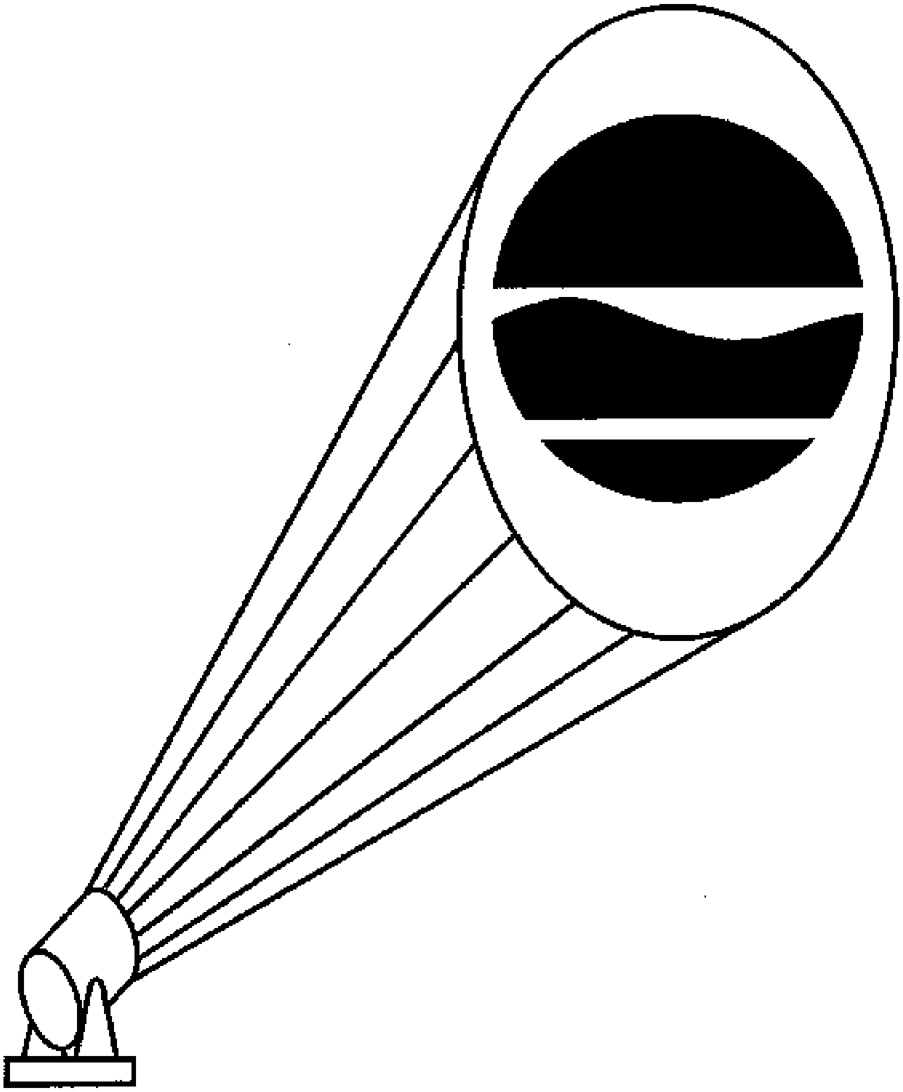

Spill
Prevention
Operations
Technology
Series

SPOTS Memo #14
Site Assessments at Bulk Storage Facilities

Prepared by:
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Langdon Marsh
Commissioner

August 1, 1994

MEMORANDUM

To: Regional Spill Supervisors, Bureau Directors and Section Chiefs
Subject: Spill Prevention Operations Technology Series (SPOTS #14)
Site Assessments at Bulk Storage Facilities
(Originator: Paul Sausville/Russ Brauksieck)

I. PURPOSE

Under the federal EPA Underground Storage Tank (UST) regulations (40 CFR Part 280), an owner or operator who is closing an underground tank storing a regulated substance must inspect the site for past leaks and spills, and identify any soil or water contamination. The EPA refers to these inspections as "site assessments".

A site assessment is different than a site investigation. A site assessment is designed to determine if there is any contamination present at the site. Once any contamination is found then a site investigation needs to be done to determine the extent of the problem.

This SPOTS is written for tank owners or operators, and consultants seeking guidance from the Department on how to conduct a site assessment. It focuses on those studies and measurements needed to determine if the site is free of contamination and is suitable for closure, but it does not address the level of site investigation to be performed if contamination is discovered, the action levels at which clean-up is required, or what is considered clean. These topics will be addressed in a coming guidance.

II. BACKGROUND

In December 1988, the EPA passed the federal Underground Storage Tank (UST) regulations (40 CFR Part 280). These regulations set forth strict rules for the underground storage of petroleum and hazardous substances, including requirements that tank owners or operators perform site assessments to determine if any leaks or spills have occurred at their storage facilities. Subpart 280.72 of the regulations states:

> "...owners and operators must measure for the presence of a release where contamination is most likely to be present at the UST site. In selecting sample types, sample locations, and measurement methods, owners and operators must consider the method of closure, the nature of the stored substance, the type of backfill, the depth to groundwater, and other factors appropriate for identifying the presence of a release."

The requirement to perform a site assessment is applicable to any tank that stores a substance that is regulated by 40 CFR Part 280. This includes all CERCLA chemicals and all petroleum products including waste oil but does not include heating oil if it is used for consumptive use on the premise where stored.

An assessment is required for any of the following situations:

- an existing tank is replaced with a new one;
- a tank, whether in-service or previously abandoned, is taken out-of-service permanently;
- a tank has been temporarily out-of-service for more than one (1) year; or
- the product stored in a tank is switched from a regulated substance to an unregulated substance.

In addition, EPA may require an assessment for tanks closed prior to December 1988 if EPA believes that the tank poses a current or potential threat to human health or the environment.

A site assessment may also be required when complying with 40 CFR Part 280 which requires owners of underground tanks to demonstrate financial responsibility for any leaks that would occur from the tank. Before issuing insurance policies that will fulfill this requirement, most insurance companies will require a site assessment which may be similar to or exceed that required by subpart 280.72.

Banks may also require site assessments before loans are issued. Moreover, many realtors and buyers are reluctant to undertake real estate purchases without assurances that the land and groundwater have not been contaminated by past spills.

The recommended assessment practices, as follows, may be applied to aboveground storage tanks as well as underground tanks, and may be useful beginning steps in any spill investigations such as those required by Article 12 of the Navigation Law and by the Chemical Bulk Storage regulations, Title 6NYCRR, Paragraph 595.2(d)(1).

Title 6 NYCRR, paragraph 613.8 - Reporting of spills and discharges, requires:

> "Any person with knowledge of a spill, leak or discharge of petroleum must report the incident to the Department within two (2) hours of discovery. The results of any inventory record, test or inspection which shows a facility is leaking must be reported to the Department within two (2) hours of the discovery."

