



Tighe&Bond

**Quality Site Assessments & Investigations
Using the
Conceptual Site Model Approach**



PART II: SITE INVESTIGATION

Testing the Conceptual Site Model

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SITE INVESTIGATION WORK PLAN

Conceptual Site Model

SITE INVESTIGATION WORK PLAN - CSM

Develop the Initial CSM

“The CSM is a site-specific description of how contaminants entered the environment, how they have been and may be transported within the environment, and routes of exposure to human and environmental receptors...” *Source: MCP Definitions, 310 CMR 40.0006*

The CSM is a Dynamic Framework For:

- Identifying and addressing data gaps and managing uncertainty
- Eliminating or controlling contaminant sources
- Developing and conducting response action strategies
- Evaluating whether response actions have achieved desired endpoints

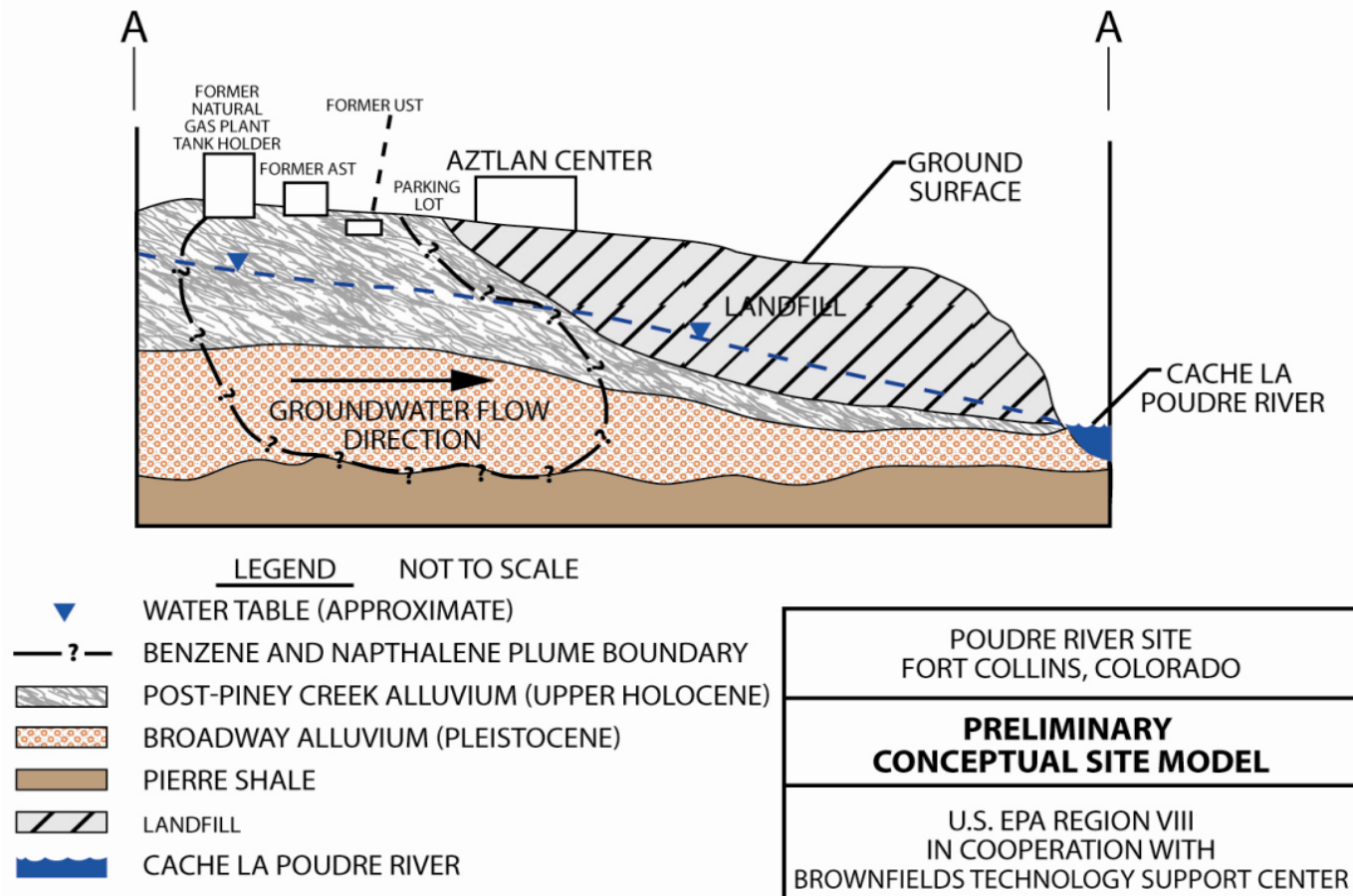
SITE INVESTIGATION WORK PLAN - CSM

Develop the Initial CSM

- **Summarize Known and Hypothesized Information - Visual, Descriptive**
 - Location of RECs, AOCs, Sudden Releases, etc.
 - On-site features or processes that could exacerbate RECs, AOCs, etc.
 - Infrastructure details
 - Identify/hypothesize contaminants of concern
 - Evaluate anticipated contaminant behavior in the environment
 - Mobility, density, volatility, biodegradability
