A DECISION TREE INCORPORATING VAPOR INTRUSION INTO SCREENING RISK ASSESSMENTS OF HAZARDOUS WASTE SITES

Patty Wong-Yim, Loveriza A Sarmiento,
Michael J Wade, Brian K Davis,
and Michael J. Anderson

Department of Toxic Substances Control
California Environmental Protection Agency
Sacramento, California
www.dtsc.ca.gov

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ABSTRACT

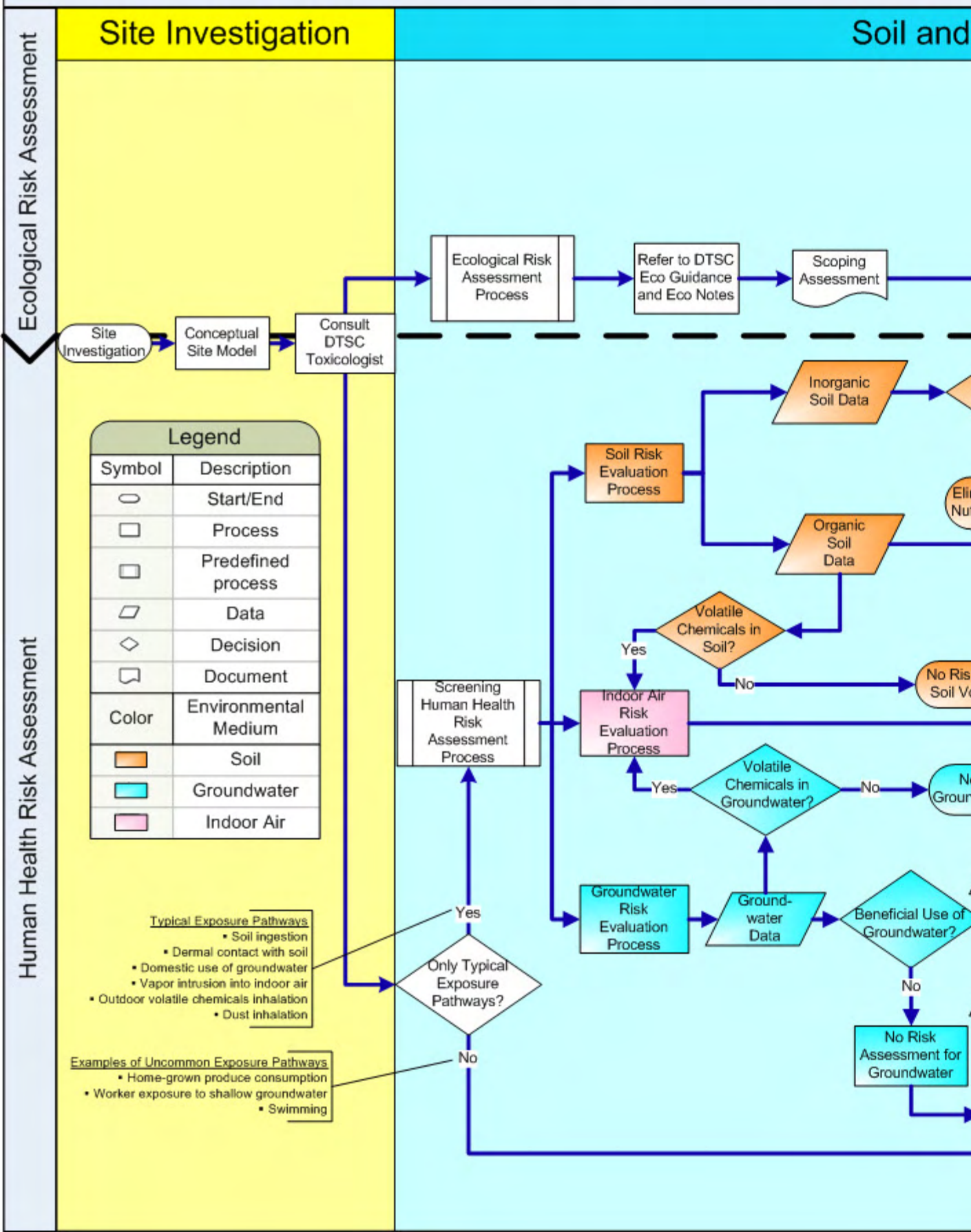
Over the last decade, California has evolved a process for screening level risk assessments at Federal Facilities, using US EPA Region 9 Preliminary Remedial Goals (PRGs) supplemented with CAL-modified PRGs reflecting California-derived toxicity criteria where appropriate. With increasing recognition of the importance of vapor intrusion into indoor air, we developed a decision tree approach to incorporate that exposure pathway.