A responsible party (buyer, seller, owner, previous owner) is to undertake further investigation and, as necessary, remediation, or if DEC undertakes the remediation to protect the public or environment, one of the parties must pay back the costs and any imposed penalties. Contamination discovered during a site assessment is to be reported to DEC by any person with knowledge of the release (including consultants and contractors) and appropriately investigated by DEC.

DEC will not make a property clean to facilitate real estate or other transactions. DEC personnel are not to become involved in any real property or other transactions by verifying that sites are "free of contamination," or by reviewing plans, reports, investigations or laboratory results, or by assisting the parties of such transactions in any consultive basis. DEC will exercise its regulatory responsibilities should it become apparent at any time that a spill or release has occurred. Response to Freedom of Information Law (FOIL) requests shall be limited to a computer search of existing spill or bulk storage records, or party access to files if/as available. It will be the parties responsibility to evaluate or investigate further for their own protection.

III. GUIDANCE

This paper addresses five elements which make up a thorough site assessment: review of background information, field observations, field measurements and analyses, lab measurements and analyses, and an exposure assessment. In this paper, the review of background information will be called the "Phase I Site Assessment;" the field observation, field measurements and analysis, and lab measurements and analysis will be called the "Phase II Site Assessment;" and the exposure assessment will be called the "Phase III Site Assessment."

For more information on the site assessment procedure, refer to API Publication 1628, "A Guide to the Assessment and Remediation of Underground Petroleum Releases."

In addition, although owners/operators may do site assessments on their own, they should seriously consider acquiring the services of qualified and experienced professionals such as geologists, licensed engineers, or environmental scientists. This will allow them to demonstrate to regulatory officials, banks, insurance agents and future buyers of sites that an independent and professional assessment has been made. If the information is obtained by an interested party (i.e., owner, operator, buyer, etc.), the assessment may be considered biased.

Also, owners/operators are encouraged to obtain the services of NYS certified labs if lab analyses are to be done. A list of NYS certified labs is available from the NYS Department of Health.

If the site assessment is being done in conjunction with a tank closure in place, the site assessment should be done before the actual closure. If the tank is going to be removed, the site assessment should be done during or after the tank closure.

A. Phase I Site Assessment: Review of Background Information

The first phase of the site assessment involves the gathering of readily available information. Before field monitoring takes place, the inspector, whether he is the owner/operator or a hired consultant, should review the system design, site history, and geological information. Such information **may** include:

System Design

- tank/pipe design (material of construction, pump system, etc.)
- age of equipment
- layout
- location of transfer stations and vents
- sources of stray underground electric currents

Site History

- previous owner(s)/user(s)
- contractor who installed tank
- product stored
- history of spills
- tank test reports
- inventory monitoring reports
- water pump-out records
- tank relining and repair records
- location of all underground utilities
- information from local fire departments about fumes in sewers, nearby utilities, houses, etc.
- identify potentially affected areas on-site and off-site
- identification of off-site sources that may contribute to contamination

Geological Information

- soil maps
- geological reports
- groundwater and aquifer maps
- soil resistivity/soil chemistry data
- well records
- copies of any analysis done on the soil or groundwater
- history of excessive settlement or excessive surface water retention in soil layers

System design information is useful in locating potential sources of spills/leaks. Fill pipes, manways and vents are points where previous spills may have occurred. Old bare steel tanks and unprotected pipes are likely sources of leaks, especially if they are constructed of light gauge steel as is normally used for small tanks. (Tanks with a capacity of 4,000 gallons or less are normally constructed of .075 - .18 inch thick steel stock. Larger tanks are usually .25 - .31 inch thick.)

Historical information on the product stored provides clues on the chemicals which may be found at the site. A history of spills, a failed tank test (or a tank that barely passed a test), a discrepancy in the inventory records, frequent water pump-outs, tanks that had been relined, or a tank that was taken our-of-service for no apparent reason are all signs that a release to the environment **may** have occurred.

Information on product solubility, stability (whether it decomposes in the environment), concentration, density, viscosity and vapor pressure enable the inspector to draw conclusions on the extent of dispersion and underground movement of contaminants. Insoluble products that float are easier to locate and recover than products that are soluble and miscible with water. Substances with a high vapor pressure (high volatility) such as gasoline, will vaporize and migrate more readily through the pores of the soil and can be detected with field instruments. In general, a more viscous product will not spread as far nor as quickly as a less viscous product. Heated fuel oils will migrate more readily than unheated oils because of their viscosities. Regardless of viscosity, petroleum or chemical compounds can travel a considerable distance depending on the geological substrate.

Geological maps and reports will give information on permeability and porosity of the soil, soil chemistry, depth to bedrock, depth to groundwater, and direction of groundwater movement. This will give information on how far any contamination might have moved, what resources may have been affected, and where the contamination might move to. The inspector should be on the lookout for moist, clay-rich, and sulphur-rich soils or backfill consisting of debris such as coal dust, wood, stone, etc. which create a corrosive and hostile underground environment for steel tanks and pipes. Tanks installed in these soils usually leak in their first 15 years of use. Tanks installed near an underground electrical or telephone line are subjected to an electrical field and can be found to be highly corroded in only 1-2 years after installation.

Environmentally sensitive areas (for example, where there are nearby drinking water wells, aquifers or recharge areas) should be identified in the Phase I Site Assessment. If sand or gravel exists at the site, a well or aquifer is nearby, or there is prominent contamination evident, the owner should scale-up the level of investigation to include a groundwater contamination survey. Likewise, a downscaling in the intensity of investigation to a fewer number of sampling locations or possibly just visual examination may be considered if the site is not in an environmentally sensitive area and the Phase I Site Assessment shows no reason to believe that a release has occurred. A site assessment must be a credible site assessment; therefore if it is decided that lab measurements and analyses will not be done, then the site assessment report must document why the site is considered not in an environmentally sensitive area and shows no reason to believe that a release has occurred.

By performing a good Phase I assessment, better decisions can be made on which substances to look for, which monitoring instruments to use, and where and how many samples to collect. All of these decisions will be used in Phase II.

