Background Information

Principles of Environmental Site Assessment

Across the nation, elected officials, civic leaders, community groups, and private citizens often need to assess environmental risks in their communities. Environmental risks are a factor in many public issues, such as zoning for new industrial sites, the regulation of existing industries, the management of different kinds of waste, and the cleanup of abandoned hazardous waste sites. People make decisions about these issues based on many factors, including science, economics, politics, social pressure, and emotions.

Polls show that the public's top environmental concern is toxic releases from active and abandoned hazardous waste sites. This background discusses some of the scientific factors considered in evaluating the environmental risks posed by these facilities.

A Little History

In the late 1970s, the public grew alarmed over contamination of a residential subdivision that had been built over an old hazardous waste landfill in Love Canal, New York. Contaminants leaked into people's basements, and residents soon complained of a host of illnesses. In 1980, while the furor over Love Canal was fresh, Congress enacted a law to deal with the cleanup of abandoned waste sites and older facilities that had stored or disposed of hazardous waste before the more stringent environmental regulations of the 1970s were in place. Called the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and also known as Superfund, the law provides mechanisms for responding to hazardous waste spills, investigating and remediating abandoned sites, reparation of people harmed (for example, providing funds for relocation or for medical treatment and monitoring), and determining who is liable for the cleanup and reparation.

The U.S. Environmental Protection Agency (EPA) and other government bodies soon realized that the number of sites potentially falling under CERCLA regulations was in the tens of thousands. Addressing all of them equally would have been logistically and financially impossible.

Addressing a Superfund site typically requires a detailed remedial investigation to determine the nature and extent of contamination (often conducted in several phases), a feasibility study to determine cost-effective ways to clean up the contaminants, and an environmental risk assessment.

Environmental risk assessment is the process of evaluating and quantifying the risk posed by environmental contaminants. (Environmental contaminants are defined as physical agents or chemical substances that travel to and interact with humans or the environment in ways that cause or have potential to cause harm.) The risks being assessed may be those to humans (health risk assessment) or to other organisms and the environment (ecological risk assessment). The risk assessment process usually involves several component studies which may include exposure assessment to measure how much exposure to the contaminant people or the environment actually incurred; toxicological or epidemiological studies to determine whether exposure to the contaminant causes adverse health effects; and dose-response assessments that quantify the relationship between contaminant dose received and increased occurrence of the health effect.

Remedial investigations, feasibility studies, and environmental risk assessments usually entail years of work and are very expensive to conduct. For these reasons, the EPA established a process for quickly and less expensively determining which of the thousands of CERCLA sites warranted further investigation. This abbreviated process is called environmental site assessment.

Environmental Site Assessment

Environmental site assessment is the process of evaluating hazardous waste sites to identify those that pose the most serious threats and therefore require the highest priority in cleanup. It is a sort of "quick and dirty" remedial investigation/risk assessment. Although designed primarily for abandoned waste sites, the site assessment methodology involves many of the same principles used to evaluate any site that handles hazardous substances.

Site assessment usually involves two steps: a site inspection and a hazard ranking. The site inspection is used to identify the types of hazardous substances present, evaluate whether they have been (or could be) released to the environment, and determine whether people or the environment have been or could be exposed to these substances. Data collected from the site inspection are then used to calculate a hazard ranking score based on EPA's Hazard Ranking System (HRS). Sites that score above a certain number are considered eligible for Superfund cleanup. Sites scoring lower are designated "no further action planned" and are shelved but remain listed as potential problems. In theory, sites with the highest scores receive the highest priority for remedial investigation, risk assessment, and cleanup.

