Starting Soon: TPH Risk Evaluation at Petroleum-Contaminated Sites

- TPH Risk Evaluation at Petroleum-Contaminated Sites (TPHRisk-1, 2018)
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  - CLU-IN training page at https://clu-in.org/conf/itrc/TPHrisk/ Under "Download Training Materials"

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TPH Risk Evaluation at Petroleum-Contaminated Sites

Prepared by

The Interstate Technology & Regulatory Council

TPH Risk Evaluation Team

Sponsored by: Interstate Technology and Regulatory Council (www.itrcweb.org)
Hosted by: US EPA Clean Up Information Network (www.cluin.org)

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TPH Risk Evaluation at Petroleum-Contaminated Sites (TPHRisk-1, 2018)

TPH Risk Evaluation at Petroleum-Contaminated Sites

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Welcome

TPH Risk Evaluation at Petroleum-Contaminated Sites (TPHRisk-1)

1 Overview

The Interstate Technology and Regulatory Council (ITRC) Total Petroleum Hydrocarbons (TPH) Risk Evaluation team has developed this guidance to assist state regulators and practitioners with evaluating risk and establishing cleanup requirements at petroleum release sites. This guidance focuses on factors that are unique to petroleum hydrocarbon releases and builds on other available documents published by the TPH Criteria Working Group (TPHCWG) (1997a, 1997b, 1997c, 1998a, 1998b, 1999), ITRC Risk-3 (2015), Massachusetts Department of Environmental Protection (MADEP) (2014), California State Water Board–San Francisco Bay Region (CASWB-SFBR) (2016a), and Texas Commission on Environmental Quality (TCEQ) (2017b).

Road Map

- Why the Guidance?
- Learn What TPH is
- Learn TPH Analytical Methods
- Questions and Answers
- Environmental Fate of TPH
- Assessing Human and Ecological Risk from TPH
- Stakeholders Considerations
- Closing
- Questions and Answers

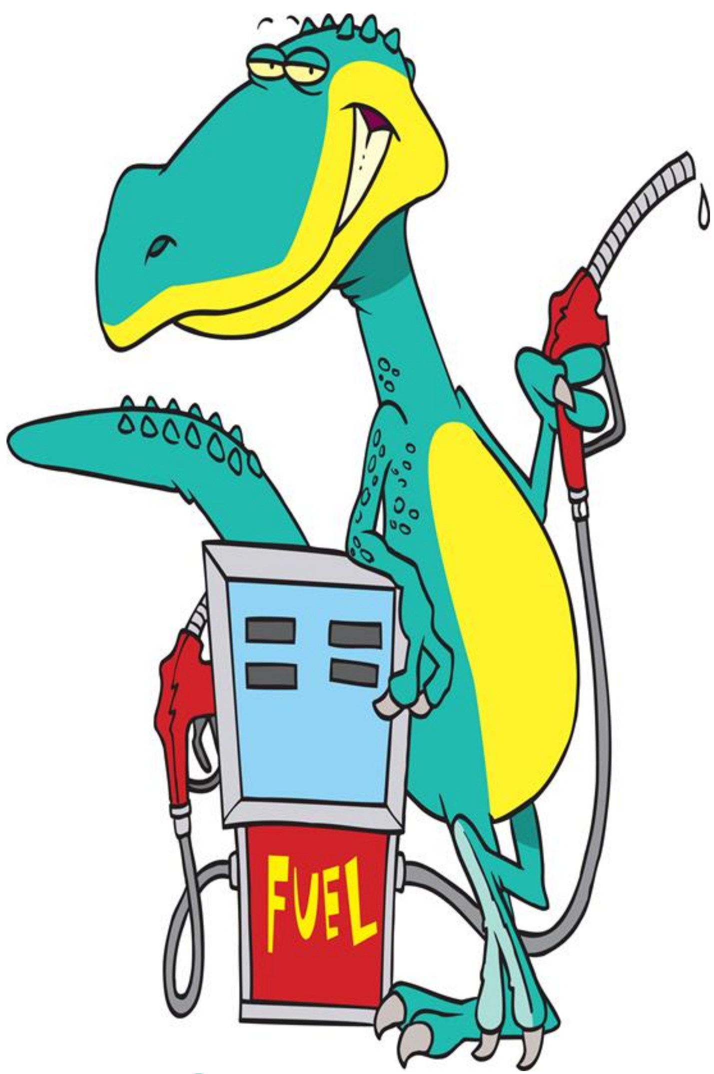
Why This Guidance?

- Purpose
  - Facilitate better-informed decisions relating to the evaluation of TPH risk at petroleum-contaminated sites, help regulators and project managers, who may not be skilled in risk assessment, interpret results
- Goal
  - Create better TPH guidance to help states develop consistent methodology for establishing risk-based cleanup levels and for establishing methods for risk-based corrective actions

Learning Objectives

- After participating in this ITRC training course you will:
  - Recognize the ITRC document as a go-to resource for evaluating TPH risk at petroleum-contaminated sites
  - Recognize how TPH can change over time
  - Select appropriate analytical method(s) to match site objectives
  - Apply the decision process to determine when a site-specific target level may be more appropriate than a generic screening level for TPH

Regulatory Framework for TPH



- Remedial Approaches & Risk Management
  - are not consistent;
  - may not address long- and short-term concerns with petroleum contaminant mass;
  - petroleum cleanups were based on laboratory concentrations to non-detect; and
  - the States Survey (Appendix C) shows a trend to a risk-based approach.
- Federal & State TPH Regulations
  - challenges
- State Underground Storage Tank Program Contacts:
  - https://www.epa.gov/ust/underground-storage-tank-ust-contacts#states

Benefits to the Audience

- Provides practical, applicable guidance on evaluating TPH for risk assessors
  - Regulators
  - Consultants
  - Industry
  - Stakeholders

How to Use This Document

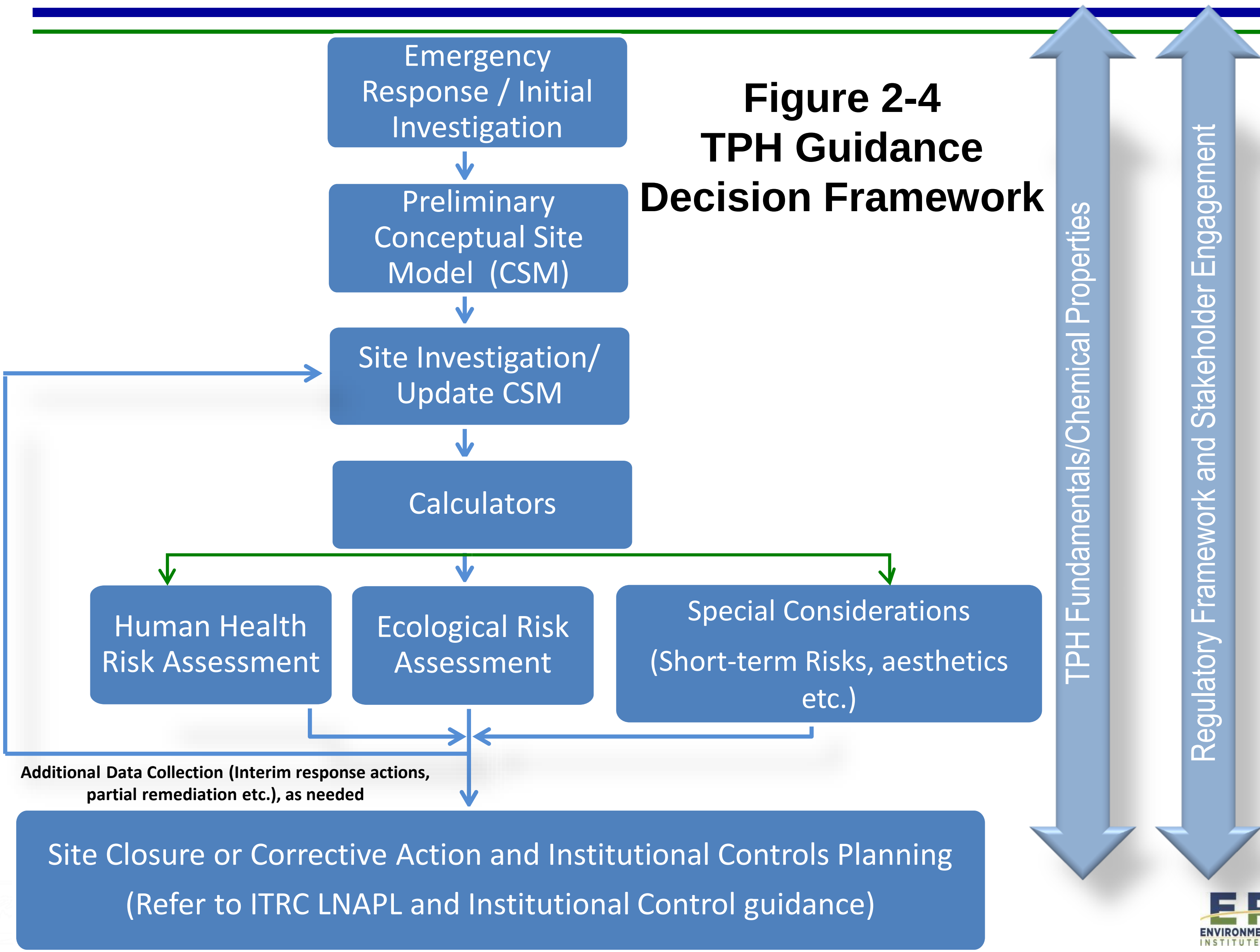


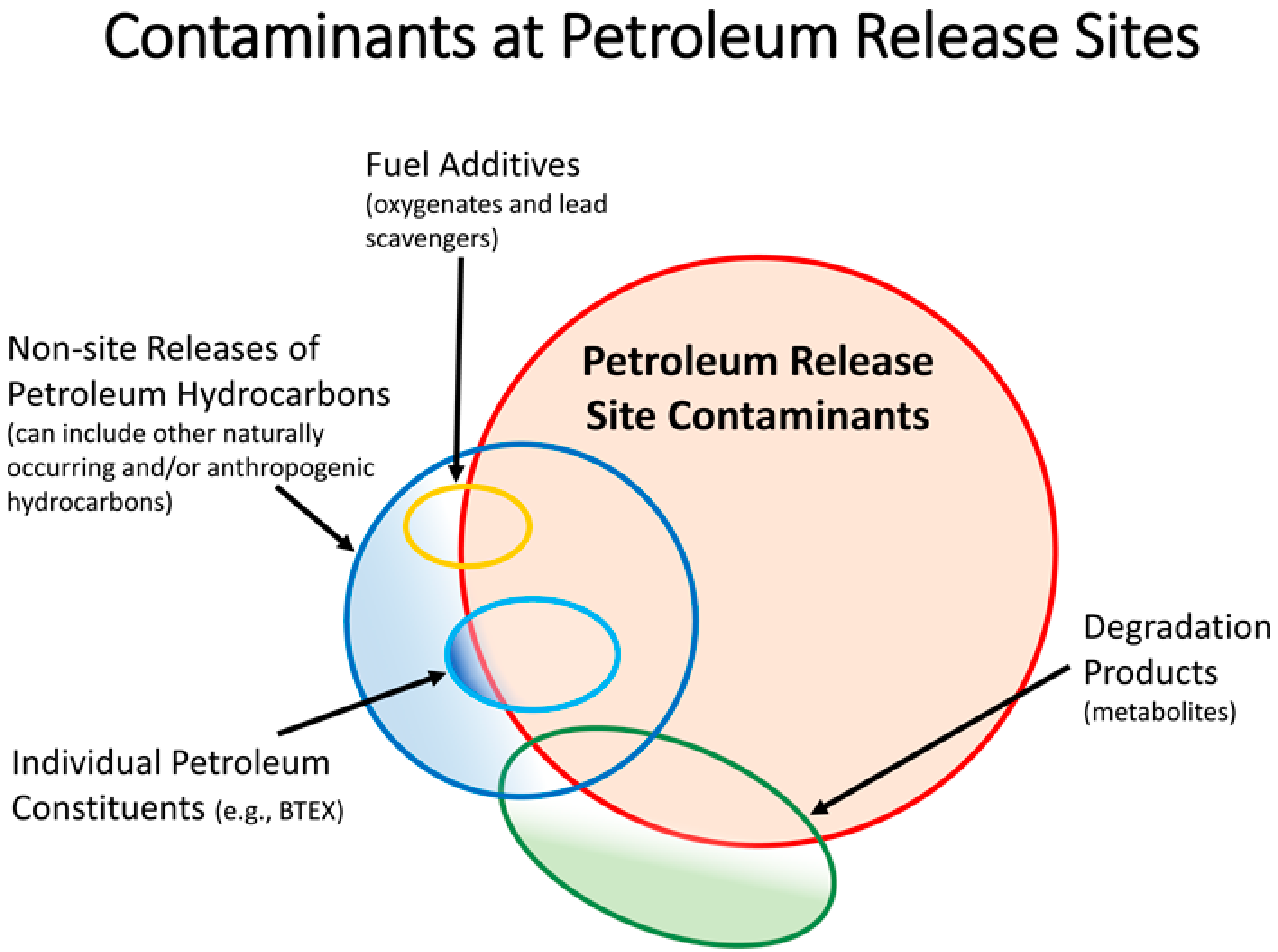
Figure 2-4
TPH Guidance Decision Framework

Case Study: Tank Farm

- **Site Status:** Inactive, Commercial Redevelopment
- **Petroleum Release Type**: Gasoline & Diesel
- **Impacted Media:** Soil, Soil Vapor, & Groundwater

HIDOH Case Study #1 (HIDOH 2018)

How will YOU treat TPH Differently?



ITRC TPHRisk-1 Figure 2-2

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Learn What TPH is

GRO DRO EPH PRO

ETPH PVOC Gx STARS

VPH Dx NWTPH

Ran out of Space!

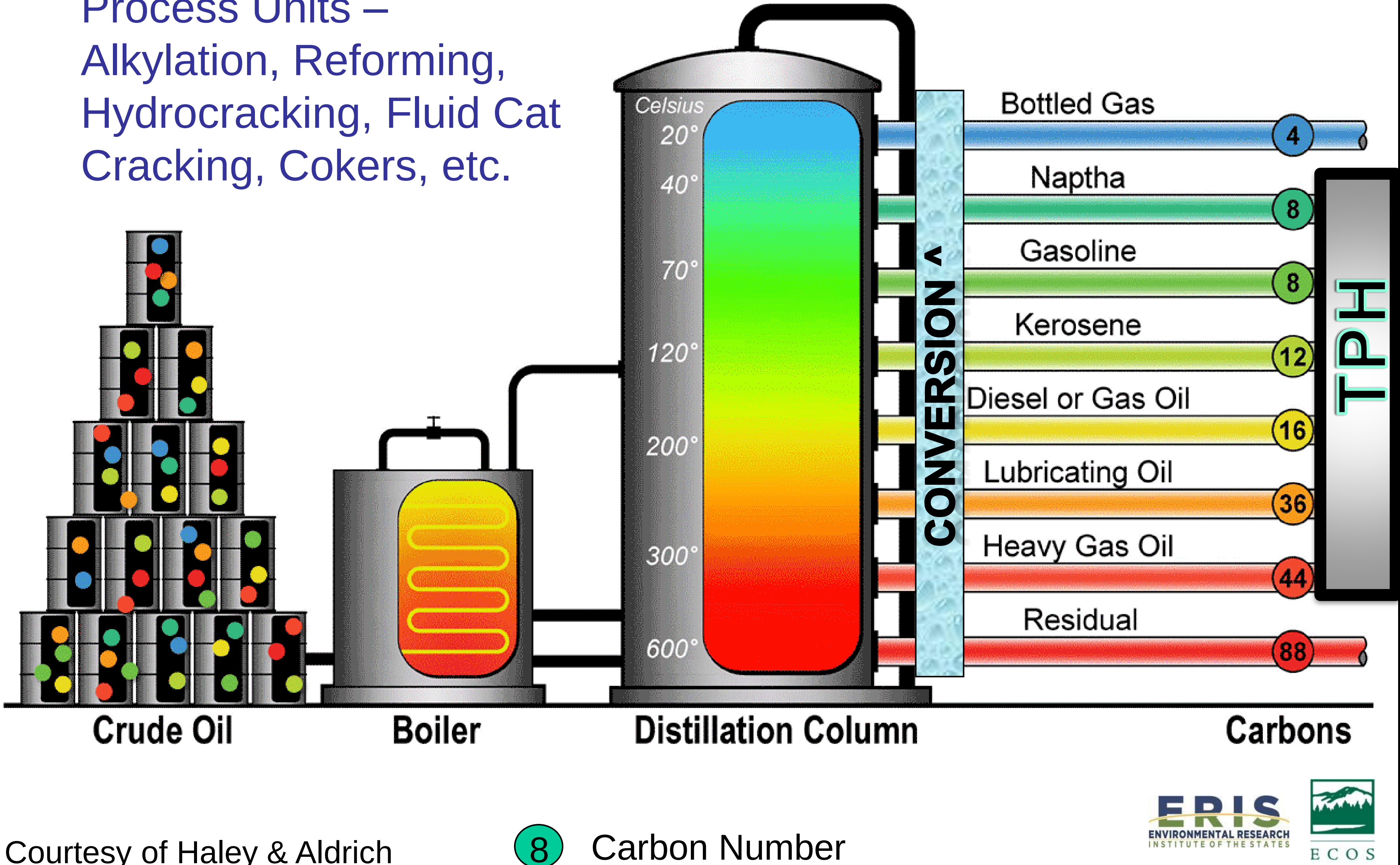
Let's untangle these terms!

Learning Objectives – Learn What TPH is

- Know TPH sources and releases
- Identify TPH constituents and properties
- Understand bulk TPH and challenges
- Provide considerations for TPH - specific CSM using the case study
- Be familiar with common pitfalls with CSM development

TPH – Where does it come from?

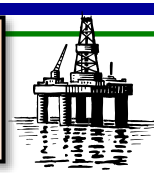
Process Units – Alkylation, Reforming, Hydrocracking, Fluid Cat Cracking, Cokers, etc.



Courtesy of Haley & Aldrich

TPH – Where does it come from?