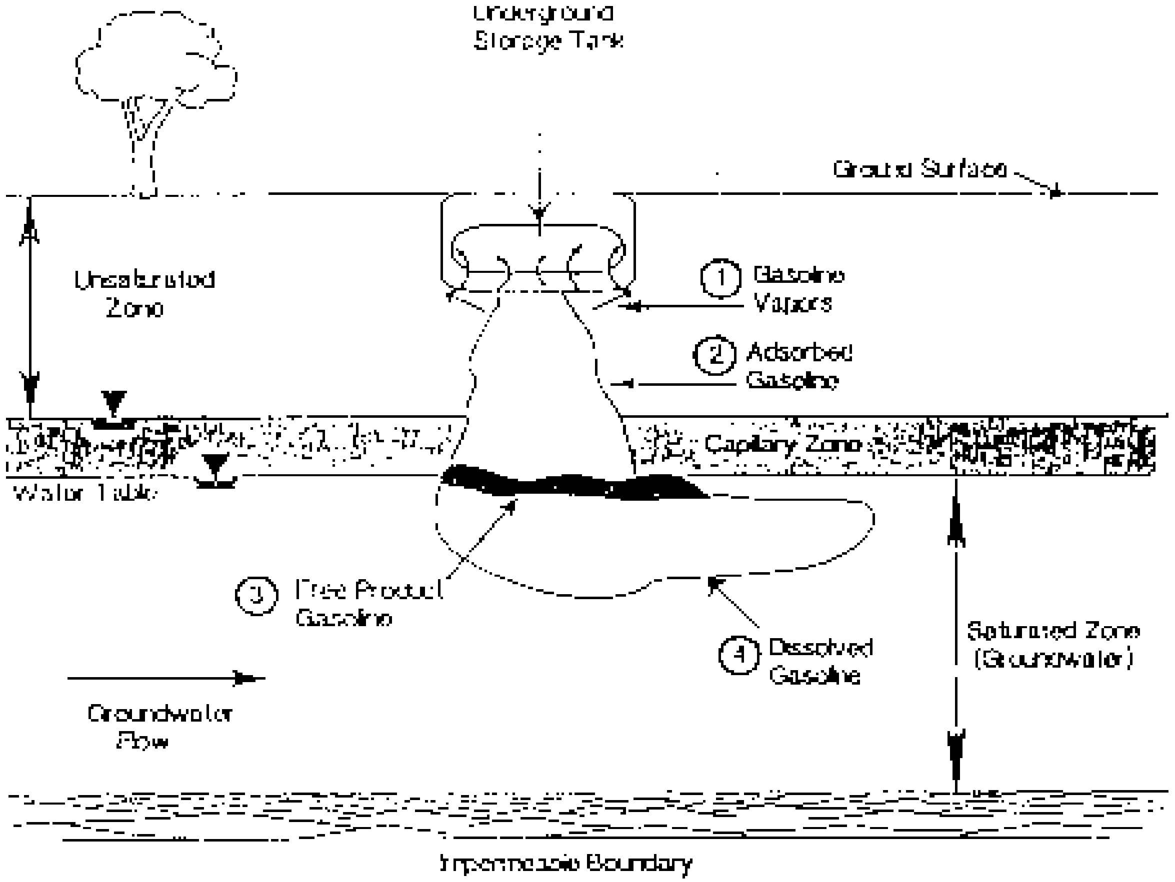

Figure 1. The Subsurface Environment and the 4 Phases of Contamination

Source: Camp, Dresser & McKee Inc.,
Cleanup of Releases from Petroleum USTs
April 1988

B. Phase II Site Assessment: Field Observations; Field Measurements and Analysis; and Lab Measurements and Analysis

The objective of the second phase of the site assessment is site characterization. This will include field observations, field measurements and analyses, and possibly lab measurements and analyses. This phase should provide the data necessary to plan any remedial measures which may be needed.

Contamination can be found as vapor, soil residual, free product or dissolved constituents in the groundwater as shown in Figure #1. Vapors are usually found in the unsaturated soil zone and are generated from gasoline or other similar volatile substances. In addition to vapors, these soils may contain a residual of product which is adhering to the soil particles. For small spills of highly viscous substances, the substance is trapped in the soil and "depletes" as it travels downward. In some cases, the substance may never actually reach groundwater although there is evidence that soluble constituents may move beyond the immediate contamination zone.

Substances which do reach the water table may be found floating (if the specific gravity of the substance is less than 1), found at the bottom of the aquifer (if specific gravity is greater than 1), or found mixed or dissolved in the groundwater (if the substance is miscible or soluble in water).

For safety reasons, the inspector should not enter the tank excavation to collect soil or groundwater samples. It is safer to direct the backhoe operator to bring soil up in the backhoe bucket from specified locations within the excavation. The inspector can then use a clean trowel or auger to dig or bore into the soil in the backhoe bucket.

1. Field Observations

Serious contamination can usually be discovered through simple observation: looking for stained soil, smelling for chemical or petroleum odors, or looking for signs of a sheen on the water surface.

All field observations should be recorded and kept as part of the site assessment record. If tanks or pipes are being excavated, the depth of stained or discolored soil, and depth to groundwater should be noted. Note any signs of leaking pipe joints and localized areas of corrosion. Scrape away excess dirt or rust from the tank or pipes to locate possible holes or pits. Note location and condition of any abandoned underground tanks and lines that are found during excavation.

Investigate odors safely. It may be unhealthy to sniff soils directly. Keep in mind that prolonged exposure to many substances such as petroleum will also inhibit your sense of smell. Records should be kept of any obvious contaminant odors.

A "bucket test" or "jar test" is one form of visual observation which can be very useful for petroleum. This test is done simply by mixing a small quantity of soil in a bucket or jar of clean water and allowing the mixture to settle. A sheen appearing on the water surface is evidence of contamination. However, the absence of a sheen does not indicate that the material is clean. Further investigation is necessary to determine that a site is free of contamination.

If a monitoring well exists at the site (or if one is installed as part of the site assessment), it should be checked for free-product. This can be done by lowering a weighted steel measuring tape with water or hydrocarbon finding paste (if product stored was a petroleum product) into the well. An interface probe or bailer can also be used. A water sample may be collected to send for lab analysis to analyze for dissolved constituents. Procedures for checking monitoring wells are described in API Publication 1628.

For a thorough site assessment, it is necessary to supplement visual and olfactory observation with field measurements. Laboratory measurements are also recommended and is necessary as evidence that no contamination of concern exists in the sample or to determine the type and quantity of contamination.

2. Field Measurements and Analyses

Field instruments are useful for making on-the-spot analyses for contamination. They provide immediate data on petroleum and chemical vapors in soil or water to justify on-site decisions for excavation and to determine optimal locations for soil/water sampling. The results of such analyses can show whether the site is contaminated and needs further investigation or can be closed. Instruments most frequently used to obtain direct readings of vapors coming off contaminated water or soil are:

- **Explosimeters (or Combustible Gas Indicators).** Explosimeters measure vapor concentrations sufficient to support an explosion. These meters should always be used when entering a site where explosive vapors may be encountered. This, however, can not be used to show the absence of contamination.

