[SLIDE 1]Welcome to the CP Initial training module on 'rules eight and nine', the generic numerical standards rule and the property specific risk assessment rule. What we'll do today is introduce each of the rules conceptually, introduce some of the mathematical concepts used in developing Generic standards and then run through a brief case scenario.

Generic standards are derived for environmental media under Ohio statute for the VAP. These standards (either generic or property specific) are considered applicable cleanup standards when they have been appropriately applied on a VAP property. The purpose of this introduction is to provide you with a framework for the appropriate implementation of these standards.

Let's talk briefly about the purpose of the standards:

[SLIDE 2]There are a number of types of applicable standards characterized in rules 07, 08, 09, 10 and 11, but we are focusing in this module on numerical standards for environmental media. These can be either generic, which are listed in rule 08, or property-specific, which are derived using the procedures provided in rule 09.

In both cases they are constructed with the understanding that when applied correctly the environmental media can be considered protective of human health and the environment.

[SLIDE 3]"Environmental media" is defined in the VAP as soil, sediment, surface water, and ground water. Environmental media also include naturally occurring transitional zones between soil, sediment, surface water or ground water, such as bedrock, soil gas, and air.

[SLIDE 4]In the broadest sense the generic standards cited in rule 08 are for hazardous substances and petroleum for the particular media that are listed here (fundamentally soil and ground water). The values are concentrations of COCs that are protective of receptors on and off the VAP property that are reasonably anticipated to be exposed.

A quick note here: in the current rules we use 'Appendix A' to house the actual tables of values for the generic standards; in previous rules the tables were housed in the rule itself. The citations for standards will cite the rule, for example "3745-300-08 Paragraph C" for direct contact soil standards.

Rule 08 provides the methodology for the application of generic standards when a determination is made that a complete exposure pathway exists to surface water or between

sediments and human receptors. The rule also includes the generic consideration for the exposure of important ecological resources to sediments, and a process to develop soil standards for leaching to ground water.

[SLIDE 5]Discussions earlier today focused on Phase I and Phase II property assessments. Rules 06 and 07 detail the procedures by which the CP, acting for the volunteer, presents the release history of the property and assessment of these releases. The Phase II includes assessment of existing and potentially complete exposure pathways, and selection of COCs.

The concentration at a potential point of contact to a receptor is known as the "exposure point concentration". In order to determine whether concentrations of COCs at a property are protective of human health and the environment, the concentration of COCs must meet an applicable standard. This is evaluated in the Phase II.

[SLIDE 6]Generic standards for human exposures are, with some exceptions, developed in accordance with US EPA's "Risk Assessment Guidance for Superfund," also known as RAGS. These same principles are used when deriving an applicable standard for human health within a property-specific risk assessment. The complete methodology for their development is found in the "Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures". Other useful documents used in the development of the standards is U.S. EPA's "Soil Screening Guidance, User's Guide and Technical Background Document" and U.S. EPA's "Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites."

[SLIDE 7]In the VAP, generic standards for direct contact with soils consider the following exposure routes to humans:

- Incidental ingestion of contaminated soil;
- Inhalation of contaminated soil particulates;
- Inhalation of volatile COCs from soil to outdoor air; and
- Dermal contact.

[SLIDES 8 and 9]Here are two examples of soil issues on properties. The first set of photographs is from New Boston Coke in southern Ohio.

This was one of the first projects to be granted a CNS and involved a rather extensive PCB clean-up along with other COCs in soil.

[SLIDES 10 and 11]The second set of photos is from Alsco Aluminum in Gnaddenhuten, Ohio. This was a former Superfund site and has been redeveloped for recreational land use.

[SLIDE 12]Sometimes generic standards cannot solely be utilized in the demonstration of applicable standards at all properties. If a complete exposure pathway is not included in the development of the generic standards, a property-specific risk assessment must be conducted in accordance with rule 09.

The generic standards for human exposures to soils are developed for specific exposure scenarios, namely residential, commercial/industrial, and construction scenarios. If exposure scenarios are different; for example, a proposed recreational land use, the generic standards may not be appropriate. In such cases, clean-up standards must be derived through a property-specific risk assessment, or a demonstration made that generic standards are protective.

The following scenarios require a property-specific risk assessment as well:

- there are COCs present on the property that are not listed in the generic standards tables;
- there are complete exposure pathways not considered in the development of the standards;
- **[SLIDE 13]**there are exposure pathways to important terrestrial ecological resources; and finally,
- if generic standards are exceeded for sediment or surface water.

