Maryland
Department of
the Environment

FACTS ABOUT:

Voluntary Cleanup Program
Phase II Environmental Site Assessments

A Phase II Environmental Site Assessment (ESA) is the second phase of environmental assessment. The assessment consists of an environmental professional conducting a field investigation and sampling program designed to either confirm or deny the presence of contamination due to the recognized environmental conditions identified by the Phase I ESA.

The VCP statute requires an applicant to submit a Phase II ESA for each VCP application. The only time a Phase II ESA is not required to be submitted with an application is if the Department concludes there is sufficient information to determine that no recognized environmental conditions are present that warrant further investigation.

> What is a Recognized Environmental Condition?
> According to the American Society of Testing and Materials (now known as ASTM International) E1527-13 standard, a recognized environmental condition is defined as the presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to any release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment. De minimis conditions are not recognized environmental conditions.

In accordance with 7-506(c), of the Environment Article, an application may be accompanied by a work plan for a Phase II ESA in lieu of a completed Phase II. However, if the applicant delays the Phase II submission, all related VCP deadlines will be extended accordingly to conform to the submittal date of the completed Phase II ESA. Generally, the Department does not require a new Phase II ESA for subsequent applications submitted for an active VCP application where sufficient investigation has been completed. This fact sheet presents standards, practices, and technical considerations for Phase II ESAs at properties applying for participation in the VCP.

While the VCP allows and encourages submittal of the Phase II ESA in an electronic format, the VCP also requires submittal of a hard copy of the entire document, including all appendices for review purposes. It is not possible for the VCP to review and compare multiple large documents in electronic format. For the purposes of the VCP, Phase II ESA information must be less than one year old. Please note that this requirement is less stringent than the six month timeframe currently defined under ASTM E1527-13 standard and the federal All Appropriate Inquiry (AAI) Final Rule (40CFR312). The one

year requirement also applies to use of the Phase I ESA for submittal of subsequent applications by different entities or for a change in use.

A Phase II ESA is a second step of the transaction screen process intended to assist in making informed business decisions about the property, and, where applicable, provide the level of knowledge necessary to satisfy one of the requirements for the potential landowner liability protections offered under CERCLA [AAI Final Rule (40 CFR 312)]. As outlined in the ASTM guidance, the objectives of conducting a Phase II ESA are to evaluate the recognized environmental conditions identified in the Phase I ESA and follow an iterative approach to environmental investigation that allows the user to terminate the investigation at the point where sufficient data have been generated to meet the user's objectives (which may include whether to pursue purchase of the property). The ASTM guidance notes that achieving these business decision objectives may require the performance of more than a single iteration of assessment and ASTM E 1903-11 clearly acknowledges that it is not intended to satisfy the level of inquiry that may be necessary to support remedial solutions for a site.

For the purposes of the VCP, the Phase II ESA is the first step in evaluating the environmental impacts at the property. As discussed above, a Phase II ESA is not intended to provide all environmental information and data necessary to: 1) provide a complete assessment of environmental impacts at a property; 2) evaluate a change in use as part of redevelopment; 3) complete a risk assessment, or 4) propose a comprehensive remedial approach for a property. Therefore, based on the results of the Phase II ESA, the VCP often must request additional environmental assessment of the property and require the applicant to provide additional data to demonstrate that the proposed future land use will not be negatively impacted by the environmental conditions at the site.

During the Phase II ESA and subsequent investigations, the applicant must still adhere to regulations and reporting requirements related to oil (petroleum) contamination. Specifically, if during the course of the initial ESA, there are indications of petroleum saturated soil or free phase product in monitoring pipes or wells, this information must be reported to the Oil Control Program (OCP), per the requirements of Code of Maryland Regulation (COMAR) 26.10.08.01, whether or not the property will be submitted to the VCP.

A. Soil Sampling Technical Considerations

Generally, samples must be collected and analyzed for any potential contaminants identified in the Phase I based on historical operations at the property. Environmental sampling may be necessary for volatile organic compounds (VOCs); semi-volatile organic compounds (SVOCs) including polycyclic aromatic hydrocarbon (PAHs); Priority Pollutant List (PPL) metals; oil (petroleum); and any other contaminants that may be present at the site. When applicable, the VCP tries to limit the required sample

locations and sample analyses to areas of concern and analysis based on the results of Phase I ESA or to confirm the results of previous but dated investigations. In some cases, a Phase I ESA or subsequent investigation may have overlooked an area of concern, potential suite of contaminants, or potential pathway of concern. In such cases, the VCP will require additional sampling.