- **Photoionization Detectors (H-Nu Meters).** These detect most organic and selected inorganic compounds, and give the results in parts per million (ppm);

- **Flame Ionization Detectors (Organic Vapor Analyzers).** These detect trace levels of organic vapors. In the gas chromatograph mode, they separate and measure individual chemical components, and give the results in parts per million (ppm); and

- **Colorimetric Reading Tubes.** These identify a specific chemical group in a short amount of time, based on a color change of the material inside the tube, and give the result in parts per million (ppm);

Table 1: Field Instruments, found in the Appendix, discusses the advantages, disadvantages, and application of each instrument. The disadvantages limit these tools to use as qualitative devices which can only be used to determine if contamination exists. Therefore, any instrument reading which indicates that any level of contamination exists must be investigated further. Laboratory analysis of soil and groundwater samples is necessary to determine type and quantity of contamination, or to prove that no contamination exists in the sample.

As a general rule, these tools are only useful for certain products that have volatile components (such as gasoline). They are less effective for products with lower volatility, such as heavy fuel oil. Furthermore, they cannot detect vapors at concentrations below 0.5 ppm. Instrument readings have also shown a poor correlation with laboratory results, especially in situations where the spill has weathered (i.e., much of the volatile fraction has volatilized) or when the soil is contaminated by migrating vapors as opposed to free product. Some direct-reading instruments that detect a particular class of substances (e.g., detector tubes) are subject to interferences (i.e., may react to other substances such as methane) and may give a false reading. Despite these limitations, these field instruments are useful direct read-out devices used for initial screening of site conditions. They are primarily used to determine where contamination exists, and where sampling and remediation is required.

Sampling for Field Analysis: Tank Removed

Samples should be taken from numerous locations all around the excavation. These samples can be taken after the tank has been removed and should be taken from any area that appears to be visually contaminated. If there are no areas of visually contaminated soil, then at least 1 sample should be taken from each side-wall of the excavation, at least 2 samples should be taken from the bottom of the excavation, and at least 2 samples should be taken from 2 to 3 feet below the bottom of the excavation. If the groundwater is within 5 feet of the bottom of the excavation, then a groundwater sample should also be taken.

Sampling for Field Analysis: Tank Left In-Place

If the tank is left in-place, it will be harder to determine if there is any contamination present. For this situation, use the procedures outlined for Sampling: Tanks Left In-Place in the Lab Measurements and Analysis section of this paper.

Sampling for Field Analysis: Piping

Since the piping system is a common place of failure and of releases, an assessment of the piping run and dispenser is also recommended. Soil sampling every 20 feet of the piping run (or at every pipe joint, if known) and analysis with a field instrument will usually be sufficient.

Field Analysis

All soil and water samples that are taken should be analyzed using headspace analysis. This involves putting the sample in a jar or a bag, sealing it, and after a period of time, analyzing the vapor space in the top of the jar or bag with one of the field instruments listed above (except explosimeters, which are inaccurate for detecting low levels of contamination).

Because field analysis cannot prove that no contamination exists, a minimum amount of sampling for laboratory analysis is also recommended. Additional sampling and laboratory analysis may then be instituted based on a comparison between the results of these analyses and the conditions of the remainder of the site as determined by the field instruments. If the field analyses does not indicate any contamination at the site, and laboratory analysis of a minimum amount of sampling of soil/water taken from around the tank and piping confirms no contamination at the sample locations, it is reasonable to assume that no contamination exists at the site.

If this minimum sampling does show contamination, then the Department must be notified of this contamination. Additional laboratory analysis may be required in locations where field instruments indicated similar or worse conditions than for the location of these original samples.

3. Lab Measurements and Analyses

Deciding where and how to collect samples depends on the form of contamination suspected at the site and whether the tank/pipes are being closed in-place or are being removed.

If a group of tanks are being removed or an industrial site is being closed, many more samples may be necessary. The length of the interval between sample points depends on the size of the site and tank field; site hydrogeology; and the number of samples to be collected.

Sampling for Lab Analysis: Tank Removed

In order for the assessment to give a realistic picture of the site, sampling points must be carefully selected. The findings from the Phase I Assessment and the results from the field measurements described earlier will enable the inspector to select the best number and locations for sample collection. Samples for lab analysis should be taken from those locations that have the highest field measurement readings. These samples should be sent to the lab for individual analysis.

If the field instruments do not indicate a relative difference in soil conditions across the site, 1 sample should be collected from each end of the tank and 1 from beneath the fill pipe or manway. It is also recommended that samples be collected at a depth of 2 to 3 feet beneath the tank excavation and at the sides of the excavation. These samples may be composited. A minimum of 2 groundwater samples taken within 25 feet downgradient from the tanks is also recommended if the groundwater is within 20 feet of the surface. A well may be necessary to obtain these samples. Samples should also be taken between the source of possible contamination (tank and piping) and wells or nearby buildings to determine if there are any plumes of contamination which may be migrating towards them.

Sampling for Lab Analysis: Tank Left In Place

Tank and piping removal is the best practice to follow. However, if this is not practical, closure in-place is acceptable. If the tank and piping are being closed in-place, then the soil will not be exposed and borings are needed to groundwater or bedrock. A minimum of three borings is recommended. Soil samples should be taken at each boring from a split spoon at a depth of every 5 feet down to 3-6 feet below the tank bottom. Additional samples should be collected at 10 foot interval at depths 10 feet below the tank bottom, to groundwater or bedrock. If groundwater is encountered, a minimum of 1 groundwater sample should be taken from each boring. The final sample at each boring should be collected from the soil/water or soil/bedrock interface. Screening of each sample for vapor contamination with a field instrument or by general awareness of odors will guide the inspector in his decision on which samples are contaminated and therefore should be sent to the lab for analysis. If the field instrument does not indicate that any of the samples are contaminated, then the final sample from the soil/water or soil/bedrock interface should be sent to the lab for analysis. These samples should be sent to the lab for individual analysis.

Soil vapor sampling and analysis may also be done to give an idea of the contamination that may exist. The vapor would be analyzed by using a field instrument. The soil vapor analysis should not be used by itself but may a useful supplement to the soil and/or groundwater samples that are collected. More information on soil vapor sampling and analysis may be obtained from EPA's manual "Field Measurements: Dependable Data When You Need It".

Sample Collection

The actual collection of the samples, and their care and custody is extremely important. If care is not taken, it is possible to contaminate a sample, lose volatile components of the sample, or for the contaminant to biochemically degrade and change form during sampling and shipment to the laboratory. Sample collection and handling is best left to qualified personnel. Sampling procedures including number, type, location, retrieval, care, custody, and analysis of samples are thoroughly discussed in Appendix N: Sample Collection Protocol of the Division's Spill Response Guidance Manual, in the forthcoming report "Sampling Guidelines and Protocols," and in API Publication 1628 "Assessment and Remediation of Underground Petroleum Releases."

Lab Analysis

Lab analysis is the most accurate form of measurement and should be used when the owner: 1) needs conclusive evidence and documentation that no contamination exists at the site; or 2) needs to determine the severity once contamination is discovered.