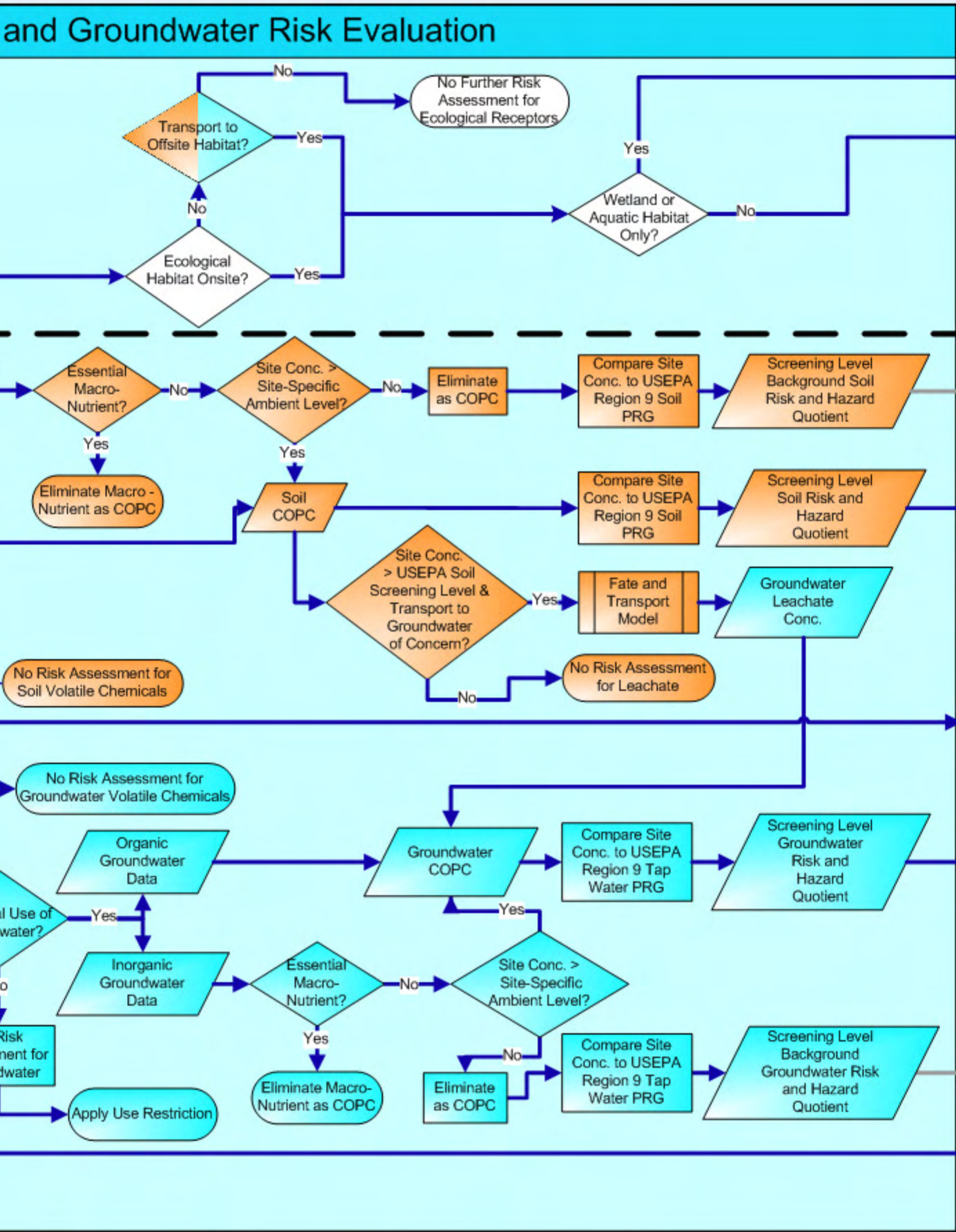
The Decision Tree accounts for contaminants in soil (ingestion, dermal absorption, inhalation of particles and vapors) and groundwater (ingestion and inhalation of vapors). Vapor intrusion is estimated on a site-specific basis using the Johnson and Ettinger model. Potential migration of contaminants from soil to groundwater can be estimated using US EPA soil screening levels.