Crude Oil



Trucks, Railcar, Ship, Barge, Pipeline

Refinery

Terminals

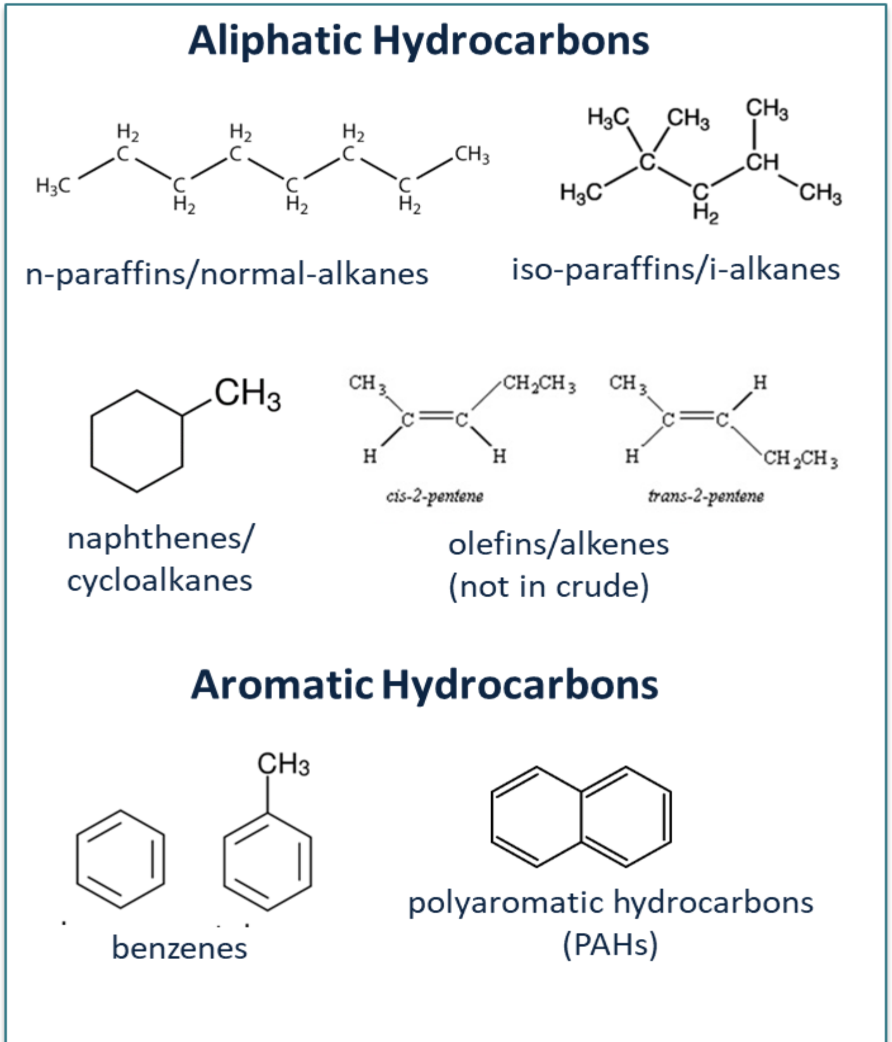
Additives

Distribution & Retail

End User(s)

- Exploration and Production
- Refineries
- Air/Sea ports
- Offshore sheens
- Terminals
- Service stations
- Pipelines/Utilities/Sewers
- Residential (think heating oil)

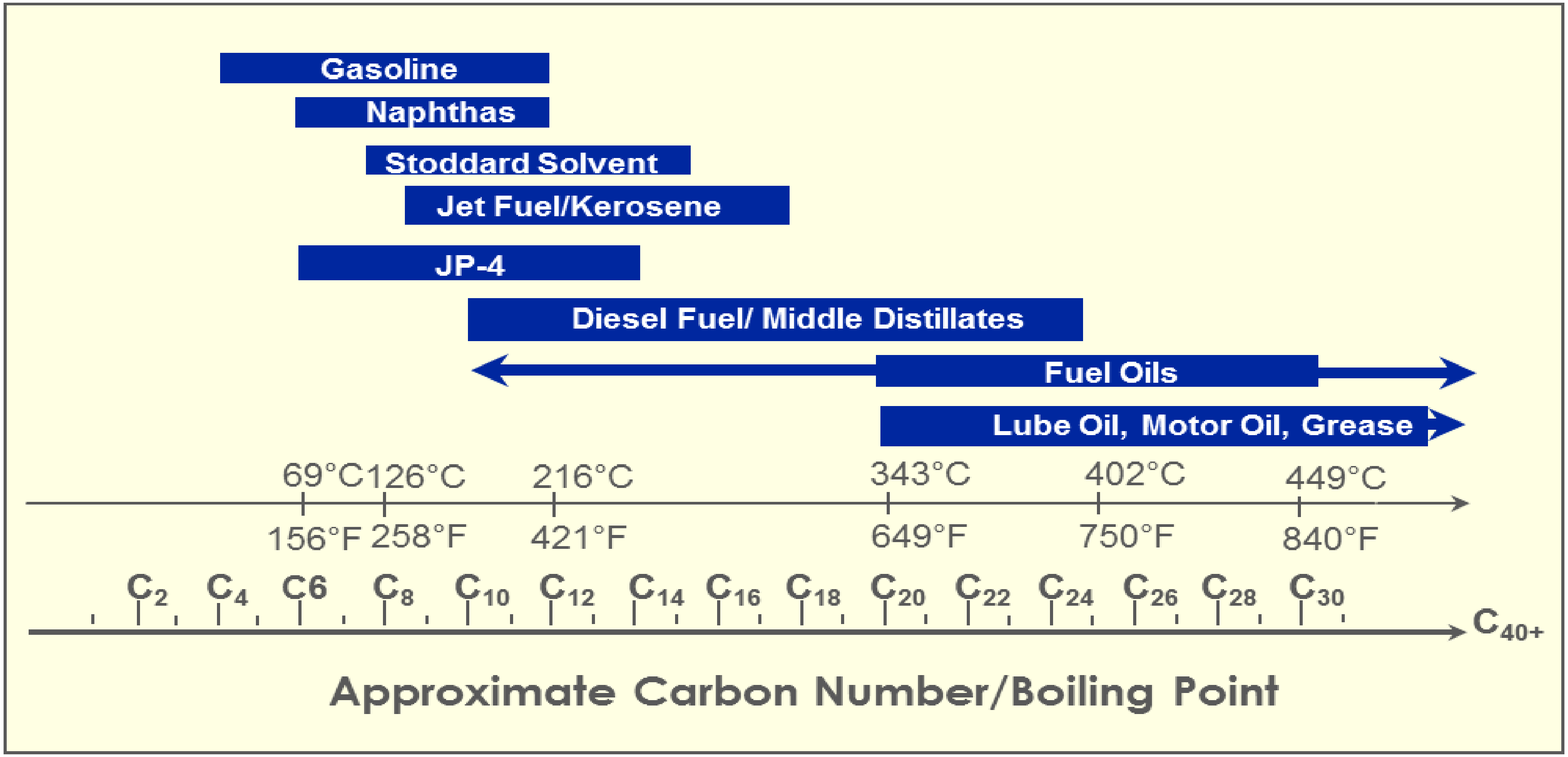
TPH Constituents – Key Properties



- **Aliphatic Hydrocarbons**:
  - Straight, branched and cyclic
  - Non-polar
  - Low water solubility
- **Aromatic Hydrocarbons:**
  - Ring structures
  - Some polarity
  - Increased solubility in water

ITRC TPHRisk-1 Figure 4-3

What is in that petroleum release?

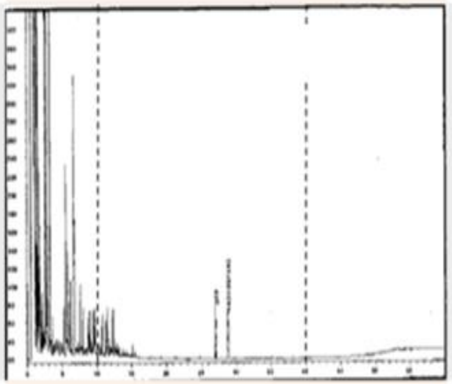
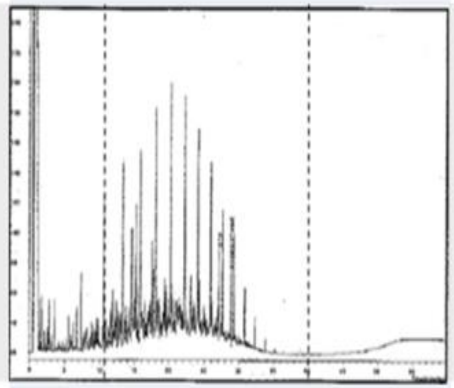
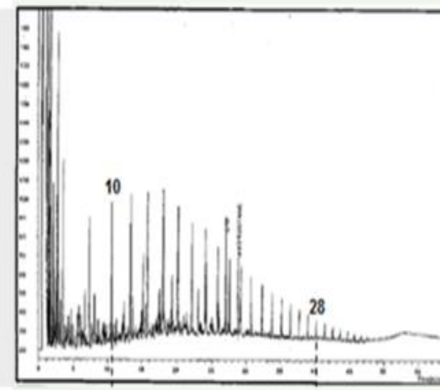


Bulk TPH Analysis is not composition specific.
Products overlap in carbon ranges.

ITRC TPHRisk-1 Figure 4.2 (TPHCWG 1998)

JP – Jet Propellant

Bulk TPH – What's in that number?

	Sample 1	Sample 2	Sample 3
Example Numeric Result by GC-FID (8015B) Extractable	15,000 mg/kg	15,000 mg/kg	15,000 mg/kg
Example chromatogram for same analysis (Chromatograms courtesy of Chevron)			

Note that the first dotted line on the chromatograms is at C10, the second at C28

Gasoline	Diesel Fuel	South Louisiana Crude

X- AXIS: Elution Time/Carbon Number
Y AXIS: Relative Concentration

ITRC TPHRisk-1 Figure 2-3

So what is TPH?

- TPH in environmental media is a measurement that is:
  - Defined by the analytical method used to measure it
  - Provides an approximate concentration of the total hydrocarbons in a complex mixture
  - Provides information about the size and distribution of the hydrocarbons
  - Not necessarily “total”, not necessarily all from petroleum and not necessarily all hydrocarbons

TPH data can only be properly interpreted with a good CSM!

TPH Evaluation - Challenges

- Composition changes with time and space due to weathering, influenced by site-specific conditions
- Impractical to analyze for hundreds of individual compounds
- Limited toxicity data

Group hydrocarbons with similar characteristics (e.g., environmental fate, toxicity, etc.)

Case Study: Tank Farm

HIDOH Case Study #1 (HIDOH 2018)

Common Pitfalls to CSM Development

- Reliance on BTEX and PAH data for CSM development
- CSM development allied with human direct exposure only
- Incorrect consideration for natural degradation data (e.g., consideration for TPH metabolites)
- Failure to incorporate nature, location and concerns from residual contamination

Poll Question

- What is TPH?

1. TPH is defined by the analytical method
2. TPH is an accurate measure of the total hydrocarbons
3. TPH concentration does not include biodegradation products and metabolites
4. None of the above

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Learning Objectives – Learn TPH Analytical Methods

- Select the appropriate TPH Analytical Method based on data quality objectives
- Properly interpret analytical results
- Recognize when to question analytical results
- Recognize uses for field methods

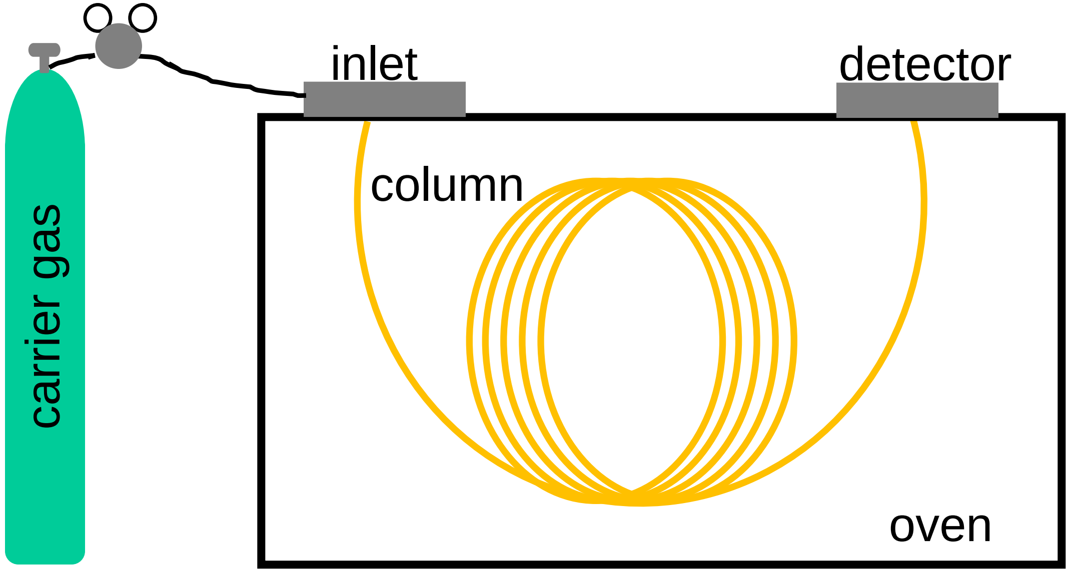
TPH: Method Defined Parameter

- Considerations in selecting the analytical method include:
  - Project Objectives
  - Regulatory Requirements
  - Application (detection, delineation, monitoring, risk assessment, etc.)
  - Petroleum type (if known)
  - Media

No method can do everything!

Preferred Laboratory method

- Laboratory method for TPH analysis: Gas Chromatography
  - For separating mixtures into components
  - Based on volatility of molecules
  - Several options for detectors



Selecting appropriate TPH Lab Methods (Table 5-4)

- Site Assessment, determination of extent of impacts, total extractable organics
  - EPA Methods 8015 and 8260
  - TX1005
- Human Health Risk assess[illegible]ate and Transport, RSLs, Si[illegible]c Ecological Risk assessmen[illegible]
  - T[illegible]ADEP VPH/EPH, WA Dep Ecology
- [illegible]o Assessment of hydrocarbons only, determination of extent of hydrocarbon impacts
  - EPA Method 3630C with 8015, 8260
  - EPA Method 3630C with TX1005

Talk to the Lab if there are questions!

For additional details see Table 5-4 of guidance document, Zemo, 2016 Whitepaper

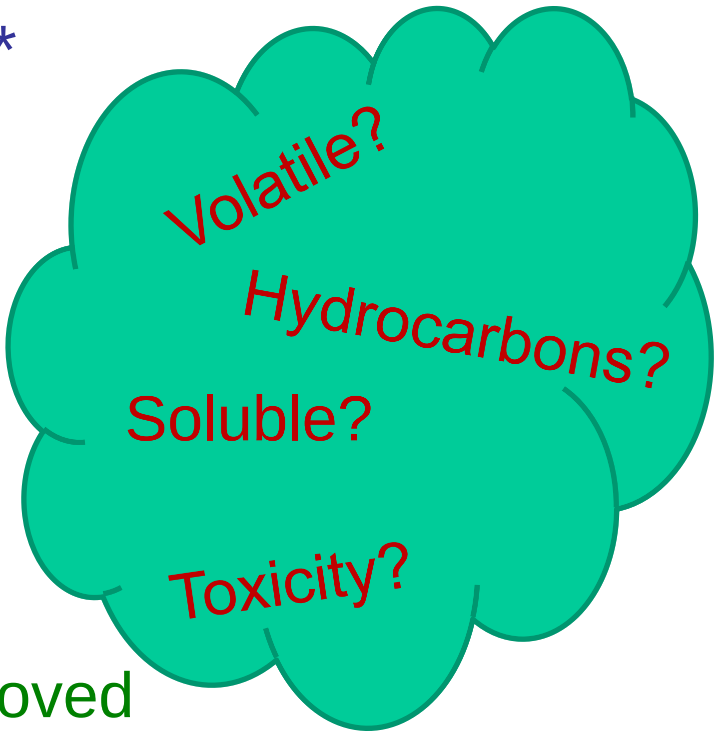
Silica Gel Cleanup (Fact Sheet A.2)

- USEPA Method 3630C
  - Removes non-hydrocarbons
  - Column cleanup is most effective
  - Should request that lab surrogate be added to ensure efficient cleanup
  - Used with Bulk TPH method
- Uses include:
  - Determination of extent of hydrocarbon impact
  - Delineation of true hydrocarbons or what could be natural occurring organics in background or metabolites
- Not to be used for TPHg or Air samples

For additional details see Appendix A of guidance document

Fractionation (Fact Sheet A.7)

- Fractionation typically relies on the use of silica gel to separate the sample into aliphatic and aromatic *classes**
- The fractions are then injected into a GC for separation into *carbon ranges*
- However, they
  - Cost more than bulk TPH
  - Raise the reporting limits
  - Non-hydrocarbons will be removed from analysis (results)



* Class separation in the volatile range does not rely on use of silica gel

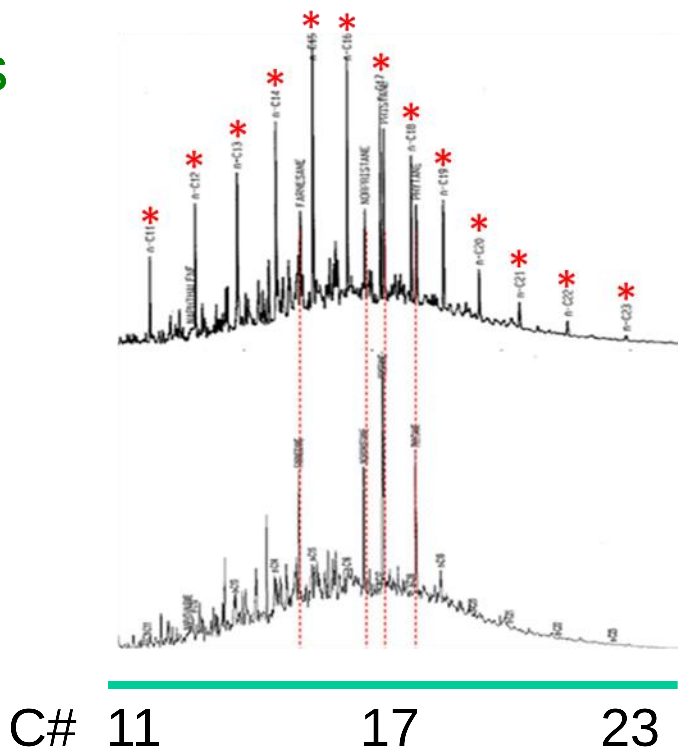
Case Study: Tank Farm Application of Analytical Methods