Properties at which historical operations are uncertain or the types and locations of activities have changed over time will require more extensive soil sampling and a more diverse set of analytical parameters for characterization. If the Phase II ESA completed for the VCP application is the first environmental investigation conducted at the property, the results may identify environmental contamination but not be sufficient to determine the extent of contamination, allow for selection of a remedy, or allow the applicant to sufficiently estimate the costs of a proposed remedy.

***1. Sample Depths**:*

Surface (0-1') and subsurface (4-5') grab samples are generally required at each sample location for site characterization and risk evaluation purposes. Surface soil samples should only be analyzed for VOCs if there is visual or historical evidence that makes the presence of VOCs in the surface soil likely (i.e. outside the rear door of dry cleaning facility or beneath areas of staining). Deeper soil samples may be required in some areas depending on historical operations or the presence of certain features, such as underground storage tanks.

2. VOC Sample Collection:

United States Environmental Protection Agency (US EPA) SW 846 Method 5035A is a closed system purge and trap collection method suggested for VOC analysis of soil samples collected at VCP projects. This method incorporates sample collection techniques to limit the volatilization and biodegradation of organic compounds. The VOC soil samples must be received and preserved by the laboratory within 48 hours. Please refer to the guidance document published by U.S. EPA Region III, "Field Samplers' Guide to the Collection and Handling of Soil Samples for Volatile Organic Analysis Using SW-846 Method 5035A", May 15, 2003.

3. Special Analysis Considerations:

Chromium Analyses in Soils: If total chromium (Cr) is detected in soil samples at levels exceeding the relevant MDE cleanup standard, each of those soil samples must be collected and speciated for chromium(VI) and chromium(III). If total chromium concentrations reported to the Department are not speciated for chromium(VI) and chromium(III), the Department will assume that the chromium concentrations reported are chromium(VI), which is the more toxic form of chromium and has lower cleanup

standards than chromium(III).

Mercury Analyses in Soils: If mercury is detected in soil samples at levels exceeding the relevant Department cleanup standard, at least two samples (with the highest mercury concentrations) must be differentiated for inorganic/elemental mercury. If total mercury concentrations are not differentiated, the Department will evaluate the reported mercury as both elemental mercury and organic mercury.

Underground Storage Tanks (USTs): At sites where petroleum contamination is anticipated due to the presence of USTs and/or piping, a minimum of three soil borings should extend from the ground surface to the first unconfined saturated zone. The borings should be continuously cored or split spooned to accurately determine lithology and detect contamination. In addition, please note that the VCP analytical requirements for petroleum impacted soil require analysis of samples for full suite VOCs and may not be limited to benzene, toluene, ethylbenzene and xylene compounds (BTEX), total petroleum organics- diesel range organics (TPH-DRO) or total petroleum organics-gasoline range organics (TPH-GRO). As such, samples collected for tank removals under the OCP are not usually sufficient to meet VCP requirements.

4. Sampling for Residential Development:

While the sampling frequency varies across sites dependent on Recognized Environmental Condition (RECs) and future development, please note that the sampling conducted as part of most Phase II ESAs is not sufficient to demonstrate that a property is suitable for certain types of residential development or unrestricted residential use.

B. Groundwater Sampling Technical Considerations

Generally, groundwater samples are necessary as part of Phase II ESA to evaluate impacts to groundwater. Samples must be analyzed for any potential contaminants identified in the Phase I ESA based on current and historical operations at the property. Groundwater samples should be taken in locations most likely to have been contaminated by past and present operations on the property. Analysis for a broader range of parameters will be necessary at sites with an uncertain or varying operational history. A sufficient number of groundwater samples are necessary to evaluate impacts to groundwater in the vicinity of source areas or areas of potential concern.

