V00524

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A Member of The IT Group

April 4, 2002

David Pratt, PE
NYSDEC-Region 8
6274 East Avon-Lima Road
Avon, New York 14414-9519

Re: IRM Excavation Work Plan Addendum
Response to Comment Letter dated March 25, 2002

Dear Mr. Pratt:

IT Corporation, Inc. (IT), on behalf of CSX Transportation, Inc. (CSXT), has prepared this addendum in response to the New York State Department of Environmental Conservation (NYSDEC) comment letter dated March 25, 2202 for the revised IRM-Excavation Work Plan submitted on March 8, 2002.

C1: Work Plan, general – The City of Rochester sample results for the riverbank indicate removal of soil along the bank is necessary. Additional sampling will be necessary to define the extent of contamination along the bank. This should be performed concurrent with other IRM activities. A work plan specifying how the riverbank soils will be removed should be prepared for our review and approval as soon as possible.

A. *Agreed. CSXT has contracted a geotechnical firm to conduct a geotechnical study of the site and riverbank and to install additional geoprobe points to delineate the soil impacts along the riverbank. This work is scheduled to take place April 10 through 19, 2002. Based on the results of this work, a stand-alone riverbank removal plan will be prepared and submitted to the NYSDEC for review and approval.*

C2: Work Plan, general – CSXT committed to sampling the playground at Holy Cross School at a public meeting held on March 4. A sampling and analysis plan should be prepared for the playground.

A. *At the request of the public, Center for Toxicology and Environmental Health, L.L.C. (CTEH) conducted soil sampling at the school playgrounds and at the lighthouse on March 5, 2002.* ***Attachment 1*** *contains the sampling report containing the analytical results.*

C3: Work Plan, Section 1 – This section states that a 5-point composite sample would be collected from each 500-yard stockpile of soil. Composite sampling for volatile compounds is not appropriate. These must be discrete samples.

A. *One grab sample will be gathered from a minimum of 12-inches beneath the surface of the stockpile and sampled for methylene chloride and acetone. This methodology is agreeable with the disposal facilities.*

C4: Work Plan, Section 1.1 – Specifications for polyethylene thickness and tie-downs at the soil staging areas should be provided.

A. *The polyethylene liner that will be used to stage the stockpiled soils will be 10-ml thick. The sides of the staging area will be bermed to contain any run-off. The staging area will also be sloped to a sump type area where the run-off waters can to transfered to a holding tank for sampling and disposal. The stockpiles awaiting analytical results and loading will be covered with 6-ml polyethylene sheeting and sand bag tie-downs.*

C5: Work Plan, Section 1.2 – Liners and covers for the trucks and rail cars should be specified.

A. *The haul trucks will arrive lined with 4-mil polyethylene and reusable, retractable tarps with an 8 oz fabric weight. The railcars will be lined with 6-mil polyethylene and covered with disposable 3.5 oz woven tarps.*

C6: Work Plan, Section 2.1 – For clarification purposes, the samples from "nodes" are to be obtained at the bottom of the excavation.

A. *Correct.*

C7: Work Plan, Section 2.1 – FID screening should be done via head space screening.

A. *Agreed.*

C8: Work Plan, Section 2.1 – This section implies that if the FID screening does not detect VOCs, then no confirmatory samples would be necessary. Please be aware that we require that the lab analyze all final confirmatory samples.

A. *CSXT understands that the depth and lateral extent of the excavation is determined by laboratory tested end-point sampling analysis results.*

C9: Work Plan, Section 3 – The list of utility contacts should be included in the work plan.

A. ***Attachment 2*** *contains a list of the utility contacts.*

C10: Work Plan, Section 5 – Due to the depth of the excavation and proximity to the river we are not convinced that "...large volumes of groundwater and contact water are not anticipated…". CSXT should be prepared to deal with treatment and disposal of large volumes of groundwater and saturated soils which may need to be staged on site. Staged soil areas may require a sump to collect water which drains from saturated soils. Confirmatory samples should be planned for the staged soil after it is decommissioned.

A. *The staging area will contain a water collection area. Confirmatory soil samples will be collected from the soils beneath the staging area once the stockpile area has been decommissioned.*

C11: Work Plan, Section 7.1 – IT is proposing the use of BioSolve to suppress vapors. A material safety data sheet (MSDS) should be included in the HASP.

A. ***Attachment 3*** *contains the MSDS for BioSolve. This MSDS will be added to the Site Specific Health and Safety Plan.*

C12: Sediment Sampling Plan, Quality Control Sample section – This section states that there will be "twelve samples at each locations." The phase "at each location" should be removed.

A. *Agreed. The initial river sediment sampling event on March 19, 2002 included 13 (one extra was completed) sample locations, not 12 samples at each location.*

C13: Attachment 6, Air Sampling and Monitoring Plan – This plan references temporary emergency exposure limits (TEELs) and occupational guidelines which are not appropriate for this site. The TEELs are used for emergency planning for catastrophic releases, however exposures at this site can be controlled through monitoring and engineering controls without exposing the public to the levels cited in the plan. The use of occupational guidelines (work force) should not be extrapolated to the general populations with contains a more sensitive segment (children, elderly, invalids, etc.). The guidelines cited should be used for workers who have the appropriate HazMat training and medical evaluations. Furthermore, since a Community Air Monitoring Plan has been developed the Air Sampling and Monitoring Plan should drop references to the "general public".

A. *Agreed. The Air Sampling and Monitoring Plan has been updated to contain the changes requested. A copy of the updated draft can be referenced in* ***Attachment 4****.*

C14: Community Air Monitoring Plan, Section 2 – The Health and Safety Plan defines "sustained reading" as 5 minutes. The CAMP and HASP should be consistent.

A. *5 minutes will be equivalent to "sustained reading" in the CAMP.*

C15: Community Air Monitoring Plan, Section 5, Major Vapor Emission Response Plan – The process should include contacting potentially impacted businesses.

A. *Agreed.*

C16: The NYSDEC has received a copy of the City of Rochester's comments dated March 18, 2002 (enclosed). The NYSDEC concurs with the City's comments and requires that the Work Plan be revised appropriately.

A. ***Attachment 5** addresses the City of Rochester comments.*

C17: As discussed with your consultant, IT, a "contained-out" determination regarding the soil to be removed is necessary prior to excavation. Please continue to coordinate this with Henry Wilkie of the NYSDEC Division of Solid and Hazardous Materials in Albany. He may be reached at (518) 402-8594. Also, please copy me on correspondence regarding this process. As discussed with IT, the "contained-out" determination is not self-implementing. The NYSDEC must approve such a determination.

A. *CSXT/IT has requested a 'contained-out' determination from Henry Wilkie (NYSDEC). CSXT/IT has supplied all requested information to date. A determination is expected within the next few days. David Pratt (NYSDEC) will be copied on all correspondence.*

Please note that the QA/QC Field Sampling Plan was submitted to the NYSDEC on April 3, 2002.

CSXT has reserved Mr. Dominic's on the Lake Restaurant (4699 Lake Avenue, Rochester, NY) for Thursday, April 11, 2002 from 2:00 PM to 4:00 PM for the Pre-Construction Meeting.

If you have any additional questions or concerns, please contact Tom Antonoff or me at (518) 783-1996.

Sincerely,
IT Corporation, Inc.

Marie T. Dowd

Marie T. Dowd, I.E.
Project Engineer

M:/97bc/CSX/DEC Comments_032502

Attachments	1.	Holy Cross School and Lighthouse Sampling Report
	2.	Utility Contacts List
	3.	MSDS-BioSolve
	4.	Air Sampling and Monitoring Plan
	5.	Response to City of Rochester's March 22, 2002 Comments

Cc:	Todd Caffoe, P.E.	NYSDEC
	Paul Kurzanski	CSXT
	Janet Scagnelli, Esq.	CSXT
	Tom Antonoff	IT
	George Mackey, Esq.	Hiscock, Barclay, Saperston & Day
	Dr. Glen Millner	CTEH
	Donald Crumb, Jr Esq.	City of Rochester

Center for Toxicology and Environmental Health, L.L.C.

Summary Report for Soil Sampling and Analysis

CSXT River St. Derailment
Rochester, N.Y.

Prepared for:

CSX Transportation, Inc.
500 Water Street, J275
Jacksonville, FL 32202

April 4, 2002

Prepared by:

Center for Toxicology and Environmental Health, L.L.C.
615 W. Markham St.
Little Rock, AR 72201
501-614-2834

INTRODUCTION

On Sunday, December 23, 2001 a CSX train derailment occurred along River Street in the Charlotte section of Rochester, NY. The train contained forty three railcars, twenty seven of which were involved in the derailment. Most of the cars that derailed contained coal; however, the accident also involved one tank car containing methylene chloride (dichloromethane) and two tank cars containing acetone. The contents of the acetone cars were ignited, which resulted in the combustion of both acetone and methylene chloride. During the emergency response phase, the Center for Toxicology and Environmental Health, L.L.C. (CTEH) conducted substantial air monitoring to assess the potential hazards of the derailment site and to protect the surrounding communities from potential chemical exposures. The emergency response phase is complete; however, residual amounts of acetone and methylene chloride remain in the soil environment and shallow groundwater in the immediate vicinity of the derailment site.

In response to community concerns raised at the town meeting on March 5, 2002, CTEH conducted additional soil and air sampling in Charlotte, NY. Although the playgrounds and the lighthouse located near the derailment site were not in the direct path of the chemicals released, the surrounding communities continued to have concerns that these areas potentially contained increased levels of methylene chloride and acetone. This report summarizes CTEH's sampling efforts that showed that the soils located within the playgrounds and lighthouse did not contain elevated levels of acetone or methylene chloride.

METHODS

On March 6, 2002, CTEH collected two soil samples from the playgrounds of the Holy Cross Catholic School and collected one soil sample at the lighthouse. The map in Appendix A graphically illustrates these locations. The samples collected by CTEH were composite samples derived from three sampling sites at each location. The samples were collected from frozen surface samples using new spades, were immediately contained in self-sealing specimen containers, and were then stored on ice. The soil samples were subsequently sent to Columbia Analytical Services's Lab for methylene chloride and acetone analysis. The analytical method used by Columbia Analytical Services's was the United States Environmental Protection Agency (USEPA) approved method 8260B (Appendix B).

While collecting the soil samples, CTEH also monitored ambient air to assess whether the chemicals of concern were volatilizing from the soil. CTEH utilized a MultiRae Plus photoionization detector with an 11.7 eV lamp for these analyses. Photoionization detection is a nondestructive technique that detects volatile organic chemicals, such as methylene chloride and acetone. Photoionization detectors equipped with an 11.7 eV lamp can simultaneously detect acetone and methylene chloride at concentrations greater than 0.14 ppm and 0.1 ppm, respectively.

RESULTS

Soil

The laboratory results from the soil analyses are provided in Appendix C. In brief, the results of these soil samples are as follows:

(1) Playground -1 (ball-field):

Methylene chloride = not detected (<7.0 μg/kg)
Acetone = 29 μg/kg

(2) Playground -2 (day care):

Methylene chloride = not detected (<7.0 μg/kg)
Acetone = 28 μg/kg

(3) Lighthouse:

Methylene chloride = not detected (<7.0 μg/kg)
Acetone = not detected (<27.0 μg/kg)

Air

No volatile organic chemicals were detected in ambient air during the collection of the soil samples. These data suggest that methylene chloride and acetone were not volatilizing from the frozen surface soil as the samples were being collected.

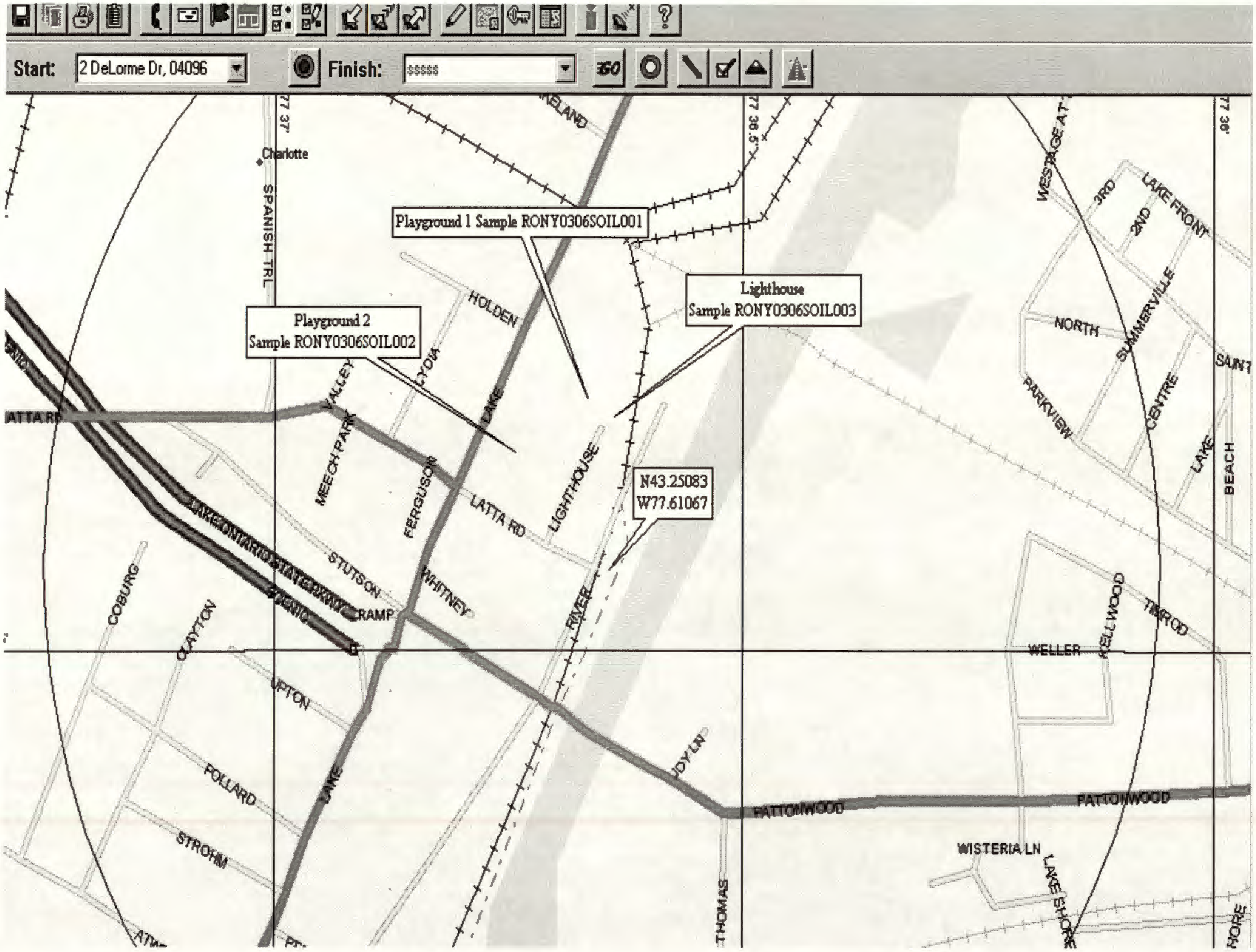
DISCUSSION

Soil samples collected by CTEH showed that soil within the playgrounds and the lighthouse near the accident site did not contain increased levels of acetone and methylene chloride. None of the samples collected by CTEH contained detectable amounts of methylene chloride (7.0 μg/kg). In addition the soil sample collected at the lighthouse did not contain detectable levels of acetone (27.0 μg/kg). The two samples collected within the playgrounds contained levels of acetone which are within normal background levels (6 - 9,484 ug/kg, Appendix D) for acetone. Acetone is a naturally occurring chemical in soil and air. Natural sources include plants and trees, forest fires, insects and microbes. Other sources of acetone in soil include agricultural and food waste, animal waste, atmospheric deposition, automobile exhaust, etc.

The New York State Department of Environmental Conservation (NYSDEC) has established cleanup criteria to protect receptors from chemicals and have recommended a soil cleanup level for acetone (200 μg/kg). In addition, the NYSDEC has also recommended soil cleanup objective (TAGM 4046, Appendix E) to protect ground water from acetone in soil (110 μg/kg). The USEPA Health Based level for acetone in soil is 8,000,000 μg/kg. Other USEPA Regions, such as Region 9, have established 16,000,000 μg/kg as a health based residential soil level for acetone. Thus, the maximum detected concentration of acetone (29 µg/kg) is well below health based and groundwater protection criteria for soil.

Appendix A

Map I: Approximate Locations of Playgrounds and Lighthouse



Start: 2 DeLorme Dr, 04096

Finish: $$$$$

Playground 1 Sample RONY0306SOIL001

Playground 2
Sample RONY0306SOIL002

Lighthouse
Sample RONY0306SOIL003

N43.25083
W77.61067

CTEH®

Appendix B

STANDARD OPERATING PROCEDURE

VOLATILE ORGANIC COMPOUNDS BY GC/MS

VOC-8260B

Revision 5.0

September 28, 2001

Approved By: ______________________ ________
Supervisor Date

______________________ ________
QA Coordinator Date

______________________ ________
Laboratory Manager Date

1 Mustard Street, Suite 250
Rochester, New York 14609

Annual review of this SOP has been performed and the SOP still reflects current practice.
Initials: ______ Date: __________
Initials: ______ Date: __________
Initials: ______ Date: __________

DOCUMENT CONTROL
NUMBER: __________
Initials: ______ Date: ______

1 SCOPE AND APPLICATION

This SOP is used to determine the concentration of volatile organic compounds in water and soil using USEPA Method 8260B. This method may also be applicable to various types of aqueous and nonaqueous waste samples. Table 1 lists the compounds that can be routinely determined by this method, and the compounds' practical quantitation limits (PQLs) in water and soil.

2 METHOD SUMMARY

2.1 This method gives gas chromatographic/mass spectrometric (GC/MS) conditions for the detection of parts per billion (ppb) levels of volatile organic compounds. A sample aliquot is injected into the gas chromatograph (GC) by either the purge and trap method or by direct injection. The compounds are separated on a wide bore fused silica capillary GC column or small bore capillary columns. The compounds are detected by a mass selective detector (MSD), which gives both qualitative as well as quantitative information.

2.2 Lower PQLs can be achieved by purging a volume larger than the standard 5mL discussed herein. With a 25mL purge, all reporting limits listed in Table 1 would be one-fifth that value. The analytical procedure, instrumentation, and QC limits are according to the following, however final sample volume would be 25mL. All internal, surrogate, and matrix spike solutions are prepared in the same manner discussed herein, only spiked into a 25mL sample volume thereby diluting the actual concentration by a factor of five. The initial and continuing calibration standards would also require the additional dilution thereby decreasing the range of calibration by a factor of five.

2.3 In the purge and trap process an inert gas, helium, is bubbled through the sample aliquot, at room temperature. This gas stream sweeps the volatile organic compounds out of the aqueous phase and into the gas stream - it purges the compounds out of the sample. The gas stream then passes through a sorbent column which selectively adsorbs, (traps) these compounds out of the helium. After the purging sequence is done, the sorbent column (the trap) is heated and backflushed onto the GC column. The GC column separates the compounds and passes then onto the MSD for identification and quantification.

3 DEFINITIONS

Analysis Window - Samples are analyzed in a set referred to as "a window". The window begins with the injection of the tune verification standard. After this standard has passed the method specific criteria a 12 hour analysis window is started.

Next, a calibration curve or a continuing calibration standard (CCV see below) is run followed by a method blank. If both pass their specific criteria, then samples are run until the 12 hour time limit closes. A new window must then be opened and the sequence repeated.

Internal Standards - Internal standards are organic compounds which are similar to the analytes of interest but which are not found in the samples. The chosen internal standards are used to help calibrate the instrument's response.

Independent Calibration Verification (ICV) - Verification of the ratio of instrument response to analyte amount, a calibration check, is done by analyzing for analyte standards in an appropriate solvent. ICV solutions (refered to as laboratory control samples or reference samples) are made from a stock solution which is different from the stock used to prepare calibration standards(Second Source).

Matrix Spike/Duplicate Matrix Spike Analysis - In the matrix spike analysis, predetermined quantities of standard solutions of certain analytes are added to a sample matrix prior to sample extraction and analysis. The purpose of the matrix spike is to evaluate the effects of the sample matrix on the methods used for the analyses. Samples are split into duplicates, spiked and analyzed. Percent recoveries are calculated for each of the analytes detected. The relative percent difference between the samples is calculated and used to assess analytical precision. The concentration of the spike should be at 5 to 10 times the MRL or at levels specified by a project analysis plan.

Standard Curve - A standard curve is a curve which plots concentrations of a known analyte standard versus the instrument response to the analyte.

Surrogate - Surrogates are organic compounds which are similar to the analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. The purpose of the surrogates is to evaluate the preparation and analysis of samples. These compounds are spiked into all blanks, standards, samples, and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate.

Continuing Calibration Verification Standard (CCV) - A mid-level standard injected into the instrument at specified intervals and is used to verify the initial calibration. The source of this standard is the same as that used for calibration purposes.

Method Blank (MB) - The method blank (also called continuing calibration blank) is a volume of clean reagent water analyzed on each GC/MS used for sample analysis. The purpose of the blank is to determine the levels of contamination associated with the instrumental analysis itself.

4 INTERFERENCE'S

4.1 Interference's by common laboratory extraction solvents, such as Methylene Chloride and Acetone can cause problems. The area where volatile organic analyses are performed should be free of these solvents.

4.2 Other interference's include but are not limited to impurities in the inert purge gas, dirty plumbing/purge vessels, cross contamination of highly contaminated samples, in transport and storage, and carry over from one analysis to subsequent ones.

5 SAFETY

The toxicity or carcinogenicity of each compound or reagent used with this method is [illegible] known. Each compound, mix of standards, internal standards and surrogates as well [illegible] the samples should be treated as a potential health hazard. Exposure to each should be reduced to the lowest level possible through the use of gloves and a hood. Reference files of Material Safety Data Sheets (MSDS) are available to all personnel. [illegible]AS also has a file of the current OSHA regulations regarding the safe handling of the compounds specified in this method.

6 SAMPLE CONTAINERS, COLLECTION, PRESERVATIONS, AND STORAGE

6.1 All sample containers for volatile organic analyses are purchased precleaned and certified from major lab equipment suppliers. All containers should be of glass or amber glass and equipped with a screw top cap and PFTE (teflon) lined septa and capable of containing a minimum of [illegible] mL of aqueous sample or 2-4 oz. of soil sample. All new lots of vials acquired are recorded by our SMO area and routinely checked for cleanliness and target compound contamination.

6.2 Aqueous Samples
Collect all samples in duplicate, triplicate when possible. Prepare the proper number of sample bottles/containers prior to the sampling event with preservatives to adjust the samples pH to <2 with [illegible] HCl.
Slowly fill aqueous sample bottles to just overflowing taking care not to flush out the preservative or to entrain air bubbles in the samples. Seal the bottles with PFTE lined septa toward the sample and invert to check for entrained air bubbles.

6.3 Soil Samples

Soil samples are collected per individual state, agency, or QAP requirements. See State Summary spreadsheet in VOA lab office for details. The following options are available:

Option 1:

Soil jars with PFTE lined septa are used to collect soil samples. The soil is pressed into the jar to the top to eliminate any headspace.(New York State). Holding time is 14 days from sample collection to analysis.

Option 2.

Encore style sampler and capsules are sent to the field and a fraction of either approximately 5 gm or 25 gm are collected by field personnel and shipped back to the laboratory chilled temperature of 0-6°C while in transit. The laboratory then has 48 hrs from sampling to preserve the soil fractions in sodium Bisulfate for the low concentration fraction and Methanol for high concentration fraction. Or optionally the samples must be run within 48 hours of sampling.

Option 3.

Soil vials are prepared by laboratory personnel. Two 40 ML VOA vials containing a 5 mL solution of Sodium Bisulfate ([illegible]gm/5mL) are sealed labled and Tarred, sent with this is a 40 mL VOA vial containing 10 mL of Purge And Trap Methanol, sealed, labled and tarred. A Top Loading balance is supplied to the field personnel and a 5 gm fraction is added to each of the three supplied Vials. Optionally a Encore sampler may be used to sample these fractions, then added to the above mentioned vials. The field sampler then returns the fractions (40mL vials) back to the laboratory chilled to 0-6°C at which time the lab re-weighs the vials to determine soil content and must perform the analysis within 14 days of sampling. (See VOC-5035).

6.4 All samples must be stored at 0-6°C and must be analyzed within 14 days of collection. Aqueous samples not prepreserved with HCl must be analyzed within 7 days of collection.

7 APPARATUS AND EQUIPMENT

7.1 Gas chromatograph/Mass Selective Detector Systems

Each GC/MS system is set up with a GC, injection onto a wide bore capillary column, and either a glass or stainless steel jet separator at the column/detector end prior to the transfer line interfaced with the MSD. Each MSD is a HP5970B, or HP5971 that is controlled by the HP-MSDOS Chemstation software.