- Soil: Bulk TPH collected across the site
- Soil Vapor: Fractionation data collected at select locations in the diesel plume to determine site specific screening levels
- Groundwater: Bulk TPH with silica gel cleanup collected in select areas along downgradient edges of diesel plume to assess the degradation state and determine locations requiring active remediation

HIDOH Case Study #1 (HIDOH 2018)

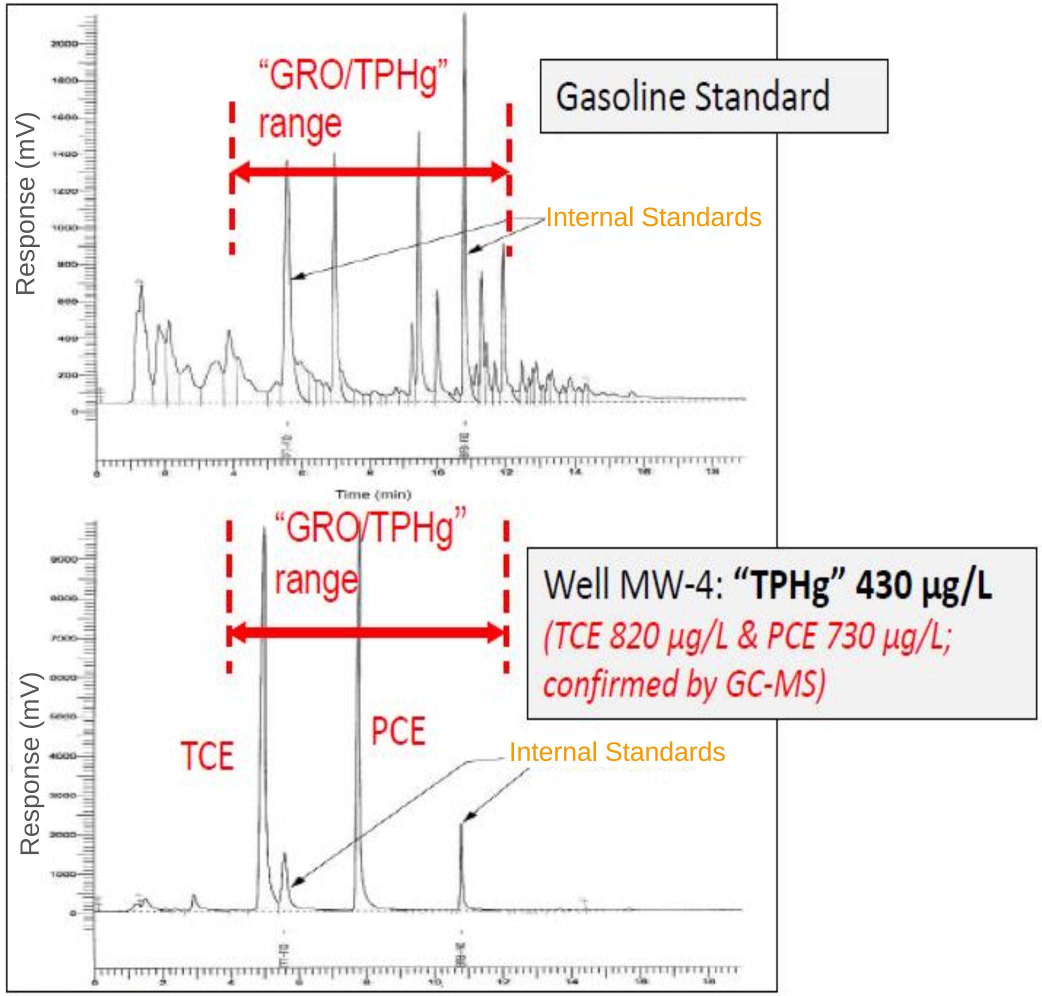
Chromatograms are not just pretty pictures (Fact Sheet A.6)

- Provide information on
  - Type of material
  - Presence of non-hydrocarbons
  - Presence of solvents
  - Presence of non-dissolved hydrocarbons
  - Poor integration
  - Weathering
    - Degree of weathering
    - Type of weathering



ITRC TPHRisk-1 Figure A5-3

Practical Example #1 of Measurement Interferents (as determined by chromatograms)

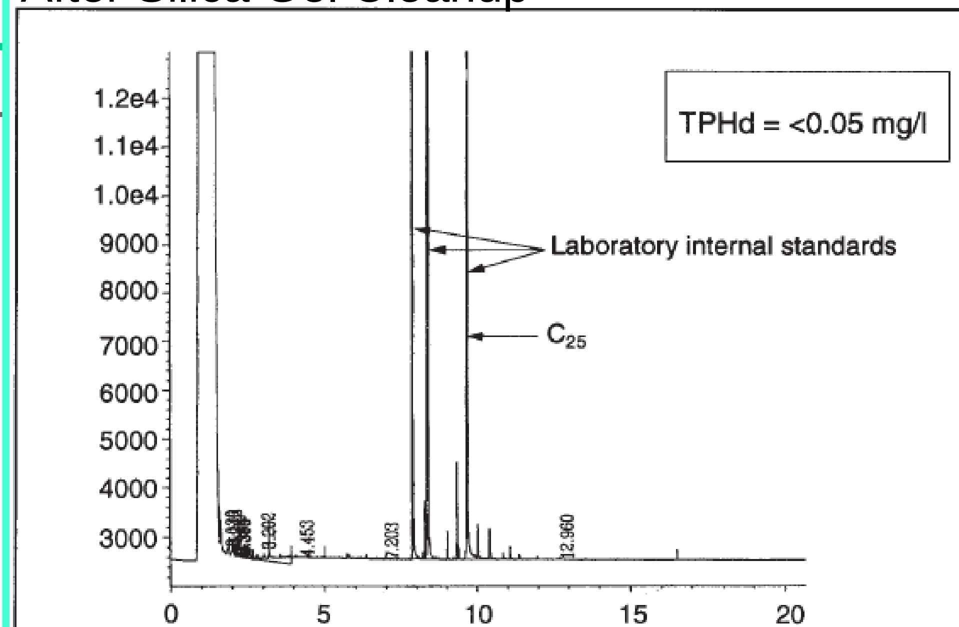


Zemo & Associates, Inc.

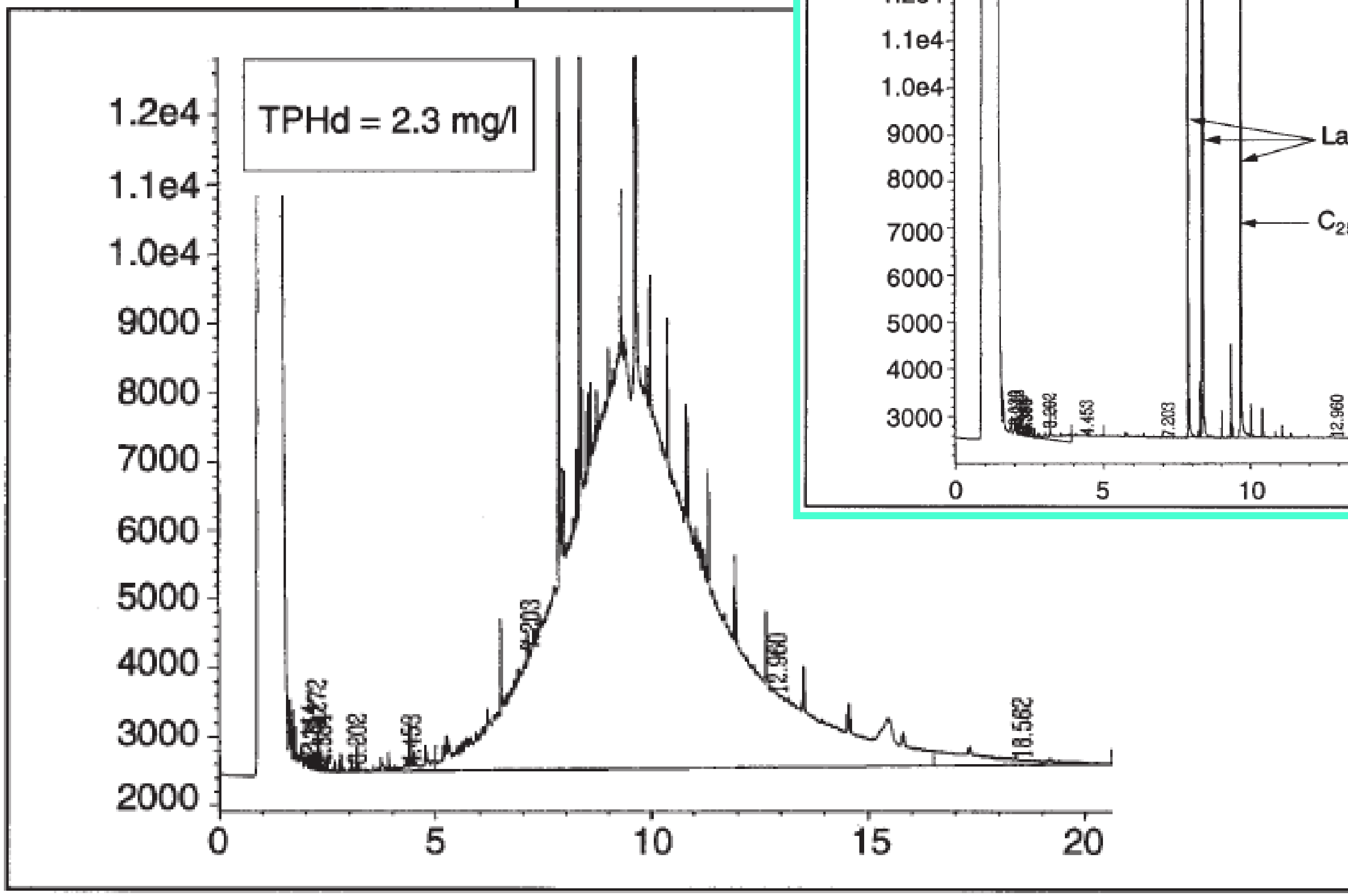
ITRC TPHRisk-1 Figure A5-6

Practical Example #2 of Measurement Interferents (as determined by chromatograms)

After Silica Gel Cleanup



Before Silica Gel Cleanup



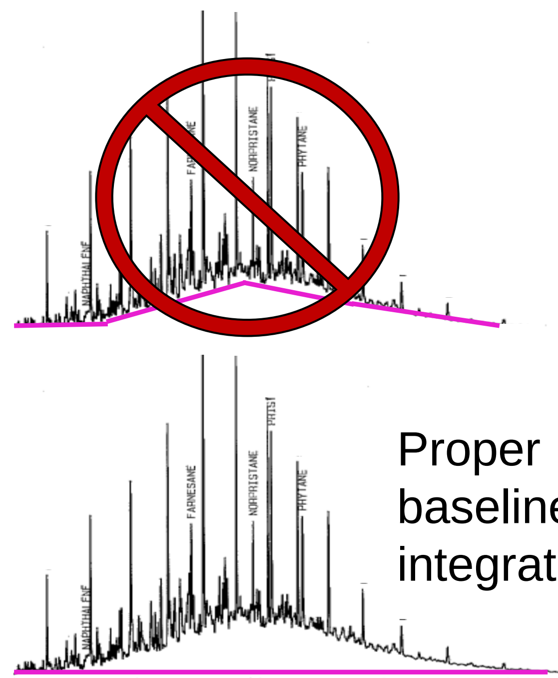
ITRC TPHRisk-1 Figure A5-5 (Zemo 2016)

Poll Question

- All USEPA Method 8015 results are directly comparable, regardless of lab
  1. True
  2. False
  3. Not Sure

Not all TPHd by EPA method 8015 is Equal

- Extraction Solvent
  - n-pentane
  - dichloromethane
- Baseline Correction
- Carbon Ranges
  - C6-C10 vs. C6-C12
  - C12-C26 vs. C12-C28
- Calibration Standard

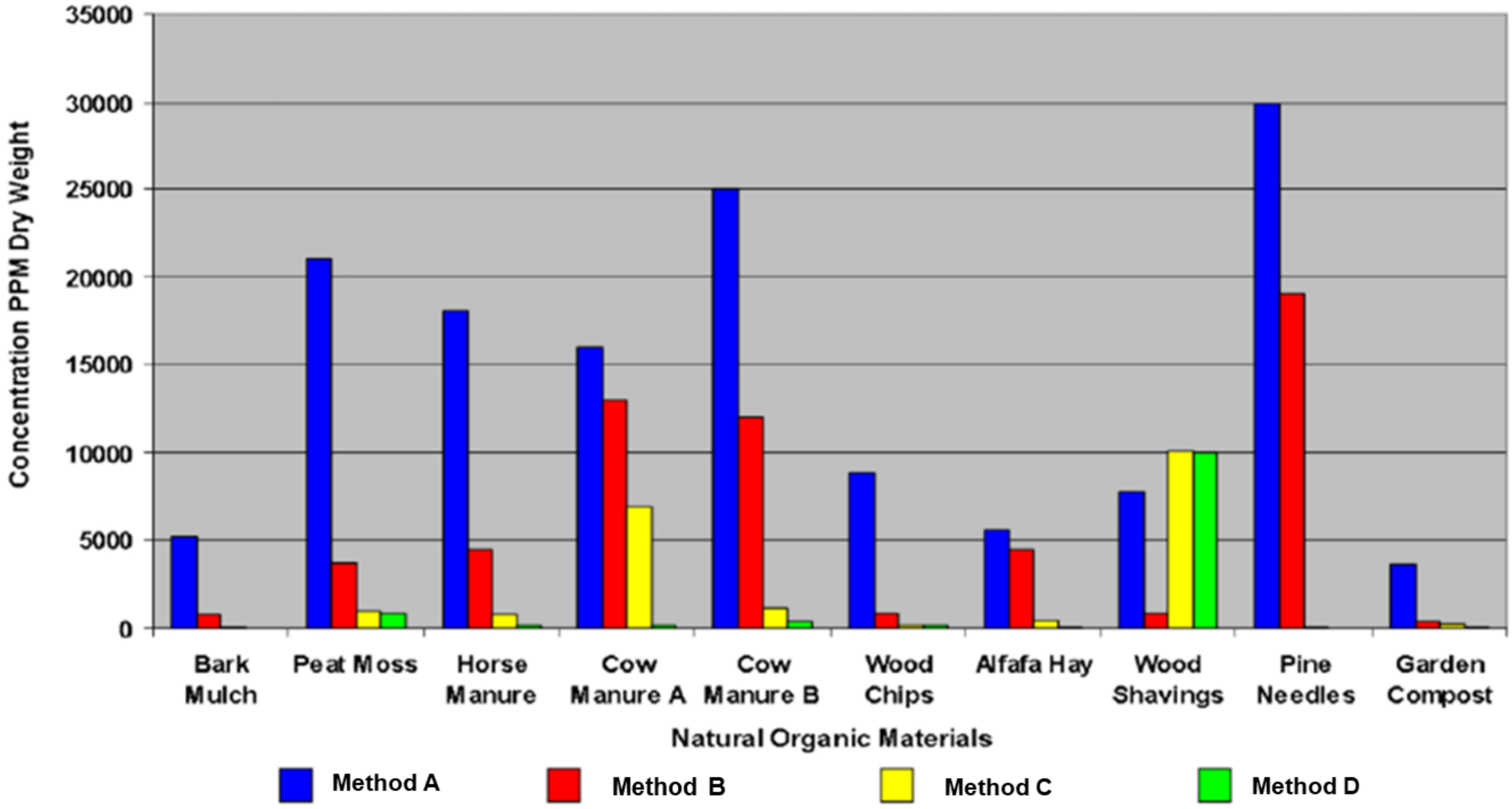


Proper baseline integration

Don't assume a change has occurred at a site if the TPH value suddenly changes!

Modified from ITRC TPHRisk-1 Figure A5-3

Four TPH Methods will Yield Four Different Results



And will measure "TPH" for non-petroleum hydrocarbons!

