Module 8: SI Strategies: Groundwater and Surface Water

8-1

Groundwater Migration Pathway

8-2

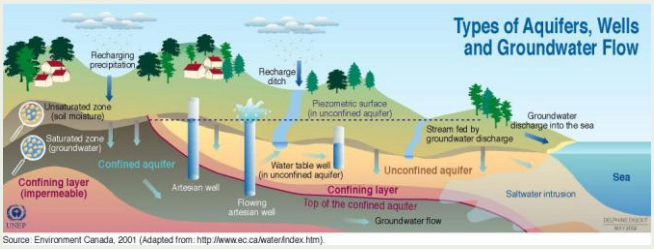
Objectives for Groundwater Pathway Sampling

- **Participants will be able to devise and evaluate groundwater pathway sampling strategies that:**
  - » Demonstrate an observed release
  - » Identify potential contamination targets
  - » Identify aquifer of concern
  - » Assess target distance limits
  - » Identify and assess nearest well and background well
  - » Address multiple aquifers and blended systems
- **Case study example**

EPA 8-3

Factor Category Considerations

- **Pathway score and aquifers and wells to be sampled depend on:**
  - » Likelihood of release to each aquifer
  - » Likelihood that drinking water wells are contaminated by the site
  - » Number of people served by each aquifer



Source: Environment Canada, 2001 (Adapted from: http://www.ec.ca/water/index.htm).

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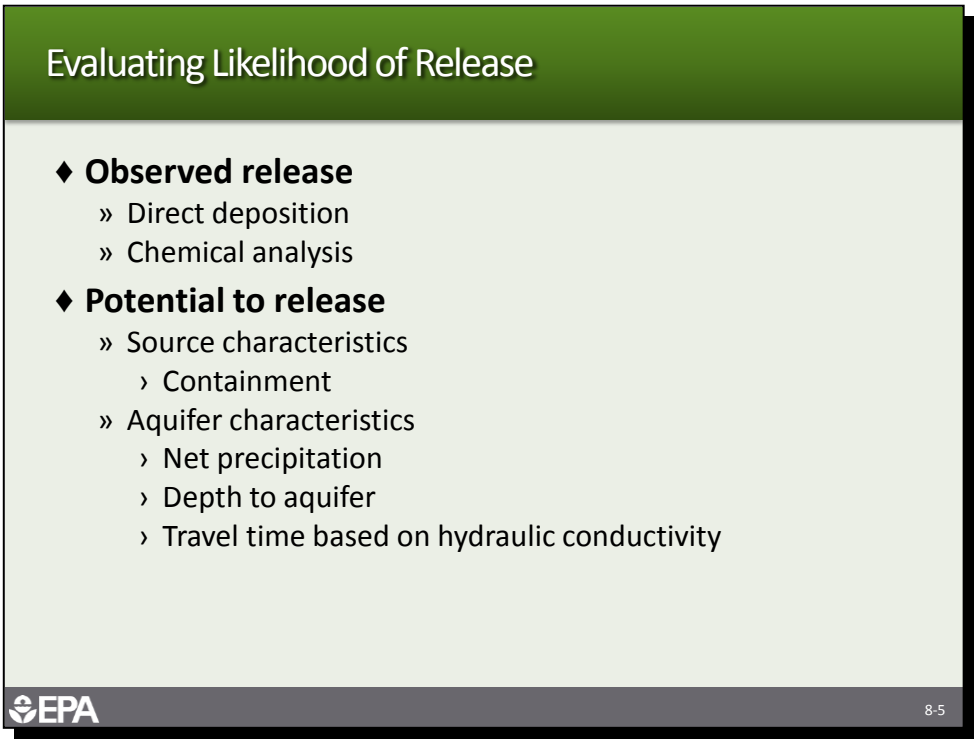
Notes

- **Pathway score and aquifers and wells to be sampled depend on:** The groundwater pathway score and the aquifers and wells to be sampled depend on the number of people served by each aquifer; the likelihood of a release to each aquifer; and the likelihood that drinking water wells are contaminated by the site.
  - » **Likelihood of release to each aquifer:** An observed release will increase the pathway score. If no release has been documented, then the score will be lower using the potential to release mechanism.
  - » **Likelihood that drinking water wells are contaminated by the site:** If drinking water wells are contaminated, then actual contamination targets will exist and the pathway score will increase. Level I contamination, where contaminants are detected in a drinking water well at levels equal or greater than benchmarks, will yield the highest score. Level II contamination, where contaminants are detected in a drinking water well at levels below benchmarks or when benchmarks are not available, will score lower than a Level I release, but higher than potential contamination. Without Level I or II actual contamination, the target score must use the potential contamination mechanism.
  - » **Number of people served by the aquifer:** The greater the number of people (targets) served by the aquifer within 4 miles of the source, the greater the pathway score.



Notes

- **Observed release:** Material that contains one or more hazardous substances must be known to have entered groundwater through direct deposition or must be seen entering groundwater, or chemical analysis of groundwater must be conducted, to document an observed release to groundwater:
  - **Direct deposition:** Direct deposition to establish a release may include injection and deposition of hazardous substances below the water table. In most cases, chemical analysis of groundwater samples is preferred to establish a release.
  - **Chemical analysis:** An observed release can be established using analytical evidence. The analytical evidence must conclusively show the presence of a hazardous substance in groundwater at concentrations significantly above the background level, where a portion of the significant increase is attributable to site sources.
- **Potential to release:** If an observed release cannot be established through sampling, then the likelihood of release factor category will need to be scored as potential to release. The following source and aquifer characteristics must be identified to score potential to release:
  - Containment of source
  - Net precipitation
  - Depth to aquifer
  - Travel time based on hydraulic conductivity

Participant Poll

- **What data would show an observed release to groundwater through direct deposition, check all that apply:**
  - A. Facility records showing disposal of hazardous substances below the water table
  - B. Aerial photographs showing disposal of hazardous substances below the water table
  - C. Facility records and state or local records showing injection of hazardous substances into the subsurface
  - D. Saturated soil sample from below water table that is contaminated with hazardous substances attributable to sources or site
  - E. None of the above

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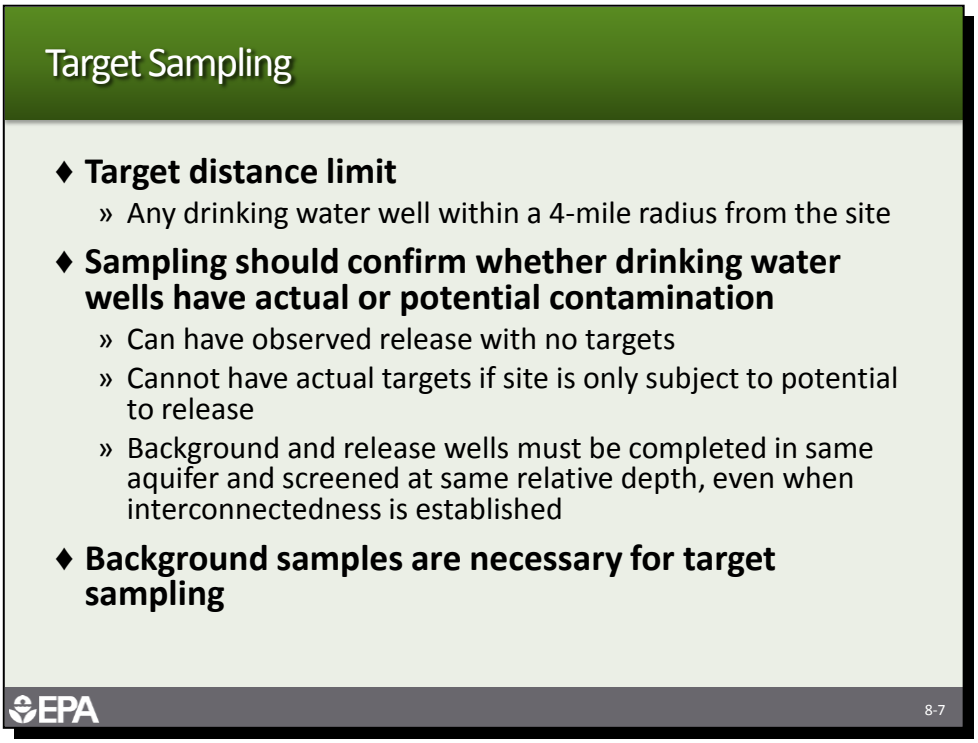

Notes

- **Target distance limit:** The target distance limit for the groundwater migration pathway is a 4-mile radius from the site. Any drinking water well within a 4-mile radius may be an actual or potential contamination target.

- **Sampling should confirm whether drinking water wells have actual or potential contamination:** Samples collected during the SI should focus on confirming whether drinking water wells contain actual contamination. If no drinking water wells are contaminated, then the groundwater targets must be scored as potential contamination. It is possible to have an observed release but not to have actual contamination of targets. However, there cannot be actual contamination targets if the likelihood of release is a potential to release. If wells are screened, the well screen intervals must be in the same aquifer, particularly when water occurs within small lenses isolated by clay segments in surrounding material. Even if interconnection of aquifers has been established, both background and release wells must be completed in the same aquifer. In addition, to the degree possible, background and observed release samples should be collected from approximately the same depth in the aquifer of concern. When the depth is selected, the investigator should consider elevation relative to a reference rather than depth below the ground surface. In addition, well completion techniques should be similar for background and observed release wells. Groundwater resources within 4 miles should be examined as targets, regardless of the aquifer where they are completed.

- **Background samples are necessary for target sampling:** As with likelihood of release sampling, background samples are necessary for target sampling. The same considerations for background sampling of release wells apply to sampling target wells.