7.2 Purge and Trap with Autosampler

7.2.1 Each volatile GC/MS analytical system uses a purge and trap to introduce the sample onto the GC column. Each purge and trap has an autosampler (A/S) attached to run multiple samples, one at a time, and run unattended for extended periods of time. A Tekmar ALS 2016 or its equivalent for extended unattended automated running is needed.

New generation purge and trap instruments have evolved to include greater production capabilities. These new autosamplers have the capability of running up to 50 positions continuously unattended. They also afford the ability to add both Internal Standards and Surrogate Standards automatically from two individual recepticals, removing some of the inconsistencies related to the repetitive analyst setup of the older autosampler technology. These new instruments include Varians Archon autosamplers and Tekmars new Precept II's. All lend themselves nicely to the new requirements of EPA Method 5035. In turn the sample and standard preparation vary for both methods 5030 and 5035 using these autosamplers. The preparation of both samples and standards for method 8260B by 5030 and 5035 will be addressed below.

7.2.2 Adsorbent Traps: Supelco K-Traps Carboxen Vocarb 3000

7.3 GC Columns

Column 1: Restex RTX-502.2, 105 M x 0.53mm id fused silica column 3.0 micron film thickness

Column 2: Hewlett Packard HP-624, 25 M x 0.2[illegible]mm id fused silica, 1.12 micron film thickness

Column 3: J&W DB624, 60 M, 0.32 mm ID, fused silica, 1.8 micron film thickness

8 PREVENTATIVE MAINTANENCE

8.1 All maintenance activities are recorded in a maintenance logbook kept for each instrument. Most routine maintenance and troubleshooting is performed by CAS staff. Other maintenance or repairs may, or may not require factory service, depending upon the nature of the task. Typical preventive maintenance measures include, but are not limited to, the following items:

- Check gas supply
- Change in-line filters, septum, and injection port liner, as needed
- Clip column and change guard column, as needed
- Clean source and jet separator

9 STANDARDS, REAGENTS, AND CONSUMABLE MATERIALS

9.1 Solvents

Methanol, purge and trap grade or equivalent and reagent water, prepared from deionized water.

9.2 Stock Standard Solutions

Commercially prepared and certified stock standards are used routinely for all the routine method analytes. All such mixtures are also routinely checked against an independent source for both analyte identification and analyte concentration. All such stock standard mixtures have expiration dates given by the manufacturer. Once opened, the mixtures must be replaced after 6 months, or sooner if the composition with the independent check standards indicates a problem. Store with minimal headspace, at -10° to -20°C and protect from light.

9.3 Calibration Standards (Tekmar 2016 - 5 mL or 5 gm aliquots)

A minimum of five different concentration levels for all the analytes are prepared by diluting the stock standards into prepared reagent water. The lowest concentration level shall be at the method reporting level. The remaining four levels should define the working linear range of the analytical system.

The suggested levels 5, 20, 50, 100, and [illegible]00 ppb for waters and soils. All calibration solutions are made up daily using the following procedures:

9.3.1 Calibration Standard Mix (50 ppm) Prepare a standard mix from purchased standard mixes which typically include a 200 ppm Volatiles Mix with gases, and a 200 ppm Custom Volatiles Mix and 300 ppm Baseline Std mix 2.

- Calibration Standard Mix 1 (50 ppm) = 0.625 mL of each of 200 ppm standard Volatile + gases mixes and 200 ppm Custom Volatile Mix above and dilute to 5.0 mL with methanol. Prepare weekly, unless verified by a second source with each use and store at -10° to -20°C.

- Calibration Standard Mix 2 (300 ppm) = 0.750 mL of Acrolein/ Acylonitrile at 2000 ppm and dilute to 5.0 mL with methanol. Prepare monthly, unless verified by a second source with each use and store at -10° to -20°C.

- Internal / Surrogate Mix (50 ppm) = 2500 ppm purchased Stock [illegible] mL/10mL Meoh = 250 ppm , 1mL 250 ppm /5mL = 50 ppm

Prepare monthly, unless verified by a second source with each use and store at -10° to -20°C.

Calibration Standards are prepared using the 50 ppm mix as follows:

Standard Concentration (ppb)	uL's of 50 ppm Mix 1	uL's of 300 ppm Mix 2	Final Volume (mL)**
5	5.0	5.0	50 (then 5.0 mL purge)
20	2.0	2.0	5.0
50	5.0	5.0	5.0
100	10.0	10.0	5.0
200	20.0	20.0	5.0

*****Internal Standards and Surrogates are added to all standards and samples at a rate of 5 ul of 50 ppm to each 5 mL aliquot.***

The surrogates recommended are Dibromofluoromethane, toluene-d_8 and 4-bromofluorobenzene. The internal standards recommended are pentafluorobenzene, 1,4-difluorobenzene, 1,4-dichlorobenzened_4 and chlorobenzene-d_5. The other internal standards and surrogates may be used, depending on the analysis requirements. All surrogates and internal standards are added to every standard, sample, blank and spike at 50 mg/L (5 ul of a 50 ppm working standard mix to 5.0 mL sample volume) for waters and soils.

9.3.2 Internal/Surrogate Stock Standards (2500 ppm) are purchased and used to prepare working standards for spiking purposes. Purchased stocks expire upon manufacturer's expiration date and stored at -10° to -20°C.

Internal/Surrogate Working Standard (50 ppm). Prepare monthly and store at -10° to -20°C.

- Prepare a 500 ppm Stock Standard by diluting [illegible] mL each of the purchased 2500 ppm stock to 5.0 mL with methanol.
- Internal/Surrogate Working Standard Mix (50 ppm) = [illegible] mL of the 500 ppm stock standard and dilute to 5.0 mL with methanol.

9.4 Calibration Standards (Archon Autosampler using 40 mL VOA vials)

9.4.1 Calibration Standard Mix (500 ppm) - Prepare a standard mix from purchased standard mixes which typically include a 500 ppm Volatiles Mix with gases, and a 500 ppm Custom Volatiles Mix + 54 Targets. Store at -10° to -20°C.

- Calibration Standard Mix 1 (500ppm) = 2.50 mL of each of 1000 ppm standard gases mixes and dilute to 5.0 mL with methanol.

Prepare weekly, unless verified by a second source with each use and store at -10° to -20°C.

- Calibration Standard Mix 2 (500 ppm) = 1.25mL 2000 ppm 54 Targets and 1.25 mL Custom volatile mix dilute to 5.0 mL in a class A volumetric flask, with methanol. Prepare monthly, unless verified by a second source with each use and store at -10° to -20°C.

Internal / Surrogate Mix (250 ppm) = Internal Std 2500 ppm purchased Stock 1.0 mL/10mL methanol = 250 ppm, Surrogate Std 2500 ppm purchased Stock -1.0 mL/10mL methanol = 250 ppm. Prepare monthly, unless verified by a second source with each use and store at -10° to -20°C.

Calibration Standards are prepared daily using the 500 ppm mix's as follows:

Standard Concentration (ppb)	ul's of 500 ppm Mix 1	ul's of 500 ppm Mix 2	Final Volume (mL)
5	1.0	1.0	100
20	2.0	2.0	50
50	5.0	5.0	50
100	10.0	10.0	50
200	20.0	20.0	50

- Internal Standards and Surrogates are added to all standards and samples at a rate of 1 ul of 250 ppm to each 5 mL aliquot. This is accomplished by the Archon Auto-Sampler at the time of analysis.The sample or standard is transfered from the Archon through a nickel transfer line, past a ported valve that is calibrated to deliver 1 ul of IS/Surr mix. The sample fraction is transferred to a fritted sparge chamber on the Tekmar 2016 Concentrator at which time the sample or standard is purged on to the adsorbent trap.

- In the case of water analysis on the Archon autosampler, setup differs from the 2016 sampler in that a filled 40 mL VOA vial takes the place of the 5 mL fraction added to 2016. This setup is preferable in that the sample or standard is retained with zero headspace until just prior to analysis. This does in fact change the procedure for calibration which is noted above, that of addition of standard solution to a 40 mL VOA vial.

It should be noted that in the cases where calibrating for the analysis of soil by 5035/8260B that the standard solution above must contain the same amount of Sodium Bisulfate as the samples being analyzed.

9.5 Internal Standards and Surrogate Standards

The surrogates recommended are Dibromofluoromethane, toluene-d_8 and 4-bromofluorobenzene. The internal standards recommended are pentafluorobenzene, 1,4-difluorobenzene, 1,4-dichlorobenzened_4 and chlorobenzene-d_5. The other internal standards and surrogates may be used, depending on the analysis requirements. All surrogates and internal standards are added to every standard, sample, blank and spike at 50 ug/L (1 ul of a 250 ppm working standard mix to 5.0 mL sample volume) for waters.

9.5.1 Internal/Surrogate Stock Standards (2500 ppm) are purchased and used to prepare working standards for spiking purposes.

Internal/Surrogate Working Standard (250 ppm)

- Prepare a 250 ppm Stock Standard by diluting 1.0 mL each of the purchased 2500 ppm stock's to 10.0 mL with methanol.
- This mix is transferred to a sealed glass ampule that acts as a reservoir where the auto-samplers adds a 1 ul fraction per addition.

9.6 Tune Standard (25 ppm)

9.6.1 A second source BFB (surrogate standard diluted to 25 ppm) is directly injected into the instrument or purged on the Tekmar on a daily basis as the BFB Tune.
The standard is added at a rate of 2ul of 25 ppm BFB/ 5 mL or 50 ng on column.

9.7 Matrix Spike (50 ppb)

Routinely five compounds recommended by the method for determining accuracy on a particular sample matrix are 1,1-dichloroethene, trichloroethene, benzene, toluene, and chlorobenzene. All samples designated for MS analysis are spiked at 50 ug/L (4.25 ul of a 500ppm working standard mix to 40 mL sample vial).

9.7.1 Although method 8260 requires monitoring recoveries for the five above mentioned compounds it is our practice to spike our Matrix Spike/ Matrix Spike Dups with all Target Compounds specified by our clients. This is accomplished by spiking samples as though they were a 50 ppb initial calibration point. 4.25 ul Std Mix 1 500 ppm, 4.25 ul Std Mix 2 500ppm/ 40 mL VOA sample vial. After adding the spiking standard the vial is inverted 3 times to insure equilibration of the standard addition.

9.8 Laboratory Control Sample (20 ppb)

By definition a LCS or commonly known Reference is a standard aquired from a secondary source than that of the Target Compounds used for the initial calibration.

- Volatile Reference Mix1 (20 ppm) - Commercially available 200 ppm 54 component mix diluted 1mL / 10 mL Meoh (20 ppb = 5 ul /5mL DI)

- Volatile Reference Mix2 (20/200 ppm) = Commercially available 1000 ppm Acrolein/Acrylonitrile 1 mL/ 5 mL Meoh, HSL 400 ppm, .250 mL / [illegible] mL Methanol

Prepare the 20 ppb LCS or Reference = 50ul Mix1 + 50 ul Mix2 / 50 mL DI.

10 RESPONSIBILITIES

10.1 It is the responsibility of the analyst to perform the analysis according to the instructions in this SOP and to complete all documentation required for data review. Analysis and interpretation of the results are only to be performed by personnel in the laboratory who have demonstrated the ability to generate acceptable results utilizing this SOP. This demonstration is in accordance with the training program of the laboratory. Final review and sign-off of the data is performed by the department supervisor/manager or designee.

11 PROCEDURE

11.1 Sample Preparation

11.1.1 Water Samples

No preparation is generally required, other than dilution with reagent water to bring analytes into the upper half of the calibration range. Thus, a 5 mL sample volume is run straight from the sample vial.

11.1.2 All water samples should be checked to have a pH of 2 (pH < 2). The pH shall be noted in the run log.

11.1.3 Samples requiring dilutions due to targets above the linear range of the instruments are prepared as follows:

1:5 = 10 mL sample adjusted to 50 mL in a 50 mL ground glass graduated cylinder inverted twice and transfered to a 40 mL VOA vial

1:25 = 2.0 mL sample adjusted to 50 mL in a 50 mL ground glass graduated cylinder inverted twice and transfered to a 40 mL VOA vial

1:50 = 1.0 mL sample adjusted to 50 mL in a 50 mL ground glass graduated cylinder inverted twice and transfered to a 40 mL VOA vial

- Spiking of the diluted sample is similar to the 50 ppb CCV:
  5 ul Mix1 + 5 ul Mix2 invert and add to 40 mL VOA vial.

Note: At no time should less than 1 mL of the original sample fraction be used for the preparation of the diluted sample. This insures a representative fraction of sample is diluted.

11.2 Calibration

11.2.1 BFB Tuning Criteria

Each volatile GC/MS analytical system set up to run 8260B must meet the criteria listed in Table 2 of the method for a 50 ng injection of BFB. An acceptable BFB tune must be run prior to any analysis or every twelve hours there after.

The analyst may use documented approaches suggested by the instrument manufacturer or others to acquire scans for the BFB tune. Do not background subtract part of the BFB peak.

11.2.2 GC/MS Analytical System 5 Point Calibrations

Prior to conducting any sample analyses, a 5 point calibration must be run. Recommended calibration levels are 5, 20, 50, 100, and 200 ppb. Starting with the lowest level, analyze each calibration standard and tabulate the area response of the characteristic quantitation ion versus concentration for each compound, internal standards and surrogate. The low level standard used during calibration shall be the reporting level for the analysis. Calculate the response factors (RF) for each compound and surrogate relative to the specified internal standard by:

$$RF_x = \frac{(A_x)(C_{ISTD})}{(A_{ISTD})(C_x)}$$

Where:

A_x = Area of the characteristic quantitation ion for compound x.
A_{ISTD} = Area of the characteristic quantitation ion for the specified internal standard.
C_x = The concentration of the compound added.
C_{ISTD} = The concentration of the specified internal standard.

Calculate the mean response factor $(\overline{RF_x})$ for each analyte and surrogate from the five calibration levels. Calculate standard deviation (SD) and the percent relative standard deviations (%RSD) for each analyte from the mean with:

$$\%RSD = \frac{(SD)}{(\overline{RF_x})}100.$$

The % RSD should be less than 15% for each target compound. However, the % RSD for each individual CCC must be less than 30%. The CCC's are: 1,1-Dichloroethene, Chloroform, 1,2-Dichloropropane, toluene, Ethylbenzene and Vinyl Chloride.

> If a % RSD greater than 30% is measured for any CCC, then corrective action to eliminate a system leak and/or column reactive sites is required before reattempting calibration.
>
> If the % RSD for any target compound is 15% or less, linearity can be assumed over the calibration range, and the relative response factor for each analyte and surrogate is used to quantitate sample analytes.
>
> If the % RSD of any compound is > 15%, construct a linear calibratio curves of area ratio (A/A_{is}) versus concentration.
>
> If a curve scheme is to used. the required Corr.Coef. must be greater than 0.99 and the origin must not be used inclusively as a point of the curve. It is good lab practice to mark all target compounds on a curve with an asterisk to identify target compounds calculated using linear regression. It is also a requirement that if a client's sample contains a compound calculated via non-linear curve, that he or she be notified by the laboratory. *(See Method 8000B)*
>
> Due to the large compound lists quoted in 8260B some compounds are problematic by nature. It is stated in the methodology that if certain compounds exceed 15 % RSD and that the mean % RSD of all target compounds in the curve do not exceed 15% that the curve is valid. This is frowned upon by our laboratory but may sometime be used if the compound in question is known to be continually a problematic or non-typical compound. In any case these issues would be addressed in a case narrative.

Note: For some states, such as South Carolina, all reported target compounds must be quantitated from an initial calibration yielding an RSD ≤15% for that particular compound.

The response of 5 SPCC's must also be checked for their minimum $\overline{RF}_x$:

Chloromethane	>0.10
1,1-Dichloroethane	>0.10
Bromoform	>0.10
Chrorobenzene	>0.30
1,1,2,2-Tetrachloroethane	>0.30

After the 5-point calibration has passed all of the above criteria, and the mid-point (CCV) has been checked against the curve, then samples can be analyzed.

11.3 Daily GC/MS Calibration

11.3.1 The start of a 12-hour analysis window requires a check of the MSD's tune via an injection of 50 ng of BFB. If the criteria found in Table 2 of USEPA 8260B are met, then a check of the initial calibration curve is done. If the first run of the BFB fails, retry. If the second run also fails, inform your supervisor. You may have to retune and recalibrate the system.

11.3.2 After the tuning criteria have been verified, the initial calibration must be checked and verified by analyzing a midrange calibration standard (CCC). The 50 ppb level is recommended. For 8260B, water daily check standards are 5µl of the 50 ppm 8260 working standard spiked into 5 mL of reagent water. The results are compared with those of the initial calibration's $\overline{RF}$ using the following equation:

$$\%Drift = (RF_1 - RF_2)/ RF_1 \times 100$$

where:

RF_1 = Average response factor for the initial calibration
RF_2 = Response factor from the continuing calibration check standard

If the percent drift is less than 20 %, the Initial Calibration is assumed to be valid. Also, the criteria for the SPCCs and the CCCs, as outlined above, must be met.

11.3.3 If the tune criteria and the continuing calibration criteria are met, then the retention times of all compounds, surrogates, and internal standards are checked against the initial calibration. If the retention time for any internal standard changes by more than 30 seconds from the last calibration check (12 hours), the system must be inspected for malfunctions and corrections must be made, as required. If the area for any of the internal standards changes by a factor of 2 (-50% to +100%) from the last daily calibration check std., corrections must be made to the system.

11.4 Identification of Analytes

The MSD data system software identifies a sample component by first finding and identifying the surrogate and internal standards. After they have been integrated, the extracted ion chromatogram is searched for all calibrated analytes. Any peak associated with the proper retention time window having the primary characteristic quantitation ion identified has it's results calculated. If there is no peak found for an analyte in the expected retention time window and the mass spectra does not match according to the method criteria, then the analyte is "not found". Example retention times are provided in Appendix I, however must only be used as a reference due to the variability on a daily basis due to instrument conditions

12 QA/QC REQUIREMENTS

12.1 12-Hour Analysis Window Requirements

For every 12-hour analysis window, after meeting the tune and continuing calibration criteria, at least one method blank must be run and reportable for each matrix.All blanks reported must be free from target analytes with the exception of known common laboratory contaminants, These compounds may include Acetone and Mecl2 at a level no greater than 5 times the compounds PQL and all samples effected should be marked with the appropriate lab flag.

12.2 Analytical Batch Requirements

For each batch of samples (20 samples maximum), a minimum of one MS/MSD pair and an LCS for each matrix must be analyzed to ensure instrument performance.

12.3 Acceptance Criteria and Corrective Action

12.3.1 The acceptance criteria for tuning verification, initial and continuing calibration verification are discussed in the procedure.

12.3.2 For every 12-hour analysis window, after meeting the tune and continuing calibration criteria, at least on method blank must be analyzed and reported for each matrix. All method blanks reported must be free from all target compounds quantitated above the reporting limit during the 12-hour sequence.
Exception: if a target analyte is greater than ten times the method blank contaminant, the analysis may continue since the sample concentratio

is high enough that possible contamination has not effected it's concentration.

12.3.2 Table 3 contains the acceptance criteria for evaluating matrix spikes and surrogate recoveries. LCS recovery requirements for all target compounds is 70-130% (method-required limits until lab generated limits are recalculated). Matrix spikes and LCSs are performed on a 5% frequency. When batches are less than 20 samples, LCS standards are performed on a per batch basis.

- Any MS/MSD that fails the required QC Accuracy or precision requirements will be reanalyzed and the precision and accuracy data checked. It is a requirement that a LCS be run concurrently with any matrix spikes. If the LSC passes QC requirements it is presumed that matrix has effected the spiked samples and the run may continue. If the concurrent LCS fails for the same compound or any other compound the validity of the LCS should be looked at and any samples prior to the LCS and after the last CCV should be reanalyzed.

- Typically a full LCS spike is analyzed to evaluate the performance of all samples, however only the 5 method specific compounds may be reported with sample results. For some states, such as South Carolina, the full LCS spike is reported and target compound recoveries are required to be within laboratory limits for all compounds quantitated above the reporting limit.

- When instances of Surrogate or internal area count failures occur, the associated sample is repeated and the results are compared. If the questioned samples fail a second run, the first run is reported to the client and the sample flagged with an "*" indicating a probable matrix interference exists. In the case where Tier package work is required and the appropriate forms need to be generated, the second analytical analysis is also reported to the client.

12.4 Calculate the recovery of each matrix spike compound as follows:

$$\text{Matrix Spike Recovery} = \frac{SSR - SR}{SA} \times 100$$

Where,
SSR = Spiked sample result
SR = Sample result
SA = Spike added

12.5 Calculate the relative percent difference (RPD) of the recoveries of each compound in the matrix spike and matrix spike duplicate as follows:

$$\text{RPD} = \frac{|\text{MSR} - \text{MSDR}|}{\frac{1}{2}(\text{MSR} + \text{MSDR})} \times 100$$

Where,
MSR = Matrix spike recovery
MSDR = Matrix spike duplicate recovery

12.6 Method Performance - Method Detection Limit (MDL) studies should be performed annually for both soil and water matrices. See CAS SOP ADM-MDL for specifics.

13 DATA REDUCTION AND REPORTING

13.1 Calculations

The GC/MS data stations, in current use, all use the H-P RTE Integrator to generate the raw data used to calculate the standards $\overline{RF_x}$ values, the sample amounts, and the spike values. The software does three passes through each data file. The first two identify and integrate each internal standard and surrogate. The third pass uses the time-drift information from the first two passes to search for all method analytes in the proper retention times and with the proper characteristic quantitation ions.

13.1.1 The results for a water sample are calculated as follows when $\overline{RF_x}$ is used:

$$A_x = \frac{(Resp_x)(Amt_{ISTD})}{(Resp_{ISTD})(\overline{RF_x})} \times DilFactor$$

Where:
A_x = the amount, in ppb, of the analytes in the sample;
$Resp_x$ = the peak area of the analytes of interest;
$Resp_{ISTD}$ = the peak area of the associated internal standard;
$\underline{Amt_{ISTD}}$ = the amount, in ppb, of internal standard added, and
$\overline{RF_x}$ the average response from the five-point for the analytes of interest.

13.1.2 The results for a soil sample are broken into two types, the low-level type and the high-level type.

13.1.2.1 The low-level type is a direct heated purge of soil and requires its own separate five-point. For soil, 5 grams is weighed out into the sample vial, and is purged with 5 mL of blank reagent water at a temperature of 40°C ±2°. The results for low-level soil work are calculated by taking the normal print out, in ppb, (see the water results outlined above) and correcting for the total, dry soil sample actually purged:

$$(A_x) * \frac{(5\ grams)}{(ASW_t\ gr)(\%\ Solids)} = A_x\ Low\text{ - }Level\ Soil$$

Where:
A_x = the amount, in ppb, from the data station;
5 grams = the nominal amount of soil that is heated and purged;
ASW_t = the actual soil wet weight, in grams, that is purged
% Solids = the correction factor for dry weight.

It is to be noted that new methods evolve due to the requirement of outside agencies. This includes the adoption of method 5035. Although similar to the above mentioned low level soil methods, specific criteria must be met for this methodology. This includes running all low level soils against an appropriate curve in which all standards in the calibration were heated. Although the method differs due to autosampler requirements, data calculation and reduction remains the same. For further information and procedures in regards to this method see Method 5035.

13.1.2.2 The high-level type is an extraction method and is only done when needed. In general, a four gram wet weight of soil is extracted with 10 mL of purge-and-trap methanol. A 100 ul aliquot of this extract is run against the results for a high-level soil extract are calculated as follows:

$$(A_x) * \frac{(Dilution)(5\ ml)}{(ASW_t)(\%\ Solids)} = A_x\ High\text{ - }Level\ Soil\ Amt.$$

Where:
A_x = the data station results, in ppb;
Dilution = the dilution of the extract.
5 mL = the amount of methanol used to extract the soil;
ASW_t = the actual wet weight of soil extracted
% Solids = the dry soil correction.

It should be noted that some states and governing agencies require differing amounts of soil and Methanol ratio be maintained these ratios are generally, 1:2.5, 1:2, 1:1. The amount of extract added is never greater than 100 ul per 5 mL DI. As an example, the Archon *autosampler would require the addition of 1.0 mL to 49 mL DI. This is then transfered to a 40 mL VOA vial. See the included table in method 5035 for specific state regulation on soil to Methanol ratios.*

13.2 Reporting

Most reports are generated using STARLIMS. All data is transferred electronically from the instrument into STARLIMS. The report is composited and all applicable QC reported.

14 WASTE MANAGEMENT AND POLLUTION PREVENTION

14.1 It is the laboratory's responsibility to comply with all federal, state, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

14.2 Excess, unused samples and testing byproducts are disposed following the procedures in the *SM[illegible]IS.*

15 REFERENCES

15.1 *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*, USEPA SW-846, Third Edition, December 1996.

16 TRAINING OUTLINE

16.1 Read current SOP and applicable methodologies. Demonstrate a general understanding of the methodology and chemistry.