ITRC TPHRisk-1 Figure 5-3 (NewFields. 2002)

TPH Field Methods

- When do field methods make sense
  - During initial field screening
  - During plume delineation
  - While excavation is open
- Which field methods make sense
  - Is product known
    - Volatiles
    - Semi-volatiles
    - Wet chemistry vs meter
- Appendix D
  - Pros and Cons

Follow up with laboratory methods to confirm your conclusions!

http://www.buygasmonitors.com/rae-systems-minirae-3000

Oil-in-soil collected by Maine DEP

www.hach.com/test-kits/immunoassay-test-kits

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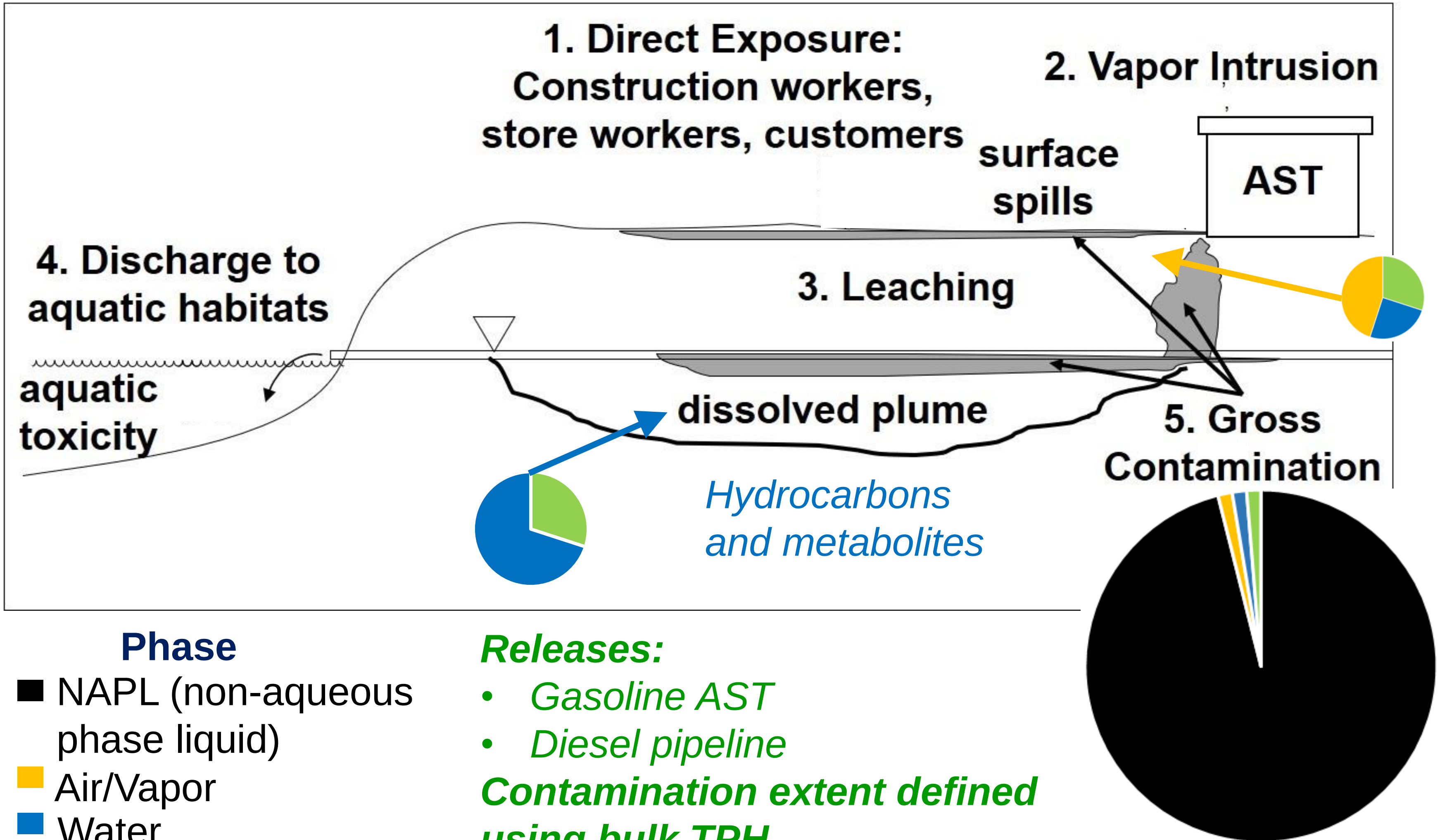
Learning Objectives – Environmental Fate of TPH

- Key Message: TPH composition changes after release to the environment and composition affects risk.
- Understand how physical weathering changes TPH composition
- Understand biological weathering also changes TPH composition and generates petroleum metabolites
- Anticipate TPH composition changes throughout a site

Conceptual Site Model: Source and Migration Pathways

Case Study



Phase

- NAPL (non-aqueous phase liquid)
- Air/Vapor
- Water
- Sorbed

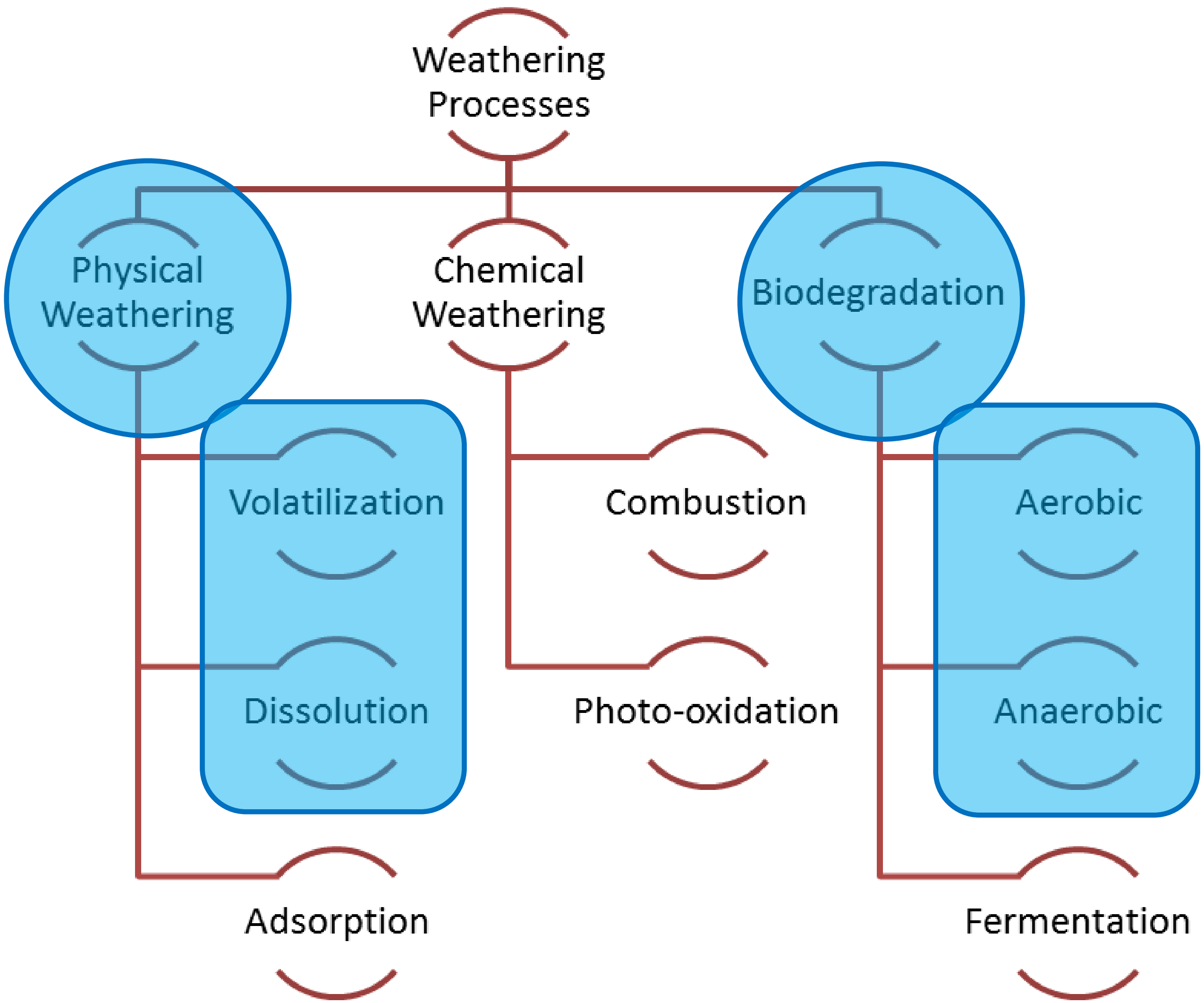
Releases:

- *Gasoline AST*
- *Diesel pipeline*

Contamination extent defined using bulk TPH

HIDOH Case Study #1, Figure 1-3 (HIDOH 2018)

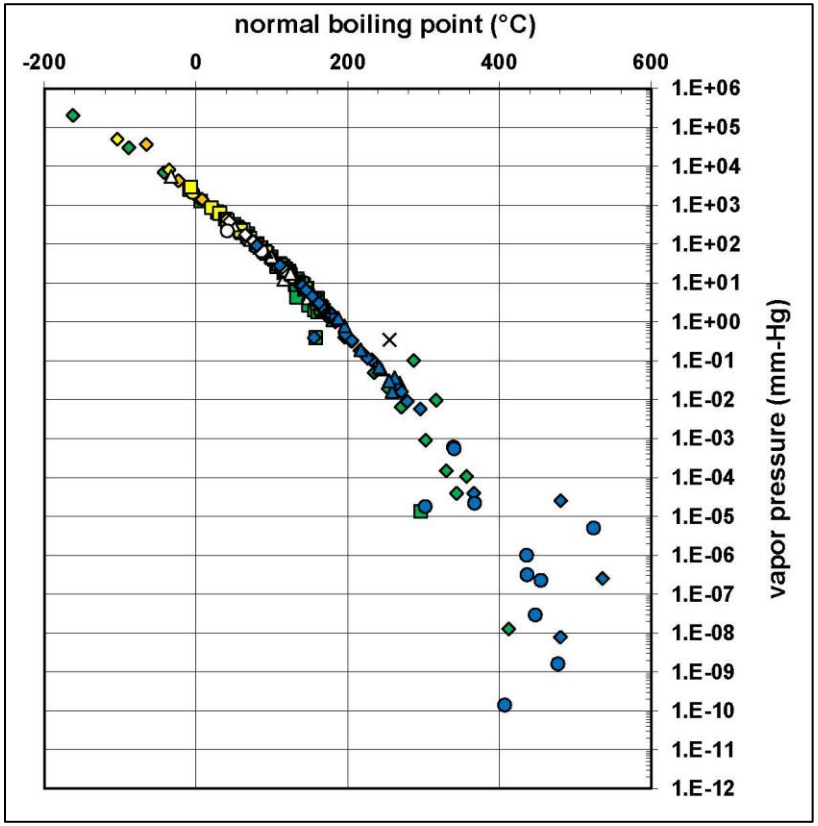
Weathering Processes Overview



ITRC TPHRisk-1 Figure 4-8

Partitioning: Oil to Vapor

Boiling Point vs. Vapor Pressure



- All classes plot along single curve
- Smaller hydrocarbons have greater volatilization potential and likely dominate TPH vapor composition
- Note: Scatter at lower vapor pressure is related to measurement difficulty

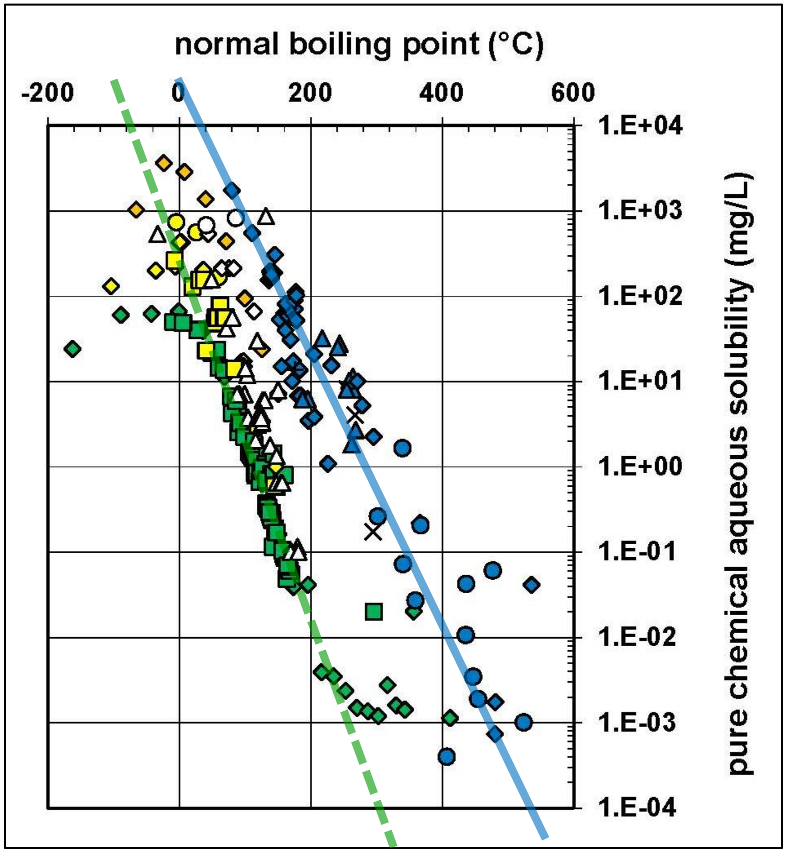
Aliphatics | Aromatics | x Biphenyls

Alkynes | Cycloalkenes and cyclodienes | Alkenes (straight and branched) and Dienes

Graph courtesy of Shell

Partitioning: Oil to Water

Boiling Point vs. Aqueous Solubility



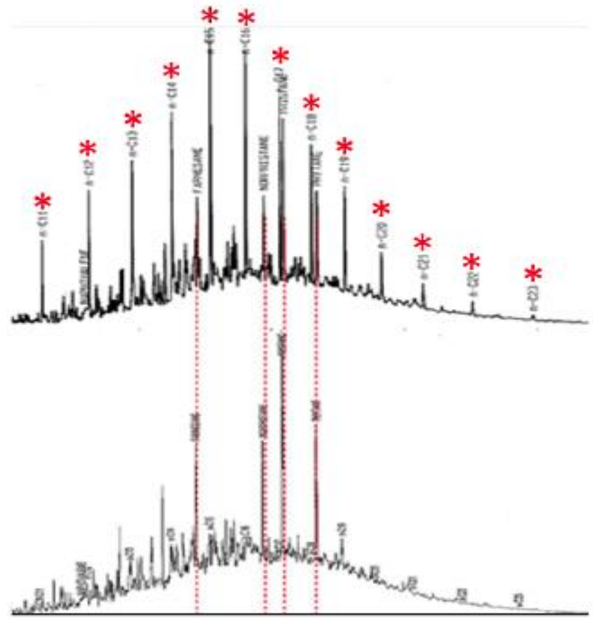
Aliphatics
Aromatics
x Biphenyls
Alkynes
Cycloalkenes and cyclodienes
Alkenes (straight and branched) and Dienes

Graph courtesy of Shell

- Smaller hydrocarbons are more soluble
- Hydrocarbon structure differences:
  - Aromatics (solid line/right) most soluble
  - Aliphatics (dashed line/left) least soluble
- TPH water composition likely dominated by aromatics

Biodegradation (Biological Weathering)

- Biodegradation of hydrocarbons well documented for +100 years
- Hydrocarbons readily undergo biodegradation under aerobic conditions
  - Some hydrocarbons degrade more readily than others (see figure)
- Biodegradation is a stepwise process – each step leads to new metabolites
- Anaerobic biodegradation typically is slower and more prone to buildup of petroleum metabolites



Highly Branched Alkanes Remain After Biodegradation

ITRC TPH RISK-1 Figure A5-3

Petroleum Metabolites

- Are intermediate biodegradation products
- Molecules include oxygen and have properties different from hydrocarbons (e.g., polar)
- Commonly detected as extractable TPH when silica gel cleanup (SGC) not used. Identify using:
  - Chromatogram pattern
  - Analysis with and without SGC
  - Understanding of solubility
  - Conceptual site model

Solubility of n-Hexane vs. Two n-Hexane Metabolites

Chemical	Formula	Boiling Point (°C)	Solubility (µg/L)
n-Hexane	C_6H_{14}	69	9.5E+03
2-Hexanone	$C_6H_{12}O_1$	128	7.7E+06
Hexanoic Acid	$C_6H_{12}O_2$	205	5.8E+06

Characteristic Metabolite Unresolved Complex Mixture (Hump)

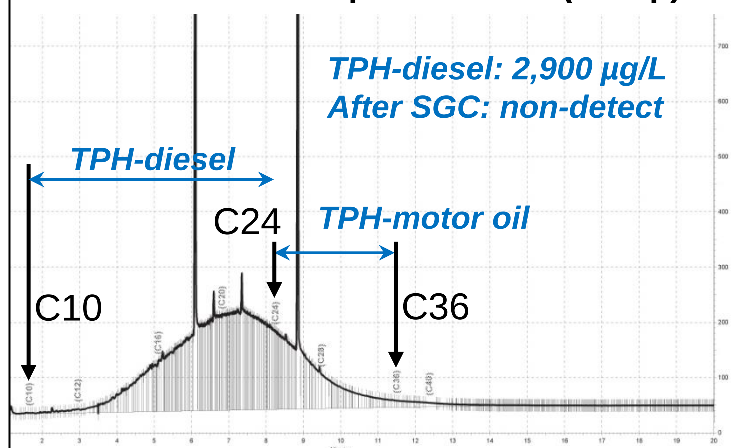
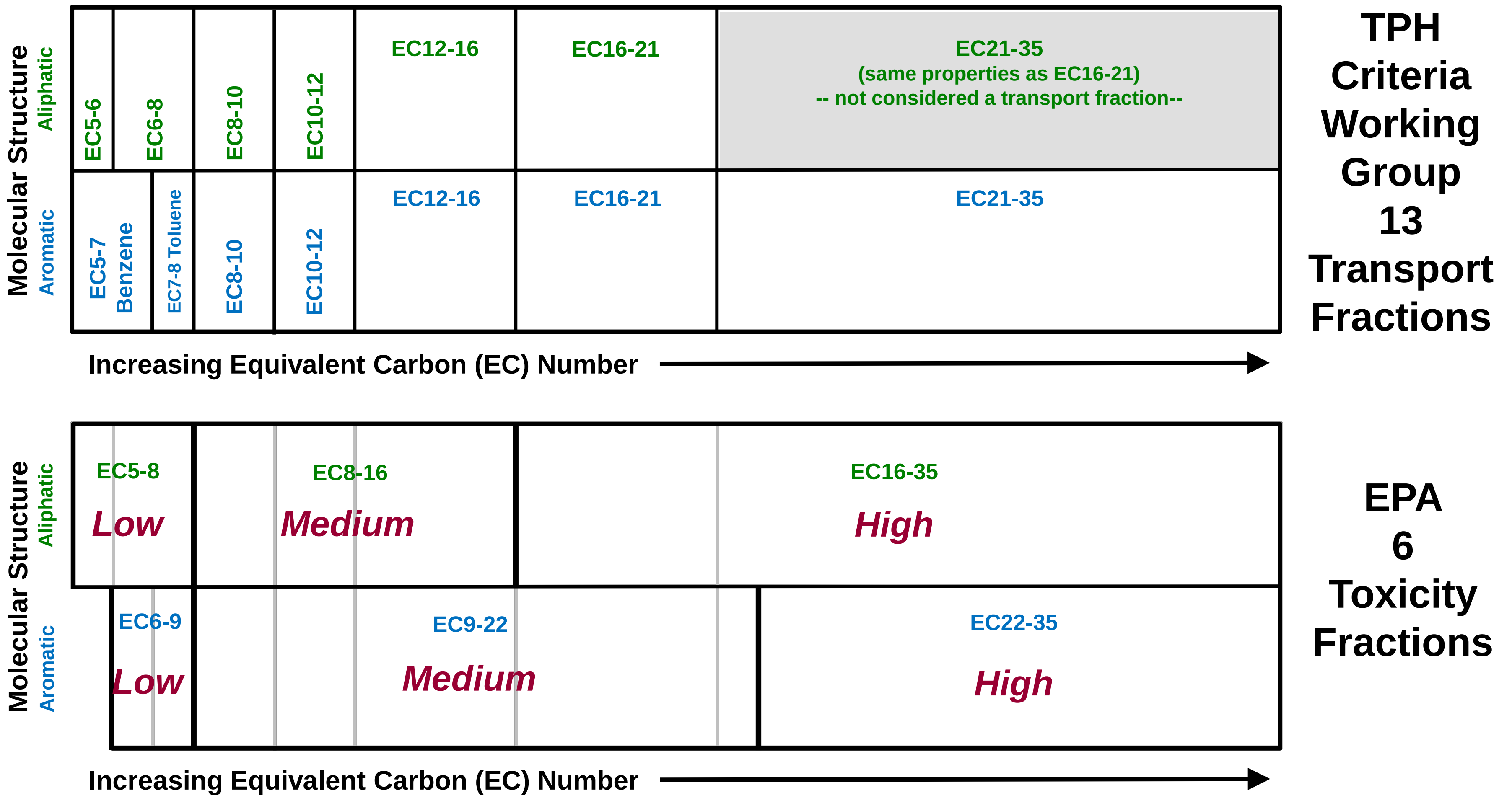


