Welcome to the CLU-IN Internet Seminar

CEC Training for OSCs...Oil Spill Response (Part 1)

Sponsored by: EPA Office of Superfund Remediation and Technology Innovation

Delivered: November 6, 2013, 1:00 PM - 4:00 PM, EST (18:00-21:00 GMT)

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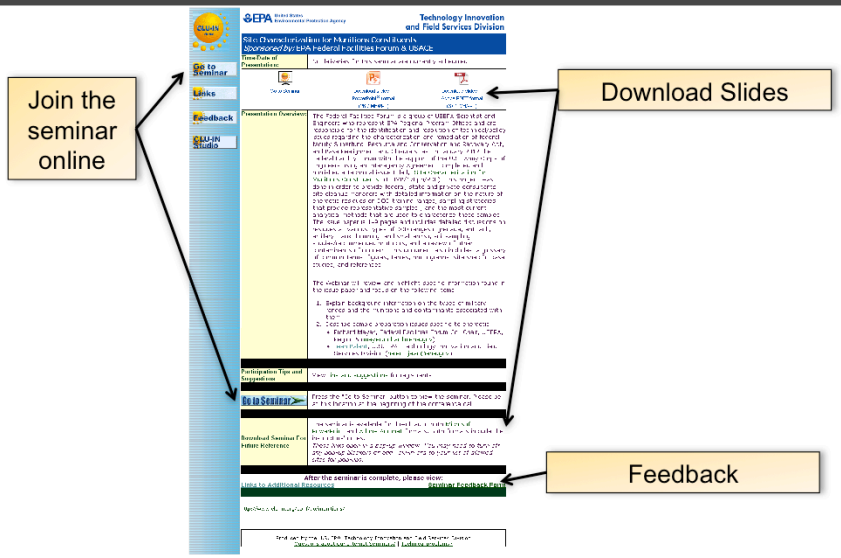
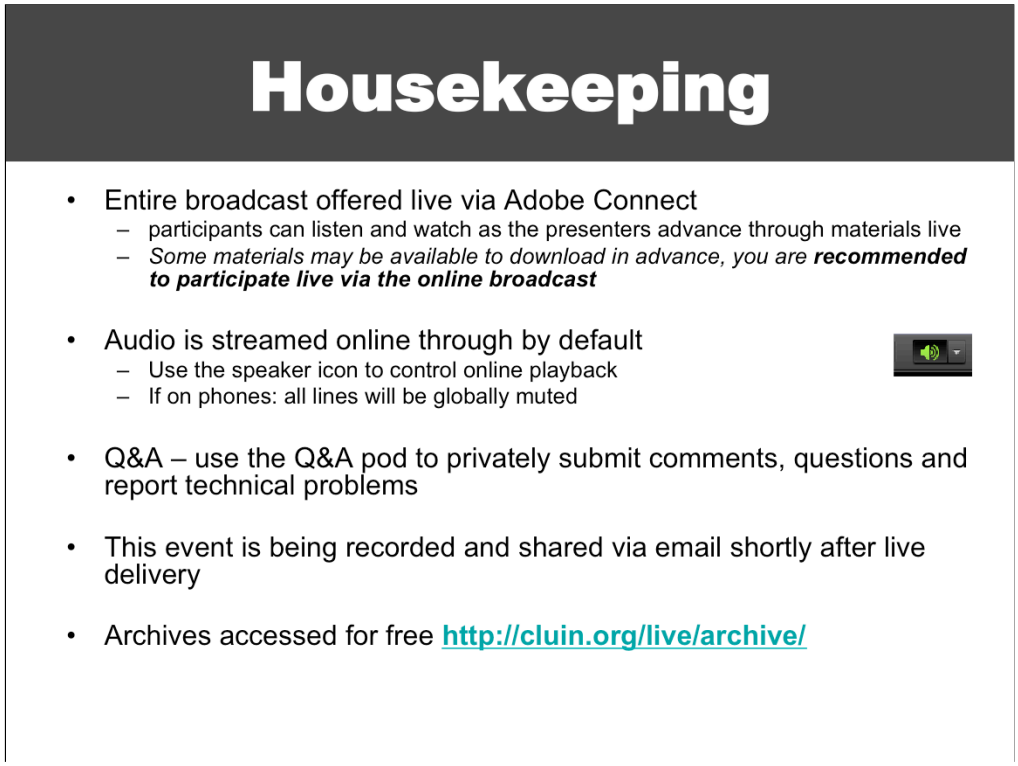
Seminar Homepage





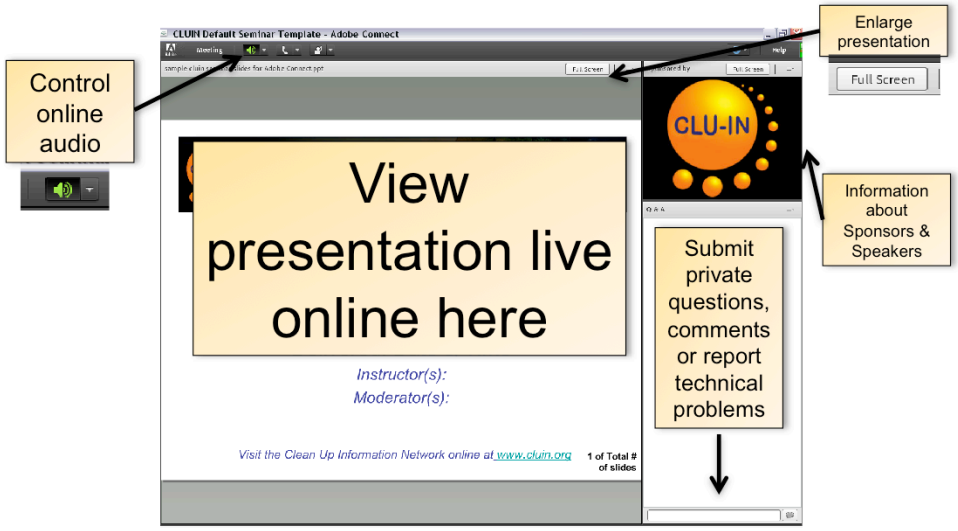
Although I'm sure that some of you have these rules memorized from previous CLU-IN events, let's run through them quickly for our new participants.

Please mute your phone lines during the seminar to minimize disruption and background noise. If you do not have a mute button, press *6 to mute #6 to unmute your lines at anytime. Also, please do NOT put this call on hold as this may bring delightful, but unwanted background music over the lines and interupt the seminar.

You should note that throughout the seminar, we will ask for your feedback. You do not need to wait for Q&A breaks to ask questions or provide comments. To submit comments/questions and report technical problems, please use the ? Icon at the top of your screen. You can move forward/backward in the slides by using the single arrow buttons (left moves back 1 slide, right moves advances 1 slide). The double arrowed buttons will take you to 1st and last slides respectively. You may also advance to any slide using the numbered links that appear on the left side of your screen. The button with a house icon will take you back to main seminar page which displays our agenda, speaker information, links to the slides and additional resources. Lastly, the button with a computer disc can be used to download and save today's presentation materials.

With that, please move to slide 3.

New online broadcast screenshot



DISCLAIMER

The purpose of this presentation is to stimulate thought and discussion.

Nothing in this presentation is intended to supersede or contravene Federal Statutes, Regulations, or Official EPA Policies.

Instructors

- Earl Liverman is an EPA On-Scene Coordinator located in the Region 10 Coeur d'Alene, Idaho, field office. Earl has been with EPA since 1991 working in the Remedial and Emergency Response and Removal programs.
- Greg Weigel is an EPA On-Scene Coordinator in Region 10. Greg is located in a field office in Boise, Idaho, where he has served as an OSC for the past 18 years.
- Doug Kodama is a Section Chief in EPA Region 2, serving New York, New Jersey, Puerto Rico and the US Virgin Islands. Doug has been with EPA since 1986 working in the Emergency Response and Oil Spill preparedness and prevention programs.
- Jim Mullins works part time for TetraTech, a support contractor to EPA. Jim retired from the EPA Region 6 Dallas TX office after working 25 years in oil spill and hazardous waste response programs.

Oil Spill Response - I

Earl Liverman, Doug Kodama, Greg Weigel,
and Jim Mullins

EPA United States Environmental Protection Agency

16th Annual OSC Readiness Training Program

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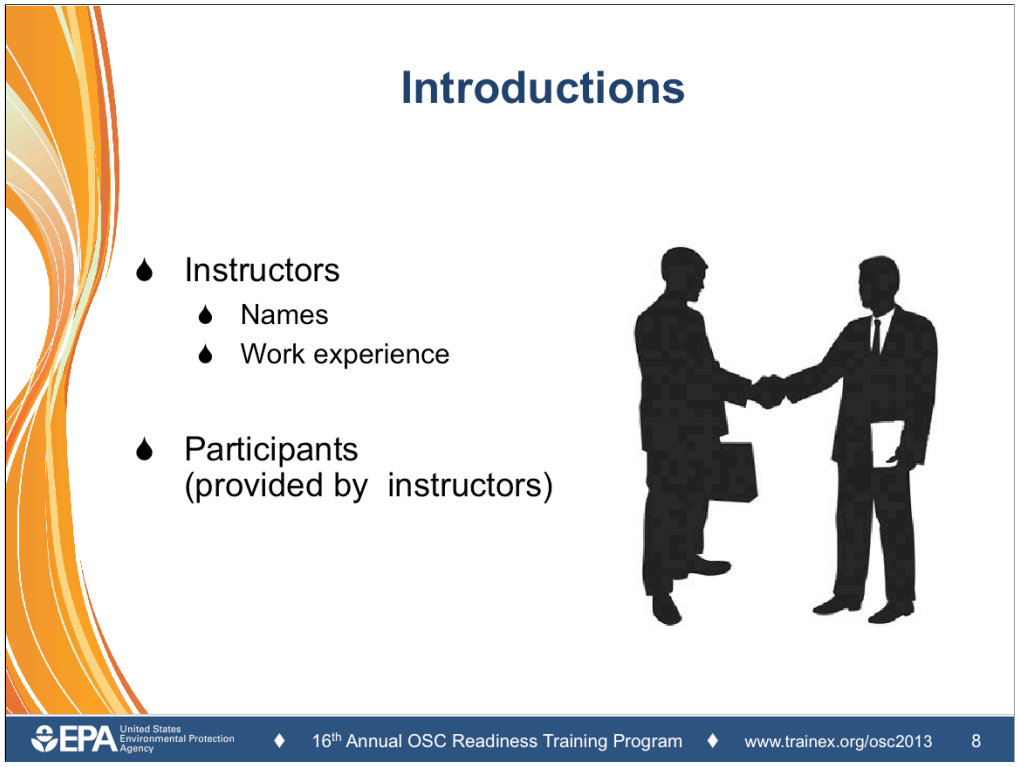


- This course is intended to provide only a broad overview of many, but not all, concerns/issues potentially associated with the vast field of oil spill response

- Note national and international diversity of participants

AGENDA – Day 1
Wednesday, 6 November 2013

- Course Overview
- I. Statutory and Regulatory Authority
- II. Oil Spill Liability Trust Fund
- III. What is Oil?
- IV. Fate and Behavior of Oil in the Environment
- V. Factors Affecting Response and Cleanup Decisions

AGENDA – Day 2
Thursday, 7 November 2012

- VI. Statutory and Regulatory Authority Thresholds for Response to Oil Spills
- VII. Oil Spill Management
- VIII. Oil Spill Response Techniques
- IX. Disposal of Oil and Oily Debris
- X. Summary Statement