While the site assessment process can be laborious in practice, its principles and concepts are straightforward. Suppose you were asked to investigate an industrial facility or abandoned waste site to decide whether it was a significant environmental threat. Where would you begin? First, you might look at the type and quantity of substances the facility handled, determine how hazardous these substances were, and determine how carefully the company handled the substances. Next, you might look for signs of spills, leaks, or contaminant discharge into nearby streams. Then you might test samples of groundwater or surface water to see whether the substances used by the company or disposed of at the site are present in the samples. You might test nearby drinking water wells to see if those contaminants were present. You might review historical aerial photos to look for areas of past waste disposal or conduct a survey to see how many people live nearby, where they get their water, or whether schools or nursing homes are located nearby.

These common-sense steps closely resemble the steps of an actual environmental site assessment. However, additional details are involved that the general public may not consider. The following sections describe the factors that must be present to constitute an environmental problem and the hazard ranking process.

Do We Have a Problem?

In order for an environmental problem to present a serious threat to human health or the environment, four conditions must be present:

- a source of hazardous substances,
- a release of hazardous substances to the environment,
- a route of transport (pathway) for the substances to travel from the source to the target, and
- targets (human or ecological) that are exposed to the substances.

Sometimes these conditions can be met by a natural phenomenon, such as a volcano, but such natural phenomena generally tend to be out of human control. Therefore, discussions about environmental hazards focus almost exclusively on those caused by human activity.

One might argue on ethical grounds that any release of hazardous substances to the environment should be cleaned up, even if the pathways and targets are minimal or lacking. However, in order to make the most of finite resources such as time and money, the most urgent problems must be identified and prioritized for remediation. Again, this is the purpose of site assessment.

Once environmental site assessors establish evidence of a potential environmental hazard, the next step is to decide what steps, if any, should be taken to address the problem. Consider an example from a real site located in a rural portion of northern Ohio. In the late 1980s, hundreds of bags filled with waste asbestos were illegally dumped into a small creek where people regularly fished. Do the bags represent an immediate health threat? Certainly the bags should be cleaned up, but the director of the regional EPA office with a limited cleanup budget had other sites vying for attention and emergency response. He or she had to decide whether to send an emergency Hazmat team to deal with the cleanup and disposal. Asbestos is primarily an inhalation hazard to people in confined areas such as buildings. In the stream environment, it will eventually erode down to silt or clay, becoming part of the stream sediments. Asbestos is unlikely to contaminate the aquatic food chain because it doesn't readily accumulate in fish tissue, as some substances do.

Thus, even though all four conditions were present in this example, the properties of the contaminant are such that the threat to potential targets (people eating fish from the creek or breathing in the asbestos) was low. In the end, this dumping posed a litter problem, not necessarily an imminent environmental hazard. The EPA consultant recommended that cleanup of this site would be best handled by state or local agencies and need not involve the EPA or Superfund. The thought process used to make this decision was based on applying the HRS.

The Hazard Ranking System (HRS)

Site inspection data are used to calculate an HRS score for a site. The scoring process looks at three factors: waste characteristics, likelihood of release, and targets. These factors are evaluated for each pathway (groundwater, surface water, soil, and air).

The waste characteristics factor deals with properties of the source: how much waste it has released or could release, how hazardous the substances are, and what unique environmental threats the substances pose. For example, some substances, such as DDT, are ecological threats. Waste characteristics values for these substances may be higher if they are threatening a nearby endangered species habitat than if they are threatening only groundwater.

Likelihood of release, as the term suggests, deals with variables that could increase or decrease the chances that a hazardous substance is released to a given pathway. Factors influencing likelihood of release include how well contained the source is, geologic factors, and climatic variables such as rainfall.

Lastly, the targets factor concerns the location, proximity, and number of potential human and environmental targets. Table 1 shows each of the factors and the kinds of information each factor is based on.