Phasing and Using Existing Wells

- **SI strategy – can be a two phase process**
- **Sampling existing wells**
  - » Review information on existing wells
  - » Select multiple wells if available to increase likelihood of intercepting a contaminant plume
  - » Existing analytical data should not be older than 5 years

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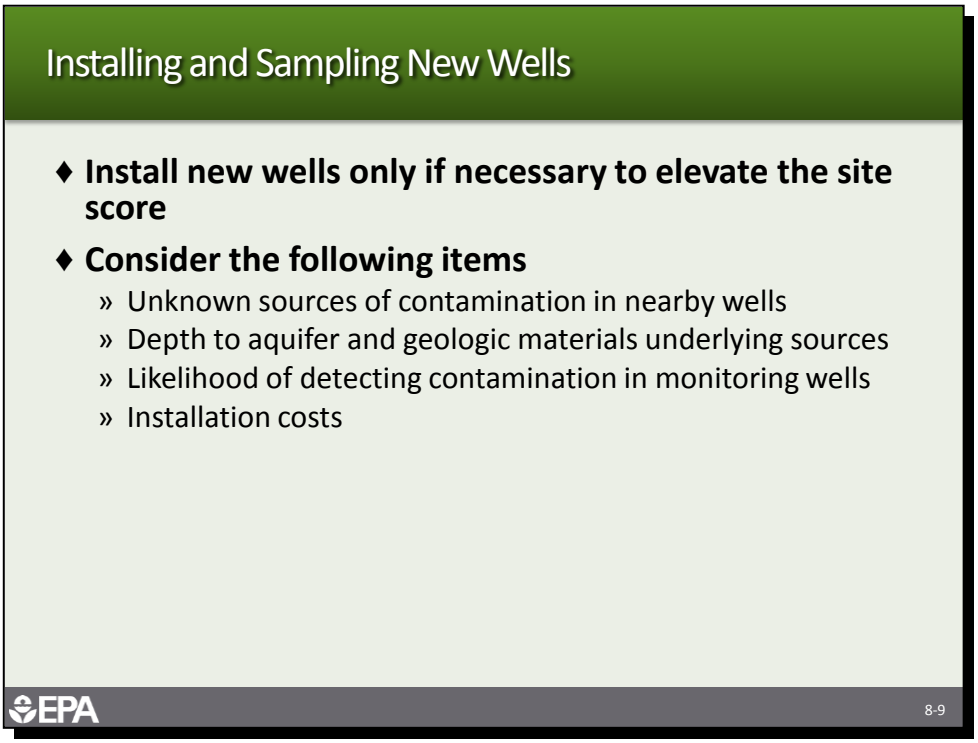
Notes

- **SI Strategy – can be a two phase process:** The primary objective of the SI is to demonstrate a release based on HRS documentation requirements, to demonstrate targets exposed to actual contamination and to measure levels of exposure.

- **Sampling existing wells:** Existing analytical data from wells within the vicinity of the site should be carefully reviewed to identify abnormalities and any required resampling. If no reliable data exist, samples from existing wells completed in the aquifer or installation of monitoring wells may be necessary. Wells evaluated for a release should be completed in the same aquifer and screened at a depth comparable to the background well. Multiple wells should be selected to increase the likelihood that the contaminated plume will be intercepted, particularly because local groundwater flow may differ from regional flow.



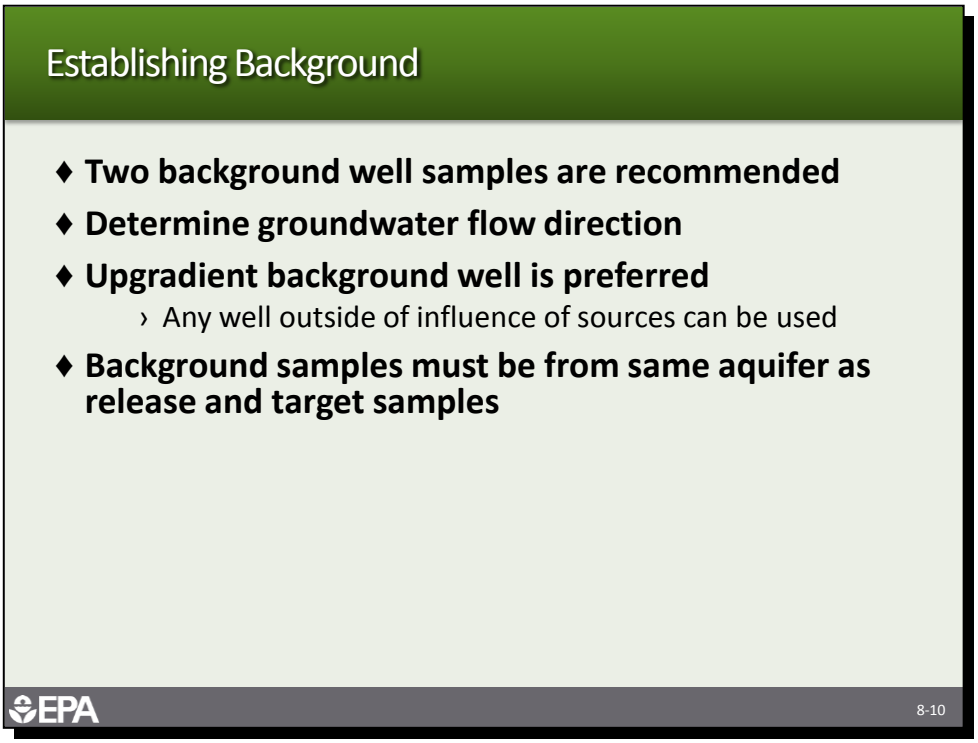
Notes

- **Installing and sampling wells:** Monitoring wells should not be installed unless they are necessary for the site score to be 28.50 or greater based on an observed release. It would not be necessary to score an observed release if other pathways elevate the overall score to above 28.50 or if the groundwater pathway already scores high based on the potential to release and potential contamination targets.

- **Consider the following items:** Before wells are installed, the following items should be considered:

  - Unknown source of contamination in nearby wells
  - Depth to aquifer and type of geologic materials underlying the sources
  - Likelihood that contamination will be detected in the monitoring wells
  - Installation costs
  - Public health concerns

  The field team should prepare a drilling log during monitoring well installation. The drilling log may be used to document potential to release factors, including lithology, hydraulic conductivity, travel time and depth to aquifer.



Notes

- **Two background well samples are recommended:** In most cases, a groundwater background sample will be needed, requiring samples from a minimum of two wells. The selection of these wells depends on the direction of groundwater flow.

- **Determine groundwater flow direction:** Flow direction can be calculated by installing piezometers; comparing static water-level elevations in a series of wells completed in the same aquifer; reviewing published hydrogeologic reports; and examining evidence of other previously investigated nearby groundwater contamination. It should be noted that at least 3 monitoring points are needed to determine groundwater flow direction.

- **Upgradient background well is preferred:** The background sample should be located upgradient of the site; however, any well outside the influence of sources at the site can be used. If background wells are not available, a spring sample collected before groundwater reaches the surface may be used.

- **Background samples must be from same aquifer as release and target samples:** Background well samples should be collected from the same aquifer as the wells used to establish a release. If the wells are screened, the well screen intervals must be in the same aquifer and preferably at the same depth in the same aquifer. Even if interconnection of aquifers has been established, both background and release wells must be completed in the same aquifer.

Groundwater Sampling Strategies

Criterion	SI Data Collection
Primary objective	Test release and actual contamination hypotheses Demonstrate release Demonstrate actual contamination
Data quality	Rigorous
Average number of samples	1 to 14
Types of activities	Sample existing wells Install drive points or shallow boreholes Collect multiple samples from drinking water wells Install wells as needed
Background samples	2 per 3 release samples Install background wells, if needed Should not rely on published data
Attribution samples	Those necessary to show attribution
QA/QC samples	Those necessary to obtain precise and accurate data

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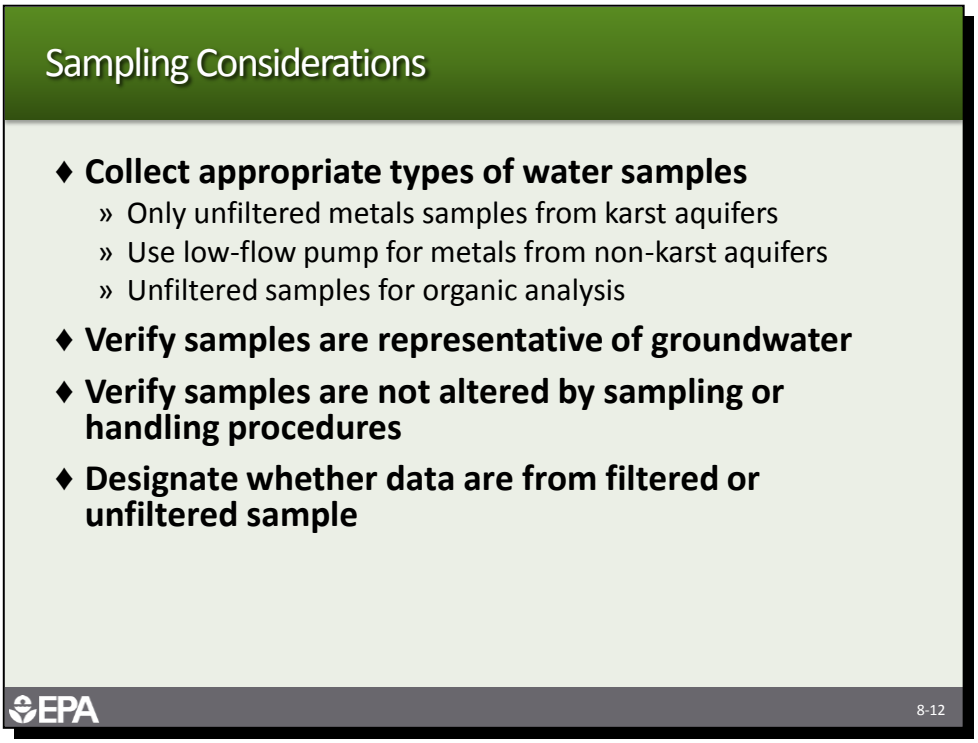

Notes

- **Collect appropriate types of water samples:** When sampling groundwater, the investigator should collect the appropriate types of water samples for the analytical suite. Only unfiltered metals samples should be collected from karst aquifers. Water samples for analysis of metals should be collected from non-karst aquifers using a low-flow pump to provide a representative sample. Only unfiltered water samples should be collected for the analysis of organic substances.

