of waste. Therefore, it is estimated that 5,000,000 pounds of lime were used treat liquid waste, the solid residuals of which are contained in Cell #3.

precipitate metals. In some batches, this was a sufficient quantity of sodium sulfide to treat 100 percent of the metals present. In other cases, each unit of sodium sulfide potentially resulted in one unit of excess lime in the LTR. Metal sulfides are less soluble than metal hydroxides by three to four orders of magnitude.

The calculation of buffering requirements for acid rain uses data collected in Abington, Windham County, CT, at the monitoring station operated by the National Atmospheric Deposition Program (NADP) (http://nadp.sws.uiuc.edu). A statistical summary of precipitation chemistry (including pH) for samples from this station are available from 1999 through 2006 (Appendix D). The minimum weekly pH value over the data set was 3.6, and the maximum weekly pH value was 5.8. The minimum annual precipitation-weighted pH from the available precipitation data was 4.18, and the average annual precipitation-weighted pH value was approximately 4.6.

Equation 1 was used to estimate the amount of non-target metal hydroxides (i.e., CaOH and MgOH) that would be required to buffer precipitation over a range of observed pH values. A summary of the calculation is presented in Table 1. (Note: Equation 2 below is referenced in Equation 1.)

Equation 1:

$$M_{OH^-} = H^+ \times \frac{1\,mole\,OH^-}{1\,mole\,H^+} \times MW_{OH^-}$$

where:

M_{OH-} = mass of OH^- (g/yr)
H^+ = H^+ (moles/yr) [calculated in Equation 2]
MW_{OH-} = molecular weight of OH^- (g/mole) = 17

Equation 2:

$$H^+ = 10^{-pH} \times L \times W \times P \times F_I \times \frac{1\,ft}{12\,in} \times \frac{28.31\,L}{1\,ft^3}$$

where:

H^+ = H^+ (moles/yr) {varies by pH}
L = length (ft) = 125 [of treatment Cell #3]
W = width (ft) = 130 [of treatment Cell #3]
P = precipitation rate (inches/yr) = 52.53 [average annual precipitation]
F_I = fraction of precipitation that infiltrates LTR (-) = 0.001 [based on relative permeability; see Section 1]

Table 1
Estimated Amount of Non-Target Metal Hydroxides Required to Buffer Acid Rain Infiltration

Precipitation		Buffering Equivalent	
pH	[H+] (moles/yr)	[OH-] (g/yr)	(lb/yr)
3.5	0.64	10.83	0.024
4	0.20	3.42	0.008
4.5	0.06	1.08	0.002
4.6	**0.05**	**0.86**	**0.002**
5	0.02	0.34	0.001
5.5	0.01	0.11	0.000
6	0.00	0.03	0.000
6.5	0.00	0.01	0.000
7	0.00	0.00	0.000

These calculations were completed for Cell #3, which has both the greatest surface area and LTR content of the three cells and, therefore, has the greatest potential for impacting the underlying groundwater. The average rainfall value used in this calculation is 52.53 inches, which is the 64-year average presented in Table 4 of Appendix F of the 1998 LTR Study Report. (As a point of reference , the average rainfall reported by NADP for their Windham County monitoring station for 1999-2006 period is 47.89 inches.) Based on the difference in relative permeability of the LTR and the surrounding native soil, it was assumed that 0.1% (F_I = 0.001) of precipitation infiltrates the LTR, and the remainder of precipitation is able to runoff of the LTR surface and/or evaporate from surface ponding.

The buffering requirement in Cell 3 to offset the acidity of precipitation infiltration into the LTR is estimated at 0.002 lbs of hydroxide each year. This value is associated with the average annual precipitation-weighted pH value 4.6. Based on this result, it is estimated that the buffering requirement for 100 years, 500 years and 1,000 years would be 0.2 lb, 1 lb and 2 lbs of hydroxide, respectively.

As previously noted, it is estimated that 5,000,000 lbs of lime (as CaOH or MgOH) were used to treat liquid waste, the solid residuals of which are contained in Cell 3. The buffering requirement of 2 pounds of hydroxides to neutralize 1,000 years infiltrating precipitation is a factor of 0.0000004 (i.e., 4×10^{-7}) of this amount, based on the assumptions outlined in this assessment. Expressed as a ratio, the pounds of lime used in the treatment process (5,000,000), as compared to the pounds of hydroxide required to neutralize 1,000 years of acid rain infiltration (2) is a ratio of 2,500,000 to 1.

Provided in Appendix E to this letter is a complementary engineering analysis that considers the unlikely scenario that target metal hydroxides contained in the LTR are the sole available source of hydroxides to neutralize infiltrating acid rain. This scenario is overly conservative inasmuch as it is based on two unlikely conditions: 1) The LTR has no lime content (i.e., calcium hydroxide and magnesium hydroxide) and, therefore, is not a source of non-target metal hydroxides to buffer infiltrating precipitation; and 2) Of the seven possible target-metal hydroxide species contained in the LTR, only one is available as the sole buffering agent, although it is far more likely that multiple species would act simultaneously to buffer infiltrating precipitation and, thus, reduce the potential to impact the underlying aquifer.

Conclusion

This analysis was designed to test the hypothesis that the LTR material in Cells 1, 2, and 3 does not, and will not over the long term, impact the underlying aquifer. It assesses the quantity and pH of regional precipitation, the degree of precipitation infiltration through the natural cap, the permeability of the LTR, and amount of hydroxides required to buffer the effect of infiltrating acid rain.

The analysis shows that the average annual precipitation-weighted pH value is approximately 4.6 and the average annual rainfall is 52.53 inches. Accordingly, the analysis calculates that the annual buffering requirement for acid rain infiltrating the LTR is 0.002 lbs of hydroxide each year (Table 1), which is equivalent to 0.2 lb, 1 lb and 2 lbs of hydroxide for 100 years, 500 years and 1,000 years of acid rainfall, respectively.

The LTR in Cells 1, 2, and 3 was generated from wastes routinely received and processed by the facility. The LTR present in Cell 3 (which has the greatest surface area and volume of LTR) is the solid residual of an estimated 5,000,000 lbs of lime as (CaOH or MgOH) used by Envirite to process waste.

Also, it is notable that in addition to the use of lime to precipitate metals, a minimum of 0.02 pounds of sodium sulfide per gallon of waste was added for each gallon of waste contained in each treatment batch. The addition of sodium sulfide resulted in the formation of metal sulfides, which are less soluble than metal hydroxides by three to four orders of magnitude

It is estimated that 2 pounds of hydroxides are needed to buffer 1,000 years of acid rain infiltration in the LTR contained in Cell 3. As compared to 5,000,000, this value is a factor of 0.0000004 (i.e., $4x10^{-7}$). Expressed as a ratio, the pounds of lime used in the treatment process (5,000,000), as compared to the pounds of hydroxide required to neutralize 1,000 years of acid rain infiltration (2) is a ratio of 2,500,000 to 1.

In light of all factors considered, this engineering analysis demonstrates that the LTR contained in naturally-capped Cells 1, 2, and 3 does not, and will not over the long-term, impact the underlying aquifer.

If you have any questions or need further information, please do not hesitate to contact me at 215.734.1414 or via email at wmctigue@cps-2comply.com.

Sincerely,

William R. McTigue, Jr., PHR
Manager, Regulatory Compliance and
Risk Management
Compliance Plus Services, Inc.
wmctigue@cps-2comply.com

WRM/jan
Attachments

Appendix A

Approved Scope of Work

- Proposal, Dated February 20, 2008
- Approval, Dated February 26,2008

CPS

COMPLIANCE PLUS SERVICES

February 20, 2008

Via UPS Ground Delivery

Mr. Raphael J. Cody
U.S. Environmental Protection Agency
Corrective Action Section
One Congress Street
Boston, MA 02114

Re: Envirite Corporation Monofill Located in Thomaston, CT; Supplemental Information for Corrective Measures Study; Analysis of Landfill Treatment Residue

Dear Mr. Cody,

On behalf of Envirite Corporation ("Envirite"), Compliance Plus Services, Inc. ("CPS") is pleased to provide the attached proposal from XDD (a technical consulting firm) to CPS. We proffer this letter and the proposal as a work plan.

As part of a Corrective Measures Study currently being developed for the site, XDD will seek to develop a defendable technical analysis to support a long-term, site-wide management strategy for the landfilled treatment residues (LTR) that are located in monofills on the property of Envirite's TSD facility in Thomaston, CT.

It is intended that XDD's analysis will help Envirite meet the requisite regulatory requirements for a final Corrective Action disposition for the facility. The analysis, in particular, will focus on whether existing conditions at monofill cells 1 thru 3 are consistent with implementation of a long-term, site wide management strategy for the facility. CPS has engaged XDD to provide the text and calculations as required and appropriate, and as a reference for the Corrective Measures Study currently under development.

We recognize that protocol may require you to address directly to Envirite your approval of this work plan. If so, please specify CPS as a copyholder.