 - Geology
 - Groundwater flow direction
 - Surface Runoff Patterns
 - Hypothesize extent of contamination
 - Vertical and horizontal extent
 - Nearby sensitive receptors (potable/supply wells, indoor air, reservoirs, endangered species)

SITE INVESTIGATION WORK PLAN - CSM

Develop the Initial CSM



Source: USEPA *Environmental Cleanup Best Management Practices:
Effective Use of the Project Life Cycle Conceptual Site Model*

SITE INVESTIGATION WORK PLAN - CSM

Develop a Work Plan Based on The CSM

– Start with the End in Mind

- Connect the source areas to receptors
- Identify potential site uses and exposure pathways requiring evaluation
- Evaluate/build on existing data
- Design a workplan that provides useful data for risk characterization

– Consult Quality Assurance Plans and Standard Operating Procedures

- Regional EPA QAPP Procedures - Brownfields
- State governmental guidance documents (eg. MassDEP Vapor Intrusion Guidance)
- Industry or company-specific SOPs (decontamination procedures, HASP, engineering controls)

– Develop an Initial Site Sketch

- Existing physical site features identified in CSM
- Receptors (potable/supply wells, indoor air, surface waters)
- Proposed sample, boring, monitoring well locations
- “Scope and detail commensurate with release and site conditions”