Table 1: Factors Used in Hazard Ranking of an Environmental Site	
Factor	Basis Used for Evaluation
Waste Characteristics	• waste quantity • toxicity of waste • mobility or persistence of waste in the environment • ecotoxicity and bioaccumulation potential of the waste
Likelihood of Release	• containment of sources • topography • geology • climate
Targets	• number of targets • distance of targets from source • actual contamination or only potential for contamination • level of contamination (if actual)

Numerical values for the three factors are calculated for each of the pathways and multiplied together to derive a pathway score. The pathway scores are then combined to calculate a total score for the site. The details of calculating these scores are unimportant for our purposes. What matters is that one understands the logic of the process and the kinds of information that must be gathered and assessed before a score can be generated.

Waste Characteristics Factor

The waste characteristics factor is based on how many sources are present on site and the quantity and toxicity of the substances present. Depending on the pathway evaluated, a substance's mobility (say in groundwater), bioaccumulation potential, or persistence in the environment are also considered in the evaluation.

A Word About Terminology

Under CERCLA, sources are evaluated for releases of (or potential to release) hazardous substances, pollutants, or contaminants. Superfund defines hazardous substance by referencing substances specifically covered under other federal statutes. A hazardous substance may be a chemical specifically listed as hazardous or one that has the characteristics of being hazardous (for example, ignitable or corrosive). The terms "pollutant" and "contaminant" are very broadly defined and could include any substance known or reasonably anticipated to be harmful to human or ecological health. Because no substances are actually listed as pollutants or contaminants, EPA determines on a case-by-case basis which substances fall within the definition. For example, warm water is not normally considered a hazardous substance, but if it were released into a body of water resulting in a fish kill, it could be regarded as a pollutant or contaminant. In this background document, the term "hazardous substance" will include actual regulated hazardous substances as well as pollutants or contaminants. The terms "contaminant" or "contamination" will generally refer to hazardous substances or pollutants that have been released to the environment.

Identifying Sources

Human-made contaminant sources are classified as either point or nonpoint. Point sources, as the name suggests, are single locations from which the contaminants originate, such as a sewage pipe, smokestack, or leaking storage tank. Nonpoint source contaminants, such as auto exhaust or agricultural or urban runoff, come from many locations and can be more difficult to control. It is generally impossible to attribute environmental contamination resulting from nonpoint sources to any one person, group of people, or company.

Identifying the specific source of a contaminant is often difficult. A large industrial area may contain numerous point sources of contamination. An entire site or facility is hardly ever considered a source; instead, the source is more likely to be specific areas within a site where hazardous substances have been deposited, stored, or disposed of. Some typical industrial sources include the following:

- storage and transport containers, such as drums, tanks (both above and below ground), pipelines, railcars, and tanker trucks;
- waste disposal and treatment units, such as landfills, treatment/storage ponds (also called surface impoundments), waste piles, piles of mine tailings, burn pits, and incinerators;
- waste water discharge pipes (outfalls) and smokestacks (generally not a concern at abandoned waste sites); and
- other sources such as process spills, contaminated soil, and contaminated buildings.

Waste Quantity

After identifying the sources, the next step in waste characterization is to determine the quantity of hazardous substances in the source. This factor is called the waste quantity value. All other things being equal, a facility with 10,000 drums of hazardous waste is more of a threat than one with 10 drums. Similarly, a 250-acre landfill is more worrisome than a 5-acre landfill of similar content and construction.

In general, waste quantity depends largely on two factors: the amount of waste and the concentration of hazardous substances in the waste. For example, a 1,000-gallon tank containing dilute levels (e.g., part-per-million) of hazardous substances may have a smaller waste quantity value than a 100-gallon tank of a highly concentrated chemical. At abandoned waste sites, information about the total mass of hazardous substances in a source is usually lacking. For this reason, site assessors employ several different tiers of waste types to calculate waste quantity. These tiers represent decreasing levels of information about the source. The waste quantity values for each source are added together to obtain a waste quantity value for the site.

Human Toxicity of the Waste

In order to fully characterize the waste in a source, we need to determine exactly what hazardous substances are present in the waste and how toxic they are to humans. Some sources, like a product storage tank, may contain only one substance; other sources, such as landfills, could contain hundreds of hazardous substances. The number and types of hazardous substances present can be determined from product labels, company records, manifests, or, in most cases, direct sampling of material in the source.

