[SLIDE 1] Ground Water Evaluation

Ground water can play a key role in affecting the timing and cost associated with investigations at Voluntary Action Program properties. Taking the time to develop a well-planned ground water investigation can pay off in lowering costs and moving projects forward with fewer complications or delays.

We understand that each VAP property is unique, as is the investigation approach taken by each CP. The following information is intended to identify the basic concepts that should be considered for any VAP ground water investigation. Your investigation may require more or less, depending on the conditions encountered at your site and your own investigation style.

Ohio EPA encourages and invites you to engage in technical assistance at any stage of investigation prior to the issuance of the NFA Letter. Ohio EPA's VAP staff are here to support you.

The first section covers the investigation of soils, the determination of whether ground water is present, and the potential impact of COCs in soil to ground water. This is followed by a discussion of the obligations to protect ground water determined or assumed to be "clean" and the implications of these obligations.

[SLIDE 2]Today we will discuss the elements of ground water investigation, including:

- The conceptual site model,
- Identification and protection of ground water zones, and
- soil/leaching investigations,

[SLIDE 3]Conceptual site model, or CSM.

Good planning can go a long way toward streamlining your ground water investigations and lowering your overall project costs. Starting with a good CSM can help you as the CP develop a systematic investigation strategy that is customized to your site.

The ground water portion of your CSM should help illustrate the relationships between contaminants, transport media, and receptors. It should also identify exposure scenarios, COCs, and land uses. Some of the important things to consider in your CSM include:

- identification of regional ground water zones,
- locations of surface water bodies relative to the VAP property,

- anticipated ground water flow directions, and
- presence or absence of regional ground water confining units.

You should also consider property-specific characteristics, such as the locations of the identified areas, or IAs determined during your Phase I and initial portions of your Phase II investigation, as well as the intended land use.

The CSM should be a living document; meaning, it should evolve as your understanding of the conditions at your VAP property improves. Remember to update your CSM with your property-specific data to more efficiently direct your investigation.

[SLIDE 4]Data Quality Objectives or DQOs.

During your planning stages, always be mindful of your DQOs for ground water. These should include your laboratory analytical data requirements for soils and ground water. In addition, include technical aspects such as monitoring well construction methods, proper well development, ground water sampling methods, and geotechnical sampling methods. The key is ensuring representative sampling to support your demonstrations of compliance with applicable standards.

Fortunately, Ohio EPA has guidance documents to aid in identifying and establishing appropriate DQOs. The "Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring," or TGM, includes useful guidance on a wide variety of ground water issues. These include well construction, development, and sampling.

The VAP also has a Technical Guidance Compendium on its website. The TGC documents specific to ground water explain Ohio EPA's interpretation and expectations regarding ground water sample filtration for metals, yield testing, leaching demonstrations, and modeling.

Keep in mind that other peer-reviewed, field validated guidance documents may be used, if they are appropriate for the intended purpose, and will ensure representative sampling.

[SLIDE 5]Requirement to Protect Ground Water Meeting unrestricted potable use standards, or UPUS.

The VAP requires that each property be evaluated to determine whether ground water meets or exceeds UPUS. This can be done through either direct sampling of ground water or through a weight-of-evidence demonstration that ground water **meets** UPUS.

Using a weight-of-evidence approach, a CP may **assume** that a ground water zone below a property is "clean" or unimpacted above UPUS, if the weight-of-evidence supports that:

- it is unlikely to have been impacted from releases on the property, and
- will continue to be protected from exceeding UPUS from source areas on the property in the future.

In any event, Ohio law and VAP rules indicate that ground water which is not already contaminated may not become contaminated in the future, either through the action or inaction of a volunteer. This is referred to as the Protection of Ground Water Meeting UPUS.

It is important to note here that the VAP does not permit a CP to ever assume or otherwise conclude – without testing – that ground water beneath a site *is* contaminated**.**

[SLIDE 6]When starting your investigation of ground water, there are a number of basic questions to consider:

- Is ground water a potential problem on your VAP property?
- Next, if there is the potential for contamination of ground water, does ground water meet or exceed UPUS?
- If ground water is demonstrated to exceed UPUS, what are the representative concentrations of each COC?
- If ground water meets UPUS, will it continue to meet UPUS?