SITE INVESTIGATION WORK PLAN - CSM

Develop a Work Plan Based on The CSM

– Consider Potential Anthropogenic Influences

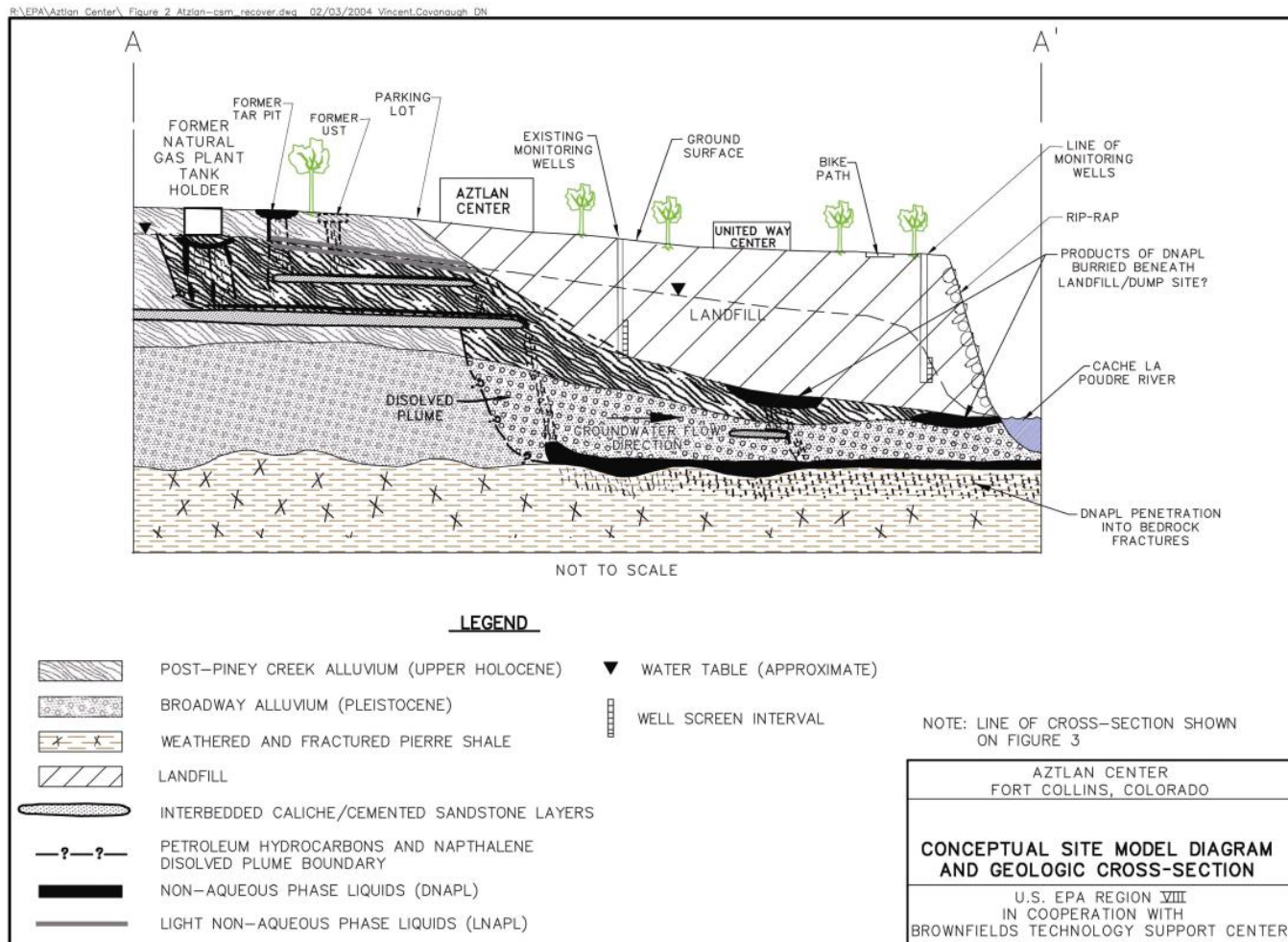
- Potential groundwater mounding from septic/stormwater infiltration
- Abandoned building foundations and footings
- Preferential pathways from utility gravel beds
- Cutting and filling
- Historical fill

Identify Analyses Required

- Data sensitivity and risk characterization needs
- Microscopy analysis

SITE INVESTIGATION WORK PLAN - CSM

Redeveloping the CSM



Source: USEPA Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model



TESTING THE CSM

Potential Exposure Pathways

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Exposure Pathway

An *exposure pathway* is the link between a contaminant source and a receptor (U.S. EPA).

Eg. Groundwater, drinking water, indoor air, surficial soil

Exposure Route

An *exposure route* is the way a chemical enters an organism upon contact (U.S. EPA)

Eg. Ingestion, inhalation, dermal absorption

TESTING THE CSM

Potential Exposure Pathways

Air Pathways

- Outdoor/ambient air
- Indoor Air (vapor intrusion)

Soil Pathways

- Dermal Absorption (recreation)
- Incidental Ingestion (construction)
- Inhalation of Particles (construction)
- Produce (agriculture/gardening)
- Soil Gas (vapor intrusion)

