Risk-Based Decision Making (RBDM) and Surface Waste Management

Testimony at NMOCC Hearing

Ben Thomas, Ph.D.

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Introduction

- Risk-Based Decision Making (RBDM) is an effective regulatory tool and should be used by OCD.

- My background:
  - Pathology, toxicology, and risk assessment.
  - Completed 50+ risk assessments for industry and regulatory agencies.
  - Served as consultant to LDNR concerning amendment of Statewide Order 29-B (treatment of E&P wastes).

Presentation Outline

- RBDM and BDAT
- The RBDM Process
- Landfarming
  - Crude Oil and Condensate
    - Chemistry
    - Measurement
    - Toxicity
    - Landfarming Risk
  - Sodium Chloride
    - Toxicity
    - Landfarming Risk
- Landfarming -- RBDM Summary
- Unanswered Questions
- RBDM Benefits and Conclusions

Surface Waste Management Rule

- Describes the regulatory processes involved in the permitting, operation, and closure of …
  - Landfarms – for treatment of hydrocarbon-contaminated soils
  - Landfills – for permanent burial of "untreatable" exempt or non-hazardous oilfield wastes

General Comments

- OCD has adopted what they call a "Best Demonstrated Available Technology" (BDAT) approach – a one-size-fits-all technical solution with no risk-based decision process.

- In my opinion, a Risk-Based Decision Making (RBDM) process would provide a logical and consistent framework from which OCD can better regulate oil field wastes.

General Comments

- EPA and other agencies (including NMED), have rejected BDAT-type approaches -- manpower intensive, expensive to implement, and difficult to enforce.

- These agencies have now adopted RBDM approaches.

RISK-BASED DECISION MAKING (RBDM)

Definitions

- Hazard – the ability to produce an adverse effect.
- Risk – the probability that an adverse effect will occur.

- Risk assessment became necessary when EPA recognized that contaminants must be regulated not based on the hazard (e.g., toxic effect) associated with a chemical, but on the risk that chemical poses to public health and the environment.

Risk-Based Decision Making

- RBDM provides a logical and consistent way of thinking through landfarm issues by evaluating who and what need to be protected and why.

- In contrast to a default BDAT approach, RBDM evaluates site-specific factors, then determines what are the most effective and appropriate regulatory actions to manage the risks at that site.
  - RBDM provides OCD (and the Operator) greater flexibility to manage potential threats to public health, fresh water, and the environment.
  - Without RBDM, OCD cannot determine if conditions at a landfarm warrant adoption of BDAT.

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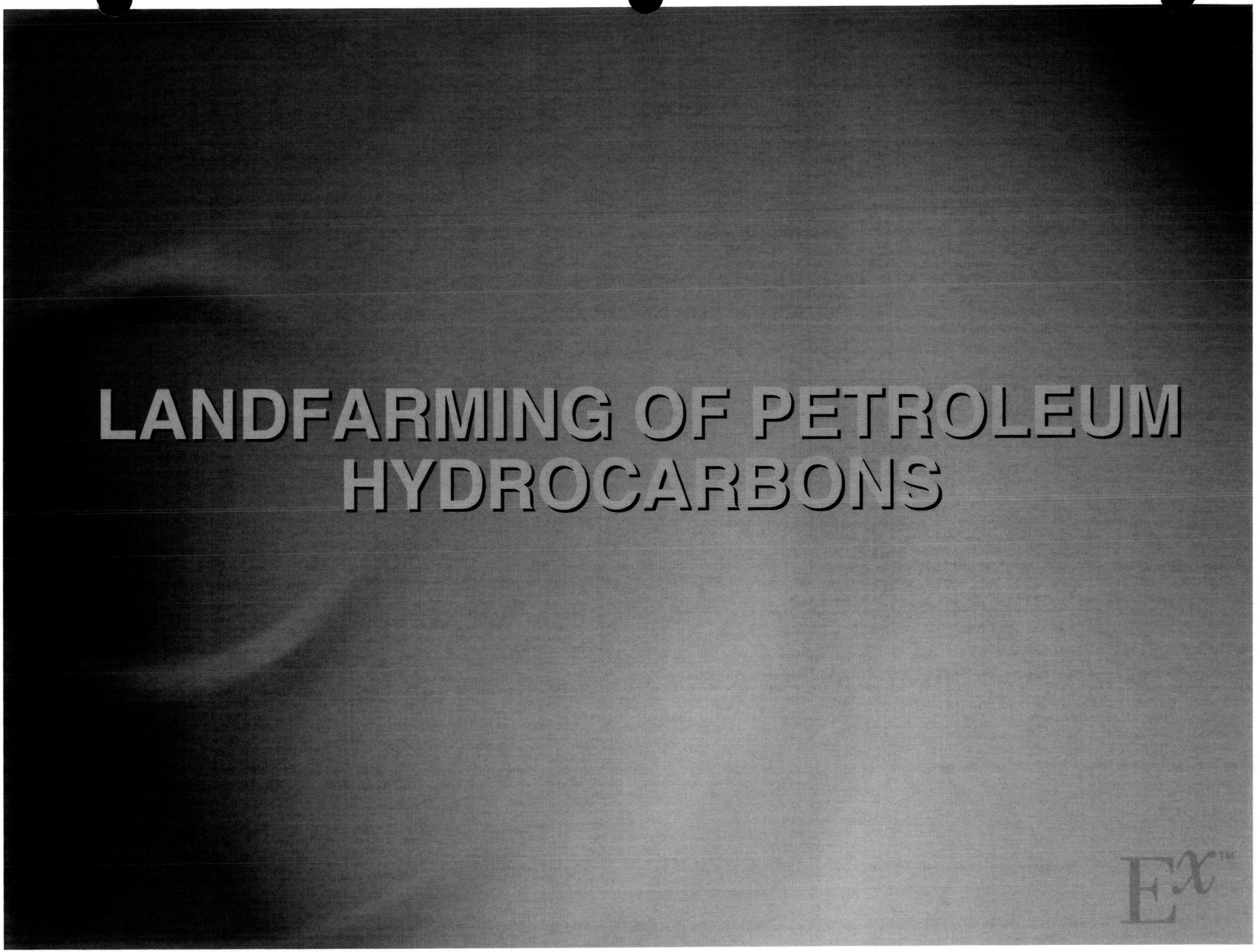
Risk-Based Decision Making (RBDM) is a formal process that defines:

- What chemical (or agent) is of regulatory concern;
- Who specifically is the "receptor" being protected from that chemical (present and future);
- What are the most likely pathways and levels of exposure to that chemical;
- What is considered to be an appropriate level of risk (the "target risk level"); and
- Based on the above, RBDM defines the maximum allowable concentration of the chemical in soil or water such that the "target risk level" is not exceeded.

Risk-Based Decision Making (RBDM)

- Recognizes that each SWM facility may be unique in terms of size, mass loading, types of soils, depth to groundwater, etc.
- Uses a tiered approach for regulation:
  - Tier 1 – makes conservative (protective) risk-based assumptions to develop soil screening levels (SSLs) for applicable chemicals of concern. May be applied at any facility.
  - Tier 2 – allows certain site-specific parameters be used in the Tier 1 regulatory risk equations.
  - Tier 3 – allows an Operator to propose an alternative risk model that he believes is more appropriate for site conditions.

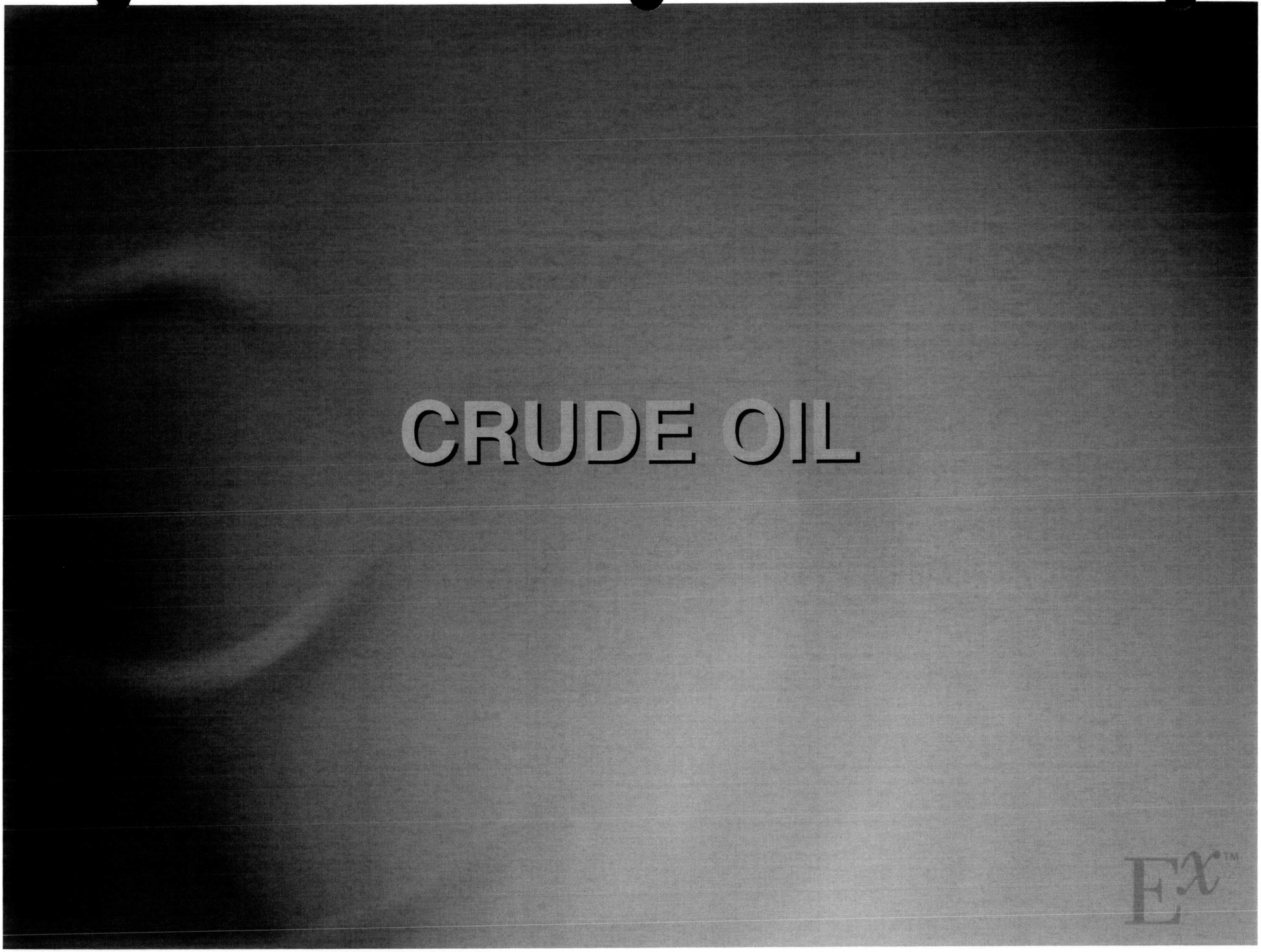

LANDFARMING OF PETROLEUM
HYDROCARBONS

Materials Allowed in Landfarms

Soils and soil-like materials that contain…

- Crude Oil
- Natural Gas Liquids (Condensate)
- Possibly Tank Bottoms (a mix of water, sediment, crude oil, and water-soluble hydrocarbons)
- Salt (especially Sodium Chloride)

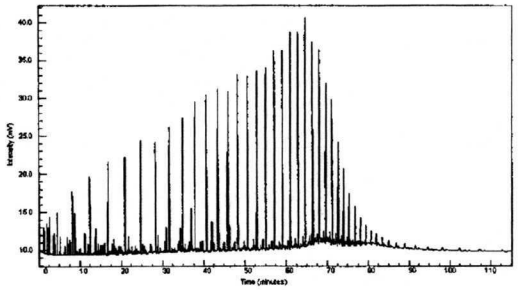