The utility of the Decision Tree approach was demonstrated at two test Sites. At both sites, the use of PRGs alone led to the conclusion that risks are minimal and the site could be eliminated as a concern. Risk assessment of all exposure pathways, including vapor intrusion into indoor air, yielded incremental risk estimates of 2E-3 for Site A and 4E-4 for Site B. Most (100% at Site A and 95% at Site B) of the risk estimate was from the vapor intrusion pathway.

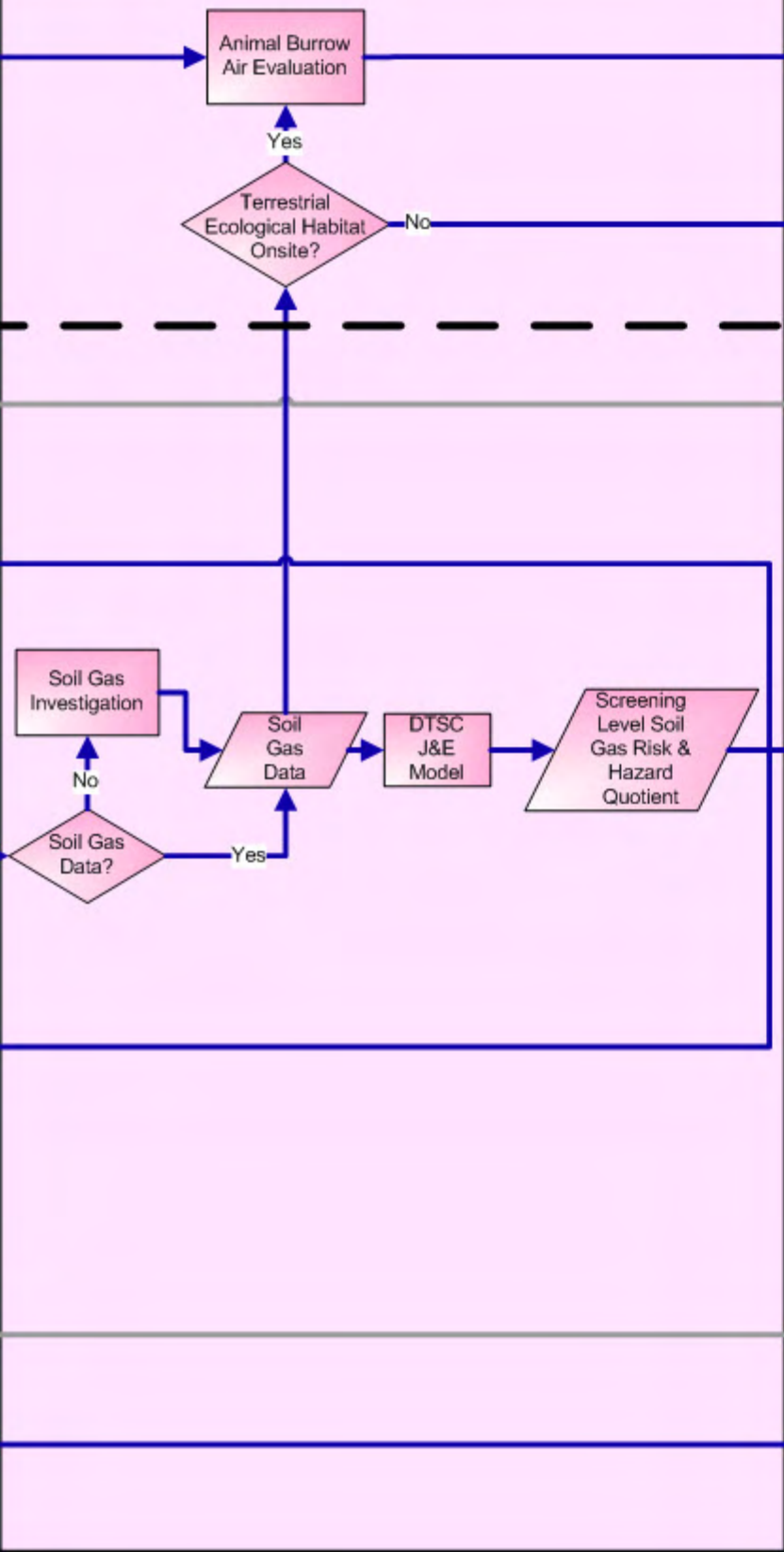
The Decision Tree approach is flexible, cost- and time-effective, and accounts for the vapor intrusion pathway. It evaluates total, incremental and background risks for both residential and industrial scenarios. The approach also provides a transition to a more site-specific (baseline) evaluation when a site does not meet the requirements for a screening level assessment. Additional pathways, such as home-grown produce consumption, may necessitate a baseline risk assessment. If ecological receptors need to be addressed, a separate ecological assessment is required.