- **Verify samples are representative of groundwater:** Verify that samples are representative of the groundwater at that location. The turbidity, temperature and hardness of the groundwater sample should be relatively the same as the in situ groundwater.

- **Verify sample is not altered by sampling or handling procedures:** Ensure that SOPs for sampling, handling and shipping samples minimize any alteration of the sample. For example, use of dedicated sampling equipment to collect the samples will minimize the potential cross contamination.

- **Designate whether data are from filtered or unfiltered sample:** Clearly designate whether data derived from the samples are from filtered or unfiltered samples. This distinction is important when using the data, because samples for some analyses must be filtered, while the samples cannot be filtered for other analyses.

Equipment Considerations

- **Possible equipment needed for investigation:**
  - Water level
  - Disposable bailers
  - Low-flow pumps
  - Bottles with and without preservative
  - Auger drilling rig
  - Geoprobe drilling rig
  - pH meter
  - Water turbidity meter
  - Survey equipment
  - GPS unit
  - Electrical conductivity meter
  - Hydraulic profiling tool

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Notes

- **Possible equipment needed for investigation:** When groundwater is sampled, it is important to establish the groundwater level in the wells being sampled. A water level measurement device should be used and water levels should use a relative reference, such as mean sea level, rather than depth below ground surface. Disposable bailers can be used to collect the groundwater samples. Low-flow pumps are recommended to collect samples for analysis of metals from non-karst aquifers. Low-flow pumps limit the turbidity and the need for filtering the sample. Water samples should be poured into bottles of the proper size and that do or do not contain preservatives, depending on the analysis to be conducted on the sample. If wells are being installed, an auger drilling rig may be used to drill the boring for the well. A direct push drilling rig can also be used to install temporary wells or to sample water from boreholes. The direct push rig drills a smaller-diameter hole than the auger drilling rig. The geology of the subsurface and its ability to transmit water can be measured in situ using direct push technologies such as an electrical conductivity meter or hydraulic profiling tool.

Common Problems or Issues

- **Rushed well construction practices**
- **Screening wells in wrong vertical location**
- **Correlating data over too great of horizontal or vertical distances**
  - » Underestimating heterogeneity of subsurface and the effects it may have
- **Drilling in karst aquifers**

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Notes

- **Rushed well construction practices:** Rushed well construction can lead to highly turbid samples. Filtration of groundwater samples for metals is one way to reduce the turbidity.
- **Screening wells in wrong vertical location:** If the wells are screened, the well screen intervals must be in the same aquifer, particularly when water occurs within small lenses isolated by clay segments in surrounding material.
- **Correlating data over too great of horizontal or vertical distances:** Caution should be exercised when data are correlated between drill holes. Extrapolations of data more than 20 feet apart are not acceptable in nonhomogeneous geological environments. Site-specific data should be compared with regional geologic information to assess the homogeneity of the subsurface geology.
- **Drilling in karst aquifers:** Drilling can create interconnections between karst aquifers. Installing wells in a karst aquifer is generally not recommended because of the high likelihood that hazardous substances will be introduced into karst aquifers.

Participant Poll

- **What investigative approach can improve the type and amount of data from groundwater characterization efforts?**
  - A. Phased approach
  - B. Monitoring well installation
  - C. High resolution site characterization
  - D. Hanging plumes in space
  - E. All of the above
  - F. None of the above

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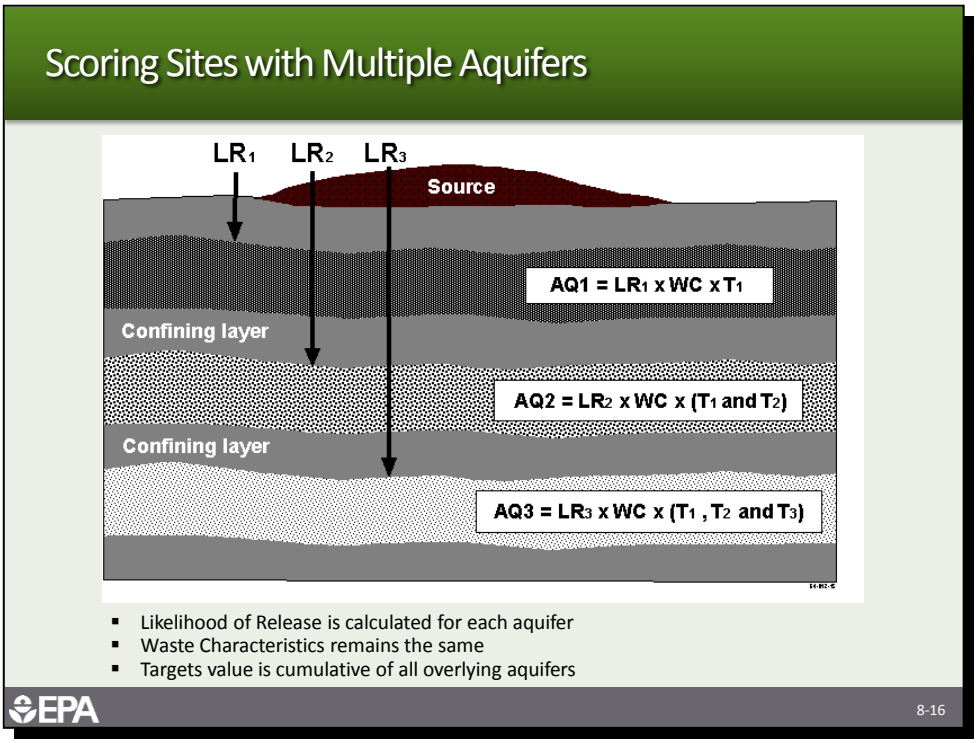

Notes

- A multiple aquifer system is a hydrogeologic situation consisting of two or more aquifers that are not interconnected and that underlie sources at the site. A groundwater pathway score is calculated for each aquifer at the site, and the highest score is selected as the groundwater pathway score. When evaluating an aquifer, the HRS specifies that the targets using water from that aquifer are included as well as targets using water from all overlying aquifers through which hazardous substances would migrate to reach the aquifer being evaluated.

  As this example shows, the groundwater score for Aquifer 1 is calculated by multiplying the Likelihood of Release (LR) for Aquifer 1, the Waste Characteristics (WC) score for Aquifer 1 and the Targets (T) for Aquifer 1. Aquifer 2 is scored by multiplying the LR for Aquifer 2, the WC for Aquifer 2 and the targets for both Aquifer 2 and Aquifer 1. Aquifer 3 is scored by multiplying the LR for Aquifer 3, the WC for Aquifer 3 and the targets for Aquifer 3, Aquifer 2 and Aquifer 1. In most cases the WC will be the same for all aquifers but the LR may be different.

Case Study Example
Lakefield Farm Site – PA Findings

- **Residents near the Lakefield Farm Site rely on shallow domestic wells for drinking water**
- **A municipal well that provides drinking water to about 10,000 people is located 0.5 mile southeast of the site**
- **The municipal well and several nearby irrigation wells are screened in the deep aquifer, which appears to be interconnected with the shallow aquifer**

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Case Study Example
Lakefield Farm Site – PA Findings

- **The PA identified all domestic wells within 0.25 mile of the site and the municipal well as primary targets**
- **Groundwater flows south**
- **Several domestic wells appear to be downgradient from the site**
- **Based solely on the groundwater pathway, site will not score above 28.50 using potential to release**

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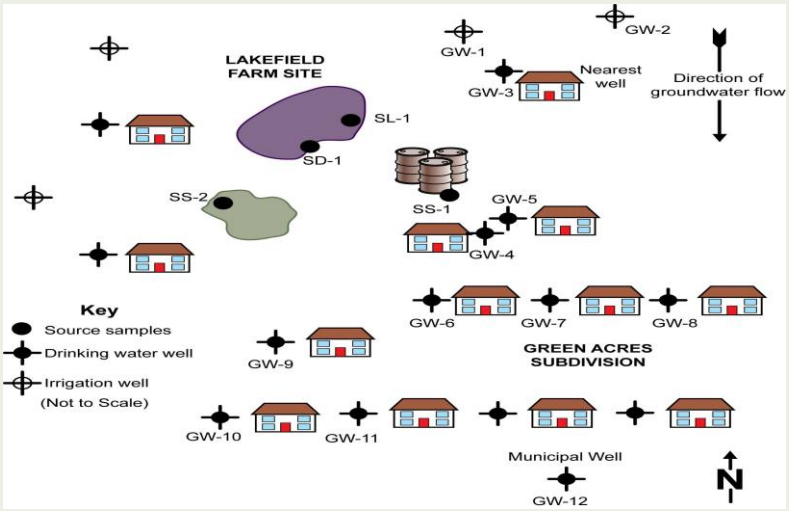
Lakefield Farm Site – Map