Thank you for your attention in this matter.

Sincerely,

William R. McTigue Jr.

William R. McTigue, Jr., PHR
Manager, Regulatory Compliance & Risk Management
Compliance Plus Services, Inc.
wmctigue@cps-2comply.com

WRM/jan

cc: Geoffrey Stengel, Jr. (Envirite Corporation)
Michael Marley (XDD)

N:\LETTERS\3000-3999\3096 - Ltr to Cody EPA - Acid Rain Work PLan Feb2008 Draft.doc

STRATEGIC. ENVIRONMENTAL. SOLUTIONS.

February 19, 2008

Via email (wmctigue@cps-2comply.com)

Mr. William R. McTigue, Jr., PHR
Manager, Regulatory Compliance & Risk Management
Compliance Plus Services, Inc.
P.O. Box 186
Hatboro, PA 19040

Re: Revised Proposal for Consulting Services: Envirite Corporation – Hypothesis Testing for Landfill Treatment Residue
XDD Proposal No. P7060

Dear Bill,

Xpert Design and Diagnostics, LLC (XDD) appreciates the opportunity to submit this revised proposal to Compliance Plus Services, Inc. (CPS) for consultation support for the above referenced site.

1.0 OBJECTIVE

XDD work will seek to develop a defendable analysis supporting a site-wide management strategy - for Envirite Corporation's property in Thomaston, CT – that meets all regulatory requirements of post-closure monitoring at the site. The analysis in particular will focus on the subject of whether existing conditions at Cells 1 thru 3 are consistent with implementation of the management strategy. It is anticipated that the management strategy will also include (a) removal of the Pre-Envirite Waste Material (PEWM) under the first portion of the property's entrance driveway and (b) maintenance of a proper financial assurance mechanism available should post-closure monitoring require any further action in future years. Lastly, CPS wishes XDD to provide the text and calculations as required and appropriate, and as a reference for the Corrective Measures Study under development for the site.

2.0 WORK ITEMS

The following tasks are suggested in performing the analysis:

1. Compile information on groundwater concentration of compounds of concern in monitoring wells immediately down gradient of cells 1 through 3
2. Determine LTR permeability – primarily research available documents to get information to develop a range of the permeability of the LTR. The permeability will be determined based on air permeability testing and grain size analysis performed during previous work at the site

3. Review natural soil and LTR properties – primarily research available documents to get enough information to understand the capacity of the natural soils and LTR to neutralize the pH of the infiltrating rainfall, including available and relevant EP Toxicity test data
4. The text and supporting analysis will be developed to illustrate, through multiple lines of evidence, the present and future stability of the LTR. The lines of evidence will be based on the following:
    - Past and current concentrations of compounds of concern in ground water immediately down gradient of cells 1 through 3 which show that there was no past or is no present significant impact to groundwater from the LTR
    - Determine if the permeability of LTR is such that minimal or insignificant flow of infiltrating rainfall occurs through the LTR and that the LTR itself has a permeability comparable or less permeable than the criteria used for landfill caps
    - Determine if the capacity of the natural soils would prevent low pH rainfall from reaching the LTR for a significant time period
    - Determine if the capacity of the LTR would prevent low pH rainfall from destabilizing the LTR for an extensive time period, if ever
5. Develop Draft text and analysis – 2 to 4 pages of text for inclusion in the CMS with Appendix containing supporting tables, figures and calculations, as required
6. The Draft text and analysis is assumed to require one round of comments prior to issuing the final deliverable.

3.0 BUDGET

XDD will provide the services described in Section 2.0 on a time and material not to exceed basis in accordance with the attached rate schedule. The projected cost to complete the scope of work is

XDD

4.0 ACCEPTANCE

This proposal for services identified above may be accepted by signing in the appropriate spaces below and returning one copy to XDD. No changes alterations or amendments of the Proposal for Services or Terms and Conditions are authorized or effective unless they are in writing and signed by an officer of XDD.

CLIENT NAME: Michael D. Logan

COMPANY: Compliance Plus Services, Inc.

PRINTED NAME: Michael D. Logan

TITLE: Vice President, Environmental Services

DATE: 2/26/08

XDD appreciates the opportunity to be of assistance to CPS on this project. Please do not hesitate to call us at (603) 778-1100 should you have any questions on the contents of this proposal.

Sincerely,

XDD, LLC

Michael C. Marley
President

Attachment: Rate Schedule

MCM/cg

William McTigue

From: William McTigue [wmctigue@cps-2comply.com]
Sent: Tuesday, February 26, 2008 6:16 PM
To: 'Cody.Ray@epamail.epa.gov'
Cc: 'Stengel, Sandy (WingspanTech)'; 'Mike Marley'; 'MLoganCPS@aol.com'
Subject: Envirite Landfill, Thmaston, CT; Hypothesis Testing Work Plan
Attachments: CPSXDD LTR Proposal.pdf

Dear Mr. Cody,

On behalf of Envirite Corporation ("Envirite"), Compliance Plus Services, Inc. is pleased to provide the attached work plan, which is presented in the form of an executed proposal for services between consulting firms XDD and CPS for the benefit of Envirite. Included in the attached file is a cover letter, which frames the work plan in terms of the Corrective Measures Study that is currently being developed for the site, and the work plan itself.

CPS recognizes that protocol may require you to address directly to Envirite your approval of this work plan. If so, please specify CPS as a copyholder for all related communications. Thank you for your attention in this matter.

Sincerely,

William R. McTigue, Jr., PHR
Manager, Regulatory Compliance & Risk Management
Compliance Plus Services, Inc.
120 Gibraltar Road, Suite 210
Horsham, PA 19044
215-734-1414
215-734-1424 (Fax)
WMctigue@cps-2comply.com

RECEIVED
BY CPS DATE 3-6-08

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
New England Region
1 Congress Street, Suite 1100
Boston, Massachusetts 02114-2023

February 26, 2008

Mr. Geoffrey Stengel, Jr., Chairman
Envirite Corporation
490 Norristown Road
Suite 250
Blue Bell, PA 19422

Re: APPROVAL for Corrective Measures Study Evaluation of Landfill Treatment Residue
Envirite Corporation Facility, Thomaston, CT
EPA ID No. CTD 093 616 613
RCRA Docket No. I-90-1032

Dear Mr. Stengel,

The purpose of this letter is to inform you that the United States Environmental Protection Agency, (EPA) has reviewed your proposal, including a brief scope of work, for further evaluating the Landfill Treatment Residue (LTR) within the monofills located on the above-referenced site. Your proposal is hereby APPROVED.

This work will be conducted as part of the ongoing Corrective Measures Study (CMS) under your Consent Order with EPA. We assume that the work will be conducted in accordance with an overall timeline for completion of the CMS, again now currently under development.

If you have any questions, please do not hesitate to contact me.

Sincerely,

Raphael J. Cody
Corrective Action Program
Office of Site Remediation and Restoration
U.S. EPA – Region 1
Suite 1100-HBT
One Congress Street
Boston, MA 02114-2023
617/918-1366
cody.ray@epa.gov

cc: Dave Ringquist, CTDEP
William McTigue, Jr., CPS, Inc.

Appendix B

Facility Permits

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

November 14, 1975

Liqwacon
Liquid Waste Conversion
Old Waterbury Road
Thomaston, Connecticut 06787

Attn: Richard W. Welch, President

Re: DEP/WPC-140-024
Town of Thomaston
Naugatuck River Watershed

Gentlemen:

We have reviewed the situation with respect to the disposal of your industrial sludge. From our review it appears that the maximum groundwater elevaion in the vicinity of the sludge pit is at about 328.5 feet. Therefore, two feet of sand fill should be added to the pit to provide an adequate separating distance. A well constructed of bricks or concrete blocks and a gravel layer should be placed in one corner so that rainwater can be removed. Once the quality of the leachate is verified to be of such a quality that it will not contaminate groundwater, the liner shall be perforated to allow seepage into the natural soil. This change to the sludge disposal pit must be made prior to use.

We hope this resolves this matter and if you have any questions please feel free to call the office.

Very truly yours,

Robert L. Smith

Robert L. Smith
Sr. Sanitary Engineer

RLS:llg

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OFFICE BUILDING HARTFORD, CONNECTICUT 06115

Mr. Dick Welch
Liqwacon Corporation
Olds Waterbury Road
Thomaston, Connecticut 06787

PERMIT

Gentlemen:

This letter shall be considered as the PERMIT required by Section 25-54hh of the Connecticut General Statutes and is issued with the following provisions.

1. That the collection, transportation, and disposal of oil, petroleum, and chemical waste materials shall be conducted in accordance with the requirements of the Department of Environmental Protection.

2. That this PERMIT shall expire on June 30, 1977.

3. That this PERMIT may be renewed annually in accordance with procedures and requirements established by the Department of Environmental Protection.