[SLIDE 7]Let's start with leaching. One of the initial ways to determine if ground water is even an issue for your property is to start by evaluating the potential for COCs on your property to leach to ground water at concentrations that could cause an exceedance of UPUS. It can also be useful to evaluate future compliance with applicable ground water standards, if contaminants remain in vadose zone soils.

[SLIDE 8]Leaching demonstrations can help answer a number of questions, including:

- Do I need to install wells or sample ground water to investigate whether ground water meets UPUS?
- Will ground water that meets UPUS continue to meet UPUS if source areas persist in vadose zone soils? (This can affect whether cleanup of impacted soils may be necessary.)

- Do I need an engineering control to prevent leaching that could lead to an exceedance of applicable standards?
- Will leaching to ground water lead to an exceedance of an applicable standard later at a point of compliance or receptor? (such as, surface water, indoor air, or meeting UPUS at the property boundary)

Sufficient representative soil analytical data will be needed to support any leaching demonstration. One goal of the site investigation process is to collect soil analytical data within the direct-contact point of compliance interval based upon the intended future land use. However, it may also be necessary to evaluate the interval situated below the direct-contact point of compliance interval and above the first ground water zone underlying the property to evaluate whether COCs are present at concentrations that could potentially leach to ground water.

This is a critical point, and one that cannot be emphasized enough under the VAP: comparison to direct-contact soil standards is only a start. This is critical to understand if the ground water beneath a site is clean, or may be assumed to be clean based upon the release history and other lines of evidence As you begin investigation of a property, it is always important to evaluate all previous investigations of ground water or soil to assist in developing your sampling strategy.

There are several ways that a CP may evaluate whether a COC could potentially leach to ground water at a concentration which would exceed a VAP unrestricted potable use standard. Perhaps the easiest way is to use the Ohio EPA's VAP guidance document titled "Derived Leach-Based Soil Values" that is on the division website. This document is very useful, and contains look-up tables that provide generic leach-based soil concentrations for several of the more common COCs found in soil at VAP sites.

[SLIDE 9] When dealing with organic constituents – such as these shown in the slide – it is important to apply the correct soil type at your property. There is a discussion in the guidance document as to how a CP goes about determining whether the site has Type I, Type II, or Type III soils.

[SLIDE 10].The narrative in the guidance document lists the criteria that must be met for these look-up values to be used at a particular property. This guidance document is useful, but only to the extent that the CP exercises care in determining whether their particular property meets the criteria to use these values.

[SLIDE 11]. The guidance document also discusses the use of what are referred to as dilution/attenuation factors that may be applied to these generic leaching values. Dilution/attenuation factors are essentially multipliers which can be applied to Ohio EPA derived leach-based soil values. For metals, multipliers of 10 or 20 may be applied, depending upon the size of the potential source area.

[SLIDE 12]For organic constituents, dilution/attenuation factors may be applied based upon the characteristics of the ground water zone that may be affected by soil leaching. You can see from this slide that the dilution factor for organic constituents is one (no dilution) if the uppermost ground water zone has a hydraulic conductivity of less than or equal to 1 times ten to the minus third centimeters per second. The guidance document is clear on how to calculate a dilution factor that may be applied to the look-up values for organic constituents in the guidance document. Make sure to properly document and justify what you have done, if you intend to apply a dilution factor.

Use of these so-called generic leaching values is one way to evaluate potential leaching of COCs to ground water. A second way is the performance of site-specific soil partitioning calculations to evaluate leaching potential. Typically, soil partitioning values are calculated for those constituents detected in soil for which there is no corresponding look-up value in the guidance document. And to do so, one may use the following equation.

[SLIDE 13]This equation is a modification of the equation in the VAP TGC document on the use of soil partitioning coefficient to evaluate leaching. I would also refer you to the TGC document that discusses the Soil Attenuation Model, or “SAM”, and the Risk-Based Corrective Action, or “RBCA”, Tool Kit. Both the RBCA Tool Kit and SAM models have equations that are useful in evaluating the concentration of a COC that can be left in soil above the first ground water zone that would be protective of UPUS.