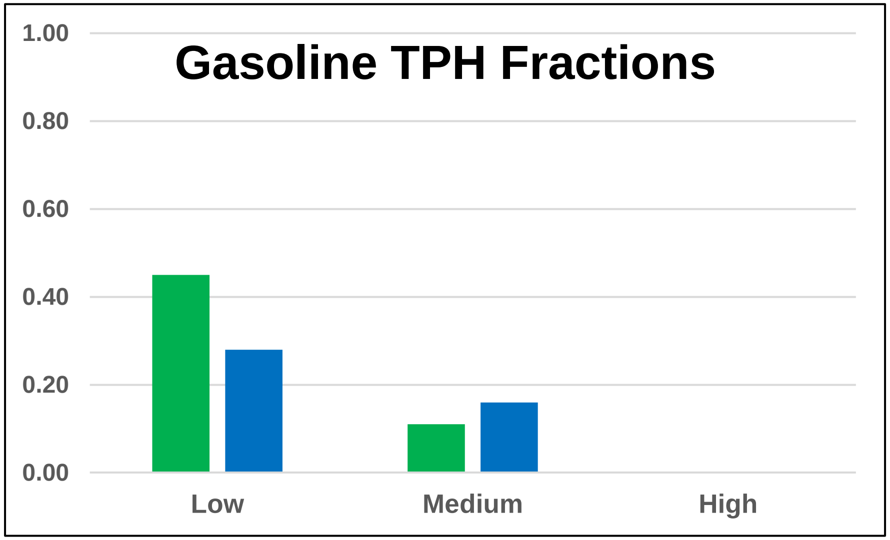
Table values from USEPA Estimation Parameter Interface Suite
Chromatogram from CA site

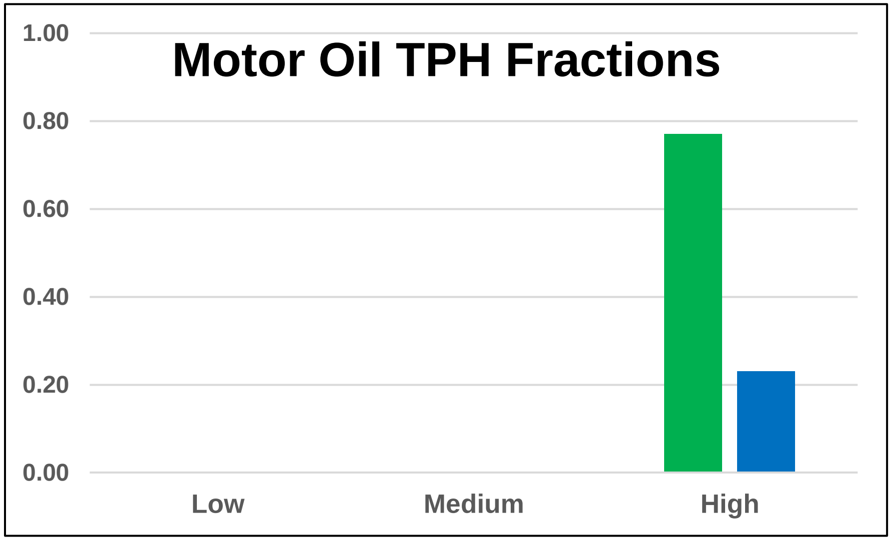
Example TPH Fractions: TPH Criteria Working Group vs. EPA

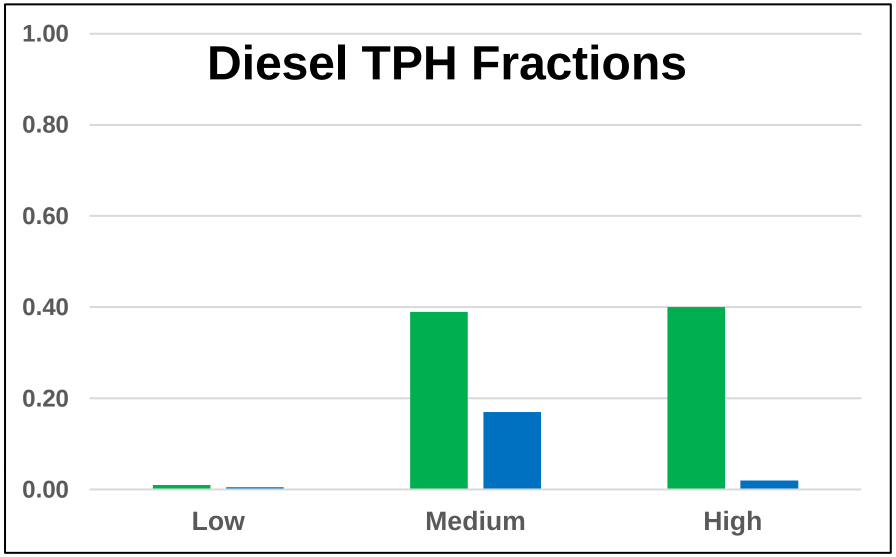


TPH Composition in Non-Aqueous Phase Liquid (NAPL)

Example TPH Fraction Proportions in Three Unweathered NAPLs







Aliphatic   Aromatic

Y-Axis: Mass fraction (1.00 = 100%)

Using 6 EPA TPH Fractions

Fraction compositions estimated from ATSDR documents

NAPL: TPH Composition Change Due to Weathering

- Weathering of NAPL is also known as Natural Source Zone Depletion (NSZD) – see ITRC LNAPL-3 (2018)

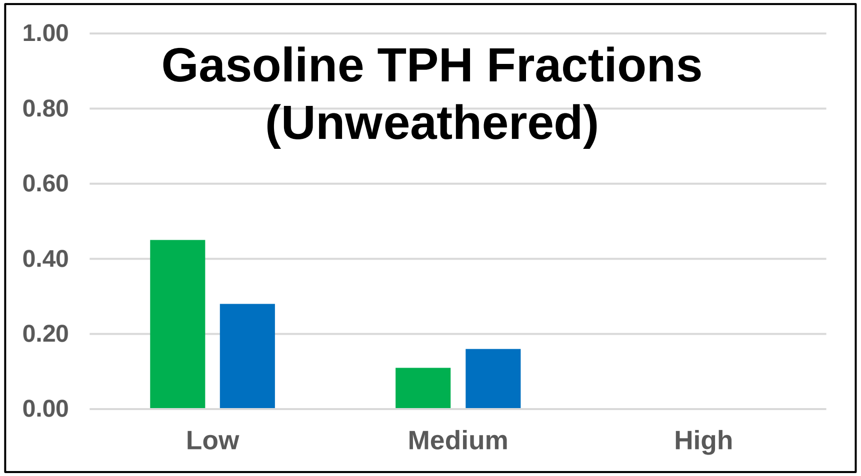
Printed from: Interstate Technology & Regulatory Council (ITRC). 2018. *Light Non-Aqueous Phase Liquid (LNAPL) Site Management: LCSM Evolution, Decision Process, and Remedial Technologies.* LNAPL-3. Washington, D.C. https://lnapl-3.itrcweb.org.

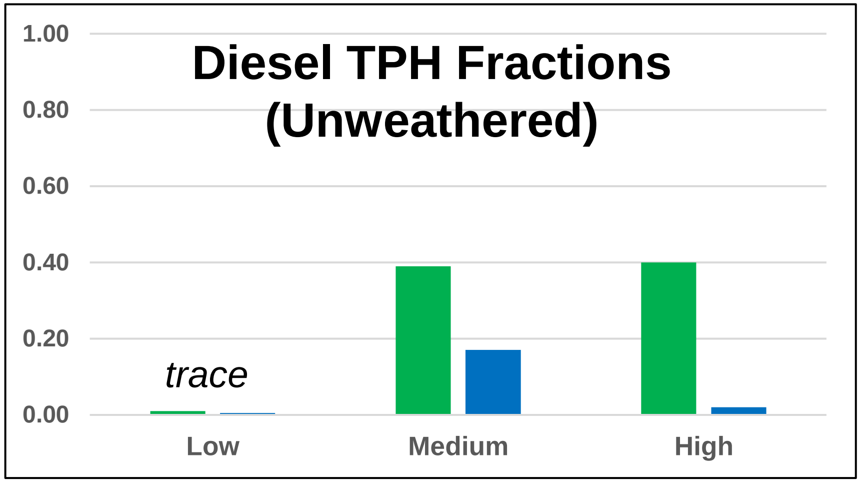
Appendix B-Natural Source Zone Depletion (NSZD) Appendix

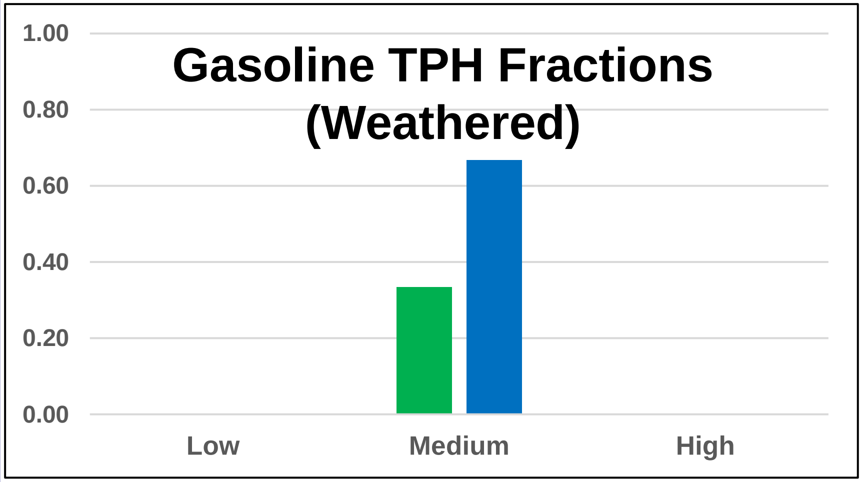
- Over time, weathering changes the remaining NAPL composition (and therefore risk)
  - Mobile hydrocarbons partition out, depleting the remaining NAPL
  - While biodegradation continues, metabolites will be generated

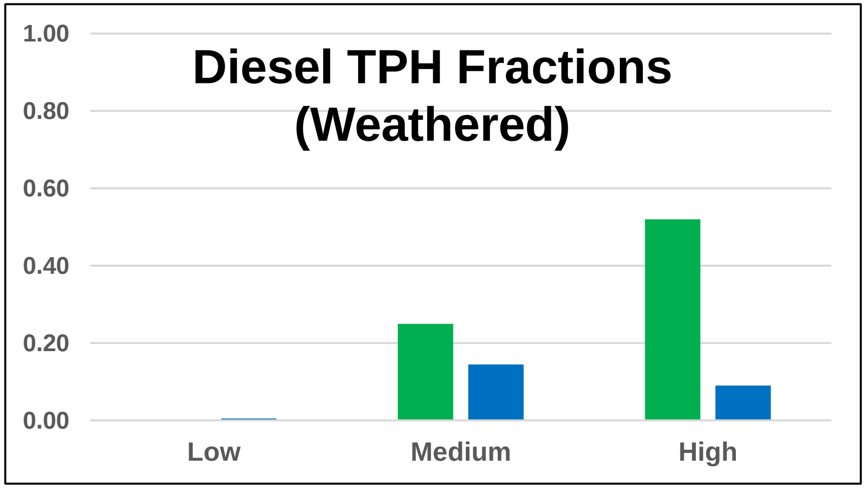
Weathered NAPL: TPH Composition Change Example

Case Study





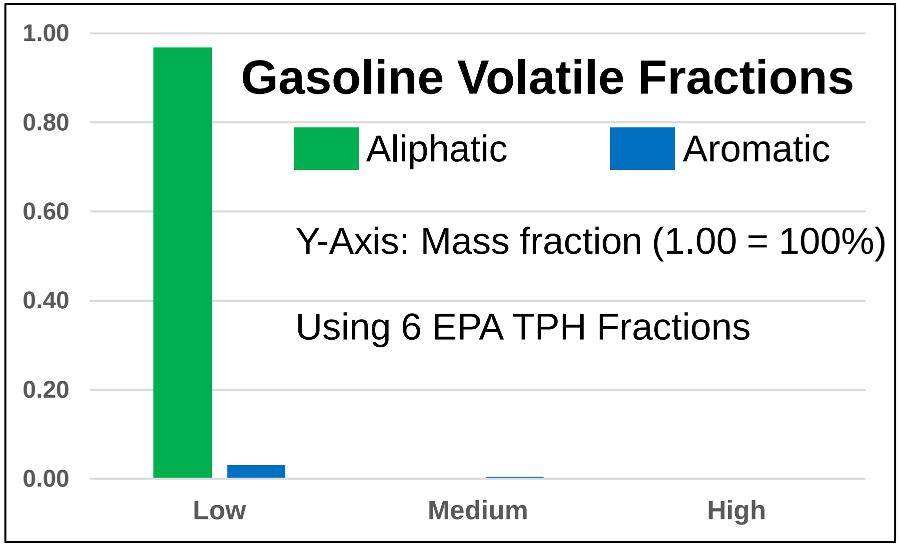


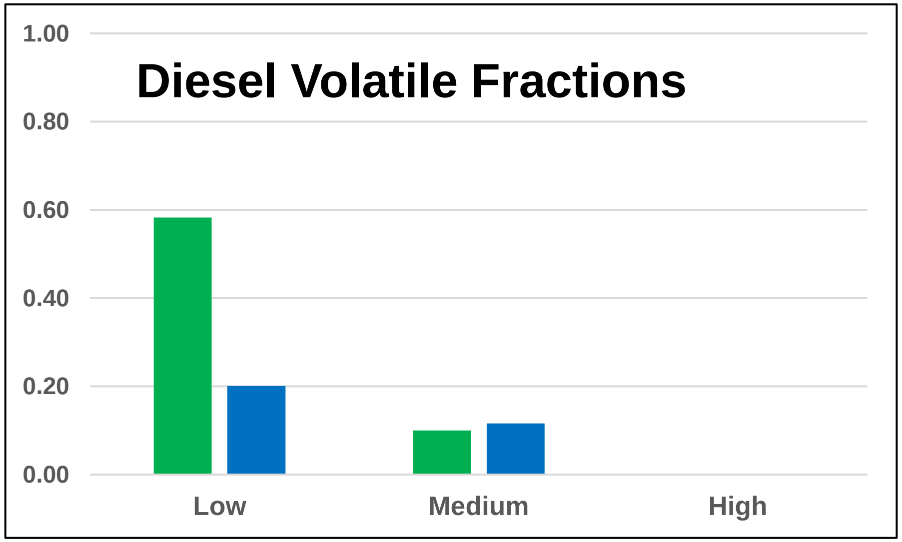


Aliphatic Aromatic

Composition: weathered gasoline from IRhodes
weathered diesel based on TPHCWG data

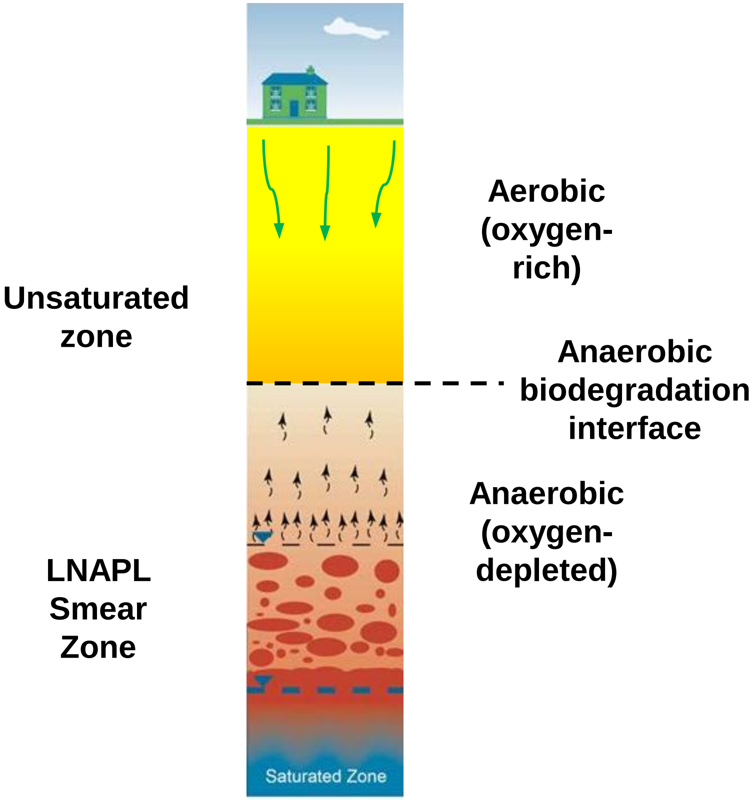
Vapor: TPH Fraction Composition Near NAPL and Fate/Exposure