Robert B. Taylor

Robert B. Taylor, DIRECTOR
WATER COMPLIANCE & HAZARDOUS SUBSTANCES

Appendix C

Sample of Lime Use Data

Summary of Lime Batching from a Selection of Customer Evaluation Sheets

Customer	1181WyGo01301987	1478 Wa02041987	2951 WyGo04191988	763 FrPu11041987	2559 WiNaPl	1345 WiNaPl09141981	1377 WyGo10191981	TOTAL
Lime (lbs/gal)	4.7	0.56	2.53	0.25	3.9	1.7	3.3	
Sulfide (lbs/gal)	0.02	0.02	0.06	0.02	0.02	0.02	0.02	
Qty (gall)	4700	4600	1000	17500	1100	750	2000	31,650
Mass of Lime (lbs)	22090	2576	2530	4375	4290	1275	6600	43,736

Appendix D

Precipitation Data From
NADP/NTN Site Ct15
1999 To 2006

National Atmospheric Deposition Program/National Trends Network
1999 Annual & Seasonal Data Summary for Site CT15
Page 1: Summary of Sample Validity and Completeness Criteria
(Printed 08/29/2000)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41:50:24
Longitude	72:36:29
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	48
Valid Samples	38
with precipitation	36
with full chemistry**	31
without chemistry	5
without precipitation	2
Invalid Samples	10
with precipitation	10
missing precipitation data	0

Summary Period Information

	Annual*	Winter*	Spring	Summer	Fall*
First summary period day#	12/29/1998	12/01/1998	03/02/1999	06/01/1999	08/31/1999
Last summary period day	12/28/1999	02/23/1999	06/01/1999	08/31/1999	11/30/1999
Summary period duration	364	91	91	91	91
Number of samples	48	5	13	13	13
Measured precipitation (cm)	110.5	14.6	24.0	15.0	48.8
Valid samples with full chemistry**	31	4	10	7	7
Valid field pH measurements	17	1	3	3	7

NADP/NTN Completeness Criteria

	Annual*	Winter*	Spring	Summer	Fall*
1.Summary period with valid samples (%)	73.1	30.8	84.6	76.9	53.8
2.Summary period with precip coverage (%)	92.3	38.5	100.0	100.0	100.0
3.Measured precipitation with valid samples (%)	88.0	97.3	99.5	78.1	80.6
4.Collector efficiency (%)	95.4	90.3	100.2	99.3	96.1
Precip with full chemistry and valid field pH (%)	56.9	16.5	31.1	37.2	80.6

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry . data are available

= Summary period start and end days do not correspond to the first or last sample day.

National Atmospheric Deposition Program/National Trends Network
1999 Annual & Seasonal Data Summary for Site CT15
Page 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual*	0.07	0.080	0.033	0.667	0.15	0.93	1.15	1.27	2.48E-02	2.15E-02	4.61	4.67
Winter*	0.03	0.026	0.013	0.218	0.15	0.75	0.38	1.07	2.48E-02	3.47E-02	4.61	4.46
Spring	0.16	0.184	0.068	1.587	0.23	1.46	2.62	1.96	3.46E-02	1.08E-02	4.46	4.97
Summer	0.08	0.025	0.021	0.128	0.31	1.88	0.25	2.41	5.40E-02	7.53E-02	4.27	4.12
Fall*	0.04	0.052	0.023	0.410	0.07	0.41	0.78	0.63	1.08E-02	1.48E-02	4.97	4.83

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual*	0.82	0.884	0.365	7.370	1.67	10.29	12.73	14.02	2.74E-01	2.37E-01	--	--
Winter*	0.05	0.038	0.019	0.319	0.22	1.09	0.56	1.56	3.62E-02	5.07E-02	--	--
Spring	0.39	0.442	0.163	3.814	0.55	3.51	6.29	4.70	8.31E-02	2.59E-02	--	--
Summer	0.12	0.037	0.031	0.192	0.47	2.81	0.38	3.61	8.07E-02	1.13E-01	--	--
Fall*	0.17	0.254	0.112	2.002	0.33	1.98	3.79	3.08	5.28E-02	7.21E-02	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.01	0.003	0.003	0.021	0.03	0.19	0.04	0.35	6.03E-03	1.58E-03	3.93	3.94
Percentile 10	0.02	0.009	0.006	0.038	0.05	0.39	0.09	0.51	8.15E-03	1.01E-02	4.16	3.99
Percentile 25	0.04	0.018	0.012	0.070	0.09	0.66	0.17	0.84	1.86E-02	1.15E-02	4.34	4.34
Percentile 50	0.07	0.025	0.028	0.169	0.21	1.35	0.29	1.54	3.02E-02	2.09E-02	4.52	4.68
Percentile 75	0.15	0.077	0.054	0.448	0.34	2.02	0.78	2.19	4.57E-02	4.66E-02	4.73	4.94
Percentile 90	0.31	0.173	0.111	1.521	0.52	3.76	2.65	4.41	6.90E-02	1.01E-01	5.10	4.99
Maximum value	0.53	0.428	0.141	3.750	0.62	4.64	6.12	5.73	1.17E-01	1.15E-01	5.22	5.80
Arithmetic mean	0.12	0.068	0.041	0.513	0.24	1.52	0.88	1.87	3.58E-02	3.72E-02	4.45	4.43
Arith. std dev	0.12	0.102	0.038	0.921	0.17	1.15	1.51	1.33	2.56E-02	3.56E-02	--	--
Below detection	1	0	0	0	0	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** cm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	0.03	5.2	0.78	1.21	0.78
Percentile 10	0.16	7.7	0.95	1.28	0.85
Percentile 25	1.07	12.3	1.38	1.44	0.93
Percentile 50	1.75	21.5	1.73	1.66	0.96
Percentile 75	4.32	32.0	2.08	2.16	1.00
Percentile 90	6.61	46.0	2.60	2.71	1.04
Maximum value	12.70	63.3	3.67	2.83	1.06

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual*	1.76	1.67	0.99
Winter*	1.85	1.38	1.04
Spring	1.73	1.86	1.02
Summer	1.66	1.49	0.95
Fall*	2.01	1.82	0.94

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2000 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria

(Printed 10/08/2002)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41:50:24
Longitude	72:36:29
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	53
Valid Samples	43
with precipitation	42
with full chemistry**	41
without chemistry	1
without precipitation	1
Invalid Samples	10
with precipitation	10
missing precipitation data	0

Summary Period Information

	Annual	Winter	Spring	Summer	Fall*
First summary period day	12/28/1999	11/30/1999	02/29/2000	05/30/2000	08/29/2000
Last summary period day	01/02/2001	02/29/2000	05/30/2000	08/29/2000	11/28/2000
Summary period duration	371	91	91	91	91
Number of samples	53	13	13	13	13
Measured precipitation (cm)	118.3	23.9	39.9	32.2	20.6
Valid samples with full chemistry**	41	10	10	10	9
Valid field pH measurements	36	9	8	10	8

NADP/NTN Completeness Criteria

	Annual	Winter	Spring	Summer	Fall*
1.Summary period with valid samples (%)	79	85	85	77	69
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	89	92	95	78	92
4.Collector efficiency (%)	92	87	90	96	91
Precip with full chemistry and valid field pH (%)	81	91	74	78	88

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry . data are available

National Atmospheric Deposition Program/National Trends Network
2000 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual	0.07	0.031	0.018	0.238	0.19	1.14	0.43	1.35	2.99E-02	3.22E-02	4.52	4.49
Winter	0.06	0.051	0.024	0.460	0.08	0.92	0.77	0.89	2.20E-02	2.30E-02	4.66	4.64
Spring	0.12	0.039	0.026	0.260	0.26	1.39	0.49	1.61	3.29E-02	3.54E-02	4.48	4.45
Summer	0.05	0.020	0.012	0.151	0.24	1.20	0.28	1.59	3.38E-02	3.72E-02	4.47	4.43
Fall*	0.04	0.016	0.009	0.125	0.13	0.82	0.22	1.25	2.91E-02	3.25E-02	4.54	4.49