[SLIDE 14]Before I discuss the standards listed in various tables in rule 08, I'd like to explain how the VAP applies standards for petroleum releases. For residential and commercial properties, the generic standards for petroleum in soil and ground water are those developed by the Department of Commerce, Bureau of Underground Storage Tank Regulations, also known as BUSTR. These standards, which are mandated by statute, apply regardless of whether the release is BUSTR regulated; that is, for any release of petroleum, regardless of the source. For instance, if a petroleum release occurs from an aboveground storage tank, the generic standards are those developed by BUSTR.

For any petroleum release at residential or commercial properties, the generic standards are the BUSTR Tier I action levels. At commercial or residential properties applying generic standards, it is not necessary to derive or apply standards for additional COCs.

Additionally, all pathways addressed through the application of BUSTR generic standards are satisfactory for VAP purposes.

[SLIDE 15]Free product in groundwater is defined as a separate liquid hydrocarbon phase that has a measurable thickness of greater than one one-hundredth of a foot. When applying BUSTR petroleum standards for voluntary actions, all free product must be removed to the maximum extent practicable. Properties with free product exceed unrestricted potable standards for ground water. Response requirements found in rule 10 apply even if there are no dissolved constituents exceeding UPUS.

[SLIDE 16]Appendix A to rule 08 contains three different tables for generic direct contact soil standards.

Table I lists generic direct contact standards for residential land use. These standards also apply for any property where land use is unrestricted. At residential properties, exposure for direct contact is assumed from the surface to 10 feet below surface. In other words, unrestricted land use must meet residential standards up to a 10 foot point of compliance. Residential standards are considered protective for, and may be applied to, all land use categories, without restriction.

[SLIDE 17]Table II lists values for commercial and industrial land use. For commercial and industrial properties, direct contact is assumed from the surface to two feet below the surface. The application of commercial and industrial direct contact soil standards requires an environmental covenant which allows for the long-term enforcement of institutional controls, or activity and use limitations, as a remedy.

[SLIDE 18]Direct contact soil standards for construction and excavation activities are listed in Table III. For this category, the point of compliance is the anticipated depth of activity.

Please note that because the methods to calculate the standards for lead differ from all of the other COCs, the lead standards are not subject to multiple chemical adjustment with the other COCs.

[SLIDE 19]In this next section I'll talk generally about the development of generic standards. The procedures and rationale used to generate the generic standards are found in the "Support Document for the Development of Generic Numerical Standards and Risk

Assessment Procedures". The support document details contaminant transport and intake equations, chemical and physical parameters, calculation methodologies for clean-up standards for cancer and non-cancer endpoints, soil saturation, the derivation of TPH limits, and the rationale for the lead soil standard. The support document also provides rationale for the exposure factors used and is updated with the revision of the generic standards and the rule every five years.

[SLIDE 20]The construction of the generic standards was changed in a fundamental way in 2014. Prior to the 2014 rule review the generic standards were constructed using a probabilistic method with certain parameters in the model described through the use of probability distributions. The current rule uses a deterministic method where the all of the inputs are point values.

[SLIDE 21]Most of these point values are the default U.S. EPA assumptions that are used in the construction of the Regional Screening Levels, or RSLs. There are a few inputs specific to Ohio, however, including construction worker, PEF and VF inputs.

[SLIDE 22]The use of some of the U.S. EPA default inputs brings the VAP closer to other state cleanup programs; the Remedial Response program and the RCRA program. These programs rely on the RSLs for screening level determinations. It is important to note that the VAP is not adopting RSLs and it is not appropriate to apply the RSLs as VAP cleanup standards. The VAP cleanup standards were calculated independently and are promulgated standards for use under the VAP rules and statute as cleanup levels. Additionally, it is not appropriate to apply the VAP cleanup standards to other cleanup program applications. The Ohio EPA risk and hazard goals of One E minus five and One are reflected in the development of each of these standards.

There are more than 300 COCs for which the VAP has generated generic standards. It is important to note here that if there is more than one COC on the Property, each of the standards will need to account for the presence of the others, using what is called a multiple chemical adjustment. We will talk more about this soon.