Note: Refinery wastes and hazardous wastes (e.g., wastes like chlorinated solvents, PCBs, etc.) are not allowed by OCD to be placed in an OCD permitted or registered landfarm.


CRUDE OIL

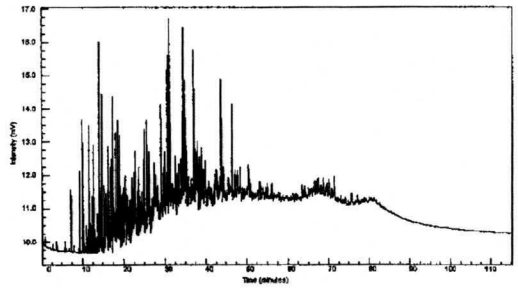
Crude Oil

- Crude oils are extremely complex mixtures, and vary widely. Constituents not easily separated for identification and quantification.
- Crude oils have low acute toxicity, chronic toxicity, and carcinogenicity in animals, and low toxicity to plants.
- Toxic constituents are present, but only at small concentrations in the mixture.

Widuri Crude Oil



SJV Crude Oil



Crude Oil (TPH)

- The most common surrogate measure for crude oil is called Total Petroleum Hydrocarbon (TPH-Total) in which hydrocarbons are extracted into a solvent, then quantified by various methods.
  - Method 418.1 – Extract into Freon-113; quantify by extent of absorption of infrared light.
  - Method 8015M – Extract into an appropriate solvent (e.g., hexane) and analyze by GC-FID.

Crude Oil (TPH Methods)

- Method 418.1 – This is OCD's preferred method for TPH-Total, but it is no longer listed as an approved method in EPA SW-846.

- Method 8015M – This is an appropriate method approved by EPA.

Crude Oil (TPH Measurement)

- TPH methods are non-specific…not everything reported as TPH is petroleum. "TPH-Total" content by Method 418.1…
  - Grass (TPH-Total = 14,000 mg/kg)
  - Pine Needles (TPH-Total = 16,000 mg/kg)
  - Oak Leaves (TPH- Total = 18,000 mg/kg)

- TPH estimates by different methods are not directly comparable.