It is recommended that the owner coordinate work with a laboratory well in advance of the need for the lab analysis to avoid excessive delays and minimize the cost of the analysis. The laboratory should be consulted as to the number and type of samples that are required for the type of analysis to be done, the type of report that is expected, and how long it will take to get results.

The samples should be analyzed in the lab using the most appropriate test to characterize the sample for what was stored in the tank. For example, if a tank contained gasoline, then water and soil samples should be analyzed for benzene, toluene, ethylbenzene and xylene (BTEX) and methyl tertiary butyl ether (MTBE) using EPA test method 8021 or other equivalent method. Samples may also be analyzed for ethylene dibromide (EDB) and ethylene dichloride (EDC). If a tank contained other petroleum products, then water and soil samples should be analyzed for semi-volatiles using EPA test method 8270 or other equivalent method. For tanks storing other hazardous substances, measurements should be made of the actual substance stored.

Table 2: Methods for Analyzing Water, Soil, and Free Product Samples for Compounds Found in Petroleum Products, found in the Appendix, lists chemicals or indicators to be measured and the analytic method to be used for petroleum and other regulated substances. A more complete treatise on test methods, their application, and targeting substances for measurement will be forthcoming in the Division's report, "Sampling Guidelines And Protocols." The results from lab analysis should be compared to the current DEC contaminated soil policy which sets the criteria for contamination of concern and will determine the need for any remediation.

C. Phase III Site Assessment: Exposure Assessment

The Phase III Site Assessment is an exposure assessment to predict possible migration routes, and to identify areas where a hydrocarbon or chemical release may impact public health or the environment.

The procedures include mapping the distribution of contamination and any potential outlets, predicting the migration rates for the contamination, and predicting the pathways for exposure. The factors considered include: the volume released, the adsorptive capacity of the soil; the relative ability of the soil to allow water movement, and vapor and free liquid contamination; the rate and direction of groundwater movement; and all processes that dilute concentrations and limit the area of the contaminated zones. For more guidance refer to API Publication 1628.

D. Reporting

State regulations require that the Department be notified within 30 days prior to the date of closure. This must be done by modifying the registration information for the facility on bulk storage registration application forms supplied by the Department. The Department may or may not be at the site during the closure, depending on the work schedule that day. Telephone calls should be made to the regional office to inform the regional bulk storage staff at least 3 days before work begins as to the date and time of actual tank closure.

In addition, if at any time any evidence of contamination is discovered, the Department of Environmental Conservation must be notified on the Spill Hotline (1-800-457-7362) within two (2) hours from the time of discovery. A DEC Spill Investigator from the regional office will advise you on steps which must be taken to deal with the contamination and to proceed with closure.

If the facility is located in Nassau, Suffolk, Rockland or Cortland County, there are county regulations and reporting requirements that must be complied with.

E. Record Keeping

Proper records must be kept of the tank closure and the site assessment. A report should be prepared which documents how the site assessment was done, where the samples were taken, dates taken, who took them, types of samples, depths of the samples, field results and the lab results. If wells were drilled, then a driller's log should be kept which describes the five characteristics of the drill cuttings: (1) color; (2) hardness, plasticity or competency; (3) grain size distribution; (4) presence or absence of water; and (5) visual, olfactory or field instrument readings which show evidence of contamination. The records should include a site plan showing where the tanks were located and where the samples were taken in relation to the tanks. Also, the site plan should show the resources that would be impacted if a release had occurred, including groundwater usage in the area, utilities, etc. It is recommended that the documentation include a photographic record of the site assessment work that was done on the site.

The final report should be kept by the owner as documentation. Table 3, "Site Assessment Recordkeeping Checklist", found in the appendix, is a checklist of recordkeeping that may be compiled during a site assessment.

Salvatore Pagano, Director
Division of Spills Management

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8. USEPA, Assessing UST Corrective Action Technologies: Site Assessment and Selection of Unsaturated Zone Treatment Technologies, March 1990.

9. USEPA, Field Measurements: Dependable Data When You Need It, May 30, 1990.

Table 1
FIELD INSTRUMENTS

Instrument	Ease of Operation	Calibration	Applications	Limitations
Flame Ionization Detectors (FID) or Organic Vapor Analyzers (OVA) Method Organic volatiles are ionized by hydrogen flame. A current is produced in proportion to the number of ions present.	OVA in survey mode requires an operator with moderate skills. OVA in GC mode requires a more experienced operator to obtain useful data and interpret results.	Factor calibrated to methane. Requires calibration for the analyte of interest for specific identification.	In survey mode detects the total concentration of many organic vapors (alkanes and aromatics) In the gas chromatograph (GC) mode, identifies and measures specific constituents. Analyze In Situ soil vapor by direct readings from a borehole or well head. Used for In Situ soil vapor analysis after collection in sample vial or bag. Used for dynamic and static headspace analysis of soil and water in sample jar or via. Used for dynamic headspace analysis of soil and water in the Polyethylene Bag Sampling System.	Detects methane and may yield false readings due to presence of naturally occurring methane. Flow rate below 1.2 liter/min. can yield inaccurate results. Use at temperature less than 40^0F (4^0C) is not recommended. Complete destruction of sample does not allow further analysis. Low oxygen levels can cause flame out (e.g., soil gas) Accuracy ± 10% Detection range 0.5 - 10,000 ppm.
Photo-Ionization Detectors (PID) Or Hnu Meter Method Ionizes molecules using UV radiation. Produces a current proportional to the number of molecules ionized.	Effective use of this instrument requires that the operator understand the operating principles and limitations to yield useful data and properly interpret results. Easier to use than FID.	Factory calibrated to benzene or isobutylene. Instrument may be calibrated by exposing the probe to a field standard gas such as benzene or isobutylene. Calibrations is done prior to sample analysis and as needed during analysis.	Total concentration of volatile organic gases are detectable (aromatics) and a few inorganic gases. PID instruments do not detect methane or other alkanes, thus eliminating anomalous methane contributions to total concentration readings. PID instruments are often used in the field the same as the FID.	Moist atmospheric conditions (E.G., rain) and high relative humidity (>90%) "quench" signal resulting in low readings. Responses may change if gas mixtures are present yielding misleading results. For concentration >150 ppm TOV, the PID may provide non-linear or erratic responses.