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual	0.85	0.367	0.213	2.815	2.25	13.45	5.09	16.00	3.54E-01	3.81E-01	--	--
Winter	0.13	0.122	0.057	1.101	0.19	2.20	1.85	2.13	5.27E-02	5.51E-02	--	--
Spring	0.47	0.156	0.104	1.038	1.02	5.56	1.94	6.41	1.31E-01	1.41E-01	--	--
Summer	0.16	0.064	0.039	0.487	0.78	3.87	0.90	5.13	1.09E-01	1.20E-01	--	--
Fall*	0.08	0.033	0.019	0.258	0.27	1.68	0.46	2.58	6.00E-02	6.70E-02	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.02	0.004	0.003	0.020	0.02	0.20	0.05	0.25	9.12E-03	1.12E-02	3.96	3.94
Percentile 10	0.02	0.007	0.005	0.030	0.03	0.38	0.08	0.46	1.09E-02	1.27E-02	4.03	3.99
Percentile 25	0.04	0.014	0.011	0.063	0.06	0.64	0.12	0.74	1.70E-02	1.69E-02	4.20	4.17
Percentile 50	0.09	0.023	0.017	0.142	0.18	1.50	0.28	1.42	3.24E-02	3.81E-02	4.49	4.42
Percentile 75	0.11	0.047	0.027	0.321	0.40	2.69	0.53	2.44	6.31E-02	6.73E-02	4.77	4.77
Percentile 90	0.17	0.075	0.045	0.611	0.52	3.81	1.02	3.71	9.42E-02	1.02E-01	4.96	4.90
Maximum value	0.34	0.110	0.055	0.927	1.13	6.37	1.83	4.97	1.10E-01	1.15E-01	5.04	4.95
Arithmetic mean	0.09	0.032	0.021	0.232	0.26	1.88	0.42	1.75	4.26E-02	4.72E-02	4.37	4.33
Arith. std dev	0.07	0.026	0.014	0.238	0.25	1.53	0.41	1.24	3.00E-02	3.26E-02	--	--
Below detection	0	0	3	0	3	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** cm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	0.51	6.5	0.07	1.11	0.85
Percentile 10	2.28	9.4	0.48	1.16	0.90
Percentile 25	5.97	10.8	1.19	1.36	0.93
Percentile 50	24.13	20.9	1.51	1.52	0.97
Percentile 75	40.00	34.0	1.86	1.69	1.01
Percentile 90	61.66	50.1	2.51	2.34	1.03
Maximum value	85.34	58.6	2.75	4.22	1.08

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual	1.54	1.55	0.98
Winter	1.25	1.52	0.98
Spring	1.49	1.70	0.98
Summer	1.71	1.55	0.97
Fall*	1.98	1.35	0.99

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2001 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria
(Printed 10/08/2002)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41:50:24
Longitude	72:36:29
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	52
Valid Samples	44
with precipitation	39
with full chemistry**	37
without chemistry	2
without precipitation	5
Invalid Samples	8
with precipitation	8
missing precipitation data	0

Summary Period Information

	Annual	Winter	Spring	Summer*	Fall*
First summary period day	01/02/2001	11/28/2000	02/27/2001	05/29/2001	08/28/2001
Last summary period day	01/01/2002	02/27/2001	05/29/2001	08/28/2001	11/27/2001
Summary period duration	364	91	91	91	91
Number of samples	52	13	13	13	13
Measured precipitation (cm)	95.7	19.3	29.4	38.0	12.4
Valid samples with full chemistry**	37	11	9	10	8
Valid field pH measurements	21	7	2	7	5

NADP/NTN Completeness Criteria

	Annual	Winter	Spring	Summer*	Fall*
1.Summary period with valid samples (%)	83	92	92	77	69
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	86	98	99	72	80
4.Collector efficiency (%)	92	91	85	98	95
Precip with full chemistry and valid field pH (%)	38	82	35	17	52

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry data are available

National Atmospheric Deposition Program/National Trends Network
2001 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual	0.07	0.022	0.016	0.163	0.17	1.10	0.29	1.32	2.89E-02	3.63E-02	4.54	4.44
Winter	0.05	0.034	0.015	0.337	0.10	1.05	0.60	0.94	2.65E-02	2.37E-02	4.58	4.63
Spring	0.10	0.021	0.015	0.149	0.14	0.93	0.25	1.16	2.31E-02	1.75E-02	4.64	4.76
Summer*	0.07	0.018	0.019	0.094	0.26	1.26	0.20	1.72	3.54E-02	8.59E-02	4.45	4.07
Fall*	0.05	0.044	0.019	0.401	0.11	0.66	0.68	0.78	1.59E-02	2.16E-02	4.80	4.67

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual	0.71	0.210	0.153	1.559	1.66	10.49	2.79	12.64	2.77E-01	3.47E-01	--	--
Winter	0.09	0.066	0.029	0.652	0.19	2.03	1.17	1.81	5.12E-02	4.58E-02	--	--
Spring	0.30	0.062	0.044	0.439	0.42	2.73	0.74	3.41	6.81E-02	5.15E-02	--	--
Summer*	0.27	0.068	0.072	0.357	0.97	4.78	0.75	6.53	1.34E-01	3.26E-01	--	--
Fall*	0.06	0.054	0.024	0.497	0.14	0.81	0.84	0.96	1.97E-02	2.68E-02	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.02	0.003	0.003	0.008	0.02	0.23	0.03	0.34	8.91E-03	9.12E-03	3.82	3.65
Percentile 10	0.02	0.007	0.003	0.026	0.04	0.37	0.11	0.45	1.20E-02	1.32E-02	3.99	3.82
Percentile 25	0.04	0.011	0.010	0.071	0.07	0.74	0.18	0.88	2.14E-02	2.45E-02	4.15	4.01
Percentile 50	0.08	0.028	0.018	0.178	0.18	1.64	0.27	1.30	3.39E-02	5.01E-02	4.47	4.30
Percentile 75	0.13	0.044	0.031	0.303	0.44	2.73	0.51	3.45	7.00E-02	9.77E-02	4.67	4.61
Percentile 90	0.29	0.083	0.045	0.560	0.71	5.64	0.93	4.63	1.01E-01	1.52E-01	4.92	4.88
Maximum value	0.47	0.164	0.068	1.230	2.71	6.38	2.35	7.01	1.51E-01	2.24E-01	5.05	5.04
Arithmetic mean	0.11	0.036	0.021	0.244	0.34	2.03	0.44	2.14	4.66E-02	6.58E-02	4.33	4.18
Arith. std dev	0.10	0.034	0.015	0.272	0.46	1.69	0.47	1.74	3.48E-02	5.20E-02	--	--
Below detection	0	0	2	0	1	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** cm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	0.51	6.6	0.54	1.16	0.89
Percentile 10	3.25	6.9	0.66	1.19	0.91
Percentile 25	5.59	12.7	1.17	1.34	0.93
Percentile 50	12.22	20.9	1.48	1.51	0.96
Percentile 75	30.48	42.0	1.91	1.74	0.99
Percentile 90	54.25	60.0	2.08	1.99	1.04
Maximum value	124.71	87.6	2.32	4.69	1.18

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual	1.56	1.56	0.96
Winter	1.15	1.38	0.98
Spring	1.61	1.69	0.97
Summer*	1.77	1.59	0.96
Fall*	1.53	1.69	1.00

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2002 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria
(Printed 08/13/2003)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41.84
Longitude	-72.0101
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	54
Valid Samples	38
with precipitation	37
with full chemistry**	37
without chemistry	0
without precipitation	1
Invalid Samples	16
with precipitation	16
missing precipitation data	0

Summary Period Information

	Annual*	Winter	Spring	Summer*	Fall*
First summary period day	01/01/2002	11/27/2001	02/26/2002	05/28/2002	09/03/2002
Last summary period day	12/31/2002	02/26/2002	05/28/2002	09/03/2002	12/03/2002
Summary period duration	364	91	91	98	91
Number of samples	54	13	13	16	13
Measured precipitation (cm)	114.4	15.5	34.0	29.2	29.2
Valid samples with full chemistry**	37	12	11	7	8
Valid field pH measurements	32	11	11	6	7

NADP/NTN Completeness Criteria

	Annual*	Winter	Spring	Summer*	Fall*
1.Summary period with valid samples (%)	72	100	85	52	62
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	81	100	95	60	72
4.Collector efficiency (%)	92	97	95	91	88
Precip with full chemistry and valid field pH (%)	72	99	95	56	65

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry data are available

National Atmospheric Deposition Program/National Trends Network
2002 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual*	0.06	0.034	0.017	0.279	0.19	1.28	0.51	1.28	2.92E-02	3.65E-02	4.54	4.44
Winter	0.05	0.034	0.014	0.319	0.17	1.65	0.56	1.47	3.95E-02	3.91E-02	4.40	4.41
Spring	0.08	0.032	0.021	0.242	0.22	1.12	0.43	1.42	2.79E-02	3.16E-02	4.55	4.50
Summer*	0.06	0.017	0.010	0.091	0.25	1.77	0.20	1.92	4.55E-02	5.20E-02	4.34	4.28
Fall*	0.05	0.057	0.022	0.512	0.17	1.42	0.92	0.89	2.35E-02	3.28E-02	4.63	4.48