16.2 Observe Sample Preparation and Analysis.

16.3 Participate in the methodology, documentation, and data reduction with guidance

16.4 Instrument Operation and Maintenance, if applicable

16.5 Demonstrate Competency by performing the analysis independently. Analyze a known proficiency or standard. If recovery is within acceptable limits, complete training form and have the supervisor sign-off as being proficient. An IDC study must be performed and the departmental supervisor must approve the study before the new analyst may analyze samples independently. Four replicates must be analyzed within LCS control limits to complete the IDC study.

17.0 INSTRUMENT-SPECIFIC ADDENDUM

See Operations Manual

18.0 ATTACHMENTS

Table 1	Summary of Target Compounds and Reporting Limits
Table 2	BFB Tune QC Criteria
Table 3	Surrogate/Matrix Spike/Reference Standard QC Criteria
Appendix 1	Example Retention Times

19.0 CHANGES FROM PREVIOUS REVISION

- Expanded Section 6.0 to include options for soil sample collection and holding times.
- Revised expiration dates for VOA standards in Section 9.0. Revised preparation sections to reflect current standards purchased.
- Discussed tune criteria and scan requirements further in Section 11.0.
- Omitted options to use quadratic fit.
- Included a statement that the low level standard during an ICAL was to be used as the lowest level of detection and discouraged the use of averaging RSD values for ICAL acceptance.
- Revised method blank acceptance criteria in section 12.0.
- Added calculations for accuracy and precision in Section 12.0.
- Added annual MDL study requirements to Section 12.0.
- Included IDC study requirements under Section 16.0.

TABLE 1
VOLATILE ORGANIC COMPOUNDS VIA EPA METHOD 8260B

Compound	*LOW(25 ml) Water (ug/L)*	*REG(5 ml) Water (ug/L)*	*LOW Soil (ug/Kg)*	*5035Medium Soil (ug/Kg)*	*(OLD 4G/10ML Medium Soil (ug/Kg)*
1,1,1-Trichloroethane (TCA)	1.0	5.0	5.0	500	625
1,1,2,2-Tetrachloroethane	1.0	5.0	5.0	500	625
1,1,2-Trichloroethane	1.0	5.0	5.0	500	625
1,1-Dichloroethane	1.0	5.0	5.0	500	625
1,1-Dichloroethene	1.0	5.0	5.0	500	625
1,2-Dichloroethane	1.0	5.0	5.0	500	625
1,2-Dichloropropane	1.0	5.0	5.0	500	625
2-Butanone (MEK)	5.0	10	10	1000	1250
2-Hexanone	5.0	10	10	1000	1250
4-Methyl-2-pentanone (MIBK)	5.0	10	10	1000	1250
Acetone	10	20	20	2000	2500
Benzene	1.0	5.0	5.0	500	625
Bromodichloromethane	1.0	5.0	5.0	500	625
Bromoform	1.0	5.0	5.0	500	625
Bromomethane	1.0	5.0	5.0	500	625
Carbon Disulfide	5.0	10	10	1000	1250
Carbon Tetrachloride	1.0	5.0	5.0	500	625
Chlorobenzene	1.0	5.0	5.0	500	625
Chloroethane	1.0	5.0	5.0	500	625
Chloroform	1.0	5.0	5.0	500	625
Chloromethane	1.0	5.0	5.0	500	625
cis-1,2-Dichloroethene	1.0	5.0	5.0	500	625
cis-1,3-Dichloropropene	1.0	5.0	5.0	500	625
Dibromochloromethane	1.0	5.0	5.0	500	625
Ethylbenzene	1.0	5.0	5.0	500	625
Methylene Chloride	1.0	5.0	5.0	500	625
Styrene	1.0	5.0	5.0	500	625
Tetrachloroethene (PCE)	1.0	5.0	5.0	500	625
Toluene	1.0	5.0	5.0	500	625
Total Xylenes	1.0	5.0	5.0	500	625
trans-1,2-Dichloroethene	1.0	5.0	5.0	500	625
trans-1,3-Dichloropropene	1.0	5.0	5.0	500	625
Trichloroethene (TCE)	1.0	5.0	5.0	500	625
Vinyl Chloride	1.0	5.0	5.0	500	625

TABLE 2

4-BROMOFLUOROBENZENE CHARACTERISTIC ION ABUNDANCE CRITERIA

Mass/é ratio	Ion Abundance Criteria
50	15 - 40% of mass/é 95
75	30 - 60% of mass/é 95
95	base peak, 100% relative abundance
96	5 - 9% of mass/é 95
173	<2% of mass/é 174
174	>50% of mass/é 95
175	5 - 9% of mass/é 174
176	>95%; <101% of mass/é 174
177	5 - 9% of mass/é 176

Table 3

Surrogate/Matrix Spike QC Criteria

	Soil	Water
Surrogates		
Dibromofluoromethane	80-120	86-118
Toluene-d8	81-117	88-110
4-Bromofluorobenzene	74-121	86-115
Matrix Spikes		
1,1-Dichloroethene	59-172	61-145
Benzene	66-142	76-127
Trichloroethene	62-137	71-120
Toluene	59-139	76-125
Chlorobenzene	60[illegible]33	75-130

APPENDIX I

Example Retention Times

Appendix C

COLUMBIA ANALYTICAL SERVICES

VOLATILE ORGANICS
METHOD 8260B SITE LIST
Reported: 03/26/02

CTEH
Project Reference: CSX Derailment
Client Sample ID : RONY0306SOIL001

Date Sampled : 03/05/02 11:00 **Order #:** 534934 **Sample Matrix:** SOIL/SEDIMEN
Date Received: 03/05/02 **Submission #:** R2210962 **Percent Solid:** 71.3

ANALYTE	PQL	RESULT	UNITS
DATE ANALYZED : 03/06/02			
ANALYTICAL DILUTION: 1.00			Dry Weight
ACETONE	20	29	UG/KG
METHYLENE CHLORIDE	5.0	7.0 U	UG/KG

SURROGATE RECOVERIES	QC LIMITS		
4-BROMOFLUOROBENZENE	(42 - 149 %)	66	%
TOLUENE-D8	(71 - 128 %)	85	%
DIBROMOFLUOROMETHANE	(70 - 127 %)	75	%

COLUMBIA ANALYTICAL SERVICES

VOLATILE ORGANICS
METHOD 8260B SITE LIST
Reported: 03/26/02

CTEH
Project Reference: CSX Derailment
Client Sample ID : RONY0306SOIL002

Date Sampled : 03/05/02 11:05 **Order #:** 534935 **Sample Matrix:** SOIL/SEDIME
Date Received: 03/05/02 **Submission #:** R2210962 **Percent Solid:** 96.9

ANALYTE	PQL	RESULT	UNITS
DATE ANALYZED : 03/06/02			
ANALYTICAL DILUTION: 1.00			Dry Weight
ACETONE	20	28	UG/KG
METHYLENE CHLORIDE	5.0	5.2 U	UG/KG

SURROGATE RECOVERIES	QC LIMITS		
4-BROMOFLUOROBENZENE	(42 - 149 %)	73	%
TOLUENE-D8	(71 - 128 %)	84	%
DIBROMOFLUOROMETHANE	(70 - 127 %)	84	%

COLUMBIA ANALYTICAL SERVICES

VOLATILE ORGANICS
METHOD 8260B SITE LIST
Reported: 03/26/02

CTEH
Project Reference: CSX Derailment
Client Sample ID : RONY0306SOIL003

Date Sampled : 03/05/02 11:15 **Order #:** 534936 **Sample Matrix:** SOIL/SEDIME
Date Received: 03/05/02 **Submission #:** R2210962 **Percent Solid:** 73.7

ANALYTE		PQL	RESULT	UNITS
DATE ANALYZED : 03/06/02				
ANALYTICAL DILUTION: 1.00				Dry Weight
ACETONE		20	27 U	UG/KG
METHYLENE CHLORIDE		5.0	6.8 U	UG/KG
SURROGATE RECOVERIES	QC LIMITS			
4-BROMOFLUOROBENZENE	(42 - 149 %)		82	%
TOLUENE-D8	(71 - 128 %)		94	%
DIBROMOFLUOROMETHANE	(70 - 127 %)		79	%

Appendix D

ACETONE

CASRN: 67-64-1

For other data, click on the Table of Contents

Environmental Fate & Exposure:

Environmental Fate/Exposure Summary:

Acetone's production and use as a solvent for fats, oils, waxes, resins, rubbers, plastics, pharmaceuticals and rubber cements may result in its release to the environment through various waste streams. Its use as an extracting reagent and starting material or intermediate in the manufacture of chemical products will also lead to its release to the environment. **Acetone** occurs naturally as a metabolic byproduct of plants and animals and is released into the atmosphere by volcanoes and forest fires. Based on an experimental vapor pressure of 231 mm Hg at 25 deg C, **acetone** is expected to exist solely as a vapor in the ambient atmosphere. Vapor-phase **acetone** is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals with an estimated atmospheric half-life of 71 days. **Acetone** also undergoes photodecomposition by sunlight with an estimated half-life of about 80 days. **Acetone** is expected to have very high mobility in soils based upon an estimated Koc value of 1. Volatilization from dry soil surfaces is expected based upon the vapor pressure of this compound. Volatilization from moist soil surfaces is also expected based upon the measured Henry's Law constant of 1.87X10-5 atm-cu m/mol. This compound is expected to biodegrade under aerobic and anaerobic conditions. In water, **acetone** is not expected to adsorb to suspended solids or sediment based upon its estimated Koc value. Volatilization from water surfaces is expected to be an important environmental fate process given its estimated Henry's Law constant. Estimated half-lives for a model river and model lake are 38 and 333 hours, respectively. Experimentally determined volatilization half-lives in a shallow stream were measured in the range of 8-18 hours. Bioconcentration in aquatic organisms is considered low based upon an estimated BCF value of 1. Occupational exposure may be through inhalation and dermal contact with this compound at workplaces where **acetone** is produced or used. The general population may be exposed to **acetone** through the use of commercially available products containing this compound such as paints, adhesives, cosmetics, and rubber cements. Exposure will also arise from inhalation of ambient air, ingestion of drinking water, and food that contains **acetone**. (SRC)
`**PEER REVIEWED**`

Probable Routes of Human Exposure:

NIOSH (NOES Survey 1981-1983) has statistically estimated that 1,510,107 workers (466,677 of these are female) are potentially exposed to **Acetone** in the US(1). Occupational exposure may be through inhalation and dermal contact with this compound at workplaces where **acetone** is produced or used(SRC). The 8 hour TWA exposure to **acetone** was in the range of 0-70,000 umols/cu m in a survey of 659 occupationally exposed male subjects working in shoe, plastics and chemical plants in Italy (2). Workers in a Japanese acetate fiber producing plant had detectable levels of **acetone** in urine samples between 1 and 160 mg/l(3). The average TWA exposure to **acetone** in 7 spray painting and glue spraying plants was 0.9, 3.2, 2.3 0.9 and 5.6 ppm for higher-aromatic paint spraying, lower-aromatic paint spraying, glue spraying, solvent wiping, and paint mixing respectively(4).
`[(1) NIOSH; National Occupational Exposure Survey (NOES) (1983) (2) Ghittori S et al; Am Ind Hyg Assoc J 48: 786 (1987) (3) Fujino A et al; Br J Ind Med 49: 654-57 (1992) (4) Whitehead LW et al; Am Ind Hyg Assoc J 45: 767-72 (1984)]**PEER REVIEWED**`

The general population may be exposed to **acetone** through the use of commercially available products containing this compound such as paints, adhesives, cosmetics, and rubber cements(SRC). Exposure will also arise from inhalation of ambient air, ingestion of drinking water, and food that contains **acetone**(SRC). The average blood concn of **acetone** in 600 non-occupationally exposed persons in the US was 3,100 ppb(1).
`[(1) Ashley DL et al; Clin Chem 40: 1401-04 (1994)]**PEER REVIEWED**`

Body Burden:

Acetone was detected in the expired breath of 23 of 26 smokers and 42 of 43 nonsmokers in the US(1). **Acetone**

people (387 samples) with a geometric mean concn of 101.3 ng/l(2). **Acetone** loss in the urine is generally 1 mg/24 hr for a normal adult but is about 50 mg in children(3,4). **Acetone** was detected in the expired breath of children in 2 classrooms in France at an average concn of 800 ng/l(5).
[(1) Gordon SM; J Chromatogr 511: 291-302 (1990) (2) Krotoszynski BK et al; J Anal Toxicol 3: 225-34 (1979) (3) Harper HA; Review of Physiological Chemistry 12th ed p. 303 (1969) (4) White WL et al; Chemistry for Medical Technologists 3rd ed Mosby Co St Louis, MO (1970) (5) Cailleux A et al; Chromatographia 37: 57-59 (1993)]**PEER REVIEWED**

Average Daily Intake:

AIR INTAKE (assume air concn of 0.05-20 ppb): 24-960 mg; WATER INTAKE - insufficient data; FOOD INTAKE - insufficient data. (SRC)
PEER REVIEWED

Natural Pollution Sources:

/Component/ of oxidation of humic substances.
[Verschueren, K. Handbook of Environmental Data on Organic Chemicals. 3rd ed. New York, NY: Van Nostrand Reinhold Co., 1996. 112]**PEER REVIEWED**

Acetone has been produced by the fermentation of west coast kelp.
[Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984.,p. 15(81) 294]**PEER REVIEWED**

Acetone occurs naturally as a metabolic byproduct of plants and animals and is released into the atmosphere by volcanoes and forest fires(1).
[(1) Graedel TE et al; Atmospheric Chemical Compounds. NY,NY: Academic Press p. 263 (1986)]**PEER REVIEWED**

Artificial Pollution Sources:

Emissions from wood-burning fireplaces were measured. **Acetone** was one of the compounds identified.
[Lipari F et al; Environ Sci Technol 18 (5): 326-30 (1984)]**PEER REVIEWED**

Acetone's production and use as a solvent for fats, oils, waxes, resins, rubbers, plastics, pharmaceuticals and rubber cements(1,2) will result in its release to the environment through various waste streams(SRC). Its use as an extracting reagent and starting material or intermediate in the manufacture of chemical products(1) will also lead to its release to the environment(SRC).
[(1) Budvari S; Merck Index, 12th ed, Whitehouse Station,NJ: Merck & Co. p. 1773 (1996) (2) Stoye D; Ullmann's Encycl Indust Chem 5th ed Deerfield,FL: VCH Publ A24: 489 (1993)]**PEER REVIEWED**

Environmental Fate:

TERRESTRIAL FATE: Based on a recommended classification scheme(1), an estimated Koc value of 1(SRC), determined from an experimental log Kow of -0.24(2), and a recommended regression-derived equation(3), indicates that **acetone** is expected to have very high mobility in soil(SRC). Volatilization of **acetone** from moist soil surfaces(SRC) is expected given the measured Henry's Law constant of 1.87X10-5 atm-cu m/mole(4). Volatilization from dry soil surfaces is expected based upon the experimental vapor pressure of 232 mm Hg at 25 deg C(5,SRC). **Acetone** is expected to biodegrade under both aerobic and anaerobic conditions as indicated by numerous screening tests(6-9).
[(1) Swann RL et al; Res Rev 85: 23 (1983) (2) Hansch C et al; Exploring QSAR Hydrophobic, Electronic and Stearic Constants Washington,DC: Amer Chem Soc (1995) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington,DC: Amer Chem Soc pp. 4-9 (1990) (4) Benkelberg HJ et al; J Atmos Chem 20: 17-34 (1995) (5) Alarie Y et al; Toxicol Appl Pharmacol 134: 92-99 (1995) (6) Suflita JM, Mormile MR; Environ Sci Technol 27: 976-78 (1993) (7) Waggy GT et al; Environ Toxicol Chem 13: 1277-80 (1994) (8) Schwartz LJ; Appl Biochem Biotechnol 28/29: 297-305 (1991)(9) Chou WL et al; Bioeng Symp 8: 391-414 (1979)]**PEER REVIEWED**

determined from an experimental log Kow of -0.24(2), and a recommended regression-derived equation(3), indicates that **acetone** will not adsorb to suspended solids and sediment in water(SRC). **Acetone** is expected to volatilize from water surfaces(3,SRC) based on the measured Henry's Law constant of 1.87X10-5 atm-cu m/mole(4). Estimated half-lives for a model river and model lake are 38 and 333 hours, respectively(3,SRC). Experimentally determined volatilization half-lives in a shallow stream were measured in the range of 8-18 hours(5-7). Biodegradation of this compound is expected, but volatilization has been shown to be the primary removal process of **acetone** in water(5-7). According to a classification scheme(8), an estimated BCF value of 1(3,SRC), from an experimental log Kow(2,SRC), suggests that bioconcentration in aquatic organisms is low(SRC).
[(1) Swann RL et al; Res Rev 85: 23 (1983) (2)Hansch C et al; Exploring QSAR Hydrophobic, Electronic and Stearic Constants Washington,DC: Amer Chem Soc (1995) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington,DC: Amer Chem Soc pp. 4-9 (1990) (4) Benkelbberg HJ et al; J Atmos Chem 20: 17-34 (1995) (5) Rathbun RE et al; J Hydrol 104: 181-209 (1988) (6) Rathbun RE et al; J Hydrol 123: 225-42 (1991) (7) Rathbun RE et al; Environ Pollut 79: 153-62 (1993) (8) Franke C et al; Chemosphere 29: 1501-14 (1994)]**PEER REVIEWED**

ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), **acetone**, which has an experimental vapor pressure of 231 mm Hg at 25 deg C(2), will exist solely as a vapor in the ambient atmosphere. Vapor-phase **acetone** is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals(SRC); the half-life for this reaction in air is estimated to be about 71(3,SRC) days. The average rate constant for the photodissociation of **acetone** by natural sunlight in the lower troposphere was measured as 1X10-7 sec-1(4). This corresponds to a half-life of about 80 days(4).
[(1) Bidleman TF; Environ Sci Technol 22: 361-367 (1988) (2) Alarie Y et al; Toxicol Appl Pharmacol 134: 92-99 (1995) (3) Atkinson R; J Phys Chem Ref Data (1989) (4) Meyrahn H et al; J Atmos Chem 4: 227-91 (1986)]**PEER REVIEWED**

Environmental Biodegradation:

Biological oxygen demand: (Theoretical) 122%, 5 days
[U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5.]**PEER REVIEWED**

The percent theoretical BOD of **acetone** in water seeded with settled domestic sewage was 56%, 76%, 83% and 84%, over 5, 10, 15 and 20 day incubation periods(1). Percent theoretical BOD's of **acetone** in a raw sewage inocula were reported as 37% and 81% over 5 and 20 day incubation periods respectively(2), 54% over a 5 day incubation period(3), 71% over a 7 day incubation period(4), 55% and 72% over 5 day and 10 day incubation periods respectively(5) and 38% over a 5 day incubation period(6). **Acetone** was shown to be readily biodegradable under anaerobic conditions(7-9). The percent theoretical methane recovery of **acetone** in an anaerobic aquifer was 89% over a 3 week incubation period following a 25 day acclimation period(9).
[(1) Waggy GT et al; Environ Toxicol Chem 13: 1277-80 (1994) (2) Young RHF, et al; J Water Pollut Contr Fed 40: 354-68 (1968) (3) Bridie Al, et al; Water Res 13: 627-30 (1979) (4) Helfgott TB et al; An Index of Refactory Organics USEPA-600/2-77-174 (1977) (5) Lamb CB, Jenkins GF; Proc 8th Industrial Waste Conf, Purdue Univ p. 326-9 (1952) (6) Vaishnav DD et al; Chemosphere 16: 695-703 (1987) (7) Schwartz LJ; Appl Biochem Biotechnol 28/29: 297-305 (1991) (8) Chou WL et al; Bioeng Symp 8: 391-414 (1979) (9) Suflita JM, Mormile MR; Environ Sci Technol 27: 976-78 (1993)]**PEER REVIEWED**

Environmental Abiotic Degradation:

The rate constant for the vapor-phase reaction of **acetone** with photochemically-produced hydroxyl radicals has been measured as 2.26X10-13 cu cm/molecule-sec at 25 deg C(1). This corresponds to an atmospheric half-life of about 71 days at an atmospheric concn of 5.0X10+5 hydroxyl radicals per cu cm(1,SRC). The average rate constant for the photodissociation of **acetone** by natural sunlight in the lower troposphere was measured as 1X10-7 sec-1(2). This corresponds to a half-life of about 80 days(2). When water containing **acetone** is treated with chlorine for disinfection purposes, the **acetone** can react with the hypochlorite ion formed by the hydrolysis of chlorine leading to the production of trichloromethane(3). This reaction is strongly pH dependent and is expected to have a significant effect only at pH values of 6-7(3).

(1986) (3) Stevens AA et al; J Am Water Works Assoc 68: 615-20 (1976)]**PEER REVIEWED**

Environmental Bioconcentration:

An estimated BCF value of 1 was calculated for **acetone**(SRC), using an experimental log Kow of -0.24(1) and a recommended regression-derived equation(2). According to a classification scheme(3), this BCF value suggests that bioconcentration in aquatic organisms is low(SRC).
[(1) Hansch C et al; Exploring QSAR Hydrophobic, Electronic and Stearic Constants Washington,DC: Amer Chem Soc (1995)(2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington,DC: Amer Chem Soc pp. 5-4, 5-10 (1990) (3) Franke C et al; Chemosphere 29: 1501-14 (1994)]**PEER REVIEWED**

Soil Adsorption/Mobility:

The Koc of **acetone** is estimated as approximately 1(SRC), using an experimental log Kow of -0.24(1) and a regression-derived equation(2,SRC). According to a recommended classification scheme(3), this estimated Koc value suggests that **acetone** is expected to have very high mobility in soil(SRC). **Acetone** showed no adsorption to montorillonite, kaolinite clay, or stream sediment(4,5).
[(1) Hansch C et al; Exploring QSAR Hydrophobic, Electronic and Stearic Constants Washington,DC: Amer Chem Soc (1995) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington,DC: Amer Chem Soc pp. 4-9 (1990) (3) Swann RL et al; Res Rev 85: 23 (1983) (4) Rathbun RE et al; Chemosphere 11: 1097-114 (1982) (5) Wolfe TA et al; J Water Pollut Control Fed 58: 68-76 (1986)]**PEER REVIEWED**

Volatilization from Water/Soil:

The Henry's Law constant for **acetone** was measured as 1.87X10-5 atm-cu m/mole(SRC) at 25 deg C(1). This value indicates that **acetone** will volatilize from water surfaces(2,SRC). Based on this Henry's Law constant, the volatilization half-life from a model river (1 m deep, flowing 1 m/sec, wind velocity of 3 m/sec) is estimated as approximately 38 hours(2,SRC). The volatilization half-life from a model lake (1 m deep, flowing 0.05 m/sec, wind velocity of 0.5 m/sec) is estimated as approximately 333 hours(2,SRC). Volatilization rate constants of a model stream (234 m long, water velocity 0.67 m/min) were measured in the range of 8.23X10-4 min-1 to 11.1X10-4 min-1(3). These rate constants correspond to volatilization half-lives of about 10-14 hours(3). Similar experiments in the same stream measured **acetone** volatilization rate constants in the range of 6.22X10-4 min-1 to 14.5X10-4 min-1(4,5). These rate constants correspond to volatilization half-lives of about 8-18 hours(4,5). **Acetone** is expected to volatilize from dry soil surfaces given its experimental vapor pressure(1,SRC).
[(1) Benkelbberg HJ et al; J Atmos Chem 20: 17-34 (1995) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington,DC: Amer Chem Soc pp. 15-1 to 15-29 (1990) (3) Rathbun RE et al; J Hydrol 104: 181-209 (1988) (4) Rathbun RE et al; J Hydrol 123: 225-42 (1991) (5) Rathbun RE et al; Environ Pollut 79: 153-62 (1993)]**PEER REVIEWED**

Environmental Water Concentrations:

A concentration of 0.6 g/l of **acetone** was found in a sample of a one-year old leachate from a ... sanitary landfill.
[Verschueren, K. Handbook of Environmental Data on Organic Chemicals. 3rd ed. New York, NY: Van Nostrand Reinhold Co., 1996. 114]**PEER REVIEWED**

DRINKING WATER: **Acetone** was identified, not quantified, in 10 out of 10 drinking water samples collected in the US(1). **Acetone** was identified, not quantified, in the drinking water of New Orleans, LA(2), Seattle, WA(3) and Tuscaloosa, AL(4). **Acetone** was detected in a drinking water well in New Jersey at a concn of 3,000 ppb(5). Six drinking water wells in the vicinity of a landfill contained 0.2 to 0.7 ppb of **acetone**(6). An unspecified concn of **acetone** leached from a section of high density polyethylene tubing supplying drinking water in Paris(7). **Acetone** was detected in the municipal wells in Waite Park, MN at concns between 74-3,300 ug/l(8).
[(1) Fielding M, Packman RF; J Inst Water Eng Sci 31: 353-75 (1977) (2) USEPA; New Orleans Area Water Supply Study. Draft Analytical Report by the Lower Mississippi River Facility, Slidell (1974) (3) Keith LH et al; Identification of Organic Pollut Water Ann Arbor, MI