Crude Oil (TPH Fractions)

- **Because toxicology / risk data are available for the common distillate fractions of crude oil, TPH-Total is often separated by GC methods (e.g., 8015M) into …**
  - **TPH-GRO (gasoline, C6-C10),**
  - **TPH-DRO (kerosene and diesel fuel, C10-C28), and**
  - **TPH-ORO (lubricating oil, C28-C40).**
  - **Asphalt-range constituents of crude oil (C40+) are not able to be extracted by light aliphatic solvents, and cannot be analyzed directly.**

Crude Oil (Toxicity)

- Scientific literature indicates that a concentration of 1%wt (TPH-Total = 10,000 mg/kg) of crude oil in soil does not affect plant growth, or groundwater quality.
- The constituents of greatest concern from a toxicity and environmental migration perspective are:
  - Benzene, Toluene, Ethylbenzene, Xylenes, called BTEX) that exist in the TPH-GRO fraction; and
  - Naphthalene that exists in the TPH-DRO fraction.
- The BTEX and Naphthalene compounds are volatile, water-soluble, and bioavailable constituents of petroleum. They are preferentially degraded by bacteria and other microorganisms in soil and water.

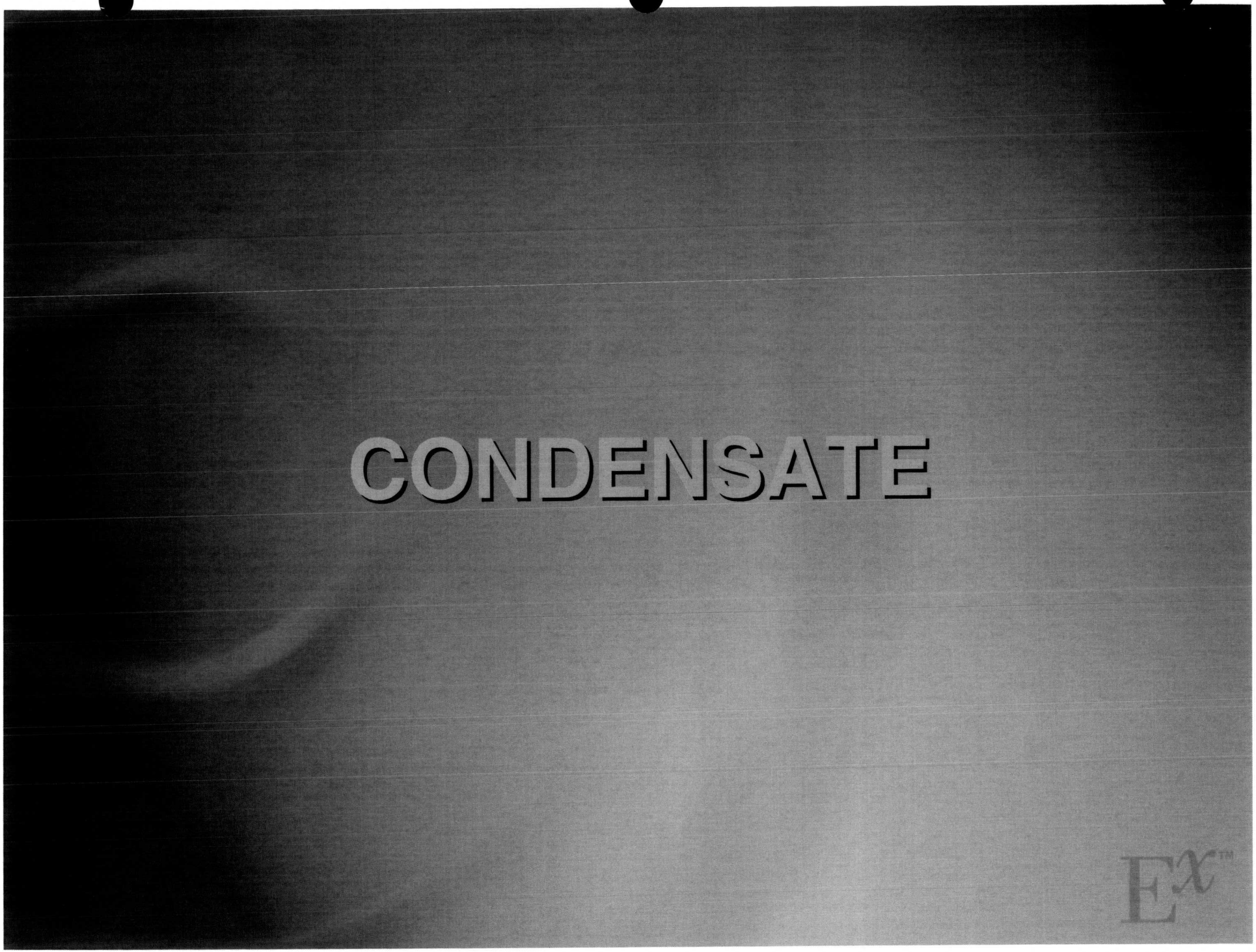
Landfarming – Crude Oil

- When oil-impacted soils are placed in a Landfarm, the Operator tills, and adds organic matter, water and/or nutrients as needed.
- Landfarming promotes the growth of microorganisms that preferentially metabolize the smaller hydrocarbon constituents including BTEX (TPH-GRO) and Naphthalene (TPH-DRO) – eliminates toxicity.