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual*	0.70	0.389	0.195	3.193	2.17	14.68	5.78	14.66	3.34E-01	4.17E-01	--	--
Winter	0.08	0.053	0.022	0.494	0.26	2.56	0.87	2.28	6.12E-02	6.05E-02	--	--
Spring	0.27	0.109	0.071	0.823	0.74	3.81	1.45	4.84	9.50E-02	1.08E-01	--	--
Summer*	0.19	0.050	0.029	0.265	0.73	5.16	0.60	5.61	1.33E-01	1.52E-01	--	--
Fall*	0.15	0.166	0.064	1.494	0.50	4.13	2.68	2.60	6.85E-02	9.57E-02	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.01	0.003	0.003	0.003	0.02	0.13	0.02	0.20	4.79E-03	8.32E-03	3.95	3.90
Percentile 10	0.01	0.005	0.003	0.017	0.06	0.40	0.07	0.39	1.01E-02	1.25E-02	4.08	4.04
Percentile 25	0.02	0.009	0.005	0.043	0.09	0.66	0.13	0.71	1.61E-02	2.02E-02	4.24	4.19
Percentile 50	0.06	0.020	0.010	0.115	0.16	1.19	0.23	1.06	2.69E-02	3.47E-02	4.57	4.46
Percentile 75	0.09	0.033	0.026	0.242	0.38	2.74	0.44	2.20	5.83E-02	6.47E-02	4.80	4.69
Percentile 90	0.20	0.077	0.043	0.693	0.50	3.83	1.21	3.69	8.36E-02	9.04E-02	5.00	4.90
Maximum value	0.23	0.440	0.155	4.030	0.65	5.54	7.06	5.16	1.12E-01	1.26E-01	5.32	5.08
Arithmetic mean	0.07	0.039	0.021	0.312	0.24	1.68	0.57	1.59	3.70E-02	4.37E-02	4.43	4.36
Arith. std dev	0.06	0.073	0.028	0.681	0.17	1.32	1.18	1.25	2.79E-02	3.08E-02	--	--
Below detection	1	2	6	1	1	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** mm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	1.27	3.6	0.53	1.25	0.83
Percentile 10	4.49	7.0	0.72	1.31	0.89
Percentile 25	11.98	10.0	0.96	1.41	0.92
Percentile 50	20.57	18.2	1.40	1.57	0.95
Percentile 75	36.62	31.9	1.64	1.73	0.99
Percentile 90	53.59	47.5	1.98	2.25	1.02
Maximum value	68.37	68.6	2.11	2.86	1.07

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual*	1.29	1.62	0.94
Winter	1.15	1.45	0.93
Spring	1.64	1.71	0.96
Summer*	1.40	1.51	0.92
Fall*	0.81	1.76	0.94

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2003 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria
(Printed 07/07/2004)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41.84
Longitude	-72.0101
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	52
Valid Samples	50
with precipitation	45
with full chemistry**	43
without chemistry	2
without precipitation	5
Invalid Samples	2
with precipitation	2
missing precipitation data	0

Summary Period Information

	Annual	Winter	Spring	Summer	Fall
First summary period day	12/31/2002	12/03/2002	02/25/2003	06/03/2003	09/02/2003
Last summary period day	12/30/2003	02/25/2003	06/03/2003	09/02/2003	12/02/2003
Summary period duration	364	84	98	91	91
Number of samples	52	12	14	13	13
Measured precipitation (cm)	127.0	28.1	36.7	31.5	30.0
Valid samples with full chemistry**	43	8	12	10	13
Valid field pH measurements	33	4	10	9	11

NADP/NTN Completeness Criteria

	Annual	Winter	Spring	Summer	Fall
1.Summary period with valid samples (%)	96	92	93	100	100
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	97	98	98	100	100
4.Collector efficiency (%)	90	81	93	100	94
Precip with full chemistry and valid field pH (%)	69	48	72	88	85

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry . data are available

National Atmospheric Deposition Program/National Trends Network
2003 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual	0.05	0.031	0.015	0.254	0.16	0.83	0.47	1.00	2.16E-02	2.31E-02	4.67	4.64
Winter	0.03	0.011	0.005	0.105	0.08	0.58	0.21	0.60	1.52E-02	2.42E-02	4.82	4.62
Spring	0.09	0.028	0.014	0.190	0.24	1.16	0.35	1.19	2.45E-02	2.82E-02	4.61	4.55
Summer	0.04	0.011	0.007	0.077	0.19	0.98	0.16	1.32	3.06E-02	2.68E-02	4.51	4.57
Fall	0.05	0.058	0.026	0.515	0.10	0.58	0.95	0.78	1.53E-02	1.48E-02	4.82	4.83

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual	0.66	0.394	0.190	3.226	2.01	10.58	6.01	12.65	2.74E-01	2.93E-01	--	--
Winter	0.07	0.031	0.014	0.295	0.21	1.63	0.58	1.68	4.27E-02	6.81E-02	--	--
Spring	0.31	0.103	0.051	0.697	0.89	4.27	1.28	4.35	8.98E-02	1.04E-01	--	--
Summer	0.12	0.035	0.022	0.243	0.61	3.09	0.50	4.17	9.65E-02	8.45E-02	--	--
Fall	0.15	0.174	0.078	1.542	0.30	1.75	2.84	2.35	4.58E-02	4.43E-02	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.01	0.003	0.003	0.003	0.02	0.19	0.01	0.10	4.07E-03	6.31E-03	4.01	4.09
Percentile 10	0.01	0.004	0.004	0.015	0.04	0.26	0.05	0.31	6.51E-03	8.08E-03	4.13	4.19
Percentile 25	0.02	0.008	0.006	0.051	0.06	0.32	0.11	0.48	9.33E-03	1.01E-02	4.40	4.36
Percentile 50	0.04	0.015	0.011	0.108	0.11	0.65	0.21	0.82	2.00E-02	2.46E-02	4.70	4.61
Percentile 75	0.10	0.043	0.022	0.300	0.36	1.34	0.55	2.07	3.98E-02	4.42E-02	5.03	4.99
Percentile 90	0.14	0.140	0.061	1.218	0.86	3.06	2.29	3.62	7.35E-02	6.44E-02	5.19	5.09
Maximum value	0.72	0.375	0.129	3.300	1.25	7.84	6.26	4.59	9.77E-02	8.13E-02	5.39	5.20
Arithmetic mean	0.08	0.044	0.022	0.341	0.25	1.27	0.64	1.43	2.95E-02	2.92E-02	4.53	4.53
Arith. std dev	0.13	0.074	0.027	0.620	0.29	1.54	1.15	1.24	2.54E-02	2.16E-02	--	--
Below detection	1	2	2	0	1	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** mm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	1.52	3.5	0.29	1.06	0.87
Percentile 10	6.65	5.1	1.00	1.26	0.92
Percentile 25	10.23	8.2	1.26	1.34	0.97
Percentile 50	24.38	13.5	1.80	1.55	0.98
Percentile 75	46.99	27.2	2.04	1.97	1.03
Percentile 90	55.07	45.2	2.71	2.48	1.06
Maximum value	90.17	57.5	4.23	4.15	1.12

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual	1.54	1.58	0.99
Winter	1.32	1.44	0.95
Spring	1.32	1.78	1.00
Summer	1.75	1.42	1.00
Fall	1.73	1.68	0.97

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2004 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria
(Printed 08-15-2005)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41.84
Longitude	-72.0101
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	52
Valid Samples	48
with precipitation	44
with full chemistry**	43
without chemistry	1
without precipitation	4
Invalid Samples	4
with precipitation	4
missing precipitation data	0

Summary Period Information

	Annual	Winter	Spring	Summer	Fall
First summary period day	12-30-2003	12-02-2003	03-02-2004	06-01-2004	08-31-2004
Last summary period day	12-28-2004	03-02-2004	06-01-2004	08-31-2004	11-30-2004
Summary period duration	364	91	91	91	91
Number of samples	52	13	13	13	13
Measured precipitation (cm)	126.4	23.3	42.0	25.3	37.0
Valid samples with full chemistry**	43	8	12	10	12
Valid field pH measurements	23	3	6	5	6

NADP/NTN Completeness Criteria

	Annual	Winter	Spring	Summer	Fall
1.Summary period with valid samples (%)	92	85	100	77	100
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	98	75	100	97	100
4.Collector efficiency (%)	88	79	77	97	96
Precip with full chemistry and valid field pH (%)	49	5	51	40	55

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry . data are available

National Atmospheric Deposition Program/National Trends Network
2004 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual	0.05	0.019	0.011	0.155	0.16	0.85	0.28	1.00	2.34E-02	2.14E-02	4.63	4.67
Winter	0.03	0.036	0.017	0.349	0.05	0.41	0.64	0.42	1.08E-02	2.22E-02	4.97	4.65
Spring	0.07	0.018	0.012	0.111	0.23	1.19	0.20	1.27	2.91E-02	1.96E-02	4.54	4.71
Summer	0.04	0.010	0.007	0.065	0.22	0.91	0.13	1.47	3.24E-02	1.53E-02	4.49	4.81
Fall	0.04	0.021	0.012	0.191	0.08	0.49	0.35	0.59	1.40E-02	1.89E-02	4.85	4.72