Soil Crop Sci Soc Fl Proc 44: 1-8 (1985) (6) Dewalle FB, Chain ESK; J Am Water Works Assoc 73: 206-11 (1981) (7) Anselme C et al; Sci Total Environ 47: 371-84 (1985) (8) Minnesota Dept of Health; Health assessment for Waite Park ground water contamination site, Waite Park, Minnesota, Region 5. CERCLIS No MND981002249, PB90-107475 (1990)]**PEER REVIEWED**

GROUNDWATER: **Acetone** was detected in groundwater near a chemical manufacturing facility in Michigan at a maximum concn of 1,600 ug/l(1). **Acetone** was detected in groundwater in NJ at a concn of 3,000 ug/l(2). **Acetone** was detected at a concn of 620 ppb in the groundwater at the Lipari landfill, NJ(3). **Acetone** was detected at a concn of 11 ug/l in the on-site wells and 0.19 ug/l in the off-site groundwater near a manufacturing facility in MI(4). **Acetone** was identified, not quantified, in 12.4% of the groundwater samples at 178 sites in the US(5) and in the groundwater of a waste disposal facility in SC(6). The average concn of **acetone** in groundwater sampled at 5 wood treatment facilities was 20 ug/l(7). **Acetone** was detected in the groundwater of a coal strip-mine in Ohio at concns of 1,300 mg/l and 2,700 ug/l(8).
[(1) USEPA; Superfund Record of Decision: Cordova Chemical Site, North Muskgon, MI. USEPA/ROD/RO5-89/111 (1989) (2) Jury WA et al; Ecosystem 99: 119-64 (1987) (3) USEPA; Superfund Record of Decision: Lipari Landfill Mantau Township, NJ. USEPA/ROD/RO2-88/074 (1988) (4) USEPA; Superfund Record of Decision: US Aviex, MI USEPA/ROD/RO5-88/073 (1988) (5) Plumb RHJR; Groundwater Monit Rev 7: 94-100 (1987) (6) ATSDR; Public health assessment for Carolawn, Fort Lawn, Chester County, South Carolina, Region 4, CERCLIS No. SCD980558316. Addendum. NTIS PB93-146249 (1993) (7) Rosenfeld JK, Plumb RHJR; Groundwater Monit Rev 11: 133-40 (1991) (8) USEPA; Superfund Record of Decision: Summit National Site, Deerfield OH. USEPA/ROD/R85-88/068 (1988)]**PEER REVIEWED**

SURFACE WATER: Five of nine sites in Lake Michigan contained 1-4 ppb **acetone**(1). In a survey of 14 heavily industrialized river basins in the USA (204 samples), 33 contained detectable amounts of **acetone** including 18 of 31 sites in the Chicago area and the Illinois River basin, 8 of 30 sites in the Delaware River basin, 1 of 45 sites in the Mississippi River basin, 3 of 27 sites in the Ohio River basin, and 3 of 15 west coast sites(2). **Acetone** was identified, not quantified, in the Black River in Tuscaloosa, AL(3), and the Cuyahoga River in the Lake Erie basin(4). **Acetone** was detected in the Potomac River at a concn of less than 40 ug/l(5).
[(1) Konasewich D et al; Great Lake Water Qual Board (1978) (2) Ewing BB et al; Monitoring to Detect Previously Unrecognized Pollutants in Surface Waters Appendix USEPA-560/6-77-015 (1977) (3) Berstch W et al; J Chromatog 112: 701-18 (1975) (4) Great Lakes Water Quality Board Ontario; An inventory of chemical subtances identified in the Great Lakes ecosystem volume 1 - Summary. Report to the Great Lakes Water Quality Board. Windsor Ontario, Canada p. 195 (1983) (5) Hall LWJR et al; Aquat Toxicol 10: 73-99 (1987)]**PEER REVIEWED**

SEAWATER: Samples of seawater and surface slicks taken from Biscayne Bay and the Florida Current contained 39.6 and 89.7 ppb of **acetone**, respectively(1). Grab samples of surface water from the Straits of Florida and the Eastern Mediterranean contained 20 and 28 ppb of **acetone**, respectively(2). Samples of ocean water taken at 1,200 m depths contained unspecified concns of **acetone**(2).
[(1) Seba DB, Corcoran EF; Pestic Monit J 3: 109-3 (1969) (2) Corwin JF; Bull Mar Sci 19: 504-9 (1969)]**PEER REVIEWED**

RAIN/SNOW: 50 ppb of **acetone** was detected in one of 6 samples tested at 5 cities in California(1). An unspecified concn of **acetone** was detected in rain in Japan(2). **Acetone**/acrolein was detected in rainfall in Los Angeles, CA at a concn of 0.05 ug/ml and in ice at Urban Fairbanks, AK at a concn of 0.21 umols/ml(3). **Acetone** was identified, not quantified, in rainfall in Germany(4). **Acetone** was detected in the clouds (460 ng/l) and rainfall (0.5 ng/l) at a state park in North Carolina(5).
[(1) Grosjean D, Wright B; Atmos Environ 17: 2093-6 (1983) (2) Kato T et al; Yokohama Kokuritsu Daigaku Kankyo Kagaku Kenkyu Senta Kiyo 6: 11-20 (1980) (3) Mazurek MA, Simoneit BRT; CRC Crit Rev Environ Control 16: 140 (1986) (4) Levson K et al; Chemosphere 21: 1037-61 (1990) (5) Aneja VP et al; J Air Waste Manag Assoc 43: 1239-44 (1993)]**PEER REVIEWED**

Effluent Concentrations:

Acetone was detected in the effluent of a chemical plant located in Sweden at a concn of 5.5 kg/cu m(1). **Acetone** was detected in the effluent of municipal landfill sites in North America at concns of 6,838 ppb and 32,500 ppb(2). **Acetone** was identified, not quantified in the emissions of new carpets(3), automobiles(4,5) and common household waste(6-9). **Acetone** was detected in the effluent from a solid waste composting plant at

m(middle age compost), 6,100 ug/cu m(old compost) and 2,300 ug/cu m(curing region)(10). **Acetone** was identified, not quantified, in the emissions of 314 out of 1,005 common household products(11). **Acetone** was detected in the effluent of a waste incinerator in Germany at a concn of 17.6 ug/cu m(12). **Acetone** was detected in the emissions of a photocopying machine at rates of less than 100 ug/hr to 2,200 ug/hr(13). **Acetone** was detected at a concn of 25 ug/cu m in the emissions of a composting facility in Virginia(14).
[(1) Brorson T et al; Environ Toxicol Chem 13: 543-52 (1994) (2) Brosseau, Heitz M; Atmos Environ 25A: 1473-77 (1994) (3) Hodgeson AT et al; J Air Waste Manage Assoc 43: 316-24 (1993) (4) Sawyer RF; Environ Health Perspect 101: 5-12 (1994) (5) Harley RA et al; Environ Sci Technol 26: 2395-2408 (1992) (6) Wilkins CK, Larsen K; J High Resol Chromatogr 18: 373-77 (1995) (7) Wilkins K, Larsen K; Chemosphere 31: 3225-36 (1995) (8) Wilkins K, Larsen K; Chemosphere 32: 2049-55 (1996) (9) Wilkins K; Chemosphere 29: 47-53 (1994) (10) Eitzer BD; Environ Sci Technol 29: 896-902 (1995) (11) Sack TM et al; Atmos Environ 26A: 1063-70 (1992) (12) Jay K, Stieglitz L; Chemosphere 30: 1249-60 (1995) (13) Leovic KW et al; J Air Waste Manage Assoc 46: 821-29 (1996) (14) Vandurme GP et al; Water Environ Res 64: 19-27 (1992)]**PEER REVIEWED**

Acetone was detected in the leachate of several municipal landfills at concns between 6-4,400 ug/l(1). **Acetone** was detected in the wastewater of a truck parts producing plant in Michigan at a concn of 44.5 ug/l(2). **Acetone** was detected in the effluent of an unauthorized hazardous waste disposal facility in New Jersey at a concn of 480 ug/l(3). **Acetone** was detected at a concn of 46.6 ppb in the leachate of a landfill in Delaware containing industrial and municipal waste(4). **Acetone** was detected at concns between 0.05-62 mg/l and 0.14-44 mg/l in the leachate of industrial landfills and municipal landfills in the US(5). **Acetone** was detected in the leachate of a landfill in Connecticut at a concn of 3,500 ug/l(6).
[(1) Christensen TH et al; Crit Rev Environ Sci Technol 24: 119-202 (1994) (2) USEPA; Superfund Record of Decision: Kysor Industrial, Cadillac, MI. USEPA/ROD/R05/-89/113 (1989) (3) USEPA; Superfund Record of Decision: Lang Property, Pemberton Township, NJ. USEPA/ROD/R05/-89/113 (1987) (4) Dewalle FB, Chian Esk; J Am Water Works Assoc 73: 206-11 (1981) (5) Brown KW, Donnelly KC; Haz Waste Haz Mater 5: 1-30 (1988) (6) Sawhney BL; pp 447-74 in Reactions and Movements of Organic Chemicals in Soils SSSA Special Pub No 22 (1989)]**PEER REVIEWED**

In gasoline exhaust: 2.3-14.0 ppm (partly propionaldehyde)
[Verschueren, K. Handbook of Environmental Data on Organic Chemicals. 3rd ed. New York, NY: Van Nostrand Reinhold Co., 1996. 113]**PEER REVIEWED**

Sediment/Soil Concentrations:

Acetone was detected in the soil of a coal strip mine in Ohio at mean concns of 9,484 ug/kg (surface soil), 2,263 ug/kg (2-4 feet), 9644 ug/kg (4-6 feet), 5,272 ug/kg (6-8 feet)(1). **Acetone** was identified, not quantified, in the sediment and subsurface soil of a gravel mine in Tennessee(2). **Acetone** was detected at an average concn of 736 ug/kg in the soil of an unauthorized hazardous waste disposal facility in New Jersey(3).
[(1) USEPA; Superfund Record of Decision: Summit National Site, Deerfield OH. USEPA/ROD/R85-88/068 (1988) (2) USEPA; Superfund Record of Decision: Galloway Ponds Site, Galloway, TN. USEPA/ROD/R04-86/013 (1987) (3) USEPA; Superfund Record of Decision: Lang Property Pemberton Township, NJ USEPA/ROD/R02-86/031 (1987)]**PEER REVIEWED**

Atmospheric Concentrations:

SOURCE DOMINATED: **Acetone** was detected at 22 source dominated sites in the USA at a median concn of 0.350 ppb and a maximum concn of 53 ppb(1). **Acetone** was detected at concns between 2.3-3.3 ppb near the Texaco Refinery in Tulsa, OK(2).
[(1) Brodzinsky R, Singh HB; Volatile Organic Chemicals in the Atmos SRI International Contract 68-02-3452 (1982) (2) Arnts RR, Meeks SA; Atmos Environ 15: 1643-51 (1981)]**PEER REVIEWED**

URBAN/SUBURBAN: **Acetone** was detected at a concn of 1-8 ppb in Denver, CO(1). **Acetone** was detected at mean concns of 13.9 ppb in Boston, MA, 34.5 ppb(2) and 6.1 ppb(3) in Houston, TX and 12 ppb in Tucson, AZ(4). The average concn of **acetone**/formaldehyde at 4 southern California locations was 0.30 ppb(5). **Acetone** was detected at a concn of 2.07 ppb in Columbus, OH(6). The average concn of **acetone** at 5 sites in Stockholm was between 4.04-19.40 ppb(7).
[(1) Anderson LG et al; Isr J Chem 34: 341-53 (1994) (2)

JR, Dawson GA; J Geophys Res, D: Atmos 90: 3797-805 (1985) (5) Grosjean E et al; Environ Sci Technol 30: 2687-2703 (1996) (6) Spicer CW et al; Atmos Environ 30: 3443-56 (1996) (7) Jonsson A et al; Environ Int 11: 383-92 (1985)]**PEER REVIEWED**

INDOOR AIR: **Acetone** was detected at an average concn of 39 ug/cu m at 14 homes and buildings in Italy(1). **Acetone** was detected in 2 buildings in Portland, OR at concns between 14.9-66.0 ug/cu m and 7.4-33.9 ug/cu m(2). **Acetone** was detected in a building in Switzerland at a concn of 7,763 ug/cu m(3). **Acetone** was detected at a concn of 10 and less than 1 ng/l in 2 elementary school classrooms in France(4).
[(1) Debortoli M et al; Environ Int 12: 343-50 (1986) (2) Hodgeson AT et al; J Air Waste Manage Assoc 41: 1461-68 (1991) (3) Rothweiler H et al; Atmos Environ 26A: 2219-25 (1992) (4) Cailleux A et al; Chromatographia 37: 57-59 (1993)]**PEER REVIEWED**

RURAL/REMOTE: **Acetone** was detected at an average concn of 14.72 ng/l in the air of a state park in North Carolina(1). **Acetone** was identified, not quantified, in the air of a German forest(2). **Acetone** was detected at concns between 0.39-3.26 ppb and 0.72-3.81 ppb in Egbert Ontario and Dorset Ontario respectively(3). **Acetone** was detected at a mean concn of 1,140 parts per trillion in Eastern Canada(4). **Acetone** was detected at a mean concn of 2.6 ppb at 2 rural sites in AZ(5) and 5.1 ppb in Rio Blanco county, CO(6). The **acetone** concn in air at Pt Barrow, AK (22 measurements) ranged from 0.3 to 2.9 ppb, with a mean concn of 1.21 ppb(7). **Acetone** was detected at a concn of 1.9 ppb in the Jones State Forest near Houston, TX(8).
[(1) Aneja VP et al; J Air Waste Manag Assoc 43: 1239-44 (1993) (2) Helmig D et al; Chemosphere 19: 1399-1412 (1989) (3) Shepson PB et al; Atmos Environ 25A: 2001-15 (1991) (4) Singh HB et al; J Geophys Res 99: 1805-19 (1994) (5) Snider JR, Dawson GA; J Geophys Res, D: Atmos 90: 3797-805 (1985) (6) Arnts RR, Meeks SA; Atmos Environ 15: 1643-51 (1981) (7) Cavanagh LA et al; Environ Sci Technol 3: 251-7 (1969) (8) Seila RL; Non-urban Hydrocarbon concns in Ambient Air North of Houston, TX USEPA USEPA-500/3-79-010 p.38 (1979)]**PEER REVIEWED**

Food Survey Values:

Acetone was identified, not quantified, in the volatiles of kiwi fruit(1,2), blue cheese(3), raw chicken(4), cured pork(5), chickpea seeds(6), nectarines(7), mutton, chicken and beef(8). **Acetone** has been identified, not quantified, as a volatile component of baked potatoes(9), roasted filberts(10), dried beans and legumes(11), and French cognac(12).
[(1) Bartley JP, Schwede AM; J Agric Food Chem 37: 1023-25 (1989) (2) Tatsuka K et al; J Food Sci 38: 2176-80 (1990) (3) Day EA, Anderson DF; J Agric Food Chem 13: 2-4 (1965) (4) Grey TC, Shrimpton DH; Brit Poultry Sci 8: 23-33 (1967) (5) Hinrichsen LL, Anderson HJ; J Agric Food Chem 42: 1537-42 (1994) (6) Rembold H et al; J Agric Food Chem 37: 659-62 (1989) (7) Takeoka GR et al; J Agric Food Chem 36: 553-60 (1988) (8) Shahidi F et al; CRC Crit Rev Food Sci Nature 24: 141-243 (1986) (9) Coleman EC et al; J Agric Food Chem 29: 42-8 (1981) (10) Kinlin TE et al; J Agric Food Chem 20: 1021 (1972) (11) Lovegren NV et al; J Agric Food Chem 27: 851-3 (1979) (12) TerHeide R et al; pp. 249-81 in Anal Foods Beverages, Chavalambous G, ed. NY,NY: Academic (1978)]**PEER REVIEWED**

Plant Concentrations:

Acetone is emitted from Bay Leaf Willows, European Firs and Evergreen Cyprus(1).
[(1) Singh HB, Zimmerman PB; Adv Environ Sci Technol 24: 177-235 (1992)]**PEER REVIEWED**

Milk Concentrations:

Acetone was identified, not quantified, in human milk from Bayonne, NJ, Jersey City, NJ, Pittsburgh, PA and Baton Rouge, LA(1). **Acetone** was identified, not quantified, in all 8 samples of mother's milk analyzed from 4 industrial urban areas in the USA(2). **Acetone** was identified, not quantified from milk samples in Australia(3).
[(1) Erickson MD et al; Acquisition and chemical analysis of mother's milk for selected toxic substances. USEPA-560/13-80-029. Washington DC: US EPA Off Pestic Toxic Subst (1980) (2) Pellizzari ED et al; Bull Environ Contam Toxicol 28: 322-8 (1982) (3) Urbach G; J Chromatogr 404: 163-74 (1987)]**PEER REVIEWED**

Other Environmental Concentrations:

Cigarette smoke - 1,100 ppm

Van Nostrand Reinhold Co., 1996. 113]**PEER REVIEWED**

Acetone was detected in cigarette smoke at a concn of 1,620 ug per cigarette(1).
[(1) Otson R, Fellin P; pp. 335-421 in Gas Pollut: Charact Cycl, Nriagu JO ed. NY,NY: John Wiley & Sons (1992)]**PEER REVIEWED**

5. POTENTIAL FOR HUMAN EXPOSURE

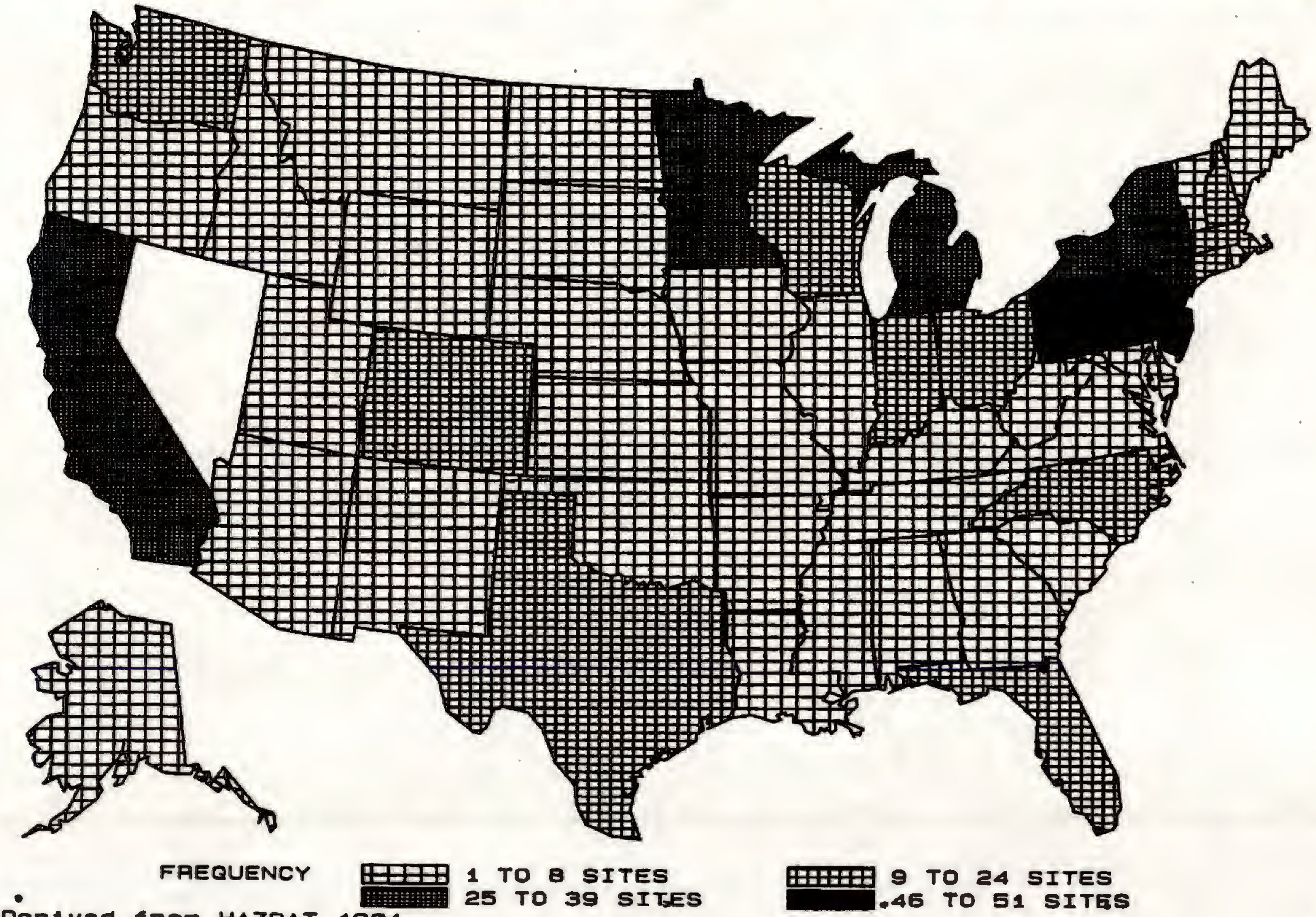
5 . 1 OVERVIEW

Acetone is emitted into the atmosphere both from natural and anthropogenic (man-made) sources. Natural sources of emission include plants and trees (Graedel et al. 1986; Isidorov et al. 1985; Khalil and Rasmussen 1992), volcanic eruptions (Isidorov et al. 1990), forest fires (Graedel et al. 1986), and insects and microbes (Graedel et al. 1986). Acetone is also produced endogenously and expired in human breath (Conkle et al. 1975). Some important anthropogenic sources of acetone in the air include vehicular exhaust (Graedel et al. 1986), chemical manufacturing (Graedel et al. 1986), tobacco smoke (Manning et al. 1983), wood burning and pulping (Graedel et al. 1986), refuse and polyethylene combustion (Graedel et al. 1986; Hodgkin et al. 1982; NAS 1976), petroleum production (Graedel et al. 1986), certain landfill sites (Hodgson et al. 1992; LaRegina et al. 1986), and solvent use (Graedel et al. 1986). The sensitized photoreaction of dissolved organic matters naturally produces acetone in seawater (Mopper and Stahovec 1986). Chemical manufacturing industries (Abrams et al. 1975), energy-related industries (Mohr and King 1985), and user industries (Abrams et al. 1975) release acetone to surface waters. Acetone is released into groundwater mainly as a result of leaching from municipal and industrial landfills (Brown and Donnelly 1988). The principal sources of acetone in soil are municipal and industrial discharge in landfills (EPA 1988b). Another source is atmospheric deposition (Grosjean and Wright 1983). Acetone is released in soil from natural sources, such as disposed agricultural and food wastes and animal wastes (Graedel et al. 1986).

Acetone has been identified in at least 560 of the 1,350 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (HAZDAT 1991). However, the number of sites evaluated for acetone is not known. The frequency of these sites within the United States can be seen in Figure 5-l. Of these sites, 559 are located in the United States and 1 is located in the Commonwealth of Puerto Rico (not shown).

The two processes that are important in determining the fate of acetone in the atmosphere are reaction with hydroxyl radicals and photolysis. The estimated half-life of acetone in the air due to combinations of these two reactions is 22 days (Meyrahn et al. 1986). Because of this reasonably long half-life, acetone is transported long distances from its source of emission. Wet deposition transports

FIGURE 5–1. FREQUENCY OF NPL SITES WITH ACETONE CONTAMINATION *



*Derived from HAZDAT 1991

atmospheric acetone to surface water and the terrestrial surface (Grosjean and Wright 1983). The most important fate determining process for acetone in water is biodegradation (Rathbun et al. 1982). Because of its high water solubility, acetone does not adsorb significantly to sediment and suspended solids in water. Acetone does not bioconcentrate in aquatic organisms (Rustung et al. 1931), and there is no data on acetone biomagnification in aquatic and terrestrial food chains. Biodegradation is the most important degradative process for acetone in sediment and soil (Rathbun et al. 1982). The important transport processes of acetone in soil are volatilization to the atmosphere and leaching into groundwater.

The levels of acetone in ambient air and water are generally low. The concentration of acetone in the atmosphere in remote areas is ≤1 ppb (volume per volume [v/v]) (1 ppb=0.001 ppm) (Cavanagh et al. 1969; Arnold et al. 1986). Its mean concentration in the atmosphere of rural areas is <3 ppb (Shepson et al. 1991; Snider and Dawson 1985). The mean concentration of acetone in urban air in the United States is 6.9 ppb (Shah and Singh 1988). Acetone concentration in indoor air in the United States is generally slightly higher than outdoor air (8.0 ppb versus 6.9) (Shah and Singh 1988), due to the use of household consumer products containing acetone. The concentration of acetone in open seawater near the Bahamas was 0.35 ppb (Kieber and Mopper 1990). The concentration of acetone in the Potomac River in Virginia was below the detection limit of 40 ppb (Hall et al. 1987), and the level will be higher in water receiving industrial and municipal discharge containing acetone. An industrial landfill leachate in Michigan contained 62 ppm acetone (Brown and Donnelly 1988). An acetone concentration ≤3,000 ppb was detected in a drinking water well in New Jersey (Burmaster 1982). The level of acetone in finished drinking water is generally low (Coleman et al. 1976; Keith et al. 1976), and the reported concentration in drinking water from Seattle, Washington, was 1 ppb (Keith et al. 1976). A concentration of 6 ppb acetone was detected in the sediment of a creek adjacent to a landfill in Louisville, Kentucky (Stonebraker and Smith 1980). Acetone has been detected in the volatile components of several fruits and vegetables (Bartley and Schwade 1989; Lovegren et al. 1979).