Groundwater Pathways

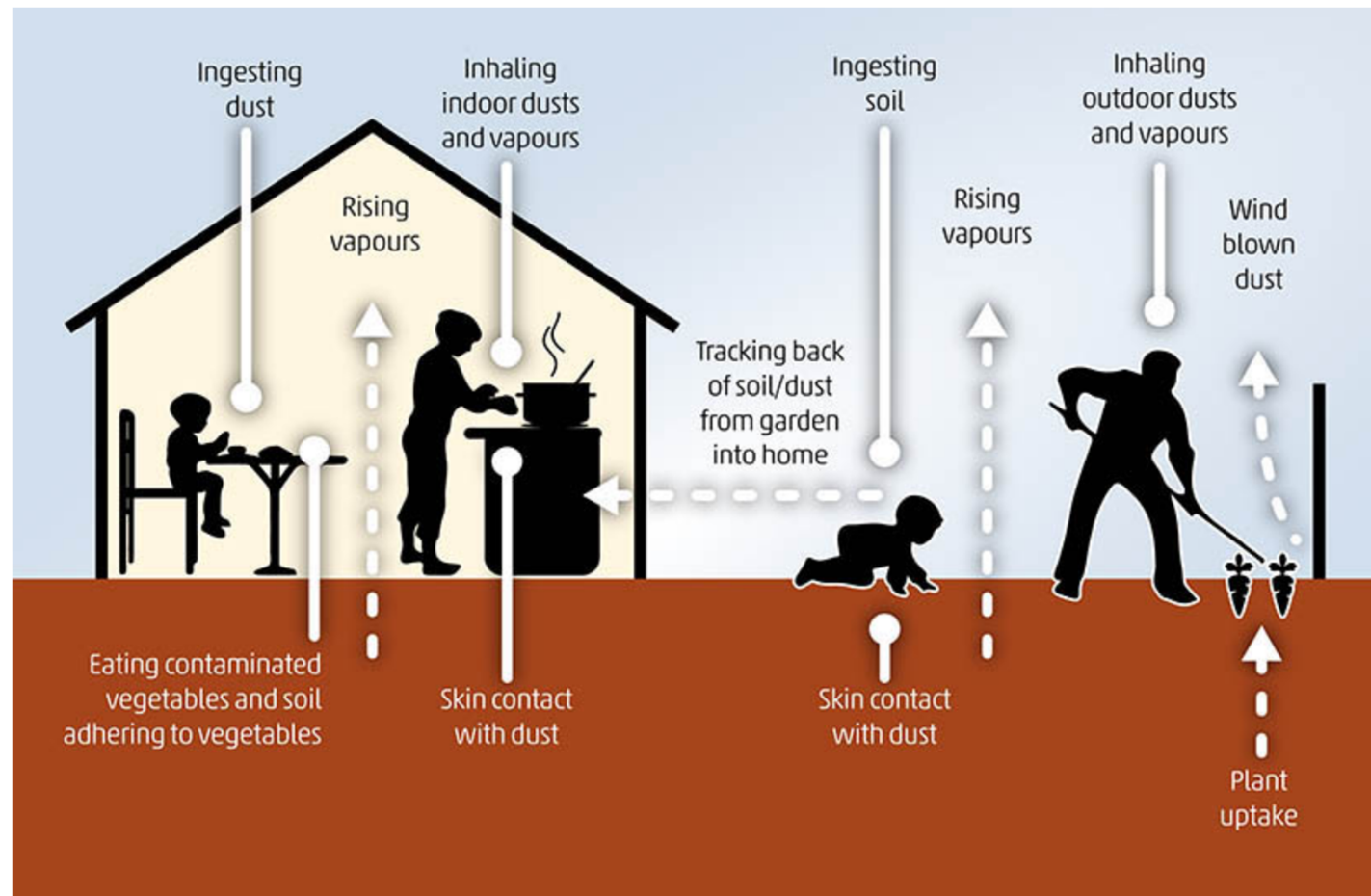
- Direct Consumption (drinking, cooking)
- Dermal Absorption (bathing)
- Inhalation (bathing)

Surface Water Pathways

- Dermal Absorption (recreation)
- Incidental Ingestion (recreation)

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Soil



Source: *United Nations Environmental Assembly*: Chapter 4. Environmental, health and socio-economic impacts of soil pollution

