ALASKA DEC: AN INTRODUCTION TO CONCEPTUAL SITE MODELS

Janice Wiegers

Alaska Tribal Conference
on Environmental Management
November 6, 2012

WHAT WE'LL COVER

- What is a Conceptual Site Model
- Definitions:
  - Complete Exposure Pathways
  - Contaminant Sources
  - Release Mechanisms
  - Impacted Media
  - Transport Mechanisms
  - Exposure Media
  - Exposure Routes
  - Receptors
- Using the CSM Scoping Form to Complete a CSM for a site

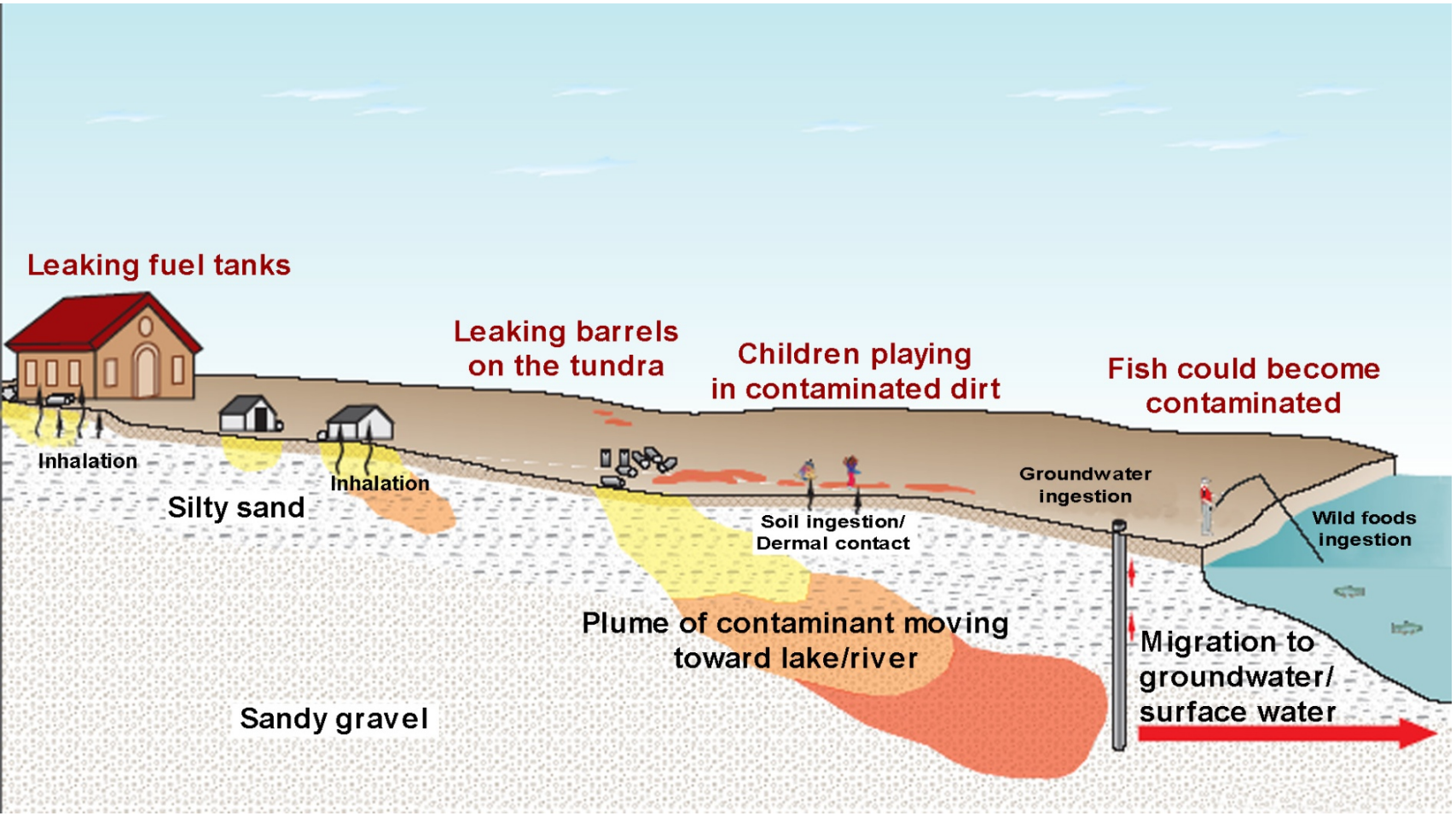
WHAT IS A CONCEPTUAL SITE MODEL?

A conceptual site model (CSM) is a way to describe and evaluate how people, animals, and plants might come in contact with contaminants at a location.

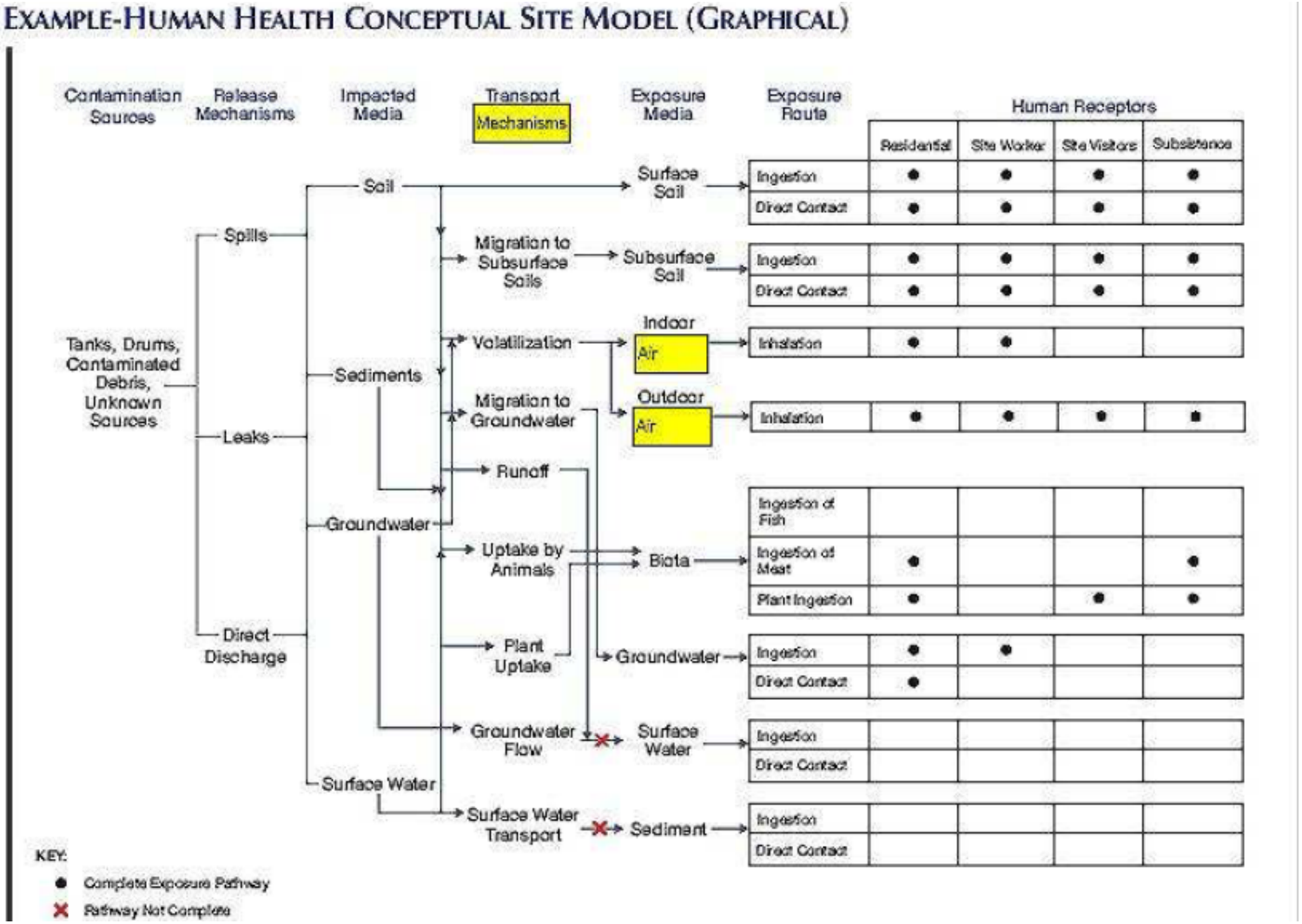
It shows the current and possible future spread of contamination in the environment (i.e. fate and transport).