After determining the identity of the hazardous substances, we must identify the most toxic substances in the waste. Toxicity is a relative term that depends on dosage and the duration and type of exposure. (See "An Introduction to Toxicology" Background.) But in general terms, some substances are simply more toxic than others.

Ecological Toxicity of the Waste

Some substances, such as the pesticide DDT, pose a particular hazard to ecological targets. The toxicity of a substance to wildlife or sensitive environments is also considered in calculating the waste characteristics factor. Pesticides have very high ecotoxicities as do some other organic compounds. Some inorganic contaminants considered to have high ecotoxicities are chromium, mercury, and zinc sulfate. HRS also calculates ecotoxicity values based on whether the contaminants have been released to freshwater or salt water. In general, ecotoxicity for most substances is considered lower in salt water.

Bioaccumulation Potential of the Waste

Bioaccumulation is the accumulation of increasing concentrations of potentially toxic substances in an organism. Substances that bioaccumulate tend to be nonpolar, lipophilic (fat-loving) compounds that accumulate in the fatty tissues of organisms and are not efficiently metabolized into easily excreted forms. Highly bioaccumulating substances are usually oily organic compounds, like many pesticides and all PCBs, but can also include metals such as lead and mercury if these metals are present in compounds which organisms can readily absorb. Bioaccumulating substances may pass through several levels of the food chain, becoming more concentrated in the tissues of organisms higher on the food chain. This process is known as biomagnification.

HRS views bioaccumulation of contaminants as threats to both the human food chain and to the ecology. Bioaccumulation is generally higher in aquatic than in terrestrial organisms. For this reason, HRS does not account for, say, cattle grazing in a contaminated field. However, such a food chain threat would be considered in a full risk assessment.

Environmental Mobility and Persistence of the Waste

The mobility and persistence of a substance are important factors in characterizing waste because these qualities determine how much of a future threat the source poses to human health and the environment. These properties are assigned HRS values depending on the pathway being evaluated.

Groundwater Mobility

The ability of a substance to enter the groundwater pathway depends on a number of complex physical and chemical properties, which site assessors consider in calculating a groundwater mobility factor. Groundwater mobility depends most heavily on the substance's solubility in water and the permeability and other properties of the aquifer threatened.

Whether the contaminant was originally released as a liquid is probably the most significant factor determining groundwater mobility. Liquids flow and can move directly to the groundwater, while solid substances must be carried by percolating rainwater.

One geologic factor to consider is whether the contaminants were released in a karst terrain. Karst terrains are characterized by having numerous underground caverns and passageways through which contaminants can rapidly flow for long distances.

Substances considered to have relatively high groundwater mobilities include volatile organic compounds and soluble inorganic substances. Substances with low groundwater mobilities include most pesticides, PCBs, and polynuclear aromatic hydrocarbons. These substances rarely become groundwater hazards because most are not very soluble in water and tend to bind with soil particles.

Once a liquid substance enters groundwater, its behavior is influenced not only by its solubility but also by its density and other properties. Some substances form a nonaqueous-phase liquid layer (like oil on water), which may float or sink in the aquifer depending on their density. Some contaminants eventually break down to form compounds that can be less toxic or more toxic than their precursors. For example, many chlorinated solvents can ultimately degrade to vinyl chloride, a powerful human carcinogen. However, these fate and transport issues are generally beyond the scope of most site assessments.

Surface Water Persistence

Once the contaminant has entered a surface water body, it is subjected to various natural forces that tend to break the substance down or remove it from the water column. Such processes include biodegradation (eaten by bacteria), hydrolysis (broken down by water), photolysis (broken down by sunlight), or volatilization (evaporation). Some substances like PCBs and DDT linger in sediments and degrade very slowly. However, some volatile organic compounds may disappear almost immediately through evaporation. Inorganic substances may precipitate out or disperse and stay in solution. Persistence also depends on the type of water body contaminated; it is considered larger for lakes than river because the former do not flow and generally lack outlets.