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Soil Exposure Pathway

- Direct contact with soil is the primary concern
- Exposure pathways are categorized based on soil contaminant accessibility to receptors
- Exposure routes include dermal absorption, incidental ingestion, dust inhalation

Surficial Soil

- Considered “accessible” in most cases (top 3 feet)
- Typically residential activities (passive recreation, gardening, home produce)
- Majority of ecological exposures are in the top 2 feet

Soil “at Depth”

- Considered “potentially accessible” or “inaccessible” (below 15 feet)
- Typically associated with construction activities (excavations, utility work)
- Can become “surficial” soil if cutting/filling occurs in the future

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

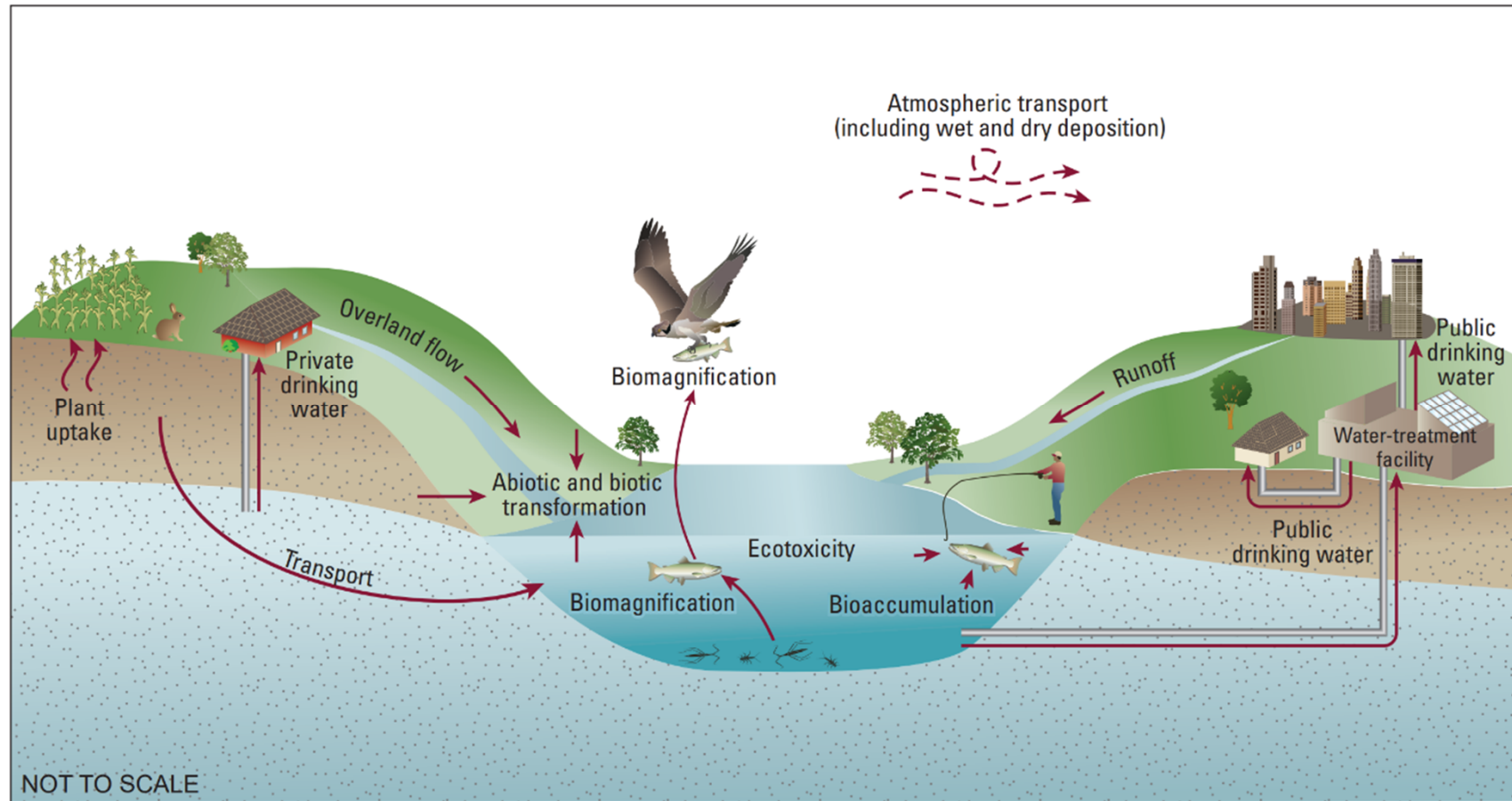
Soil Exposure Pathway Assessment

Soil Sampling

- Hand tools for surficial soil
- Soil borings for deep assessment
 - Geoprobe is economical, but compression can cause uncertainty in sample depths
 - Hollow-stem auger is slower, but gives more precise sample depths