Developing a CSM is a critical step in evaluating a contaminated site, and must be prepared during the site characterization phase.

CONCEPTUAL SITE MODEL

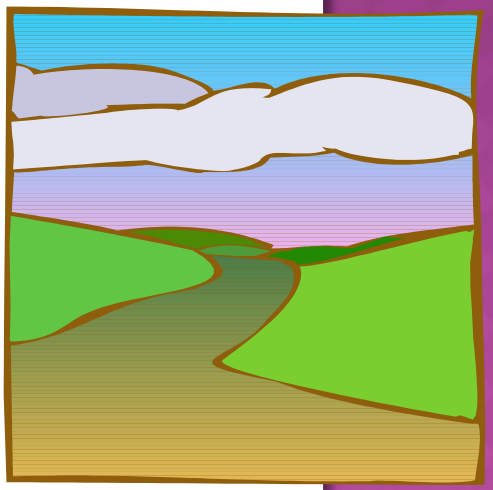


EXAMPLE OF A CSM GRAPHIC:

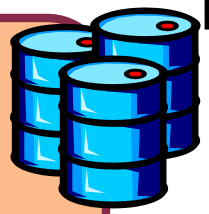


ELEMENTS OF COMPLETE EXPOSURE PATHWAY

Conceptual Site Models identify exposure pathways and outline the course a chemical takes from the source of contamination to a potentially exposed person, animal or plant (receptor).



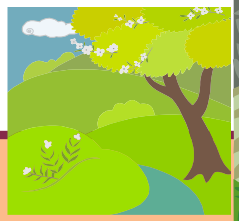
Generalized Example Exposure Pathways



SOURCE

Release Mechanism

(spill, leak, emission)



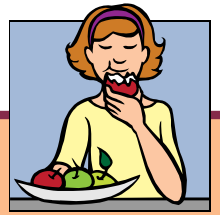
IMPACTED MEDIA

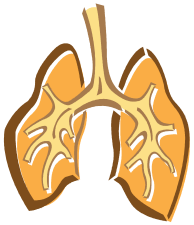
Transport Mechanism

(runoff, leaching, precipitation)

EXPOSURE MEDIA

Exposure Route





RECEPTOR

SOURCE

All sources of contamination at the site need to be identified.

Many times the source is from a tank, drum, transformer, garage, shop, storage area, or landfill.

Other sources may include discarded batteries, deteriorating buildings, or pesticide application.

TYPICAL SOURCES OF CONTAMINATION FOUND IN VILLAGES:

TYPICAL CONTAMINANTS FOUND IN VILLAGES:

- Storage tanks: diesel, gasoline, and aviation fuel
- Power plants: transformer oil, PCBs, and waste oil
- Vehicle maintenance shops: waste oil, glycol, and chlorinated solvents
- Mining activities: fuels and heavy metals
- Former military activities: various contaminants
- Abandoned dumps: various contaminants

Some contaminants are more hazardous than others due to their different toxicities.

RELEASE MECHANISM

The release mechanism describes how contaminants were released from the source into the environment.

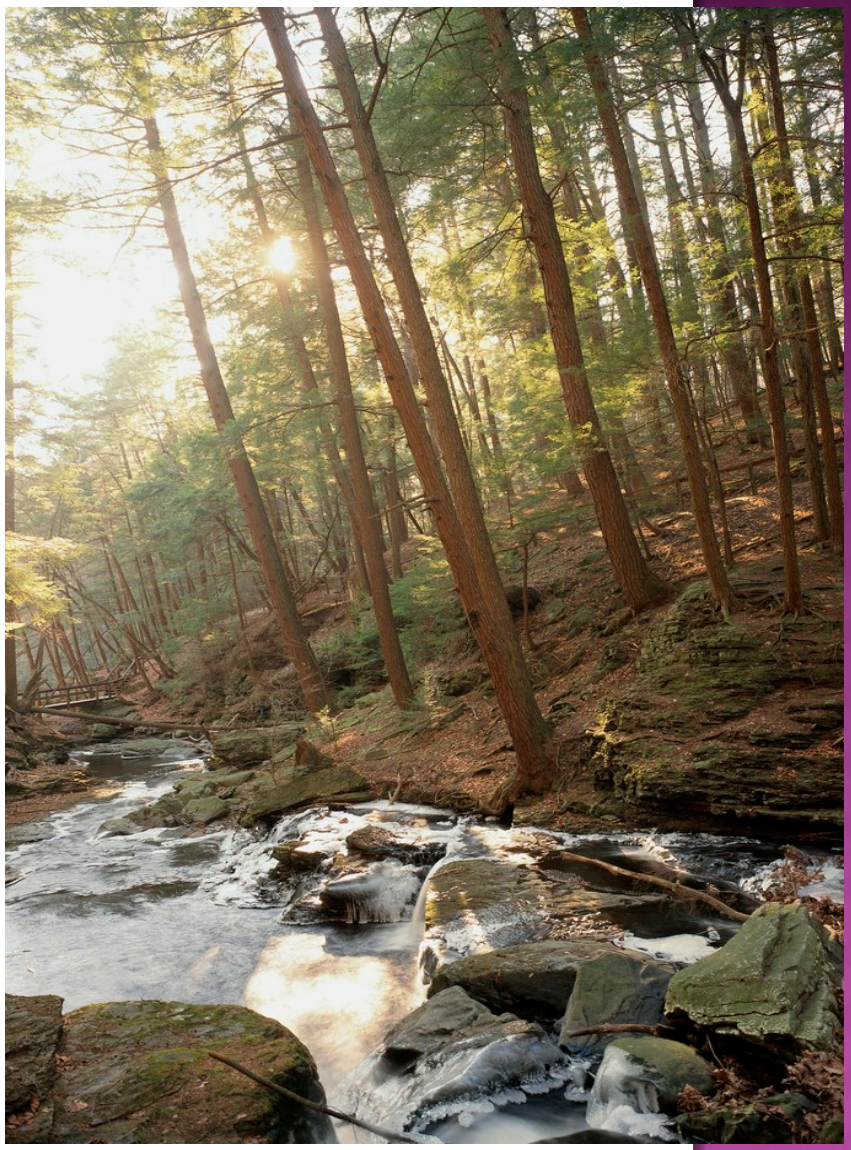
Common release mechanisms include spills, leaks, direct discharge, and burning, etc.