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Lakefield Farm Site SI Sampling Considerations

- **Site will not score above the cut-off unless the municipal well or four domestic wells are actual contamination targets**
- **Municipal well is screened in deeper aquifer than domestic wells**
- **Irrigation wells are screened in same aquifer as municipal well**

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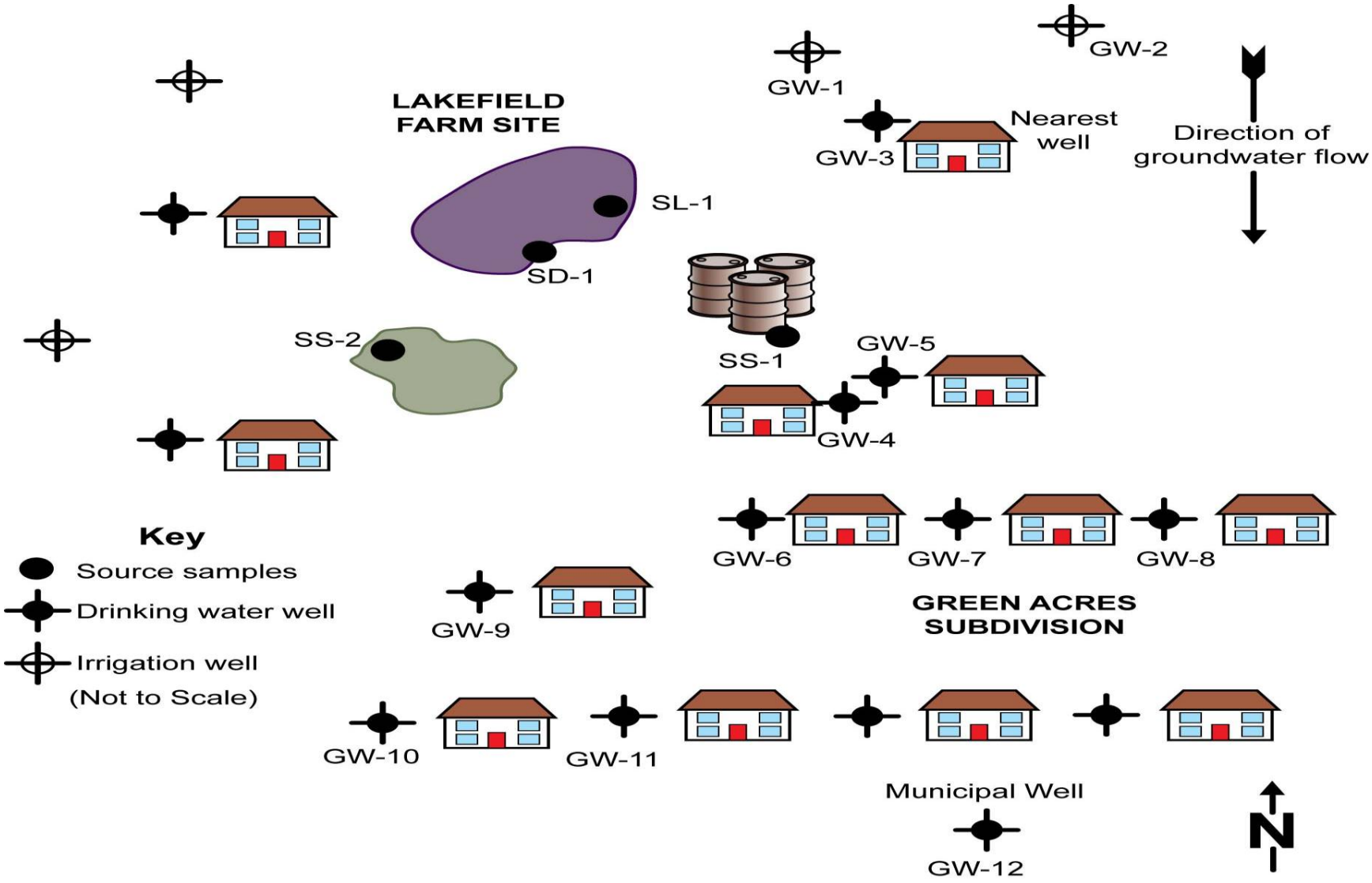
LAKEFIELD
FARM SITE
SL-1
SD-1
SS-2
SS-1
GW-1
GW-2
GW-3
Nearest
well
Direction of
groundwater flow
GW-4
GW-5
GW-6
GW-7
GW-8
GREEN ACRES
SUBDIVISION
GW-9
GW-10
GW-11
Municipal Well
GW-12
N
Key
Source samples
Drinking water well
Irrigation well
(Not to Scale)

Lakefield Farm Site
SI Sampling Strategy

Samples	SI Sampling Strategy	HRS Considerations	Non-Sampling Data Collection
Municipal well (GW-12)	Collect samples before treatment Sample to document type and level of contamination	Determine municipal well contamination	Verify aquifer from which well draws Verify population served
Domestic wells (GW-3 through GW-11)	Sample nearest domestic wells suspected of exposure	Determine domestic well contamination	Verify aquifer from which wells draw Verify population served
Background (GW-1 and GW-2)	Sample drinking water aquifer Limit number of samples	Determine concentration of hazardous substances	Verify aquifer from which well draws
Sources (SD-1, SL-1, SS-1, SS-2)	Grab or composites to identify hazardous substances at site	Do not sample to increase HWQ, amounts not close to breakpoints	Obtain physical dimensions of surface impoundment Estimate area of contaminated soil Verify number of drums
QC (Q-1 and Q-2)	Monitor sample collection and decon procedures, rinsate, field blank, duplicates, MS/MSD, temperature blank		

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Lakefield Farm Site
Outcome of SI

- Municipal well was not contaminated
- One domestic well (GW-4) showed elevated levels of hazardous substances during source sampling
- Site will not score above cut-off
- NFRAP considered
- Refer domestic well contamination to state or removal program

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Lakefield Farm Site
Variation of Site Conditions

- Two domestic wells south of the site were closed because of contamination by volatile organic compounds (VOC)
- East of the site are two facilities that use solvents
- Uncertain whether Lakefield Farm contributed to groundwater contamination
- May need to install monitoring wells to prove attribution

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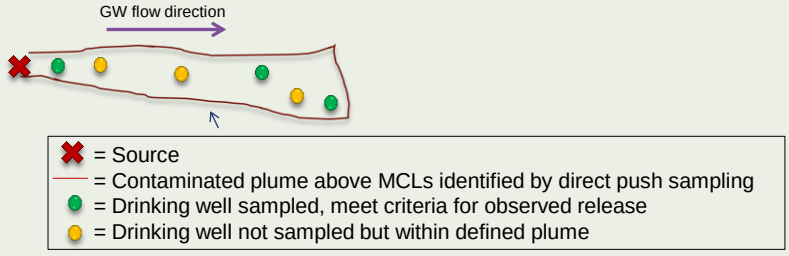
Participant Poll

- A contaminant plume is identified as shown below, which wells can be counted as actual target wells?



A. Count only the drinking water wells sampled as actual targets
B. Count all drinking water wells as actual targets
C. Count only the drinking water wells not sampled as actual targets
D. Do not count any actual targets because direct push sampling used to define plume

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Groundwater Summary

- **Samples are collected to establish an observed release and actual contamination of targets**
- **Release and target sampling both require background sampling**
- **Background samples must be from the same portion of the same aquifer as the release or target samples they will correlate**

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EPA 8-25

Groundwater Summary

- **Sampling considerations include:**
  - » Collecting a representative sample free from alteration by sampling or handling procedures
  - » Determining whether sample should be filtered or unfiltered
  - » Collecting adequate QA/QC samples
- **Wells should be installed only if they are necessary to elevate the overall site score to 28.50 or higher**

EPA 8-26

Surface Water Migration Pathway

8-27

Objectives for Surface Water Pathway Sampling

- **Participants will be able to devise and evaluate surface water sampling strategies that:**
  - » Demonstrate an observed release
  - » Establish background concentrations
  - » Address surface water targets of drinking water, human food chain and environmental threats
- **Case study example**

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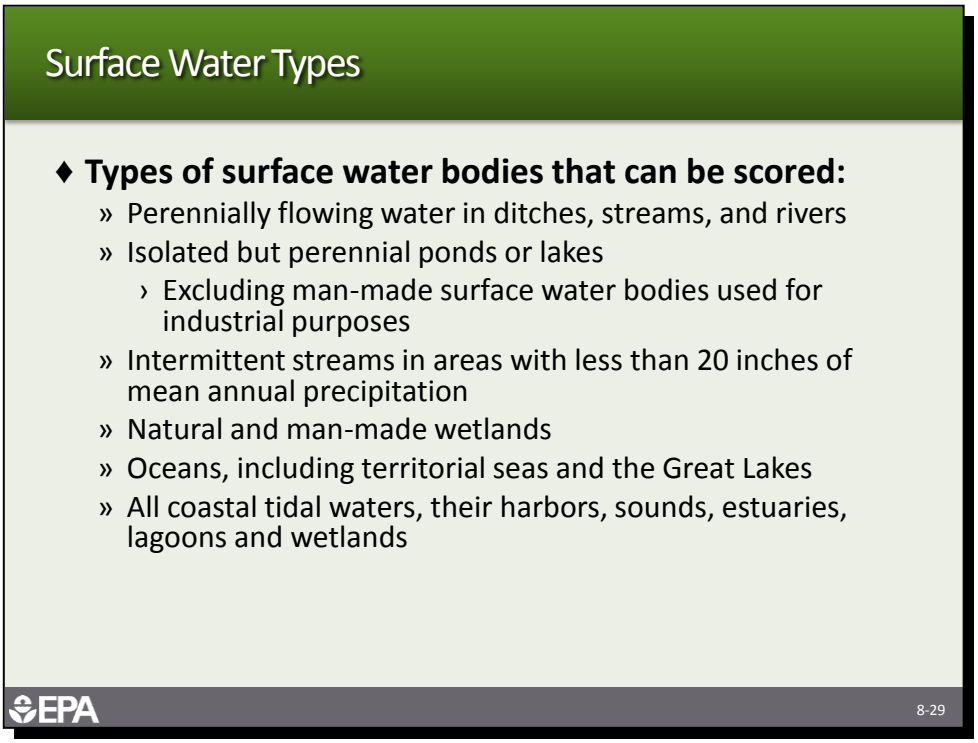
8-28