- Field screening techniques available (TPH, total VOCs)
 - Guides assessment (vertical, horizontal) and analytical sample selection
- Match sample depths to exposure pathways (e.g. 0-3 feet, > 15 feet)
- Avoid spanning exposure categories (e.g. 2-4 feet)

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Groundwater



Source: **USEPA**: Improving Understanding and Coordination of Science Activities for Per- and Polyfluoroalkyl Substances (PFAS) in the Chesapeake Bay Watershed

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Groundwater Exposure Pathway

- Direct consumption (GW-1)
 - Private wells
 - Municipal supply wells
 - Facility potable/supply wells
 - Future exposures (Potentially Productive Aquifers)
- Vapor Intrusion (GW-2)
 - Within 30 horizontal feet of a building
 - Average groundwater depth < 15 feet
- Recreational and Ecological (GW-3)
 - Potential discharge to surface water bodies

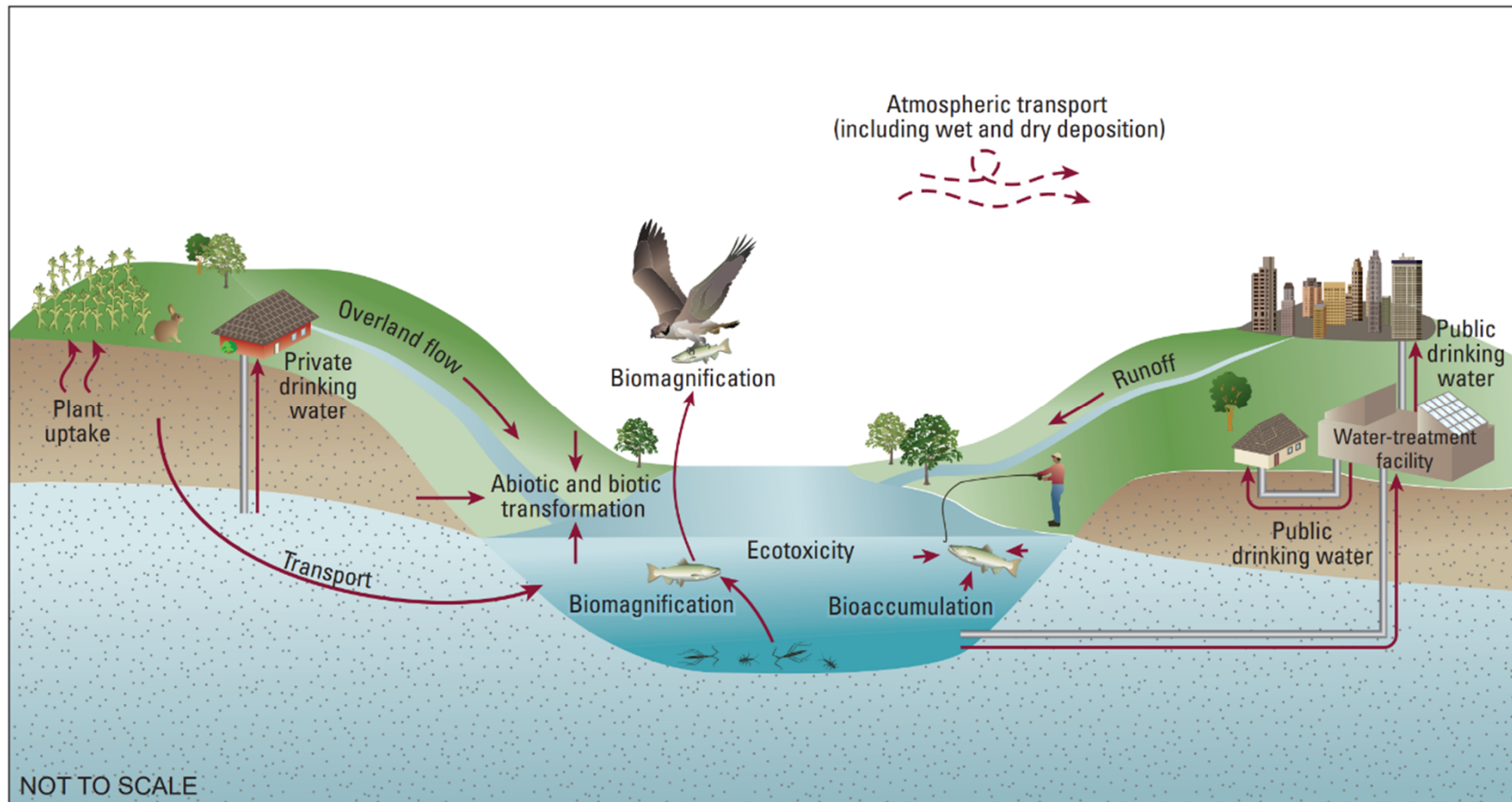
TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Groundwater Pathway Assessment