In some instances the release mechanism is unknown and may need to be an educated guess based on the available information.

IMPACTED MEDIA

The impacted media at a site are the environmental substances to which a contaminant is directly released.

The impacted media may include soil, sediment, groundwater, surface water, or air.



TRANSPORT MECHANISMS

Transport mechanisms show how contaminants in the impacted environmental media may be moved to other media.

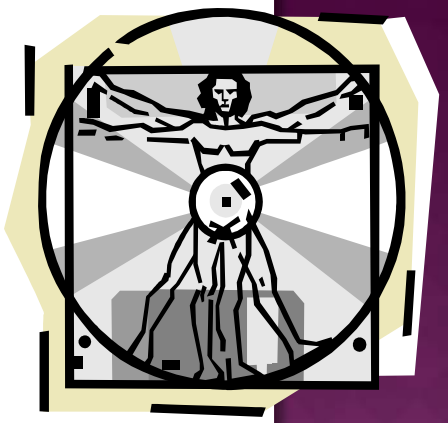
EXPOSURE MEDIA

Exposure media is the environmental substance an individual is exposed to.

Exposure media may include soil, sediment, groundwater, surface water, air, and biota (plants and animals).

Exposure media includes all impacted media that people may directly have contact with.

EXPOSURE ROUTES



An exposure route is the way a contaminant comes in contact with a receptor and the way a chemical enters the body.

- Ingestion
- Inhalation
- Dermal contact

MAIN ROUTES OF EXPOSURE FOR HUMANS

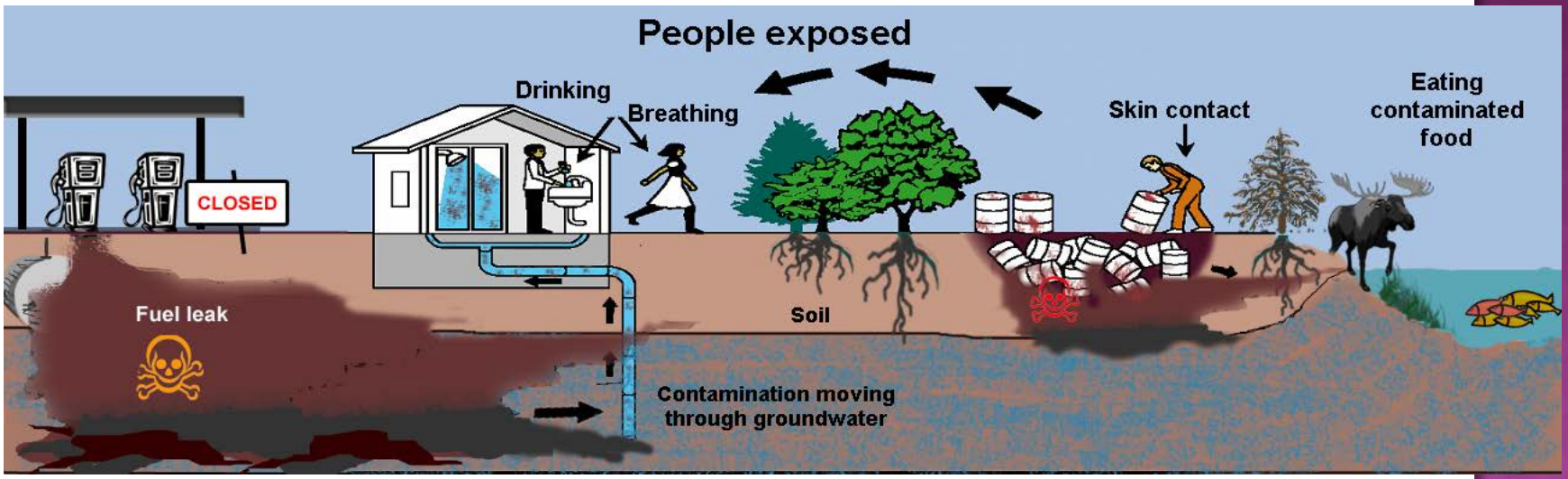
- Eating/drinking (ingestion),
- Breathing (inhalation), and
- Skin (dermal) contact.