Table 1 (cont'd)

Instrument	Ease of Operation	Calibration	Applications	Limitations
Photo-Ionization Detectors (PID) or HNU Meter (cont'd)				Dust particles may absorb ultraviolet energy and cause erratic responses in PIDs that do not have filters. Uses lead acid battery which loses power in cold werather. Readings may be affected by power lines, transformers, or radio wave transmitters. Accuracy ± 15% Detection range 0.5 - 2,000 ppm
Gas Chromatograph <u>Method</u> Samples are chromatographically separated into specific constituents and are detected using a PID, FID, or ECD. A chart recorder plots results as a "chromatograph" displaying peaks for constituents detected.	Requires a substantial level of skill to operate. A qualified investigator is necessary to assure proper calibration and analysis as well as correct interpretation of results.	Depending upon the detection used (PID, FID, or ECD), calibration standards include benzene, methane, isobutylene and various predetermined mixtures. An injection of known amount and type of substance produces a response and is compared to the response of an unknown sample. Ambient conditions can affect instrument performance if not calibrated under similar conditions.	Used for analysis of constituents in vapor or water samples. Applications are similar to FID and PID started above. Analyze <u>In Situ</u> soil vapor by passive collection using activated charcoal. Distinguish a wide range of individual constituents simultaneously.	Specific constituents in mixtures can be difficult to resolve on a chromatogram. Separation of components with wide range of volatility can be difficult. Injection and analysis of a water sample requires an additional extraction step using an organic solvent (methylene chloride). Skilled or experienced operator is necessary to assure accurate results. Accurante ± 15% Detection range 0.1 - 10,000 ppm Prior knowledge of probable contaminant mixture needed to identify components.

Table 1 (cont'd)

Instrument	Ease of Operation	Calibration	Applications	Limitations
Direct-Reading Colorimetric Tubes Method Air is drawn through a tube which reacts with the indicator chemical in the tube, producing a stain, whose length of color change is proportional to the constituent's concentration.	Minimal operator training is necessary. Operator experience is helpful for placement and "reading" the tubes.	Calibrated by manufacturer. Pump that draws a specific volume of sample into the tube should be checked for leaks.	Used for measuring concentrations of specific or total organic compounds. Some applications are similar to FID or PID for vapor samples stated above. Specific tubes are available for detecting hydrocarbons and other petroleum product constituents. Determine constituent concentration that may interfere with other field analytical techniques (e.g., methane affecting OVA readings.	Measured concentration of the same compound may vary amount different manufacturer's tubes. Constituents that are similar may interfere with detecting the constituent of interest. High humidity has adverse affects. Jagged edge of the stain makes it difficult to obtain accurate readings. Tubes that have been previously opened or past their expiration date should not be used. Accuracy ± 25% Detection range variable, Slow and tedious.

Table 1 (cont'd)

Instrument	Ease of Operation	Calibration	Applications	Limitations
Explosion Meter or Combustible Gas Indicator (CGI) Method A platinum filament in the meter is heated which then combusts the gases around it. The combustion raises the temperature of the filament causing an imbalance in the resistor circuit which produces a reading on a meter.	Minimal operator training is necessary. Operator must watch needle continuously to detect concentrations above the lower explosive limit (LEL) because needle will return to zero once LEL is reached.	Before using CGI, the percent of oxygen should be measured with an oxygen meter. Must be calibrated against certain gas.	Measures concentrations of flammable vapors and gases in air. Results are shown as percentage of lower explosive limit of the calibration gas. Action limit is 25% of lower explosive limit.	It is critical to watch the needle continuously when taking readings and to walk with instrument from uncontaminated zone to test zone. Otherwise, concentrations above the LEL may go undetected, leading the inspector to the icorrect conclusion that there are no combustible gases on-site. Accuracy ± 50% Readings should be taken at ground, waist and overhead levels to ensure detection of vapors whose density are greater or less than air. Should not be used in oxygen rich nor deficient areas. Leaded gasoline may poison internal filament.

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TABLE 2

Methods for Analyzing Water, Soil, and Free Product

The table below contains currently known compounds of concern from petroleum products, and recommended analytical methods for the associated compounds in different sample forms of water, soil, and free product. The compounds for the petroleum products such as gasoline, kerosene, jet fuel, diesel fuel, turbine fuel, and fuel oil, lubricating oil and grease, and halogenated and non-halogenated solvents, are generally listed according to their volatility, the most volatile at the top. As the EPA 500S analytical methods series were originally developed for monitoring of drinking water and the 600S series for municipal and industrial wastewater, this table provides a separate, but parallel, method for each water category. Although the methods in either series can be used for both categories, the user should choose an analytical method based on category it was developed for. The reasons are: 1) the detection limit of analytical methods may be slightly different; 2) the requirements for drinking water may be more stringent than the other. The analytical methods for water samples can be adapted and used for air samples by direct injection technique or by adsorbing pollutant onto a sorbent first, then dissociating the pollutant from the sorbent for analysis. For appropriate preparation of samples before analysis, see EPA extraction procedures #1310, TCLP, #3500s, and #5000S if the preparation is not indicated within the analytical method. When interpreting the laboratory results, the laboratory contractor's percent recovery and method detection limit should be considered.

TABLE 2
Methods for Analyzing Water, Soil, and Free Product Samples for Compounds found in Petroleum Products

VOLATILE ORGANICS (GASOLINES)*

Currently Known Compounds of Concern^{*2}, Benzene(B)^{P1}, Toluene(T)^{P2}, Xylenes(X)^{P3}, Ethyl Benzene (EB)^{P4}, Propyl Benzenes^{P5}, Trimethyl BenzenesP5,. Butyl Benzenes^{P6}, Butyl Benzenes^{P7}, Cyclohexane^{P8}, Naphthalene^{P9}, Anthracene^{P10}, Fluorene^{P11}, Phenaanthrene^{12}, Pyrene^{P13}, Acenaphthene^{P14}, Ethylene Dibromide(EDB)^{A1}, Ethylene Dichloride(EDC)^{A2}, Tetraethyl Lead (TML)^{A4}, Tetracthyl Lead (TEL)^{A4}, Phenols^{A5}, Dimethyl Amine^{A6}, Methyl t-Butyl Ether (MTBE)^{B1}