- Consider characteristics of contaminant(s) being assessed
 - Well screen intersects top of water table (NAPL)
 - Well screened at confining layers (DNAPL)
 - Assess bedrock as needed
 - Well placement near buildings (GW-2)
 - Sample potable/supply wells directly
- Monitoring well network (source area, mid-plume, edge of plume)
 - Contaminant mobility
 - Anticipated groundwater flow direction
- Quality Assurance
 - Develop monitoring wells (reduce turbidity)
 - Bailer or low-flow sampling
 - Sample integrity: keep samples cool, meet analytical method holding times

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

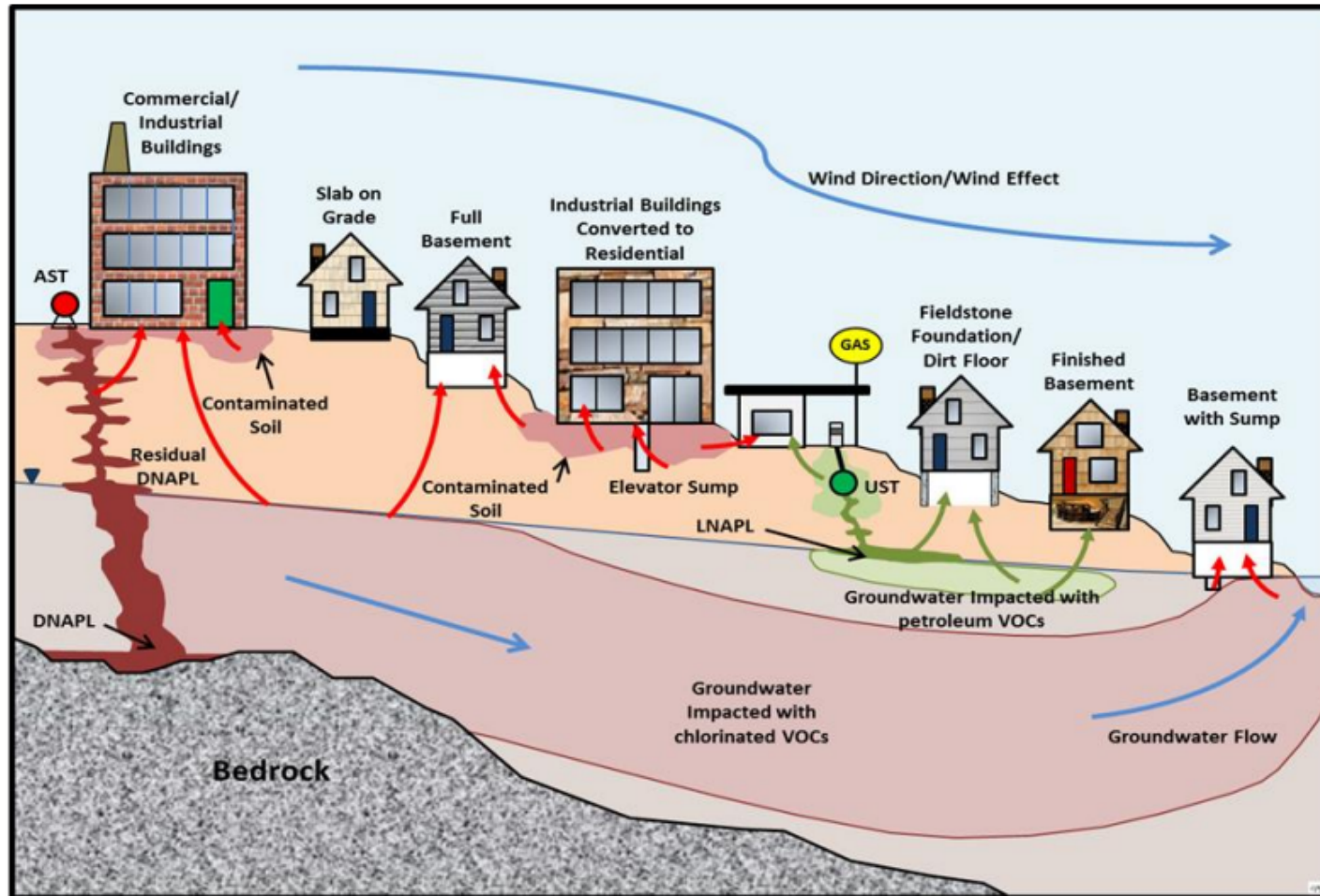
Sediment and Surface Water



Source: **USEPA**: Improving Understanding and Coordination of Science Activities for Per- and Polyfluoroalkyl Substances (PFAS) in the Chesapeake Bay Watershed

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Air



Source: MassDEP Vapor Intrusion Guidance: Site Assessment, Mitigation and Closure
Policy #WSC-16-435

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Air Exposure Pathway

- Volatile substances
- Vapor intrusion is often the primary concern
- Begins with soil and groundwater assessment
- Sub-slab soil gas assessment

Soil Vapors

- Assess within 6 feet horizontally or 10 feet vertically of building (MassDEP)
- LNAPL/DNAPL sources near building

Groundwater Vapors