Soil partitioning equations and models are intended under the VAP as screening tools for fast assessment of the potential for a COC to leach to ground water. I would emphasize that there is no one right way to derive prospective leaching concentrations for soils. If you have questions regarding your leaching evaluation, you can always have Ohio EPA evaluate your leaching demonstration through Technical Assistance.

Since the partitioning equation can be so useful, it may be beneficial to create a spreadsheet so that you can plug in a few variables to this equation, and generate a screening value which – in some circumstances – may turn out to be an applicable standard at your property.

Let's run through this equation briefly. What you are trying to determine is C_S, which is your site-specific leach based soil value. To calculate this, you must first know the target concentration for your COC in ground water in milligrams per liter, which is C_w. This value may either be a published generic UPUS or a risk-derived UPUS. These are printed in look-up tables in Rule 08. If your COC has neither a published generic nor a risk-derived UPUS, contact the Ohio EPA VAP staff, and discuss the situation. You may not be the first CP who needed a value in ground water calculated for your COC for which there is no published standard. The agency may be able to provide you with a value to use. Just make sure you document where you got the value you used, and that you include this documentation in your final Phase II report. Or, you may derive a target concentration for your COC in ground water as part of a property-specific risk assessment.

The next site-specific parameter in our equation is the organic carbon partitioning coefficient, or K_{oc}. The Ohio EPA has complied lists of K_{oc} values that may be used for COCs on VAP projects. Another approach would be to suggest a K_{oc} value and the basis for its use to Ohio EPA and then seek concurrence from Ohio EPA under technical assistance.

The last parameter is fraction of organic carbon, or f_{oc}. One can use a default value – the agency has generally accepted a default value of 0.2 percent – or one can obtain a site-specific value through the collection of undisturbed geotechnical samples at your site. If you opt for the site-specific approach, geotechnical information related to f_{oc} needs to be collected

in areas that are not affected by COCs. Typically, geotechnical information is collected after you have a complete characterization of soils on-site and you can bias your geotechnical sample collection to appropriate areas and soil horizons known to be unaffected by COCs.

Before we leave this point and go back to the equation, I would point out that the Ohio EPA has a TGC document regarding how to sample and analyze soils for f_{oc}. Failure to sample and analyze f_{oc} appropriately in the Phase II process can have significant impacts on demonstrations made in the NFA letter submittal. The analysis must subtract the inorganic carbon concentrations due to calcareous or newly limed soils.

With this information, one can calculate a soil partitioning value for organic COCs. As discussed when using generic Ohio EPA-derived leach based soil values, dilution/attenuation factors may be applied to these site-specific soil partitioning values as appropriate.

[SLIDE 14]There is a somewhat similar equation to derive site-specific soil partitioning coefficients for inorganic constituents in the event that the Ohio EPA has not published a generic look-up value, or you want to calculate your own site-specific soil partitioning value for metals.

As you can see, the terms are similar to the previous equation: C_s is the concentration in soil that we are looking for and C_w is the target concentration in ground water, Note that there are there are three new terms as well: the soil/water partitioning coefficient, or K_d; water-filled soil porosity, or $theta_w$; and soil bulk density, or rho_b. As with K_{oc}, the Ohio EPA has recommended values of K_d that can be provided to CPs. If a K_d does not exist for your particular metal, an internet search will generally yield a range of values that can be applied. It is advisable to be conservative in your selection of an inorganic K_d value, since there is variation in the literature. Finally, we enter a value – in kilograms per liter – for dry weight soil bulk density. A word of caution: watch your units, because most geotechnical laboratories will report bulk density in pounds per cubic foot, or grams per cubic centimeter.