Notes

◆ **Types of surface water bodies than can be scored:** Surface water bodies within 2 miles of the site can be scored if they are potentially affected by the site. Generally, the surface water pathway need not be evaluated if there are no surface water bodies within 2 miles of the site. The following types of surface water bodies may be evaluated:

» Perennially flowing water in ditches, streams and rivers

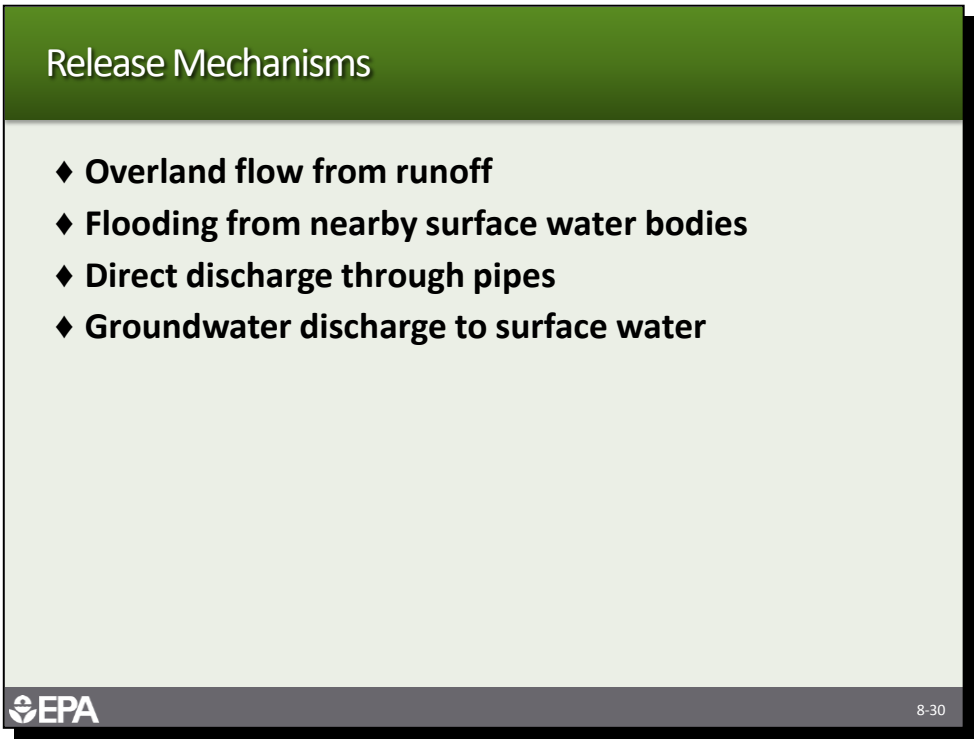
» Isolated but perennial ponds or lakes, excluding man-made surface water bodies used for industrial purposes, such as cooling ponds

» Intermittent streams in areas with less than 20 inches of mean annual precipitation

» Natural and man-made wetlands

» Oceans, including territorial seas and the Great Lakes

» All coastal tidal waters, their harbors, sounds, estuaries, lagoons and wetlands



Notes

- **Overland flow from runoff:** Hazardous substances may be released to surface water during storms that cause overland flow and runoff of contaminants from sources. Heavy rain may also cause surface impoundments or lagoons that contain hazardous substances to overtop and flow into surface water bodies.
- **Flooding from nearby surface water bodies:** In some cases, nearby surface water bodies may flood and contact site sources that contain hazardous substances.
- **Direct discharge through pipes:** Hazardous substances may also be directly discharged from a floor drain or surface impoundment through an outfall to a nearby surface water body.
- **Groundwater discharge to surface water:** Groundwater contaminated with hazardous substances from the site may discharge into surface water bodies near the site. This release mechanism is difficult to prove and requires a great deal of data collection.

Scoring Considerations
Likelihood of Release

- **Observed release**
  - Direct observation
  - Flooding of source area
  - Chemical analysis
    - Aqueous
    - Sediment
    - Aquatic tissues
- **Background**
  - Apples to apples

EPA 8-31

Notes

- **Observed release:** There are three ways to document an observed release. Each is discussed below:
  - **Direct observation:** Direct observation includes seeing hazardous substances entering surface water bodies or historical information showing the deposition of hazardous substances into surface water bodies from runoff or direct discharge through a pipe. In these cases, the effluent, source runoff or leachate should be sampled to show they contain hazardous substances. However, no background samples are required for effluent, runoff or leachate samples. The investigator also can rely on existing analytical data indicating that the effluent contains hazardous substance. Finally, direct observations should be photodocumented when possible.
  - **Flooding of source area:** Historical source data and flood information should be used to document the flooding of site sources and the direct contact of the site sources with floodwaters. Newspaper and aerial photographs can be used to document the extent of the flooding. No SI sampling is necessary, but historical watermarks found on buildings and trees should be documented. The Federal Emergency Management Agency (FEMA) website provides floodplain information.

- » **Chemical analysis:** Chemical analysis of one downstream and one upstream sample are enough to demonstrate an observed release. The sample may be aqueous, sediment or tissue from sessile, benthic organisms. The downstream sample should be collected as close as possible to the PPE. If multiple PPEs exist, each should be sampled. Sediment samples typically detect contamination more often than other sample types. The level of hazardous substances in the release sample must be three times the level of the same hazardous substances in the background sample to demonstrate an observed release by chemical analysis.

◆ **Background:** Background sampling is necessary to show an observed release through chemical analysis. Background samples must be of the same type and the same depth as the release samples. For example, the background and release sediment samples should be from the same type of sediment, silt-to-silt or organic-to-organic. Background samples should be as free from other non-site contaminants as possible.

Scoring Considerations
Targets

- **Target distance limit**
  - 15 miles downstream of the PPE
- **Potential targets**
  - Drinking water threat
  - Human food chain
  - Environmental threat
- **Benchmarks**

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Notes

- **Target distance limit:** The TDL is measured as the stream segment 15 miles downstream from the PPE. If the stream ends in a lake or ocean, then the remaining distance is measured in an arc in the lake or ocean. All targets within the target distance limit can be scored. The populations associated with the drinking water intakes are the target populations.
- **Potential targets:** The potential targets include the drinking water threat, human food chain and environmental threat. A score is generated for each of these target populations.
- **Benchmarks:** Sampling results are compared with benchmarks to decide whether Level I or Level II actual contamination can be shown for each of the surface water targets.

Sample Types to Support Release and Target Contamination

HRS Factors	Sediment	Aqueous	Effluent	Sessile Benthic Organism	Non-sessile Benthic Organism	Finfish, amphibians, reptiles
Observed release	Yes	Yes	Yes	Yes	No	No
Level I drinking water	No	Yes	No	No	No	No
Level II drinking water	Yes	Yes	Yes	Yes	No	No
Level I human food chain (fisheries)	No	No	No	Yes	Yes	Yes
Level II human food chain (fisheries)	Yes	Yes	Yes	Yes	No	No
Level I environmental (sensitive environments)	No	Yes	No	No	No	No
Level II environmental (sensitive environments)	Yes	Yes	Yes	Yes	No	No

EPA 8-33

Notes

- **Sample Types to Support Release and Target Contamination:** The table above shows what types of samples can be used to support an observed release and Level I and II actual contamination for the three target populations. An observed release and Level II actual contamination for all targets can be established with sediment, aqueous, effluent and sessile benthic organism samples. Level I drinking water and environmental actual contamination can be established only with aqueous samples. Level I human food chain actual contamination can be established only through aquatic organism tissue sampling of edible organisms.

Sample Types to Support Release and Target Contamination

HRS Factors	Sediment	Aqueous	Effluent	Sessile Benthic Organism	Non-sessile Benthic Organism	Finfish, amphibians, reptiles
Observed release	Yes	Yes	Yes	Yes	No	No
Level I drinking water	No	Yes	No	No	No	No
Level II drinking water	Yes	Yes	Yes	Yes	No	No
Level I human food chain (fisheries)	No	No	No	Yes	Yes	Yes
Level II human food chain (fisheries)	Yes	Yes	Yes	Yes	No	No
Level I environmental (sensitive environments)	No	Yes	No	No	No	No
Level II environmental (sensitive environments)	Yes	Yes	Yes	Yes	No	No

Release and Target Sampling Considerations

- **Sampling sequence**
  - » Downstream before upstream
  - » Aqueous before sediment
- **Sample conditions**
  - » Weather conditions that affect streamflow
  - » Grain size, organic compounds and structure of sediment
- **Multiple watersheds**
- **Inferring contamination**

EPA 8-34

Notes

- **Sampling sequence:** The sequence of sampling is important to avoid cross-contamination of samples. Downstream samples should always be collected before upstream samples to avoid disturbing sediment that may then move downstream and affect downstream samples. When both aqueous and sediment samples are collected, the aqueous samples should be collected before the sediment samples to avoid collecting suspended sediments (caused by disturbing the sediment through sampling) in the aqueous sample.