[SLIDE 23]Default values are listed in the support document for exposure assumptions used in the development of the generic standards. Property-specific data used in the

identification of receptor populations, the identification of exposure pathways, or the quantification of chemical-specific intake is allowed if one were to develop a property-specific risk assessment following the procedures in rule 09. However, property-specific data must be collected in accordance with Rule 07. Property-specific information used to define any parameter which requires the prediction of human use and activity patterns of the receptor populations must be representative of the reasonably anticipated land use and the actual property characteristics, and must be included in an institutional or engineering control.

[SLIDE 24]Determining the ability and extent of contaminant transport from soils is modeled within the equations using standardized modeling assumptions for soil and climatic parameters such as:

- Fraction vegetative cover;
- Soil porosity;
- Soil bulk density;
- Fraction organic matter;
- Wind speed;
- Diffusion height…etc.

These are used primarily to quantify the amount of contaminant that can become airborne either through particulate emission or volatilization. These, combined with COC-specific physical and chemical properties, are used to approximate mass quantities available for intake pathway quantification.

[SLIDE 25]Chemical-specific values used to generate risk-derived standards include physical properties such as:

- molecular weight,
- Henry's law constant,
- octanol - water coefficient,
- solubility,
- air and water diffusivities, and
- melting point.

The Support Document for the Development of Generic Numerical Standards and Risk Assessment Procedures lists the sources for physical, chemical and toxicology information.

[SLIDE 26]For toxicity, the Ohio EPA relies heavily on the U.S. EPA-developed toxicity assessments for numerous chemicals and has made available the resulting toxicity information and toxicity values. These values are published only after extensive peer review. Toxicity values are chosen for generic standards development and/or deriving a standard through a property-specific risk assessment through the following information hierarchy:

- U.S. EPA's Integrated Risk Information System, also known as IRIS;
- National Center for Environmental Assessment – U.S. EPA provisional peer reviewed toxicity values (PPRTVs);
- Agency for Toxic Substance and Disease Registry, also known as ATSDR; and
- Third Tier. Occasionally, Ohio EPA will refer to documents that rely on other sources, such as California EPA or possibly other states.

[SLIDE 27]Ohio EPA has adopted a number of new toxicity values and approaches that are used in U.S. EPA's RSL development. I won't go into much detail here but the use of these in the development of our standards can be explored in the latest support document on our website and further through IRIS or one of the Regional Screening Level Users Guides.

Some COCs, such as TCE and methylene chloride, have been explicitly described in IRIS to have a mutagenic mode of action. For these COCs, age-adjusted exposure factors are applied in the development of the standards. Appendix A notes those COCs to which this construct has been applied. Important examples are vinyl chloride and arsenic that also have unique toxicity characteristics that were adopted within the 2014 VAP rule review.

[SLIDE 28]OK let's step back a moment and review what we've covered so far. Generic standards are cleanup concentrations of COCs in environmental media that are protective of human health and the environment. They are generated by and for the Ohio EPA VAP. They use constructs adopted from the methods used in the development of the U.S. EPA Regional Screening Levels. Their use must be based on the understanding that the property comports with the exposure use described in the appropriate land use and the appropriate receptors. Another way to say this is that property-specific standards must be developed if the proposed

land use on the property is not equal to the land use that was considered within the construct of the generic standards. The single chemical generic direct-contact soil standard listed in the tables is the lowest of the cancer, non-cancer or soil saturation value for each COC.

[SLIDE 29]Here is the equation we use for determining the saturation concentration of a COC that is liquid at normal temperatures within the soil. What's important to note here is that if the soil saturation value is determined to be less than the toxicity based value, then the standard will default to using the soil saturation value. This is the value that will be listed in the far right column of the soil tables in Appendix A.

[SLIDE 30]Within Appendix A, tables IV and V contain generic indoor air standards due to vapor intrusion for both the residential land use category and the commercial industrial land use category. The understanding here is that these values will allow the volunteer to address this pathway in a number of ways.

[SLIDE 31]The indoor air pathway is becoming better understood all the time. These generic standards should allow the volunteer to use attenuation factors or modeling more efficiently. Typically, the volunteer will sample ground water, soil gas or sub-slab vapor, and either model the gas intrusion or apply attenuation factors in order to estimate indoor air concentrations. Comparing these modeled values to the generic standards would be one alternative. Another option for the volunteer would be to sample the indoor air and make the comparison using these.