[SLIDE 15]It is often necessary to collect certain geotechnical data to support leaching evaluations. You should obtain the minimum needed to be able to evaluate site-specific soil partitioning, analysis of soils for fraction of organic carbon and bulk density. Many CPs also

evaluate geotechnical samples for porosity, in situ permeability, cation exchange capacity, and other variables. Since the VAP does not certify laboratories for the analysis of geotechnical parameters, CPs are advised to use established, reputable geotech labs, and to make the laboratory selected aware of the provisions of various TGC documents relative to the analysis of samples for fraction of organic carbon and dry weight evaluation of soil bulk density.

In addition to generic leach-based values and calculated soil partitioning values, there are models which may estimate the potential of a particular COC to leach to ground water. These include VLEACH and SESOIL. These models are available commercially, and have been used successfully in making demonstrations of potential leaching to ground water as part of the VAP. Properly applied, the use of modeling is an acceptable approach to develop screening levels for COCs and their potential to leach to ground water.

[SLIDE 16]One other option available to the CP is the use of a weight-of-evidence demonstration to make a case that COCs do – or do not – have the potential to leach to ground water in excess of UPUS. A weight-of-evidence demonstration can include a variety of factors, among them:

- Whether or not ground water is even present beneath a property;
- The separation distance between the constituents in soil and the uppermost occurrence of ground water;
- Site-specific geological factors that would inhibit the migration of COCs to ground water;
- The residence time that a particular COC has been in soil and yet not impacted ground water; and
- The presence of man-made structures that reduce or prevent infiltration and leaching of COCs to the ground water zone.

There are obviously other factors that can be used in a weight-of-evidence demonstration, many of which are specific to the particular geologic or geochemical make-up of your site.

[SLIDE 17]Please note – if you are relying upon the presence of man-made structures to prevent leaching, you will need to identify that as an engineering control that is subject to the operation and maintenance requirements of VAP Rule 11.

At this point you may be asking, what does all this have to do with ground water? Simply this: the VAP requires that each property be evaluated to determine whether ground water on the property meets or exceeds UPUS. Sampling ground water is always an option to determine this, but VAP rules do allow a CP to use a weight-of-evidence demonstration to assume that the ground water below a property is "clean".

[SLIDE 18]A comparison of concentrations of COCs in soil to leach-based soil values could be used as one of the pieces of information in a weight-of-evidence demonstration to evaluate whether it is appropriate to make the assumption ground water is "clean". A few cautionary notes related to making this assumption must be stated. To make this assumption, VAP rules require an understanding of the nature and type of the release; that is, the site release history. Further, the CP must understand the physical characteristics of the vadose zone and the overall site geology, as well as any other factors important to determining whether ground water could be impacted even when a leaching evaluation suggests no leaching potential. Migration routes, such as releases directly to ground water from USTs, vertical contaminant migration through fractured soils, or other mechanisms must be considered. Off-property sources impacting ground water on the property also need to be considered. As you see, the leaching potential is only part of the weight-of-evidence demonstration.

A quantitative evaluation of leaching is not a required component of a weight-of-evidence demonstration. There may be certain circumstances that justify an assumption that ground water will not be impacted even when leaching calculations might suggest otherwise. For example, an old release of a traditionally immobile substance such as certain metals to shallow soils with a large separation distance to ground water. In this example, it is important to obtain soil data at depth to demonstrate that any contamination indeed remains at a shallow interval and has not migrated, even though leaching calculations might suggest otherwise. Although a leaching evaluation of soils is often a good first step in determining whether or not to investigate ground water, other considerations may or may not lead to a decision to sink wells.

[SLIDE 19]There may be certain sites where the release history, site-specific subsurface conditions, the areal and vertical distribution of COCs in soil, and the absence of potential off-site sources of ground water contamination support a conclusion that there is a limited probability that ground water beneath your property has been impacted in excess of UPUS. In these cases, the CP may **assume** that ground water meets UPUS, where the weight-of-evidence supports this assumption. This has the potential to be a big time and money saver for your client.

For each zone underlying a property that meets UPUS, a protection demonstration must be made. But where do you start?

[SLIDE 20] One way to approach the protection demonstration is to work from the top and move down sequentially. Determine which saturated zones should be grouped together or separated into different ground water zones. Determine the presence of confining units, and how they may separate ground water zones.