Composition based on Uhler et al. 2010

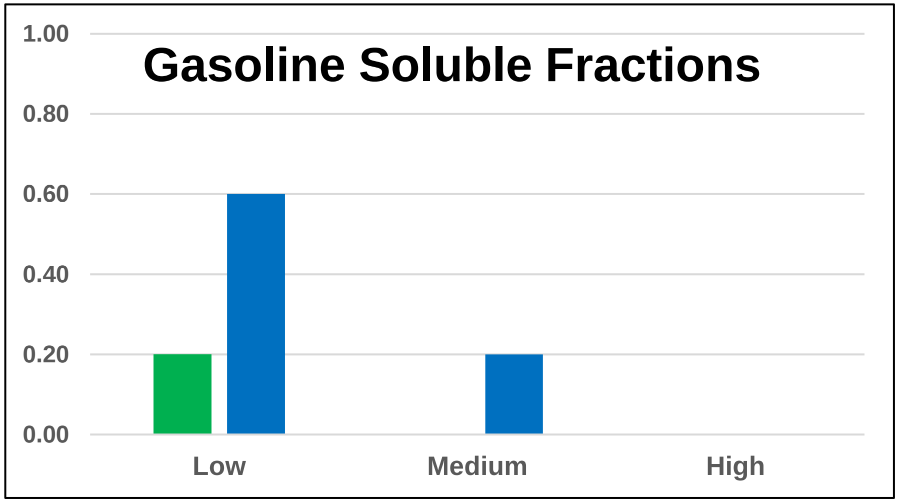
TPH Vapor Attenuation to Surface in Presence of Oxygen

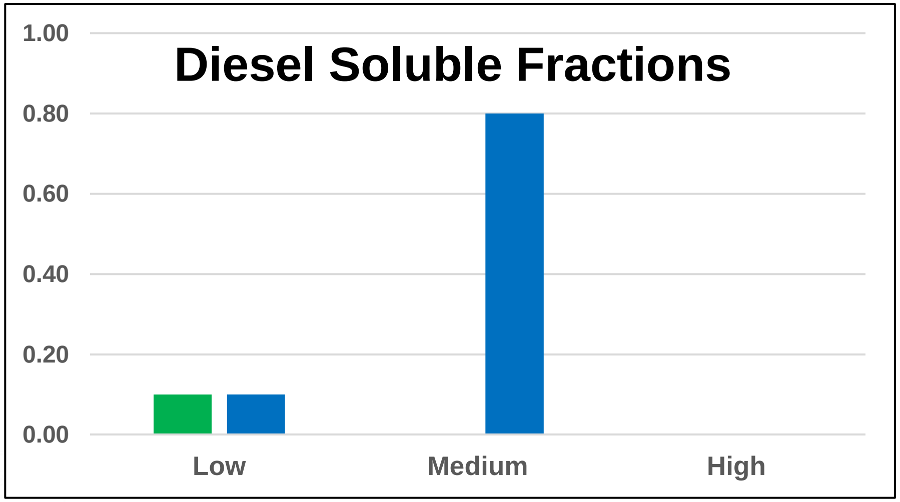


Source: ITRC PVI Guidance 2014

Groundwater: TPH Fraction Composition (Near NAPL)

Example TPH Fraction Proportions in Water from Two NAPLs (Unweathered)





Composition based on Zemo and Synowiec (1995)

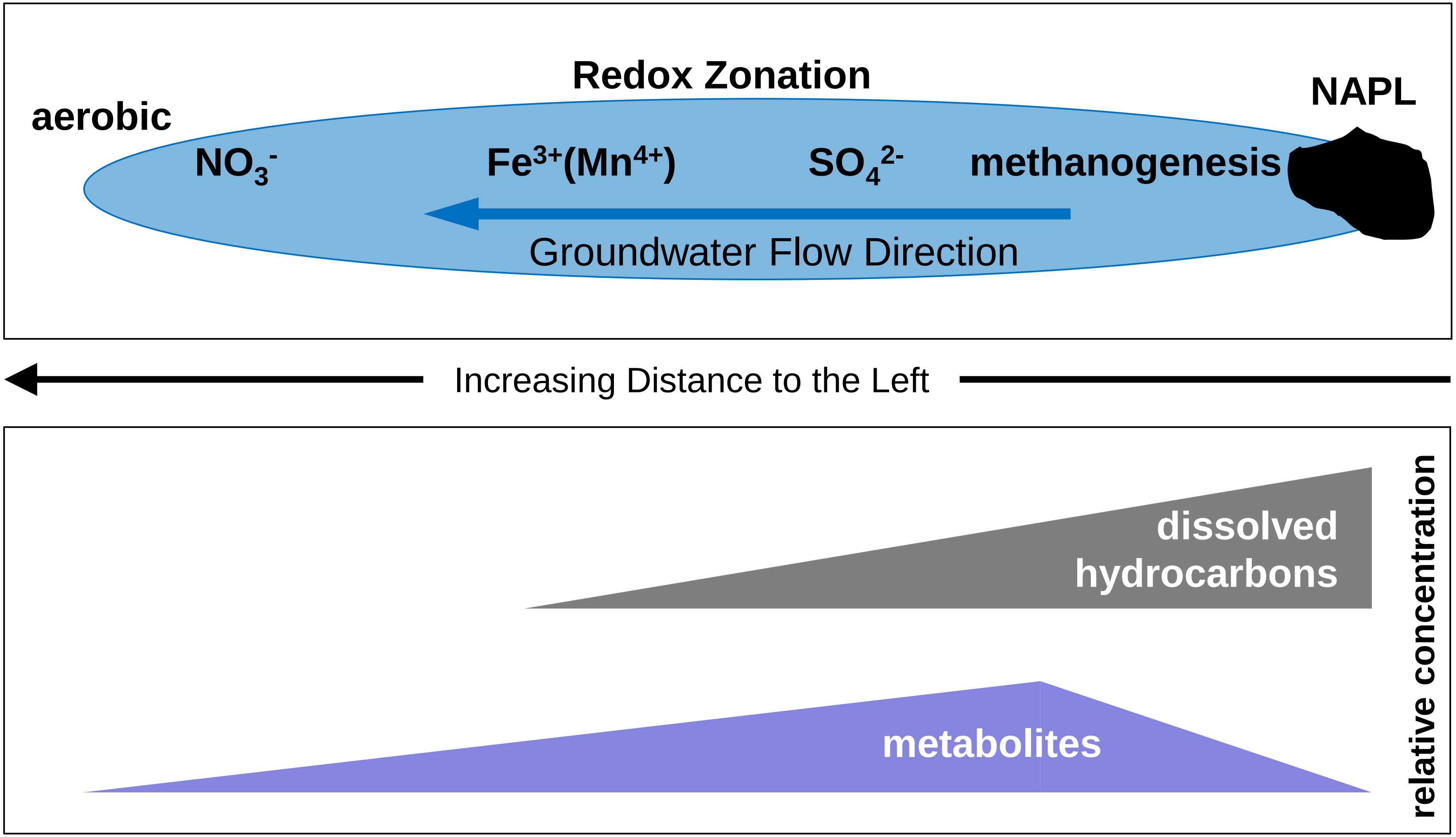
Aliphatic Aromatic

Y-Axis: Mass fraction (1.00 = 100%)

Using 6 EPA TPH Fractions

- **Fate of TPH Groundwater Plumes**
  - Dissolved hydrocarbons attenuate with increasing distance from release
  - TPH-Gasoline Plume Length (Shih et al. 2004):
    - Median: about 220 feet
    - Max: about 600 feet

Groundwater: Fate and Exposure



Information on relative hydrocarbon/metabolite concentrations based on Zemo et al. 2016. Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface (Wiedemeier et al. 1999)

Poll Question

- CSM: 30-year old, large diesel spill at bulk terminal site, where diesel is about EC8-EC26.
- What soluble TPH fractions or petroleum-related compounds are more likely present in a groundwater sample downgradient of the source area?
  1. All fractions/chemicals
  2. Low aromatics (EC6-EC9)
  3. High aliphatics (EC16-EC35)
  4. Petroleum metabolites
  5. None of the above

Summary: Environmental Fate of TPH

- TPH is a complex mixture
- The mass and composition of TPH change after release in a site-dependent manner depending on:
  - Individual hydrocarbon properties
  - Site conditions
- Understanding how TPH mass and composition change at a site leads to understanding how TPH risk changes at a site

Road Map

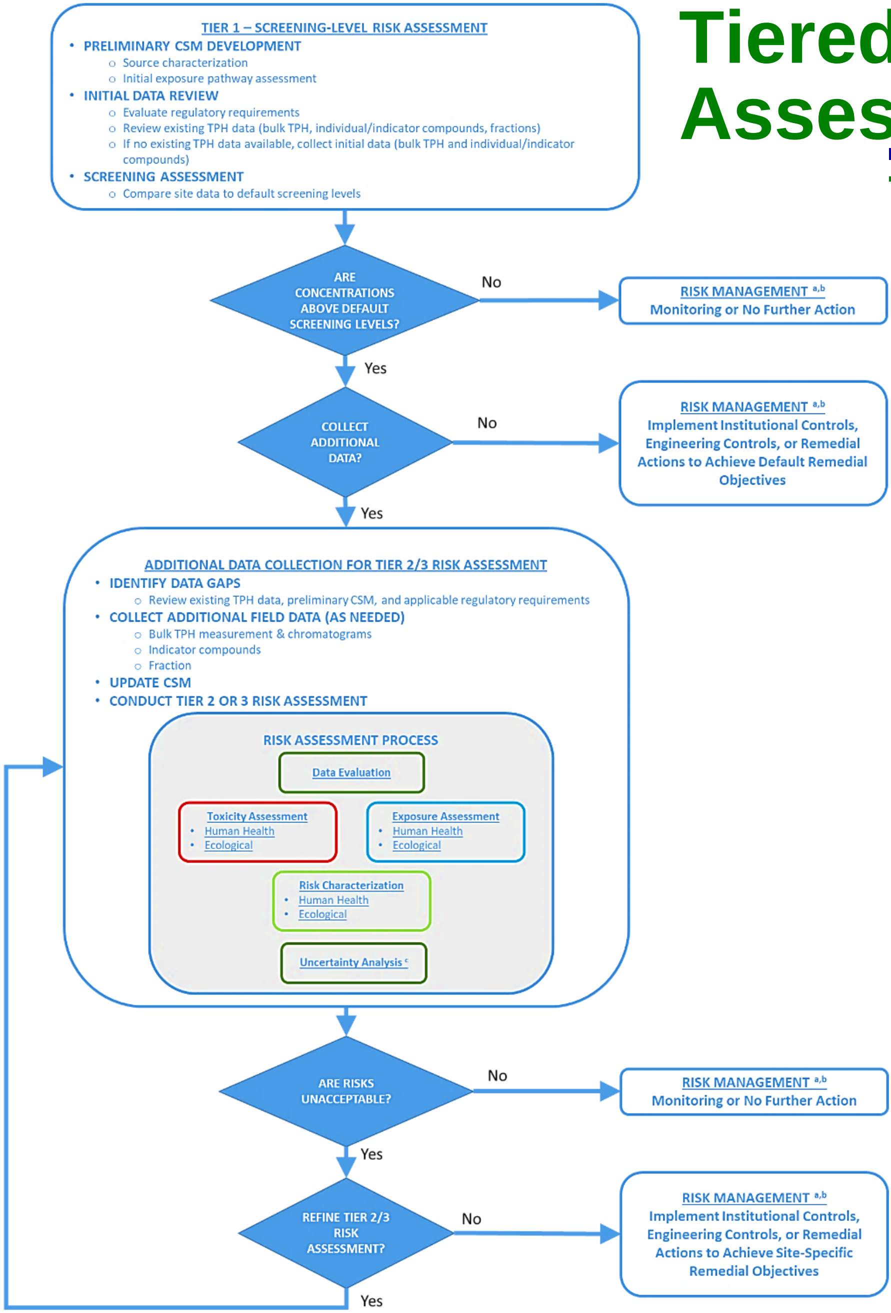
- Why the Guidance?
- Learn What TPH is
- Learn TPH Analytical Methods
- Questions and Answers
- Environmental Fate of TPH
- Assessing Human and Ecological Risk from TPH
- Stakeholders Considerations
- Closing
- Questions and Answers

Learning Objectives – Assessing Human and Ecological Risk from TPH

- Learn how tiered screening-level and site-specific approaches can be applied to human health and ecological TPH risk assessments
- Recognize how the unique analytical and fate and transport characteristics of TPH as a mixture affect risk assessment
- Determine whether your existing data is sufficient to estimate TPH risk
- Gain an appreciation for the uncertainties specific to TPH risk assessment

Poll Question

Tiered TPH Risk Assessment Framework



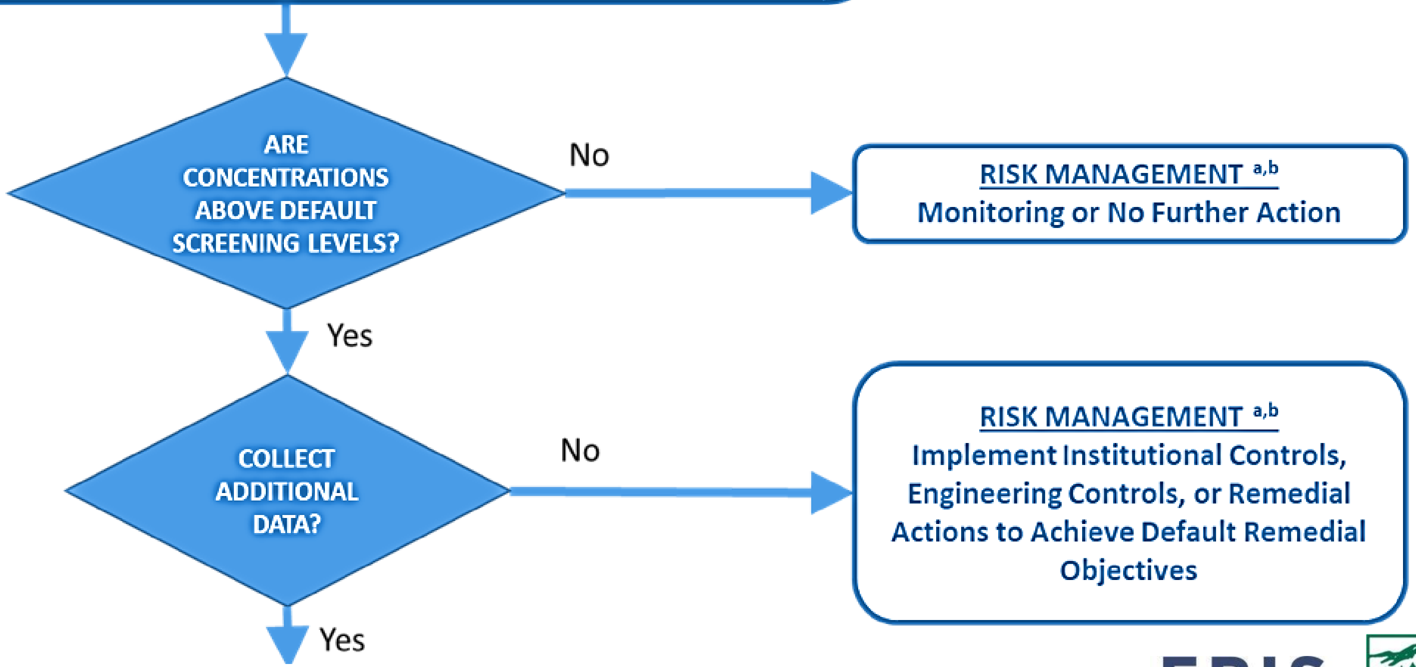
- Screening level assessment
- Site-specific assessment
- Human health and ecological

ITRC TPHRisk-1 Figure 1-1

Screening-Level Assessment

TIER 1 – SCREENING-LEVEL RISK ASSESSMENT

- **PRELIMINARY CSM DEVELOPMENT**
  - Source characterization
  - Initial exposure pathway assessment
- **INITIAL DATA REVIEW**
  - Evaluate regulatory requirements
  - Review existing TPH data (bulk TPH, individual/indicator compounds, fractions)
  - If no existing TPH data available, collect initial data (bulk TPH and individual/indicator compounds)
- **SCREENING ASSESSMENT**
  - Compare site data to default screening levels



ITRC TPHRisk-1 Figure 1-1

Site-Specific Assessment

ADDITIONAL DATA COLLECTION FOR TIER 2/3 RISK ASSESSMENT

- **IDENTIFY DATA GAPS**
  - Review existing TPH data, preliminary CSM, and applicable regulatory requirements
- **COLLECT ADDITIONAL FIELD DATA (AS NEEDED)**
  - Bulk TPH measurement & chromatograms
  - Indicator compounds
  - Fraction
- **UPDATE CSM**
- **CONDUCT TIER 2 OR 3 RISK ASSESSMENT**