Multiple technologies may be used to obtain groundwater samples, including monitoring wells, piezometers, direct push technologies, and multi-level groundwater sampling devices. The technology should be selected based on the objectives of the site investigation. Direct-push technology using exposed screens or well points to collect groundwater samples is acceptable for initial characterization and detailed plume delineation, but not necessarily acceptable for determining groundwater gradients. Sites

potentially contaminated with petroleum (oil) products and controlled hazardous substances (CHS) may require multilevel samplers or nested monitoring wells to accurately determine the presence of free-phase light or dense nonaqueous phase liquids.

All monitoring wells must be installed in a manner that prevents downward migration of contamination into lower water bearing units. Wells should not be completed below confining layers without prior approval of the installation and construction methodology. At VCP properties, wells or piezometers less than two inches in diameter are acceptable, but if free product recovery is required, four inch or larger wells may be necessary.

Considering the nature of the known or suspected contamination, groundwater samples must be collected at appropriate depths to delineate the vertical extent of contamination. Groundwater samples may also be necessary to evaluate the impact from off-site sources, such as gasoline stations that may impact the vapor intrusion pathway on the property.

Prior to sampling any monitoring well, or direct push borehole, the sampler should verify that floating free phase product is not present by use of a clean, clear bailer or a factory-calibrated interface probe. Monitoring wells should be purged of at least three well volumes prior to sampling. All purge water must be properly containerized and characterized to determine the appropriate disposal method. If measurable (0.01 feet) free phase petroleum product is present in a monitoring well, the groundwater should not be sampled for volatile or semi-volatile organics since analysis would be skewed by the presence of the product. Product samples may be collected for characterization of the petroleum type.

Monitoring wells installed using hollow-stem augers must be developed and allowed to equilibrate for 7 to 10 days prior to sampling and measuring static water levels. Small-diameter wells or piezometers installed using direct-push technologies must be allowed to equilibrate for at least 24 hours prior to gauging or sampling.

All wells must be installed by a Maryland licensed well driller, with proper permits obtained from the county or municipality in which the field investigation is conducted. Copies of well installation reports and boring or well logs must be provided in the Phase II ESA. In cases in which the VCP applicant does not want the property to be subject to a groundwater use restriction, additional wells and sampling requirements, including analysis by drinking water methods are necessary.

Groundwater sample locations should be located such that wells can be used to determine groundwater flow direction (i.e. they may not be located in a straight line). Groundwater flow direction is necessary to evaluate potential impacts of contaminated groundwater on nearby receptors, such as drinking water wells, surface water bodies, or nearby homes and buildings via vapor intrusion. For this reason, monitoring wells, including small-

diameter temporary wells or piezometers, must be surveyed to allow for the measurement of groundwater elevation. If free product is present, the water table elevation must be corrected for the differences in density. Direct-push technology using exposed screens or well points to collect groundwater samples is not appropriate for determining groundwater elevation since adequate time is necessary to allow the aquifer to equilibrate to steady state conditions. Although this method may be useful for characterizing groundwater contamination and determining the horizontal and vertical extent of contamination, more permanent monitoring wells or piezometers will be required under most circumstances to evaluate groundwater flow direction.

Groundwater samples for metals analyses must be filtered prior to preservation because Maximum Contaminant Levels (MCLs) and water quality criteria are based on metals in solution (dissolved concentrations) rather than in suspension (total concentrations). However, for some sites, unfiltered groundwater samples may be required for comparison purposes or to evaluate the potential risk from dermal contact under a construction worker scenario.

More extensive groundwater sampling will be necessary at properties located in groundwater use areas or instances where vapor intrusion from groundwater may be of concern. This may include thorough areal and vertical delineation of the plume. This may include down gradient samples near the property boundary as well as up gradient samples.

In some cases, groundwater contamination identified on the VCP property may be a risk to off-site receptors. In such cases, off-site groundwater sampling is sometimes necessary if the contaminant plume is suspected to be migrating off site in the direction of drinking water wells or there is the potential for impact to neighboring properties through the vapor intrusion pathway. Since the VCP authority does not extend to off-site issues, the Department encourages applicants to work closely with the OCP or CHS Enforcement Division (which may be handled by a VCP project manager) when off-site contamination is known or expected. Applicants may be requested to seek permission to install and sample off-site monitoring wells on adjacent properties or in rights-of-way or to reduce or remediate the source to eliminate off-site migration of contaminants.