Soil Exposure
The soil exposure pathway is different from the other pathways because it is not really a migration route. The emphasis in this pathway is on the likelihood that people will come into contact with hazardous substances where those substances already are. For this reason, mobility and persistence of the hazardous substances present are not factors in evaluating the waste characteristics for the soil pathway.

Air Mobility
A substance's mobility in the air pathway depends on whether the substance is a gas or a particulate. The air mobility of a gaseous contaminant, including many volatile and semivolatile organic compounds, depends on the nature of the gas and its vapor pressure and temperature. The mobility of a particulate substance depends on particle size, dryness, concentration, and climatic variables. For example, air mobility from a dry chemical waste pile is a greater threat in an arid, windy climate than in a humid one.

Putting Waste Characteristics Together
At this point in the evaluation, the person doing the site assessment would plug in a set of numbers for waste quantity, toxicity, mobility/persistence, and ecotoxicity/bioaccumulation to determine a waste characteristic factor value for each of the pathways of concern.

In summary, to assess the waste characteristics of a contaminant source, begin by asking the following questions: What are the sources? How large are they? What's the concentration of hazardous substances in them? How toxic are the hazardous substances? What particular environmental threats do they pose? (For example, do they bioaccumumulate?) How mobile or persistent are the substances in the environment?

Likelihood of Release Factor

Next, an assessor looks at whether the sources have released or are likely to release hazardous substances into the environment. As with waste characteristics, the likelihood of release factor is evaluated based on the pathway being considered.

Containment
One of the most important factors influencing likelihood of release is how well contained the sources are. Stroll through any number of industrial facilities with chemical storage tanks and you're likely to see raised walls or berms around the tank bases. The walls are designed to contain the chemicals in case of a spill. Another common containment feature is a synthetic or clay liner underneath a landfill. The liner helps prevent landfill contaminants from leaching into the underlying groundwater. For similar reasons, you're likely to see chemical drums stored on a concrete pad. If a leak were to occur, the pad would prevent much of the spill from directly seeping into the ground. Containment levels are evaluated

based on the type of source and the pathway being evaluated. But for our purposes, it is sufficient to understand the concept and not the details.

Hazardous substances in a source are not necessarily free to migrate along each pathway. For example, an uncovered waste pile may be open to the air pathway, but if it's sitting on a liner and has good runoff control, it may have near zero likelihood of release to the groundwater or surface-water pathways.

Natural Environmental Variables

Likelihood of release is influenced by a number of natural variables such as site geology, topography, hydrology, and climate. We need to discuss these variables as they pertain to each pathway.

Releases to Groundwater

Variables that determine a source's likelihood of releasing a hazardous substance to groundwater include depth to the aquifer of concern, the permeability of rock layers between the surface and aquifer, and regional rainfall patterns. For example, would you be more worried if the aquifer supplying the town's drinking water was 400 feet below a potential source or 40 feet below the source? Perhaps the source lies on a surface of impermeable clay, or underground shale layers are present that will impede the flow of contaminants from the source. The geology of the area must be investigated before the environmental threat can be properly assessed.

Net precipitation in the area also plays a significant role in the likelihood of a contaminant being released to groundwater. In a humid climate, substances are much more readily flushed downward into the water table.

Releases to Surface Water

In the case of surface water contamination, we must consider not only precipitation but also the proximity of the source to streams or lakes and whether a path is available for movement of the contaminants. For example, a chemical spill located in a closed depression 2 miles from the nearest stream is unlikely to be a threat to that stream. We must also consider soil type and the amount of vegetation, because runoff from a source will be more extreme in areas where the soil is relatively impermeable or where little vegetation is present. Another question to consider is whether the source is located on a floodplain, where contaminants may be swept downstream by periodic floods.