[SLIDE 21]The first thing that a CP needs to do is to determine whether ground water as defined under the VAP is actually present in the uppermost ground water zone.

According to the rules, a CP **must** assume that the uppermost saturated zone contains ground water, or make a demonstration that it falls below one of the minimum criteria for ground water as defined in the rule. A zone is defined as containing ground water if the *in situ* hydraulic conductivity is greater than or equal to five times ten to the minus 6 centimeters per second, or the zone is capable of yielding to a properly constructed well a minimum of 1.5 gallons of water within eight hours. I would stress that this is an "either – or" situation: a zone needs to fail only one of these criteria for the water in the zone to not be considered ground water. It does not have to fail both.

An evaluation as to whether a zone contains ground water as defined under the VAP should be reserved for "marginal" saturated zones, such as a perched non-contiguous unit beneath a site. There are TGC documents on this issue, should you ever find yourself in one of these "marginal" positions. If you aren't sure, consult these TGC documents and proceed accordingly.

If you determine that your uppermost zone – or any zone beneath the property, for that matter – does not contain ground water as defined under the VAP, the CP may treat any COCs detected in the water within this zone as soil. In other words, the concentrations of COCs reported for this zone may be compared to leaching to ground water standards, or direct-contact standards for construction and excavation activities, if the zone is shallow enough to be encountered during these activities.

[SLIDE 22]Let's assume that the uppermost ground water zone identified is ground water. Start at the top and determine which zones exceed UPUS and which zones meet UPUS.

[SLIDE 23] In the case of an uppermost ground water zone that **meets** UPUS, the protection demonstration is made when a CP concludes that, based upon the evidence, ground water beneath a site is not contaminated, and that the concentrations of COCs remaining in soil support a determination that ground water will not become contaminated in the future.

[SLIDE 24] If the uppermost ground water zone is demonstrated to **exceed** UPUS, there is no longer an obligation to protect **that** zone, but the protection requirement then applies to the next deeper ground water zone meeting UPUS.

[SLIDE 25]Please note that a common mistake is to assume that the next lower ground water zone that requires protection is a deeper regional aquifer. This may not be true. VAP rules require any ground water zone beneath a property be protected if this zone meets UPUS. Therefore, a low-yielding ground water zone between your shallow contaminated zone and the regional aquifer may end up being the zone you have to demonstrate is protected. Often the existence of these zones is not known except by site-specific characterization of the hydrogeology.

This demonstration of protection for deeper ground water zones when you have a shallow ground water zone that is contaminated is an iterative, site-specific process. Many CPs seek agency technical assistance if the geologic setting is particularly complex.

The concept of the need to protect ground water that meets UPUS can be difficult to grasp initially. However, if the weight-of-evidence at your site supports a protection demonstration, this can be a way for your volunteer to save some time and effort. The moral of the story is, assemble your soil data population carefully, particularly at sites where there has

been no previous investigation of ground water. Bear in mind that if your soil data indicates achievement of generic or derived leach-based standards and the site release history supports it, there may be an exit ramp to avoid the need to sample ground water at all.

[SLIDE 26]Let's say we have gone through our soil sampling exercise at our VAP property, and we have determined that concentrations of COCs are present in soil at concentrations that could leach to ground water. Or, let's assume that we have previous reports of existing ground water data that indicate that ground water beneath a property may already contain COCs in excess of UPUS. This commits the CP to evaluate the ground water situation beneath the property. From a logical standpoint, the clearest way to proceed with our investigation of ground water beneath a site is from top-down, rather than from bottom-up. This is somewhat intuitive, although there have been instances where a CP has assessed a deeper ground water zone while ignoring ground water conditions in shallower zones.

[SLIDE 27]An example is in southern Cuyahoga County or northern Summit County, where the CP may be faced with up to four ground water zones: a shallow unconsolidated ground water zone; the underlying Sharon Sandstone; the Mississippian Cuyahoga Formation; and the Berea Sandstone. Conducting one's initial assessment of the Berea Sandstone because it is being exploited by local private water wells is very costly, time consuming, and potentially irrelevant from the standpoint of the VAP. Assessing ground water at a VAP property should be looked at like unpeeling an onion. The uppermost layer is evaluated first, and then subsequent layers evaluated if warranted, based upon the investigation of the first layer.