RISK ASSESSMENT DECISION TREE

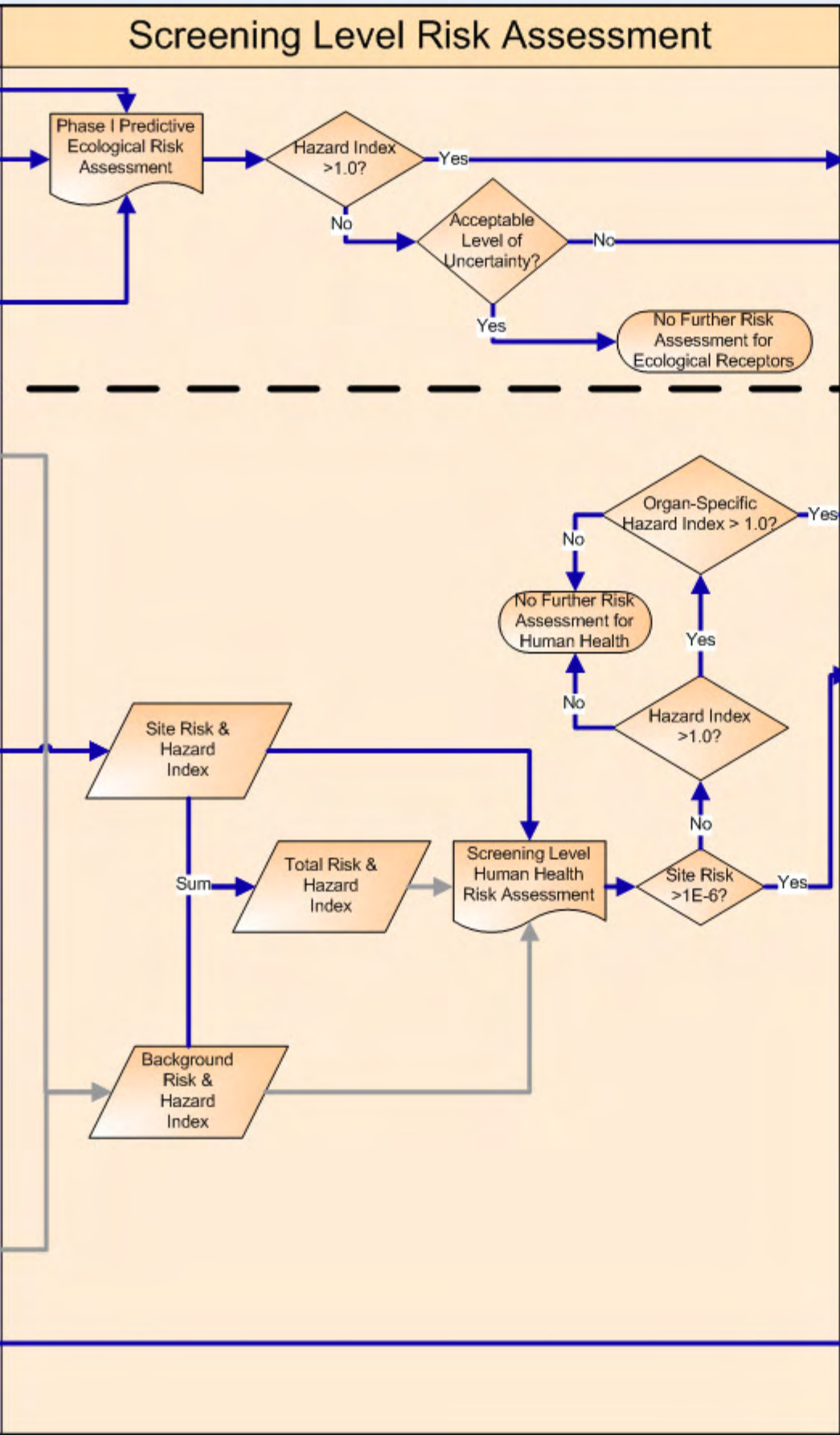



and Groundwater Risk Evaluation
No
No Further Risk Assessment for Ecological Receptors
Transport to Offsite Habitat?
Yes
No
Ecological Habitat Onsite?
Yes
Yes
Wetland or Aquatic Habitat Only?
No
Essential Macro-Nutrient?
No
Site Conc. > Site-Specific Ambient Level?
No
Eliminate as COPC
Compare Site Conc. to USEPA Region 9 Soil PRG
Screening Level Background Soil Risk and Hazard Quotient
Yes
Eliminate Macro - Nutrient as COPC
Yes
Soil COPC
Compare Site Conc. to USEPA Region 9 Soil PRG
Screening Level Soil Risk and Hazard Quotient
Site Conc. > USEPA Soil Screening Level & Transport to Groundwater of Concern?
Yes
Fate and Transport Model
Groundwater Leachate Conc.
No Risk Assessment for Soil Volatile Chemicals
No
No Risk Assessment for Leachate
No Risk Assessment for Groundwater Volatile Chemicals
Organic Groundwater Data
Groundwater COPC
Compare Site Conc. to USEPA Region 9 Tap Water PRG
Screening Level Groundwater Risk and Hazard Quotient
l Use of water?
Yes
Yes
Inorganic Groundwater Data
Essential Macro-Nutrient?
No
Site Conc. > Site-Specific Ambient Level?
Risk nent for dwater
Yes
No
Eliminate Macro-Nutrient as COPC
Eliminate as COPC
Compare Site Conc. to USEPA Region 9 Tap Water PRG
Screening Level Background Groundwater Risk and Hazard Quotient
Apply Use Restriction