HUMAN RECEPTORS

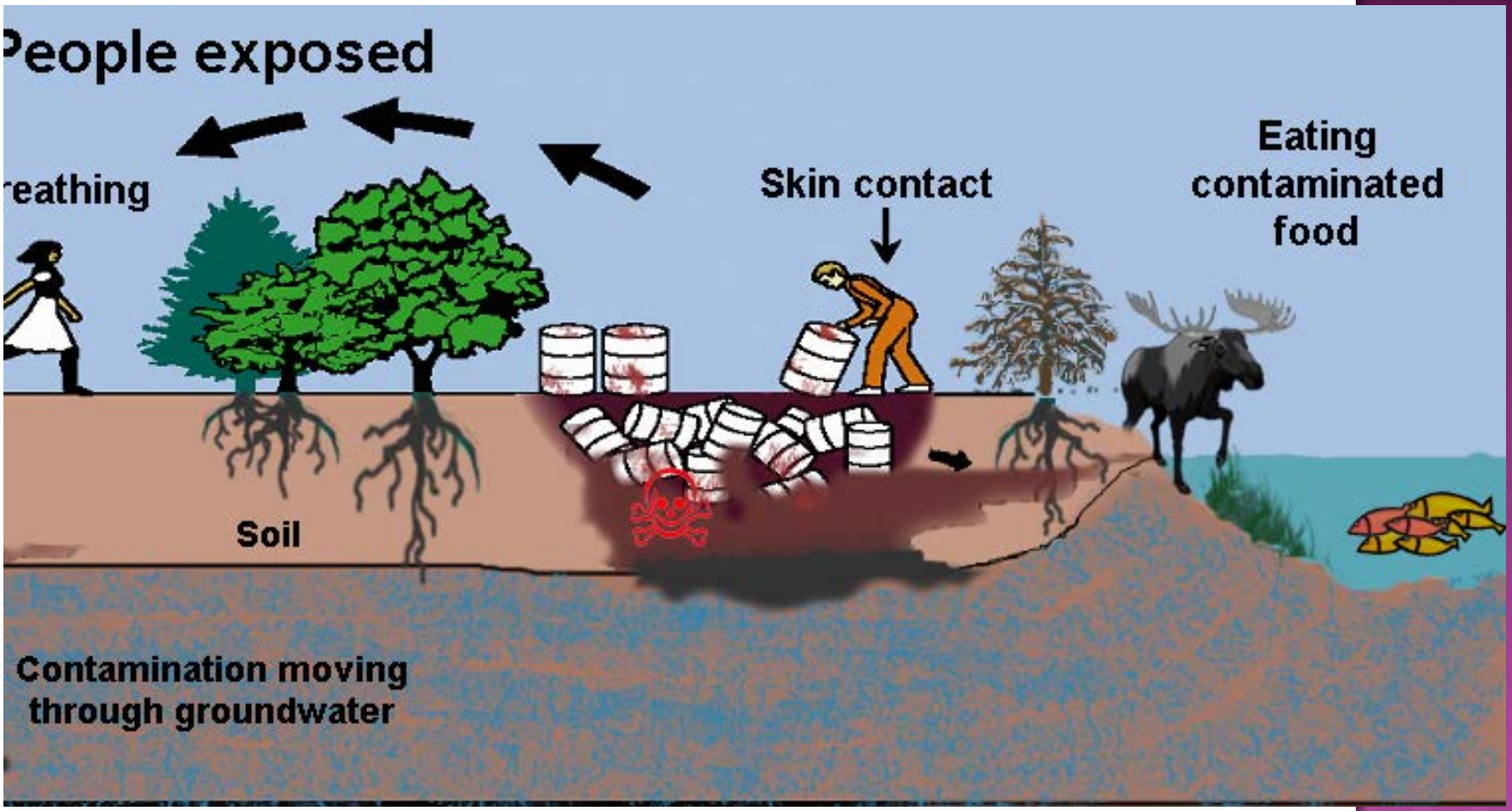
When determining human receptors for a site, it is important to keep in mind both **current** and **future** land use. This information should be included in the human health CSM. Potential receptors may include the following:

- Resident (adult and child);
- Commercial or industrial worker;
- Construction worker;
- Site visitor;
- Trespasser;
- Recreational user;
- Farmer;
- Subsistence harvester, or
- Subsistence consumer.

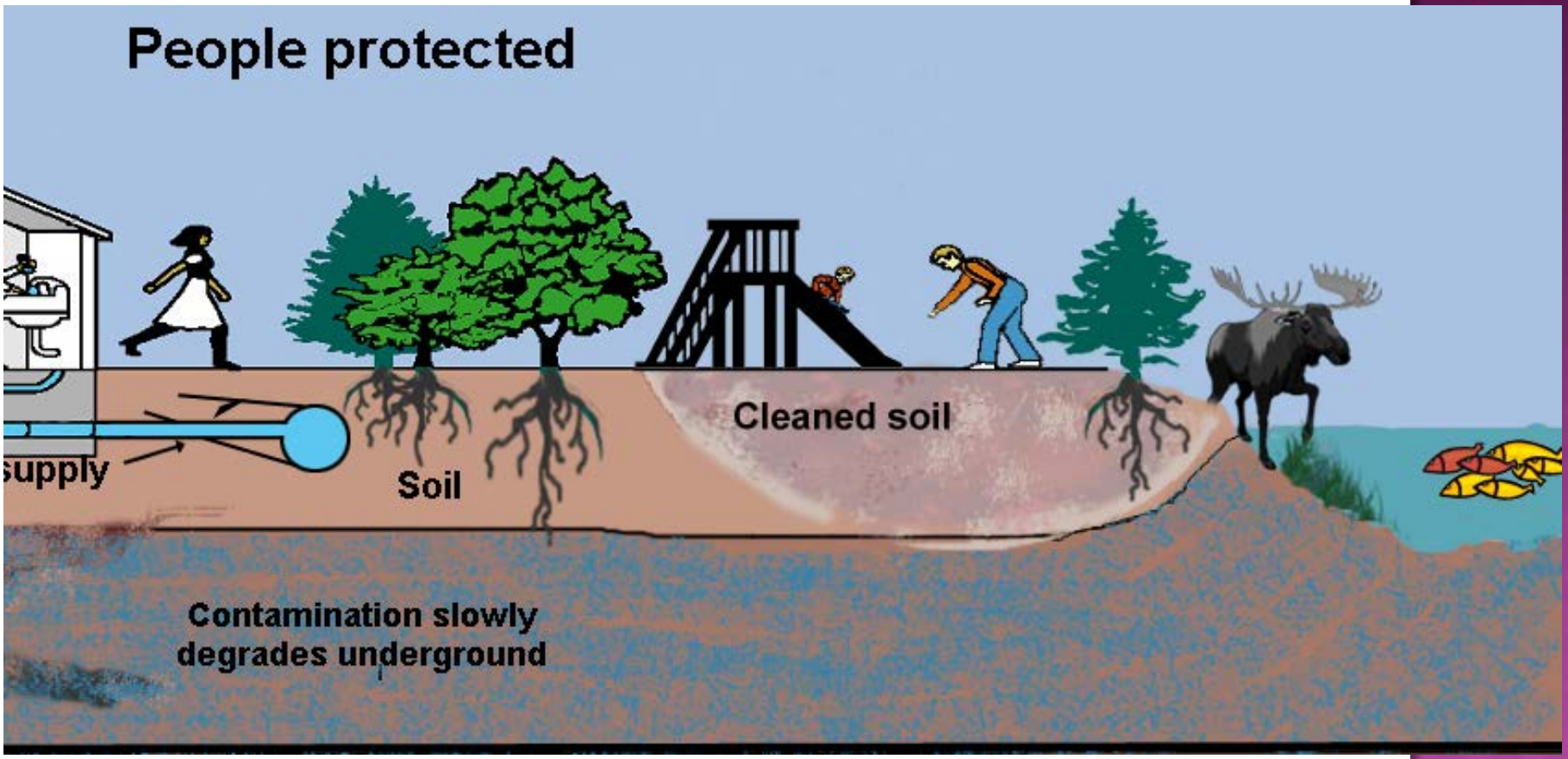
ANOTHER EXAMPLE: WHAT ARE THE POTENTIAL EXPOSURE ROUTES?