RISK ASSESSMENT PROCESS

Data Evaluation

Toxicity Assessment
- Human Health
- Ecological

Exposure Assessment
- Human Health
- Ecological

Risk Characterization
- Human Health
- Ecological

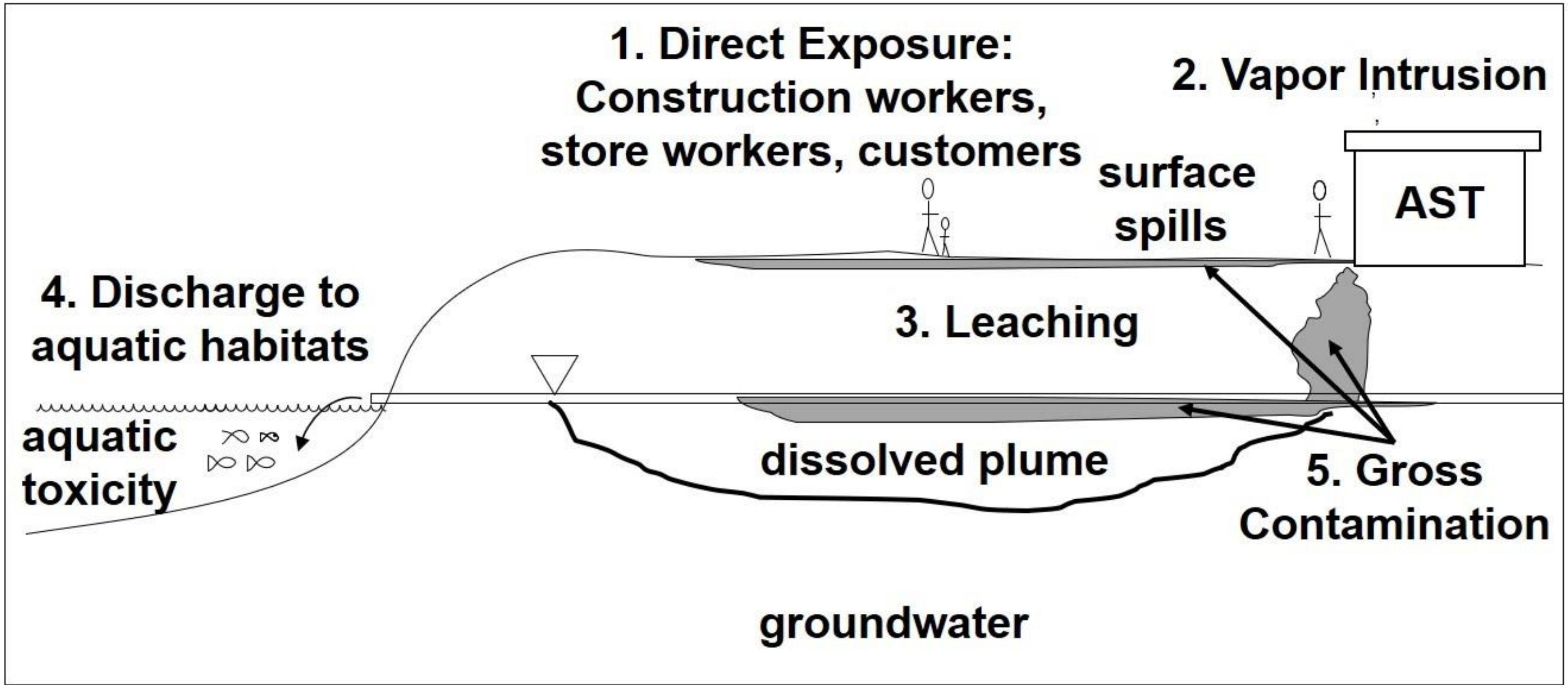
Uncertainty Analysis [c]

ITRC TPHRisk-1 Figure 1-1

Conceptual Site Model: Exposure Assessment

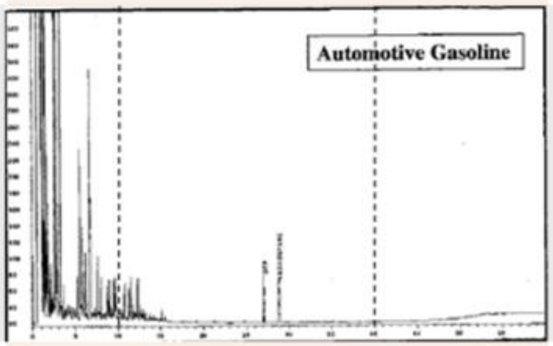
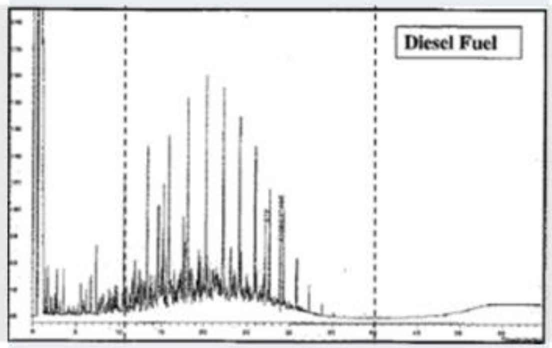
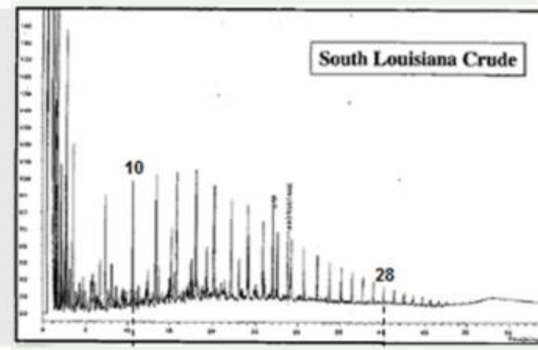
Case Study

- Unique characteristics of TPH effect exposure assessment
  - Partitioning across media
  - Changes over time



Human Health Exposure Pathways – Poll Question

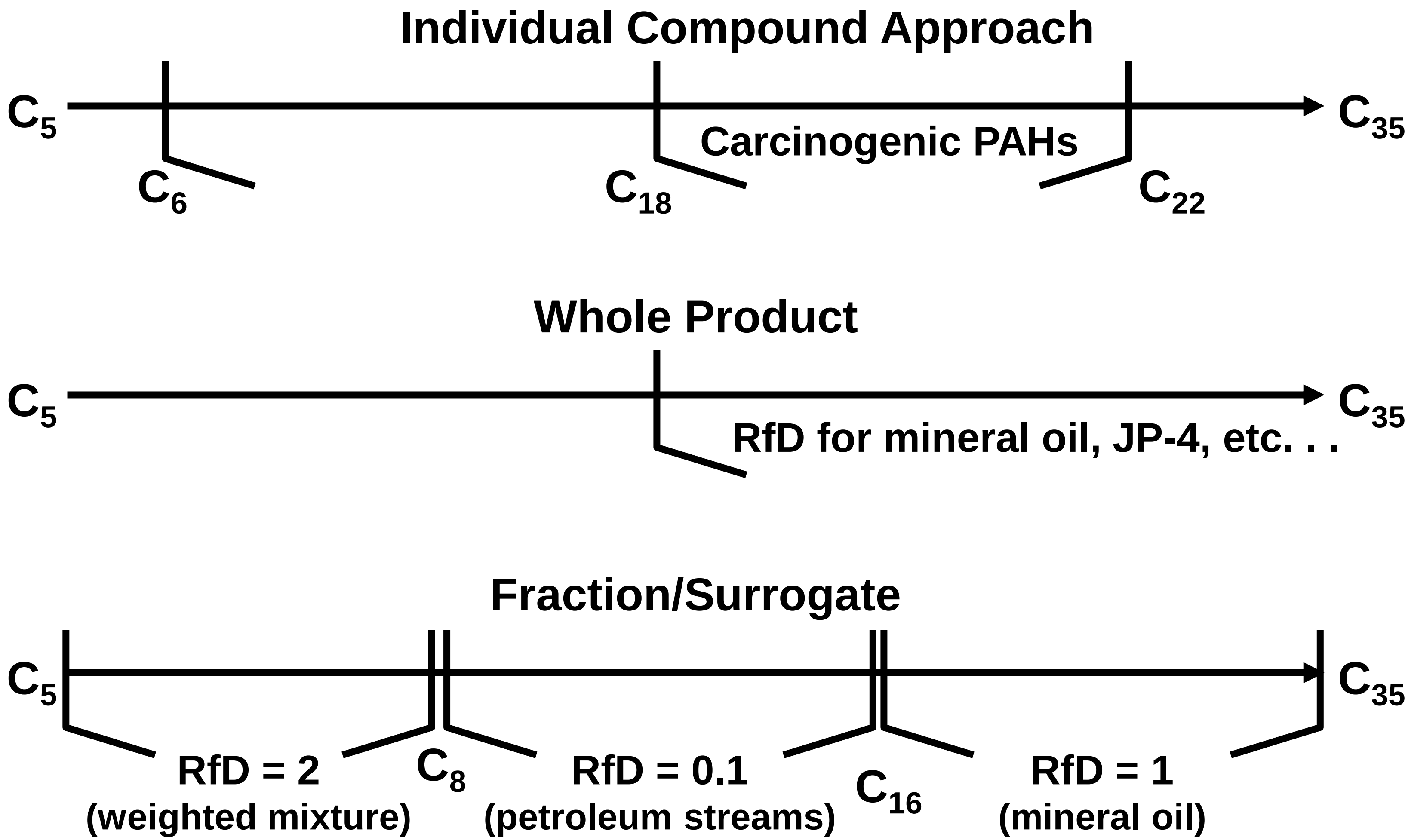
Poll Question

Sample 1	Sample 2	Sample 3
15,000 mg/kg	15,000 mg/kg	15,000 mg/kg
		
Gasoline	Diesel	South Louisiana Crude

Note that the first dotted line on the chromatograms is at C10, the second at C28

ITRC TPHRisk-1 Figure 2-3

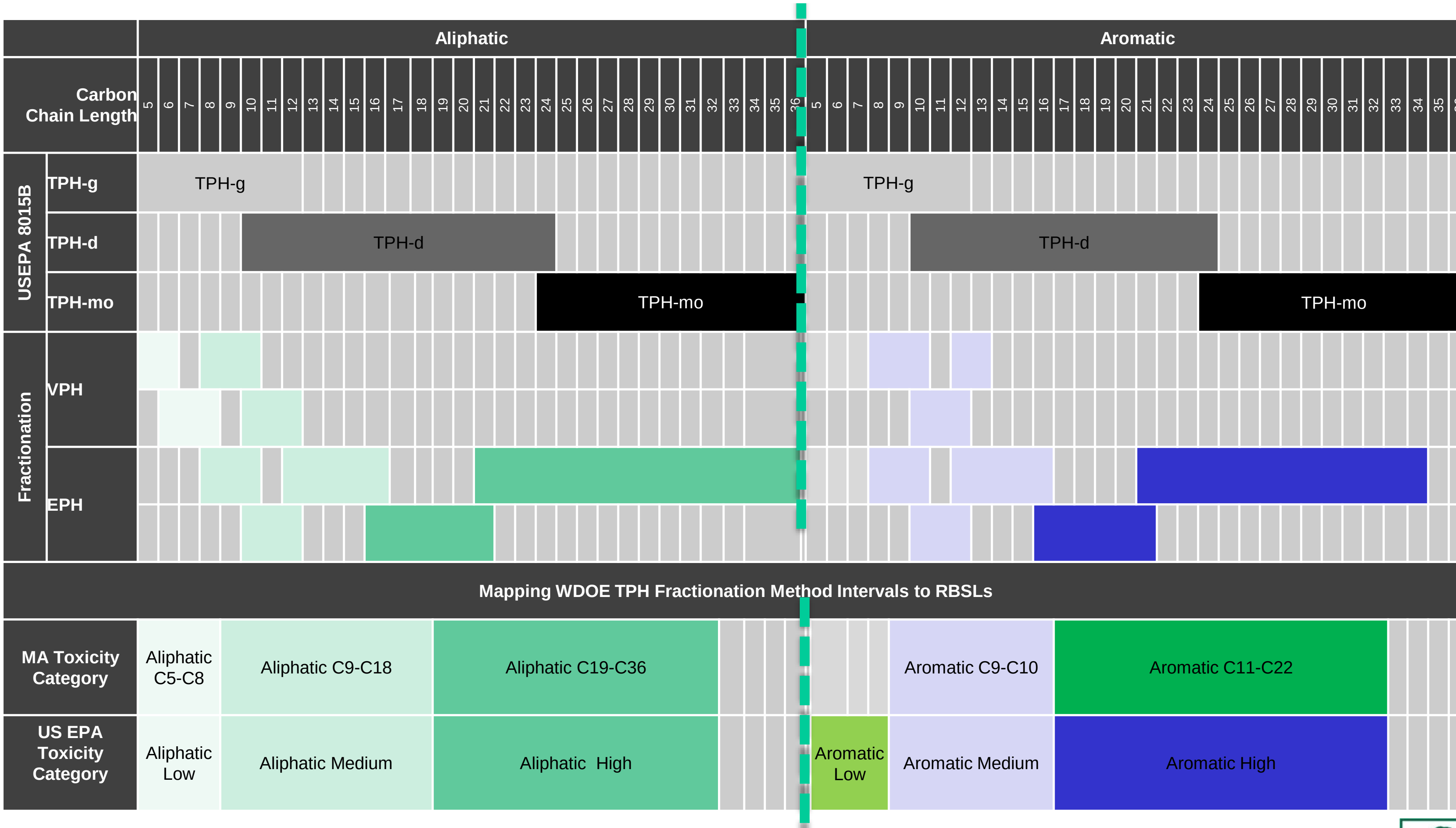
Human Health Toxicity Assessment



ITRC TPHRisk-1 Figure 6-2

Analytical Methods vs Toxicity Values

Group TPH Fractions intervals to be consistent with TPH toxicity values



from Goldberg Day, AEHS March 2015

Example Toxicity Values Under TPH Fraction Approach

Fractions	TPHCWG (1997)		MA DEP (2003)		USEPA PPRTV (2009)		TCEQ (2010)	
	RfD (mg/kg-d)	Surr (s) Comp (c)	RfD (mg/kg-d)	Surr (s) Comp (c)	RfD (mg/kg-d)	Surr (s) Comp (c)	RfD (mg/kg-d)	Surr (s) Comp (c)
Aliphatics Low Carbon Range (C5-C8) (EC5-EC8)	5	(s) Commer-cial hexane where n-hexane is ≤53%	0.04	(s) n-hexane	0.3	(s) n-hexane	0.06	(s) n-hexane
Aromatics Low Carbon Range(C6-C8) (EC6-EC<9)	0.2	(s) toluene	NA	(c) benzene	0.004	(c) benzene	0.1	(s) ethyl-benzene
			0.2	(c) toluene	0.08	(c) toluene		
			0.1	(c) ethyl-benzene	0.1	(c) ethyl-benzene		
			2	(c) xylenes	0.2	(c) xylenes		
			0.2	(c) styrene				

TPHCWG – Total Petroleum Hydrocarbon Criteria Working Group
MA DEP – Massachusetts Department of Environmental Protection
USEPA = United States Environmental Protection Agency
TCEQ – Texas Commission on Environmental Quality
PPRTV – Provisional Peer-Reviewed Toxicity Values

ITRC TPHRisk-1 Table 6-1

Case Study – Toxicity Assessment

Case Study

Started with bulk TPH data

COPC	Example Soil Data (mg/kg)	TPH Screening Level		
		Direct Exposure (mg/kg)	Leaching (mg/kg)	Gross Contamination (mg/kg)
TPHg	12,000	2,400	400	500 (5,000)
TPHmd	48,000	500	500	500 (5,000)
TPHrf	17,000	140,000	1000	2,500 (5,000)

Uncertainty in nature of product in diesel range prompted fraction analysis for soil gas

Carbon Range	Assumed Subslab Vapor Concentration (mg/m^3)	Subslab Vapor Screening Level (mg/m^3)
C5-C8 aliphatics	3,200	350
C9-C12 aliphatics	5,500	59
C13-C18 aliphatics	130	59
C9-C10 aromatics	32	59
C11-C16 aromatics	ND (<4)	59

HIDOH Case Study #1 (October 2018)

Assessment of Metabolites

- Challenge assessing risk
  - Limited toxicity information for individual metabolites and mixtures
- Options for evaluating metabolite toxicity
  - Exclude from evaluation
  - Use the RfD from the Rogers et al. (2002) study
  - Adopt the toxicity ranking model from Zemo et al. (2013, 2016)
  - Treat the bulk metabolites and bulk hydrocarbons as having similar toxicity (HIDOH, 2017) and (CSWB-SFBR, 2016)

Case Study – Risk Management

- Primary pathway of concern was vapor intrusion
- Acute safety/explosive concern
- Addressed stakeholder concerns
  - Vapor mitigation systems
  - Asphalt cover to address direct contact
  - Emergency hazard management plans for safety concerns

Now let's move on from humans…

ERA Poll Question

- Three different sites:
  - Site A – gas station release from a UST, paved site, depth to groundwater at 100 feet below land surface
  - Site B – gas station release, paved with channeled groundwater discharge to a creek a half-mile away
  - Site C – continuing release from an oil refinery with terrestrial and aquatic habitats nearby

An ERA may not be Necessary When:

- Absence of viable habitats (e.g., paved sites)
- Contamination found below the root zone and burrowing zones of ecological receptors
- No release to nearby, viable (or protected) aquatic and terrestrial habitats
- Policies and regulations on exclusion criteria (see Table 5-3)

Do a Screening-Level ERA When:

- State or local regulations require an ERA
- Screening Level values are available
- Screening levels are appropriate for site conditions and type of release
- Data Requirements for Screening ERA
  - Consider data for bulk TPH (TPH-g, TPH-d) and indicators (BTEX, PAHs)
  - TPH fraction data usually not available or necessary
  - See Tables 7-12 and 7-13 for analytical data choices and uses

ITRC TPHRisk-1 Tables 7-12 and 7-13

Example TPH Screening Levels – TPH-g

- CA Water Board Whole Product Screening Levels for Water (Table 7-1)

	Fresh (ppb)	Marine (ppb)	Estuarine (ppb)
TPH-g	500	3,700	500

- Canadian Soil Guidelines for Fraction F1

	Plants and Invertebrates (ppm)	Wildlife (ppm)
TPH F1 (C6-C10)	210-320	11,000

- More details on available screening levels in Section 7.2 and Table 7-1

Do a Site-Specific ERA When:

- When screening levels are lacking or exceeded
- At complex sites with multiple media, sensitive habitats and receptors
- Data needs for Site-Specific ERA
  - Consider combination of useful data types
    - Whole product and indicators
    - Water soluble and water accommodated fractions for aquatic habitats
    - Aliphatic/Aromatic fractions primarily available for aquatic assessment
    - See Tables 7-2,7-3 and 7-4 for analytical data choices and uses

ITRC TPHRisk-1 Tables 7-12 and 7-13

Scoping a Site-Specific ERA

- Exposure Assessment
  - Focus on direct exposure
  - Bioaccumulation
    - Primarily PAHs
- Toxicity Assessment
  - Aquatic and terrestrial biota
  - Physical toxicity
    - (not included in this guidance)
  - Chemical toxicity
    - – Multiple approaches
  - Metabolites
    - Emerging concern under study

Toxicity Assessment - Approaches

Source of TPH Toxicological Data

Research Literature

Ecotoxicity Databases

Upside – Based on real world testing.
Downside – Limited availability of data for whole product and TPH fractions. Variable data quality on underlying studies.

Structure Activity Models

Hydrocarbon Toxicity Models

Upside – Can be defined for site-specific mixtures or components.
Downside – Untested or unverified assumptions.