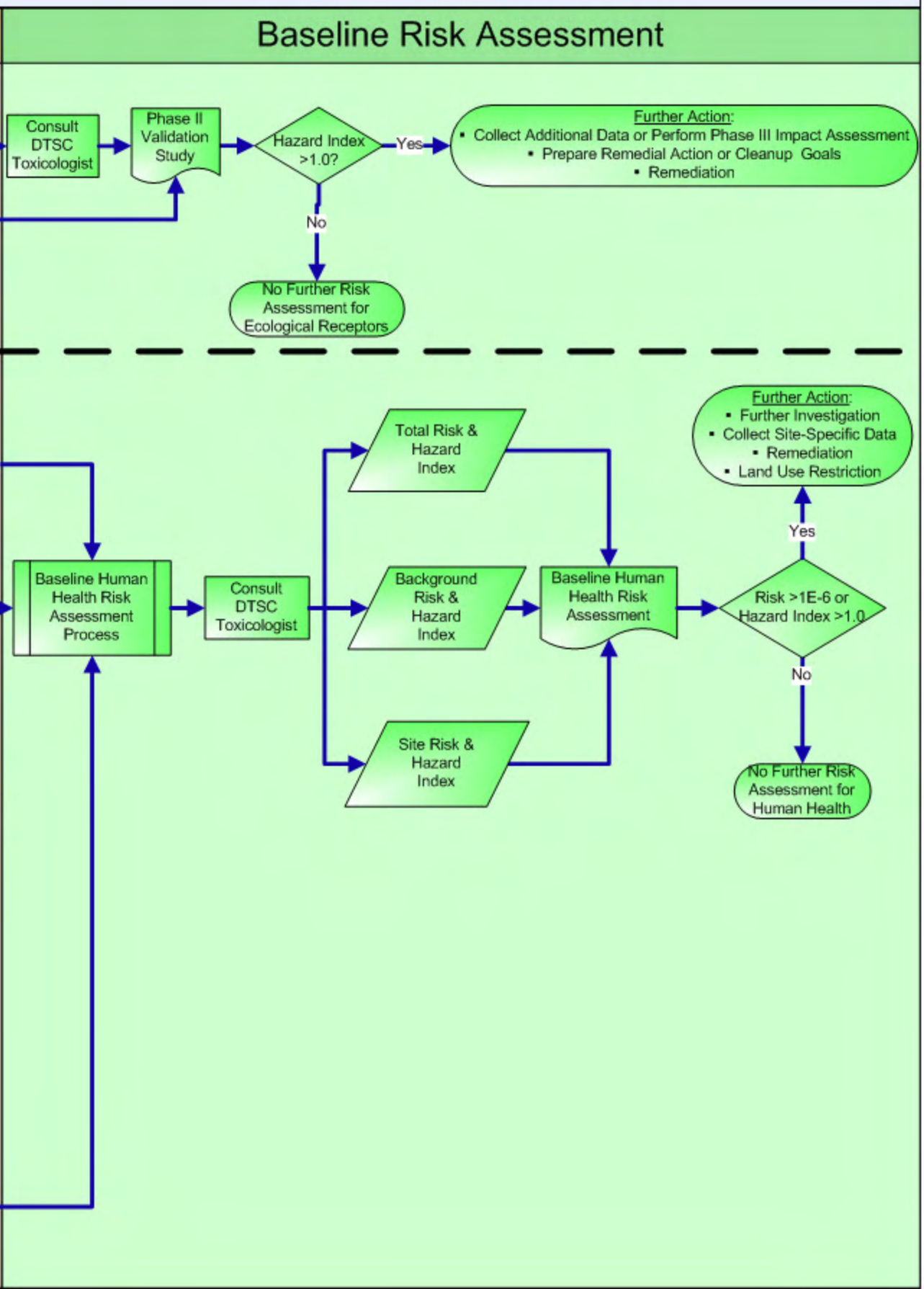
Indoor Air Risk Evaluation



Screening Level Risk Assessment



Baseline Risk Assessment



SITE 'A' RISK ASSESSMENT SUMMARY

- Two acre area with three industrial buildings, used for waste oil recovery.
- Shallow groundwater (about five feet below ground surface).
- Several volatile organic chemicals found in groundwater and soil.
- Contamination in groundwater was evaluated for vapor intrusion into indoor air, but not domestic use because it is not potable.
- The facility used U.S. EPA Region 9 Preliminary Remediation Goals to eliminate contaminants and concluded that there are no chemicals of potential concern in surface soil.
- Ingestion and dermal contact with groundwater were not evaluated because it is not potable.
- The decision tree presented in this paper demonstrates that in fact potential risks and hazards may be quite high if all pathways are evaluated.

SITE 'A' RISK ASSESSMENT				
Exposure Medium	Residential Scenario		Industrial Scenario	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Soil	4×10^{-7}	0.05	1×10^{-7}	0.001
Indoor Air (Vapor Intrusion)	2×10^{-3}	28	5×10^{-5}	0.6

SITE ‘B’ RISK ASSESSMENT SUMMARY

- Consists of several buildings for operational and administrative services.
- Average depth to groundwater is 76 feet below ground surface.
- Groundwater is currently not used.
- Primary environmental concern is tetrachloroethylene in groundwater.
- Risk and hazard index estimates were based on the ratios of chemical concentrations in soil and groundwater to corresponding U.S. EPA Region 9 Preliminary Remediation Goals for soil and tap water.
- The results demonstrate that the indoor air pathway, which is not incorporated in the U.S. EPA Preliminary Remediation Goals can be a significant contributor to the cumulative risk and hazard index.