Course Overview

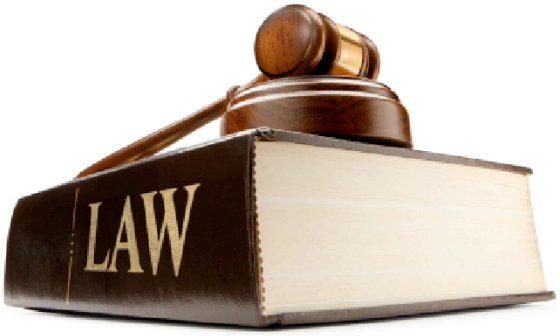
- Better understand the statutory and regulatory authority for responding to an oil spill
- Gain an awareness of the Oil Spill Liability Trust Fund
- Better understand the definition of oil and the fate and behavior of oil in the environment
- Gain an awareness of the effect of oil spills on human health, environment, and wildlife
- Gain an awareness of the environmental and human factors affecting cleanup decisions

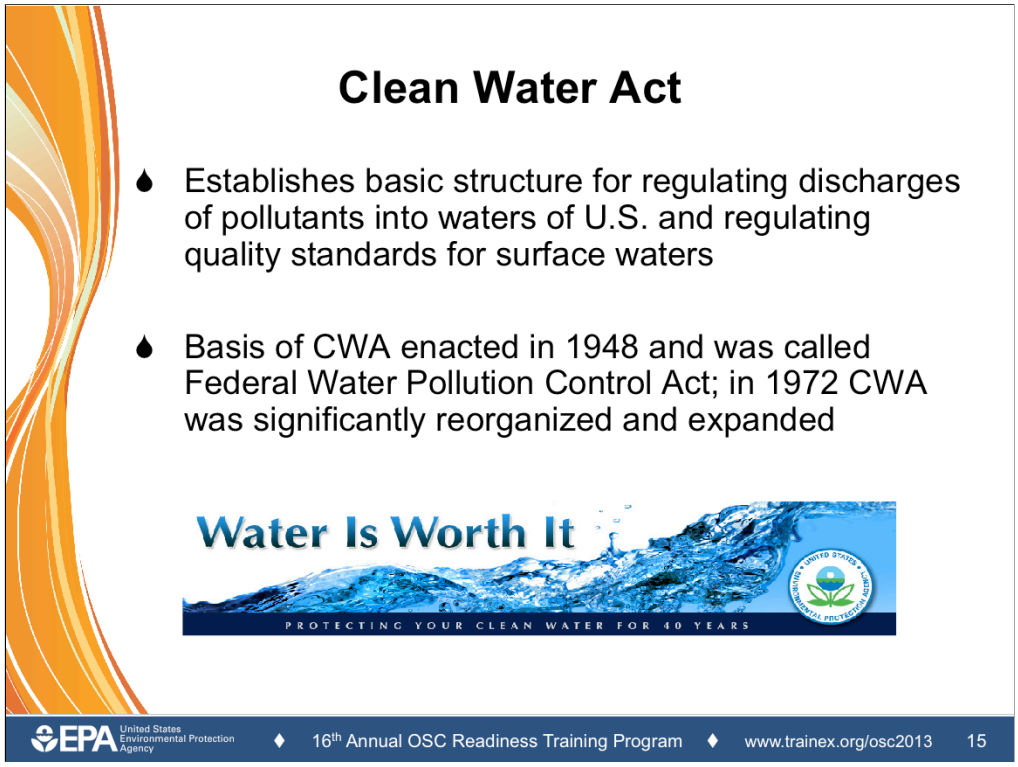
Course Overview . . .

- Better understand the main tasks an OSC is responsible for during an oil spill response
- Better understand the statutory and regulatory thresholds for Response to Oil Spills
- Gain an awareness of oil spill response techniques
- Better understand how to dispose of oil and oily debris


TIME FOR QUESTIONS

I. Statutory and Regulatory Authority





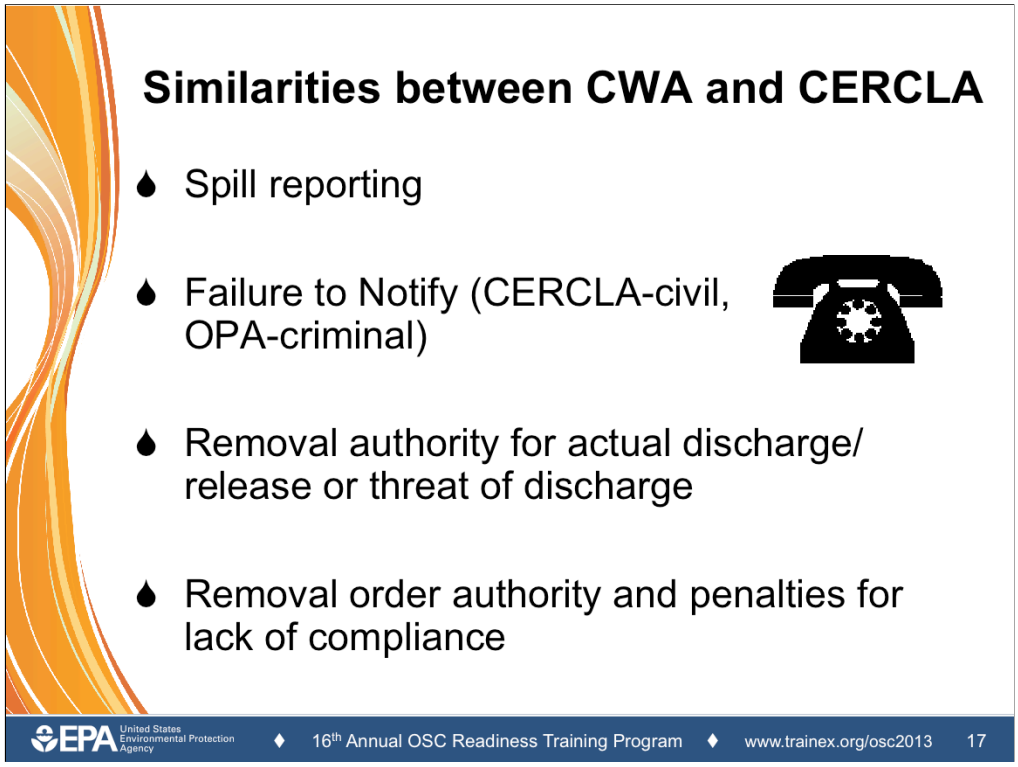
• Most participants in this class do not have a good sense of the staggering water pollution of the late 1960's early 1970's.. An Ohio river caught on fire a number of times. This (and other gross pollution events) stimulated mass demonstrations. Up to 20 million Americans were involved. Because apx 10% of the population of USA was demonstrably angry, President Nixon created US EPA and the Clean Water Act was passed by Congress...both in the early 1970's

• https://www.youtube.com/watch?feature=endscreen&NR=1&v=nlHiaZFvcXA

Oil Pollution Act of 1990

- Expanded prevention and preparedness activities
- Strengthened federal response authorities
- Expanded the scope of liability for responsible parties (RPs)
- Increased the liability limits applicable to spill incidents
- Established a new Oil Spill Liability Trust Fund (OSLTF)

United States Coast Guard
U.S. Department of Homeland Security



• Mention that the Comprehensive Environmental Response, Compensation, and Liability Act provides a comprehensive group of authorities focused on one main goal: to address any release or threatened release of hazardous substances, pollutants, or contaminants that could endanger human health and/or the environment. CERCLA's response provisions focus on human health and the environment.

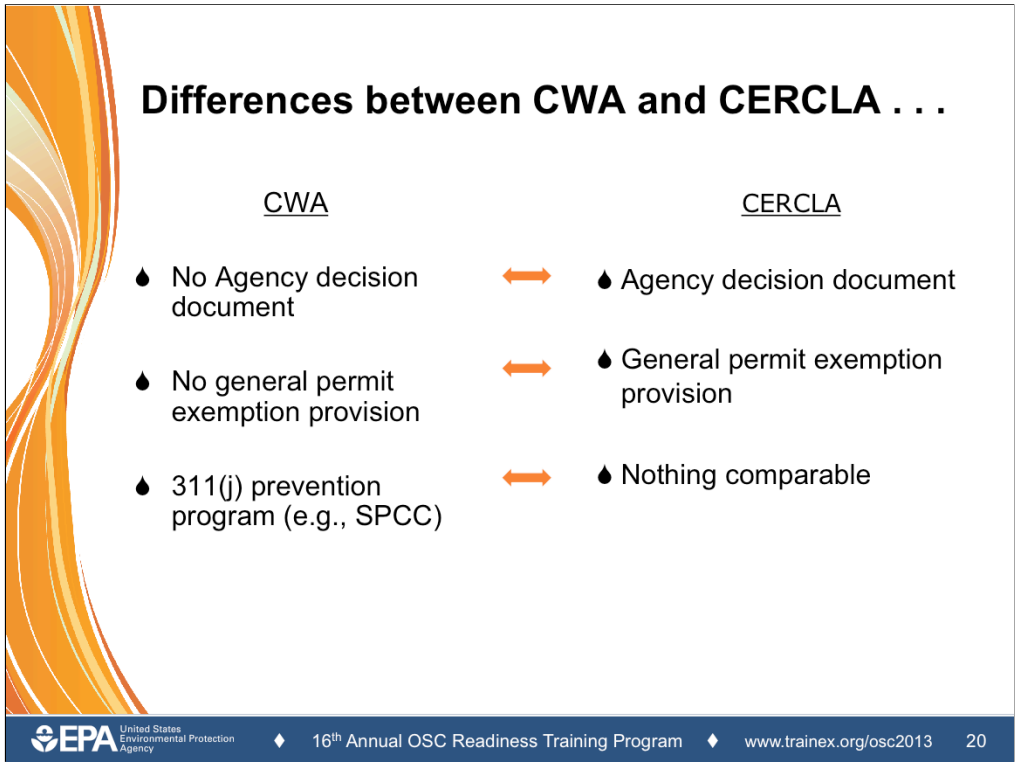
• Explain why the following slides discuss the similarities and differences between CWA and CERCLA

Similarities between CWA and CERCLA . . .

- Liability provisions and cost recovery provisions ("polluter pays")
- Both have trust fund allowing direct government cleanup action
- United States Coast Guard (USCG) does cost recovery for CWA/OSLTF while EPA does for CERCLA
- Both CERCLA and oil removals must be consistent with the NCP
- Similar natural resource provisions

Differences between CWA and CERCLA

CWA		CERCLA
CWA/OPA addresses navigable waters and adjoining shorelines	⟷	Addresses any environmental media
OPA has third party claims	⟷	Does not
Requirement for preparedness at a facility and governmental level	⟷	Response and cleanup


Differences between CWA and CERCLA . . .
CWA
CERCLA
No Agency decision document
Agency decision document
No general permit exemption provision
General permit exemption provision
311(j) prevention program (e.g., SPCC)
Nothing comparable
EPA United States Environmental Protection Agency
16th Annual OSC Readiness Training Program
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Differences between CWA and CERCLA . . .

CWA		CERCLA
Significant administrative and civil judicial penalty assessments for the prohibited discharge of oil or CWA hazardous substances	⟷	Does not have
States may access the fund through Pollution Removal Funding Agreements (PRFAs) or direct access approved by the OSC	⟷	Federal tool

⟵ FUNDING ⟶

Discharge of Oil Regulation
(40 CFR 110)

- Discharge of Oil regulation, commonly known as "sheen rule," establishes criteria for determining whether an oil spill may be harmful to public health or welfare as follows:
  - Discharges that cause a sheen or discoloration on the surface of a body of water
  - Discharges that violate applicable water quality standards
  - Discharges that cause a sludge or emulsion to be deposited beneath the surface of the water or on adjoining shorelines

Discharge of Oil Regulation . . .