C. Surface Water and Sediment Sampling Technical Considerations

Surface water and sediment samples generally must be collected on the property and from adjacent drainage ditches, outfalls, intermittent streams, or other areas that receive significant amounts of runoff from the VCP property. In situations where a surface water body traverses the property, surface water and sediment samples should be collected at both the upstream and downstream property boundaries to ensure that the property in the VCP is not a source of contamination.

D. Soil Gas and Indoor Air Sampling Technical Considerations

The presence of volatile contaminants in the soil and groundwater may affect the quality of indoor air in overlying and nearby structures. The inhalation pathway is evaluated to determine if volatile compounds, other than radon gas, can potentially migrate from the soil or groundwater into an existing or future occupied structure. To evaluate the potential for vapor intrusion, a comprehensive characterization of foundation air must be performed, which may include sampling of the groundwater, soil gas, and indoor air. Typically, this characterization is performed in a systematic manner utilizing generally accepted strategies for evaluating potential vapor intrusion to indoor air from technical documents such as the Office of Solid Waste and Emergency Response (OSWER) Final Guidance for Assessing and Mitigating the Vapor Intrusion Pathway From Subsurface Sources to Indoor Air and the Vapor Intrusion Pathway: A Practical Guide presented by the US EPA and the Interstate Technology & Regulatory Council (ITRC), respectively.

The guidance describes the recommended framework for assessing vapor intrusion that relies upon collecting and evaluating multiple lines of evidence to support risk management decisions.

Evaluation of the vapor intrusion pathway may require that certain compounds, such as total mercury, be differentiated to determine their presence in the subsurface. Failure to differentiate may require the Department to evaluate risk using more conservative assumptions.

Indoor air models such as the Vapor Intrusion Screening Calculator and Johnson & Ettinger models are valuable screening tools for estimating the human health risks from the migration of volatile compounds from soil and groundwater into an indoor air space. If the results of the screening process and modeling indicate a potential risk, the model must be verified to ascertain whether an inhalation risk actually exists at a property. The Department recommends a systematic approach that may require soil gas sampling from beneath a building foundation and indoor air sampling to determine potential attenuation factors and validate indoor air model results.

1. *Sub-slab Soil Gas Sampling:*

The Department may require sub-slab soil gas samples to be collected beneath existing buildings, including potentially impacted tenant spaces, in order to help identify potential soil gas contamination.

In addition to the above noted strategies for the collection of soil gas samples, the Department recommends the protocols for analysis of sub-slab soil gas and indoor air samples conveyed in the U.S. EPA Methods TO15, TO17, or equivalent. U.S. EPA Method 8260 may also be used as a field screening tool depending on what detection

limit is necessary to meet data requirements. At a minimum, samples should be collected in accordance with the following requirements:

- Sub-slab samples should be collected just beneath the foundation slab, or for soil gas sampling from a depth between five to eight feet below ground surface or from the layer of highest permeability;
- Sample should be collected beneath the building and at least several feet from the edge of the building (angled boring may be used if sub-slab sampling cannot be performed);
- To ensure that representative samples are collected, sampling periods should be eight hours or greater for commercial properties and at least twenty-four hours for residential properties. The sampling frequency and period should be sufficient to minimize the effects of breakthrough of ambient air into the vapor sample and changes in barometric pressure and temperature;
- At least one duplicate sample should be collected;
- The hole in the slab should be plugged immediately following initiation of sample collection with non-VOC pliable caulk or equivalent;
- Canister leak testing should be performed;
- Helium testing of the vapor point should be conducted prior to sampling; and
- Other soil should not be disturbed.

Results reported to the Department should include the following:

- A narrative summary describing the area sampled, slab condition, sampling period, initial pressure reading, sample depth, methods used, and soil type encountered;
- A minimal vacuum pressure between -5 to -1 mercury (Hg) should exist in the summa canisters upon completion of sampling in order to ensure a representative regulated sample was collected over the prescribed time period;
- Figures and photographs adequately documenting the location of the sample and condition of the slab;
- Results for all detected analytes in units of milligrams per cubic meter (mg/m^3); and
- Copies of the laboratory analytical data sheets with minimum detection limits and practical quantitation limits.