The general population is exposed to acetone by inhaling ambient air and by ingesting drinking water and food containing acetone. No data for the total daily intake of acetone for the general population were located. There is a great deal of evidence that workers in certain industries, such as certain paint, plastic, artificial fiber, and shoe factories are exposed to much higher levels of acetone than the general population (Kawai et al. 1990a; Pezzagno et al. 1986). Professional painters, and commercial and household cleaners are also likely to be exposed to higher acetone concentrations than the general population. Among the general population, smokers, frequent users of nail polish removers and people who live near certain landfill sites (emitting higher than ambient levels of acetone) or other industrial sources of emission are susceptible to higher exposure concentrations of acetone.

5.2 RELEASES TO THE ENVIRONMENT

5.2.1 Air

Acetone is emitted into the atmosphere both from natural and anthropogenic (man-made) sources. Natural sources of emission include plants and trees. Acetone has been detected in a number of plant volatiles including onions, grapes, cauliflower, tomatoes, wild mustard, beans, and peas (HSDB 1992), and emissions have been detected from a variety of trees including willow, aspen, birch, balsam poplar, oak, fir, pine, juniper, cedar, and cypress (Isidorov et al. 1985; Khalil and Rasmussen 1992). Acetone is produced endogenously and released as a component of human breath (Conkle et al. 1975; Krotoszynski 1977; Trotter et al. 1971). Volatiles from animal wastes, microbes, and insects are also examples of natural sources of acetone in the air (Graedel et al. 1986). In addition, forest fires and volcanic eruptions emit acetone into the atmosphere (Graedel et al. 1986; Isidorov et al. 1990).

Some important anthropogenic sources of acetone in the air are automobile and diesel exhaust (Barber and Lodge 1963; Jonsson et al. 1985; Lloyd 1978), chemical manufacture (Graedel et al. 1986), tobacco smoke (Manning et al. 1983), wood burning and pulping (Graedel et al. 1986; Kleinienst et al, 1986; Lipari et al. 1984), polyethylene burning (Hodgkin et al. 1982), refuse combustion (NAS 1976), petroleum production (Graedel 1978), certain landfill sites (Hodgson et al. 1992; LaRegina et al. 1986; Militana and Mauch 1989), and solvent uses (Medinilla and Espigares 1988). Acetone is also formed in the atmosphere from the photochemical oxidation of propane (Arnold and Ziereis 1986; Singh and Hanst 1981) and possibly from propylene oxide and epichlorohydrin (Spicer et al. 1985). Atmospheric emissions are also likely from several consumer products including nail polish removers, particle board (Tichenor and Mason 1988), carpet backing (Hodgson et al. 1993), some paint removers (Hahn and Werschulz 1986), and a number of liquid/paste waxes or polishes (Knoeppel and Schauenburg 1989; Sack et al. 1992). Certain detergents/cleansers (Knoeppel and Schauenburg 1989; Sack et al. 1992), adhesives, and carburetor and choke cleaners (EPA 1989) are also known to contain acetone.

Acetone released into air from facilities in each state in the United States that manufactured or processed acetone during 1990 are listed in Table 5-l (TR190 1992). According to TR190 (1992), an estimated total of 180 million pounds of acetone, amounting to 96.7% of the total environmental release, was discharged to the air from manufacturing and processing facilities in the United States in 1990. The TRI data should be used with caution since only certain types of facilities were required to report. This is not an exhaustive list. From the monitoring data on levels of acetone in pristine areas and urban/suburban areas (see Section 5.4.1), it seems likely that the total emission of acetone in the atmosphere from anthropogenic sources exceeds the total emission from natural sources.

52.2 Water

Acetone is released into surface water as waste water from certain chemical manufacturing industries (Gordon and Gordon 1981; Hites and Lopez-Avila 1980; Jungclaus et al. 1978). It is also released in water from energy-related industries, such as coal-gasification (Mohr and King 1985; Pellizzari et al. 1979) and oil shale processing (Hawthorne and Sievers 1984; Pellizzari et al. 1979). Acetone was found in 27 of 63 effluent waters from a wide range of chemical industries in the United States (Perry et al, 1979). A survey of industrial effluents indicates that acetone was detected in effluents from various industrial products such as, paper, plastic, pharmaceutical, specialty cleaning and polishing products, paint and allied products, gum and wood chemicals, cyclic intermediates, industrial organic chemicals, gypsum products, and paper board products (Abrams et al. 1975).

Acetone is released to groundwater as a result of leaching from municipal and industrial landfills (Brown and Donnelly 1988; Gould et al. 1983; Sawhney and Raabe 1986; Steelman and Ecker 1984; Stonebraker and Smith 1980). Leaching from polyethylene distribution pipes may be a source of acetone in drinking water (Anselme et al. 1985). One of the sources of acetone in seawater is the sensitized photoreaction of dissolved organic matters (Mopper and Stahovec 1986). The releases of acetone to water from facilities that manufactured or processed acetone in states within the United States during 1990 are reported in Table 5-l (TR190 1992). According to TR190 (1992), an estimated total of 1.28 million pounds of acetone, amounting to 0.7% of the total environmental release, was discharged to the water from manufacturing and processing facilities in the United States in 1990. In addition, these facilities discharged an estimated 12.2 million pounds of acetone, amqunting to 6.6% of the total environmental release to municipal waste water of publicly owned treatment works (POTW) in 1990 (TR190 1992).

TABLE 5-1. Releases to the Environment from Facilities That Manufacture or Process Acetone[a]

		Range of reported amounts released in thousands of pounds[b]						
State[c]	Number of facilities	Air	Underground injection	Water	Land	Total Environment[d]	POTW[e] transfer	Off-site waste transfer
AK	1	22.5-22.5	0.0-0.0	2.5-2.5	0.0-0.0	25.0-25.0	0.0-0.0	0.0-0.0
AL	46	0.0-240.6	0.0-0.0	0.0-7.8	0.0-16.0	0.0-240.9	0.0-0.3	0.0-30.7
AR	50	0.3-540.0	0.0-0.0	0.0-14.9	0.0-0.3	0.3-540.0	0.0-0.0	0.0-41.3
AZ	24	0.0-1835.1	0.0-0.0	0.0-0.0	0.0-49.6	0.0-1835.1	0.0-43.0	0.0-68.5
CA	220	0.0-160.3	0.0-0.0	0.0-63.0	0.0-0.0	0.0-160.3	0.0-56.5	0.0-132.0
CO	17	0.0-228.1	0.0-0.0	0.0-0.0	0.0-0.0	0.0-228.1	0.0-12.9	0.0-38.2
CT	27	0.0-81.2	0.0-0.0	0.0-400.0	0.0-0.0	0.0-414.6	0.0-378.9	0.0-178.0
DE	12	0.1-71.7	0.0-0.0	0.0-0.0	0.0-0.0	0.1-71.7	0.0-40.5	0.0-41.1
FL	107	0.0-1114.6	0.0-64.0	0.0-6.3	0.0-0.3	0.1-1114.6	0.0-397.3	0.0-198.3
GA	80	0.0-950.0	0.0-0.0	0.0-17.0	0.0-0.8	0.0-952.2	0.0-290.0	0.0-201.5
HI	1	9.7-9.7	0.0-0.0	0.0-0.0	0.0-0.0	9.7-9.7	0.0-0.0	0.0-0.0
IA	36	0.0-490.0	0.0-0.0	0.0-0.3	0.0-0.2	0.0-490.0	0.0-0.8	0.0-14.8
ID	9	1.0-57.0	0.0-0.0	0.0-7.1	0.0-5.7	1.0-57.9	0.0-0.3	0.0-37.2
IL	110	0.0-862.0	0.0-0.0	0.0-6.0	0.0-0.3	0.0-862.0	0.0-302.6	0.0-259.5
IN	132	0.0-2480.0	0.0-0.0	0.0-0.9	0.0-0.3	0.0-2,480.0	0.0-190.0	0.0-2600.0
KS	34	0.0-330.0	0.0-0.0	0.0-7.0	0.0-0.0	0.0-337.0	0.0-92.8	0.0-39.6
KY	41	0.1-760.0	0.0-0.0	0.0-4.7	0.0-0.3	0.1-760.0	0.0-0.3	0.0-191.4
LA	37	0.0-128.0	0.0-1500.0	0.0-17.1	0.0-0.5	0.0-1510.9	0.0-0.0	0.0-70.5
MA	66	0.0-430.6	0.0-0.0	0.0-21.7	0.0-4.3	0.0-430.6	0.0-6.5	0.0-233.7
MD	17	0.0-57.0	0.0-0.0	0.0-0.0	0.0-0.0	0.0-57.0	0.0-30.0	0.0-54.1
ME	23	1.1-165.4	0.0-0.0	0.0-11.0	0.0-4.6	1.3-165.4	0.0-1.3	0.0-20.8
MI	140	0.0-824.0	0.0-775.9	0.0-7.5	0.0-1.5	0.0-1553.3	0.0-748.0	0.0-104.2
MN	63	0.3-175.6	0.0-0.0	0.0-19.0	0.0-0.1	0.3-175.6	0.0-25.4	0.0-62.1
MO	71	0.1-402.2	0.0-0.0	0.0-0.0	0.0-0.3	0.1-402.2	0.0-53.0	0.0-83.0
MS	31	0.0-435.2	0.0-0.0	0.0-13.0	0.0-0.1	0.0-435.2	0.0-0.0	0.0-7.3
MT	1	5.9-5.9	0.0-0.0	6.8-6.8	0.0-0.0	12.7-12.7	0.0-0.0	0.0-0.0
NC	154	0.0-503.4	0.0-0.0	0.0-9.3	0.0-0.3	0.0-503.4	0.0-141.0	0.0-60.0
ND	2	10.1-16.5	0.0-0.0	0.0-0.0	0.0-0.0	10.1-16.5	0.0-0.0	0.0-0.0
NE	17	0.2-68.2	0.0-0.0	0.0-0.0	0.0-0.0	0.2-68.2	0.0-0.0	0.0-15.9
NH	16	0.0-59.2	0.0-0.0	0.0-4.2	0.0-8.5	0.5-59.2	0.0-0.0	0.0-16.2
NJ	98	0.0-931.5	0.0-0.0	0.0-1.2	0.0-48.3	0.0-931.5	0.0-318.4	0.0-570.2
NM	8	1.0-53.0	0.0-0.0	0.0-0.0	0.0-0.3	1.0-53.0	0.0-0.0	0.0-2.4
NV	3	1.3-81.9	0.0-0.0	0.0-0.0	0.0-0.0	1.3-81.9	0.0-0.0	0.0-1.5
NY	89	0.0-2730.0	0.0-0.0	0.0-21.0	0.0-0.8	0.0-2730.3	0.0-340.0	0.0-456.7
OH	157	0.0-1369.0	0.0-630.0	0.0-4.3	0.0-3.7	0.0-1955.0	0.0-75.0	0.0-632.4
OK	13	0.5-165.2	0.0-0.0	0.0-0.0	0.0-0.0	0.5-165.2	0.0-1.7	0.0-46.4
OR	46	0.3-1305.8	0.0-0.0	0.0-7.5	0.0-0.3	0.3-1305.8	0.0-93.7	0.0-115.5
PA	130	0.0-335.1	0.0-0.0	0.0-2.5	0.0-2.5	0.0-335.1	0.0-1894.0	0.0-190.3
PR	25	0.0-1342.4	0.0-0.0	0.0-0.0	0.0-0.1	0.0-1342.4	0.0-201.6	0.0-153.2

TABLE 5-1. Releases to the Environment from Facilities That Manufacture or Process Acetone[a] *(Continued)*

		Range of reported amounts released in thousands of pounds[b]						
State[c]	Number of facilities	Air	Underground injection	Water	Land	Total Environment[d]	POTW[e] transfer	Off-site waste transfer
RI	18	0.0-233.7	0.0-0.0	0.0-6.1	0.0-0.0	0.0-233.7	0.0-0.0	0.0-302.9
SC	55	0.0-2921.8	0.0-0.0	0.0-12.0	0.0-1.6	0.0-2923.8	0.0-1.7	0.0-301.8
SD	3	1.4-32.0	0.0-0.0	0.0-0.0	0.0-0.0	1.4-32.0	0.0-0.0	1.6-6.3
TN	83	0.3-31100.0	0.0-0.0	0.0-42.8	0.0-8.9	0.3-31123.0	0.0-47.2	0.0-85.0
TX	166	0.0-5223.8	0.0-326.0	0.0-9.0	0.0-5.9	0.0-5223.8	0.0-380.0	0.0-462.8
UT	16	0.0-98.2	0.0-0.0	0.0-0.0	0.0-0.0	0.0-98.2	0.0-7.2	0.0-6.6
VA	81	0.0-10530.0	0.0-0.0	0.0-3.8	0.0-5.4	0.0-10535.7	0.0-1889.7	0.0-60.6
VT	4	0.0-41.9	0.0-0.0	0.0-0.0	0.0-0.0	0.0-41.9	0.0-0.0	0.0-10.4
WA	65	0.0-404.2	0.0-0.0	0.0-12.0	0.0-2.7	0.0-404.2	0.0-1.5	0.0-93.1
WI	75	0.0-222.2	0.0-0.0	0.0-2.2	0.0-0.0	0.0-222.2	0.0-42.4	0.0-268.0
WV	16	0.1-3218.1	0.0-0.0	0.0-10.0	0.0-18.7	0.1-3222.4	0.0-483.0	0.0-116.9

[a] Derived form TRI90 (1992)

[b] Data in TRI are maximum amounts released by each facility. Quantities reported here have been rounded to the nearest hundred pounds, except those quantities >1 million pounds, which have been rounded to the nearest thousand pounds.

[c] Post office state abbreviation

[d] The sum of all releases of the chemical to air, land, water, and underground injection wells by a given facility

[e] POTW = publicly owned treatment works

5.2.3 Soil

Acetone leaches readily in soil (see Section 5.4.3). Therefore, the detection of acetone in leachate and groundwater from municipal and industrial landfills indicates the source of acetone in landfill soils is municipal and industrial discharge. Information regarding the release of acetone from facilities that manufactured or processed the compound in 1990 is reported in Table 5-1 (TR190 1992). Table 5-1 shows that the amount of acetone released into soil from these facilities accounts for 0.1% of the total environmental release of acetone. Other sources of acetone released into soil include disposal of agricultural and food waste, animal wastes (see Section 5.2.1), and atmospheric wet deposition. Household septic tank effluents are another source of acetone in soil because these effluents containing acetone are discharged into the soil (DeWalle et al. 1985). According to the HAZDAT of ATSDR, acetone was detected in 43% of the soil from Superfund sites tested for acetone (HAZDAT 1991). The information used from the HAZDAT includes data from NPL sites only.

5.3 ENVIRONMENTAL FATE

5.3.1 Transport and Partitioning

Organic compounds with ambient vapor pressure >10^{-4} mmHg should exist almost entirely in the vapor phase (Eisenreich et al. 1981). Since the vapor pressure of acetone is 181.72 mmHg at 20°C (see Table 3-2), acetone should exist exclusively in the vapor phase in the atmosphere. Furthermore, the collection methods used for the quantification of acetone in the atmosphere (Jarke et al. 1981; Juttner 1986; LaRegina et al. 1986) indicate that atmospheric acetone exists as vapor. Due to the atmospheric half-life, which is on the order of days (see Section 5.3.2.1), acetone will be transported long distances in the air. Although not a large sink (Chatfield et al. 1987), small amounts of acetone will be removed from the atmosphere by wet deposition (Grosjean and Wright 1983), which will transport acetone from the atmosphere to surface water and soil.

The complete miscibility of acetone in water suggests that partitioning of acetone from the water column to sediments and suspended solids in water is not significant. The estimated low value of 0.73 for log K_{oc} (see Table 3-2) also suggests that adsorption of acetone to sediments and suspended solids is not significant. In the absence of water, acetone vapor adsorbs rather strongly to the clay component of soil by hydrogen bonding (Goss 1992; Steinberg and Kreamer 1993). The sorption is dependent on relative humidity, and increasing the humidity decreases sorption drastically. In water saturated soil or sediment, only organic carbon, as indicated by K_{oc}, and not hydrogen bonding may control the sorption of acetone (Steinberg and Kreamer 1992). The experimental adsorption studies with kaolinite, monkmorillonite, and stream sediments showed very little or no loss of acetone from water to the adsorbents (Rathbun et al. 1982). The transport of acetone from the water column to the atmosphere depends on the Henry's law constant. The Henry's law constant for acetone is 4.26×10^{-5} atm-m^3/mol (see Table 3-2). Therefore, volatilization of acetone from water, although not very fast, is significant (Thomas 1982). The volatilization rate of a chemical depends on the characteristics of the chemical and the water and on other ambient conditions (e.g., water depth, suspended solid concentration, water current, wind speed, temperature). Based on an estimation method (Thomas 1982) and a Henry's law constant value of 4.26×10^{-5} atm-m^3/mol, the volatilization half-life of acetone from a model river 1 m deep, flowing at a current of 1 m/second with a wind velocity of 3 m/second is about 18 hours. The mean volatilization coefficient for acetone in a model outdoor stream was in the range of 7.15×10^{-4} to 14.8×10^{-4}/minute (Rathbun et al. 1989, 1991). Therefore, the volatilization half-life of acetone from the model stream is in the range of 7.8-16.2 hours. It was concluded that volatilization will control the fate of acetone in water (Rathbun et al. 1989, 1991). Results of a laboratory study (Rathbun et al. 1982) also concluded that volatilization. is one of the important fate determining processes for acetone in streams.

The log K_{ow} value of -0.24 (see Table 3-2) suggests that bioconcentration of acetone in aquatic organisms is not significant. The measured bioconcentration factor for acetone in adult haddock exposed to acetone under static conditions at 7-9°C was <l (Rustung et al. 1931). No data regarding the biomagnification potential of acetone in aquatic organisms were located; however, the low K_{ow} value suggests that biomagnification of acetone from animals of lower to higher trophic level is unlikely.

The two significant transport properties for acetone in soil are volatilization and leaching. Leaching transports acetone from soil to groundwater. The rate of leaching from soil by rainwater depends on the sorption characteristics of acetone in soil. Since acetone may be controlled by K_{oc} in water-saturated soil and has a low K_{oc} value, sorption of acetone in such soil will be weak. The low retention ability will permit acetone to leach into groundwater. A sorption study with moist clay soils indicates that aqueous acetone causes swelling in these soils (Green et al. 1983), and this process may allow the retention of a small fraction of acetone. Groundwater monitoring studies (see Section 5.4.2) at landfill sites provided evidence of the importance of acetone leaching from soil. Volatilization transports acetone from soil to the atmosphere. The volatility rate of acetone from soil depends on the soil characteristics (moisture content, soil porosity, etc.). Since the acetone is weakly sorbed to soil, the volatility depends primarily on the moisture content of the soil. In dry soil, the volatilization rate from soil surfaces is high due to the high vapor pressure of acetone. In moist soil, the rate of volatilization is similar to acetone in water and depends on the Henry's law constant. Acetone volatilizes moderately under these conditions. The detection of acetone at higher concentrations in downwind air of a landfill site, compared to upwind air (Militana and Mauch 1989), indicates the importance of volatilization as a transport process in soil.

No data regarding the transport of acetone from soil to plants were located.

5.3.2 Transformation and Degradation

5.3.2.1 Air

The reactions of acetone vapor with nitrogen oxides, hydroxyl radicals (OH), singlet molecular oxygen ($^1\Delta_g$, singlet atomic oxygen ($O[^3P]$), and nitrate radicals have been studied. Given the second order rate constants for the reactions of acetone with $^1\Delta_g$ (Datta and Rao 1979) and $O(^3P)$ (Lee and Timmons 1977), and the concentrations of singlet molecular and atomic oxygen in the atmosphere (Graedel 1978), these reactions are insignificant in determining the fate of acetone in the atmosphere. The reaction of acetone with nitrate radicals in the atmosphere was also determined to be insignificant (Boyd et al. 1991). Smog chamber studies with acetone and nitrogen oxides conclude that acetone has low reactivity in terms of ozone and nitrogen dioxide formation and that the rate of disappearance of acetone by this process is low (Altshuller and Cohen 1963; Dimitriades and Joshi 1977; Yanagihara et al. 1977). The photochemical oxidation of acetone in the presence of nitrogen oxides produces small amounts of peroxyacetic acid and peroxyacetyl nitrate (Hanst and Gay 1983).

The two significant processes in determining the fate of acetone in the atmosphere are reaction with hydroxyl radicals and photolysis. The rate constant for the reaction of hydroxyl radicals with acetone at 25°C is in the range of $2.2\text{-}5.0\times10^{-13}$ cm^3/molecule-second (Cox et al. 1980; Cox et al. 1981; Meyrahn et al. 1986). The estimated average lifetime of acetone due to reaction with hydroxyl radicals is 44.5 days (Meyrahn et al. 1986). The probable pathways for the reaction of acetone with hydroxyl radicals in the troposphere have been postulated, and methylglyoxal is the primary product of this reaction (Altshuller 1991). Acetone underwent significant photolysis with an artificial light (cutoff wavelength of 270 nm) with a maximum emission intensity of 300 nm (Fujiki et al. 1978). Besides free radicals, the primary products of acetone photolysis in sunlight are carbon dioxide and acetylperoxynitrate (Altshuller 1991). The lifetimes of acetone due to photolysis under cloudless conditions at 40° N latitude, and at sea level during winter and summer are estimated to be 83 and 19 days, respectively (Martinez et al. 1992). Other investigators have estimated that the average atmospheric lifetime of acetone due to photolysis at 40° N latitude is 115.7 days/year (Meyrahn et al. 1986). The estimated average lifetime of acetone at 40° N due to combined hydroxyl radical reaction and photolysis is 32 days/year (Meyrahn et al. 1986), corresponding to a half-life of 22 days. Due to the pressure dependence of the quantum yield, the rate of photodissociation will increase as altitude increases, whereas the reaction rate with hydroxyl radicals will decrease because temperature decreases at higher altitudes. Therefore, the lifetime of acetone in the atmosphere will remain approximately constant with respect to altitude. However, the rate will show a pronounced dependence on latitude with greater losses of acetone occurring near the equator, compared to the poles (Meyrahn et al. 1986).

5.3.2.2 Water

Based on the rate constant for the reaction of acetone with hydroxyl radicals in water at pH 7 ($5.8\text{-}7.7\times10^{7}$/M-second) (Anbar and Neta 1967) and the concentration of hydroxyl radicals in eutrophic waters (3×10^{-17}M) (Mill and Mabey 1985), this reaction will not be significant in water. When distilled water or natural water containing acetone were exposed to sunlight for 2-3 days, no photodecomposition of acetone was observed (Rathbun et al. 1982). Therefore, photolysis of acetone in water is not an important process.

Many aerobic biodegradation screening studies with mixed microorganisms from waste-treatment plant effluents, activated sludge, or sewage have examined the biodegradability of acetone (Babeu and Vaishnav 1987; Bhattacharya et al. 1990; Bridie et al. 1979; Ettinger 1956; Gaudy et al. 1963; Hatfield 1957; Heukelekian and Rand 1955; Lamb and Jenkins 1952; Price et al. 1974; Stafford and Northup 1955; Thom and Agg 1975; Urano and Kato 1986a, 1986b). These studies indicate that acetone is easily biodegradable with acclimatized microorganisms or after a suitable lag period (≈ 1 day) (Urano and Kato 1986a, 1986b), as long as the initial concentration of acetone is not at a toxic level. For example, acetone at a concentration of 500 mg/L was toxic to microorganisms when biooxidation of acetone by activated sludge was attempted (Gerhold and Malaney 1966). Biodegradation of acetone was much slower in seawater than in fresh water (Takemoto et al. 1981). After a suitable lag period (5 days), acetone biodegraded quantitatively under anaerobic conditions with anaerobic acetate enriched culture medium (Chou et al. 1979). A biodegradation study of acetone in natural water collected from Lago Lake near Athens, Georgia, determined that the biodegradation kinetics is multiphasic in nature and depends on the substrate concentration. The determined rate of degradation was faster at higher initial concentrations (the maximum concentration used was 0.5 mg/L) (Hwang et al. 1989).