- *Sheen* means an iridescent appearance on the surface of water
- *Sludge* means an aggregate of oil or oil and other matter of any kind in any form other than dredged spoil having a combined specific gravity equivalent to or greater than water

National Oil and Hazardous Substances Pollution Contingency Plan

- National Oil and Hazardous Substances Pollution Contingency Plan (NCP) was established in 1968 and amended by the CWA and CERCLA
- Promotes overall coordination of the hierarchy of responders and establishes procedures for conducting responses for oil and hazardous substances
- Designates the OSC as the manager of spills of oil and removal response for hazardous substances

Key Provisions of the NCP

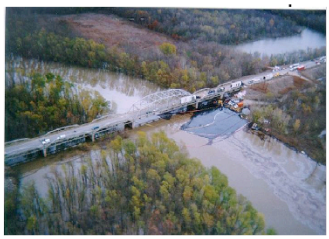
- §300.120 – Establishes general responsibilities of federal On-Scene Coordinators
- §300.135(a) – Authorizes pre-designated OSC to direct all federal, state, and private response activities at the site of a discharge
- §300.135(d) – Establishes unified command structure for managing responses to discharges
- §300.175 – Lists federal agencies that have duties associated with responding to releases

Key Provisions of the NCP Related to Oil Removal

- 300.317 - Establishes national priorities for responding to a discharge
- §§300.320 - Establishes the general pattern of response to be executed by the OSC, including determination of threat, classification of the size and type of the release, notification of the RRT and the NRC, and supervision of thorough removal actions

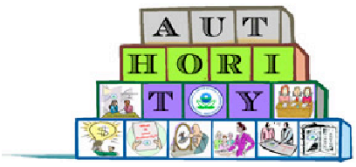
Key Provisions of the NCP related to Oil Removal . . .

- §300.322 - Authorizes the OSC to determine whether a discharge poses a substantial threat to the public health or welfare of the United States based on several factors
- §300.323 - Provides special consideration to discharges which have been classified as a spill of national significance
- §300.355 - Provides funding for responses to oil discharges under the OSTLF, provided certain criteria are met
- Subpart J – Product Schedule (dispersants and other chemical biological products)
- Appendix E to Part 300 – Oil Spill Response



FOSC Removal Authority

- Clean Water Act Section 311(c)
  - Statutory Authority



- Executive Order 12777
  - Delegates Statutory Authority to Executive Branch
- Delegation 2-89
  - Removal of Discharge or Threat of Discharge
  - Delegates EPA's Authorities to OSCs

• Delegations may vary a bit from Region to Region . . . refer to Regional delegations memoranda

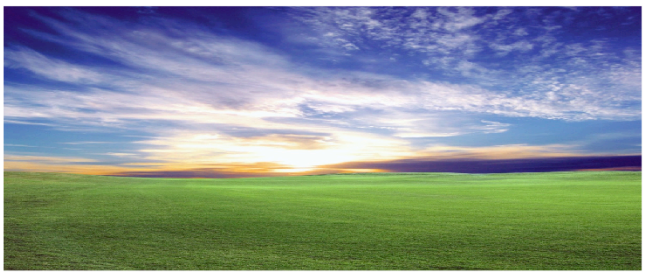
FOSC Removal Authority . . .

(from Delegation 2-89)

- To remove or arrange for the removal of a discharge and to mitigate or prevent a substantial threat of a discharge
- To direct or monitor all Federal, State, and private actions
- To remove and, if necessary, destroy a vessel that is discharging or threatening to discharge
- To consult with affected natural resource trustees
- To determine when the removal is complete

Trust Natural Resource

- OPA and CERCLA define natural resources broadly to include land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources [CERCLA §101(16); OPA §1001(20); 40 CFR 300.5]



Trust Natural Resource . . .

- Both statutes limit natural resources to those resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any, State, an Indian Tribe, a local government, or a foreign government

Natural Resource Trustees

- **Federal** - Secretaries of Agriculture, Commerce, Defense, Energy, Interior (40 CFR 300.600)
- **State** - designated by the Governor (40 CFR 300.605)
- **Tribal** - designated by Tribal Chairperson or the Secretary of the Interior may serve as trustee at request of the tribe (40 CFR 300.610)
- **Other** – Under OPA, foreign officials can also act as Trustee (40 CFR 300.612)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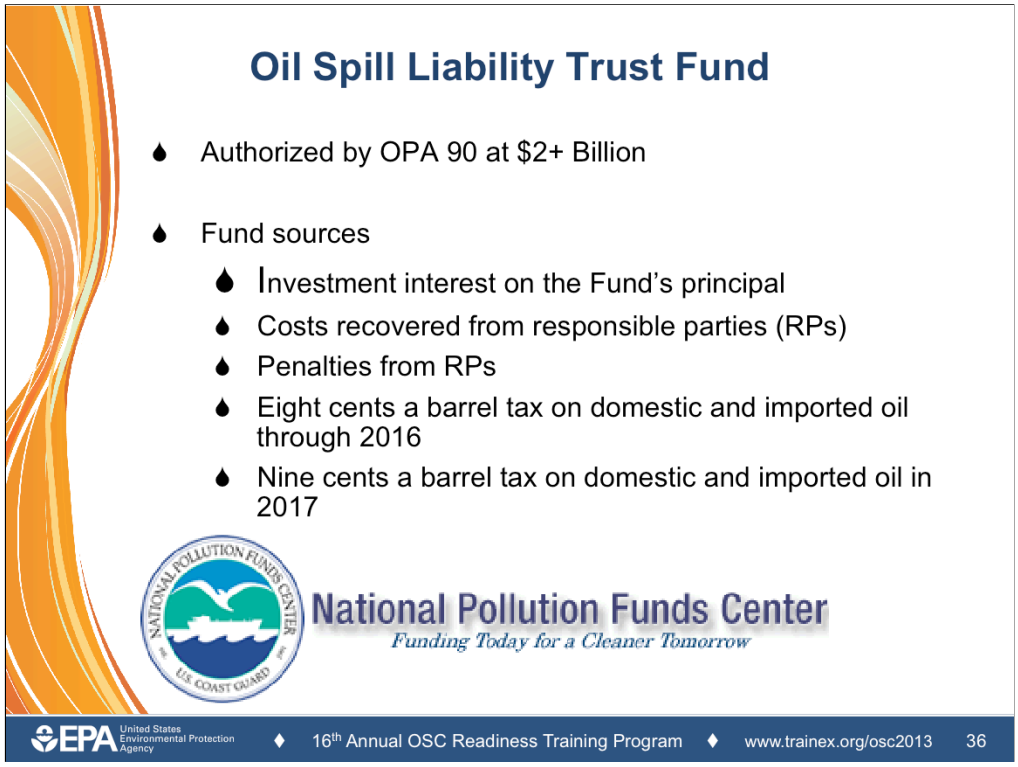
II. Oil Spill Liability Trust Fund



The Principal Fund of the OSLTF has several recurring and nonrecurring sources of revenue.

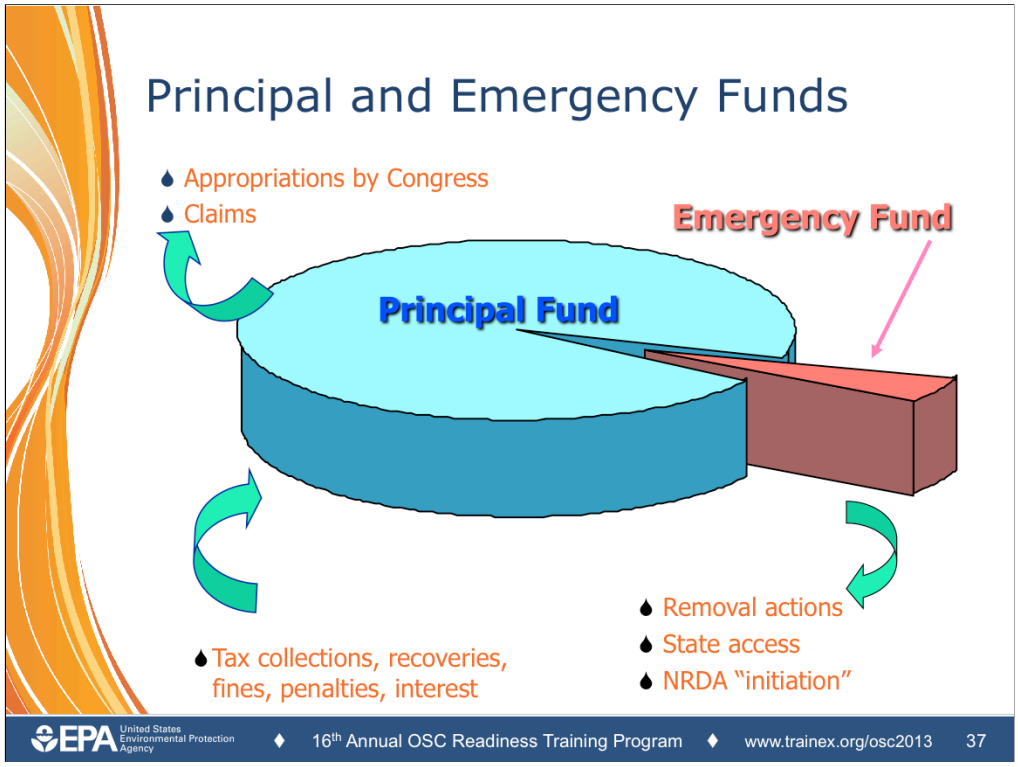
- **Barrel Tax**. The largest source of revenue has been a per-barrel excise tax, collected from the oil industry on petroleum produced in or imported to the United States

- **Transfers**. A second major source of revenue has been transfers from other existing pollution funds

- **Interest**. A recurring source of OSLTF revenue is the interest on the Fund principal from U.S. Treasury investments

- **Cost Recoveries**. Another source is cost recoveries from responsible parties (RPs); those responsible for oil incidents are liable for costs and damages. NPFC bills RPs to recover costs expended by the Fund. As these monies are recovered, they are deposited into the Fund

- **Penalties**. In addition to paying for clean-up costs, RPs may incur fines and civil penalties under OPA, the Federal Water Pollution Control Act, the Deepwater Port Act, and the Trans-Alaska Pipeline Authorization Act. Penalty deposits into the OSLTF are generally between $4 million and $7 million per year.