Here is a simple model illustrating the many factors that influence vapor intrusion to indoor air. The contamination could be in the ground water or as a vapor cloud, and due to the physical chemical properties of volatile compounds enters the indoor environment.

There are several tools that can be used to evaluate this pathway; the Ohio EPA has developed program-specific guidance for this pathway and the U.S. EPA has recently developed a vapor intrusion guidance, among others.

[SLIDE 32]For ground water, the VAP generic standards for human exposure address only the unrestricted potable use pathway. There are two tables of generic unrestricted potable use standards (UPUS):

Table VI lists standards adopted from US EPA, known as Maximum Contaminant Levels, or MCLs, or other regulatory established criteria. MCLs by definition are the highest level of a contaminant that is allowed in drinking water at public water intakes. MCLs are enforceable standards. Because MCLs are not based solely on risk to the receptor, they are not subject to a multiple chemical adjustment.

Table VII lists unrestricted potable use standards that are derived through risk equations with residential exposure assumptions. Ground water standards from table VII are subject to multiple chemical adjustment.

[SLIDE 33]For surface water, the generic standards are the Outside the Mixing Zone Average (known as the OMZA) chemical criteria pursuant to Chapter 3745-1-07 of the Ohio Administrative Code. The OMZA for human health and aquatic life are compared against a 30-day average value from the following locations:

- ground water monitoring wells at the property boundary or immediately adjacent to the surface water, if the ground water daylights to surface water on an adjoining property;
- surface water on the property; or
- surface water at off-property locations, at the point of immediate discharge of contaminated ground water.

Single ambient samples are not to exceed the Outside the Mixing Zone Maximum (OMZM). If chemical constituents exceed the OMZA or OMZM, then surface water must be further assessed in a property-specific risk assessment, or a remedy conducted.

[SLIDE 34]All regulated point source discharges to surface waters must comply with all permit requirements. The release of liability with a CNS does not extend to permit violations. Similarly, complete exposure pathways of a permitted storm water discharge or any other permitted source, need not be analyzed in an NFA letter. Permit requirements are assumed to address regulated pathways. As a practical application, any settling pond or retention basin does not constitute an important ecological resource if it is up-gradient of a permitted outfall.

[SLIDE 35]Sediments must be evaluated at a property when complete exposure pathways to sediments exist on the property or contaminated sediments are or have migrated

from the property. Sediment assessment includes risks to both human health and important ecological resources.

Sediments are sampled according to Ohio EPA, "Sediment Sampling Guide and Methodology" This typically requires sediment collection from areas that contain finer grained materials. Composite samples from one area are acceptable. For exposure point concentration, you can use either the maximum concentration or 95 percent UCL.

[SLIDE 36]For human health evaluation, a complete pathway from sediments to humans is considered complete only if COCs are persistent, bioaccumulative, and toxic in sediment and surface water and the potentially affected surface water body can produce a consistent supply of edible-sized fish. Complete pathways to humans can also be presumed if the surface water containing sediments supports wading, fishing, swimming, or boating.

The generic direct contact soil standards for residential land use can be used as generic sediment standards for human health. However, because these standards consider only direct contact, a property-specific risk assessment must be conducted if the COCs in sediment are persistent, bioaccumulative and toxic.

[SLIDE 37]Generic standards for sediments to important ecological resources are found in rule 08. The volunteer can sample sediments directly and compare concentrations to the Ohio-specific sediment reference values or SRVs found in Ohio EPA's "Guidance for Conducting Ecological Risk Assessments".

[SLIDE 38]If there are COCs for which there are no SRVs, then the volunteer must compare the COC concentration to the consensus-based threshold effects concentration values in MacDonald, et. al.: "Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems," or U.S. EPA, Region 5 ecological screening levels.

COCs must meet the benchmark values discussed. However, COCs that are persistent, bioaccumulative, and toxic must be evaluated through a property-specific risk assessment even if they meet the stated benchmarks, unless the benchmarks consider bioaccumulative effects.

[SLIDE 39]If sediment values are not compared to the stated hierarchy of values, or if concentrations of COCs exceed those values, then sediments must be evaluated by conducting

either bioassays or biocriteria surveys in accordance with the property-specific risk assessment rule. In lieu of further assessment, a remedy may be performed.