WATER SAMPLE			
Drinking Water	Non-Drinking Water	SOIL SAMPLE	FREE PRODUCT
EPA 502.2 or 524.2 for B,T,X,E, and those with superscript P5, P6, P7, A1, A2, P8^{*3}, P9 and MTBE^{*3}. EPA 503.1 B,T,X,E and those with superscript P5, P6, P7, P8^{*3}, P9, and MTBE ^{*3}. EPA 525 for compounds with superscript P10, P11, P12, P13, P14^{*3}. EPA 502.1 for EDB and EDC. EPA 604 for phenols. EPA 625 for Dimethyl Amine^{*3}. Both EPA 524.2 + 525 or DOH 310-13 or DOH 310-14 for unknown situation. EPA 7421 or ASTM D3559 for lead.	EPA 8021 for B,T,X,E, EDB, EDC, MTBE^{*3}, and those with superscript P5, P6, P7, P8^{*3}, P9. EPA 602 or 8020 or DOH 310-9 or DOH 310-10 or DOH 310-19 for B,T,E^{*3} and X^{*3} and MTBE^{*3} DOH 310-22 for B,T,E,X, and compounds with superscript P5, P7, P8^{*3}, P9. EPA 625 or 8270 or DOH 310-8 for compounds with superscript P9, P10, P11, P12, P13, P14^{*3}, A5, A6^{*3} EPA 610 or 8100 for compounds with superscript P9, P10, P11, P12, P13, P14^{*3}, A6^{*3}. EPA 604 or 8040 for phenols. DOH 310-29 for EDB and EDC DOH 310-13 for unknown situation or hydrocarbon scan. DOH 310-14 for unknown situation or petroleum product identification or fingerprint. (EPA 8021 or 8260)^{*3} + (EPA 418.1^{*4} 418.1^{*4} for all concerned compounds or total petroleum hydrocarbon TCLP - Lead for lead.	EPA 8021 or 8260 for B,T,X,E, EDB, EDC, MTBE^{*3}, and those with superscript P5, P6, P7, P8^{*3}, P9. EPA 8020 for B,T,X,E & MTBE^{*3}. EPA 8270 for compounds with superscript P9, P10, P11, P12, P13, P14, A5, A6^{*3}. EPA 8100 for compounds with superscript P9, P10, P11, P12, P13, P14 & A6^{*3}. EPA 8040 for phenols. DOH 310-13 for unknown situation or hydrocarbon scan^{*3}. DOH 310-14 for situation similar to the one for non-drinking water. (EPA 8021 OR 8260)^{*3} + (EPA 8270)^{*3} for situation similar to the one for non-drinking water. (EPA 8021 or 8260)^{*3} + (EPA 8270 with TCLP^{*3}) for confirming the acceptance of cleanness. TCLP - Lead for lead	The methods for soil sample can be applied here. For dilution or preparation, see EPA 3500S and 5000S methods. ASTM D1949 for separation of tretracthyl lead and tetra methyl lead. ASTM D526 or D2547 for lead.

TABLE 2 (Cont'd)

Methods for Analyzing Water, Soil, and Free Product Samples for Compounds found in Petroleum Products

SEMI-VOLATILE ORGANICS (KEROSENE-JET-DIESEL-TURBINE-FUEL OIL)

Currently Known Compounds of Concern^{*2}: Benzene(B)^{P1}, Toluene(T)^{P2}, Xylenes(X)^{P3}, Ethyl Benzene (E or EB)^{P4}, Propyl Benzenes^{P5}, Trimethyl Benzenes^{P6}, Butyl Benzenes^{P7}, Cyclohexane^{P8}, Naphthalene^{P9}, Anthracene^{P10}, Fluorene^{P11}, Phenanthrene^{P12}, Pyrene^{P13}, Acenaphthene^{P14}, Methylanthracene^{P15}, Benz(a)anthracene^{P16}, Fluoranthene^{P17}, Benzo(b)fluoranthene^{P18}, Benzo(k)fluoranthene^{P19}, Chrysene^{P20}, Benzo(a)Pyrene^{P21}, Benzo(e)pyrene^{P22}, Benzo(ghi)perylene^{P23}, Indeno(1,2,3-cd)pyrene^{P24}, Dibenzo(a,h)anthracene^{P25}, phenols^{A5}.

WATER SAMPLE		SOIL SAMPLE	FREE PRODUCT
Drinking Water	Non-Drinking Water		
EPA 502.2 or 524.2 for B,T,X,E, and those with superscript P5, :Q6, P7 P8~~^{*3}~~ and P9. EPA 503.1 for B,T,X,E, and those with superscript P5, P6, P7, P8^{*3} and P9. EPA 525 for compounds with superscript P10, P11, P12, P13, P16, P18, P19, P20, P21, P23, P24, P25, and P14^{*3}, P15^{*3}, P17^{*3}, P22^{*3}. EPA 524.2 + 525 or DOH 310-13 or DOH 310-14 for unknown situation.. Epa 604 for phenols. EPA 7421 or ASTM D3559 for lead if needed from gasoline contamination or other reason.	EPA 8021 for B,T,X,E, EDB, EDC, MTBE^{*3} and those with superscript P5, P6, P7, P8^{*3} and P9. EPA 602 or 8020 or DOH 310-9 or DOH 310-10, DOH 310-19 for B,T,E.^{*3}, X^{*3}. EPA 625 or DOH 310-8 for compounds with superscript P9, P10, P11, P12, P13, P14*P3, P15^{*3}, P16, P17, P18, P19, P20, P21, P22^{*3}, P23, P24, P25, A5, A6^{*3}. EPA 610 or 8100 for compounds with supercript P9, P10, P11, P12, P13, P14, P15^{*3}, P16, P17, P18, P19, P20, P21, P22^{*3}, P23, P24, P25. EPA 604 or 8040 for phenols. DOH 310-13 for unknown situation or hydrocarbon. DOH 310-14 for unknown situation or petroleum identification or fingerprint. (EPA 8021 or 8260)^{*3} + (EPA 418.1^{*4} or 625 or 8270)^{*3} for all concerned compounds or total petroleum hydrocarbon. TCLP-metal for metals.	EPA 8021 for B,T,X,E, EDB, EDC, MTBE^{*3} and those with superscript P5, P6, P7, P8^{*8} and P9. EPA 8020 for B,T,E,X. EPA 8270 for compounds with superscript P9, P10, P11, P12, P13, P14, P15^{*3}, P16, P17, P18, P19, P20, P21, P22^{*3}, P23, P24, P25, A5. EPA 8100 for compounds with superscript P9, P10, P11, P12, P13, P14 P15^{*3}, P16, P17, P18, P19, P20, P21^{*3}, P22^{*3}, P23, P24, P25. EPA 8040 for phenols. DOH 310-13 for unknown situation or hydrocarbon scan. DOH 310-14 for unknown situation or petroleum identification or fingerprint. (EPA 8021 or 8260)^{*3} + (EPA 8270^{*3}) for all concerned compounds or total petroleum hydrocarbons. (EPA 8021 or 8260)^{*3} +(EPA 8270 with TCLP)^{*3} for confirming the acceptance of cleanness. TCLP - metal for metals.-	The methods for soil samples can be applied here. For dilution or prearation, see EPA 3500S and 5000S Methods. ASTM D3328 for oil cross-matching.