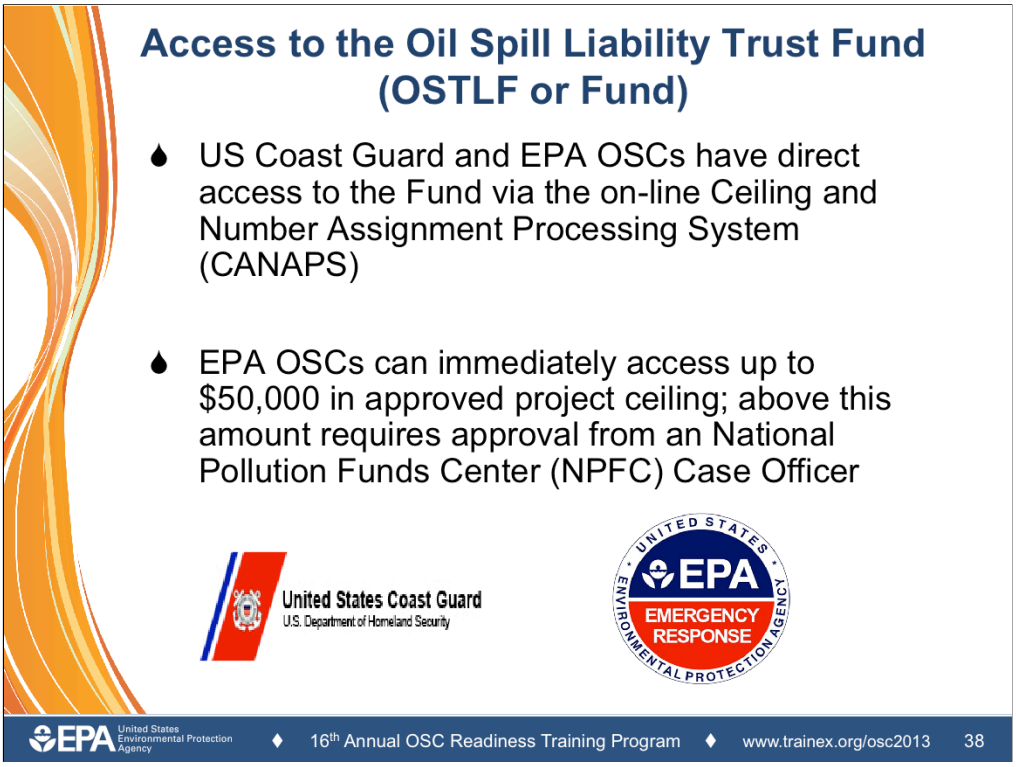


Emergency Fund

- A core mission of the NPFC is to administer the disbursement and ensure proper use of the Emergency Fund, 24 hours a day, every day, so that the FOSC can immediately respond to a discharge or monitor prompt and effective cleanup activities by the responsible party (RP)

- The Emergency Fund can be used by FOSCs to cover expenses associated with mitigating the threat of an oil spill, as well as the costs of oil spill containment, countermeasures, cleanup, and disposal activities

- While the use of the OSLTF is most closely associated with discharges from ships, it has increasingly been used for discharges at industrial or onshore oil storage and production facilities.



- All who access (listed above) use CANAPS

Threshold Criteria for Accessing the OSTLF

- The substance involved an oil
- There a discharge or substantial threat of discharge into navigable waters or adjoining shorelines
- The removal actions consistent with the NCP

- PRFA issued by OSC

- Images - WA Department of Ecology:

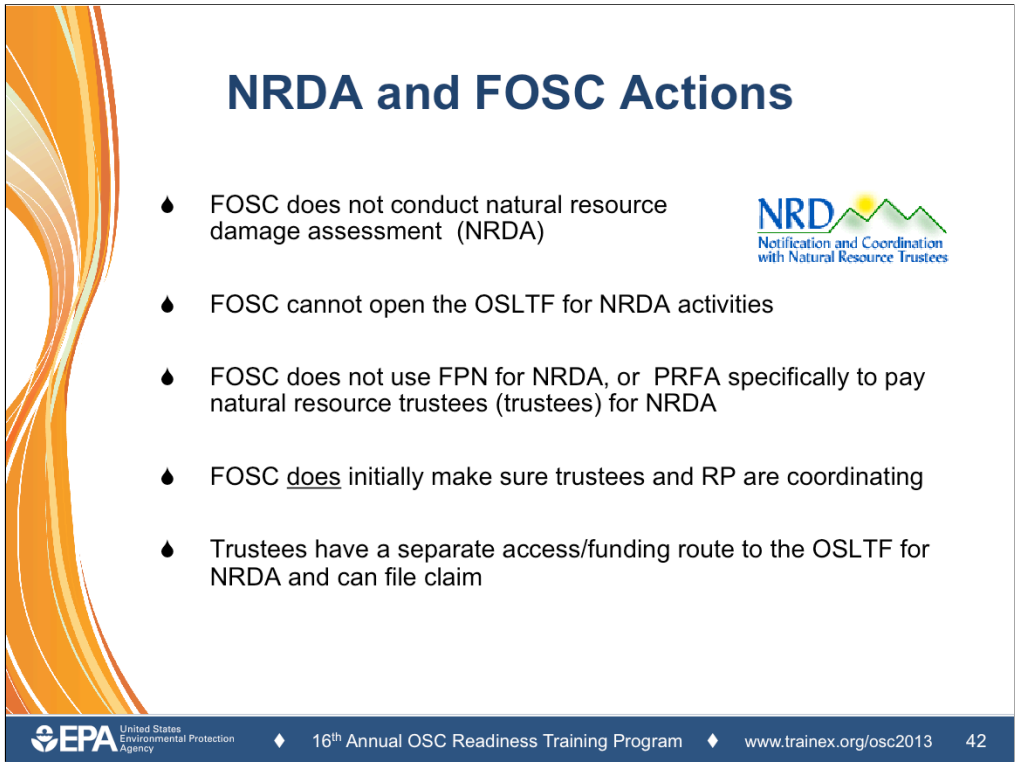
  - Hoquiam River, abandoned fishing vessel diesel spill into river from fuel tanks

  - State and their local contractor respond to spill within 1 hour

Emergency Response Costs funded by OSLTF

- Oil spill assessment by OSC
- Oil spill response conducted, overseen, or directed by an OSC, including:
  - EPA or Coast Guard response and oversight costs
  - State direct access costs
  - Costs for other federal, state, tribal, or local agency authorized by a PRFA

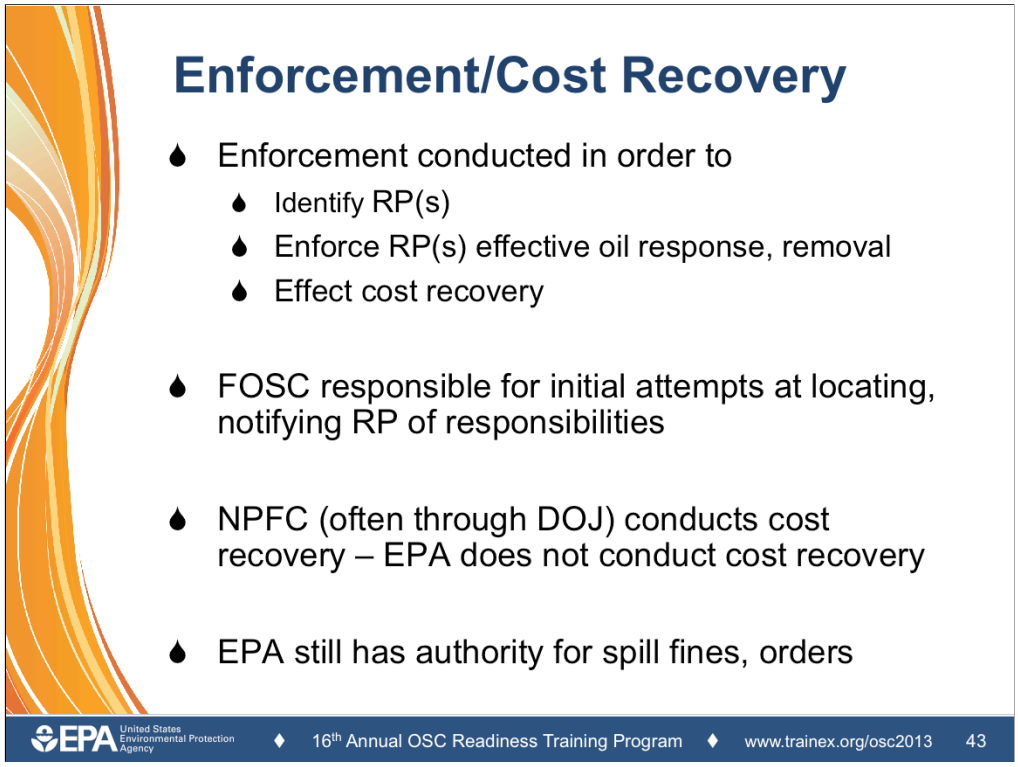
- NRDA "initiation"



• Part of OSC responsibility per the NCP is to notify Natural Resources Trustees whose administered resources are impacted or potentially impacted by the spill (e.g., NOAA Fisheries, U.S. F&W, Federal land management agencies, Tribes).

• OSC may also need to initiate emergency consultation per the Endangered Species Act, or National Historic Preservation Act.

•Costs for these efforts are appropriately funded under the FPN. However, the OSC cannot fund NRDA activities, even though the same agencies and personnel might be involved. Must separate out those activities and costs from “response” costs.



• Expectation—EPA OSCs must “set up” elements of an OSLTF cost recovery case.

OSLTF Funding Scenarios

Scenario I

- All that remains of an abandoned oil field is 3 waste pits filled with of oily waste; the pits drain to a nearby wetland
- EPA will close the pits due to frequent oil discharges to the wetland and harm to migratory waterfowl

- Pits 1 and 2 are filled with oil and water, while Pit 3 is known to contain F001 waste
- Can all three pit closures be funded by OSLTF?

- F001 waste – non-specific spent solvent---designated hazardous substance

Answer

- Yes: Pits 1 and 2 may be closed using the OSLTF
- No: Pit 3 has F001 and must be closed under CERCLA

Scenario II

- Leaking underground gasoline tank near Mojave, CA has contaminated 16 residential drinking water wells in a nearby subdivision
- Nearest navigable water is more than 5 miles away
- Can OSLTF be used for a temporary bottled water supply? Could carbon filters be installed on each well?

Answer

- No . . . must have clear nexus to navigable water

Scenario III

- A tractor trailer wreck released 8,000 gallons of red-dyed diesel fuel to roadside ditch
- Could the OSLTF be used to cleanup the diesel-contaminated soil?

Answer

- Maybe . . . must have clear nexus to navigable water


TIME FOR QUESTIONS

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III. What is Oil?

Regulatory and Statutory Definitions of Oil

- 40 CFR § 300.5. Oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil

Regulatory and Statutory Definitions of Oil . . .

- Oil, as defined by section 1001 of OPA means oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil, but does not include petroleum, including crude oil or any fraction thereof, which is specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of section 101(14) of CERCLA and which is subject to the provisions of that Act

Regulatory and Statutory Definitions of Oil . . .

- 40 CFR § 112.2. Definitions. Oil means oil of any kind or in any form, including, but not limited to: fats, oils, or greases of animal, fish, or marine mammal origin; vegetable oils, including oils from seeds, nuts, fruits, or kernels; and, other oils and greases, including petroleum, fuel oil, sludge, synthetic oils, mineral oils, oil refuse, or oil mixed with wastes other than dredged spoil

Black Gold

Regulatory and Statutory Definitions of Oil . . .

- 40 CFR § 112.2. Definitions. Non-petroleum oil means oil of any kind that is not petroleum-based, including but not limited to: Fats, oils, and greases of animal, fish, or marine mammal origin; and vegetable oils, including oils from seeds, nuts, fruits, and kernels




- Fish oil capsules
- Bottles of cooking oil
- Grape seed oil
- Lavender oil

Regulatory and Statutory Definitions of Oil . . .

- Common phrase

  ". . . oil of any kind in any form . . ."

- The statute language defines oils as broadly and comprehensively as possible
- No definitive, specific EPA list of what constitutes an oil or EPA Guidance

What is Not an Oil

- Coal Tar "waste" from former manufactured gas plants

- Creosote "Waste" from Wood Treatment Facilities
- Tires, unless they're burning and by "pyrolysis" creating an oil discharge

- CERCLA Hazardous Substances
- Listed CWA Hazardous Substances (40 CFR 116)

- Natural Gas

•These area things that may appear to be/contain oil…..but are not
• Tires are controversial . . . tires are ABS plastics made from acrylonitrile, butadiene, styrene

• Pyrolytic decomposition will break tires down to liquid forms of these chemicals

• NPFC may (appropriately) elect to request OSC get funding through CERCLA

CERCLA Petroleum Exclusion

- Petroleum is defined not to be a "hazardous substance" or "pollutant or contaminant"

CERCLA 101(14)(A) through (F) and the NCP specifically excludes crude oil and natural gas. "The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance … and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas)"

CERCLA Petroleum Exclusion . . .