Landfarming – Crude Oil (continued)

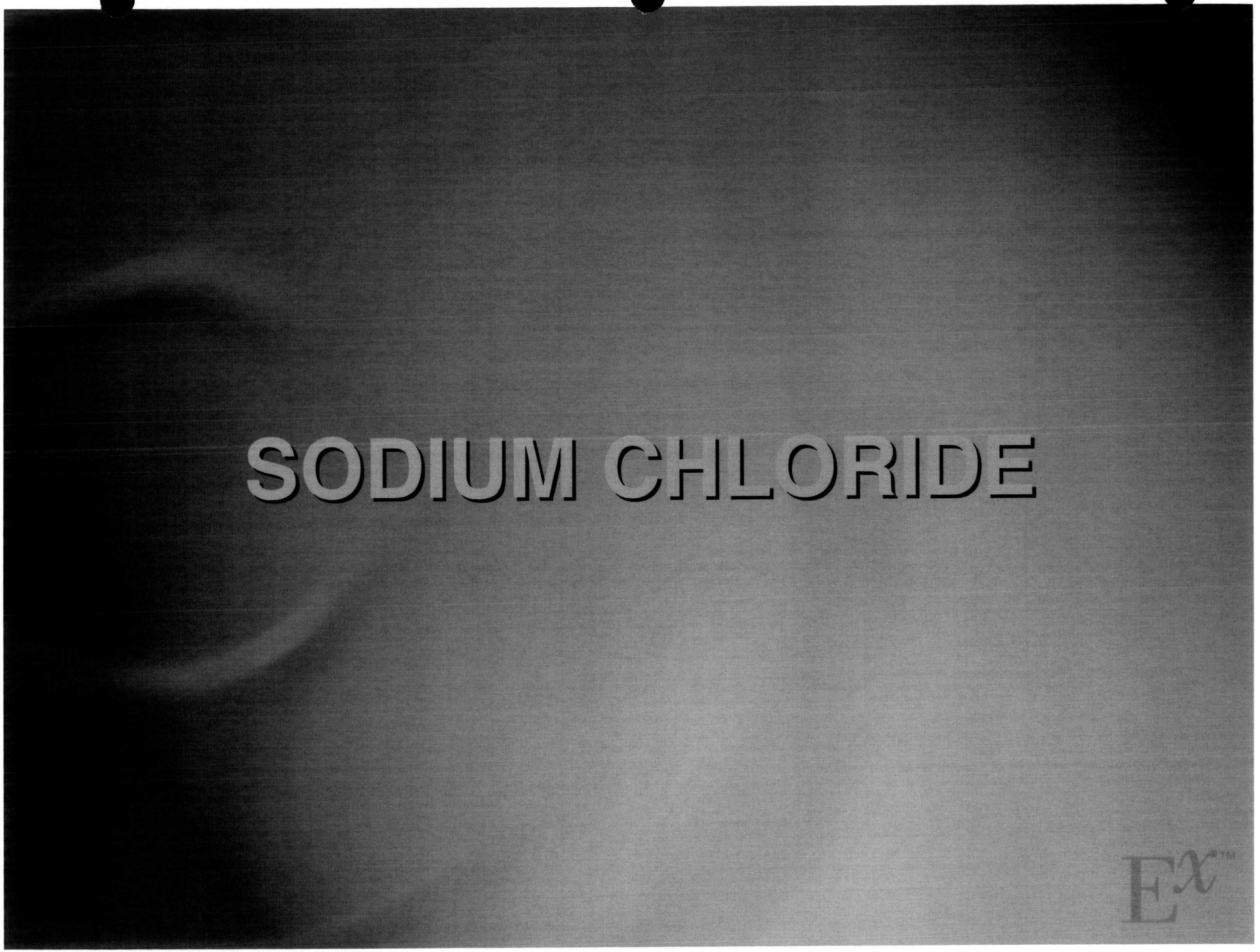
- When bioremediation is complete, the Residual TPH-Total hydrocarbons (i.e., larger TPH-DRO constituents + TPH-ORO + Asphalt) are:
  - non-toxic
  - poorly soluble
  - not environmentally mobile

- Because the crude oil has been mixed with the bioremedied soil, the Residual TPH-Total contributes to the organic content of the soil, and does not form asphaltic clumps on the landfarm surface.


CONDENSATE
EX™

Condensate

- Condensate is also called "natural gasoline" and contains primarily TPH-GRO (C6 - C10), with lesser amounts of TPH-DRO (C10 – C28) hydrocarbons.
- According to data from the Gas Research Institute (GRI), condensates contain BTEX and Naphthalene. Benzene concentrations range from 0.15 – 3.6 %wt.
- Landfarm and biopile treatment of condensate-impacted soils results in volatilization and microbial destruction of these hydrocarbons. The remaining hydrocarbons are:
  - non-toxic
  - poorly soluble
  - not environmentally mobile.