Exposure to Contaminated Soil

For this pathway we would look at factors such as the total area of contamination, how accessible the area is, and how attractive it might be to nearby residents. For example, the likelihood of exposure to soil is low for a contaminated area that looks unattractive and is surrounded by a chain-link fence. Likelihood of exposure is high for a completely accessible area regularly used for public recreations such as fishing, softball, or hiking.

Releases to Air
In addition to how well contained the sources are, the likelihood of release to the air pathway depends on the air mobility of the substances present in the source and climatic factors such as temperature, rainfall, and windiness of the area.

Observed Release, Attribution, and Background Concentrations
Determining likelihood of release is a moot issue if we already have environmental samples (such as water or sediment) containing contaminants attributable to the source or if we have visual evidence of a release from the source (such as leachate seen flowing from a landfill into a nearby stream). Then we can record an "observed release" and assign the maximum value to the likelihood of release factor.

However, documenting an observed release can be difficult. Consider another example from an actual site, a closed 50-acre municipal landfill in a rural farming community. For most of its years of operation the landfill is thought to have received only household trash, but few official records exist. The town's water supply comes from wells located near the landfill, and for several years the local water superintendent has noted increased levels of ammonia and nitrates in the water. A number of families in town have children with leukemia, and the parents are blaming the landfill.

Proving that the landfill is responsible for the contamination is particularly difficult in this situation. Ammonium nitrate fertilizers are ubiquitously applied to fields in the area. A large fertilizer supply store is even located across the street from the town's wells. To demonstrate a release from the landfill, one would need to do a detailed hydrogeologic study that would involve installing a complex monitoring well system to isolate fertilizer contaminants coming from off site (in other words measure the background concentrations) and determining whether contaminant levels hydraulically downgradient of the landfill were significantly higher than background levels.

The consultant on this case recommended that the EPA conduct no further investigations at the landfill. The expense involved would be too high, given the low probability of being able to demonstrate the landfill was at fault. Too many other potential off-site and nonpoint sources were involved. Other factors were also considered in this decision: at the time of the initial investigation, the town's wells had already been closed and relocated. (A study of one of the closed wells showed that its casing had been cracked, allowing surface contaminants to seep in and creating another possible source for the original contamination.) In addition, an epidemiological study found no evidence of statistically higher leukemia rates in the community.

The main point of this example is that background or ambient levels of contaminants must be evaluated carefully in site assessment. One has to be sure that the environmental contaminants detected are attributable to the site or source in question. Determining background concentrations is particularly important when the suspected contaminants are naturally occurring metals such as arsenic, chromium, and manganese.

Target Factor

The target factor is evaluated based on number of targets, distance of targets from source, actual or potential contamination, and level of actual contamination. Two types of targets, human and ecological, are considered in environmental site assessment. Humans can be exposed to environmental contaminants through drinking water (groundwater or surface water), food chain (surface water or soil), inhalation, and dermal contact (soil or air).

Ecological targets can consist of sensitive environments such as wetlands, habitats for threatened or endangered species, national parks, preserves, and scenic rivers. In assessing the ecological threat, one needs to look not only at the number and sizes of the sensitive environments within the target area (area subject to potential or actual contamination from the site), but also at the ecotoxicity of the contaminant. Contaminants like the pesticide DDT have enormous potential to damage the ecosystem, but others have less. Ecological targets are evaluated for each pathway except groundwater.

Groundwater Targets

The principal threat from hazardous substances entering the groundwater pathway is contamination of drinking water. Many municipalities and private homes obtain drinking water from underground aquifers. If no one is using the water in a contaminated aquifer, then the threat from the pathway may be low, unless groundwater contaminants are seeping into other aquifers or into surface water and threatening targets there. In a few cases, contaminated groundwater can be a threat to humans through the food chain if the groundwater is being used for irrigation or large-scale commercial food (animal or vegetable) preparation. Even if no one is using the groundwater, HRS still factors in a target value because a natural resource has been contaminated.