- The term “petroleum” also includes hazardous substances normally mixed with or added to crude oil or crude oil fractions as part of the refining process (even if their concentrations changed)

HOWEVER,

- Hazardous substances that are added to, or increase in concentration as a result of contamination during use are NOT considered part of petroleum and are covered by CERCLA

CERCLA Petroleum Exclusion . . .

- What does this mean for the FOSC when handling oil spills? Some examples:
  - Cannot use CERCLA to handle a crude oil spill because there is benzene in it
  - Cannot use CWA/OPA to handle an oil-based pesticide spill or mixed waste spill
- EPA petroleum exclusion website:

  http://www.epa.gov./emergencies/content/reporting/faqsubs.htm#exclusion

Mixed Substances

- OPA excludes use of Fund for CERCLA hazardous substances
- CWA definition of oil includes ". . . oil mixed with waste other than dredged spoil . . ."
- EPA is united on how to address mixed substances, and has developed a position paper on "Mixed Substance Spills"

Mixed Substances . . .

- Oil with a “minor” amount of hazardous substance(s) is an oil
- EPA will use the “primary threat posed by the material” to determine which authority/fund to use
- If concentration(s) of CERCLA hazardous substance(s) do not independently meet eligibility factors for a CERCLA removal action listed in 40 CFR 300.415(b)(2), material will be considered oil and EPA will use CWA authority and OPA funding

Is it oil, or not?
EPA Position Paper states:

- OSCs must make “swift, field determinations”
- Use readily available information regarding source of oil (RP, State, locals)
- If source is unknown . . . use “physical behavior of the material and any observed adverse environmental effects”


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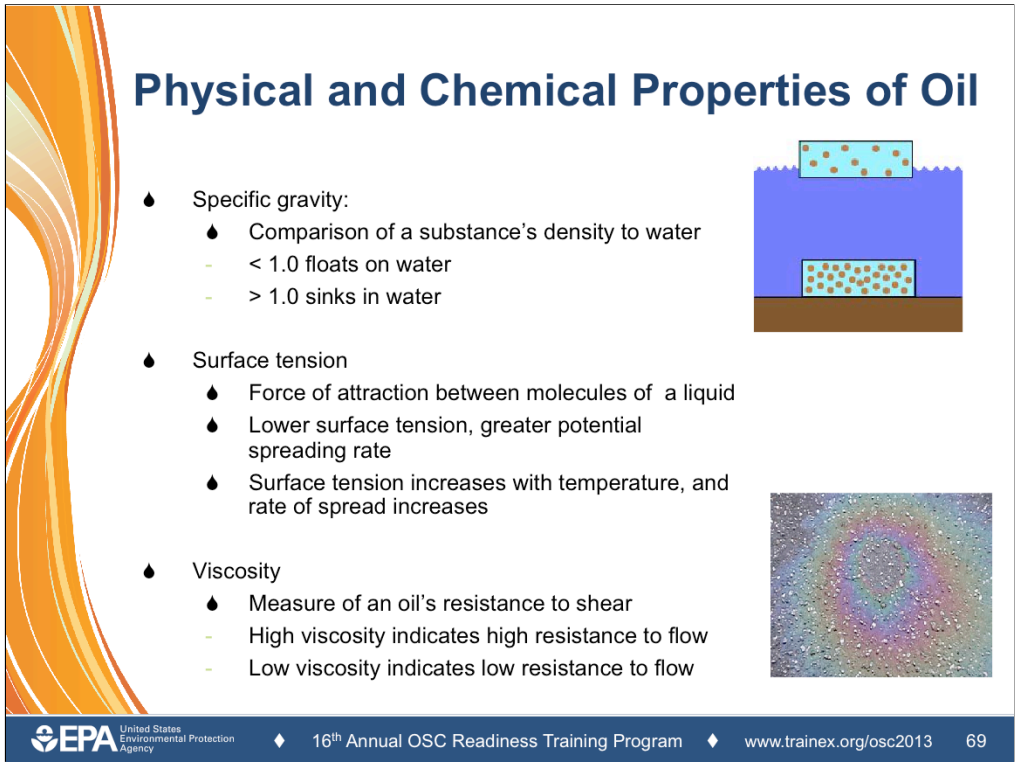
IV. Fate and Behavior of Oil in the Environment



- Ask students why properties are important to cleanup

- ***Specific gravity*** → Oil is on top or bottom of water column

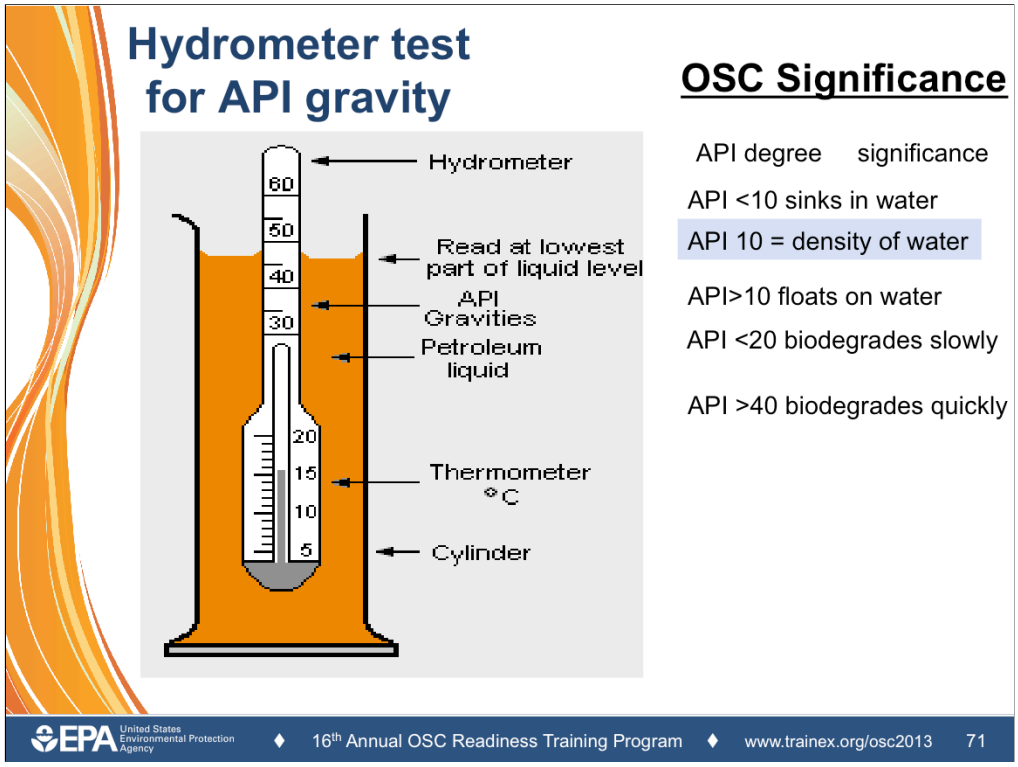
- ***Surface tension*** → Influences spreading rate of oil

- ***Viscosity*** → influences spreading rate of the oil slick; the stickiness of the oil; the oil's penetration into soil or beaches; and ability of pumps to remove/move oil

-

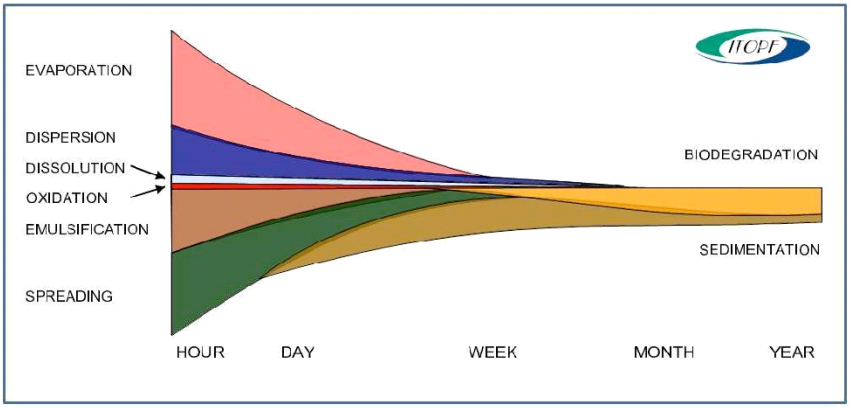
Physical and Chemical Properties of Oil . . .

- Pour point
  - Lowest temperature at which oil will pour or flow
  - Overrides effects of viscosity and surface tension
- Flash point
  - Temperature at which an oil's vapors will ignite
- Solubility
  - Amount of oil that can dissolve in a particular solvent

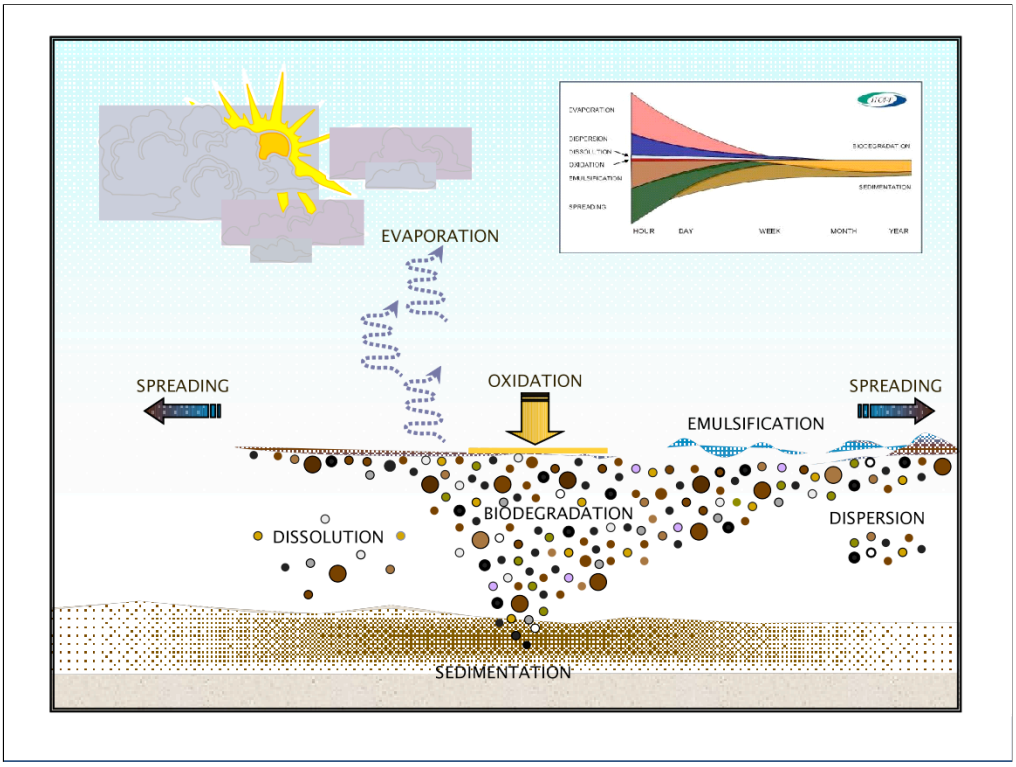


- API gravity . . . quick accurate test of petroleum density
- Higher numbers are lighter oils (more light ends) and lower