From this point forward, we are going to assume that you have determined that the uppermost ground water zone beneath your property contains ground water as defined under the VAP. At this point, it is necessary to take stock of what you know. Do you have previous reports which indicate that ground water within any ground water zone beneath your property contains concentrations of COCs in excess of UPUS? If not, it is now up to you as the CP to make this determination.

[SLIDE 28] Monitoring wells should be placed immediately down-gradient of source areas to make a determination of whether or not the ground water being evaluated has been affected by concentrations of COCs in excess of UPUS. A common mistake is to rush out and

install monitoring wells before knowing where source areas are on the property in question. This is typically ill-advised until one knows first whether one even has source areas, and secondly where these potential source areas are relative to where one can place monitoring wells.

Conducting a thorough evaluation of soil conditions on-site can be critical before one begins the ground water assessment phase of investigation to identify the appropriate placement of monitoring wells. It is sometimes necessary to place monitoring wells through soil source areas. In these instances, the VAP rules require methods of well installation, construction, and sampling that will not cause cross-contamination between ground water zones. This typically involves double-casing or telescoping your well to underlying ground water zones.

Once you know where the source areas are, it is your obligation under the VAP to install an appropriate number of properly constructed and correctly sized ground water monitoring wells down-gradient of source areas to characterize whether or not COCs are present in ground water in excess of UPUS. The concept of "appropriate number" is somewhat open to interpretation, and is at the discretion of the CP.

[SLIDE 29]From your CSM development or historical investigations, you may have a good idea of the anticipated regional ground water flow. Use this information to make the best choices for well locations.

[SLIDE 30]Keep in mind that proper placement also includes proper spacing to evaluate flow direction. Wells oriented in a straight line are not very useful for determining ground water flow directions.

[SLIDE 31]Try to optimize your well placement based upon your site knowledge, including the known locations of contaminant source areas.

[SLIDE 32]Confirm your flow directions and well placement with property-specific data. Once the wells are in place, it is important to survey their location and the top of casing elevation of each well, so that a practical determination of ground water flow direction may be made within our ground water zone. It is at this point that we may receive a surprise.

[SLIDE 33] What you thought was down-gradient of that source area actually turns out – following determination of ground water flow direction – to be side gradient, or otherwise not positioned correctly to determine if COCs are present in ground water in excess of UPUS.
[SLIDE 34]Usually, there is no way to correct this except to install additional wells. The point is made that one needs to evaluate all previous information, and still use best professional judgment when attempting to install wells down-gradient of source areas.
[SLIDE 35]Ground Water Sampling to Evaluate Meeting UPUS.

After proper development, we are now ready to collect our ground water quality data. In general, two samples must be collected to demonstrate and confirm that ground water exceeds UPUS. The VAP rules require that samples be collected within 48 hours to 90 days to make the confirmation. In some instances, one sample may be used to demonstrate that the ground water zone exceeds UPUS, if:

- the first sample collected from a properly constructed and developed well contains a concentration of a COC that exceeds its UPUS value by at least one order of magnitude, or
- if there is historic ground water data (generally pre-VAP) that demonstrates an exceedance from the same well or area to confirm the exceedance.

[SLIDE 36] VAP rules also indicate that an evaluation of temporal and spatial variations of ground water quality is an essential part of the evaluation process. Temporal variations tend to be most intense, as ground water levels fluctuate seasonally.
[SLIDE 37]Proper Well Development and Filtration Issues.

We have our wells in place, they are down-gradient of our source area or areas, and we are ready to sample, right? Not quite. Proper development of a monitoring well is crucial. Concentrations of VOCs and metals in ground water can be skewed – downward in the case of VOCs, and upward in the case of metals – if a well is not properly developed.