Any screening of the soil gas results prior to the submittal to the VCP should be against

the screening levels presented in the Department's Facts about Vapor Intrusion document. After the results have been received, the Department will review the sub-slab soil gas data to determine whether there is a potential risk based on the specific site characteristics. Comparison to the Occupational Safety and Health Administration Permissible Exposure Limits and Threshold Exposure Limits should apply to active facilities for indoor air samples collected at the property. If a risk is identified, the Department will require further investigation of the exposure pathway by indoor air sampling or remediation to remove the risk.

2. Indoor Air Sampling:

To evaluate the indoor air exposure pathway when the screening process or sub-slab sample data have identified a potential risk, the Department requires collection of indoor air samples in existing buildings or tenant spaces that may be impacted. Multiple rounds of indoor air sampling are generally recommended in order to adequately characterize exposure levels due to temporal variability and seasonal changes in habits of building occupants. The sampling protocol for indoor air should meet the following requirements:

- Identify and remove indoor chemicals that may contribute to potential exposure;
- The sampling apparatus should be located in the area likely to have the highest concentrations;
- A background ambient air sample should be collected;
- A duplicate sample should be collected for each area sampled;
- If possible, the area should be closed for at least 12 to 24 hours before the sampling period begins and the use of pressure difference causing devices (e.g. clothes dryers, exhaust fans, and Heating Ventilation Air Conditioning systems) should be suspended during this time and during the sampling; and
- The sampling apparatus should be set two (2) to five (5) feet above floor level.

If the screening process identifies a potential human health risk in an active dry cleaner facility, samples do not need to be collected from the active facility but should be collected from adjoining tenant spaces.

Results reported to the Department should include the following:

- A narrative description of the area investigated, sampling results, and methods used, including a detailed list of all possible interior sources of contamination that may have affected the results;
- A detailed drawing of the building, including all indoor partitions, doors, windows, and other sources of outdoor air including, but not limited to, exhaust

fans, plumbing vents, and heating, ventilation and air conditioning (HVAC) supply and return vents. The drawing should also include the location of samples collected and all interior sources of contamination (i.e. storage closets of cleaning products);

- A summary of all detected analytes; and
- Copies of the laboratory analytical data sheets with minimum detection limits and practical quantitation limits.

Any screening of the indoor air results prior to the submittal to the VCP should be against the screening levels presented in the Department's Facts about Vapor Intrusion document. Once the results are received, the Deparment will review the indoor air data to determine whether there is a potential risk based on the specific site characteristics. Comparison to the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) and Threshold Exposure Limit (TEL) are not acceptable unless the facility or specific tenant space is operating and utilizes the identified chemical(s) of concern in their business operations. If a potential risk is identified, the Department will require remediation to address the risk.

E. Analytical Methods

Acceptable analytical methods are summarized below. Applicants should ensure that the fixed laboratory reports include the analytical results based on the lowest possible detection limits for each methodology. For example, detection limits for groundwater samples should be comparable to federal and State MCLs, whereas soil samples should be comparable to the federal regional screening levels (RSLs). If matrix interference or high levels of contamination elevate detection limits, reasonable efforts must be made to accurately quantify contaminants of concern and a detailed explanation must be provided for these detection limits.

Analyte	Media/Matrix	Typical Analytical Method Number (Current EPA Promulgation)
VOCs	Solid	EPA Method 8260C (Rev 3 - 8/06) Note: The soil and sediment collection method has changed to EPA Method 5035.
	Aqueous	EPA Method 8260C (Rev 3 - 8/06)
	Air Summa Canister	EPA Method TO-15 (Revised 01/99)