- Monitoring well within 30 horizontal feet of a building
- Groundwater < 15 feet below ground on average
- GW-2 Standards apply
- Evaluate direct exposure pathways (e.g. bathing)

TESTING THE CSM – POTENTIAL EXPOSURE PATHWAYS

Air Exposure Pathway Assessment

Sub-Slab Soil Gas Sampling

- Concentrations are variable over short distances
- “Air-Tight” is important (water dams, counter-sunk vapor pins, helium shrouds)
- Applicable thresholds indicate need for indoor air sampling

Indoor Air Sampling

- Remove confounding sources (notify ahead of time)
- Create “representative” environment (open windows in summer, closed in winter)
- Applicable thresholds indicate need for risk characterization

Considerations

- Seasonality (“winter” conditions: indoors 10F > outdoor temperature)
- Preferential pathways/concentration gradient (heating/cooling air movement in building)
- “Other” sources - heated water from contaminated private well
- Confounding indoor sources (moth balls, brake/carburetor cleaners)

TESTING THE CSM – OTHER CONSIDERATIONS

Start with the End in Mind

- Presence/absence determination
- Risk characterization (long-term exposure)
- Groundwater / Surface Water Interactions
 - Groundwater “discharges” and “recharges” surface water seasonally
- Continually update CSM with new data



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Questions?