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual	0.57	0.240	0.139	1.958	2.00	10.77	3.56	12.69	2.96E-01	2.71E-01	--	--
Winter	0.06	0.084	0.040	0.813	0.10	0.96	1.50	0.97	2.52E-02	5.18E-02	--	--
Spring	0.28	0.076	0.050	0.466	0.96	4.98	0.83	5.33	1.22E-01	8.22E-02	--	--
Summer	0.09	0.025	0.018	0.165	0.55	2.32	0.33	3.71	8.20E-02	3.89E-02	--	--
Fall	0.13	0.078	0.044	0.707	0.31	1.83	1.31	2.18	5.19E-02	6.99E-02	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.02	0.003	0.003	0.006	0.02	0.19	0.03	0.10	5.37E-03	3.39E-03	3.75	3.60
Percentile 10	0.02	0.004	0.003	0.018	0.03	0.31	0.06	0.32	7.55E-03	6.95E-03	4.10	4.02
Percentile 25	0.03	0.007	0.006	0.047	0.07	0.46	0.09	0.55	1.35E-02	1.45E-02	4.33	4.41
Percentile 50	0.04	0.011	0.010	0.083	0.19	0.97	0.18	1.07	2.82E-02	2.45E-02	4.55	4.61
Percentile 75	0.07	0.032	0.021	0.226	0.34	2.08	0.40	2.19	4.68E-02	3.85E-02	4.87	4.84
Percentile 90	0.14	0.078	0.044	0.584	0.57	3.70	1.04	3.45	7.87E-02	9.52E-02	5.12	5.16
Maximum value	0.34	0.142	0.110	1.324	0.82	5.92	2.30	6.21	1.78E-01	2.51E-01	5.27	5.47
Arithmetic mean	0.05	0.023	0.015	0.172	0.22	1.40	0.32	1.32	3.34E-02	3.52E-02	4.48	4.45
Arith. std dev	0.04	0.027	0.016	0.247	0.20	1.33	0.43	1.19	3.11E-02	4.29E-02	--	--
Below detection	0	1	3	0	1	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** mm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	0.51	4.9	0.20	1.14	0.84
Percentile 10	2.59	6.5	0.38	1.21	0.91
Percentile 25	5.84	9.0	1.11	1.31	0.97
Percentile 50	21.38	14.7	1.61	1.45	1.00
Percentile 75	45.72	26.2	2.03	1.71	1.03
Percentile 90	67.51	44.5	2.41	2.37	1.06
Maximum value	101.21	88.9	2.97	2.57	1.14

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual	1.52	1.48	1.01
Winter	1.30	1.42	0.99
Spring	1.38	1.57	1.01
Summer	2.07	1.40	1.02
Fall	1.54	1.44	1.02

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2005 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria

(Printed 08/25/2006)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA
Sponsoring Agency	EPA
Latitude	41.84
Longitude	-72.0101
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	54
Valid Samples	43
with precipitation	41
with full chemistry**	41
without chemistry	0
without precipitation	2
Invalid Samples	11
with precipitation	11
missing precipitation data	0

Summary Period Information

	Annual	Winter	Spring	Summer*	Fall*
First summary period day	12/28/2004	11/30/2004	03/01/2005	05/31/2005	08/30/2005
Last summary period day	01/03/2006	03/01/2005	05/31/2005	08/30/2005	11/29/2005
Summary period duration	371	91	91	91	91
Number of samples	54	13	13	13	14
Measured precipitation (cm)	137.7	31.3	31.7	12.2	59.6
Valid samples with full chemistry**	41	13	12	9	8
Valid field pH measurements	--	--	--	--	--

NADP/NTN Completeness Criteria

	Annual	Winter	Spring	Summer*	Fall*
1.Summary period with valid samples (%)	79	100	100	69	62
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	85	100	100	77	80
4.Collector efficiency (%)	91	84	100	96	92
Precip with full chemistry and valid field pH (%)	--	--	--	--	--

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry . data are available

National Atmospheric Deposition Program/National Trends Network
2005 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual	0.05	0.043	0.017	0.359	0.11	0.65	0.66	0.85	1.78E-02	--	4.75	--
Winter	0.04	0.032	0.014	0.301	0.10	1.01	0.54	0.81	2.36E-02	--	4.63	--
Spring	0.07	0.039	0.019	0.319	0.18	0.81	0.57	1.07	1.98E-02	--	4.70	--
Summer*	0.06	0.011	0.011	0.025	0.28	1.26	0.08	1.91	4.11E-02	--	4.39	--
Fall*	0.04	0.057	0.019	0.485	0.05	0.28	0.89	0.54	9.53E-03	--	5.02	--

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual	0.67	0.592	0.234	4.945	1.57	8.94	9.06	11.74	2.45E-01	--	--	--
Winter	0.11	0.100	0.044	0.941	0.33	3.17	1.70	2.54	7.37E-02	--	--	--
Spring	0.21	0.124	0.060	1.013	0.57	2.57	1.80	3.38	6.27E-02	--	--	--
Summer*	0.07	0.013	0.013	0.030	0.34	1.53	0.10	2.32	5.00E-02	--	--	--
Fall*	0.21	0.339	0.113	2.889	0.29	1.64	5.31	3.19	5.67E-02	--	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.01	0.002	0.001	0.007	0.01	0.13	0.03	0.24	4.68E-03	--	3.86	--
Percentile 10	0.02	0.004	0.005	0.011	0.03	0.23	0.04	0.29	8.32E-03	--	4.17	--
Percentile 25	0.03	0.009	0.008	0.030	0.06	0.47	0.09	0.53	1.32E-02	--	4.44	--
Percentile 50	0.05	0.017	0.011	0.142	0.12	0.99	0.23	0.94	2.34E-02	--	4.63	--
Percentile 75	0.08	0.054	0.021	0.354	0.33	1.51	0.61	1.86	3.63E-02	--	4.88	--
Percentile 90	0.14	0.091	0.034	0.687	0.39	2.30	1.24	2.80	6.73E-02	--	5.08	--
Maximum value	0.34	0.122	0.266	1.018	1.63	6.09	1.76	6.50	1.38E-01	--	5.33	--
Arithmetic mean	0.07	0.031	0.021	0.232	0.22	1.30	0.43	1.38	3.11E-02	--	4.51	--
Arith. std dev	0.06	0.032	0.041	0.261	0.28	1.33	0.47	1.25	2.65E-02	--	--	--
Below detection	0	0	0	0	0	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** mm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	0.76	4.2	0.17	1.21	0.84
Percentile 10	1.56	6.5	0.59	1.25	0.93
Percentile 25	7.24	9.1	1.18	1.33	0.95
Percentile 50	15.75	15.1	1.55	1.54	0.99
Percentile 75	38.92	24.5	2.20	1.74	1.01
Percentile 90	57.74	36.2	3.29	1.96	1.06
Maximum value	215.90	74.6	4.47	2.92	1.51

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual	1.70	1.59	0.99
Winter	1.04	1.41	0.97
Spring	1.70	1.78	0.99
Summer*	1.96	1.46	1.00
Fall*	2.51	1.64	0.99

Please see page 1 for footnotes.

National Atmospheric Deposition Program/National Trends Network
2006 Annual & Seasonal Data Summary for Site CT15
Part 1: Summary of Sample Validity and Completeness Criteria

(Printed 08/26/2007)

Site Identification	
Site Name	Abington
Site ID	CT15
State	CT
County	Windham
Operating Agency	EPA-Clean Air Markets
Sponsoring Agency	EPA-Clean Air Markets
Latitude	41.84
Longitude	-72.0101
Elevation	209 m

Sample Validity for Annual Period	
Number of samples	52
Valid Samples	41
with precipitation	40
with full chemistry**	39
without chemistry	1
without precipitation	1
Invalid Samples	11
with precipitation	11
missing precipitation data	0

Summary Period Information

	Annual	Winter*	Spring	Summer	Fall*
First summary period day	01/03/2006	11/29/2005	02/28/2006	05/30/2006	08/29/2006
Last summary period day	01/02/2007	02/28/2006	05/30/2006	08/29/2006	11/28/2006
Summary period duration	364	91	91	91	91
Number of samples	52	13	13	13	13
Measured precipitation (cm)	143.2	31.1	27.2	46.3	43.9
Valid samples with full chemistry**	39	8	11	11	9
Valid field pH measurements	--	--	--	--	--

NADP/NTN Completeness Criteria

	Annual	Winter*	Spring	Summer	Fall*
1.Summary period with valid samples (%)	79	62	92	85	69
2.Summary period with precip coverage (%)	100	100	100	100	100
3.Measured precipitation with valid samples (%)	84	61	97	84	86
4.Collector efficiency (%)	96	90	96	99	96
Precip with full chemistry and valid field pH (%)	--	--	--	--	--

* = Data do not meet NADP/NTN Completeness Criteria for this period.

** = Valid samples for which all Laboratory Chemical measurements were made (The ONLY samples described by the percentile distributions in the Statistical Summary of Precipitation Chemistry for Valid Samples).