- **Sample conditions:** Precautions should be taken to ensure that samples are representative of the surface water at that location and that the sample is not altered or contaminated by sampling and handling procedures. In addition, chemical and physical properties of surface water can vary considerably within a small area. The lack of mixing in large, slowly flowing segments of rivers may affect background levels.

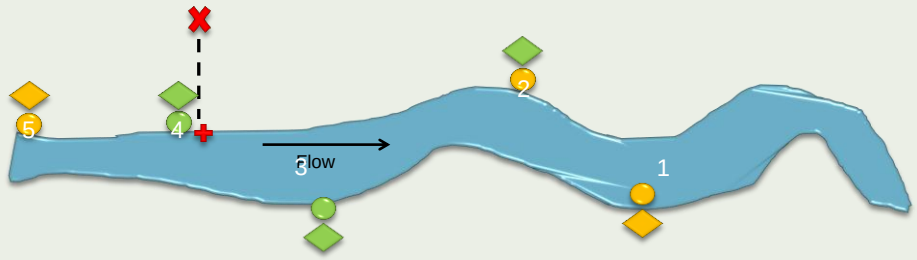
  - » **Weather conditions that affect streamflow:** Higher streamflows generally carry more suspended solids but may dilute some dissolved substances. Streamflow volume and dilution may vary after heavy rainfall or snowmelt.

  - » **Grain size, organic content and structure of sediments:** Some types of sediments may adsorb substances to a greater extent than others. An example is fine clay particles, which may adsorb metals to a greater extent than larger particles. Therefore, sediment samples should be collected from similar locations within the surface water body (i.e., center of stream channel or stream bank) to ensure that the composition of the sediment samples is similar.

- **Multiple watersheds:** If the site is affecting more than one watershed, then all potentially affected watersheds should be evaluated, and the one with the highest score should be used.

- **Inferring contamination:** Contamination can be inferred between detections for other sampling locations. There is no need to sample every target along the pathway. Inference should be used between detections. If a target exists between two sampling hits, then the target can be scored.

Example of Inferring Contamination



- Aqueous and sediment samples at 4 and 3 establish zone of actual contamination – contamination is inferred at all targets in this zone
- Sediment samples at 3 and 2 establish zone of actual contamination – contamination is inferred at all targets all targets in this zone
- Zone of potential contamination established between 2 and 1

= Source
= PPE
= Clean aqueous sample
= Observed release aqueous sample
= Clean sediment sample
= Observed release sediment sample

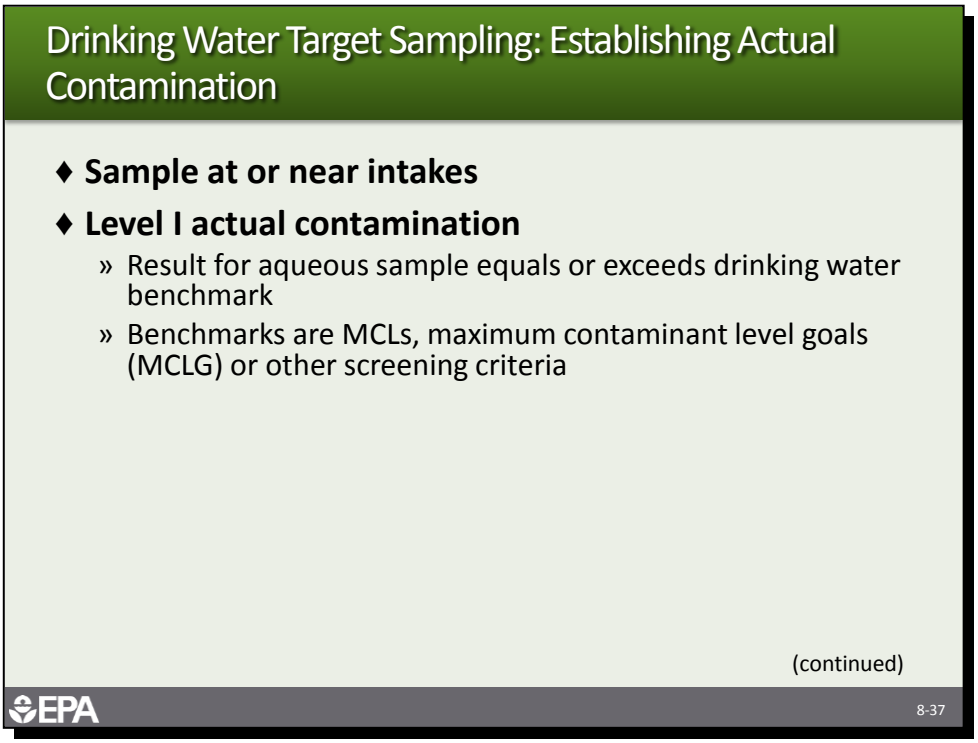
EPA 8-35

Participant Poll

♦ **Based on diagram on previous slide, what level of actual contamination is established from 3 to 2**

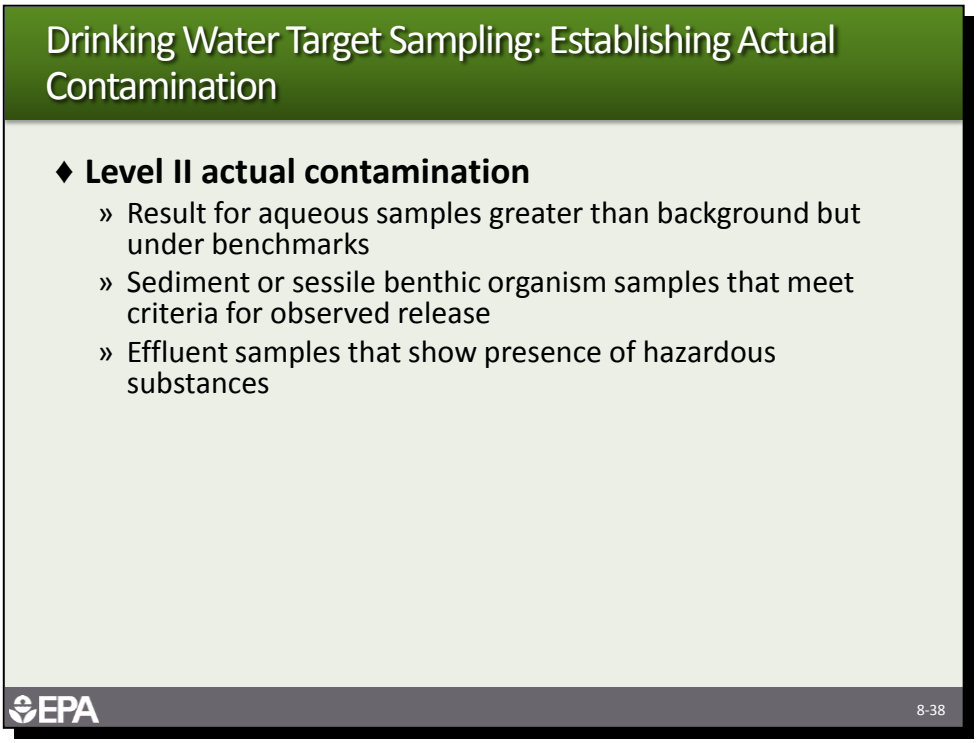
A. Level I
B. Acute
C. Chronic
D. Level II
E. None of the above

EPA 8-36



Notes

- **Sample at or near intakes:** Drinking water intakes downstream of the PPE should be sampled, especially if they are likely to be affected by hazardous substances from the site.
- **Level I actual contamination:** Only aqueous samples can be used to establish Level I actual contamination. Sample results should be compared with drinking water benchmarks. If the results are equal to or greater than the benchmarks, then Level I actual contamination is established. Drinking water benchmarks are MCLs and MCLGs promulgated under SDWA or other screening criteria if MCLs or MCLGs do not exist.



Notes

◆ **Level II actual contamination:** Level II actual contamination can be established with a number of different sample types. Aqueous or sessile benthic organism samples that exceed background but are under benchmarks establish Level II actual contamination for drinking water. Results for sediment samples that are three times greater than background establish Level II actual contamination. Finally, effluent samples that show the presence of hazardous substances attributable to the site also establish Level II actual contamination.

Human Food Chain Target Sampling: Establishing Actual Contamination

- **Address only if necessary to score the site**
- **Use sediment samples rather than organisms if possible**
- **Closed fishery may be useful for scoring**
- **Observed release at target considers bioaccumulation potential factor value (BPFV)**
  - » BPFV must be greater than or equal to 500
- **Tissue samples from aquatic organisms**
  - » Levels at or exceeding Food and Drug Administration (FDA) benchmarks
  - » Background samples

EPA 8-39

Notes

- **Address only if necessary to score the site:** The human food chain target should be pursued only if it is needed to elevate the site score to above 28.50 or if it is a significant concern.
- **Use sediment samples rather than organisms:** If documenting actual human food chain contamination is essential to the site recommendation, sediment samples should be considered in preference to catching and analyzing organisms. However, sessile benthic organism sampling can also be used to document actual human food chain contamination.
- **Closed fishery:** If a hazardous substance that caused the fishery to close is found in a release water sample within the boundaries of the closed fishery, samples from the water body can be used to score actual contamination even though no human food chain organism exists.
- **Observed release at target considers BPFV:** Establishing an observed release at a human food chain target (not a closed fishery) through aqueous or sediment sampling requires a BPFV of 500 or greater for the hazardous substances in question.