In a laboratory experiment with natural stream water and sediment, no acetone was lost in 338 hours under sterile conditions in closed flasks. However, with nonsterile natural sediment, 100% of the acetone was lost in 500 hours following a lag period of 90 hours. (Rathbun et al. 1982). The authors of this study concluded that biodegradation was one of the important processes for the loss of acetone in streams. Significant loss of acetone due to biodegradation was not observed in a later study where acetone was injected continuously in an outdoor model stream (Rathbun et al. 1988, 1989, 1991, 1993). Attempts to induce biodegradation by adding glucose and a nutrient solution containing bacteria acclimated to acetone were unsuccessful. The authors concluded that the residence time of acetone in the model stream (6 hours) was too short for the bacteria to become acclimated in the water before initiation of biodegradation. However, this explanation may not be valid if attached bacteria, rather than free-floating bacteria, dominate the biodegradation process. As an alternative explanation, the authors indicated that the observed limitation in the nitrate concentration in the stream may be responsible for the lack of acetone biodegradation.

5.3.2.3 Sediment and Soil

The biodegradation studies discussed in Section 5.3.2.2 indicate that biodegradation of acetone in sediment and soil will be significant. However, laboratory or field data examining the biodegradability of acetone in soil are lacking. No evidence was located to suggest that any degradation process other than biodegradation is important in sediment and soil.

5.4 LEVELS MONITORED OR ESTIMATED IN THE ENVIRONMENT

54.1 Air

Acetone is a volatile compound and is stable in air. Therefore, some monitoring data for the levels of acetone in air are available. The levels of acetone in urban, rural, and remote areas in the United States and the level in the troposphere are shown in Table 5-2.

It is obvious from Table 5-2 that the concentration of acetone in the air around urban areas will be higher than rural and remote areas because of higher emission rates from a larger number of sources. Besides these data, air monitoring data from an urban area (Tulsa, Oklahoma), a rural area (Rio Blanco County, Colorado), and a remote area (Smoky Mountain, Tennessee) are also available (Arnts and Meeks 1981). These data are not presented in Table 5-2 because the samples were collected in Tedlar bags that are known to contaminate air samples with acetone. As a result, the reported acetone concentrations were consistently higher than the values given in Table 5-2. Table 5-2 also indicates that the indoor concentration of acetone is generally higher than the outdoor concentration. Other investigators reported similar results (Jarke et al. 1981). The reason for the higher indoor air concentration is the use of acetone-containing consumer products inside homes. The potential for intrusion of acetone present as soil gas into a house adjacent to a landfill by diffusive and advective routes was found to be low (Hodgson et al. 1992). However, only a single house was studied, and the ambient air in the basement of the house was estimated on two separate occasions and found to be 12 and 82 ppb (v/v).

5.4.2 Water

In a National Organics Reconnaissance Survey (NORS) by EPA involving drinking water supplies from 10 cities in the United States, acetone was qualitatively detected in all 10 water samples. The 10 cities in this survey were Cincinnati, Ohio, Miami, Florida, Ottumwa, Indiana, Philadelphia, Pennsylvania, Seattle, Washington, Grand Forks, North Dakota, Lawrence, Kansas, New York, New York, Terrebonne Parrish, Louisiana, and Tucson, Arizona (Bedding et al. 1982; Coleman et al. 1976; Keith et al. 1976). The determined concentration of acetone in one of the drinking water samples (Seattle, Washington) was 1 ppb (Keith et al. 1976). Acetone has also been detected in water from several artesian wells adjacent to a landfill in Wilmington, Delaware and at a concentration of 0.3 ppb in finished drinking water from one of the wells (DeWalle and Chian 1981). The concentration of acetone was ≤3,000 ppb in a drinking water well in New Jersey (Burmaster 1982; Steelman and Ecker 1984).

The concentration of acetone in open ocean water (Tongue of the Ocean, Bahamas) was 6 nM (0.35 ppb) (Kieber and Mopper 1990) whereas the reported mean concentrations in seawater from Straits of Florida and the Eastern Mediterranean were 20 and 30 ppb, respectively (Corwin 1969). The concentration of acetone in the Potomac River, VA was below the detection limit of 40 ppb (Hall et al. 1987). Acetone has been detected in the effluent from a textile plant (Gordon and Gordon 1981) and in effluent water from a specialty chemicals manufacturing plant at a concentration of 200-230 ppm (Jungclaus et al. 1978). The compound has also been detected in groundwater, leachate, and run-off waters from landfill sites (Brown and Donnelly 1988; DeWalle and Chian 1981; Gould et al. 1983; Sawhney and Raabe 1986; Stonebraker and Smith 1980). The concentration of acetone in an industrial landfill leachate in Michigan was in the range of 0.05 to 62.0 ppm (Brown and Donnelly 1988). However, the quality of the reported data is uncertain. Acetone was detected at a mean concentration of 56 ppb in a landfill leachate in Orange County, Florida (Hallbourg et al. 1992).

5.4.3 Sediment and Soil

There are few data regarding the level of acetone in soil and sediment. Acetone has been detected in 43% of the soil samples in Superfund sites for which acetone determination has been made so far. The maximum concentration of acetone in soils from Vega Alta Public Supply well sites in Puerto Rico was 9,500 ppb (ATSDR 1988). The mean concentration of acetone in soil from Summit National Site, Ohio, was 9,484 ppb (dry weight) (EPA 1988b). Acetone has been qualitatively detected in river sediment that received effluents from a specialty chemicals manufacturing plant (Hites and Lopez-Avila 1980). A concentration of 6 ppb μg/kg) acetone was detected in the sediment of a creek adjacent to a landfill in Louisville, Kentucky (Stonebraker and Smith 1980). Because of its high water solubility and low sediment adsorption coefficient, most acetone in an aquatic system will be found in water, rather than in sediment.

5.4.4 Other Environmental Media

Acetone has been qualitatively detected as a volatile component of a number of foods including blue cheese (Day and Anderson 1965), baked potatoes (Coleman et al. 1981), roasted filbert nuts (Kinlin et al. 1972), meat (Grey and Shrimpton 1967; Shahidi et al. 1986), and nectarines (Takeoka et al. 1988). In a study carried out in Czechoslovakia, the concentrations of acetone in samples of milk and cream culture were 79.5 and 0.11 mg/l00 kg, respectively (Palo and Ilkova 1970). Acetone also has been qualitatively detected in breast milk of working mothers, although the study did not identify whether the concentrations of acetone were higher than normal physiologic levels (Giroux et al. 1992). Acetone has been qualitatively detected in 8 of 12 mothers' milk samples collected from two locations in New Jersey, Bridgeville, Pennsylvania, and Baton Rouge, Louisiana (Pellizzari et al. 1982). In kiwi fruit, the acetone concentration comprised 0.2% of total volatile components (Bartley and Schwade 1989). The concentrations of acetone in dry legumes, such as beans (mean of several varieties), split peas, and lentils were 880, 530, and 230 ppb, respectively (Lovegren et al. 1979). The level of acetone in headspace volatiles of Bisbee Delicious apples ranged from 111 to 912 pL/kg-hour (Mattheis et al. 1991). The percent of acetone (of the total) in commercial concentrated aqueous orange essences ranged from 0.003 to 0.009 (Moshonas and Shaw 1990).

Acetone has been detected in occasional rain samples collected in Hanover, Germany (Levsen et al. 1990). The authors were not sure whether the detection of acetone in the rain water was due to contamination of samples during analysis. The concentration of combined acetone and acrolein was 0.05 ppm in a rain water sample from Los Angeles, California (Grosjean and Wright 1983). The investigators could not separate acetone from acrolein by the method used for the determination of carbonyl compounds.

5.5 GENERAL POPULATION AND OCCUPATIONAL EXPOSURE

Acetone is endogenously produced by all humans. The general population is exposed to acetone by inhaling ambient air, ingesting food, and drinking water containing acetone. Dermal exposure to acetone may result from skin contact with certain consumer products (e.g., certain nail polish removers, paint removers, and household cleaning and waxing products) (see Section 5.2.1). However, no quantitative data for dermal exposure to acetone from consumer products were located. Assuming concentrations of acetone are 8.0 ppb (18.99 $\mu g/m^3$) in indoor air and 6.9 ppb (16.38 ug/m^3) in outdoor air (Shah and Singh 1988) and that a person inhales 15 m^3/day of indoor air and 5 m^3/day of outdoor air, the estimated inhalation rate of acetone is 0.37 mg/day. No experimental or estimated data were located regarding the daily intake of acetone in the general population in the United States from ingestion of drinking water and food. However, if the concentration of acetone in drinking water is $\leq$1 ppb (see Section 5.4.2), the daily intake for acetone (assuming a person consumes 2 L of drinking water/day) from this source would be negligible.

The acetone concentrations in body fluids and expired air of healthy and diabetic patients are given in Table 5-3. The concentration of acetone in whole blood does not differ from that in plasma (Gavin0 et al. 1986). Even in healthy subjects, the level of acetone in blood/plasma varies with fasting or nonfasting conditions and depends on the weight of the subject. Generally, the blood/plasma acetone concentrations are higher in fasted than nonfasted subjects and higher in subjects who are not obese, compared to obese subjects (Haff and Reichard 1977).

Workers in industries that manufacture and use acetone can be exposed to much higher concentrations of acetone than the general population. For example, the concentrations of acetone in the breathing zone air in a paint factory, a plastics factory, and an artificial fiber factory in Italy were >3.48 mg/m^3 (Pezzagno et al. 1986). The concentration of acetone in the breathing zone air of a fiber-reinforced plastic plant in Japan, where bathtubs were produced, was $\leq$108 mg/m^3 (Kawai et al. 1990a). The inhalation exposure for workers to acetone in a shoe factory in Finland ranged from 25.4 to 393.4 mg/m^3 (Ahonen and Schimberg 1988). Concentrations of acetone in the breathing zone air in shoe factories in Italy were also high (Brugnone et al. 1978). The concentration of acetone in the breathing zone air of a solvent recycling plant in the United States ranged from not detected to 43 mg/m^3 (Kupferachmid and Perkin 1986). High levels of acetone were detected in the occupational air in other industries including chemical, plastic button, and paint manufacturing industries in Italy (Ghittori et al. 1987). Isopropyl alcohol is known to oxidize in the liver and is converted to acetone (Kawai et al. 1990b). Therefore, occupational exposure (printing plants) or accidental ingestion of isopropyl alcohol also produce acetone in expired air, blood, and urine. The National Occupational Exposure Survey (NOES) statistically estimated that 1.51 million workers were potentially exposed to acetone in the United States in 1980 (NIOSH 1989). The NOES database does not contain data on the frequency, duration, concentration, or route of exposure of workers to chemicals.

TABLE 5-3. Concentrations of Acetone in Body Fluids and Expired Air of Humans

Subject	Medium	Concentration	Reference
Healthy (nonfasted)	Blood	0.016 mM (0.93 mg/L)	Gavino et al. 1986
Healthy (fasted)	Plasma	0.8 mM (46.5 mg/L)	Haff and Reichard 1977
Healthy (nonfasted)	Plasma	0.03 mM (1.74 mg/L)	Trotter et al. 1971
Ketoacidotic	Plasma	7.3 mM (424 mg/L)	Trotter et al. 1971
Ketoacidotic	Plasma	5.0 mM (290 mg/L)	Haff and Reichard 1977
Healthy	Urine	4–7 µM (0.23–0.41 mg/L)	Kobayashi et al. 1983
Healthy (endogeneous)	Urine	13.1 µM (0.76 mg/L)	Pezzagno et al. 1986
Diabetic	Urine	11–155 µM (0.64–9.0 mg/L)	Kobayashi et al. 1983
Healthy	Expired air	0.52 ppm (1.23 µg/L)	Jansson and Larsson 1969
Healthy	Expired air	0.02 µM (1.16 µg/L)	Trotter et al. 1971
Healthy	Expired air	0.023 µM (1.3 µg/L)	Phillips and Greenberg 1987
Healthy	Expired air	101.3 ng/L[a] (0.1 µg/L)	Krotoszynski et al. 1979

[a] The reason for the lower value reported by these investigators is not known with certainty but may be due to different sampling procedures (e.g., Teflon® versus polyester sampling bags).

5.6 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Workers in industries that manufacture or use acetone are one segment of the population at an especially high risk of acetone exposure compared to the general population (see Section 5.5). Professional painters and commercial and household cleaners (certain detergents, cleansers, waxes, or polishes contain acetone) are also likely to be exposed to acetone at higher concentrations than the general population, although experimental data regarding the extent of exposures for this segment of workers were not located. Among the general population, high exposure to acetone may occur among several subgroups. Cigarette smoke contains $\leq$0.54 mg acetone/cigarette (Manning et al. 1983); therefore, smokers are exposed to higher concentrations of acetone than nonsmokers. The content of acetone in certain nail polish removers is high; therefore, individuals who frequently use nail polish removers are exposed to higher levels of acetone than the general population. People who live near landfill sites that emit acetone or those who live near industrial sources of emission (e.g., refinery, incinerator, close to high vehicular traffic areas) are also susceptible to higher exposure concentrations of acetone than the general population that does not reside near these sites. People who consume contaminated well water (see Section 5.4.2) as drinking water are subject to high exposures. People who consume food containing acetone excessively would also be subject to high exposure, especially if associated with other risks.

5.7 ADEQUACY OF THE DATABASE

Section 104(i)(5) of CERCLA, as amended, directs the Administrator of ATSDR (in consultation with the Administrator of EPA and agencies and programs of the Public Health Service) to assess whether adequate information on the health effects of acetone is available. Where adequate information is not available, ATSDR, in conjunction with the NTP, is required to assure the initiation of a program of research designed to determine the health effects (and techniques for developing methods to determine such health effects) of acetone.

The following categories of possible data needs have been identified by a joint team of scientists from ATSDR, NTP, and EPA. They are defined as substance-specific informational needs that if met would reduce the uncertainties of human health assessment. This definition should not be interpreted to mean that all data needs discussed in this section must be filled. In the future, the identified data needs will be evaluated and prioritized, and a substance-specific research agenda will be proposed.

5.7.1 Identification of Data Needs

Physical and Chemical Properties. Information regarding the physical and chemical properties of acetone necessary to predict its environmental fate and transport processes in the environment is available (see Table 3-2). However, experimental determination of a value for the soil sorption coefficient of acetone from water would be helpful in assessing the potential for leaching and volatility of acetone in different soils.

Production, Import/Export, Use, Release, and Disposal. Data regarding the past and present production volume for acetone and the projected future trend (increase/decrease) in the production volume are known (CMR 1990). In 1990, the reported total production volume of acetone in the United States was 2,330 million pounds (USITC 1991). Recent export and import data for acetone would be helpful. The use pattern of acetone is known. Acetone is present in several household consumer products, but by far a larger amount of acetone is used in industry. Acetone is naturally present in many fruits and vegetables, and there is no information available to indicate that acetone is present in food as a contaminant, due to food processing or packaging. Air is the most likely environmental medium in which significant quantities of acetone contamination will occur during its production and use (TRI90 1992). More data on the rate of acetone release from household consumer products would be useful. The regulations governing the disposal of acetone are well defined. However, more information about the proportion of discarded acetone recovered from recycling, and the proportion lost due to evaporation, ground burial, and incineration would be useful in determining the relative importance of the different routes of exposure.

According to the Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. Section 11023, industries are required to submit chemical release and off-site transfer information to the EPA. The Toxics Release Inventory (TRI), which contains this information for 1988, became available in May of 1990. This database will be updated yearly and should provide a list of industrial production facilities and emissions.

Environmental Fate. The environmental fate of acetone, for the most part, has been well studied (see Section 5.3). Acetone will undergo transport from one environmental medium to another (Grosjean and Wright 1983; Rathbun et al. 1982). Due to its reasonably long half-life in air (22 days) (Meyrahn et al. 1986) and restricted volatilization from groundwater, the atmosphere and groundwater may act as sinks for acetone. More experimental data regarding the rate of sorption and biodegradation of acetone in soil and its biodegradability in groundwater would be useful to assess the relative importance of the different fate processes.

Bioavailability from Environmental Media. Acetone is readily absorbed in the lung and gastrointestinal tract following inhalation and ingestion. Acetone can also be absorbed from the skin (see Section 2.3). The low value for K_{oc} (see Table 3-2) and a moderate value for Henry's law constant (Rathbun and Tai 1987) suggest that bioavailability of acetone from contaminated water and soil as a result of skin contact may be significant. However, quantitative data regarding the rate and extent of dermal absorption of acetone from contaminated water and soil are lacking. The high water solubility and low K_{oc} value for acetone suggest that bioavailability from ingested soil (e.g., children playing at or near contaminated sites) will be high, but quantitative absorption data are lacking. Data on bioavailability of acetone from ingested plant food were not located but would be helpful.

Food Chain Bioaccumulation. Acetone does not bioaccumulate in aquatic organisms. There is no indication of biomagnification of acetone along the aquatic food chain. Studies indicating the potential for acetone transfer from soil and plants and biomagnification in terrestrial food chains would be useful to confirm its potential for food chain bioaccumulation.

Exposure Levels in Environmental Media. Data regarding the level of acetone in ambient air are available (Lagrone 1991; Shah and Singh 1988; Snider and Dawson 1985). There is a paucity of data regarding the level of acetone in drinking water (Bedding et al. 1982; Coleman et al. 1976; Keith et al. 1976). More comprehensive data on the levels of acetone in the air and water consumed by people who live near acetone-containing hazardous waste sites would be useful in estimating the daily intake from these sources. Although the levels of acetone in the volatile components of several fruits and vegetables are available (see Section 5.4.4), development of data regarding the level of acetone in the total diet would be useful. There are few data regarding the level of acetone in background soil samples.

Reliable monitoring data for the levels of acetone in contaminated media at hazardous waste sites are needed so that the information obtained on levels of acetone in the environment can be used in combination with the known body burden of acetone to assess the potential risk of adverse health effects in populations living in the vicinity of hazardous waste sites.

Exposure Levels in Humans. The levels of acetone in blood/plasma and urine of healthy people, occupationally exposed groups, and diabetic patients are available (see Table 5-3 and Section 5.5). However, data on the levels of acetone in body fluids or tissues of general populations living near sites with higher (than normal) exposure potential (e.g., hazardous waste sites) were not located. This information is useful for assessing the need to conduct health studies on these populations.

Exposure Registries. No exposure registries for acetone were located. This substance is not currently one of the compounds for which a subregistry has been established in the National Exposure Registry. The substance will be considered in the future when chemical selection is made for subregistries to be established. The information that is amassed in the National Exposure Registry facilitates the epidemiological research needed to assess adverse health outcomes that may be related to exposure to this substance.

5.7.2 On-going Studies

No on-going study that would fill the data gaps regarding the transport and fate of acetone in the environment or that evaluates its exposure potential in general population groups susceptible to higher levels of exposure was located.

As part of the Third National Health and Nutrition Evaluation Survey, the Environmental Health Laboratory Sciences Division of the National Center for Environmental Health and Injury Control, Centers for Disease Control, will be analyzing human blood samples for acetone and other volatile organic compounds. These data will give an indication of the frequency of occurrence and background levels of these compounds in the general population.

Appendix E

TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM #4046

DETERMINATION OF SOIL CLEANUP OBJECTIVES AND CLEANUP LEVELS

TO: Regional Haz. Waste Remediation Engineers, Bureau Directors, and Section Chiefs

FROM: Michael J. O'Toole, Jr., Director, Division of Hazardous Waste Remediation

SUBJECT: DIVISION TECHNICAL AND ADMINISTRATIVE GUIDANCE MEMORANDUM: DETERMINATION OF SOIL CLEANUP OBJECTIVES AND CLEANUP LEVELS

DATE: JAN 24, 1994

Michael J. O'Toole, Jr. (signed)

Appendix A - Recommended Soil Cleanup Objectives | Appendix B - Total Organic Carbon (TOC)
- Table 1 - Volatile Organic Contaminants
- Table 2 - Semi-Volatile Organic Contaminants
- Table 3 - Organic Pesticides / Herbicides and PCBs
- Table 4 - Heavy Metals

The cleanup goal of the Department is to restore inactive hazardous waste sites to predisposal conditions, to the extent feasible and authorized by law. However, it is recognized that restoration to predisposal conditions will not always be feasible.

1. INTRODUCTION:

6-9

This TAGM provides a basis and procedure to determine soil cleanup levels at individual Federal Superfund, State Superfund, 1986 EQBA Title 3 and Responsible Party (RP) sites, when the Director of the DHWR determines that cleanup of a site to predisposal conditions is not possible or feasible.

The process starts with development of soil cleanup objectives by the Technology Section for the contaminants identified by the Project Managers. The Technology Section uses the procedure described in this TAGM to develop soil cleanup objectives. Attainment ofthese generic soil cleanup objectives will, at a minimum, eliminate all significant threats to human health and/or the environment posed by the inactive hazardous waste site. Project Managers should use these cleanup objectives in selecting alternatives in the Feasibility Study (FS). Based on the proposed selected remedial technology (outcome of FS), final site specific soil cleanup levels are established in the Record of Decision (ROD) for these sites.

It should be noted that even after soil cleanup levels are established in the ROD, these levels may prove to be unattainable when remedial construction begins. In that event, alternative remedial actions or institutional controls may be necessary to protect the environment.

2. BASIS FOR SOIL CLEANUP OBJECTIVES:

The following alternative bases are used to determine soil cleanup objectives:

1. Human health based levels that correspond to excess lifetime cancer risks of one in a million for Class A[1] and B[2] carcinogens, or one in 100,000 for Class C[3] carcinogens. These levels are contained in USEPA's Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation;

2. Human health based levels for systemic toxicants, calculated from Reference Doses (RfDs). RfDs are an estimate of the daily exposure an individual (including sensitive individuals) can experience without appreciable risk of health effects during a lifetime. An average scenario of exposure in which children ages one to six (who exhibit the greatest tendency to ingest soil) is assumed. An intake rate of 0.2 gram/day for a five-year exposure period for a 16-kg child is assumed. These levels are contained in USEPA's Health Effects Assessment Summary Tables (HEASTs) which are compiled and updated quarterly by the NYSDEC's Division of Hazardous Substances Regulation;

3. Environmental concentrations which are protective of groundwater/drinking water quality; based on promulgated or proposed New York State Standards;

4. Background values for contaminants; and

5. Detection limits.

A recommendation on the appropriate cleanup objective is based on the criterion that produces the most stringent cleanup level using criteria a, b, and c for organic chemicals, and criteria a, b, and d for heavy metals. If criteria a and/or b are below criterion d for a contaminant, its background value should be used as the cleanup objective. However, cleanup objectives developed using this approach must be, at a minimum, above the method detection limit (MDL) and it is preferable to have the soil cleanup objectives above the Contract Required Quantitation Limit (CRQL) as defined by NYSDEC. If the cleanup objective of a compound is "non-detectable", it should mean that it is not detected at the MDL. Efforts should be made to obtain the best MDL detection possible when selecting a laboratory and analytical protocol.

3. DETERMINATION OF SOIL CLEANUP GOALS FOR ORGANICS IN SOIL FOR PROTECTION OF WATER QUALITY

The water/soil partitioning theory is used to determine soil cleanup objectives which would be protective of groundwater/drinking water quality for its best use. This theory is conservative in nature and assumes that contaminated soil and groundwater are in direct contact. This theory is based upon the ability of organic matter in soil to adsorb organic chemicals. The approach predicts the maximum amount of contamination that may remain in soil so that leachate from the contaminated soil will not violate groundwater and/or drinking water standards.

This approach is not used for heavy metals, which do not partition appreciably into soil organic matter. For heavy metals, eastern USA or

New York State soil background values may be used as soil cleanup objectives. A list of values that have been tabulated is attached. Soil background data near the site, if available, is preferable and should be used as the cleanup objective for such metals. Background samples should be free from the influences of this site and any other source of contaminants. Ideal background samples may be obtained from uncontaminated upgradient and upwind locations.

Protection of water quality from contaminated soil is a two-part problem. The first is predicting the amount of contamination that will leave the contaminated media as leachate. The second part of the problem is to determine how much of that contamination will actually contribute to a violation of groundwater standards upon reaching and dispersing into groundwater. Some of the contamination which initially leaches out of soil will be absorbed by other soil before it reaches groundwater. Some portion will be reduced through natural attenuation or other mechanism.

PART A: PARTITION THEORY MODEL

There are many test and theoretical models which are used to predict leachate quality given a known value of soil contamination. The Water-Soil Equilibrium Partition Theory is used as a basis to determine soil standard or contamination limit for protection of water quality by most of the models currently in use. It is based on the ability of organic carbon in soil to adsorb contamination. Using a water quality value which may not be exceeded in leachate and the partition coefficient method, the equilibrium concentration (Cs) will be expressed in the same units as the water standards. The following expression is used:

Allowable Soil Concentration $Cs = f \times Koc \times Cw$ . . . . (1)

Where: f = fraction of organic carbon of the natural soil medium.