Numeric Criteria
Regulatory or Site-Specific

Site Measurements

Media Specific Toxicity Testing

Upside – Direct measure of toxicity under site-specific conditions.
Downside – Sensitive to confounding factors and inability to identify specific cause.

Toxicity Acceptability Criteria

ITRC TPHRisk-1 Figure 7-1

Characterizing HH and Eco Risk and Uncertainties

Key Uncertainties
Representativeness of fractions, components and/or surrogates of TPH
Screening levels (representative of TPH mix, risk based source, applicable endpoints
Non-additivity of TPH risk and TPH component double-counting
Toxicity value/test representativeness to underlying exposure mechanisms, especially when TPH + non-TPH mixtures
Additional direct or indirect impacts from TPH (oiling, direct contact, indirect changes to habitat)
Use of field data
Type of data used (bulk vs fractionated)

ITRC TPHRisk-1 Table 7-15

Road Map

- Why the Guidance?
- Learn What TPH is
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- Closing
- Questions and Answers

Learning Objectives - Stakeholder Considerations

- Recognize what groups can be potential stakeholders
- Know what stakeholder engagement tools are available
- Approach some common sources of confusion and concern about TPH risk assessment and decision-making for stakeholders – e.g., fires, explosions, health, appearance, odor, taste
- Chapter 10 in the guidance document

WE ALL WANT TO BE HEARD!

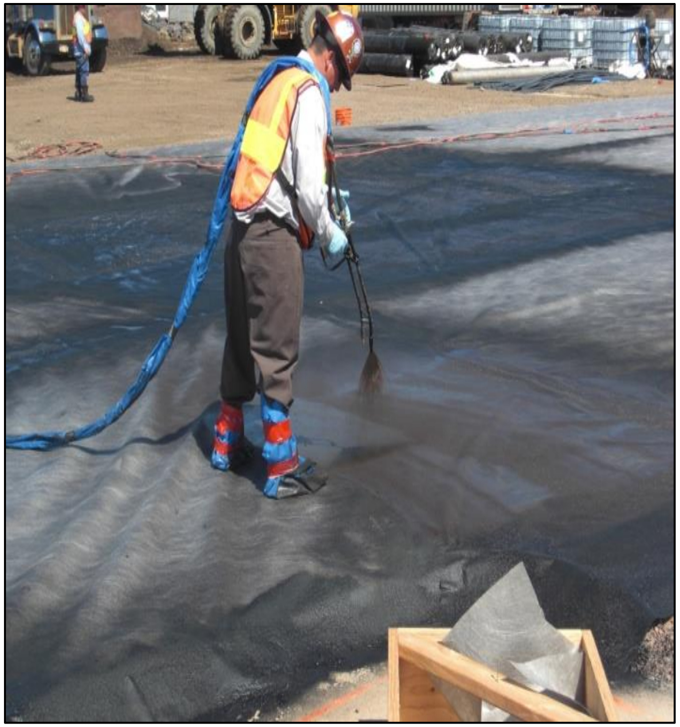
Communication with Stakeholders

- Who are Stakeholders?
- Important Components of Risk Communication
  - **Empathy and respect**
  - Understandable facts and conclusions about TPH
- Required Public Notifications
  - Notify owners and tenants before sampling
  - Provide TPH data with appropriate explanation
- Appropriate Communication Tools
  - Conveying technical concepts (Table 10-2)
  - Factsheets, posters, outreach meetings
  - Websites and links to TPH information

Tank Farm Redevelopment

Case Study

- Community Engagement Plan (CEP)
  - **Town Hall meeting scheduled several years before remediation began**
  - Built credibility and trust through targeted remedial actions, mitigation and monitoring
  - CEPs should be appropriate for the site



HIDOH Case Study #1 (HIDOH 2018)

Stakeholder Concerns Associated with TPH – Property Values

- Property Devaluation Concerns
  - Not unique to TPH
  - Devaluation may be real or perceived
  - Concern is often related to residual TPH and a Monitored Natural Attenuation (MNA) remedy
- Addressing Property Devaluation Concerns
  - Explain why selected remedy is protective and effective, especially for MNA
  - Describe how all activities are done with agency oversight
  - Address individual property owners concerns too

Stakeholder Concerns Associated with TPH – Technical Issues

- Household sources of TPH/ ”Background” TPH
  - There are many potential sources of TPH
  - Paint thinners, cosmetics, natural oils, urban air (Table 10-3)
  - We can only manage site-related TPH
- TPH and methane – explosions?
  - Potential degradation product, see ITRC PVI guidance (2014) and ASTM methane standard
- **Credibility/Comfort level with risk assessment**
  - **Including TPH means the whole mixture is addressed, not just the very small mass of indicator compounds (BTEX, and PAHs)**
- Nuisance concerns vs health risks?
  - Taste and odor are not health risks but covered in some states
- **Project Success**
  - **Technical approach + stakeholder engagement**

Road Map

- Why the Guidance?
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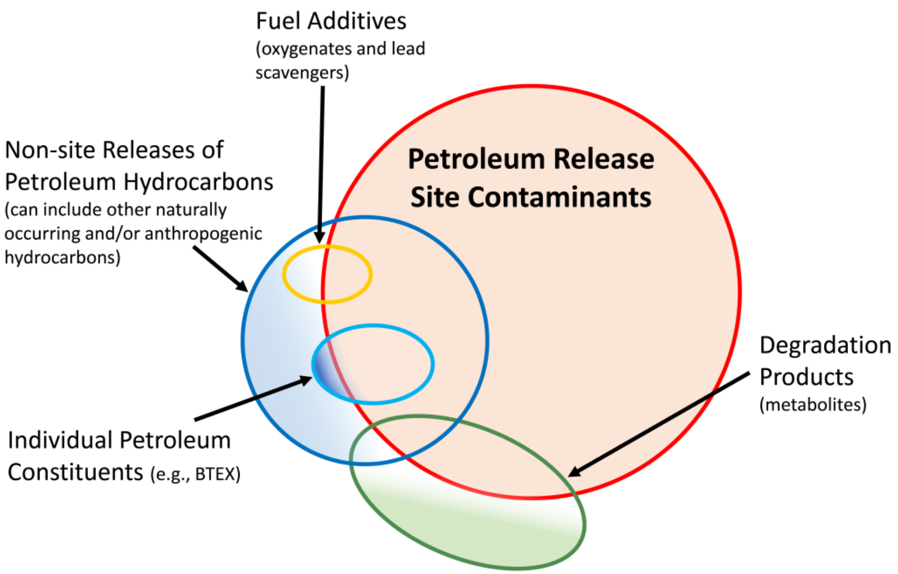
- Closing
- Questions and Answers

How will YOU evaluate TPH now?

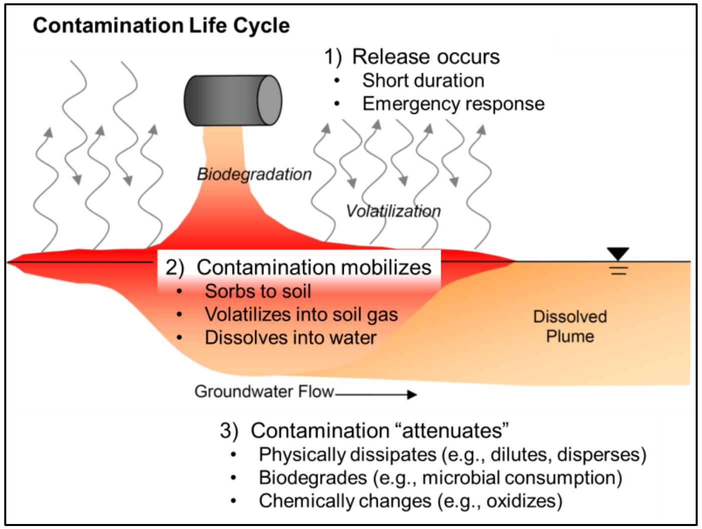
- What does your TPH site data really represent?
  - Have you considered the following:
    - Reviewing your chromatograms?
    - Fractionating your TPH results?
    - Using the silica gel cleanup method to understand the metabolite fraction? (USEPA Method 3630C)

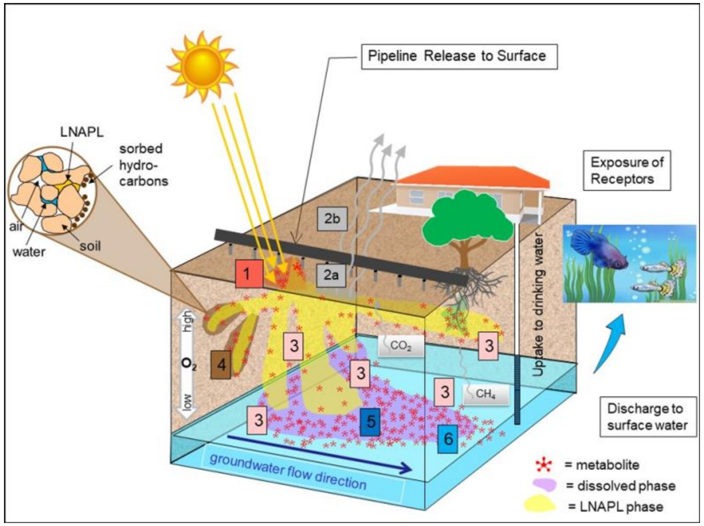


ITRC TPHRisk-1 Figure 2-2

Is Your CSM Complete?

- Are there data gaps or lifecycle considerations?
- Did you modify the CSM to integrate TPH?
- How do TPH metabolites affect your CSM?
- Old bulk TPH data at re-opened sites?
  - Should you resample and update the CSM?

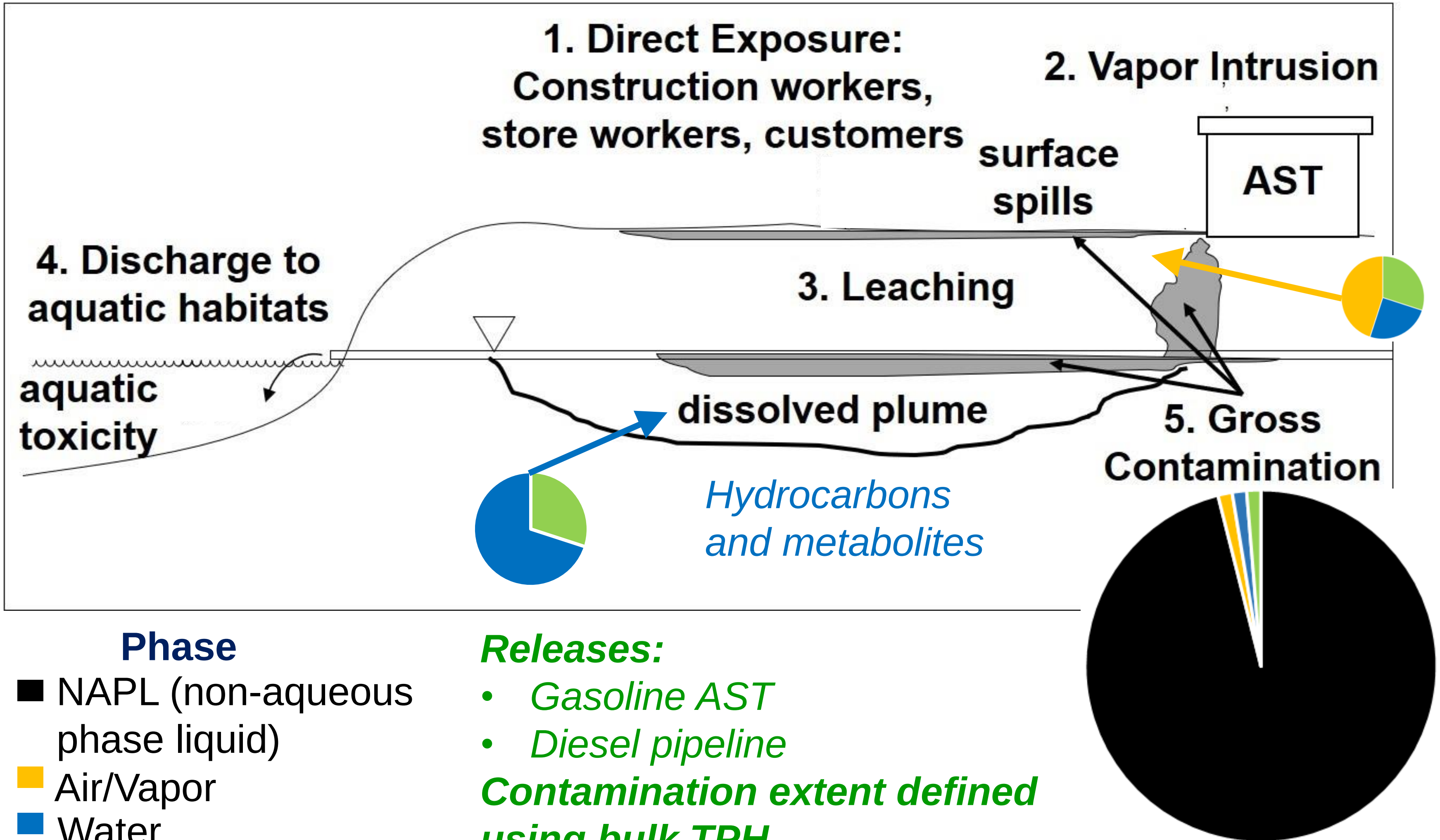




ITRC TPHRisk-1 Figures 6-1 & 4-9

Conceptual Site Model: Where is the Source Mass?

Case Study



Phase

- NAPL (non-aqueous phase liquid)
- Air/Vapor
- Water
- Sorbed

Releases:

- *Gasoline AST*
- *Diesel pipeline*

Contamination extent defined using bulk TPH

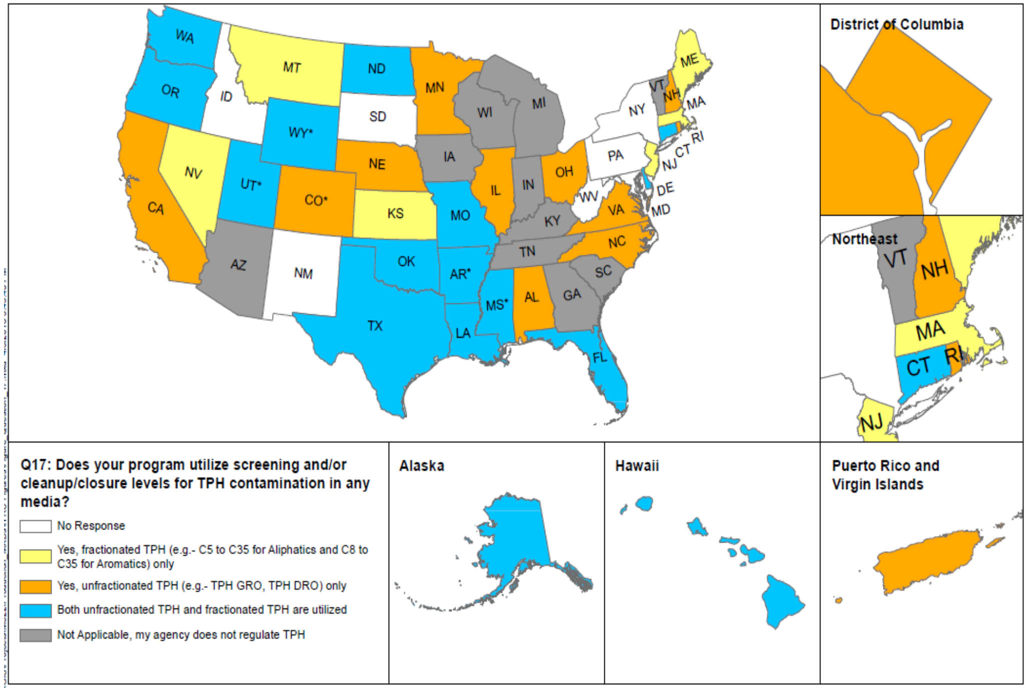
HIDOH Case Study #1, Figure 1-3 (HIDOH 2018)

Addressing Stakeholder Concerns

- Seek to build trust and credibility with communities by addressing real and perceived TPH concerns:
  - Potential Health and Ecological Impacts
    - Assessment of indoor air and sub-slab vapors
      - See ITRC Vapor Intrusion Guidance
  - Aesthetic Criteria
    - State-specific nuisance ordinances
      - Especially odor, visual complaints
  - Potential property devaluation

Use this Guidance!

- Where can I find help?
  - On-line calculators (ITRC TPH Risk Chapter 8)
  - Examples of Case-Studies using TPH data (HI)
  - What are States currently doing with TPH data? (see "TPH State Survey – Screening and/or Cleanup Levels")



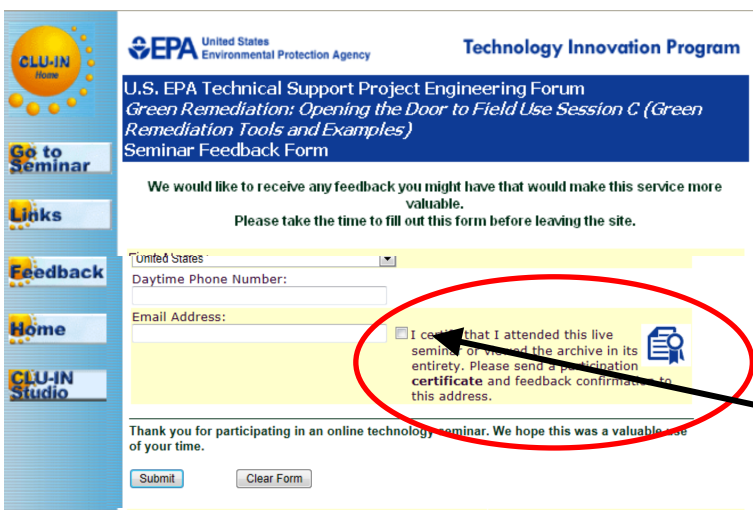
ITRC TPHRisk-1
Figure Q17

Thank You

Follow ITRC:

Poll Question

- 2nd question and answer break
- Links to additional resources
  - http://www.clu-in.org/conf/itrc/TPHrisk/resource.cfm
- Feedback form – *please* complete
  - http://www.clu-in.org/conf/itrc/TPHrisk/feedback.cfm



Need confirmation of your participation today?

Fill out the feedback form and check box for confirmation email and certificate.