*** = Measured precipitation for sample periods during which precipitation occurred and for which complete valid laboratory chemistry . data are available

National Atmospheric Deposition Program/National Trends Network
2006 Annual & Seasonal Data Summary for Site CT15
Part 2: Statistical Summary of Precipitation Chemistry for Valid Samples

Precipitation-Weighted Mean Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Annual	0.052	0.021	0.012	0.154	0.153	0.769	0.282	0.977	2.17E-02	--	4.66	--
Winter*	0.072	0.041	0.016	0.349	0.082	0.584	0.643	0.757	1.69E-02	--	4.77	--
Spring	0.085	0.031	0.018	0.211	0.212	0.932	0.377	1.146	2.13E-02	--	4.67	--
Summer	0.063	0.016	0.012	0.073	0.222	1.126	0.145	1.465	3.37E-02	--	4.47	--
Fall*	0.023	0.019	0.010	0.183	0.072	0.345	0.331	0.497	1.16E-02	--	4.93	--

Deposition

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	kg/ha											
Annual	0.744	0.301	0.172	2.205	2.190	11.009	4.037	13.987	3.10E-01	--	--	--
Winter*	0.224	0.127	0.050	1.085	0.255	1.815	1.998	2.352	5.24E-02	--	--	--
Spring	0.231	0.084	0.049	0.573	0.576	2.532	1.024	3.113	5.79E-02	--	--	--
Summer	0.292	0.074	0.056	0.338	1.027	5.211	0.671	6.780	1.56E-01	--	--	--
Fall*	0.101	0.083	0.044	0.804	0.316	1.516	1.454	2.183	5.11E-02	--	--	--

Weekly Sample Concentrations

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4	H(lab)	H(fld)	pH(lab)	pH(fld)
	mg/L											
Minimum value	0.009	0.001	0.002	0.004	0.022	0.098	0.017	0.179	5.37E-03	--	3.96	--
Percentile 10	0.014	0.005	0.006	0.012	0.029	0.278	0.059	0.245	6.46E-03	--	4.25	--
Percentile 25	0.028	0.011	0.008	0.059	0.067	0.434	0.102	0.485	1.35E-02	--	4.36	--
Percentile 50	0.069	0.022	0.015	0.118	0.201	1.145	0.209	1.259	2.75E-02	--	4.56	--
Percentile 75	0.177	0.039	0.027	0.260	0.403	1.717	0.463	2.250	4.37E-02	--	4.87	--
Percentile 90	0.324	0.086	0.045	0.694	0.616	2.566	1.175	2.783	5.62E-02	--	5.19	--
Maximum value	0.672	0.145	0.064	1.147	1.081	5.467	1.996	5.999	1.10E-01	--	5.27	--
Arithmetic mean	0.123	0.032	0.020	0.204	0.262	1.307	0.370	1.535	3.10E-02	--	4.51	--
Arith. std dev	0.142	0.032	0.015	0.246	0.252	1.083	0.429	1.247	2.37E-02	--	--	--
Below detection	0	0	0	0	0	0	0	0	--	--	--	--

Other Parameters

	Measured Precipitation*** mm	Conduc-tivity uS/cm	Equivalence Ratios SO4/NO3	SO4+NO3/H	Cation/Anion
Minimum value	1.00	3.2	0.37	0.99	0.94
Percentile 10	3.81	4.7	0.91	1.24	0.97
Percentile 25	6.35	8.9	1.11	1.34	0.99
Percentile 50	21.59	18.0	1.66	1.48	1.01
Percentile 75	49.53	25.0	2.09	1.77	1.03
Percentile 90	77.47	29.9	2.37	2.36	1.09
Maximum value	109.22	61.6	3.02	4.94	1.26

Annual and Seasonal Equivalence Ratios

	SO4/NO3	SO4+NO3/H	Cation/Anion
Annual	1.64	1.51	1.02
Winter*	1.67	1.49	1.01
Spring	1.59	1.82	1.00
Summer	1.68	1.45	1.02
Fall*	1.86	1.37	1.05

Please see page 1 for footnotes.

Appendix E

Complementary Engineering Analysis

Appendix E

Provided herein is an analysis of the scenario that only target metal hydroxides contained in the LTR are the sole available sources of hydroxides to neutralize infiltrating acid rain. This scenario is overly conservative inasmuch as it is based on two unlikely conditions: 1) The LTR has no lime content (i.e., calcium hydroxide and magnesium hydroxide) and, therefore, is not a source of non-target metal hydroxides to buffer infiltrating precipitation; and 2) of the seven target-metal hydroxide species contained in the LTR, only one is available as the sole buffering agent, although it is far more likely that multiple species would act simultaneously to buffer infiltrating precipitation and, thus, reduce the potential to impact the underlying aquifer.

E.1 Neutralization of Acid Rain by Target Metal Hydroxides

Ideally, the buffering requirements presented above can be satisfied by the non-target metal hydroxide complexes (i.e., CaOH and MgOH) comprising any lime that may be present in the LTR. However, the presence of these substances in the landfill has not been quantified by field sampling and analysis. Therefore, this assessment considers the assumption that only target-metal hydroxides would provide the necessary buffering capacity.

Given the proper conditions, a target-metal hydroxide disassociates when in the presence of an acid. The result of the disassociation is a hydroxide ion (OH^-) and a metal ion. The hydroxide ion combines with the acid and is no longer available to bond with the metal ion. Consequently, the metal ion becomes free to reside in water that occupies space (pores) among the LTR particles.

Using the results of Table E-1 (which shows that 0.002 lb of hydroxide is required to buffer 1 year of infiltrating precipitation in Cell 3), Equation E-1 calculates for any given target-metal hydroxide contained in the LTR and acting as the sole buffering agent, the mass of each target metal that would become free after one year of acid rain infiltration. This calculation is overly conservative inasmuch as it ignores the fact that multiple target-metal hydroxide species are, in fact, simultaneously available to buffer acid rain. Hence, it reflects an improbable worst-case scenario. The results of this calculation are presented in Table E.2 "Mass of Free Target Metal Due To Acid Rain Buffering by Target-Metal Hydroxides."

Table E-1
Estimated Amount of Non-Target Metal Hydroxides Required to Buffer Acid Rain Infiltration

Precipitation		Buffering Equivalent	
pH	[H+] (moles/yr)	[OH-] (g/yr)	(lb/yr)
3.5	0.64	10.83	0.024
4	0.20	3.42	0.008
4.5	0.06	1.08	0.002
4.6	**0.05**	**0.86**	**0.002**
5	0.02	0.34	0.001
5.5	0.01	0.11	0.000
6	0.00	0.03	0.000
6.5	0.00	0.01	0.000
7	0.00	0.00	0.000

Equation E-1:

$$M_{metal} = H^{+} \times \frac{1\,mole\,OH^{-}}{1\,mole\,H^{+}} \times MW_{metal} \times \frac{[metal]\,mole\ equivalent}{[OH^{-}]\,mole\ equivalent}$$

where:

M_{metal} = mass of metal released (g/yr)
H+ = H+ (moles/yr) {varies by pH}
MW_{metal} = molecular weight of metal (g/mole) {in Table 2}
[metal] mole equivalent = mole equivalent of metal {in Table 2}
[OH-] mole equivalent = mole equivalent of hydroxide {in Table 2}

Table E-2
Mass of Free Target Metals Due to Acid Rain Buffering by Target-Metal Hydroxides

Compound		Equivalent [M]	Equivalent [OH-]	MW (g/mol)	Mass of Metal Species Required to Offset Acid Rain (g/yr) pH 3.5	pH 4	pH 4.5	**pH 4.6**	pH 5	pH 5.5
Barium hydroxide 8-hydrate	$Ba(OH)_2*8H_2O$	1	2	137.3	44	14	4	**3**	1	0
Cadmium hydroxide	$Cd(OH)_2$	1	2	112.4	36	11	4	**3**	1	0
Chromium(II) hydroxide	$Cr(OH)_2$	1	2	52	17	5	2	**1**	1	0
Chromium(III) hydroxide	$Cr(OH)_3$	1	3	52	11	3	1	**1**	0	0
Lead hydroxide	$Pb(OH)_2$	1	2	207.2	66	21	7	**5**	2	1
Nickel hydroxide	$Ni(OH)_2$	1	2	58.69	19	6	2	**1**	1	0
Zinc hydroxide	$Zn(OH)_2$	1	2	65.39	21	7	2	**2**	1	0

Equation E-2 was used to calculate the concentration of each metal that would be present in one liter of the LTR's pore water, and the results are presented in Table E.3 "Concentration of Metal Species Released Due to Acid Buffering by Target-Metal Hydroxides." For comparative purposes, Table 3 includes the respective GB Mobility by TCLP or SPLP criteria specified in the RSRs. (*See* RSRs §22a-133k-3(i).)