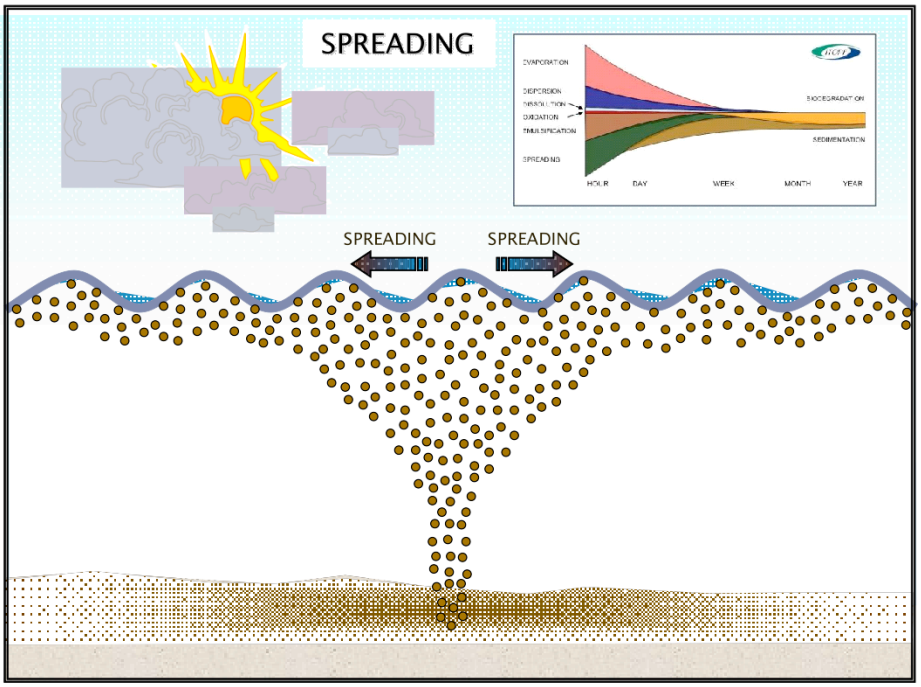
Characteristics of Oil After a release

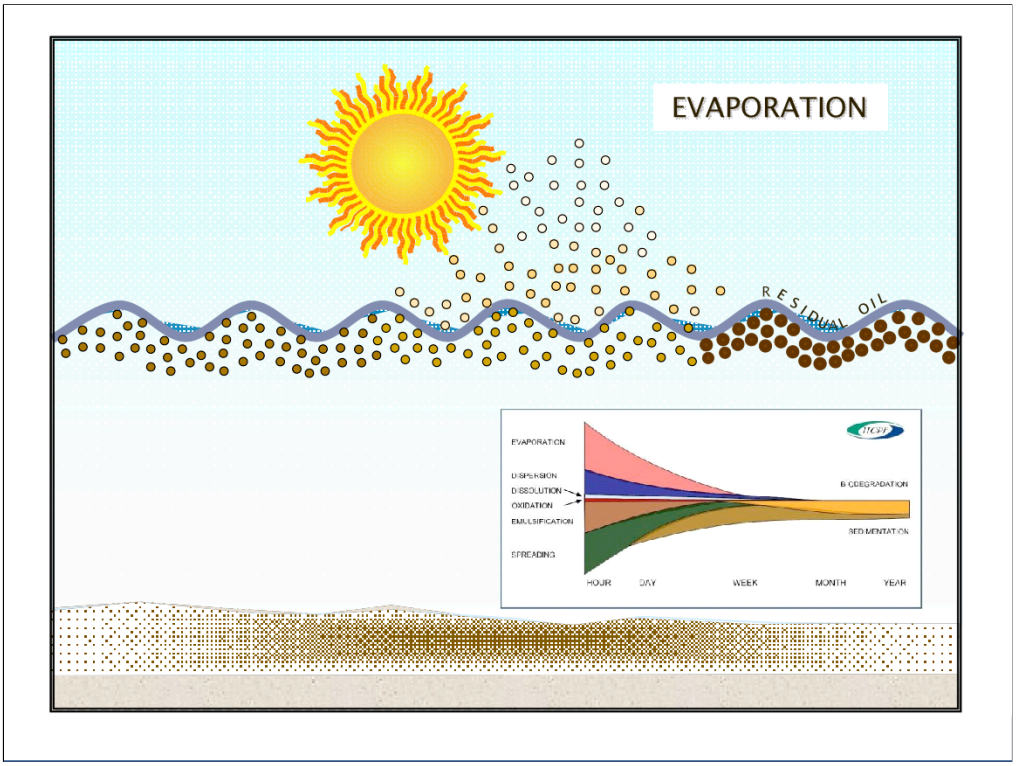


Source: International Tanker Owners Pollution Federation Ltd

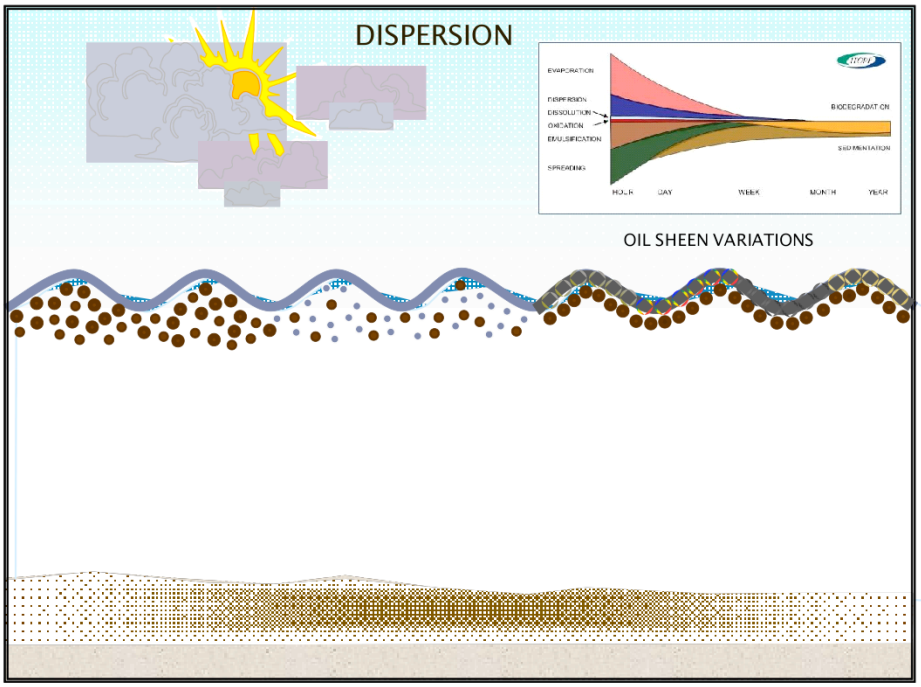


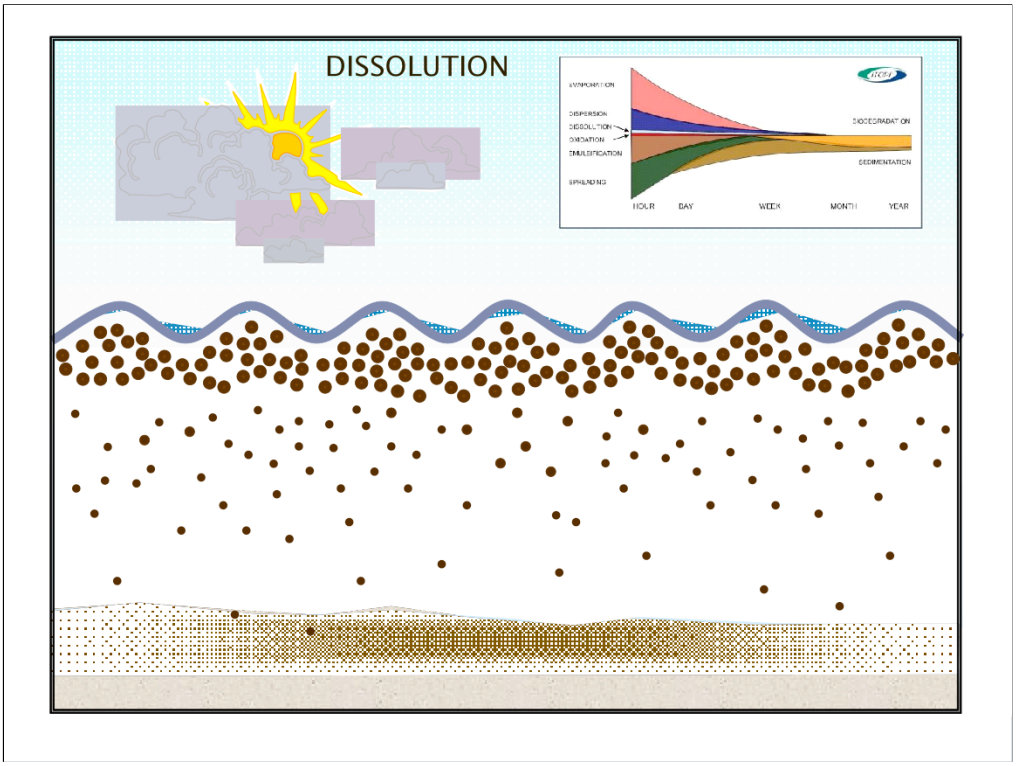
- Depicts weathering processes, including spreading, evaporation, dispersion, dissolution, oxidation, emulsification, sedimentation, and microbial degradation


SPREADING
EVAPORATION
DISPERSION
DISSOLUTION
OXIDATION
EMULSIFICATION
SPREADING
BIODEGRADATION
SEDIMENTATION
HOUR
DAY
WEEK
MONTH
YEAR
SPREADING
SPREADING

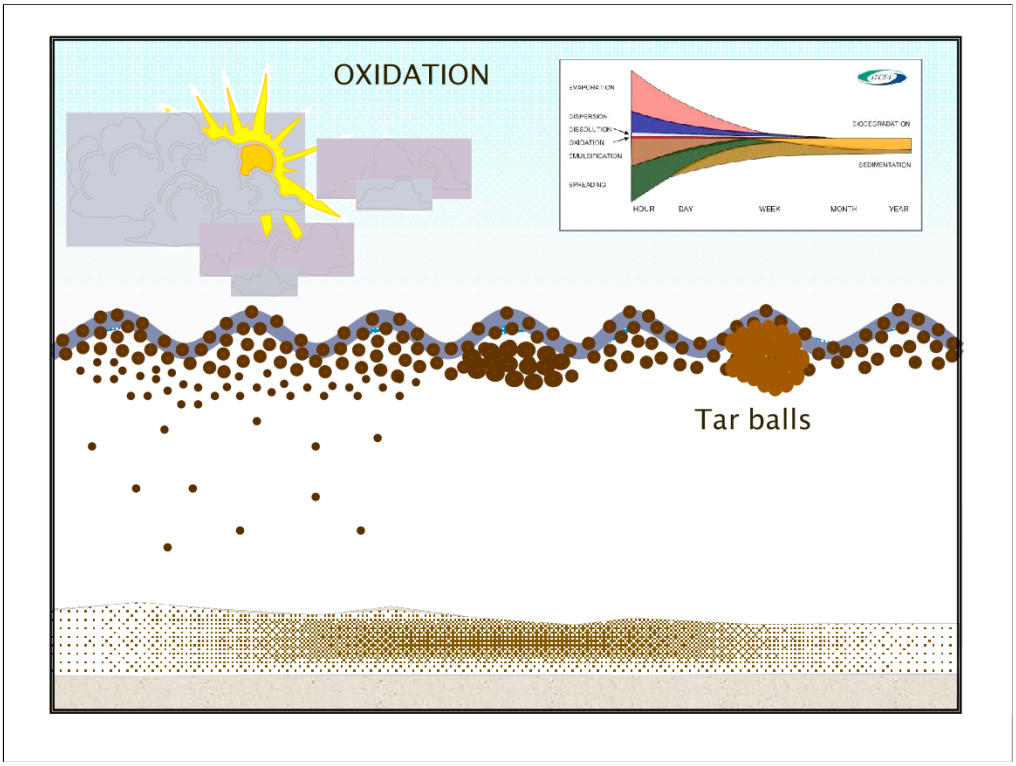


- Loss of lighter fractions to surrounding atmosphere
- Influenced by type of oil, air and water temperature, wave action