TABLE 2 (Cont'd)
Methods for Analyzing Water, Soil, and Free Product Samples for Compounds found in Petroleum Products

HEAVY ORGANICS (LUBRICATING OIL/GREASE)*

Currently Known Compounds of Concern^{*2}: Naphthalene^{P9}, Phenanthrene^{P12}, Pyrene^{P13}, Acenaphthene^{P14}, Fluoranthene^{P17}, Benzo(b)fluoranthene^{P18}, Benzo(k)fluoranthene^{P19}, Chrysene^{P20}, Benzo(a)pyrene^{P21},Benzo(a)pyrene^{P22}, Benzo(ghi)perylene^{P23}, Indeno(1,2,3-cd)pyrene^{P24}, Dibenzo(a,h)anthracene^{P25}, Benzo(g,h,i)fluoranthene^{P26}

WATER SAMPLE		SOIL SAMPLE	FREE PRODUCT
Drinking Water	**Non-Drinking Water**		
EPA 502.2 or 524.2 for compounds listed with drinking water under kerosene - fuel oil. EPA 525 for compounds with superscript P9^{*3}, P10, P11, P12, P13, P16, P18, P19, P20, P21, P23, P24, P25 and P14^{*3}, P15^{*3}, P17^{*3}, P22^{*3}, P26^{*3}. EPA 524.2 + 525 for unknown situation.	EPA 8021 for compounds listed with non-drinking water under kerosene - fuel oil. EPA 625 or 8270 or DOH 310-8 for compounds with superscript P9, P10, P11, P12, P13, P14, P15^{*3}, P16, P17, P18, P19, P20, P21, P22^{*3}, P23, P24, P25, P26^{*3}, A5 and others^{*3}. EPA 610 or 8100 for compounds listed with non-drinking water under kerosene - fuel oil. DOH 310-13 for unknown situation or hydrocarbon scan. DOH 310-14 for unknown situation or petroleum identification or fingerprint. (EPA 8021 or 8260)^{*3} + (EPA 413.2^{*4} or 625 or 8270)^{*3} for all concerned compounds or total petroleum hydrocarbons. TCLP - metal for metals.	The methods listed above for soil sample under semi-volatile organics can be applied here. In addition, EPA 413.3^{*4} (soxhlet extraction) can be used for the determination of total recoverable of oil and grease. TCLP - metal for metals.	The methods for soil sample can be applied here. For dilution or preparation, see EPA 3500S and 5000S methods. ASTM D3328 for oil cross-matching..

* If the lubricating oil/grease happens to be contaminated with fuel oil or gasoline, or is a used product, those lighter compounds listed under Semi-volatile Organics should also be evaluation.

TABLE 2 (Cont'd)

Methods for Analyzing Water, Soil, and Free Product Samples for Compounds found in Petroleum Products

HALOGENATED SOLVENTS

Currently Known Compounds of Concern[*2]: Perchloroethylene[H1], Methylene Chloride[H2], Trichloroethylene[H3], Chlorobenzene[H4], 1,2-Dichlorobenzene[H5], 1,1,1-Trichloroethane[H6], 1.1.2-Trichloroethane[H7], 1,2,2-Trifluoroethane[H8], Trichlorofluoromethane[H9], ...etc.

Non-Halogenated Table

SAMPLE WATER		SOIL SAMPLE	FREE PRODUCT
Drinking Water	Non-Drinking Water		
	EPA 502.2 or 524.2 for compounds with superscript N2[*3], P1, P2, P3, N4[*3], N10. EPA 625 or 8270 for N5, N9[*3]. EPA 8240 for N2, P1, P2, P3, N3, N4[*3], N6, H1, H2, H3, H4, H6, H7, H9. DOH 310-25 or EPA 8015 for Methanol[*3], Acetone[*3], MEK, MIBK.	EPA 8240 for compounds with superscript N2, P1, P2, P3, N3, N4[*3], N6, H1, H2, H3, H4, H6, H7, H9 EPA 8015 for Methanol[*3], Acetone[*3], MEK, MIBK. EPA 8270 for Nitrobenzene, Pyridine, Cresols[*3].	Same as those for soil sample.

FOOTNOTES:

*1: This table was derived from Chart 7-1 of Section 7.0 of "Sampling Guidelines and Protocols," NYSDEC - Water Division. The analytical method is not only used for determination of the compound, indicated in this chart. For all the target compounds see the list of the target compounds listed with each respective methodology in Table 7-1 through 7-6 in "Sampling Guidelines and Protocols."

*2: In this column, the letters P,A,B,H,N, of the superscript mean, respectively, "compounds from petroleum product", "compounds from additives", "compounds from blending agenct", "halogenate compounds from solvent", and "non-halogenated compounds from solvent" in each category of petroleum products or man-made solvents.

*3: The one with superscript [**3*] means that the analytical method has not originally included such compound in the identification, and that a verification is required.

*4: EPA 418.1, total petroleum bydrocarbon, 4132/4133 (soxhlet Extraction), total recoverable of oil and grease, only determine whether the medium is contaminated or not, it would not indicate what the contaminant is.

Table 3
Site Assessment Recordkeeping Checklist

Phase I Site Assessment:

System Design Review

- tank/pipe design (material of construction, pump system, etc)
- age of equipment
- layout
- location of transfer stations and vents
- sources of stray underground electric currents

Site History Review

- previous owners/users
- contractors who installed tank
- product stored
- history of spills
- tank test reports
- inventory monitoring reports
- water pump-out records
- tank relining and repair records
- location of all underground utilities
- information from local fire departments about fumes in sewers, nearby utilities, houses, etc.
- identify potentially affected areas onsite and offsite
- identification of off-site sources that may contribute to contamination

Geological Information Review

- soil maps
- geologic reports
- groundwater and aquifer maps
- soil resistivity/soil chemistry data
- well records
- copies of any analysis done on the soil or groundwater
- history of excessive settlement or excessive surface water retention in soil layers

Table 3 (continued)
Site Assessment Recordkeeping Checklist

Phase II Site Assessment:

Field Observations

- Are tanks or pipes being excavated?
- Depth of stained or discolored soil?
- Any sheen on water in the excavation?
- Depth of groundwater?
- Any signs of leaking pipe joints?
- Any localized areas of corrosion?
- Any holes or pits in tanks or pipes?
- Any noticeable odors?
- Jar test results?
- Any free product in any monitoring wells?
- Any other abandoned underground tanks or pipe system on site?

Field Measurements and Analysis

- Which field instruments were used?
- Tank removed
  - what were the readings from any area of visual contamination?
  - what were the results from head space analysis from areas of visual contamination?
  - what were the results from head space analysis of samples taken from the sidewall, bottom of the excavation, and below the bottom of the excavation?
- Piping
  - Results from head space analysis of samples taken every 20 feet of piping run at every joint?
- Procedures used for Head space Analysis

Lab Measurements and Analysis

- If lab measurements and analysis is not done, documentation why the site is considered not in an environmentally sensitive area and shows no reason to believe that a release has occurred.
- Tank removed
  - Results from lab analysis of samples taken from areas of highest field measurement readings.
  - Results from lab analysis of samples taken from each end of the tank, from beneath the fill, from the below the tank excavation, and any groundwater samples taken.
- Tank left in place
  - Number of borings?
  - Results from field screening of samples taken every 5 feet down to 3-6 feet below the tank and every 10 feet from there to groundwater/bedrock.
  - Lab results from samples with the highest field reading or from the final sample.
  - Results from any soil vapor sampling and analysis?
- Procedures and personnel used to collect samples.
- Lab methods that were used to test from contamination.