- **Tissue samples from aquatic organisms:** Tissue samples of aquatic food chain organisms may be collected during the SI, if necessary, to evaluate immediate health and environmental threats. Before the samples are collected, the investigator should review HRS guidance and food chain threat benchmarks for the substances expected to be present in fish tissue and benthic organisms. Food chain benchmarks include FDA Action Levels. Sessile benthic organisms for the human food chain include mussels and oysters. Non-sessile benthic organisms include crabs, snails, crayfish and lobsters. Other aquatic human food chain organisms include fish, frogs and eels. Samples may be collected at any point within or beyond the boundary of a fishery to evaluate actual human food chain contamination. Background tissue samples should be from the same tissue as the target samples and preferably be edible tissue. The organism should be from the same species and of similar age as the target species.

- **Background samples:** The sequence of sampling is important to avoid cross-contamination of samples. Downstream samples should always be collected before upstream samples to avoid disturbing sediment that may then move downstream and effect downstream samples. When both aqueous and sediment samples are collected, the aqueous samples should be collected before the sediment samples to avoid collecting suspended sediments (caused by disturbing the sediment through sampling) in the aqueous sample.

Environmental Target Sampling: Establishing Actual Contamination

- **Wetlands and sensitive environments**
- **Sample at or downstream of wetland considering minimum frontage and at sensitive environments**
  - » Unfiltered aqueous sample
  - » Sediment sample
  - » Sessile benthic organism
- **Level I actual contamination**
  - » Result for aqueous samples equal to or exceeding benchmarks

(continued)

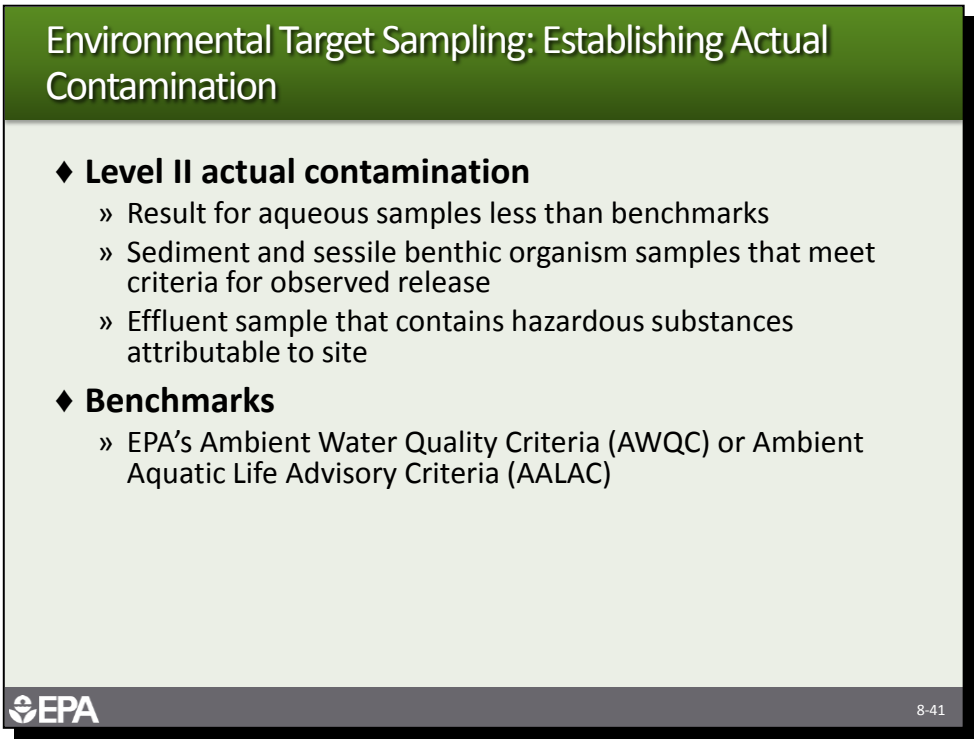
EPA 8-40

Notes

- **Wetlands and sensitive environments:** HRS Table 4-23 lists specific areas that are considered to be sensitive environments and gives point values for them. For example, a national park is a sensitive environment and is assigned the highest value of 100. Wetlands are evaluated separately. If a wetland is also a sensitive environment listed in Table 4-23, it is evaluated and scored twice: once as a wetland and once as a sensitive environment. Wetland rating values are listed in Table 4-24. When developing a sampling plan for wetlands or sensitive environments, there are many considerations, such as appropriate intervals to determine area or frontage of wetlands or sensitive environments and how to draw arcs to determine areas of contamination. The HRS rule and guidance should be carefully consulted when developing a sampling strategy for wetlands or sensitive environments.

- **Sample at or downstream of sensitive environment:** Samples should be collected at or downstream of sensitive environments. If a wetland is suspected of being exposed to contamination, two samples should be collected from the wetland at appropriate intervals. Sample types include unfiltered aqueous, sediment and sessile benthic organism. Effluent samples can also be used to establish actual contamination.

- **Level I actual contamination:** Level I actual contamination can be established only using aqueous samples. Results for aqueous samples that are equal to or exceed benchmarks establish Level I actual contamination.



Notes

- **Level II actual contamination:** Level II actual contamination can be established using several different sample types. Aqueous samples with levels below benchmarks establish Level II contamination. Sediment and sessile benthic organism samples with levels that meet the criteria for an observed release establish Level II contamination. Effluent samples that contain hazardous substances attributable to the site establish Level II contamination.

- **Benchmarks:** The only ecological benchmarks that can be used for environmental targets are EPA's AWQC or AALAC.

Surface Water Sampling Strategies

Criterion	SI Data Collection
Primary objectives	Document release based on HRS Document targets exposed to actual contamination and determine levels
Data quality	Rigorous
Average # of samples	1 to 14 based on HRS requirements
Types of activities	Sample easily accessible locations Sample sediments at or beyond targets most likely to show contamination Sample surface water locations Sample surface water targets Collect multiple aqueous samples from drinking water intakes likely to be at or near benchmarks
Background samples	2 background per 3 release samples Should not rely on published data
Attribution samples	Those necessary to show attribution
QA/QC samples	Those necessary to obtain precise/accurate data

EPA 8-42

Common Problems or Issues

- **Physical characteristics of surface water hamper sample collection**
  - » Turbidity
  - » Flow rate
  - » Rapids and meanders
- **Species types do not match**
  - » Different gender, age, tissue sampled
- **Surface water quality affected**
  - » Chemical transformations
  - » Biological influences
  - » Physical transport mechanisms
- **Collection of background and release samples occurs at different times of the year**

EPA 8-43

Notes

- **Physical characteristics of surface water hamper sample collection:** Physical characteristics of the surface water migration route can influence the detection of hazardous substances. Some hazardous substances mix and disperse rapidly in turbulent water, while others may remain as a plug or plume for longer distances in less turbulent waters. In addition, rocky bottoms, rapids and meanders can influence the likelihood that hazardous substances will be detected. Flow rate should also be a consideration because high-volume flows tend to disperse and dilute hazardous substances more quickly than low-volume flows.

- **Species types do not match:** If samples are collected from organisms, the samples should be obtained from the same species and from organisms of similar ages. In addition, similar tissue should be compared.

- **Surface water quality affected:** Chemical transformations, biological influences and physical transport mechanisms may affect surface water quality.

- **Collection of background and release samples occurs at different times of the year:** Background samples and release samples should be collected at the same time.

Case Study Example
Lakefield Farm Site – PA Findings

- **The Apsley River, a moderate to large water body (streamflow 900 cubic feet/second), is located about 200 feet north of the surface impoundment**
- **A recreational fishery is located within the river**
- **A 10-acre wetland lies 1 mile downstream from the PPE**
- **An unnamed creek flows into Apsley River about 750 feet upstream of the PPE**
- **An outfall to this creek is 1 mile upstream of this confluence**

(continued)

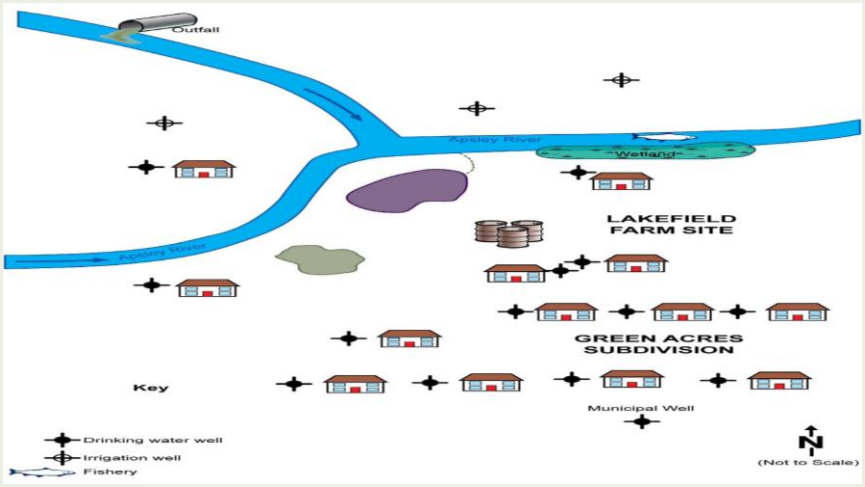
EPA 8-44

Case Study Example
Lakefield Farm Site – PA Findings

- **During the PA, the investigator suspected a release to the Apsley River from Lakefield Farm**
- **A focused SI with an expanded SI is planned because**
  - » Presence of significant threats to surface water
  - » Attribution is a problem
- **Focused SI sampling will test whether surface water targets are exposed to contamination**