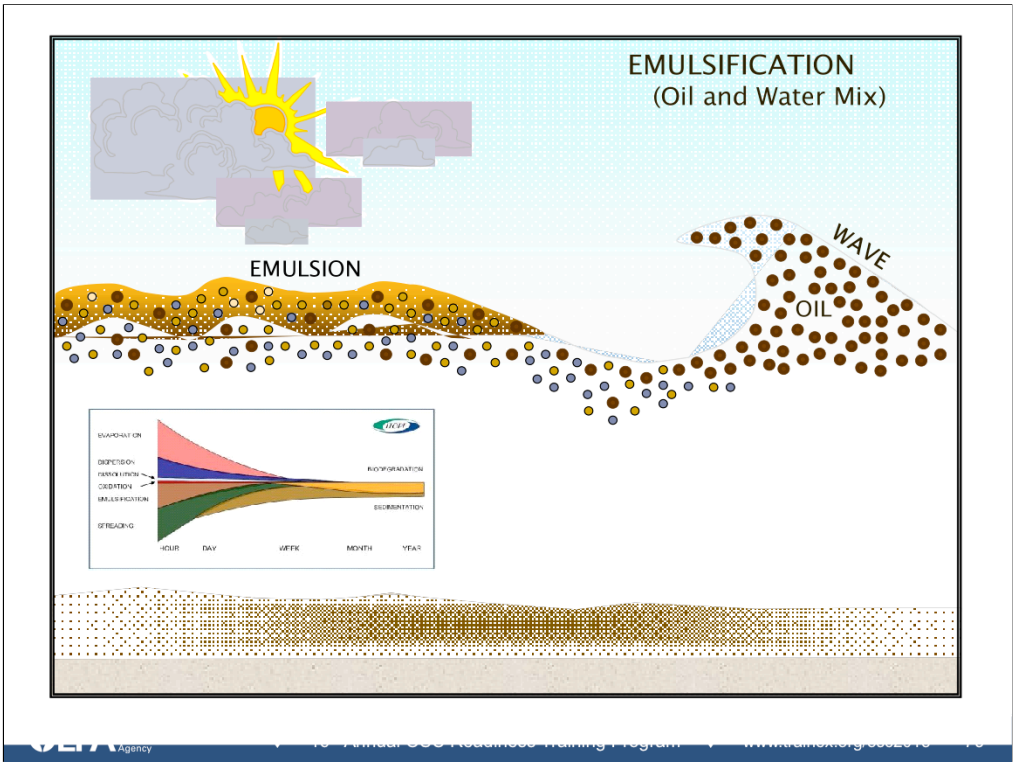

DISPERSION
EVAPORATION
DISPERSION
DISSOLUTION
OXIDATION
EMULSIFICATION
SPREADING
BIODEGRADATION
SEDIMENTATION
HOUR
DAY
WEEK
MONTH
YEAR
OIL SHEEN VARIATIONS



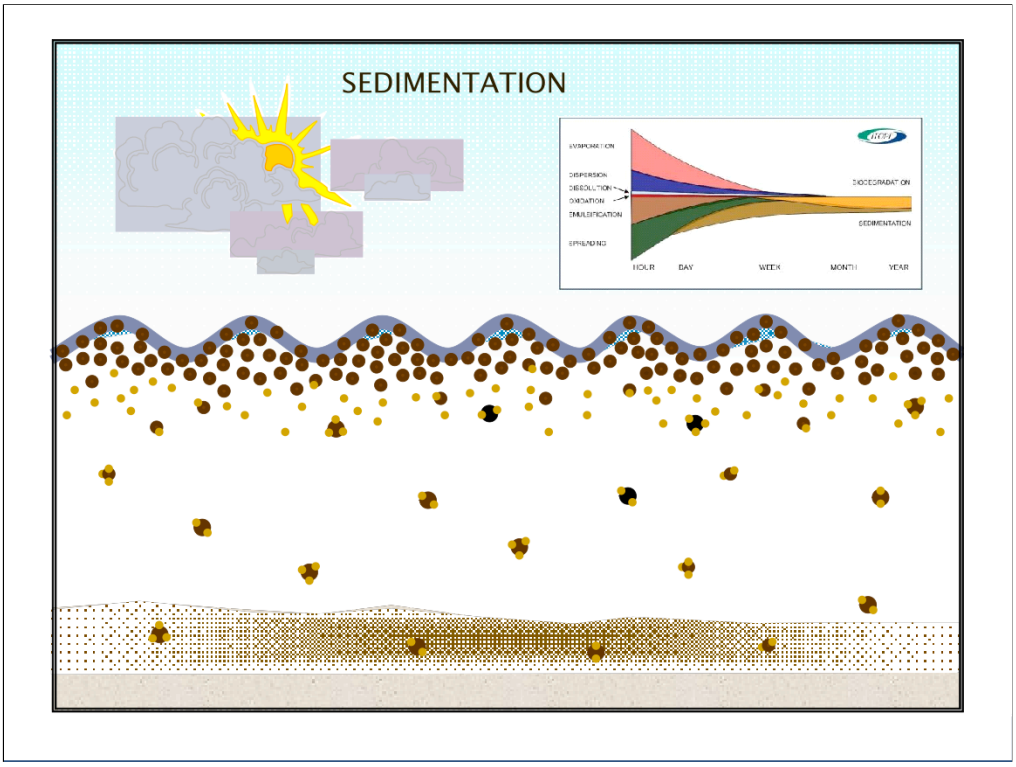
- Long term process and continues as oxidation and biodegradation produce additional soluble compounds



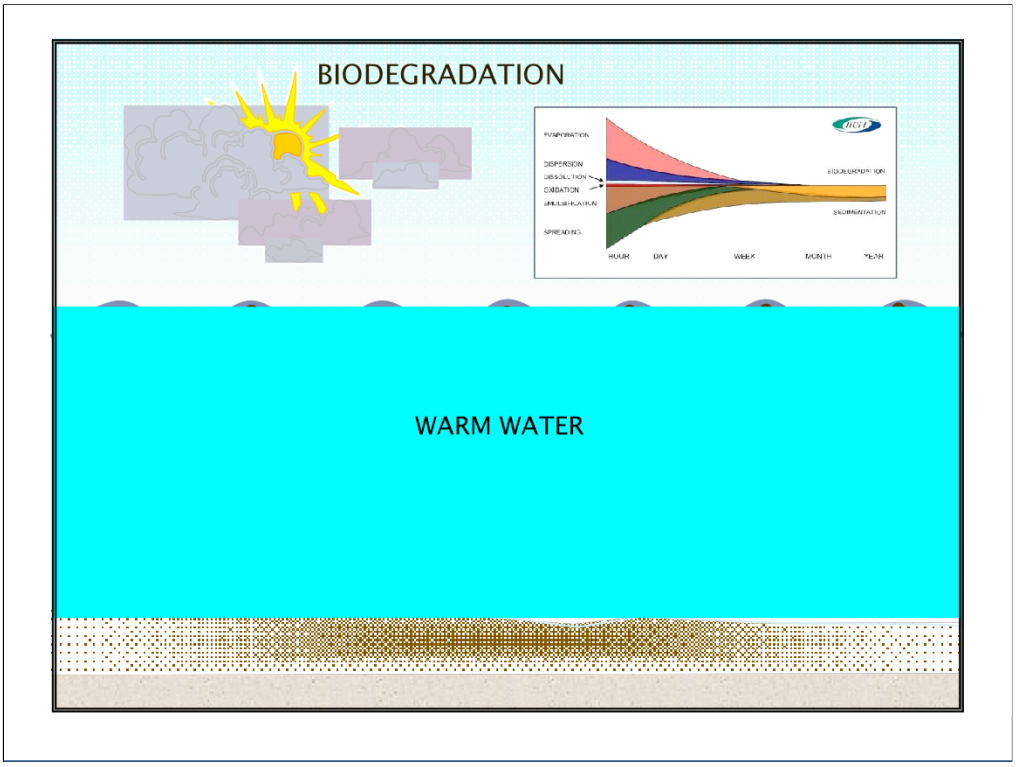
- Chemical combination of hydrocarbons with oxygen



- Process by which one liquid is dispersed into another liquid in the form of small droplets



- Oils may adhere to sediments in water
- Addition of sediment to oil may cause oil to sink

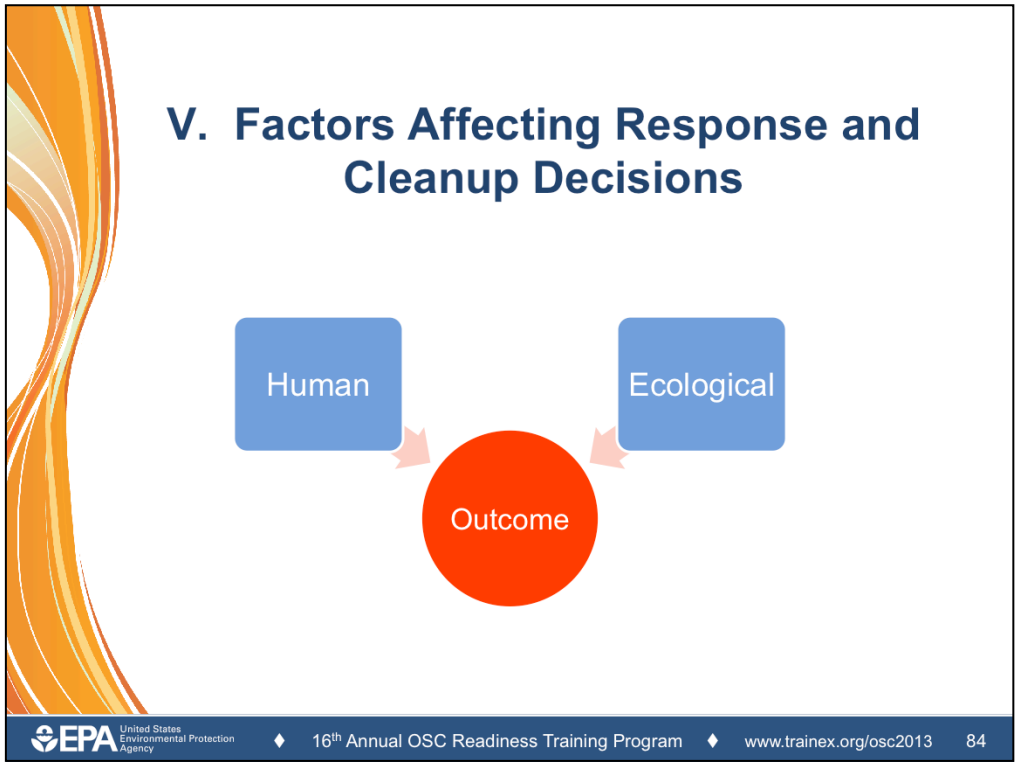


- Oil degrading microbes are present in all aquatic environments to some extent
- Rate depends on temperature, nutrients, adequate substrate


TIME FOR QUESTIONS

AGENDA

- Course Overview
- I. Statutory and Regulatory Authority
- II. Oil Spill Liability Trust Fund
- III. What is Oil?
- IV. Fate and Behavior of Oil in the Environment
- V. Factors Affecting Response and Cleanup Decisions



- This section draws information together from a **wide variety of sources and experiences**

- Will consider both **human** and **environmental** factors

Human

- Health
  - Type of product released
  - Location of release
  - Media affected by release
  - Weather

• **No. 1: Avoid restricting access and prolonged closures** (continue to conduct business activities)

• **No. 2: (1)** Setting the command structure; **(2)** speed of establishing command; **(3)** decision-making outside the command structure; **(4)** appropriate role of a responsible party; **(5)** allocation and management of resources; **(6)** costs; **(7)** role of federal, state, local, and tribal governments