Equation E-2:

$$C_{metal} = M_{metal} \times \frac{1}{L \times W \times P \times F_I \times \frac{1\,ft}{12\,in} \times \frac{28.31\,L}{1\,ft^3}} \times \frac{1000\,mg}{1\,g}$$

where:

C_{metal} = concentration of metal (mg/L) in one year {varies by pH}
M_{metal} = mass of metal released (g/yr) [calculated in Table 2]
L = length (ft) = 125 [of treatment Cell #3]
W = width (ft) = 130 [of treatment Cell #3]
P = precipitation rate (in/yr) = 52.53 [average annual precipitation]
F_I = fraction of precipitation that infiltrates LTR (-) = 0.001 [based on relative permeabilities; see Section 1]

Table E-3
Concentration of Free Target Metals Due To Acid Rain Buffering by Target-Metal Hydroxides

Compound		CT RSRs GB Mobility Criteria (mg/L)	Metal Concentration (mg/L) in LTR Solution from Offset of Acid Rain					
			pH 3.5	pH 4	pH 4.5	pH 4.6	pH 5	pH 5.5
Barium hydroxide 8-hydrate	$Ba(OH)_2*8H_2O$	Barium: 10	21.7	6.9	2.2	1.7	0.7	0.22
Cadmium hydroxide	$Cd(OH)_2$	Cadmium: 0.05	17.8	5.6	1.8	1.4	0.6	0.18
Chromium(II) hydroxide	$Cr(OH)_2$	Chromium, total: 0.05	8.2	2.6	0.8	0.7	0.3	0.08
Chromium(III) hydroxide	$Cr(OH)_3$	Chromium, total: 0.05	5.5	1.7	0.5	0.4	0.2	0.05
Lead hydroxide	$Pb(OH)_2$	Lead: 0.15	32.8	10.4	3.3	2.6	1.0	0.33
Nickel hydroxide	$Ni(OH)_2$	Nickel: 1.0	9.3	2.9	0.9	0.7	0.3	0.09
Zinc hydroxide	$Zn(OH)_2$	Zinc: 50	10.3	3.3	1.0	0.8	0.3	0.10

Note: Concentrations are calculated assuming that the entire buffering requirement is satisfied by each metal hydroxide individually; more likely, each metal hydroxide would contribute some smaller portion to the neutralization of the acid infiltration.

E.2 Dilution of LTR Leachate in the Underlying Aquifer

A metal's concentration in a unit volume of the LTR's pore water is not the equal to the metal's concentration in a unit volume of groundwater. EPA's Soil Screening Guidance (1996, Publication 9355.4-23) provides a method for determining the dilution that occurs in the aquifer by the mixing of soil leachate with clean groundwater. The reduction in concentration is expressed as a dilution factor (DF), and is the ratio of the soil leachate metals concentration to the projected downgradient diluted metals concentration. The equation to determine the DF from the EPA document is presented as Equation E-3. Calculation of the mixing zone depth factor in Equation E-6 is shown in Equation E-4.

Equation E-3:

$$DF = 1 + \frac{Kid}{IL}$$

where:

DF = dilution factor (unitless)
K = aquifer hydraulic conductivity (m/yr) = 16,400 [from Batu(1998)]
i = hydraulic gradient (m/m) = 0.0027 [based on hydraulic head data]
I = infiltration rate (m/yr) = P x F_I = 1.33 m/yr x 0.001 = 0.00133 m/yr
d = mixing zone depth (m) {calculated in Equation 6}
L = source length parallel to groundwater water flow (m) = 39 [for Cell #3]

Equation E-4:

$$d = \left(0.0112 \times L^2\right)^{0.5} + d_a \left\{1 - \exp\left[\frac{(-LI)}{Kid_a}\right]\right\}$$

where:

d = mixing zone depth (m)
L = source length parallel to groundwater water flow (m) = 39 [for Cell #3]
d_a = aquifer thickness (m) = 6 [based on representative aquifer depth]
I = infiltration rate (m/yr) = P x F_I = 1.33 m/yr x 0.001 = 0.00133 m/yr
K = aquifer hydraulic conductivity (m/yr) = 16,400 [from Batu (1998)]
i = hydraulic gradient (m/m) = 0.0027 [based on hydraulic head data]

The grain size analysis presented in Table 3.2.5-1 of the LTR Study Work Plan was used to characterize the native material below the cell LTR material; the native material is considered to be a coarse sand with a representative hydraulic conductivity of 5 x 10^{-2} cm/s (or 16,400 m/yr),

from Batu (1998)[4]. Hydraulic head data were taken from Figures 4.2.3-2, 4.2.3-3, 4.2.3-4, 4.2.3-5 and 4.2.3-6 of the 1998 LTR Study to develop a representative hydraulic gradient (i) of 0.0027 m/m. An average annual precipitation of 52.53 inches per year (or 1.33 m/yr) was also used for this analysis. It was assumed that 0.1% of precipitation enters the LTR as infiltration (or an infiltration rate of 0.00133 m/yr) and comingles completely with the LTR waste. The dilution factor calculation was completed for Cell #3, which has a source length of about 130 ft (or 39 m) in the direction parallel to groundwater flow.

A mixing zone depth (d) of 13 ft (or 4.1 m) was determined using Equation E-4 and an aquifer thickness (d_a) of 20 ft (or 6 m). The underlying aquifer thickness ranges from approximately 17 feet (at MW-51D) to 57 feet (at MW-44S).

Based on the assumptions above and Equation E-3, the LTR leachate at Cell #3 is diluted by a factor (DF) of 3,500 by the underlying aquifer.

Quarterly groundwater monitoring trend analysis shows a steady, significant improvement of groundwater during the past fifteen years, and hence no apparent impact to groundwater quality by the landfill. The dilution calculation presented above indicates that there is an additional level of protection (reducing potential leachate concentrations to approximately 0.03 percent) with dilution in the aquifer. Table E-4 summarizes the estimated metal concentrations in groundwater considering the calculated metal concentrations in LTR leachate (Table E-3) with the calculated DF of the aquifer. The concentrations presented in Table E-4 assume that only target-metal hydroxides are available to offset acid in the infiltration.

Table E-4
Estimated Diluted Metal Concentrations in the Underlying Aquifer

Compound		CT RSRs GB Mobility Criteria (mg/L)	Metals Concentration (mg/L) Considering Dilution in Aquifer					
			pH 3.5	pH 4	pH 4.5	pH 4.6	pH 5	pH 5.5
Barium hydroxide 8-hydrate	$Ba(OH)_2*8H_2O$	0	0.006	0.002	0.001	0.000	0.000	0.000
Cadmium hydroxide	$Cd(OH)_2$	0.05	**0.005**	0.002	0.001	0.000	0.000	0.000
Chromium(II) hydroxide	$Cr(OH)_2$	0.05	0.002	0.001	0.000	0.000	0.000	0.000
Chromium(III) hydroxide	$Cr(OH)_3$	0.05	0.002	0.000	0.000	0.000	0.000	0.000
Lead hydroxide	$Pb(OH)_2$	0.15	0.009	0.003	0.001	0.001	0.000	0.000
Nickel hydroxide	$Ni(OH)_2$	1.0	0.003	0.001	0.000	0.000	0.000	0.000
Zinc hydroxide	$Zn(OH)_2$	50	0.003	0.001	0.000	0.000	0.000	0.000

Note: Concentrations are calculated assuming that the entire buffering requirement is satisfied by each metal hydroxide individually; more likely, each metal hydroxide would contribute some smaller portion to the neutralization of the acid infiltration.

4 Batu. V. 1998. Aquifer Hydraulics: A Comprehensive Guide to Hydrogeologic Data Analysis. John Wiley & Sons. Table 2-2.

Conclusion

Under the unlikely scenario that non-target metal hydroxides are unavailable (i.e., that the there is no excess CaOH or MgOH in the LTR) to buffer the infiltrating acid rain, it is assumed that each target-metal hydroxide is itself the sole buffering agent. This assumption ignores the fact that multiple target-metal hydroxide species are simultaneously available to buffer acid rain; hence, it reflects an improbable worst-case scenario. This complementary engineering analysiswas conductedto determine the concentration of each target metal that becomes free in the LTR's pore water as a result of acid rain exposure and available for eventual transfer into the aquifer.

It is also notable that the facility used a minimum of 0.02 pounds of sodium sulfide per gallon in each treatment batch, resulting in the formation of metal sulfides. In some batches, this was a sufficient quantity of sodium sulfide to treat 100 percent of the metals present. In other cases, each unit of sodium sulfide potentially resulted in one unit of excess lime in the LTR. Metal sulfides are typically less soluble than metal hydroxides by three to four orders of magnitude.

EPA's Soil Screening Guidance (1996, Publication 9355.4-23) was used to determine whether the transfer of metals from the LTR impacts the aquifer. Using the appropriate calculations, it was determined that the aquifer has a dilutive effect of 3,500 to 1.

On the basis of all considered factors and calculations, it is expected that the LTR does not, and will not over the long-term, impact the underlying aquifer.