[SLIDE 40]For all COCs listed in tables I, II, III, IV, V and VII, an adjustment must be made to the applicable standard if more than one chemical is found at a property. Adjusting the standards for the presence of multiple chemicals is not appropriate for lead or ground water MCLs because those standards take into consideration factors other than risk to receptor. When using generic standards, a multiple chemical adjustment for soil and ground water is calculated separately. With some exceptions, when conducting a property-specific risk assessment, the incremental risk from each COC, media and pathway must be summed to develop an estimation of total risk for each receptor.

The reason the generic standards tables are in three columns is to provide the value for cancer and non-cancer effects and soil saturation. For a multiple chemical adjustment, the cancer and non-cancer values can be considered separately. Soil saturation is not subject to multiple chemical adjustment. For standards that default to soil saturation, perform a multiple chemical adjustment on the listed cancer and non-cancer values.

[SLIDE 41]Divide the exposure point concentration at the site by the single chemical standard value to obtain a ratio for each COC. If the sum of the ratios is less than one, then collectively the concentration of COCs at the property meet the risk goal – 1E-5 for cancer and a hazard index or HI of 1 for non-cancer.

Further separation of the non-cancer multiple chemical adjustment can be performed by categorizing COCs according to which target organ was identified in the critical study used to derive the toxicity value.

[SLIDE 42]Another way to adjust for multiple chemicals is to divide the standard for each COC by number of COCs. The adjusted value can then be compared to the single chemical value, and each ratio summed. If the summed ratios are less than 1, the applicable standards are met. If summed ratios exceed one, the applicable standards are not met.

[SLIDE 43]If the applicable standards are not met, a remedy is necessary. However, it is possible to further adjust the standards if remedial activities lower the exposure point concentration for a particular COC. Remember, the goal is for all COCs in each media to reach a

concentration such that the risk goals are met for all COCs and exposure pathways for each receptor.

[SLIDE 44]The following two slides illustrate a basic multiple chemical adjustment. Suppose a property has these four COCs in soils. For this example, soil saturation limits are higher than either the cancer or non-cancer standard value so the soil saturation values are not shown in the example.

[SLIDE 45]Using the site concentration values divided by the standard, a ratio can be calculated. If the ratios are less than one, the standard does not have to be adjusted for the presence of multiple chemicals. If the ratio exceeds 1, then the standard must be adjusted. In this case, the cancer ratio exceeds one, and thus a remedy is necessary.

[SLIDE 46]A multiple chemical adjustment can also be calculated by dividing the standard by the number of COCs and determining if site COC concentration exceeds the multiple chemically adjusted value. If there is a cushion of risk available in concentration of other COCs compared to the standard, the multiple chemically adjusted standard can be further adjusted. The goal is to meet a 1E-05 risk goal or HI of 1.

[SLIDE 47]In addition to evaluating direct exposure to contaminated media, rule 08 requires that the volunteer develop soil standards for leaching of COCs from soil to ground water, when the protection of that ground water is required or when there are potentially complete exposure pathways from ground water exposure.

[SLIDE 48]A property-specific risk assessment is based on the same principles as those used to generate the generic standards. A property-specific risk assessment can be either elective or mandatory. A volunteer can elect to use property-specific information as inputs to the algorithm generating the standard, subject to reasonableness for the property.

[SLIDE 49]Mandatory application of a property-specific risk assessment applies under the following scenarios:

- When the exposure pathways for the intended land use aren't included in the development of the generic standard or when an exposure scenario exists other than residential or commercial/industrial land use;
- If a COC at the property does not have a generic standard in rule 08;

- If concentrations of COCs in surface water or sediment exceed applicable standards in accordance with rule -08;
- **[SLIDE 50]**If complete exposure pathways to important ecological resources other than sediment or surface water exist (such as terrestrial receptors); or
- If the COCs at the property are persistent, bioaccumulative, and toxic, and the generic standards do not consider these effects.

[SLIDE 51]The risk goals that must be met within a property-specific risk assessment are the same as those when using generic standards, with one exception: for COCs with carcinogenic effects, the total site-wide risk cannot exceed 1E-05 for commercial and residential properties. For industrial properties, a volunteer may use an excess lifetime cancer risk goal of 1E-04, provided that the risk to off-property receptors is 1E-05.

When assessing petroleum releases within a property-specific risk assessment, the COCs that must be evaluated are dependent on the petroleum fraction of the released product. Applicable standards consist of meeting TPH soil saturation concentrations listed in table I for the appropriate COCs typically associated with the corresponding petroleum fraction. It may be appropriate to evaluate additional petroleum constituents or typical impurities.