Analyte	Media/Matrix	Typical Analytical Method Number (Current EPA Promulgation)
	Air Tedlar Bag	EPA Method TO-15 (Revised 01/99)
	Air Sorbent Tube	EPA Method TO-17 (Revised 01/99)
SVOCs including PAHs	Aqueous	EPA Method 8270D (Rev 5 - 7/14)
	Solid	EPA Method 8270D (Rev 5 - 7/14)
Polychlorinate Biphenyls (PCBs)*	Aqueous	EPA Method 8082A (Rev 1- 2/07)
	Solid	EPA Method 8082A (Rev 1 - 2/07)
Organochlorine Pesticides	Aqueous	EPA Method 8081B (Rev 2 - 2/07)
	Solid	EPA Method 8081B (Rev 2 - 2/07)
PPL Metals	Solid	EPA Method 6020B (Rev 2 - 7/14)
	Aqueous (Field filter sample as required prior to preservation)	EPA Method 200.8 (Rev 5.4 - 1994)
Elemental Mercury	Solid (only)	EPA Method 6800 (Rev 1 – 7/14)
Chromium, Hexavalent	Aqueous (Field filter sample as required)	EPA Method 218.6 (Rev 3 - 1994)
	Solid	EPA Method 218.6 (Rev 3 - 1994)
Perchlorate	Aqueous	EPA Method 314.0 (Rev 1.0 - 11/99)
Dioxins	Aqueous & Solid	EPA Method 8280B (Rev 2 - 2/07)
Furans	Aqueous & Solid	EPA Method 8290A (Rev 1 - 02/07)
Chlorinated Herbicides	Aqueous	EPA Method 8151A (Rev 1 - 12/96)
	Solid	EPA Method 8151A (Rev 1 - 12/96)
Free and Total Cyanide	Aqueous & Solid	EPA Method 9014 (Rev 1 - 7/14)

Analyte	Media/Matrix	Typical Analytical Method Number (Current EPA Promulgation)
Perfluorooctane Sulfonate (PFOS)	Aqueous	EPA Method 537 (Rev 1 – 9/09)
	Solid	Lab specific
Perfluorooctanoic Acid (PFOA)	Aqueous	EPA Method 537 (Rev 1 – 9/09)
	Solid	Lab specific

Note: Alternative validated methods may be utilized for an analytical suite. Adequate detection limits must be achieved.

F. Quality Assurance and Quality Control (QA/QC) Measures

The Departments recommends that VCP applicants implement data validation including appropriate quality assurance and quality control measures during the sampling program. Such a program ensures the veracity of analytical results and prevents the applicant from performing additional work that may not be necessary. These measures include the collection of blind duplicate samples, matrix spikes, field blanks, rinsate or equipment blanks, and trip blanks.

The Department recommends that QA/QC measures follow U.S. EPA's protocols for Level IV data, which is used in site characterization and risk assessments (refer to US EPA's Data Quality Objectives for Remedial Response Activities, Volumes I and II, 1987).

G. Post-Investigation Issues

1. Investigation Derived Media (IDM)

IDM includes the groundwater, surface water, soils, and sediments that are generated during an ESA. Specifically, IDM may include development and purge water from monitoring wells, drill cuttings, and soils removed during sample collection. IDM generated during a sampling event must be properly containerized and characterized prior to determining the appropriate disposal method.

To evaluate whether the IDM must be managed as a hazardous waste, the generator must first determine whether the IDM is a solid waste as defined in Section 7-201(t) of the Environment Article, Annotated Code of Maryland, and COMAR 26.13.02.02. IDM contaminated with oil may be handled with guidance from the Department's OCP (410-537-3442). At a minimum, IDM must be screened to determine if it is contaminated or

inherently waste-like. IDM must be handled as a solid waste when:

- It is visually or grossly contaminated;
- It has activated any field monitoring device indicating the presence of VOCs, metals, or other contaminants;
- In previous monitoring or sampling activities, it has exhibited levels of contamination above accepted environmental quality standards; or
- Based on historical information, the responsible party or the regulatory agency believes it warrants caution or additional testing.

If the appropriate analytical testing determines that the waste is hazardous, then it must be disposed at an appropriate hazardous waste disposal facility. If the waste is not hazardous, then the IDM may be disposed at an appropriate permitted waste management facility.

Naturally-occurring media and media with contaminant concentrations less than the appropriate comparison values (e.g. the Department's Cleanup Standards for Soil and Groundwater) need not be managed as a waste. If the appropriate analytical testing determines that purge water has no apparent contamination, it may be released to the ground surface after obtaining approval by the Department.

2. Well Abandonment

Any boreholes, including direct push locations, that intercept the water table for groundwater monitoring purposes are considered to be wells and must be abandoned according to the State of Maryland well abandonment standards (COMAR 26.04.04.11). VCP participants should petition the Department for approval to abandon existing monitoring wells.