• **No. 3:** Institutional pressures (governments, regulators, customers, competitors, community, interest groups, industry groups) impose coercive and normative pressures on companies, which in turn influence organizational characteristics such adoption of environmental management practices and performance beyond regulatory compliance

• **No. 4: Varies considerably** from one incident to another depending on a number of interrelated factors including:

- Type of oil; location of the spill and characteristics of affected area; quality of contingency plan; management and control of response operations

- Often rely predominantly on “hindsight” (examine historical spill cost data, if available); concern for both predictable and unpredictable circumstances as they play themselves out

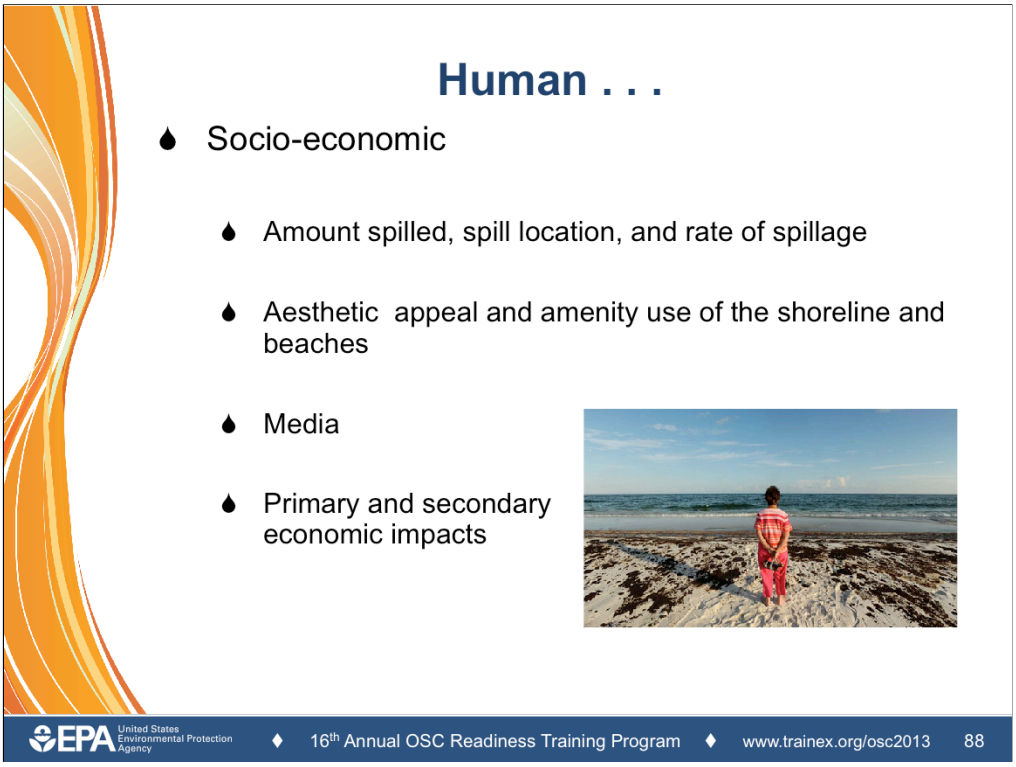
- **No. 1:** Internal and external agency constraints/initiative/policy

- **No. 2:** **(1)** Statutory and regulatory framework; **(2)** influence of existing agreements

- **No. 3:** Coordination/interaction of federal, state, local, and tribal agencies with different legal, geographic, and functional responsibilities

- **No. 4:** Perceptions of **(1)** control; **(2)** appropriate role of responsible party; **(3)** role of state and local and tribal governments; **(4)** how clean is clean

- **No. 5:** Such groups may press for aggressive responses on oiled shorelines (off-shore, near shore, shoreline) despite evidence that such operations can cause greater long-term environmental damages



- **No. 1:**

  - Some areas will be of **high** regional, national, or international importance, whereas others will rank as **locally** important

  - **Seasonal differences** will also occur in the sensitivity of these resources to an oil spill, and therefore the economic impact of the incident (e.g., salmon spawning run)

- **No. 2:**

  - Is the affected area aesthetically and recreationally pleasing or has the experience been degraded?

- **No. 3:**

  - One v. many spokespeople

  - Communications tactics are not may not be directly transferable across mediums

  - Consider the ethics of social channels

- **No. 4:**

  - Loss of income

  - Substitute income: **(1)** Primary: Wages or taxes earned resulting from cleanup activities; **(2)** Secondary: Buy products from local suppliers and purchase transportation and other services from local companies

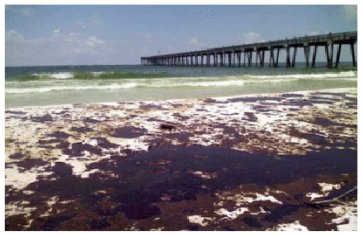
- **1st Statement**: Lighter oils tend to evaporate and degrade very quickly; heavier oils tend to form thick oil-and-water mixture which clings to rocks and sand

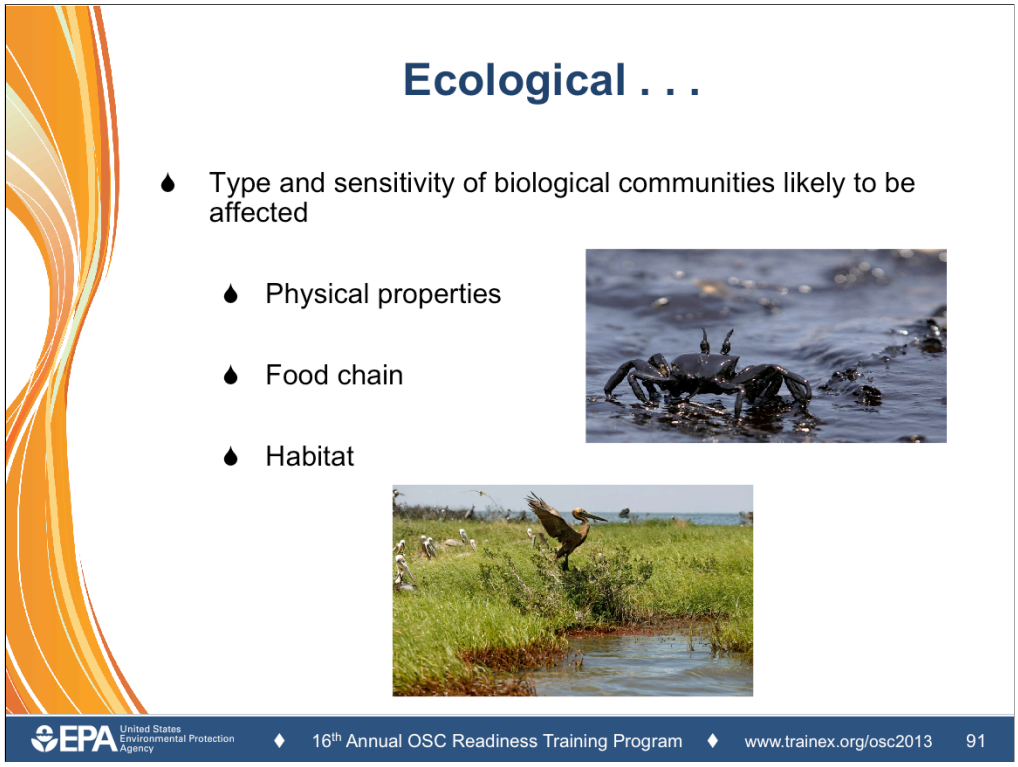
- **2nd Statement:** Rain forest

- **3rd Statement:** Oil tends to stick to sediments and surfaces of cobbles and pebbles; Standing or slow-moving water is more likely to incur severe impacts than flowing water

Ecological . . .

- Weather





• **No. 1:** Animals and plants may be affected by physical properties of spilled oil (e.g., form surface sheens, sludge's, emulsions, soluble fractions of oil) which prevent respiration, photosynthesis, or feeding

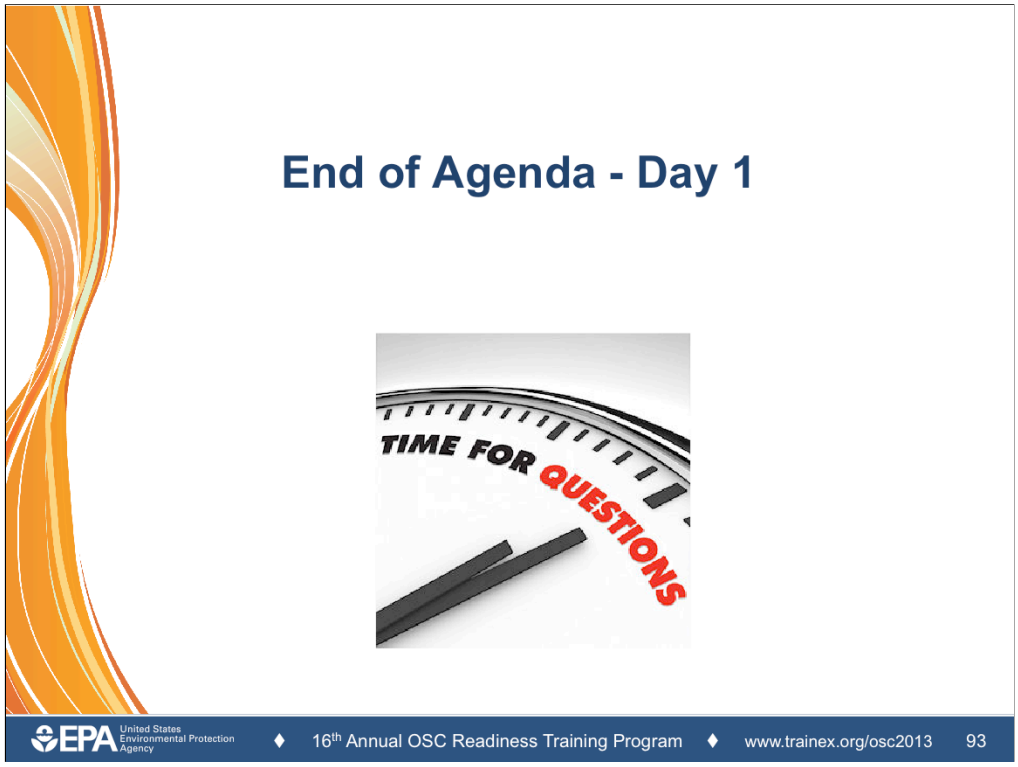
- Asphyxiation of fish and benthic fauna due to **coating by oil**; harm to waterfowl because of **loss of buoyancy or loss of insulating capacity of feathers**

- May cause fish kills due to increased biological oxygen demand and/or “closing” the air water interface where gas exchange occurs

• **No. 2:** May be toxic to some animals and plants which other organisms may depend on for food

Ecological . . .

- Species of wildlife present
- Timing of breeding cycles and seasonal migration



- Comment regarding the trilogy of courses v. a stand alone course and the need to address the “basics”

Certificates

- If you are interested in receiving a certificate for participating in this training, please send an email to Austin Oelschlager, Tetra Tech at austin.oelschlager@tetratech.com

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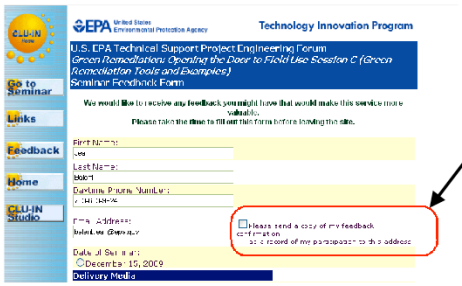
Resources & Feedback

- To view a complete list of resources for this seminar, please visit the **Additional Resources**
- Please complete the **Feedback Form** to help ensure events like this are offered in the future



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