Koc = partition coefficient between water and soil media. Koc can be estimated by the following equation:

$\log Koc = 3.64 - 0.55 \log S$

S = water solubility in ppm
Cw = appropriate water quality value from TOGS 1.1.1

Most Koc and S values are listed in the Exhibit A-1 of the USEPA Superfund Public Health Evaluation Manual (EPA/540/1-86/060). The Koc values listed in this manual should be used for the purpose. If the Koc value for a contaminant is not listed, it should be estimated using the above mentioned equation.

PART B: PROCEDURE FOR DETERMINATION OF SOIL CLEANUP OBJECTIVES

When the contaminated soil is in the unsaturated zone above the water table, many mechanisms are at work that prevent all of the contamination that would leave the contaminated soil from impacting groundwater. These mechanisms occur during transport and may work simultaneously. They include the following: (1) volatility, (2) sorption and desorption, (3) leaching and diffusion, (4) transformation and degradation, and (5) change in concentration of contaminants after reaching and/or mixing with the groundwater surface. To account for these mechanisms, a correction factor of 100 is used to establish soil cleanup objectives. This value of 100 for the correction is consistent with the logic used by EPA in its Dilution Attenuation Factor (DAF) approach for EP Toxicity and TCLP. (Federal Register/Vol. 55, No. 61, March 29, 1990/Pages 11826-27). Soil cleanup objectives are calculated by multiplying the allowable soil concentration by the correction factor. If the contaminated soil is very close (<3' - 5') to the groundwater table or in the groundwater, extreme caution should be exercised when using the correction factor of 100 (one hundred) as this may not give conservative cleanup objectives. For such situations the Technology Section should be consulted for site-specific cleanup objectives.

Soil cleanup objectives are limited to the following maximum values. These values are consistent with the approach promulgated by the States of Washington and Michigan.

1. Total VOCs < 10 ppm.
2. Total Semi VOCs < 500 ppm.
3. Individual Semi VOCs < 50 ppm.
4. Total Pesticides < 10 ppm.

One concern regarding the semi-volatile compounds is that some of these compounds are so insoluble that their Cs values are fairly large. Experience (Draft TOGS on Petroleum Contaminated Soil Guidance) has shown that soil containing some of these insoluble substances at high concentrations can exhibit a distinct odor even though the substance will not leach from the soil. Hence any time a soil exhibits a discernible odor nuisance, it shall not be considered clean even if it has met the numerical criteria.

4. DETERMINATION OF FINAL CLEANUP LEVELS:

Recommended soil cleanup objectives should be utilized in the development of final cleanup levels through the Feasibility Study (FS) process. During the FS, various alternative remedial actions developed during the Remedial Investigation (RI) are initially screened and narrowed down to the list of potential alternative remedial actions that will be evaluated in detail. These alternative remedial actions are evaluated using the criteria discussed in TAGM 4030, Selection of Remedial Actions at Inactive Hazardous Waste Sites, revised May 15, 1990, and the preferred remedial action will be selected. After the detailed evaluation of the preferred remedial action, the final cleanup levels which can be actually achieved using the preferred remedial action must be established. Remedy selection, which will include final cleanup levels, is the subject of TAGM 4030.

Recommended soil cleanup objectives that have been calculated by the Technology Section are presented in Appendix A. These objectives are based on a soil organic carbon content of 1% (0.01) and should be adjusted for the actual organic carbon content if it is known. For determining soil organic carbon content, use attached USEPA method (Appendix B). Please contact the Technology Section, Bureau of Program Management for soil cleanup objectives not included in Appendix A.

TAGM 4046 Footnotes:

1. Class A are proved human carcinogens
2. Class B are probable human carcinogens

3. Class C are possible human carcinogens

Appendix A - Recommended Soil Cleanup Objectives:

Appendix B - Total Organic Carbon (TOC)

APPENDIX B TO TAGM 4046

Conventional Sediment Variables
Total Organic Carbon (TOC)
March 1986

TOTAL ORGANIC CARBON (TOC)

USE AND LIMITATIONS

Total organic carbon is a measure of the total amount of nonvolatile, volatile, partially volatile, and particulate organic compounds in a sample. Total organic carbon is independent of the oxidation state of the organic compounds and is not a measure of the organically bound and inorganic elements that can contribute to the biochemical and chemical oxygen demand tests.

Because inorganic carbon (e.g., carbonates, bicarbonates, free CO_2) will interfere with total organic carbon determinations, samples should be treated to remove inorganic carbon before being analyzed.

FIELD PROCEDURES

Collection

Samples can be collected in glass or plastic containers. A minimum sample size of 25 g is recommended. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted on the field log sheet.

Processing

Samples should be stored frozen and can be held for up to 6 months under that condition. Excessive temperatures should not be used to thaw samples.

LABORATORY PROCEDURES

Analytical Procedures

- Equipment
  - Induction furnace

    e.g., Leco WR-12, Dohrmann DC-50, Coleman CH analyzer, Perkin Elmer 240 elemental analyzer, Carlo-Erba 1106

  - Analytical balance

    0.1 mg accuracy

  - Desiccator
  - Combustion boats
  - 10 percent hydrochloric acid (HCL)
  - Cupric oxide fines (or equivalent material)
  - Benzoic acid or other carbon source as a standard.

- Equipment preparation
  - Clean combustion boats by placing them in the induction furnace at 950° C. After being cleaned, combustion boats should not be touched with bare hands.
  - Cool boats to room temperature in a desiccator.
  - Weigh each boat to the nearest 0.1 mg.

- Sample preparation
  - Allow frozen samples to warm to room temperature.
  - Homogenize each sample mechanically, incorporating any overlying water.
  - Transfer a representative aliquot (5-10 g) to a clean container.

- Analytical procedures
  - Dry samples to constant weight at 70 + 2°C. The drying temperature is relatively low to minimize loss of volatile organic compounds.
  - Cool dried samples to room temperature in a desiccator.
  - Grind sample using a mortar and pestle to break up aggregates.
  - Transfer a representative aliquot (0.2-0.5 g) to a clean, preweighed combustion boat.
  - Determine sample weight to the nearest 0.1 mg.
  - Add several drops of HCL to the dried sample to remove carbonates. Wait until the effervescing is completed and add more acid. Continue this process until the incremental addition of acid causes no further effervescence. Do not add too much acid at one time as this may cause loss of sample due to frothing. Exposure of small samples (i.e., 1-10 mg) having less than 50 percent carbonate to an HCL atmosphere for 24-48 h has been shown to be an effective means of removing carbonates (Hedges and Stern 1984). If this method is used for sample sizes greater than 10 mg, its effectiveness should be demonstrated by the user.
  - Dry the HCL-treated sample to constant weight at 70 + 2° C.
  - Cool to room temperature in a desiccator.
  - Add previously ashed cupric oxide fines or equivalent material (e.g., alumina oxide) to the sample in the combustion boat.
  - Combust the sample in an induction furnace at a minimum temperature of 950 + 10° C.

- Calculations
  - If an ascarite-filled tube is used to capture CO_2, the carbon content of the sample

can be calculated as follows:

$$\text{Percent carbon} = \frac{A\,(0.2729)\,(100)}{B}$$

Where:

A = the weight (g) of CO_2 determined by weighing the ascarite tube before and after combustion
B = dry weight (g) of the unacidified sample in the combustion boat
0.2729 = the ratio of the molecular weight of carbon to the molecular weight of carbon dioxide

A silica gel trap should be placed before the ascarite tube to catch any moisture driven off during sample combustion. Additional silica gel should be placed at the exit end of the ascarite tube to trap any water that might be formed by reaction of the trapped CO_2 with the NaOH in the ascarite.

- If an elemental analyzer is used, the amount of CO_2 will be measured by a thermal conductivity detector. The instrument should be calibrated daily using an empty boat blank as the zero point and at least two standards. Standards should bracket the expected range of carbon concentrations in the samples.

QA/QC Procedures

It is critical that each sample be thoroughly homogenized in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased or the "O" rings should be replaced.

It is recommended that triplicate analyses be conducted on one of every 20 samples, or on one sample per batch if less than 20 samples are analyzed. A method blank should be analyzed at the same frequency as the triplicate analyses. The analytical balance should be inspected daily and calibrated at least once per week. The carbon analyzer should be calibrated daily with freshly prepared standards. A standard reference material should be analyzed at least once for each major survey.

DATA REPORTING REQUIREMENTS

Total organic carbon should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including QA replicates, method blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (e.g., range covered, regression equation, coefficient of determination).

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APPENDIX A of TAGM #4046

TABLE 1
Recommended soil cleanup objectives (mg/kg or ppm)
Volatile Organic Contaminants

Shortcut to TAGM 4046 Tables for SVOCs | Pesticides/PCBs | Heavy Metals

Contaminant	Partition Coefficient, Koc	Groundwater Standards/ Criteria, Cw (ug/l or ppb)	a Allowable soil conc., Cs (ppm)	b ** Soil cleanup objectives to protect GW quality (ppm)	USEPA Health Based (ppm)		CRQL (ppb)	*** Rec. Soil Cleanup Objective (ppm)
					Carcin- ogens	Systemic Toxicants		
Acetone	2.2	50	0.0011	0.11	N/A	8,000	10	0.2
Benzene	83	0.7	0.0006	0.06	24	N/A	5	0.06
Benzoic Acid	54 *	50	0.027	2.7	N/A	300,000	5	2.7
2-Butanone	4.5 *	50	0.003	0.3	N/A	4,000	10	0.3
Carbon Disulfide	54 *	50	0.027	2.7	N/A	8,000	5	2.7
Carbon Tetrachloride	110 *	5	0.006	0.6	5.4	60	5	0.6
Chlorobenzene	330	5	0.017	1.7	N/A	2,000	5	1.7
Chloroethane	37 *	50	0.019	1.9	N/A	N/A	10	1.9
Chloroform	31	7	0.003	0.30	114	800	5	0.3
Dibromochloromethane	N/A	50	N/A	N/A	N/A	N/A	5	N/A
1,2-Dichlorobenzene	1,700	4.7	0.079	7.9	N/A	N/A	330	7.9
1,3-Dichlorobenzene	310 *	5	0.0155	1.55	N/A	N/A	330	1.6
1,4-Dichlorobenzene	1,700	5	0.085	8.5	N/A	N/A	330	8.5
1,1-Dichloroethane	30	5	0.002	0.2	N/A	N/A	5	0.2
1,2-Dichloroethane	14	5	0.001	0.1	7.7	N/A	5	0.1
1,1-Dichloroethene	65	5	0.004	0.4	12	700	5	0.4
1,2-Dichloroethene (trans)	59	5	0.003	0.3	N/A	2,000	5	0.3
1-3 dichloropropane	51	5	0.003	0.3	N/A	N/A	5	0.3
Ethylbenzene	1,100	5	0.055	5.5	N/A	8,000	5	5.5
113 Freon (1,1,2 Trichloro- 1,2,2 Trifluoroethane)	1,230 *	5	0.060	6.0	N/A	200,000	5	6.0
Methylene chloride	21	5	0.001	0.1	93	5,000	5	0.1
4-Methyl-2-Pentanone	19 *	50	0.01	1.0	N/A	N/A	10	1.0

Tetrachloroethene	277	5	0.014	1.4	14	800	5	1.4
1,1,1-Trichloroethane	152	5	0.0076	0.76	N/A	7,000	5	0.8
1,1,2,2-Tetrachloroethane	118	5	0.006	0.6	35	N/A	5	0.6
1,2,3-trichloropropane	68	5	0.0034	0.34	N/A	80	5	0.4
1,2,4-trichlorobenzene	670 *	5	0.034	3.4	N/A	N/A	330	3.4
Toluene	300	5	0.015	1.5	N/A	20,000	5	1.5
Trichloroethene	126	5	0.007	0.70	64	N/A	5	0.7
Vinyl chloride	57	2	0.0012	0.12	N/A	N/A	10	0.2
Xylenes	240	5	0.012	1.2	N/A	200,000	--	1.2

a. Allowable Soil Concentration Cs = f x Cw x Koc
b. Soil cleanup objective = Cs x Correction Factor (CF)
N/A is not available

* Partition coefficient is calculated by using the following equation:
log Koc = -0.55 log S + 3.64, where S is solubility in water in ppm.
All other Koc values are experimental values.

** Correction Factor (CF) of 100 is used as per TAGM #4046

*** As per TAGM #4046, Total VOCs < 10 ppm.

Note: Soil cleanup objectives are developed for soil organic carbon content (f) of 1%, and should be adjusted for the actual soil organic carbon content if it is known.

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APPENDIX A of TAGM #4046

TABLE 2
Recommended soil cleanup objectives (mg/kg or ppm)
Semi-Volatile Organic Contaminants

Shortcut to TAGM 4046 Tables for VOCs | Pesticides/PCBs | Heavy Metals

Contaminant	Partition Coefficient, Koc	Groundwater Standards/ Criteria, Cw (ug/l or ppb)	a Allowable soil conc., Cs (ppm)	b ** Soil cleanup objectives to protect GW quality (ppm)	USEPA Health Based (ppm)		CRQL (ppb)	*** Rec. Soil Cleanup Objective (ppm)
					Carcinogens	Systemic Toxicants		
Acenaphthene	4,600	20	0.9	90.0	N/A	5,000	330	50.0 ***
Acenaphthylene	2,056 *	20	0.41	41.0	N/A	N/A	330	41.0
Aniline	13.8	5	0.001	0.1	123	N/A	330	0.1
Anthracene	14,000	50	7.00	700.0	N/A	20,000	330	50.0 ***
Benzo(a)anthracene	1,380,000	0.002	0.03	3.0	0.224	N/A	330	0.224 or MDL
Benzo (a) pyrene	5,500,000	0.002 (ND)	0.110	11.0	0.0609	N/A	330	0.061 or MDL
Benzo (b) fluoranthene	550,000	0.002	0.011	1.1	N/A	N/A	330	1.1
Benzo (g,h,i) perylene	1,600,000	5	8.0	800	N/A	N/A	330	50.0 ***
Benzo (k) fluoranthene	550,000	0.002	0.011	1.1	N/A	N/A	330	1.1
bis(2-ethylhexyl) phthalate	8,706 *	50	4.35	435.0	50	2,000	330	50.0 ***
Butylbenzylphthlate	2,430	50	1.215	122.0	N/A	20,000	330	50.0 ***
Chrysene	200,000	0.002	0.004	0.4	N/A	N/A	330	0.4
4- Chloroaniline	43 ****	5	0.0022	0.22	200	300	330	0.220 or MDL
4-Chloro-3-methylphenol	47	5	0.0024	0.24	N/A	N/A	330	0.240 or MDL

2-Chlorophenol	15 *	50	0.008	0.8	N/A	400	330	0.8
Dibenzofuran	1,230 *	5	0.062	6.2	N/A	N/A	330	6.2
Dibenzo(a,h) anthracene	33,000,000	50	1,650	165,000	0.0143	N/A	330	0.014 or MDL
3,3'-Dichlorobenzidine	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2,4-Dichlorophenol	380	1	0.004	0.4	N/A	200	330	0.4
2,4-Dinitrophenol	38	5	0.002	0.2	N/A	200	1,600	0.200 or MDL
2,6 Dinitrotoluene	198*	5	0.01	1.0	1.03	N/A	330	1.0
Diethylphthlate	142	50	0.071	7.1	N/A	60,000	330	7.1
Dimethylphthlate	40	50	0.020	2.0	N/A	80,000	330	2.0
Di-n-butyl phthalate	162*	50	0.081	8.1	N/A	8,000	330	8.1
Di-n-octyl phthlate	2,346 *	50	1.2	120.0	N/A	2,000	330	50.0 ***
Fluoranthene	38,000	50	19	1900.0	N/A	3,000	330	50.0 ***
Fluorene	7,300	50	3.5	350.0	N/A	3,000	330	50.0 ***
Hexachlorobenzene	3,900	0.35	0.014	1.4	0.41	60	330	0.41
Indeno (1,2,3-cd) pyrene	1,600,000	0.002	0.032	3.2	N/A	N/A	330	3.2
Isophorone	88.31 *	50	0.044	4.40	1,707	20,000	330	4.40
2-methylnaphthalene	727 *	50	0.364	36.4	N/A	N/A	330	36.4
2-Methylphenol	15	5	0.001	0.1	N/A	N/A	330	0.100 or MDL
4-Methylphenol	17	50	0.009	0.9	N/A	4,000	330	0.9
Naphthalene	1,300	10	0.130	13.0	N/A	300	330	13.0
Nitrobenzene	36	5	0.002	0.2	N/A	40	330	0.200 or MDL
2-Nitroaniline	86	5	0.0043	0.43	N/A	N/A	1,600	0.430 or MDL
2-Nitrophenol	65	5	0.0033	0.33	N/A	N/A	330	0.330 or MDL

4-Nitrophenol	21	5	0.001	0.1	N/A	N/A	1,600	0.100 or MDL
3-Nitroaniline	93	5	0.005	0.5	N/A	N/A	1,600	0.500 or MDL
Pentachlorophenol	1,022	1	0.01	1.0	N/A	2,000	1,600	1.0 or MDL
Phenanthrene	4,365 *	50	2.20	220.0	N/A	N/A	330	50.0 ***
Phenol	27	1	0.0003	0.03	N/A	50,000	330	0.03 or MDL
Pyrene	13,295 *	50	6.65	665.0	N/A	2,000	330	50.0 ***
2,4,5-Trichlorophenol	89 *	1	0.001	0.1	N/A	8,000	330	0.1

a. Allowable Soil Concentration Cs = f x Cw x Koc
b. Soil cleanup objective = Cs x Correction Factor (CF)
N/A is not available
MDL is Method Detection Limit

* Partition coefficient is calculated by using the following equation:
log Koc = -0.55 log S + 3.64, where S is solubility in water in ppm.
Other Koc values are experimental values.

** Correction Factor (CF) of 100 is used as per TAGM #4046

*** As per TAGM #4046, Total VOCs < 10 ppm., Total Semi- VOCs < 500ppm. and Individual Semi-VOCs < 50 ppm.

**** Koc is derived from the correlation Koc = 0.63 Kow (Determining Soil Response Action Levels...... EPA/540/2-89/057). Kow is obtained from the USEPA computer database 'MAIN'.

Note: Soil cleanup objectives are developed for soil organic carbon content (f) of 1%, and should be adjusted for the actual soil organic carbon content if it is known.

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TABLE 3
Recommended soil cleanup objectives (mg/kg or ppm)
Organic Pesticides / Herbicides and PCBs

Shortcut to TAGM 4046 Tables for VOCs | SVOCs | Heavy Metals

Contaminant	Partition Coefficient, Koc	Groundwater Standards/ Criteria, Cw (ug/l or ppb)	a Allowable soil conc., Cs (ppm)	b ** Soil cleanup objectives to protect GW quality (ppm)	USEPA Health Based (ppm)		CRQL (ppb)	*** Rec. Soil Cleanup Objective (ppm)
					Carcinogens	Systemic Toxicants		
Aldrin	96,000	ND (<0.01)	0.005	0.5	0.041	2	8	0.041
alpha- BHC	3,800	ND (<0.05)	0.002	0.2	0.111	N/A	8	0.11
beta - BHC	3,800	ND (<0.05)	0.002	0.2	3.89	N/A	8	0.2
delta - BHC	6,600	ND (<0.05)	0.003	0.3	N/A	N/A	8	0.3
Chlordane	21,305 *	0.1	0.02	2.0	0.54	50	80	0.54
2,4-D	104 *	4.4	0.005	0.5	N/A	800	800	0.5
4,4'- DDD	770,000 *	ND (<0.01)	0.077	7.7	2.9	N/A	16	2.9
4,4'-DDE	440,000 *	ND (<0.01)	0.0440	4.4	2.1	N/A	16	2.1
4,4'-DDT	243,000 *	ND (<0.01)	0.025	2.5	2.1	40	16	2.1
Dibenzo-P-dioxins (PCDD) 2,3,7,8 TCDD	1709800	0.000035	0.0006	0.06	N/A	N/A	N/A	N/A
Dieldrin	10,700 *	ND (< 0.01)	0.0010	0.1	0.044	4	16	0.044
Endosulfan I	8,168 *	0.1	0.009	0.9	N/A	N/A	16	0.9
Endosulfan II	8,031 *	0.1	0.009	0.9	N/A	N/A	16	0.9
Endosulfan Sulfate	10,038 *	0.1	0.01	1.0	N/A	N/A	16	1.0
Endrin	9,157 *	ND (<0.01)	0.001	0.1	N/A	20	8	0.10

Endrin keytone	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
gamma - BHC (Lindane)	1,080	ND (<0.05)	0.0006	0.06	5.4	20	8	0.06
gamma - chlordane	140,000	0.1	0.14	14.0	0.54	5	80	0.54
Heptachlor	12,000	ND (<0.01)	0.0010	0.1	0.16	40	8	0.10
Heptachlor epoxide	220	ND (<0.01)	0.0002	0.02	0.077	0.8	8	0.02
Methoxychlor	25,637	35.0	9.0	900	N/A	400	80	***
Mitotane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Parathion	760	1.5	0.012	1.2	N/A	500	8	1.2
PCBs	17,510 *	0.1	0.1	10.0	1.0	N/A	160	1.0 (Surface) 10 (sub-surf)
Polychlorinated dibenzo-furans (PCDF)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Silvex	2,600	0.26	0.007	0.7	N/A	600	330	0.7
2,4,5-T	53	35	0.019	1.9	N/A	200	330	1.9

a. Allowable Soil Concentration Cs = f x Cw x Koc
b. Soil cleanup objective = Cs x Correction Factor (CF)
N/A is not available

* Partition coefficient is calculated by using the following equation:
log Koc = -0.55 log S + 3.64, where S is solubility in water in ppm.
All other Koc values are experimental values.

** Correction Factor (CF) of 100 is used as per TAGM #4046

*** As per TAGM #4046, Total VOCs < 10 ppm.

Note: Soil cleanup objectives are developed for soil organic carbon content (f) of 1% (5% for PCBs as per PCB Guidance Document), and should be adjusted for the actual soil organic carbon content if it is known.

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APPENDIX A of TAGM #4046

TABLE 4
Recommended soil cleanup objectives (mg/kg or ppm)
Heavy Metals

Shortcut to TAGM 4046 Tables for VOCs | SVOCs | Pesticides / PCBs

Contaminants	Protect Water Quality (ppm)	Eastern USA Background (ppm)	* CRDL (mg/kg or ppm)	***** Rec. Soil Cleanup Objective (ppm)
Aluminum	N/A	33,000	2.0	SB
Antimony	N/A	N/A	0.6	SB
Arsenic	N/A	3-12 **	0.1	7.5 or SB
Barium	N/A	15-600	2.0	300 or SB
Beryllium	N/A	0-1.75	0.05	0.16 (HEAST) or SB
Cadmium	N/A	0.1-1	0.05	1 or SB
Calcium	N/A	130 - 35,000 ***	50.0	SB
Chromium	N/A	1.5 - 40 **	0.1	10 or SB
Cobalt	N/A	2.5 - 60 **	0.5	30 or SB
Copper	N/A	1 - 50	0.25	25 or SB
Cyanide	N/A	N/A	0.1	***
Iron	N/A	2,000 - 550,000	1.0	2,000 or SB
Lead	N/A	****	0.03	SB ****
Magnesium	N/A	100 - 5,000	50.0	SB
Manganese	N/A	50 - 5,000	0.15	SB
Mercury	N/A	0.001 - 0.2	0.002	0.1
Nickel	N/A	0.5 -25	0.4	13 or SB
Potassium	N/A	8,500 - 43,000 **	50.0	SB
Selenium	N/A	0.1 - 3.9	0.05	2 or SB
Silver	N/A	N/A	0.1	SB
Sodium	N/A	6,000 - 8,000	50.0	SB
Thallium	N/A	N/A	0.1	SB
Vanadium	N/A	1-300	0.5	150 or SB
Zinc	N/A	9-50	0.2	20 or SB

Note: Some forms of metal salts such as Aluminum Phosphide, Calcium Cyanide, Potassium Cyanide, Copper cyanide, Silver cyanide, Sodium cyanide, Zinc phosphide, Thallium salts, Vanadium pentoxide and Chromium (VI) compounds are more toxic in nature. Please refer to the USEPA HEASTs database to find cleanup objectives if such metals are present in soil.

SB is site background
N/A is not available

NYSDEC TAGM #4046 - Heavy Metals Soil Cleanup Criteria Table

* CRDL is contract required detection limit which is approx. 10 times the CRDL for water.

** New York State background

*** Some forms of Cyanide are complex and very stable while other forms are pH dependent and hence are very unstable. Site-specific form(s) of Cyanide should be taken into consideration when establishing soil cleanup objective.

**** Background levels for lead vary widely. Average levels in undeveloped, rural areas may range from 4-61 ppm. Average background levels in metropolitan or suburban areas or near highways are much higher and typically range from 200-500 ppm.

***** Recommended soil cleanup objectives are average background concentrations as reported in a 1984 survey of reference material by E. Carol McGovern, NYSDEC.