[SLIDE 52]A property-specific risk assessment consists of 4 parts:

1. Selection of COCs;
2. Exposure assessment;
3. Toxicity assessment; and
4. Risk characterization, which includes summation incremental risk from multiple COCs and pathways and uncertainty analysis.

[SLIDE 53]Exposure assessment in a property-specific risk assessment is no different than the process used for derivation of the applicable standards. Components include identification of receptors, evaluation of complete or potentially complete pathways, and quantification of intake for the current or intended exposure scenario.

[SLIDE 54]In a property-specific risk assessment, the total risk to the receptor must be characterized. This includes not only a multiple chemical adjustment of an applicable standard

for each media, but also includes calculation of the incremental risk from each exposure pathway. Thus, an estimation of the site-wide risk to the receptor is calculated.

[SLIDE 55]Cumulative risk from all pathways can be represented as either a ratio or incremental risk. A ratio of 1.0 indicates a total risk goal of 1E-05 and/or an HI of 1. Incremental risk and hazard must be summed for each COC and media across all complete or potentially complete exposure pathways.

[SLIDE 56]A property-specific risk assessment is also required when complete exposure pathways to important ecological resources, excluding sediment and surface water, exist. For the most part, this includes terrestrial habitats that support rare, endangered or threatened species, and wildlife populations and their important nesting areas and food resources. Estimation of habitat quality is necessary to determine if significant wildlife populations or food resources exist. For example, an industrialized property may have limited green space around buildings, roadways, etc. There may be a limited number of trees or nesting sites. This type of habitat would generally not be considered as an important ecological resource.

[SLIDE 57]If sediments or surface water exceed generic standards discussed in rule 08, or if the COCs in sediment and surface water were not compared to the COCs for which there are standards in rule 08, then an assessment of the biology is warranted. Site impacts are assessed to determine possible biology impacts for an aquatic life use designation. Determining which aquatic life use designation applies to a given water body is primarily based on the ability of the available habitat to support a given use. Two important factors are involved and include an assessment of the physical habitat and knowledge of what the habitat will biologically support. Ohio EPA sampled bodies of water throughout the entire state, and designated certain sites as “reference sites.” These reference sites were then compared to the rest of the sites within the state, and use designations were then applied.

[SLIDE 58]There are 5 different aquatic life use designations:

- exceptional warm water habitat (EWH),
- warm water habitat (WWH),
- modified warm water habitat (MWH),
- cold water habitat (CWH), and

- seasonal salmonid habitat (SSH),

which are assessed through biological assessment of fish and macroinvertebrates.

For limited resource water, or lakes, reservoirs, wetlands, or ponds, applicable standards are the absence of toxic effects for growth and mortality as measured through bioassays.

[SLIDE 59]For surface waters with an aquatic life use designation of limited warm water habitat or with no aquatic life use designation, a volunteer must either conduct a use attainability analysis or apply biocriteria for warm water habitat.

Assessing biology for designated use attainability involves assessing habitat quality that support fish and macro invertebrates, sampling biota, and the application of specific metrics to determine if site impacts are affecting the use attainment.

[SLIDE 60]In order to measure how site impacts affect use attainability, biological surveys must be conducted by a person certified by the VAP to conduct biocriteria. Ohio EPA provides training to become certified in biocriteria in Ohio. Separate certificates are issued for fish, macroinvertebrate, and habitat assessment. Alternatively, Ohio EPA can perform the bioassessment under paid technical assistance.

[SLIDE 61]Applicable standards for sediments can be achieved either through a remedy, or through a demonstration that hazardous substances or petroleum on the property are not contributing to the failure of the on-property sediments to meet applicable standards. In other words, if sediments upstream are the culprit, applicable standards for sediments for eco-receptors for the subject property can be considered to be met. The off-property "pass-through" demonstration only applies to ecological receptors. Regardless of source, on-property sediment exposures must be protective of human health.

[SLIDE 62]When conducting a property-specific risk assessment, applicable standards consist of the following:

- Concentration of COCs meeting human health risk goal;
- Concentration of COCs meeting ecological risk goals;
- Sediment standards;
- Surface water standards; and

- Soil saturation values.

For each media, the applicable standard defaults to the lowest value of these standards, after adjusting for the presence of multiple chemicals and pathways.