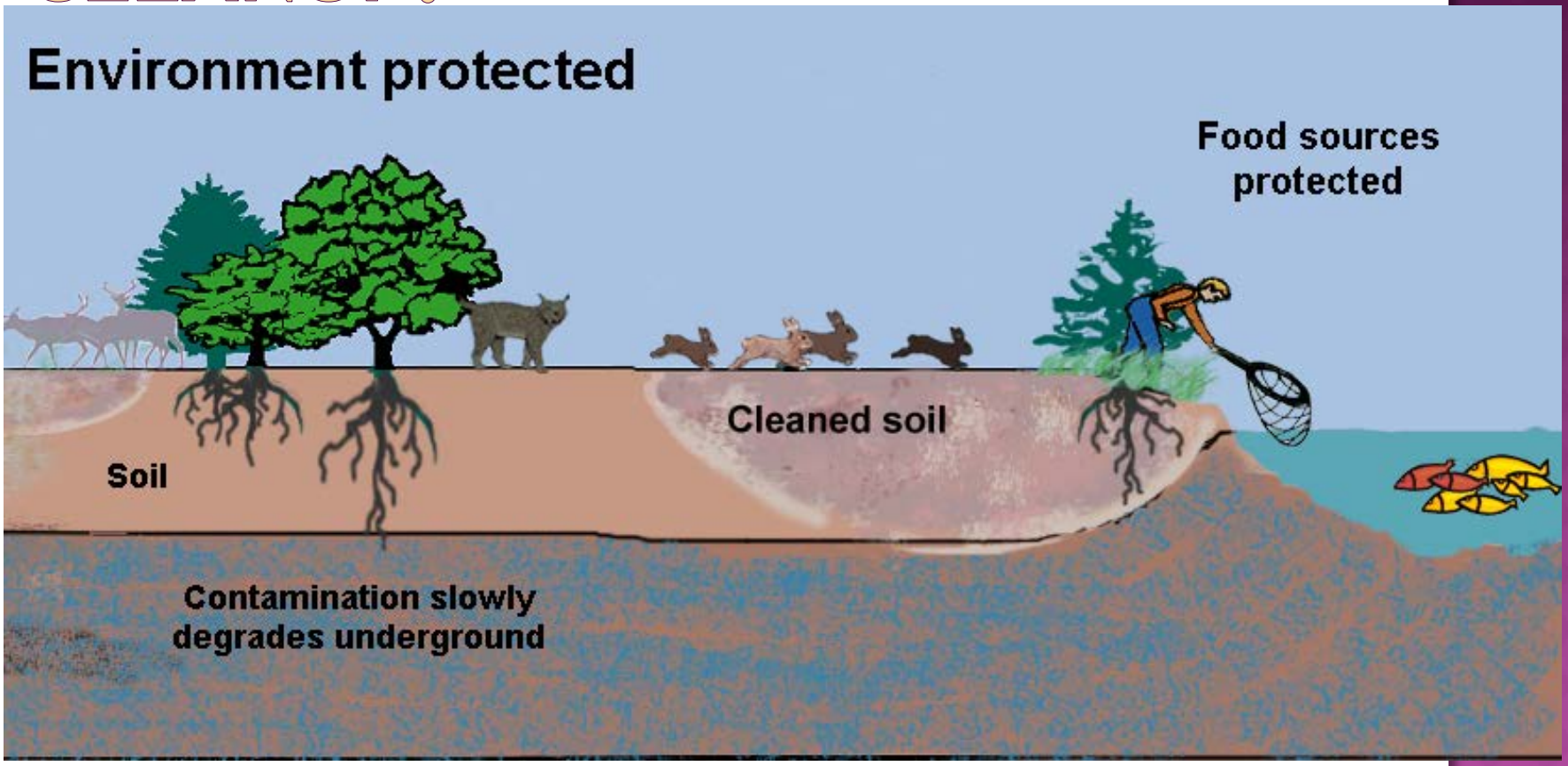
BEFORE CLEANUP:



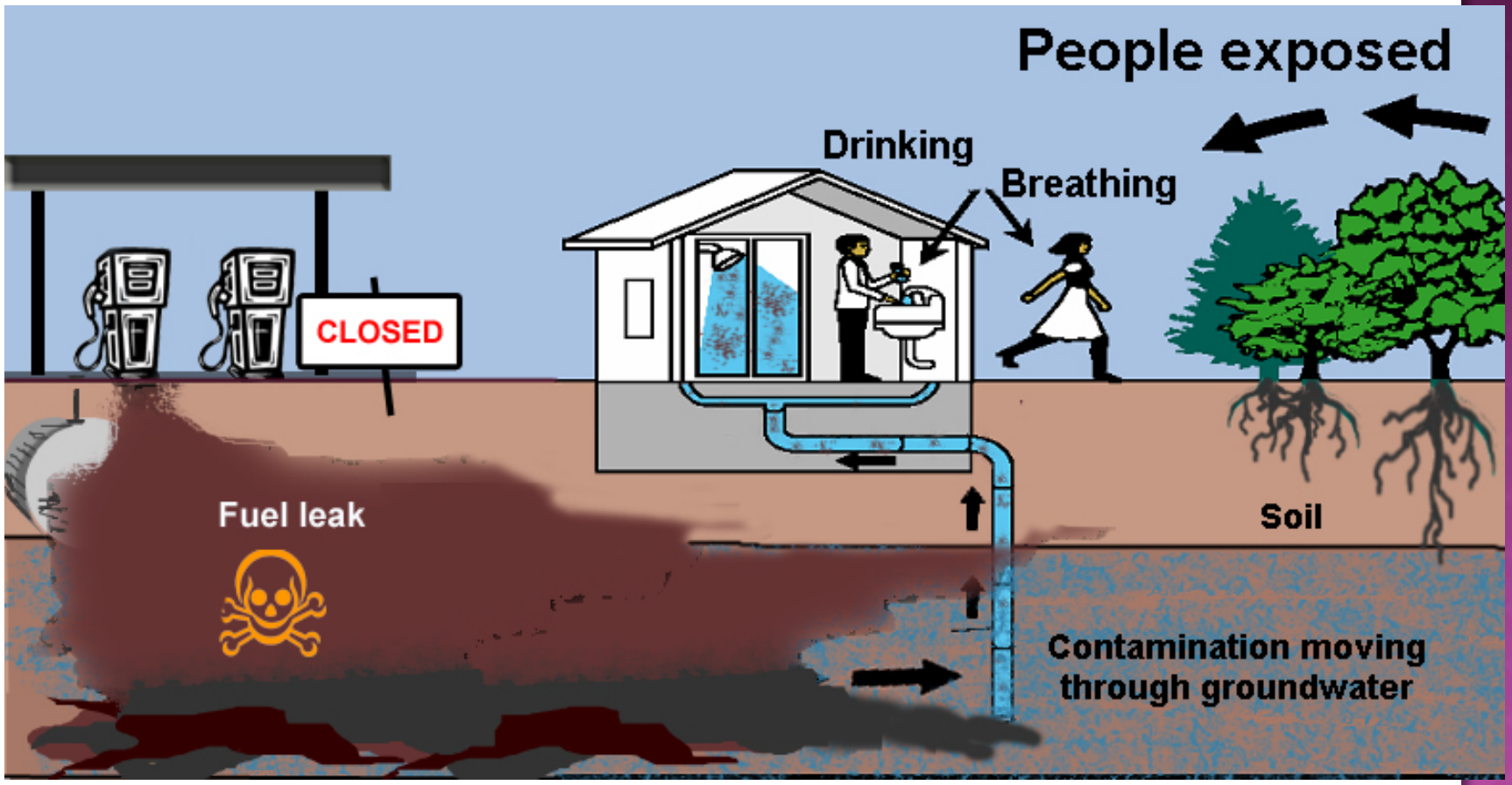
HUMAN EXPOSURE AFTER CLEANUP:



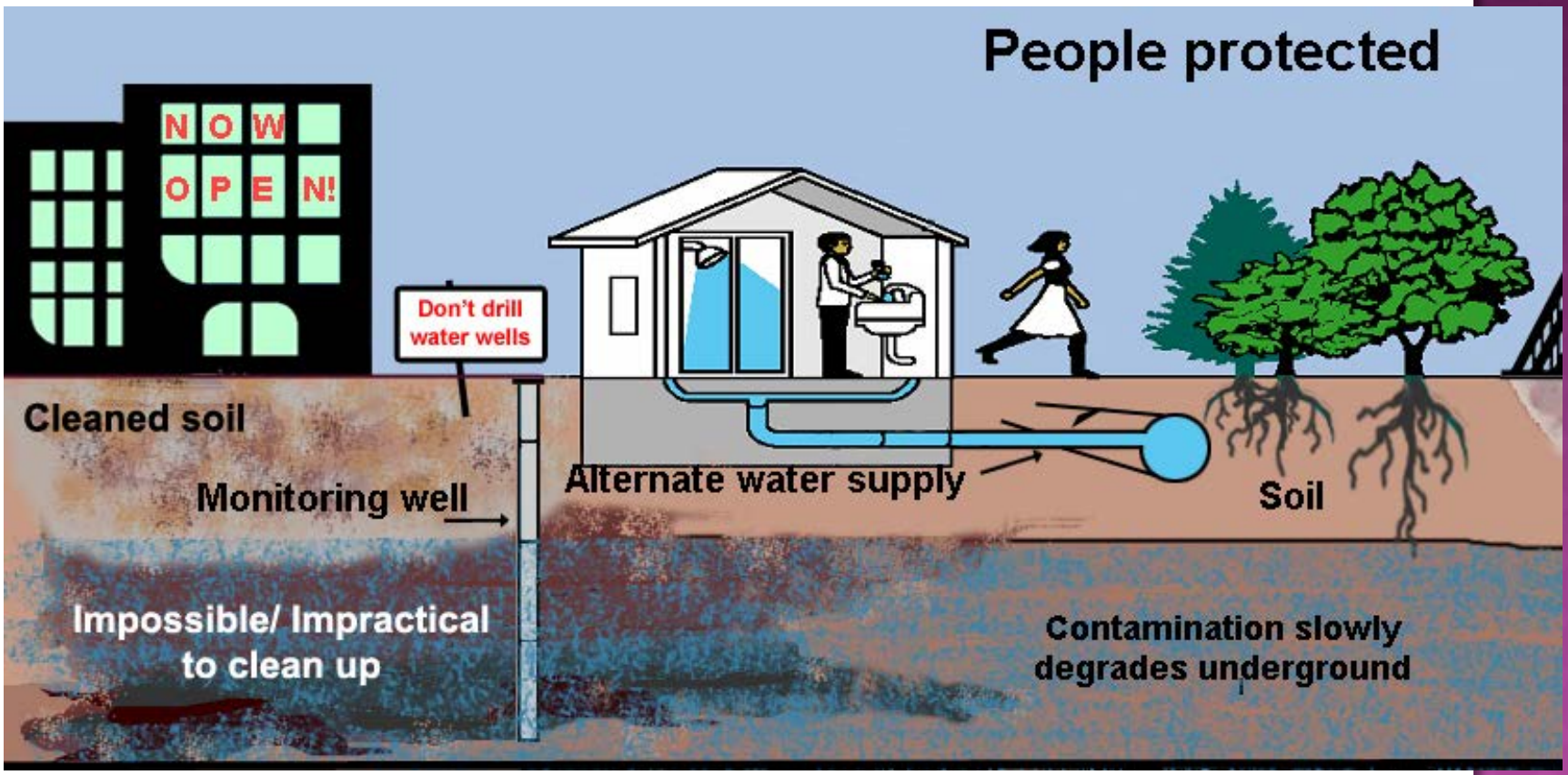
ENVIRONMENT AFTER CLEANUP:



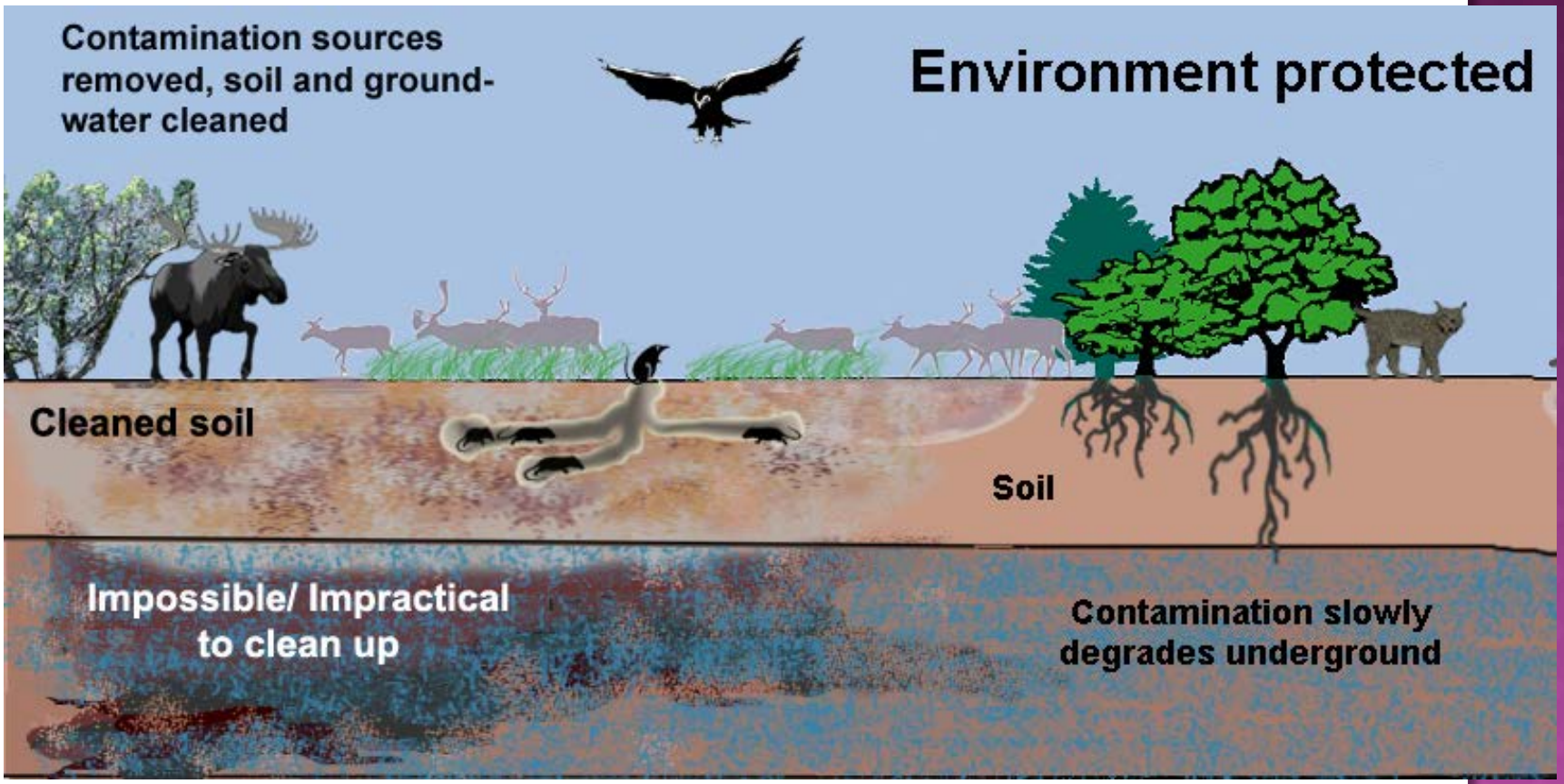
BEFORE CLEANUP:



HUMAN EXPOSURE AFTER CLEANUP:



ENVIRONMENT AFTER CLEANUP:



QUESTIONS?

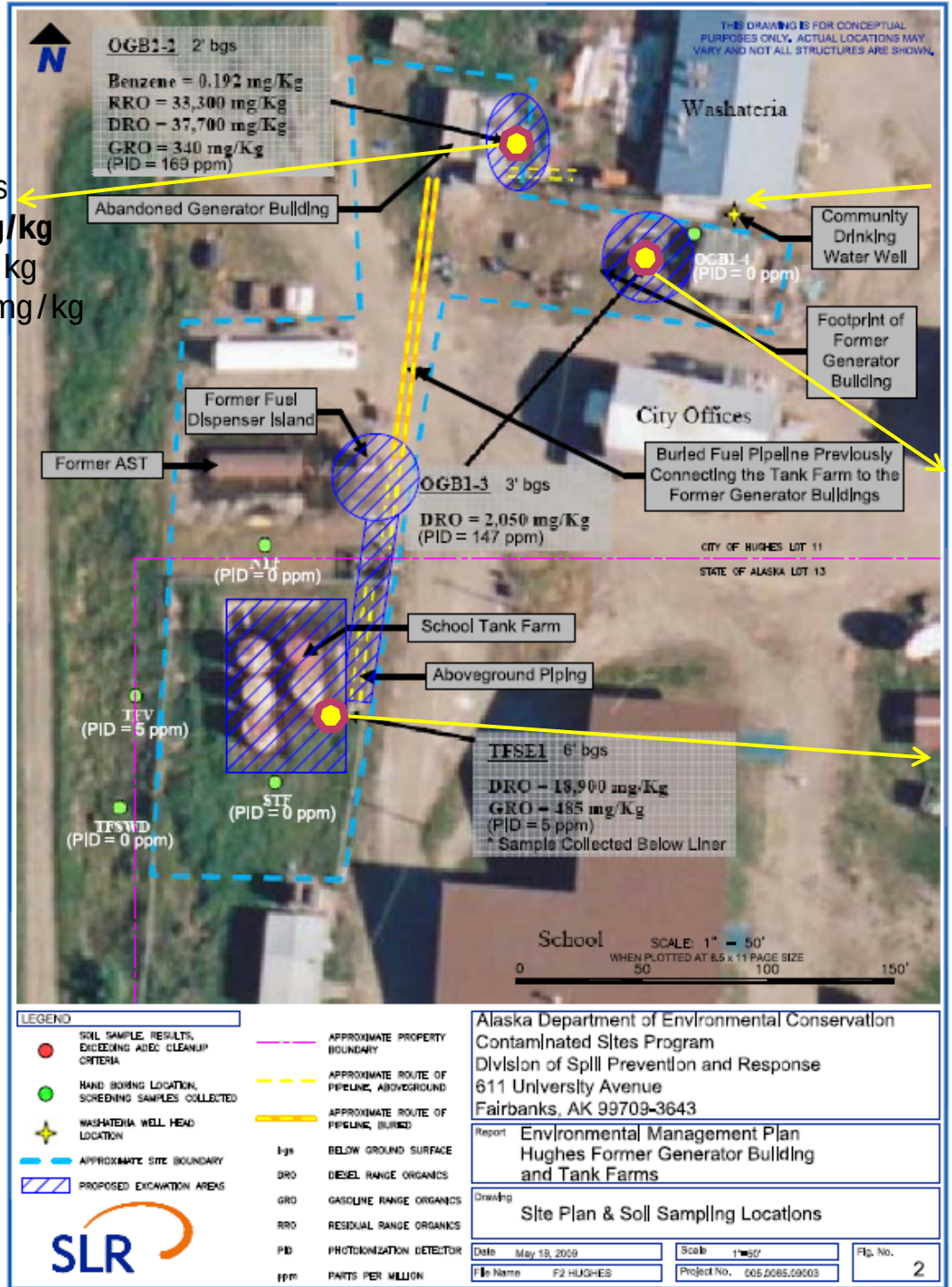
CSM EXAMPLE: HUGHES SCHOOL AND COMMUNITY TANK FARM SITE