SODIUM CHLORIDE

Sodium Chloride

- Chloride ion is highly soluble in water, and is used by environmental scientists as an indicator of water migration.
- The toxicity of chloride salts is related to the positively charged cation (e.g., sodium, calcium, etc.), rather than to the chloride anion.
  - Oral LD50 (Lethal Dose 50%) of sodium chloride in man and animals is about 4000 mg/kg.

Sodium Chloride

- Dr. Stephens has modeled the vertical migration of chloride from a hypothetical small landfarm that has been sited according to OCD criteria.
- Vertical migration is extremely slow.
- Based on his conservative model, soils containing Chloride concentrations of 4,000 to 11,000 mg/kg could be treated in small landfarms without adversely affecting groundwater.

Sodium Chloride

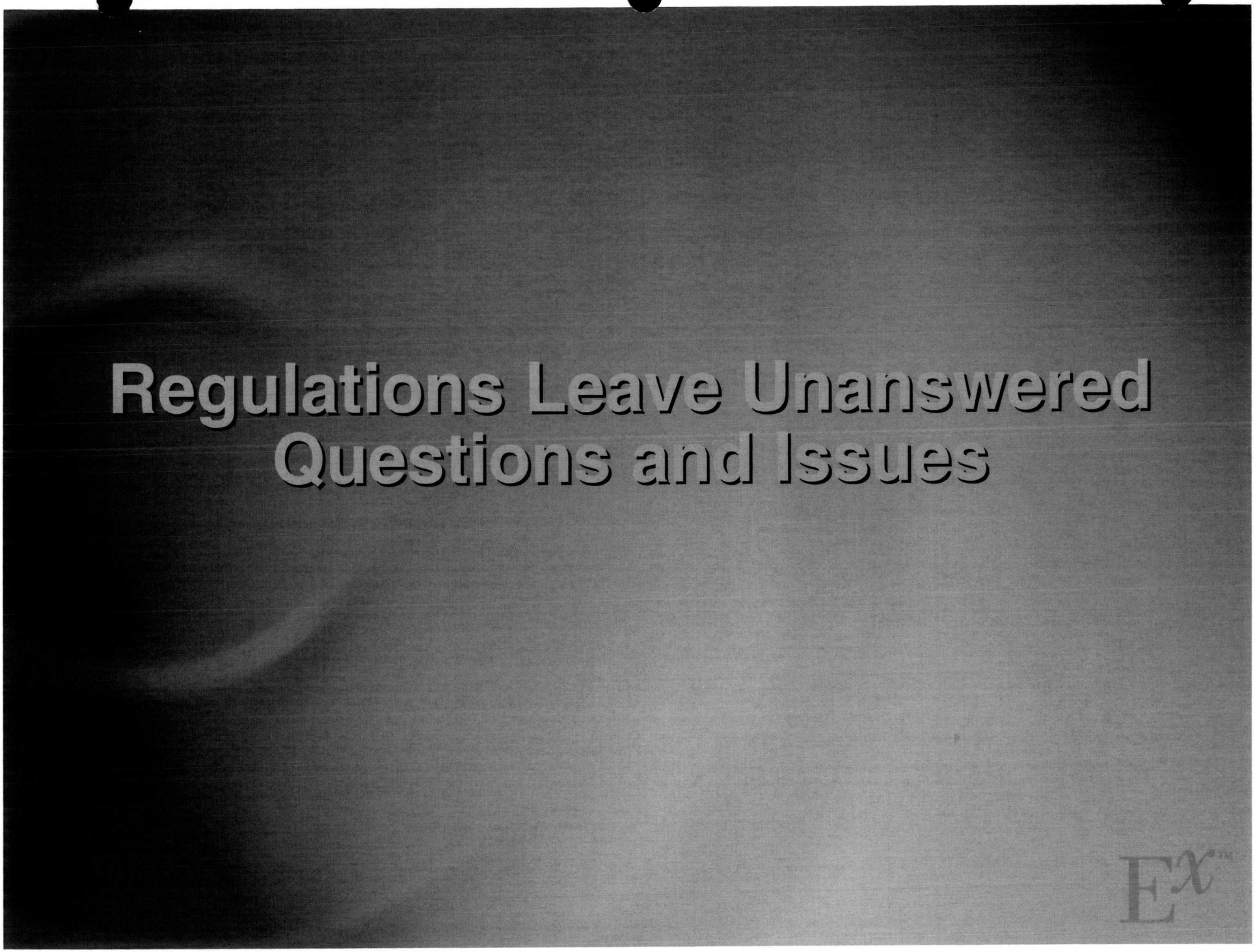
- Dr. Sublette has discussed data confirming that bioremediation of petroleum hydrocarbons occurs even at sodium concentrations of 5000 ppm in soil and higher.
- Phytotoxicity not expected when EC of soil water is < 4 mmhos/cm (or appropriate EC for the site).
- The Industry Committee has suggested a 1,000 mg/kg Tier 1 limit is acceptable.