SITE ‘B’ RISK ASSESSMENT				
Exposure Medium	Residential Scenario		Industrial Scenario	
	Cancer Risk	Hazard Index	Cancer Risk	Hazard Index
Soil	1.3 x 10-4	3.6	1.9 x 10-5	0.4
Indoor Air (Vapor Intrusion)	Not Done	Not Done	3.7 x 10-4	4.7

CONCLUSIONS

This Decision Tree illustrates how to incorporate the evaluation of vapor intrusion from soil gas to indoor air into screening risk assessments for Federal Facilities in California. This poster presents a summary of the ecological risk assessment process and a detailed description of the human health risk assessment process. Sites A and B illustrate the importance of considering indoor air exposure pathways, and potentially other site-specific exposure pathways that are excluded in the derivation of U.S. EPA Preliminary Remediation Goals. Screening risk assessments for other facilities and sites in California should be done in consultation with the appropriate regulatory groups.

REFERENCES

DTSC GUIDANCE (www.dtsc.ca.gov/AssessingRisk)

- Guidance for Ecological Risk Assessments, various dates.
- Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities. February, 1997.
- Interim Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air. February, 2005.
- Modified Johnson and Ettinger Models. 2005.

U.S. EPA GUIDANCE

- Region 9 Preliminary Remediation Goals (www.epa.gov/Region9/waste/sfund/prg).
- Soil Screening Guidance. April, 1996 (www.epa.gov/superfund/resources/soil).

DISCLAIMER

The opinions and findings in this paper are those of the authors. These recommended procedures are undergoing internal review as a protocol for screening risk assessments for Federal Facilities.