As discussed earlier, the Ohio EPA's Division of Drinking and Ground Waters' TGM describes recommended methods of monitoring well construction, development, and sampling.
[SLIDE 38]The VAP also has a TGC document specific to ground water sample filtration. I would urge all CPs and their ground water sampling staff to review this document to determine when

field filtering of ground water samples is appropriate in the context of any VAP ground water investigation. In general, the agency prefers the collection of unfiltered samples through the use of low-flow or micro-purging techniques. However, a properly developed well not only yields better quality data – regardless of whether or not you use low flow/micro-purge techniques – but is also a requirement of any investigation of ground water being conducted in accordance with the TGM. Please note that the minimum recommendations for well development discussed in the TGM are not a one-size-fits all method. Depending on the geologic conditions and the COCs encountered at your site, additional well development may be necessary to increase flow into the well or to decrease sample turbidity.

[SLIDE 39]Evaluating On vs. Off-Property Sources That Have Impacted Ground Water On Property.

The foregoing presupposes that we are dealing with a site where the source areas are exclusively on-property. While this is often the case at VAP properties, it is important to note that certain sites – particularly those in heavily industrialized areas – may have impacts to ground water that originate from areas that are off-property. The important task for the CP is to conduct your Phase II activities in such a way that both on- and off-property source areas are evaluated for their potential impact to ground water zones.

[SLIDE 40] Suppose you have a site located next to a gas station with a history of releases to shallow ground water from gasoline USTs that were identified during the Phase I. Based upon the historical data, you have reason to believe that the UST release has migrated beneath your VAP property. Your Phase II demonstrated that the only COCs for your property were metals, and that none of them exceed UPUS. However, gasoline-related COCs were detected in ground water. What are your responsibilities?

[SLIDE 41]The VAP rules require an evaluation of the extent to which off-property contamination may have affected ground water beneath the VAP property. This is needed to evaluate whether receptors on the VAP property need to be protected from contamination derived off-property.

In this case, with no sources that could leach to ground water on the VAP property, you would need to evaluate how the impacts from the leaky USTs next door might impact your VAP property.

Please note, that if the shallow ground water contamination is entirely attributable to impacts from off-property sources, there is no need for you to provide a demonstration of protection to lower ground water zones for that contamination.

[SLIDE 42]Determination of Yield for Ground Water Classification.

You have evaluated your ground water and identified the ground water zones that meet UPUS and those that exceed UPUS. What's next?

As we previously discussed, each "clean" ground water zone must have a demonstration that it will remain clean. What about the zones that exceed UPUS?

[SLIDE 43] Ground water zones demonstrated to exceed UPUS must be classified to determine the appropriate response requirements listed in rule 10. The specific criteria for classification and the response requirements for each classification will be discussed later.

[SLIDE 44] The classification often depends on the yield of the ground water zone being classified.

[SLIDE 45] The VAP rules have specific requirements for determination of yield:

- To determine whether the yield of the ground water zone being classified falls below the minimum yield requirements for Critical Resource ground water, wells must be constructed to a minimum standard of an 8-inch diameter well in a 12-inch diameter borehole.
- To determine whether the yield of the ground water zone being classified falls below the minimum yield requirements for Class A ground water, wells must be constructed to a minimum standard of a 4-inch diameter well in a 8-inch diameter borehole **or** a 2-inch diameter well in a 6-inch diameter borehole with a required correction factor of 1.15-times the measured yield being applied for the 2-inch well.
- All wells must be screened through a minimum of 80 percent of the ground water zone being classified or appropriately corrected for wells screened through less than 80 percent of the zone.

Consult the TGC documents for guidance regarding yield testing for ground water classification.

[SLIDE 46] Before moving on to ground water classification and response requirements, it is worth mentioning some requirements specific to Class B ground water zones.

While rule 10 has specific allowances for the determination of ground water classification without property-specific yield tests for Class A and Critical Resource Ground Water, classifying ground water "Class B" **requires** yield testing.

Also, please note that rule 10 contains response requirements for **potable uses** of ground water. If the ground water is determined to be Class B, it assumes that there is no potable use of that ground water zone, so response requirements are not listed in rule 10. Instead, you must evaluate compliance with applicable standards for all other (non-potable) complete exposure pathways identified in accordance with the Phase II rule.