Former tanks
Public Drinking Water Well


Public Drinking Water Well
Storage tanks
Abandoned Generator Building


DIESEL
DIESEL
DANGER
FLAMMABLE
NO SMOKING
NO OPEN LIGHTS
ALASKA LAW REQUIRES THE REPORTING OF ALL
OIL AND HAZARDOUS SUBSTANCES SPILLS
CALL: 1-800-478-9300 24 hours/day
ALASKA DEPARTMENT OF ENVIRONMENTAL CONSERVATION
FEDERAL LAW REQUIRES THE REPORTING OF ALL OIL AND HAZARDOUS SUBSTANCE SPILLS TO THE U.S. COAST GUARD AND THE U.S. ENVIRONMENTAL PROTECTION AGENCY

Depth = 2 feet bgs
DRO = 37,700 mg/kg
RRO = 33,300 mg/kg
Benzene = 0.192 mg/kg



Community Drinking Water Well

Depth = 3 feet bgs
DRO = 2,050 mg/kg

Depth = 6 feet bgs
DRO = 18,900 mg/kg
GRO = 485 mg/kg

Cross-section of the Hughes tank farm area

drinking water well

37,700 mg/kg

2,050 mg/kg

6’

18,900 mg/kg

Potential exposure routes: indoor and outdoor inhalation, ingestion soil and groundwater, and dermal contact.

Primary groundwater flow direction

Human Health Conceptual Site Model
Scoping Form

Site Name: Hughes Former Generator Building/Tank Farm

File Number: N/A/

Completed by: SLR International Corp

Introduction

The form should be used to reach agreement with the Alaska Department of Environmental Conservation (DEC) about which exposure pathways should be further investigated during site characterization. From this information, a CSM graphic and text must be submitted with the site characterization work plan.

General Instructions: Follow the italicized instructions in each section below.

1. *General Information:*

Sources *(check potential sources at the site)*

- ☐ USTs
- ☑ ASTs
- ☑ Dispensers/fuel loading racks
- ☑ Drums
- ☐ Vehicles
- ☐ Landfills
- ☐ Transformers
- ☑ Other: batteries, pipeline, generator system

Release Mechanisms *(check potential release mechanisms at the site)*

- ☑ Spills
- ☑ Leaks
- ☐ Direct discharge
- ☐ Burning
- ☐ Other: _____

Impacted Media *(check potentially-impacted media at the site)*

- ☑ Surface soil (0-2 feet bgs*)
- ☑ Subsurface Soil (>2 feet bgs)
- ☐ Air
- ☑ Groundwater
- ☐ Surface water
- ☐ Other: _____

Receptors (*check receptors that could be affected by contamination at the site)*

- ☑ Residents (adult or child)
- ☑ Commercial or industrial worker
- ☑ Construction worker
- ☐ Subsistence harvester (i.e., gathers wild foods)
- ☐ Subsistence consumer (i.e., eats wild foods)
- ☑ Site visitor
- ☑ Trespasser
- ☑ Recreational user
- ☐ Farmer
- ☐ Other: _____

* bgs – below ground surface

2. **Exposure Pathways:** *(The answers to the following questions will identify complete exposure pathways at the site. Check each box where the answer to the question is "yes".)*

a) **Direct Contact –**

1 Incidental Soil Ingestion

Is soil contaminated anywhere between 0 and 15 feet bgs? ☑

Do people use the site or is there a chance they will use the site in the future? ☑

If both boxes are checked, label this pathway complete: Complete

2 Dermal Absorption of Contaminants from Soil

Is soil contaminated anywhere between 0 and 15 feet bgs? ☑

Do people use the site or is there a chance they will use the site in the future? ☑

Can the soil contaminants permeate the skin? (Contaminants listed below, or within the groups listed below, should be evaluated for dermal absorption). ☑

Arsenic	Lindane
Cadmium	PAHs
Chlordane	Pentachlorophenol
2,4-dichlorophenoxyacetic acid	PCBs
Dioxins	SVOCs
DDT	

If all of the boxes are checked, label this pathway complete: Complete

b) **Ingestion –**

1 Ingestion of Groundwater

Have contaminants been detected or are they expected to be detected in the groundwater, OR are contaminants expected to migrate to groundwater in the future? ☑

Could the potentially affected groundwater be used as a current or future drinking water source? *Please note, only leave the box unchecked if ADEC has determined the groundwater is not a currently or reasonably expected future source of drinking water according to 18 AAC 75.350.* ☑

If both the boxes are checked, label this pathway complete: Complete

2 Ingestion of Surface Water

Have contaminants been detected or are they expected to be detected in surface water OR are contaminants expected to migrate to surface water in the future? ☑

Could potentially affected surface water bodies be used, currently or in the future, as a drinking water source? *Consider both public water systems and private use (i.e., during residential, recreational or subsistence activities).* ☐

If both boxes are checked, label this pathway complete: _____

3 Ingestion of Wild Foods

Is the site in an area that is used or reasonably could be used for hunting, fishing, or harvesting of wild food? ☑

Do the site contaminants have the potential to bioaccumulate (*see* Appendix A)? ☑

Are site contaminants located where they would have the potential to be taken up into biota? (i.e. the top 6 feet of soil, in groundwater that **could be** connected to surface water, etc.) ☑

If all of the boxes are checked, label this pathway complete: Complete

c) Inhalation

1 Inhalation of Outdoor Air

Is soil contaminated anywhere between 0 and 15 feet bgs? ☑

Do people use the site or is there a chance they will use the site in the future? ☑

Are the contaminants in soil volatile (*See Appendix B*)? ☑

If all of the boxes are checked, label this pathway complete: Complete

2 Inhalation of Indoor Air

Are occupied buildings on the site or reasonably expected to be placed on the site in an area that could be affected by contaminant vapors? (i.e., within 100 feet, horizontally or vertically, of the contaminated soil or groundwater, or subject to "preferential pathways" that promote easy airflow, like utility conduits or rock fractures) ☑

Are volatile compounds present in soil or groundwater (*See Appendix C*)? ☑

If both boxes are checked, label this pathway complete: Complete

SUMMARY

Complete Pathways

- Incidental soil ingestion
- Skin contact with soil
- Outdoor or indoor inhalation
- Groundwater ingestion

Incomplete Pathways

- Surface water ingestion
- Wildfoods ingestion


Alaska Dept. of Environmental Conservation
Janice Wiegers, Contaminated Sites Program