Risk Summary

- Landfarming of crude oil and condensate impacted soils effectively eliminates toxic aromatic hydrocarbons (BTEX and Naphthalene).
- Hydrocarbons that remain after landfarming are:
  - non-toxic
  - poorly soluble
  - not environmentally mobile
- With regard to hydrocarbons, biotreated soils do not pose a risk to public health, fresh water, or the environment.

Risk Summary

- Chloride is not toxic, but is used as an indicator of water movement.
- The Industry Committee has agreed to a Tier 1 Chloride criterion of 1,000 mg/kg to move the regulatory discussion forward.
- However, results from a conservative regulatory water model indicate that substantially higher concentrations in landfarm-treated soils will not adversely affect water quality.


Regulations Leave Unanswered Questions and Issues

Proposed SWM Rule
Unanswered Questions or Issues

- TPH – Total
- 80% Reduction of TPH – Total
- Design Equivalency
- Metals
- DAF 1 verses 20
- Criteria For 3103 Wastes

ISSUE - TPH-Total

- **SWM Rule requires Operator to analyze TPH-Total by Method 418.1 or other acceptable method.**
  - ***Comment:* Different TPH methods give widely varying estimates of TPH-Total depending on type of hydrocarbons, extraction solvent, extraction method, separation method, and quantitation method.**
  - ***Recommendation:* TPH-Total is poorly correlated with risk to health, fresh water, and environment – should not be a required parameter. TPH-GRO and/or TPH-DRO (by 8015M) are the appropriate measures, depending on type of petroleum hydrocarbons present.**

Issue - 80% Reduction of TPH-Total

- **SWM Rule specifies that TPH-Total must be reduced by at least 80% before bioremediation is considered complete.**
  - ***Comment**: OCD's technical or risk basis for an 80% Total TPH criterion is unclear, but is unrelated to protection of fresh water, public health and environment.*
  - ***Comment**: It is possible that a hydrocarbon-impacted soil has reached its Bioremediation Endpoint (i.e., no risk to public health, fresh water, or environment), yet have to be excavated and transported to a landfill because TPH-Total has not been reduced 80%.*
  - ***Recommendation**: As discussed by Dr. Sublette, TPH-GRO and/or TPH-DRO (by 8015M) are appropriate measures of bioremediation effectiveness. TPH-Total is not useful and should not be measured.*

Design Equivalency

- **SWM Rule allows Operator to propose alternative to OCD's default landfarm design (BDAT), but it is not clear how Operator is to demonstrate equivalent effectiveness.**
  - ***Recommendation: Use RBDM approach to identify relevant threats to public health, fresh water, and the environment. Operator's proposed alternate design should address those threats and show that "target risks" are not exceeded.***