[SLIDE 63]Supporting documentation used to issue an NFA letter should include:

- Reason for property-specific risk assessment;
- List of institutional and/or engineering controls;
- List of COCs not considered;
- List of exposure pathways;
- **[SLIDE 64]**Derivation of exposure pathways;
- Toxicity values;
- Risk characterization;
- **[SLIDE 65]**Uncertainty analysis (if conducted);
- Ecological, sediment, surface water assessment; and
- Summary of compliance with applicable standards.

[SLIDE 66]A lot of information has been thrown at you. Let's look at a hypothetical case study, and try to pull some the concepts together:

The volunteer is a local developer and the property owner. The volunteer wants to demolish the warehouse and build an outdoor shopping center. When you visit the site you see commercial land use to the north, west, and south. There are residences to the east. From the road, you can see a creek behind the houses. You have some questions about the property. What is the history of the property? Is there soil contamination? Is there groundwater contamination? Who are the receptors? What sort of remediation, if any, will be necessary?

Let's say that you determine that your property is eligible for the VAP in accordance with Rule 02. Your first step is a Phase I property assessment in accordance with Rule 06.

[SLIDE 67]In your Phase I, you investigate the inside of the warehouse. There are no known or suspected releases of hazardous or petroleum-related substances inside the current building. However, the Phase I indicates that there used to be a manufacturing facility south of the existing warehouse. This facility manufactured metal tools. You identify several potential

releases inside the facility and call this area IA-1. The former paint booth area is designated as IA-2.

Historic records indicate that a TCE spill occurred in the northeast corner of the property, and may have been related to operations at the former manufacturing facility. However, there are no additional details regarding the release. You designate this area as IA-3.

Historic records also revealed a former UST in the southwest corner of the property. You determined that this UST contained heating fuel for use on-property. You have received written communication from BUSTR that they do not regulate this type of UST. So, this area becomes IA-4.

During your Phase I, you also define the known or potential COCs in each IA.

[SLIDE 68]Your next step is a Phase II property assessment in accordance with Rule 07. Here, you investigate the IAs you designated in your Phase I. A site conceptual model will help guide your sampling. You need to consider whether or not various exposure pathways are complete in accordance with Rule 07. A typical site conceptual model might have a primary source of contamination such as a release of TCE to soil, a release mechanism such as leaching, to an exposure medium such as shallow groundwater.

If a VOC like TCE was present in soil or groundwater, you also need to consider vapor intrusion. In this case, there would be a release mechanism (volatilization) to a secondary medium (soil gas), followed by a transport mechanism (diffusive or convective transport) to a final exposure medium (indoor air). The receptors might be on-property commercial/industrial workers. Or, if COCs in groundwater are migrating off-property, you might have residential receptors.

The site conceptual model has helped you determine that you'll need to collect soil and groundwater samples and, if VOCs are present in either medium, you'll also need to collect soil gas, sub-slab vapor, or indoor air samples. As you learn more about the site, your site conceptual model might change.

In this hypothetical case, let's assume you do not need to evaluate groundwater potable use pathways because this site is located in an approved USD.

[SLIDE 69]You install monitoring wells to collect groundwater samples. You also collect soil borings within identified areas across the property. All of your sampling is biased to the areas you suspect contain the highest concentrations of COCs.

[SLIDE 70]In your Phase II you construct cross-sections to help define the site lithology. You also characterize the groundwater aquifers at your site and determine the direction of groundwater flow.

In this case, you confirm that there has been a release of hazardous substances to a shallow groundwater aquifer. You have also determined that groundwater is flowing east toward the creek. You conclude that the groundwater to surface water pathway is also complete, and you'll need to modify your site conceptual model to include this pathway.

You collect sediment and surface water samples from the creek behind the residential homes. The sediment samples exceed the sediment screening values in Ohio EPA's Guidance for Ecological Risk Assessments. This means a property-specific ecological risk assessment is required in accordance with rule 09.

Fortunately, Ohio EPA completed a biological survey in that creek just last year, and has determined that the creek is in full attainment of its warm water habitat aquatic life use designation. Let's see what this looks like in the site conceptual model:

[SLIDE 71]You've added the groundwater to surface water pathway to the site conceptual model. You've evaluated surface water and sediment pathway to ecological receptors. However, you still need to evaluate the surface water and sediment pathway to human receptors – in this case, the residential receptors that live adjacent to the creek.