EPA 8-45

Lakefield Farm Site
Map

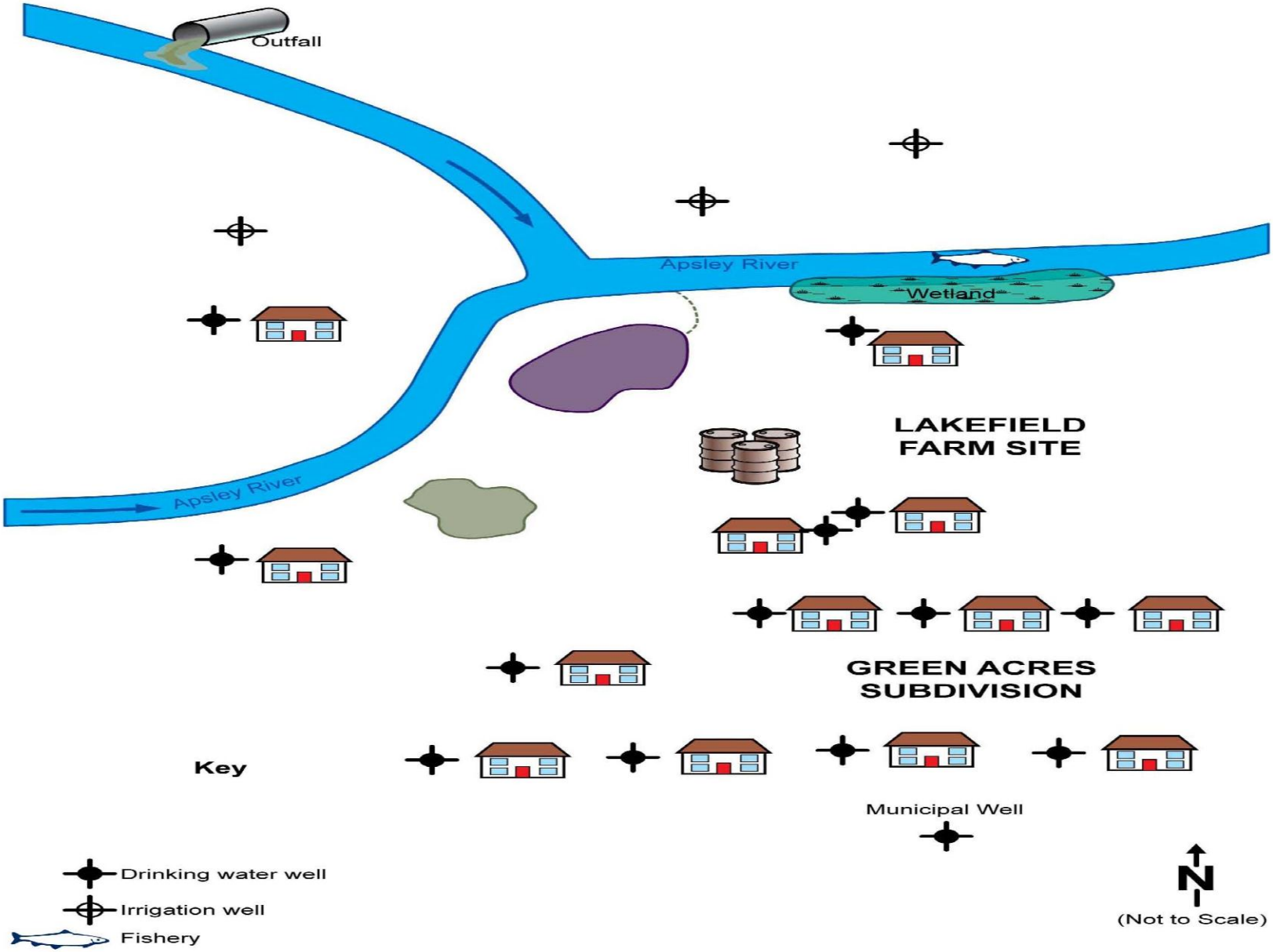


EPA 8-46

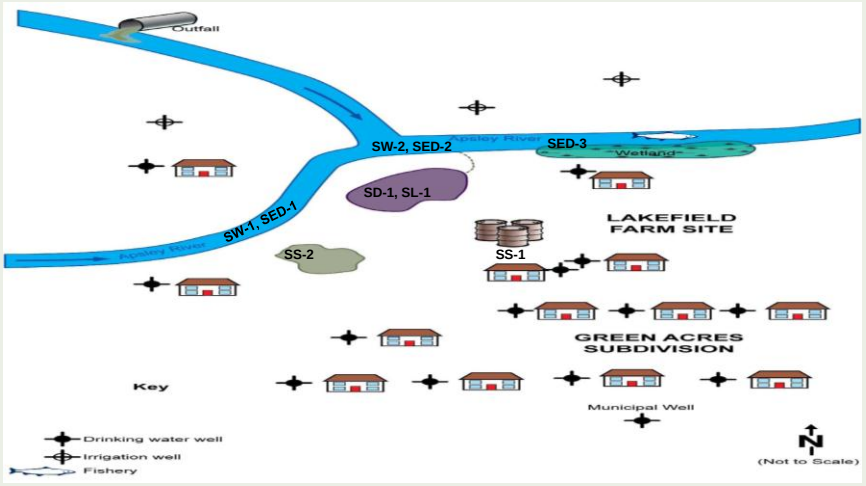
Lakefield Farm Site
Focused SI Sampling Strategy

Samples	Approach	Rationale	Non-sampling Data Collection
PPE Sampling	Determine if there is an observed release (SW-2 and SED-2)		
Surface water target locations	Determine if contamination is present in fishery (SED-2) or wetland (SED-3)	Establish human food chain or environmental contamination	Verify linear footage of wetland exposed to actual contamination
Background for surface water (SW-1 and SED-1)	Limit number of background samples	Determine levels of hazardous substances	Collect information about background locations, setting, flow, physical characteristics
Sources (SD-1, SL-1, SS-1 and SS-2)	Identify hazardous substances at site	Not to increase HWQ if amounts not close to breakpoints	Obtain physical dimensions of sources, verify number of drums
Quality control (Q-1 through Q-4)	Monitor collection and decon procedures, 1 rinsate, 1 trip blank and 1 field blank		

EPA 8-47


Outfall
Apsley River
Wetland
LAKEFIELD
FARM SITE
Apsley River
GREEN ACRES
SUBDIVISION
Key
Municipal Well
Drinking water well
Irrigation well
Fishery
N
(Not to Scale)

Lakefield Farm Site
Focused SI Sampling Locations



EPA 8-48

Lakefield Farm Site
Focused SI Results

- **PPE, fishery and wetland samples are contaminated with heavy metals**
- **Source samples also contain some metals**
- **Attribution from unnamed creek with outfall is unknown**
- **Background samples in Apsley River assigned "J" qualifiers and determined to be biased low**
  - » Heavy metals in Apsley River cannot be attributed conclusively to Lakefield Farm Site

EPA 8-49

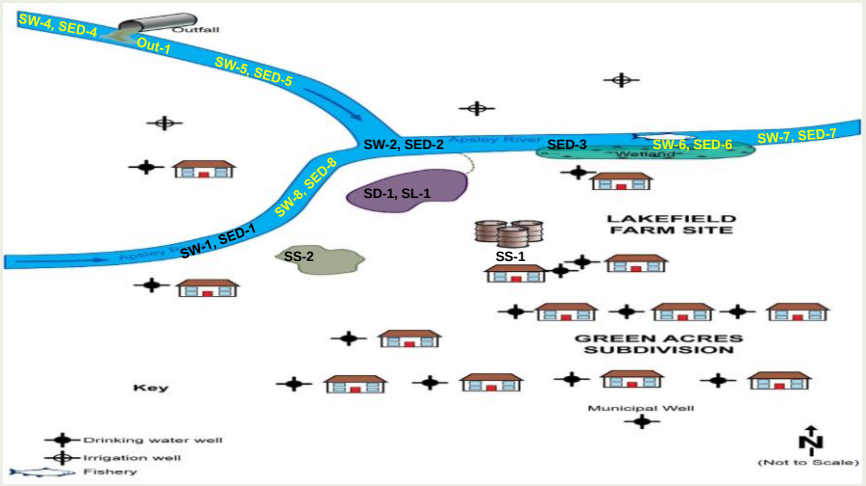
Goal of Expanded SI

- **Prove attribution of significant increase in heavy metals in Apsley River in whole or part to Lakefield sources**
  - » Sample surface water and sediment above and below outfall (SW-4, SED-4, SW-5, SED-5)
  - » Sample outfall (OUT-1)
  - » Repeat background from Apsley River upstream of confluence with unnamed creek (SW-8, SED-8)
- **Sample wetland water and sediment and confirm linear frontage of actual contamination (SW-6, SED-6)**
- **Sample from further downstream within fishery and compare with background and attribution samples (SW-7, SED-7)**

EPA 8-50

Lakefield Farm Site

Expanded and Focused SI Sampling Locations



EPA 8-51

Lakefield Farm Site
Results of Expanded SI

- **Unnamed creek and outfall eliminated as potential source of contamination at PPE and downstream**
- **Background sample was unbiased and metals results in sediment meet criteria for an observed release**
- **Additional downstream sediment and surface water samples expand the area of actual contamination**
- **Site scores by the surface water pathway using the human food chain and environmental threats**

EPA 8-52

Summary

- **Sample to confirm release and target contamination hypotheses**
- **Collect sufficient background samples for release and target sampling**
- **Target sampling includes drinking water, human food chain and environmental threats**
- **Understand what types of samples are necessary to demonstrate Level I and Level II actual contamination**
- **Samples to establish background must be the same type as the samples collected to test surface water release hypotheses or targets exposed to contamination**

EPA 8-53

Questions?

EPA 8-54

Final Module

- **Thursday , August 14, 2014;**
  1:00 p.m. – 3:00 p.m. Eastern
  - » Module 9: SI Strategies for Soil and Air Pathways

EPA 8-55