All groundwater targets are distance-weighted to determine the seriousness of the threat. For example, if all other factors are equal, a well located 5 miles from a source is less likely to become contaminated than one located 100 feet away. However, wells near a contaminant source may be at low risk of contamination if they draw water from a separate aquifer that is disconnected from the contaminated one or are hydraulically upgradient from the contaminant source.

These concepts are illustrated in the following example. A small chemical company with a long history of poor housekeeping and waste management is located in a major river valley. Nearby residents living along the bluffs of the river use private wells and have complained of foul-tasting water. They want the local health department to test their wells.

A survey of the wells indicates that they are drawing water from a bedrock zone that is some 30 feet higher in elevation than the river terrace on which the plant is situated. Since groundwater does not flow uphill, the company could not be contaminating the wells; thus, other sources of contamination must be considered and investigated.

The number of people served by the well(s) or intake is also a significant factor. Contamination in a well serving 100,000 people scores higher in HRS than contamination in a well serving two people, although by HRS, a few heavily contaminated private wells may be enough to require a cleanup under the Superfund law.

If drinking water contamination has actually resulted from a release of hazardous substances, then the concentration of the contaminants in the water must also be considered in hazard ranking. The Safe Drinking Water Act mandates federal health-based maximum contaminant levels for many substances. If these levels are exceeded in the drinking water, then the site is an especially serious concern.

Surface Water Targets

The surface-water pathway can present three separate threats. Contaminants can threaten drinking water if surface-water intakes are located close to the source. Other contaminants may be a threat to humans by entering the food chain, and being eaten in fish and other organisms. Lastly, contaminants can be a threat to sensitive ecological targets such as wetlands or endangered species.

An important factor to consider in evaluating the surface-water pathway is the size and flow rate of the water body. Large streams and lakes have tremendous potential to dilute chemicals. A small chemical spill in the Mississippi River might be undetectable several miles downstream.

As with groundwater, the seriousness of the threat is rated based on the location and proximity of the targets to the source. A surface-water intake 20 miles downstream of a source is less likely to become seriously contaminated than an intake only 1 mile away. An intake upstream of a source may not be threatened at all.

In assessing a site, contaminants released to surface water must also be evaluated for their bioaccumulation potential. The contaminated water body is then assessed based on its yield as a fishery. The annual number of fish or other aquatic organisms harvested goes into the calculation to determine the environmental hazard. If the water body is not fished, then the surface-water food-chain threat is usually considered minimal.

Soil Targets

The hazards an environmental site poses through soil exposure depend not only on the toxicity of the contaminants and their concentrations but also on whether they are present on residential property and how extensive the residential contamination is. If contaminated soil is present only on site, then only the workers at the site or nearby residents accessing the site are considered in ranking the risk. Residential contamination increases the hazard ranking. The site is considered a much more serious hazard if sensitive targets, like children at a daycare center or school, are at risk of exposure to contaminated soil.

Air Targets

The air pathway is evaluated similarly to groundwater. The targets are distance-weighted so that the more people who are living close to the site or source, the more serious the risk. Obviously, air releases in heavily populated urban areas are a greater concern than releases in rural areas.

Putting It All Together

This document has summarized in a relatively simple manner the basic steps in the site assessment process. In practice site assessment is very detailed and complex, yet still has the straightforward goal of providing answers to the following questions:

1. What is the source?
2. What is the substance?
3. How much of it is there and in what concentrations?
4. How toxic is it?
5. Has it been released or is it likely to be released to the environment?
6. What is the greatest threat posed by the substance? (drinking water? ecological?)
7. What are the relevant pathways affected?
8. Are there potential targets?
9. Is there actual contamination of targets?
10. Can you attribute the contamination to the source?
11. How large and nearby is the target population?

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