Let's turn our focus back to the on-property receptors so we can see how cumulative risk might be calculated. As you can see, there are multiple complete or potentially complete pathways to on-property commercial/industrial workers. According to the site conceptual model, you anticipate on-property commercial/industrial workers to be exposed to contaminated soil, known as the soil direct-contact pathway, and to breathe indoor air that may contain contaminants that have volatilized from groundwater or soil, otherwise known as the vapor intrusion pathway. You also may have off-property vapor intrusion of the residential properties.

[SLIDE 72]Here, in a simple example, you are calculating risk on a site-wide basis.

You have four COCs at the site. The exposure point concentration in mg/kg is the maximum concentration in soil. Your standard for a single chemical non-carcinogen and your standard for a single chemical carcinogen are from table II of Rule 08 Appendix A for generic soil direct-contact standards.

To determine the risk ratio for benzo(a)pyrene, you divide the exposure point concentration (4.1 mg/kg) by the carcinogenic standard (5.8 mg/kg) to obtain 0.707 ,or 7 x 10-6. Benzo(a)pyrene is below the risk goal of 1 x 10-5; however, you must also account for other cancer-causing COCs. Here, TCE has a risk ratio of 0.072. Therefore the cumulative risk ratio rounded to one signification figure is 0.8, or 8 x 10-6.

You calculate the hazard quotient similarly for each COC, and the final hazard index rounded to one significant figure is 0.3. Both the risk and hazard are below the risk goals of 1E-05 and 1. Note that you've checked the soil saturation values for TCE and Vinyl Chloride. Since the risk based standards are less than the soil saturation concentrations, you must use the risk based standards.

[SLIDE 73]Now let's consider the groundwater to indoor air pathway. Let's say you detected two volatile COCs in groundwater – TCE and vinyl chloride. There are many tools you can use to assess vapor intrusion to indoor air from various media including soil, groundwater, soil gas and indoor air samples. However, the area of interest is the TCE spill area where there are currently no buildings. Let's say you use U.S. EPA's VISL calculator to estimate the hazard and risk for each COC. You calculate a risk ratio of 3 or 3 x 10-5 for vinyl chloride alone, and this exceeds your risk goal of 1 x 10-5.

[SLIDE 74]Because there is always some uncertainty when evaluating vapor intrusion from media to indoor air, you've decided to collect soil gas samples. You should collect these soil gas samples in accordance with Ohio EPA's vapor intrusion guidance, considering your understanding of the source and the potential receptors.

[SLIDE 75]Once you have the soil gas data, let's say that you use U.S. EPA's VISL Calculator again, but this time evaluating soil gas to indoor air. According to the VISL results, vinyl chloride still exceeds applicable standards.

You have two options – the first option is to remediate. For example, you can perform ground water treatment to encourage degradation of TCE and vinyl chloride. However, let's say that this option is not feasible for the volunteer. The volunteer also has the option of installing an engineering control to mitigate the vapor intrusion pathway for commercial/industrial workers. However, because there is no building currently on the site, you cannot immediately install this engineering control. Therefore, you can designate what is called a building occupancy limitation area that is legally described in an environmental covenant, along with the use restriction for commercial/industrial land use.

[SLIDE 76]This building occupancy fully encompasses the area that your data indicate will result in unacceptable risk posed to commercial/industrial receptors now and in the future. You still have some volatile contamination throughout the site. Your building occupancy limitation area addressed the most elevated concentrations on the property. You determine a concentration for each COC in soil gas using the other soil gas samples collected at the property, and use the U.S. EPA VISL Calculator to estimate the cumulative vapor intrusion risk remaining at the property.

[SLIDE 77]Here, we have the hazard and risk ratios for each pathway – the soil direct-contact pathway and the vapor intrusion pathway. Note that because you collected soil gas samples, these samples represent volatilization from both the soil and the groundwater.

Your cumulative hazard index is 0.5, which is below the goal of 1. Your cumulative risk ratio is 0.9, or 9 x 10-6, which is below the risk goal of 1 x 10-5. Next, you'd go back to your site conceptual model to determine how to evaluate on-property construction/excavation workers. Remember that you still need to evaluate for off-property receptors.

This concludes our module on generic standards and risk assessment procedures. We know that becoming comfortable with the concepts presented here will take some time but feel free to call the VAP anytime for assistance.