Metals

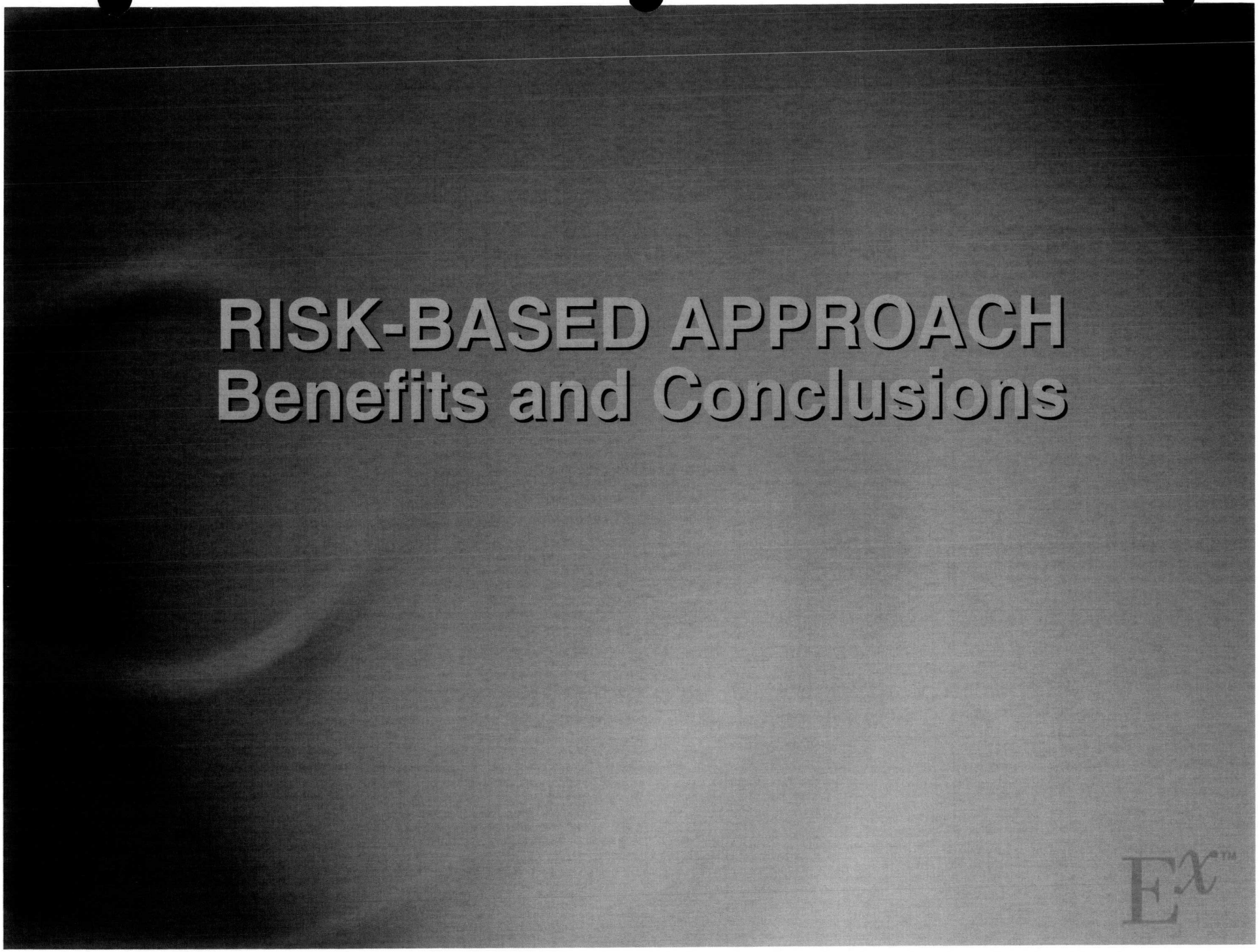
- **Commercial and centralized landfarms soil closure standards include Total Arsenic, Total Barium, Total Mercury, and other metals.**
  - ***Comment*: It is only the *soluble fraction* of a metal that is capable of environmental migration and is potentially toxic.**
  - ***Comment*: Published studies indicate that metals in crude oil- and condensate-impacted soils are present at low levels that do not pose a risk to fresh water, public health, and environment.**
  - ***Recommendation*: Measurement of metals should be based on types of wastes to be managed in a permitted commercial or centralized landfarm.**

DAF1 vs. DAF20

- **SWM Rule proposes Target Soil Closure Concentrations that are simply the lower of NMED's Residential SSL or NMED's DAF1 SSL for protection of groundwater.**
  - *Comment: Dr. Stephens discussed the many problems of adopting DAF1 value as the Tier 1 default for New Mexico…not the least of which is that precision of available laboratory methods cannot reliably estimate concentrations as low as the DAF1 SSL for many analytes – it is impossible to demonstrate compliance.*
  - *Comment: RBDM process identifies appropriate Soil Closure Concentrations for protection of groundwater.*
  - *Recommendation: OCD's Tier 1 Soil Closure Standards should be 1) Background, 2) the Practical Quantitation Limit (PQL), or 3) the lower of NMED's Residential SSL or DAF20 SSL.*

Criteria for 3103 Wastes

- **SWM Rule proposes Tier 1 Soil Closure Concentrations for 3103 wastes (e.g., chlorinated solvents, PCBs, etc.):**
  - ***Comment*: None of the listed 3103 wastes occur as natural constituents of petroleum, and none are permitted to be placed in a Landfarm.**
  - ***Recommendation*: Delete non-oilfield wastes from closure criteria.**


RISK-BASED APPROACH
Benefits and Conclusions

Risk-Based Decision Making (RBDM) is a formal process that defines:

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- Based on the above, RBDM defines the maximum allowable concentration of the chemical in soil or water such that the "target risk level" is not exceeded.

Risk-Based Decision Making (RBDM)

- **Use a tiered approach for regulation:**
  - Tier 1 – Maximum allowable concentration determined from higher of background, PQL, or either NMED Residential SSLs or NMED DAF 20 SSL; and chloride at 1000 mg/kg.
  - Tier 2 – allows certain site-specific parameters be used in the Tier 1 regulatory risk equations.
  - Tier 3 – allows an Operator to propose an alternative risk model that he believes is more appropriate for site conditions.

BENEFITS OF FORMAL RISK-BASED APPROACH TO RULEMAKING

- Provides a logical, consistent, and technically defensible thought process from which the SWM Rule can be structured and understood by all parties.
- Clearly defines OCD's reasons for requiring specific design elements, analytical data, plans, and procedures -- states OCD's intent, even if an issue is not specifically addressed in the SWM Rule.

BENEFITS OF FORMAL RISK-BASED APPROACH TO RULEMAKING

- Gives OCD and the Industry flexibility to consider site-specific conditions, as well as to reflect future changes in technology and science.

- Protects fresh water, public health, and the environment.


CONCLUSION
OCD Should Embrace RBDM