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APPENDIX A of TAGM #4046

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Barium	N/A	15-600	2.0	300 or SB
Beryllium	N/A	0-1.75	0.05	0.16 (HEAST) or SB
Cadmium	N/A	0.1-1	0.05	1 or SB
Calcium	N/A	130 - 35,000 ***	50.0	SB
Chromium	N/A	1.5 - 40 **	0.1	10 or SB
Cobalt	N/A	2.5 - 60 **	0.5	30 or SB
Copper	N/A	1 - 50	0.25	25 or SB
Cyanide	N/A	N/A	0.1	***
Iron	N/A	2,000 - 550,000	1.0	2,000 or SB
Lead	N/A	****	0.03	SB ****
Magnesium	N/A	100 - 5,000	50.0	SB
Manganese	N/A	50 - 5,000	0.15	SB
Mercury	N/A	0.001 - 0.2	0.002	0.1
Nickel	N/A	0.5 -25	0.4	13 or SB
Potassium	N/A	8,500 - 43,000 **	50.0	SB
Selenium	N/A	0.1 - 3.9	0.05	2 or SB
Silver	N/A	N/A	0.1	SB
Sodium	N/A	6,000 - 8,000	50.0	SB
Thallium	N/A	N/A	0.1	SB
Vanadium	N/A	1-300	0.5	150 or SB
Zinc	N/A	9-50	0.2	20 or SB

Note: Some forms of metal salts such as Aluminum Phosphide, Calcium Cyanide, Potassium Cyanide, Copper cyanide, Silver cyanide, Sodium cyanide, Zinc phosphide, Thallium salts, Vanadium pentoxide and Chromium (VI) compounds are more toxic in nature. Please refer to the USEPA HEASTs database to find cleanup objectives if such metals are present in soil.

SB is site background
N/A is not available

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**** Background levels for lead vary widely. Average levels in undeveloped, rural areas may range from 4-61 ppm. Average background levels in metropolitan or suburban areas or near highways are much higher and typically range from 200-500 ppm.

***** Recommended soil cleanup objectives are average background concentrations as reported in a 1984 survey of reference material by E. Carol McGovern, NYSDEC.

OVERHEAD ELECTRIC

Utility Owner: RG&E
Contact: Pete Dawes (585) 724-8170

Services Needed: Pole holding
Service Contact: Carla Rhodes (585) 771-2343
Department: Energy Service Installation Group
Lead Time Required: 3 days
Information to Provide: Tag number from pole.

4" WRAPPED STEEL GAS LINE

Utility Owner: RG&E
Contacts: Main Line (716) 546-2700
Len Lenzi (585) 771-4609 f: (585) 771-2839
Sue Flood (Environmental) (585) 724-8630
Tim Kinsella (Foreman) (585) 724-2307 p: (585) 783-6480
Karen Sahler (585) 724-8684

Protocol: During the stake-out, the mark-out person and the Contractor can review the project plans. At that time, the mark-out person can direct us to the appropriate contacts within RG&E and may be able to guide us himself. Alternately, an inspector may be assigned to the project and they will oversee the work in the vicinity of the line, guide the supports, etc. At no time is anyone from CSXT, IT, or C&W allowed to shut-off service or alter the gas line. The depth of the gas line is estimated at 3-feet below grade. The soils within 2-feet of the mark-out stake must be hand dug. Once the pipe is exposed Sue Flood may want to grab a sample. Based on the results, she will direct us to the Engineering Department.

8" PE ENCASED DI WATER MAIN

Utility Owner: Rochester Water and Lighting Bureau, 10 Felix Street, Rochester, NY 14608
Contact: Mike Bushart (585) 428-7567 f:(585) 428-6353
Bill Sauer (details) (585) 428-6851
Roger Shaunheit (specs) (585) 428-6862

Protocol: The Bureau requests a set of plans, PE designed support system, and to be on-site during the work. The water main is approximately 4.5-feet below grade. A warning tape should be present approximately 1-foot above the line. The water main is part of a pumped system. In case of emergency the water line can be shut off from the valve located at the intersection of Latta and River Street. This branch line dead-ends on the north end of River Street. The Water Bureau requires 2 complete days notice of work in the vicinity of the water line. The Hydrant Use Application costs $1490 of which $1360 is refundable. The $130 buys a wrench, meter, and PRZ (backflow preventor). The Bureau provided specifications (Section S916) for the Temporary Bypass.

24” RCP and 12” VT SANITARY LINES

Utility Owner: Monroe County-Pure Waters, 444E. Henrietta Road, Rochester, NY 14620-4643

Contacts: Dale Adams (716) 760-7610 ext. 7077
Tom Posella (In charge of Des. &Rvw Grp) (716)760-7578
Kevin Quinn (716) 760-7610 ext. 7066

Protocol: Pure Waters has provided specifications and drawings of the sanitary and stormwater lines in the vicinity of the site. IT has been instructed that the sanitary manhole rims and elevations must be surveyed and the lines tv’d. The survey has been completed and the tving is scheduled. An overview of the project with drawing was submitted to Dale Adams. Pure Waters has also stated that if excavation is to take place in the vicinity of the sanitary lines the lines need to be replaced. This would entail installing a pump-around from the southern manhole to the northern most manhole. New PVC lines must then be installed per Pure Waters requirements detailed in *Requirements for Privately Constructed Sewers in the Rochester Pure Waters District Monroe County, New York*.

Material Safety Data Sheet

THE WESTFORD CHEMICAL CORPORATION®
P.O. Box 798
Westford, Massachusetts 01886 USA
Phone: (978) 392-0689
Phone: (508) 885-1113
Emergency Phone 24 Hours: 1-800-225-3909

Ref. No.: 2001
Date: 1-1-2000

Fax: (978) 692-3487
Web Site: http://www.biosolve.com
E-Mail: info@BioSolve.com

SECTION I - IDENTITY

Name:	**BioSolve®**
CAS #:	138757-63-8
Formula:	Proprietary
Chemical Family:	Water Based, Biodegradable, Wetting Agents & Surfactants
HMIS Code:	Health 1, Fire 0, Reactivity 0
HMIS Key:	4 = Extreme, 3 = High, 2 = Moderate, 1 = Slight, 0 = Insignificant

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SECTION II - HAZARDOUS INGREDIENTS

Massachusetts Right to Know Law or 29 C.F.R. (Code of Federal Regulations)1910.1000 require listing of hazardous ingredients.

This product does not contain any hazardous ingredients as defined by CERCLA, Massachusetts Right to Know Law and California's Prop. 65.

SECTION III - PHYSICAL - CHEMICAL CHARACTERISTICS

Boiling Point:	265°F	Specific Gravity:	1.006 +/-.01
Melting Point:	32°F	Vapor Pressure mm/Hg:	NA
Surface Tension- 6% Solution:	29.1 Dyne/cm at 25°C	Vapor Density Air = 1:	NA
Reactivity with Water:	No	Viscosity Concentrate:	490 Centipoise
Evaporation Rate:	>1 as compared to Water	Viscosity 6% Solution:	15 Centipoise
Appearance:	Clear Liquid unless Dyed	Solubility in Water:	Complete
Odor:	Pleasant Fragrance	pH:	9.1+/-.3
Pounds per Gallon:	8.37	.	.

SECTION IV - Fire and Explosion Data

Special Fire Fighting Procedures:	NA	Percent Volatile by Volume:	NA
Unusual Fire and Explosion Hazards:	None	Flammable Limit:	NA
Solvent for Clean-Up:	Water	Auto Ignite Temperature:	NA
Flash Point:	NA	Fire Extinguisher Media:	NA

SECTION V - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES

Precautions to be taken in Handling and Storage: Use good normal hygiene.
Precautions to be taken in case of Spill or Leak -
Small spills: in an undiluted form, contain. Soak up with absorbent materials.
Large spills: in an undiluted form, dike and contain. Remove with vacuum truck or pump to storage/salvage vessel. Soak up residue with absorbent materials.
Waste Disposal Procedures:
Dispose in an approved disposal area or in a manner that complieswith all local, state, and federal regulations.

SECTION VI - HEALTH HAZARDS

Threshold Limit Values: NA
Signs and Symptoms of Over Exposure-
Acute: Moderate eye irritation. Skin: Causes redness, edema,drying of skin.
Chronic: Pre-existing skin and eye disorders may be aggravated by contact with this product.
Medical Conditions Generally Aggravated by Exposure: Unknown
Carcinogen: No
Emergency First Aid Procedures -
Eyes: Flush thoroughly with water for 15 minutes. Get medical attention.
Skin: Remove contaminated clothing. Wash exposed areas with soapand water. Wash Clothingbefore reuse. Get medical attention if irritation develops.
Ingestion: Get medical attention.
Inhalation: None considered necessary.

SECTION VII - SPECIAL PROTECTION INFORMATION

Respiratory Protection:	Not necessary
Local Exhaust Required:	No
Ventilation Required:	Normal
Protective Clothing:	Gloves, safety glasses Wash clothing before reuse.

SECTION VIII - PHYSICAL HAZARDS

Stability :	Stable
Incompatible Substances:	None known
Polymerization :	No
Hazardous Decomposition Products:	NA

SECTION IX - TRANSPORT & STORAGE

DOT Class :	Not Regulated/Non Hazardous
Freeze Temperature :	28°F
Storage :	35°F-120°F
Freeze Harm :	None
Shelf Life :	Unlimited unopened

SECTION X - REGULATORY INFORMATION

The Information on this Material Safety Data Sheet reflects the latest information and data that we have on hazards, properties, and handling of this product under the recommended conditions of use. Any use of this product or method of application, which is not described on the Product label or in this Material Safety Data Sheet is the sole responsibility of the user. This Material Safety Data Sheet was prepared to comply with the OSHA Hazardous Communication Regulation and Massachusetts Right to Know Law.

Work Area Air Sampling and Monitoring Work Plan for CSXT Remediation Activities
Rochester, N.Y.

1.0 Introduction and Purpose

On Sunday, December 23, 2001 a train derailment occurred along River Street in the Charlotte section of Rochester, NY. The train contained forty three railcars, twenty seven of which were involved in the derailment. Most of the cars derailed contained coal; however, the accident also involved one tank car containing methylene chloride (dichloromethane) and two tank cars containing acetone. The contents of the acetone cars were ignited, which resulted in the combustion of both acetone and methylene chloride. During the emergency response phase, the Center for Toxicology and Environmental Health, L.L.C. (CTEH) conducted substantial air monitoring to assess the potential hazards of the derailment site and to protect the surrounding communities from potential chemical exposures. The emergency response phase is complete; however, residual amounts of acetone and methylene chloride remain in the soil environment and shallow groundwater in the immediate vicinity of the derailment site. The primary work activity during the long-term remediation phase is to remove and dispose of the contaminated soil.

This work plan addresses air sampling during future remediation activities at the site. CSXT is concerned about the safety and health of personnel performing these activities. Thus, the purpose of this sampling includes the following:

- Determine if workers involved in remediation activities are adequately protected.
- Determine the levels, if any, of acetone or methylene chloride at the site.

CTEH has already collected substantial air monitoring data from December 26 to the present. The air sampling data has been periodically reviewed by the New York State Department of Environmental Conservation (NYSDEC) and the Monroe County Department of Health (MDOH). The data collected to date indicate that the air in the community is safe as well as the air in and around the derailment site. This workplan will essentially follow the existing protocols and sampling stations already reviewed by NYSDEC and MDOH.

2.0 Air Sampling and Monitoring Locations

Real time[1] air monitoring and integrated[2] air sampling will be performed at the following locations to determine the concentrations of acetone and methylene chloride in the work area:

- The immediate vicinity of remediation activities,
- Around the perimeter of the hot-zone,
- On selected workers in the hot-zone

In addition, sampling will be conducted on an as needed basis to respond to potential concerns raised by individuals working at the site.

3.0 Methods

3.1 Real-Time Monitoring

Real-time air monitoring for methylene chloride and acetone will be performed during remediation activities. The real-time monitoring instruments/apparatus that will be used and the detection limits are listed in Table 1.

Table 1 Real-Time Air Monitoring Equipment and Detection Limits for Methylene chloride and Acetone

Instrument		Methylene chloride	Acetone	Units
MultiRae Plus		0.1	0.1	ppm
SapphIRe		4.0	5.0	ppm
GasTec Detector Tubes		20.0	50	ppm
TV-1000	FID	0.1	0.1	ppm
	PID	---	0.1	ppm

3.2 Integrated Sampling

---

[1] The term "real–time" refers to direct reading instruments that allow nearly instantaneous determinations of a chemical concentration in air.

[2] The term "integrated air sampling" refers to methods that involve collection of air samples over a specified time period, followed by analysis of the average air concentration during that period. Most such methods involve the collection of a known volume of air across a collection medium (e.g., charcoal sample tube) selected to absorb the chemical from the air. The collection medium is sent to a laboratory for analysis. By knowing the volume of air collected, and the quantity of chemical absorbed onto the collection medium, the air concentration can be calculated.

Table 2 summarizes the integrated air sampling method for each chemical of concern at the remediation site.

Table 2 Summary of Integrated Air Sampling Methods

Analyte	*Analytical Method*	*Sample Media*	*Flow Rate (ml/min)*	*Sample Time (minutes)*	*Holding Time*
Methylene Chloride	NIOSH 1005	Solid Sorbent (2 coconut shell charcoal tubes, 100/50 mg)	10 - 200	720	30 days @ 5 °C
Acetone	NIOSH 1300	Solid Sorbent (1 coconut shell charcoal tubes, 100/50 mg)	10 - 200	720	Unknown

3.3 Chemical Data Objectives

- All integrated TWA samples will be sent to Galson Laboratories in Syracuse, N.Y., an AIHA Accredited Laboratory.
- All real-time instruments will be calibrated according to the manufacturer recommendations.
- Calibration logs will be kept and included in the final report.
- Real-time readings will be documented by handwritten notes or by the use of datalogging capabilities of the instrument, if available.

4.0 Occupational Exposure Standards and Action Levels

4.1 Acetone

Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) Ceiling = 1,000 ppm (2,400 mg/m^3).

American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value Time-Weighted Average (TLV-TWA) = 500 ppm TWA (1,188 mg/m^3), Ceiling = 750 ppm (1,782 mg/m^3).

4.2 Methylene chloride

OSHA PEL-TWA = 25 ppm
OSHA Action Level = 12.5 ppm
OSHA STEL = 125 ppm
ACGIH TLV-TWA = 50 ppm (174 mg/m^3)

4.3 Action Levels and Confirmation

Air monitoring using the Multirae PID are specific not specific for methylene chloride or acetone. Readings above the respective action levels with the Multirae PID connected to Lifeline (25 ppm Methylene chloride or 500 ppm acetone in work zones) should be confirmed with the Sapphire or equivalent instrument to confirm the reading and identify which chemical is present in air. If a Gastec tube or equivalent detector tube is available, the reading could also be confirmed with a Detector Tube. **NOTE THAT THE MULTIRAE PID HAS A RESPONSE FACTOR.** The action levels for acetone and methylene chloride are discussed in sections 4.3.1 and 4.3.2, respectively.

4.3.1 Acetone

Level D is permitted for all activities when real-time readings are below the PEL of 1,000 ppm

Level C is required when real-time readings are sustained at > 1,000 ppm for 5 min.

4.3.2 Methylene Chloride

Level B or supplied air is required when real-time readings are sustained at > 25 ppm for 5 min.

Level B or supplied air is required for individuals who are working in areas which have 8 hr integrated air sampling results > 25 ppm.

5.0 Project Organization

CTEH will be responsible for the following:

- Air Monitoring Plan Project Management
- Quality Assurance/Quality Control
- Data evaluation and reporting

The following key personnel with extensive experience in these types of investigations will be used for this project as follows:

- Project Director – Dr. Glenn C. Millner, Senior Toxicologist.

- Project Manager – Dr. Jeff Moran, Toxicologist
- Air Monitoring – Brett Tarkington, CIH; Cory Davis, IH, Greg Dawson, IH.

6.0 Equipment Decontamination

None required under foreseeable conditions.

7.0 Field Documentation

During the response, the response team members will maintain various field books, reports, and logs. Each of the components of the field documentation is described below.

8.0 Calibration and Maintenance of Field Instruments

The calibration and maintenance of field equipment and instrumentation will be in accordance with each manufacturer's specifications or applicable test/method specifications, and shall be documented in the Daily Activity or Site Safety and Health Logbooks.

9.0 Chain of Custody (COC)

Each sample will be identified on a chain of custody record. The integrated sample numbering system will include site name, date, analyte, and identification code unique to each sample.

10.0 Sample Labels

All sample labels used on sample containers will include, at a minimum, a sample identification code, the date of the sample, and the analyte.

11.0 Packaging and Shipping

Packaging and shipping of samples will vary depending upon sample media, contaminant concentration, preservation technique, and sample container. The person packaging the samples is responsible to ensure that the sample packaging is in suitable condition for shipping.

the IT group

IT Corporation
13 British American Boulevard
Latham, NY 12110-1405
Tel. 518.783.1996
Fax. 518.783.8397

A Member of The IT Group

April 3, 2002

Donald Crumb, Jr.
City Hall, Room 400-A
30 Church Street
Rochester, NY 14614-1295

Re: IRM-Excavation Work Plan (March 8, 2002)
Response to City of Rochester Comment Letter dated March 22, 2002

Dear Mr. Crumb:

IT Corporation, Inc. (IT), on behalf of CSX Transportation, Inc. (CSXT), has prepared this addendum in response to the City of Rochester (COR) comment letter dated March 22, 2202 for the revised IRM-Excavation Work Plan submitted to the NYSDEC on March 8, 2002.

1. Section 1.0 Soil Excavation and Disposal:

A. Since the Revised Work Plan indicates the extent of soil excavation will ultimately depend upon various factors such as building, utilities, and other technical feasibility issues, it is recommended that any changes, revisions, deletions and/or modifications of the work scope as set forth in the Revised Work Plan be documented in the final closure report.

Response: Agreed.

B. Section 1.1 labeled Excavation Activities, sets forth that if it is demonstrated by analytical results that the riverbank is impaired, the contaminated soils will be removed.

1. Recent soil sampling by the City indicates that:

a. soil in the riverbank is contaminated with high concentrations of acetone and methylene chloride;

b. these concentrations are well above NYSDEC soil cleanup objectives;

c. several of the riverbank soil samples contained the highest concentrations of methylene chloride at the accident site; and

d. the extent of contamination along the riverbank has not yet been defined since every soil sample collected by the City along the riverbank was contaminated.

Response: CSXT has contracted a geotechnical firm to conduct a geotechnical study of the site and riverbank and to install additional geoprobe points to delineate the soil impacts along the riverbank. This work is scheduled to take place April 10 through 19, 2002. Based on the results of this work, a stand-alone riverbank removal plan will be prepared and submitted to the NYSDEC for review and approval.

2. Copies of the riverbank soil analytical results were provided to CSXT and NYSDEC; therefore, the language in Section 1.1 should be revised to include the removal of all contaminated riverbank soil.

   Response: See response to B1 above.

3. The removal of the riverbank soil will also require CSXT to implement an alternate bracing or support system in order to remove the contaminated riverbank soils.

   Response: See response to B1 above.

4. Since some of concentrations of methylene chloride appear to exceed Tier I levels listed in the Revised Work Plan, the IT drawings illustrating the locations of the Tier I limits of excavation should be revised to include the City's analytical results, or alternatively, a separate riverbank excavation tier or zone to be identified.

   Response: See response to B1 above.

C. Section 1.2 of the Revised Work Plan should be revised to incorporate the statements made by CSXT/IT regarding their plans that all trucks and rail cars transporting the excavated contaminated soils from the accident site will be lined and covered to prevent spillage and dust emissions.

Response: All disposal haul trucks and railcars will be lined and covered to prevent spillage and dust emissions.

D. Section 1.2 of the Revised Work Plan should be revised to state the soils staging areas will be bermed, lined with reinforced polyethylene sheeting and sloped to gather impaired water that leaches from the soil since due to the relatively shallow groundwater table at the accident site, some contaminated soils will be wet even if dewatering is performed.

Response: The soil staging area will be lined with 10-ml polyethylene sheeting, bermed, and sloped to a water collection area. Additionally, the soils beneath the staging/loading/decontamination areas will be sampled upon completion of the project to ensure they were not impacted during the course of the work.

E. Section 1.2 of the Revised Work Plan should be revised to incorporated the statements made by CSXT/IT regarding their plans to collect and analyze post-remediation soil samples from the soil staging areas after the IRM have been completed in order to verify there have been no impacts to the underlying surface soils.

Response: Soils beneath the staging/loading/decontamination areas will be sampled upon completion of the project to ensure they were not impacted during the course of the IRM work.

II. Section 2.0 Sampling Procedures:

A. Section 2.1 should be amended to include language describing sampling methods that will be used during endpoint sampling to prevent or reduce volatization during the collection of the confirmatory samples since the high vapor pressures of acetone and methylene chloride exist at the accident site.

Response: Sampling procedures were included in the CSXT-Rochester Field Sampling Plan. A copy of this plan was forwarded to the NYSDEC and the COR on April 2, 2002.

III. Section 2.2 River Sediment Sampling:

A. The Revised Work Plan should include a drawing showing proposed sampling locations.

Response: On April 2, 2002 a copy of the March 19, 2002 river sediment sampling report was forwarded to the NYSDEC and COR. The report detailed the sampling methodology utilized, illustrated the 13 sample locations, and provided the analytical results.

1. The City shall have an opportunity to review the proposed sample locations.

Response: The initial river sediment sampling was completed on March 19, 2002. A second round of sampling to delineate the area of concern was scheduled for April 4 and 5, 2002. A copy of the Phase II Genesee River Sediment Sampling Plan was forwarded to the NYSDEC and COR on April 2, 2002. This document illustrates the locations of 31 river sediment sample points. Samples will be collected from three depths at each location.

2. The proposed sediment sampling locations should be in part based upon the City's recent riverbank soil and groundwater investigation.

Response: The Phase II sampling locations were based on the results of CSXT's March 19, 2002 river sediment sampling event.

3. Some of the eight "Middle" sediment samples should be collected adjacent to the riverbank soil and groundwater samples which contained the highest concentrations of contaminants.

Response: The Phase II sampling locations were based on the results of CSXT's March 19, 2002 sediment sampling event.

B. The sampling methodology appears vague.

Response: Comment noted.

1. The Revised Work Plan should be amended to reference a specific NYSDEC, USEPA or US Army Corps methodology.

Response: The original sampling plan was approved by the NYSDEC.

2. The Revised Work Plan should be amended to specify what sediment cleanup criteria will be used for comparison of any detectable concentrations of contaminants.

Response: Sediment clean-up criteria will be established once the extent of the contamination is fully delineated in cooperation with the NYSDEC, USEPA, and US Army Corps.

C. Once the benthic organism study, mentioned by CSXT and IT, has been completed for the accident site, it would be helpful if the report were forwarded to the City and NYSDEC.

Response: A Final Draft of the Benthic Study was forwarded to the NYSDEC and COR on April 2, 2002.

IV. Section 3.0 Restoration:

A. It may be beneficial to develop a list of each specific utility agency as well as the contacts from each of those agencies.

Response: A utility contact list has been generated and is included in Attachment 2 of the IRM Excavation Work Plan Addendum to the NYSDEC of which this letter is Attachment 5.

B. Backfill compaction performed on City property or Right of Way (ROW) must be verified via independent testing and all compaction testing results should be available to the City as soon as possible.

Response: Backfill compaction testing will be performed by SJB Contract Drilling and Testing of Henrietta, NY.

V. Section 4.0:

A. Section 4.2 labeled Community/Perimeter/Personnel Air Monitoring refers to the Community Air Monitoring Plan (CAMP).

1. Section 2.0 and 3.0 of the CAMP should be amended to replace the word "sustained" with a specified time duration, for measuring threshold levels which will trigger actions.

Response: 'Sustained' is equivalent to 5 minutes per the HASP.

2. The CAMP should recognize that portion of the Tier 3 excavation will be in close proximity to occupied buildings (e.g., Tapecon) and this factor may lead to a scenario where VOC readings less than the threshold levels could be experienced for multiple events.

   Response: Comment noted.

VI. Section 5.0:

A. Section 5.0, paragraph No. 2 requires that the Safety Officer contact the local police. It is recommended that the Safety Officer contact 911 Emergency Services, which in turn will make the necessary referrals to the police.

   Response: Per the COR request, that wording had been changed to 'The Monroe County Department of Health will immediately be contacted by the Safety Officer and advised on the situation' in IT's March 12, 2002 letter to you. Reference to contacting 911 Emergency Services will also be added.

1. The Safety Officer must also contact the affected property owners set forth on a list developed by CSXT and approved by the City.

   Response: A list of adjacent property owners is being developed. Once completed it will be faxed to the COR for review. This list will be available to CSXT and emergency responders.

If you have any additional questions or concerns, please contact Tom Antonoff or me at (518) 783-1996.

Sincerely,
IT Corporation, Inc.

Marie T. Dowd

Marie T. Dowd, I.E.
Project Engineer